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February 17, 2022

Coalition to Reduce Electropollution
126-102 Forestbrook Place
Penticton, BC V2A 7N4

Attention: Mr. Hans Karow

Dear Mr. Karow:

**Re: FortisBC Energy Inc. (FEI)**

**Project No. 1599211**

**Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project (Application)**

**Response to Coalition to Reduce Electropollution (CORE) Information Request (IR) No. 2**

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On May 5, 2021, FEI filed the Application referenced above. In accordance with the regulatory timetable as amended in British Columbia Utilities Commission Order G-389-21 for the review of the Application, FEI respectfully submits the attached response to CORE IR No. 2.

If further information is required, please contact the undersigned.

Sincerely,

**FORTISBC ENERGY INC.**

***Original signed:***

Diane Roy

Attachments

cc (email only): Commission Secretary
Registered Parties

**CORE-FEI-2022JAN13-001**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 5, lines 6 - 11**

Issue: The Project will replace most existing customer meters with advanced meters, retrofit those meters that are not replaced with AMI communication modules, and install associated AMI network/infrastructure to support delivery of hourly gas consumption and other metering information from the advanced meters/modules at customer premises, back to FEI. Communication modules will also be installed on the gas network and pipeline assets to enable the remote collection of information on FEI's gas system integrity.

1.a Please advise what qualifications will be necessary to ensure that FEI contractors or staff are fully trained.

**Response:**

Please refer to the responses to BCUC Confidential IR1 1.3 and 1.5.

**CORE-FEI-2022JAN13-002**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 12, lines 21-23**

Issue: FEI has the technical capacity to undertake the Project, having extensive experience in testing and, where required, replacing, on average approximately 60,000 meters in accordance with Measurement Canada requirements each year.

2.a Please provide the name(s) and credentials of FEI's Professional Engineers of Record for this project, along with their professional affiliation.

**Response:**

Any specific engineering work undertaken within the AMI project will be signed off by a professional engineer as required by Engineers and Geoscientists of BC. At this time FEI has not assigned specific persons to these duties and is therefore unable to provide names or titles.

**CORE-FEI-2022JAN13-003**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 12, lines 24 - 28**

Issue: FEI operates a Measurement Canada-accredited meter test facility allowing the Company to manage all aspects of FEI's gas meter fleet and of the electric meter fleet of FBC internally, including administering each utility's respective compliance sampling and testing program, completing meter maintenance and leading the annual meter exchange program.

3.a Please advise how FEI will ensure that the proposed meters are accurate given the meters are software driven and the software can be readily changed remotely at any time without the customer knowing that changes are being made.

**Response:**

Meter parameters (settings) deemed critical to measurement accuracy are considered "under the seal" and cannot be updated remotely.

Measurement Canada documents S-EG-02 *Specifications for approval of physical sealing provisions for electricity and gas meters*[1] and E-G-05 *Specifications for the approval of software controlled electricity and gas metering devices*[2] establish the meter design, construction, performance, and sealing[3] / security requirements for the approval of software-controlled electricity and gas meters. Any changes to software or parameters "under the seal" is deemed a verification triggering event and is equivalent to breaking the device's seal, rendering the meter unable to be used for billing purposes. The Sensus SonixIQ meters will require approval and certification as per these specifications.

3.b Please advise how FEI will ensure that the measurement accuracy of any meter will be maintained over all of the operating conditions.

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1 https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00588.html.
2 https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04533.html.
3 Measurement Canada Specification S-EG-2 provides the following definitions for "seal" and "sealing":

Seal - A physical mechanism that is used to secure access to a meter's metrological adjustments and legally relevant parameters so that access or changes to metrological adjustments and legally relevant parameters will be detectable.

Sealing - An action performed in order to secure a device. Securing a device includes, but is not limited to, sealing a cover to the base of an electricity meter, sealing an enclosure containing a multiple customer metering system, sealing adjustment chamber ports on a gas meter and sealing one meter module to another meter module (such as a temperature compensating module to a rotary meter).

**Response:**

The advanced meters proposed for the Project will be subject to the accuracy verification program mandated by Measurement Canada as described in PS-G-06 *Provisional specifications for the approval, verification, reverification, installation and use of ultrasonic meters*[4] and S-G-03 *Specifications for the approval of type of gas meters, ancillary devices and associated measuring instruments*.[5] This program mandates rigorous accuracy testing over a range of operating conditions prior to installation of the advanced meters and regular accuracy verification testing throughout the service life of the meters. In addition, as described in Sections 3 and 5 of the Application, the advanced meters will provide diagnostic information that will provide alarms to FEI regarding any performance issues in near-real time that may impact measurement performance.

4 https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm00156.html.
5 https://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/lm04861.html.

**CORE-FEI-2022JAN13-004**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project, Exhibit B-10, page 18, lines 3-8**

Issue: The exposure limits specified in Safety Code 6 have been established based upon a thorough evaluation of the scientific literature related to the thermal and non thermal health effects of RF fields. Health Canada scientists consider all peer reviewed scientific studies, on an ongoing basis […] The exposure limits in Safety Code 6 are based upon the lowest exposure level at which any scientifically established adverse health effect occurs.

4.a Please provide a list of the scientific literature and peer reviewed scientific studies relied upon.

**<u>Response:</u>**

The referenced lines in the preamble from Exhibit B-10 (FEI Response to CORE IR 1.15.2) are a direct quotation from Safety Code 6. The reference to “scientific literature” and “all peer reviewed scientific studies” are those that Health Canada scientists considered and used to establish the exposure limits in Safety Code 6. FEI does not have access to a list of all scientific literature and peer reviewed scientific studies Health Canada’s scientists relied upon and is not aware of public dissemination of such a list, although Safety Code 6 itself contains a References list including 64 secondary source publications.

The following additional response has been provided by Exponent.

The referenced excerpt from Safety Code 6 states that Health Canada scientists perform a “thorough evaluation of the scientific literature related to thermal and non-thermal effect of RF fields” and “consider *all* peer-reviewed scientific studies, on an ongoing basis, and employ a weigh-of-evidence approach when evaluating the possible health risks of exposure to RF fields”. This body of literature and peer-reviewed scientific studies would contain thousands of scientific papers in which exposures were applied at levels both above and below the RF exposure limits referenced in Safety Code 6. Please also see response to CEC IR 2.123.1.1. Consult Safety Code 6 (2015) and other Health Canada communications about RF as well as the TheRoyal Society of Canada Expert Panel’s report *“A Review of Safety Code 6 (2013): Health Canada’s Safety Limits for Exposure to Radiofrequency Fields”* Spring 2014 to review the peer-reviewed literature they identified for Health Canada in their most recent review, and reviews of the scientific literature contained in previous editions of Safety Code 6 and in reviews provided by The Royal Society of Canada to Health Canada in 1999, 2003 and 2007.

**CORE-FEI-2022JAN13-005**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 25 lines 22- 23 and page 26 lines 9-13**

Issue: Finally, customer complaints associated with manual meter reading activities average over 500 complaints per year as shown in the table below (for the five- year period 2016 through 2020).

As described in the sections above, there are multiple limitations and challenges associated with manual meter reading. These include a higher level of estimated bills that result in bill inaccuracies and customer experience challenges, and regular access to customer premises that can be inconvenient for customers and result in complaints and dissatisfaction for some customers.

5.a Please advise whether or not this approach would accomplish the same safety of meter readers and convenience to customers at a significantly reduced cost.

**Response:**

FEI is unclear on what "this approach" is referring to in the question. FEI interprets this IR as asking whether the AMI Project would improve both safety for meter readers, and convenience to customers, at a significantly reduced meter reading cost.

Please refer to Section 4.3.2.1 of the Application for details regarding how AMI improves safety for meter readers and convenience to customers.

Please refer to Section 6 of the Application for details regarding the Project costs.

5.b Assuming there are an average of 500 complaints per year (out of 1.1 million customers – less than 0.05%), please provide any information, facts, or evidence that the proposed technology would justify the costs.

**Response:**

FEI interprets this IR as requesting information, facts, or evidence that the proposed technology is justified given the number of customer complaints associated with manual meter reading activities.

FEI has not based its Application on the number of customer complaints associated with manual meter reading activities.

FEI has defined the need for the Project to be to automate the meter reading function. This is described fully in Section 3 of the Application where FEI sets out the four drivers for that need to be:

- Automation is more accurate and convenient for customers than FEI's current meter reading practices, which are highly manual and are vulnerable to errors, and can be inconvenient for customers;
- Automation is becoming the industry standard, thereby changing both market conditions and customer expectations;
- Automation alleviates the cost and service risks of manual reading and provides a cost-effective, long-term alternative; and
- Automation provides additional customer benefits as well as operational opportunities that support the safety, resiliency and efficient operation of the gas distribution system.

5.c Please advise what percentage of overall complaints were associated with manual meter reading activities?

**Response:**

FEI interprets this question as asking what percentage of overall complaints received were associated with manual meter reading activities in each of the years 2016 to 2020 referenced in Table 3-7, and provides that information in the table below.

| Year | # of Complaints[6] Received for Manual Meter Reading | Total # of Complaints Received | Manual Meter Reading Complaints as % of Total |
| --- | --- | --- | --- |
| 2016 | 454 | 1232 | 37% |
| 2017 | 528 | 1661 | 32% |
| 2018 | 540 | 1791 | 30% |
| 2019 | 599 | 1808 | 33% |
| 2020 | 562 | 1560 | 36% |

Please refer to the response to CORE IR2 5.b and Section 3 of the Application for a summary of the Project need and drivers and how they are impacted by this data.

[6] Complaints refer to the complaint cases created annually.

5.d Please advise what metrics FEI employs to determine when a manual reading is inconvenient for a customer.

**<u>Response:</u>**

FEI does not currently employ metrics to determine when a manual meter reading is inconvenient for a customer.

Please also refer to Section 3.1.3 of the Application where FEI describes how automation can improve convenience to customers.

**CORE-FEI-2022JAN13-006**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 54, lines 30 - 32**

Issue: AMI is a metering system that records customer consumption, meter diagnostic information and other field data on an hourly or more frequent basis and transmits the data multiple times during a 24-hour period over a two-way communication network from the meter to the utility.

6.a Please provide what “other field data” is mentioned above and explain what is or might be done by FEI and others with this data. Please provide the names of the third parties that may be provided with this data.

**Response:**

For customer meters, other field data, as quoted in the question would include temperature and/or gas pressure readings at the meter.

With respect to the FEI assets on the gas transmission and distribution systems, the AMI system would also collect pressure, temperature, and level information and cathodic protection system data as discussed in Sections 4.3.2.4.7 and 4.3.2.4.8 of the Application.

FEI may use this data for system operations troubleshooting, preventative maintenance, and verification of billing parameters. “Other field data” does not include data containing personal or private information. FEI does not expect to provide this data to third parties, excepting any entities who may be performing relevant work for FEI or as required or permitted by law.

6.b Please advise why it is necessary to have hourly or a more frequent basis for data transmission?

**Response:**

Please refer to Sections 4.3.2.2, 4.3.2.4.2 and 4.3.2.4.6 of the Application for a description of benefits which are only achievable with hourly consumption readings. Therefore, FEI has developed the Project to enable all customers within coverage of the network to benefit from hourly meter reading data.

With respect to consumption readings occurring more frequently than hourly, some industrial and commercial customers desire near real-time consumption information for their own internal energy management systems. As described in the response to CEC IR1 59.2, this functionality is provided by a direct connection to the meter not through the AMI system. FEI does not know at this time how many industrial and commercial customers will use this functionality.

6.c Please advise how many individual transmissions, and pulses, are received and emitted by the AMI meters during a 24-hour period.

**Response:**

As discussed in Appendix F-1 of the Application, the advanced meters will transmit readings six times per day with an additional three transmissions per week under normal conditions. This does not include transmissions that occur as a result of alarms, on-demand meter reads, or remote disconnects/reconnects (the latter two of which would need to be manually initiated by FEI) and are only expected to occur infrequently.

FEI notes that these individual transmissions can also be characterized as pulses. This term is used in engineering to distinguish between infrequent, short-duration transmissions (such as those emitted from the advanced meters and other commonplace wireless digital devices) and continuous-carrier transmissions that would generally transmit for much longer periods of time.

6.d Please advise what percentage of FEI's customers would need hourly or minute-by-minute use data of their natural gas consumption?

**Response:**

Please refer to the response to CORE IR2 6.b.

6.e Please advise why field data would need to be transmitted by radio multiple times in the span of 24 hours.

**Response:**

Field data from customer meters needs to be transmitted by radio multiple times in a day because the data provides important operational information to FEI, and because that is the most efficient way to transmit it.

The field data provides important operational information to FEI on its distribution system performance. Since each data transmission requires a small amount of overhead to identify the meter and provide error checking capabilities, it is most efficient from an RF transmission point of view that this data comes back with the consumption data, thereby reducing the total duty cycle of the transmitter.

Please also refer to the response to CORE IR2 6.a.

**CORE-FEI-2022JAN13-007**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 54, lines 37-38**

Issue: Finally, similar to AMR, the AMI technology is expected to offer a 20-year service life limited largely by the capacity of the battery.

7.a Please advise what threat, if any, is associated with lithium batteries, including fire threats.

**Response:**

FEI's proposed advanced meter is powered by a lithium thionyl chloride battery. This battery is encased in a gel-filled container, ensuring oxygen cannot reach the battery thereby eliminating risk of ignition. The meters are designed, tested, and certified to meet Canadian Standards Association requirements.

This battery technology has been used safely by gas utilities across North America for over 30 years, including in many existing FEI gas meters and other field devices.

7.b Please advise what information is being provided to the public regarding the environmental ramifications of a lithium battery.

**Response:**

FEI recycles used lithium batteries through Call2Recycle, the official provincial battery-recycling program. Call2Recycle recovers valuable metals from the lithium batteries which are used to manufacture new products. FEI does not provide information to its customers or the general public about lithium batteries.

7.c Please advise what, if any, are the environmental ramifications of a lithium battery from the source of extraction to the destruction or storage.

**Response:**

Please refer to the response to CORE IR2 7.b for information on FEI's lithium battery recycling practices.

**CORE-FEI-2022JAN13-008**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 55, lines 14-16**

Issue: FEI's AMI alternative would include the installation of two-way network infrastructure to support wireless delivery of data between both the advanced meters and other field devices and FEI's existing enterprise information systems.

8.a Please advise what other FEI "field devices" and what "existing enterprise information systems" are being referred to in the statement above.

**Response:**

Please refer to Section 5.4.1 of the Application which describes the field devices, and Figure 5-1 which contains the enterprise systems in the block labelled "FEI Enterprise Systems".

**CORE-FEI-2022JAN13-009**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 56, lines 6-7**

Issue: Automation alleviates the cost and service risks of manual reading and provides a cost-effective, long-term alternative

9.a Please provide what the definition of “long-term” is in terms of years.

**Response:**

FEI notes the sentence cited in the preamble was intended to recognize that automation will largely alleviate or eliminate the risks of manual meter reading and the associated costs of errors resulting from manual reading. Given that the expected service life of the advanced meters is 20 years, FEI considers advanced meters will alleviate the risk of manual reading for at least 20 years.

9.b Please advise whether the constant upgrading of the infrastructure has been considered in FEI’s assertion stated above.

**Response:**

FEI clarifies that the statement cited in the preamble above is referring to the capability and advantages of AMI meters over existing diaphragm meters that require manual reading. Although AMI meters as well as the associated infrastructure will require upgrading in the future, FEI notes that this is also true for existing meters and infrastructure, which also require periodic upgrading through FEI’s sustainment capital program. FEI notes that, as discussed in Section 4.3.2.3 in the Application, AMI meters will help FEI manage the long-term risk of existing diaphragm meters becoming obsolete as meter manufacturers continue to transition to ultrasonic meters.

9.c Please advise whether it would be possible for the refurbishment of the current manual meters and if so, whether this could be done in BC. If so, would refurbishment of the current manual meters reflect a reduction in costs for customers, as opposed to the international manufacturing of the AMI meters by Sensus in China or Olameter.

**Response:**

FEI currently completes maintenance on meters where appropriate to minimize the total lifecycle cost of operating the meter fleet.

As described in Section 3 of the Application and reiterated in the responses to BCSEA IR1 6.1, BCUC IR1 22.1 and 22.3, and BCOAPO IR1 5.1, continuing to operate the meter fleet with the current meters does not address the Project need to automate the meter reading process for all FEI customers. The deployment of AMI technology will alleviate the cost and service risks currently within the market place; it will provide operational opportunities that advance safety and system resiliency of the gas distribution system; and it will allow FEI to meet the expectations of customers about their energy information and the experience they are looking for today.

With respect to the manufacturing location of the AMI meters, the Sensus SonixIQ meter is manufactured in Dubois, Pennsylvania.

**CORE-FEI-2022JAN13-010**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 56, lines 16-18**

Issue: An AMI alternative would allow FEI to fully automate the manual meter reading function by enabling the Company to collect hourly meter reads six or more times per day over a fixed 18 communication network.

10.a Please advise whether FEI can increase the number of collection reads done per day.

**Response:**

While it is technically possible to increase the number of times the system will collect/transmit the hourly interval reads per day, FEI's proposed AMI system will be configured for a maximum of six transmissions for system efficiency and to maximize the battery life of the meters.

10.b Please advise what is the maximum number of hourly meter reads that can be completed in one day.

**Response:**

FEI assumes that this IR is requesting how many times per day the proposed AMI system can collect/transmit hourly meter reads, instead of the maximum number of hourly meter reads that can be completed in one day (which is limited to 24 due to the total number of hours in a day). Please refer to the response to CORE IR2 10.a.

10.c Please advise whether customers will be required to pay for the power consumed by the meters?

**Response:**

Please refer to the response to ICLR IR2 1.10.

10.d Please advise what, if anything, can limit the amount of radiation emitted by the meters?

**Response:**

As explained in the response to BCSEA IR1 33.1, the SonixIQ meters and SmartPoints are powered solely by a sealed battery pack consisting of either one or two “C” or “D” sized cells. Consequently, this small battery pack contains the total amount of energy required over the 20-year service life of the meter to:

a) continuously operate the meter electronics (measurement and processing);
b) actuate the shut-off valve, when necessary;
c) continuously power the wireless receiver; and
d) intermittently power the wireless transmitter (to broadcast the meter readings).

The relatively small amount of energy that can be stored in this battery pack places a significant physical limitation on the magnitude of RF emissions. To ensure successful long-term operation under these constraints, the number, duration, and intensity of RF transmissions must be minimized.

While nothing has been identified at this time that could further reduce the meter RF emissions, the constraint on the amount of power available has already ensured that Sensus has developed the FlexNet protocol to be as efficient as possible with respect to RF transmissions. It will also ensure that if opportunities are presented in the future to increase this efficiency, both Sensus and FEI are heavily incented to do so (to preserve the lifespan of the battery pack).

10.e Please advise if FEI has factored in the impact of power failures regarding the efficacy of AMI.

**Response:**

FEI has considered the impact of power failures on the AMI System. Please refer to the responses to BCOAPO IR1 8.2, ICLR IR2 1.10, and CEC IR2 109.2.

**CORE-FEI-2022JAN13-011**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 56, lines 18-22**

Issue: Although a small number of reads would still need be collected manually to accommodate customers that choose to have their advanced meter read manually (estimated to be 2 percent) or for those meters that are located in areas where it is not economically feasible to install a fixed network (estimated to be 1.5 percent), AMI would significantly reduce the need for manual meter reading services.

11.a Please advise of the economic feasibility if FEI’s estimated number of customers who will require manual meter reading is greater than 1.5 - 2%.

**Response:**

FEI’s AMI Project is not dependent on the percentage of customers who will continue to require manual meter reading being limited to 1.5 - 2 percent. Please refer to the response to CORE IR2 5.b where FEI restates the need for the Project is to automate the meter reading process, and reviews the associated drivers.

Please also refer to the response to BCUC IR2 45.3, where FEI estimates that the impact due to changing the assumption of network connectivity issues from 1.5 to 5 percent is small. Other customers may require manual meter reading because they choose to have their AMI meter set to radio-off. These customers who choose to opt out will be charged for their manual meter reads and thus their choice will have no financial impact on the Project.

11.b Please advise what measures, if any, will FEI use to read metres in the geographic areas where WiFi reception is poor, unreliable and/or impractical?

**Response:**

FEI’s proposed AMI System does not use WiFi for communications, and is unaffected by poor WiFi reception anywhere in FEI’s service territory. However, in areas outside of AMI network coverage, those meters would be read manually as discussed in Section 4.3.3.1 of the Application and in the response to BCUC IR1 9.3.1.

11.c Please advise what data encryption, if any, FEI will use to ensure compliance with existing privacy legislation such as the Personal Information Protection Act, SBC 2003, c 63.

**Response:**

Please refer to Sections 5.8.2 and 5.8.3 of the Application, and the responses to BCUC IR1 19.3, CEC IR1 66.2, and RCIA IR1 43.2 for a discussion of the security mechanisms to be used by FEI to protect the AMI data.

**CORE-FEI-2022JAN13-012**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 57, lines 6-10**

Issue: Finally, AMI would provide environmental benefits by reducing vehicle usage. Overall, vehicle usage would decrease by approximately 90 percent as meter readers driving to collect regular meter reads and off-cycle reads would be replaced with the collection of meter reads through a fixed network. This reduction in vehicle usage is estimated to create a net reduction in GHG 10 emissions by 1,100 tCO2e.

12.a Please provide any evidence, including any research studies, that support the above statement regarding the environmental benefits of AMI regarding reduced vehicle usage.

**Response:**

The estimated GHG savings cited in the preamble were calculated using information related to FEI's existing ongoing meter reading activities. As discussed in Section 3.1.1.5 of the Application, this calculation is based on the need for 150 meter readers to cover FEI's service territory, each driving an average of 35,000 km per year.

FEI used published data from the International Energy Agency on average vehicle fuel efficiency in Canada, combined with the number of vehicles used by the contractor to derive the estimated GHG savings from the Project.

12.b Please provide any research studies that indicate what, if any, deleterious effects of RF are on the environment.

**Response:**

The following response has been provided by Exponent.

The question would require significant research to address in detail, involving potentially thousands of published studies, which we consider would have limited to no value to the assessment of studies at levels similar to those produced by the FlexNet Metering system. In the main, broad reviews of interactions of RF fields with organisms of many species, largely synonymous with what we understand is meant by the term 'environment' in this information request, have not confirmed adverse effects at RF levels at or below those produced by the FlexNet Metering system.

This is consistent with the BCUC's decision regarding FortisBC Inc.'s AMI Project in 2013, which concluded based on the scientific evidence presented at the time, that "the Panel is not convinced that RF fields produced by the Project would have adverse effects on the natural habitat" (p. 151).

12.c Please provide the evidence that would demonstrate the environmental benefits of reduced vehicle usage compared with the potential environmental impacts with the use of lithium batteries.

**Response:**

FEI is not able to directly compare the environmental benefits of reduced vehicle usage and the purported environmental impacts of the lithium batteries that will be used in the proposed AMI Project.

As cited in the preamble, the AMI Project will reduce vehicle usage for meter reading purposes by 90 percent, which will have clear environmental benefits through reduced fuel usage and the associated GHG emissions.

As noted in the response to CORE IR2 7.b, FEI responsibly recycles lithium batteries through the province's Call2Recycle battery recycling program.

12.d Please advise what environmental policy, if any, FEI has implemented or will implement with respect to the proposed smart meters. If such a policy has been implemented, please provide a copy same.

**Response:**

Currently, FEI responsibly recycles all of its existing meters and the proposed advanced meters will be included within this program.

The following is FEI's Safety and Environmental Policy:[7]

> FortisBC's vision is to ensure that our employees return home safely every single day.

[7] https://www.fortisbc.com/about-us/corporate-information/safety-environmental-policy.

FortisBC recognizes that sound safety and environmental practices make good business sense. Employees are expected to work safely and to protect their health—along with the health and safety of others—and the natural environment during the course of their work, by following established policies, rules, and procedures. The company will not compromise employee and public safety, and strives for excellence in safety performance.

The company is committed to delivering safe, reliable energy in an environmentally responsible manner to all of the communities that we serve.

The company shall:

- comply with safety and environmental legislation, and operate in accordance with accepted industry practices and standards, and require the same of our contractors
- commit to injury and incident prevention, the conservation of resources, and the prevention of pollution
- identify and manage operational hazards, and minimize risks that have the potential for adverse consequences
- train employees to be aware of and meet their responsibilities in the areas of safety and environmental stewardship
- communicate openly with employees, the general public and all stakeholders about our activities and the potential impacts on our safety and environment
- support community-oriented safety and environmental initiatives and programs
- review the safety and environmental policy on a regular basis, regularly monitor our safety and environmental performance, and strive for continual improvement

12.e Please advise whether FEI has included the overall costing for the following in their calculations: manufacturing, production, and disposal of outdated meters.

**Response:**

FEI confirms that the full cost of the meters that will be removed and installed during the life of the Project and the disposal cost of all the removed meters are included in the AMI financial model.

**CORE-FEI-2022JAN13-013**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 57, lines 21-26**

Issue: The availability of hourly consumption data to customers and FEI would open up new opportunities for DSM [Demand Side Management] programs, including: Near real-time consumption reports to enhance commercial and industrial energy assessments, home energy reports for residential customers, measurement and verification activities and DSM program evaluation.

13.a Please confirm what "real-time consumption reports" means and the frequency of issuance of said reports (i.e., 12 times per day).

**Response:**

The real-time consumption reports cited are on-demand reports that can provide customers with energy use data over short intervals (e.g., daily or hourly).

FEI has not yet developed the specifics for a program, offering, or service that will provide near real-time consumption reports. The data stored in the AMI system will be sufficiently granular such that the frequency of consumption reports conceptually could occur multiple times a day. The reports would likely be offered at an interval that balances customers' needs for information and their ability to act on the data.

13.b Please confirm whether customers in rural settings will be able to access the same "near real-time consumption reports" as those who live in urban settings.

**Response:**

FEI confirms that if a program, offering, or service is developed to offer near real-time consumption reports for customers with gas AMI meters, the ability to access those reports would not differ between urban and rural settings.

**CORE-FEI-2022JAN13-014**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 57, lines 31-37**

Issue:

- Providing FEI with data to better characterize customer segments in order to make even more informed decisions when planning for future DSM programs. For instance, this data would help better inform the Residential End Use Study, Commercial End Use Study and Conservation Potential Review; and
- Gas AMI devices may be used to gather real-time data when conducting pilots and demonstrations for new natural gas saving technologies rather than FEI being required to purchase separate data loggers for this purpose.

14.a Please provide copies of the Residential End Use Study, Commercial End Use Study, and Conservation Potential Review.

**Response:**

Please refer to Attachment 14.a for the requested reports.

Please note that the use of AMI technology would not necessarily change the format of these reports. Instead, these studies would become better informed through more accurate data if AMI were in place.

14.b Please explain what is meant by the term “separate data loggers”.

**Response:**

A data logger is a device that records information at intervals over time. The information logged can include parameters such as pressure, temperature, voltage, or fluid level. In the context cited, the term “separate data logger” means that FEI currently would need to buy a distinct data logger for each site it wishes to record information at. In comparison, the communication network to be installed with the AMI Project will allow FEI to install low-cost sensors almost anywhere in the FEI service territory that can then send data back through the AMI System to be stored (logged) in a centralized database.

**CORE-FEI-2022JAN13-015**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 58, lines 22-27**

Issue: As gas meter manufacturers continue to focus resources toward development of AMI technology, the risk of technological obsolescence would be fully mitigated with the AMI alternative. Furthermore, as AMI technology is designed with a fully functioning two-way network, FEI's customers and the Company could benefit from future innovations such as potential enhancements to the meter capabilities through remote firmware upgrades, connection of new types of field devices to the network and increased capabilities through data analytics.

15.a Please advise what is meant by the words "toward development of AMI technology".

**Response:**

The words "toward development of AMI technology", in the context of the cited paragraph, refers to the fact that major gas meter manufacturers in North America are actively investing in research and development of AMI technology; this implies that this is potentially to the detriment of legacy technologies such as AMR or manually read diaphragm meters.

15.b Please advise what evidence FEI relies upon to support its assertion regarding the anticipated "technological obsolescence" indicated in the above statement that would be mitigated through the smart meter technology referenced in its application.

**Response:**

Please refer to the response to CEC IR1 24.1, RCIA IR1 24.1, and RCIA IR1 31.6.

15.c Please advise what "potential enhancements to the meter capabilities through remote firmware upgrades, connection of new types of field devices to the network and increased capabilities through data analytics" means.

**Response:**

The excerpt cited above was intending to convey that a two-way network can enable the proposed system to be enhanced in the future, as information (e.g., firmware, settings, data, new applications, etc.) can be both sent to and received from the meters and other network devices. This is in contrast to a one-way network that only allows data to flow from end devices to the system. Further, network devices and analytics applications requiring two-way connectivity that may be developed in the future would be able to be deployed without the need for a network upgrade.

**CORE-FEI-2022JAN13-016**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 60, lines 30-33**

Issue: AMI would enhance FEI’s understanding of the real-time behavior of gas consumers and the direct response of the gas system. In particular, improved understanding of customer usage patterns can be developed which would be used to support system design, improve utilization of peak resources and quantify capacity benefits of DSM activities on peak demand.

16.a Please advise whether knowledge of real-time behavior leads to time of use billing.

**Response:**

Please refer to the response to BCSEA IR2 35.1.

**CORE-FEI-2022JAN13-017**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 61, lines 12-17**

Issue: AMI would provide additional safety benefits through the near real-time use of alarms to alert FEI to issues at the meter. AMI technology would allow FEI to detect potential theft through anomalies in gas usage, tamper alarms, and other alerts communicated by the meter in near real-time as further described in Section 5.4.1.3. Awareness of the potential for theft in a timely manner would allow FEI to investigate sites and premises to assess if unauthorized alterations have created unsafe conditions.

17.a Please provide the evidence of the volume of natural gas that is subject to theft in an average year.

**Response:**

Please refer to the responses to CEC IR1 18.6 and 18.6.1.

17.b Please advise where in FEI's safety manuals and/or protocols the above information is included. Please provide a copy of FEI's safety manuals and/or protocols.

**Response:**

The requested updates to FEI's Criminal and Diversion Site Guidelines will be made during the Project planning phase, should the AMI Project be approved; consequently, the requested information is not available at this time.

**CORE-FEI-2022JAN13-018**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 61, lines 20-24**

Issue: The remote shut-off capabilities of AMI would provide FEI with the ability to enhance safety for customers, the public and employees when responding to emergencies such as gas leaks or structure fires. Advanced meters can detect large leaks downstream of the meter and be programmed to automatically shut off the internal valve, eliminating any potential for the development of a hazardous situation.

18.a Please advise how FEI intends to safeguard customers from inadvertent gas shut off.

**<u>Response:</u>**

FEI has processes in place to ensure that customers' gas service is not disconnected or reconnected inadvertently. These processes include criteria for determining when the gas service should be disconnected or reconnected, as well as multi-employee review and audits for confirmation. While these processes may need to be modified to account for the remote control capability, FEI expects those modifications will be minimal, and that gas service will not be disconnected or reconnected inadvertently.

Please also refer to the response to BCOAPO IR2 13.1.

18.b Please advise how FEI intends to safeguard customers from inadvertent "gas-on" restoration.

**<u>Response:</u>**

Please refer to the response to CORE IR2 18.a.

**CORE-FEI-2022JAN13-019**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 62, line 28**

Issue: AMI would provide FEI with the ability to offer enhanced billing options.

19.a Please advise whether one of the options referenced above would include real-time billing.

**Response:**

FEI interprets "real-time billing" to refer to the situation where a customer requests to be billed at a point in time, rather than on a regular billing cycle.

Please refer to Section 4.3.2.4.9 of the Application for details regarding the enhanced billing options that FEI will explore if the Project is approved. In addition, FEI may explore other options such as real-time billing in future.

19.b Please advise what is meant by "enhanced billing options."

**Response:**

Please refer to the response to CORE IR2 19.a.

**CORE-FEI-2022JAN13-020**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 63, lines 15-17**

Issue: FEI would also have certainty regarding its costs and supply of meters in the long-term. Additionally, customers and the Company would be able to benefit from

20.a Please provide the evidence that using a meter depending upon technology still being developed will provide certainty in terms of costs and supply of meters in the long-term.

**Response:**

FEI has negotiated a long-term supply contract (20+ years) with its AMI technology vendor, Sensus. In FEI's view this contract provides the certainty of cost and supply with respect to its meters.

20.b Please provide the cost, if available, for new generation meters.

**Response:**

Please refer to the response to RCIA IR1 16.1.

**CORE-FEI-2022JAN13-021**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 78, lines 21-28**

Issue: A Head End System (HES) is the back office that controls the advanced metering infrastructure. Sensus' HES application is the Regional Network Interface (RNI)™, a configuration of network software and servers that communicate with Base Stations to continuously gather and process data to store or forward to other AMI applications (Section 5.4.1.4). Through standards-based interfaces, the RNI enables integration with FEI enterprise systems. Standards-based interfaces ensure that applications can share data freely with one another in a way that has been designed and endorsed by a standardization group usually comprised of vendors, experts, users and other stakeholders.

21.a Please advise what specific data is being gathered by the AMI and shared freely.

**Response:**

FEI clarifies that the statement cited in the preamble and question relates to the sharing of data between FEI's internal computer systems, and does not imply the data will be available to external entities. FEI maintains and adheres to a strict privacy policy with respect to customer data and only discloses data as required or permitted by privacy law.

21.b Please advise what are the applications with which the data will be shared.

**Response:**

Please refer to Section 5.4.1 of the Application, specifically Figure 5-1 and Section 5.4.1.5, for a description of other enterprise systems with which the AMI system will share data.

21.c Please advise whether FEI has reviewed the interfaces and the standards upon which they are based. If yes, please provide the names of the vendors, experts, users, and other stakeholders who endorsed these interfaces?

**Response:**

FEI has reviewed the interfaces and standards referenced in the question. The main interfaces/standards that FEI expects to use for systems integration are Field Collection System (FCS), California Metering Exchange Protocol (CMEP), and MultiSpeak.

Although FEI does not have a list of vendors, experts, users or other stakeholders who have endorsed these interfaces, it is FEI's understanding that they have been adopted by and are in use at a significant number of utilities in North America.[8]

21.d Please provide the evidence of "standards-based interfaces" relied upon in FEI's application.

**Response:**

Please refer to the response to CORE IR2 21.c.

[8] "MultiSpeak® is the worldwide leading software interoperability standard and solutions for electric distribution utilities. MultiSpeak® facilitates data sharing between independent systems in a seamless, cyber secure, cost effective, and standardized way. Since 2000, MultiSpeak® has significantly saved both software vendors and utilities by simplifying software integration and minimizing expenses for custom interface solutions. MultiSpeak® is the only interoperability standard of its type listed in the NIST-SGIP Catalog of Standards. It is used in more than 800 plus electric cooperatives, investor-owned utilities, municipals, public power districts, water and gas utilities, universities and Department of Defense in more than 21 different countries worldwide." https://www.cooperative.com/programs-services/bts/Pages/MultiSpeak.aspx.

**CORE-FEI-2022JAN13-022**

**Reference: FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 79, lines 6-8**

Issue: The FlexNet communication network is the infrastructure that enables secure, dedicated (licensed radio-frequency spectrum) two-way data transmission between the End Points and Base Stations, and the HES.

22.a Please explain the basis for stating that the FlexNet communication system and the two-way data transmission system are secure.

**Response:**

The Sensus FlexNet communication system and the two-way data transmission system are secure as described in detail in Section 5.8.2 of the Application, and further explained in the responses to BCUC IR1 19.2, 19.3, 19.4, and 19.6.

The following response has also been provided by Sensus:

The FlexNet communication system provides end to end security layers including:

- Enterprise Data Center – Firewalls, DMZ, VPN’s;
- OS/App hardening, patching, A/V;
- Remote access, multi-factor authentication;
- Role based access control;
- Intrusion based detection/prevention, auditing/logging, SEIM;
- Redundant communication channels, disaster recovery; and
- Encryption, HSM, digital signatures, non-repudiation.

The FlexNet solution is designed and built from the ground up to provide end-to-end security protection. Sensus applies the top information security benchmark model to mitigate risks during the design, development, testing and operations of solutions. This process is guided by three elements 1) confidentiality, 2) integrity and 3) availability—also known as the CIA Triad.

Additional security protection is ensured through:

- Extensive independent third-party testing and certification;
- Application of industry standard processes and measures including NIST, SDLC and ITIL;
- Maintaining compliance of regulatory requirements;

- Continual threat prevention through patches, anti-viruses, firewalls and layered levels of encryption;
- Scrutinizing and deploying the latest cyber technology measures such as Blockchain;
- 24x7x365 data monitoring at secure Tier IV data centers; and
- 24x7x365 network monitoring at a world-class Network Operations Center (NOC).

**CORE-FEI-2022JAN13-023**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project, Exhibit B-1, Page 84, lines 23 – 26**

Issue: Sensus Analytics (SA) is Sensus' meter data management software application that stores, validates, and processes high volumes of data sent from End Points. Its data management tools aggregate information from multiple systems to produce bill-ready data for use by FEI enterprise systems.

23.a Please provide the flow charts describing how the meter software calculates the amount billed to the customer.

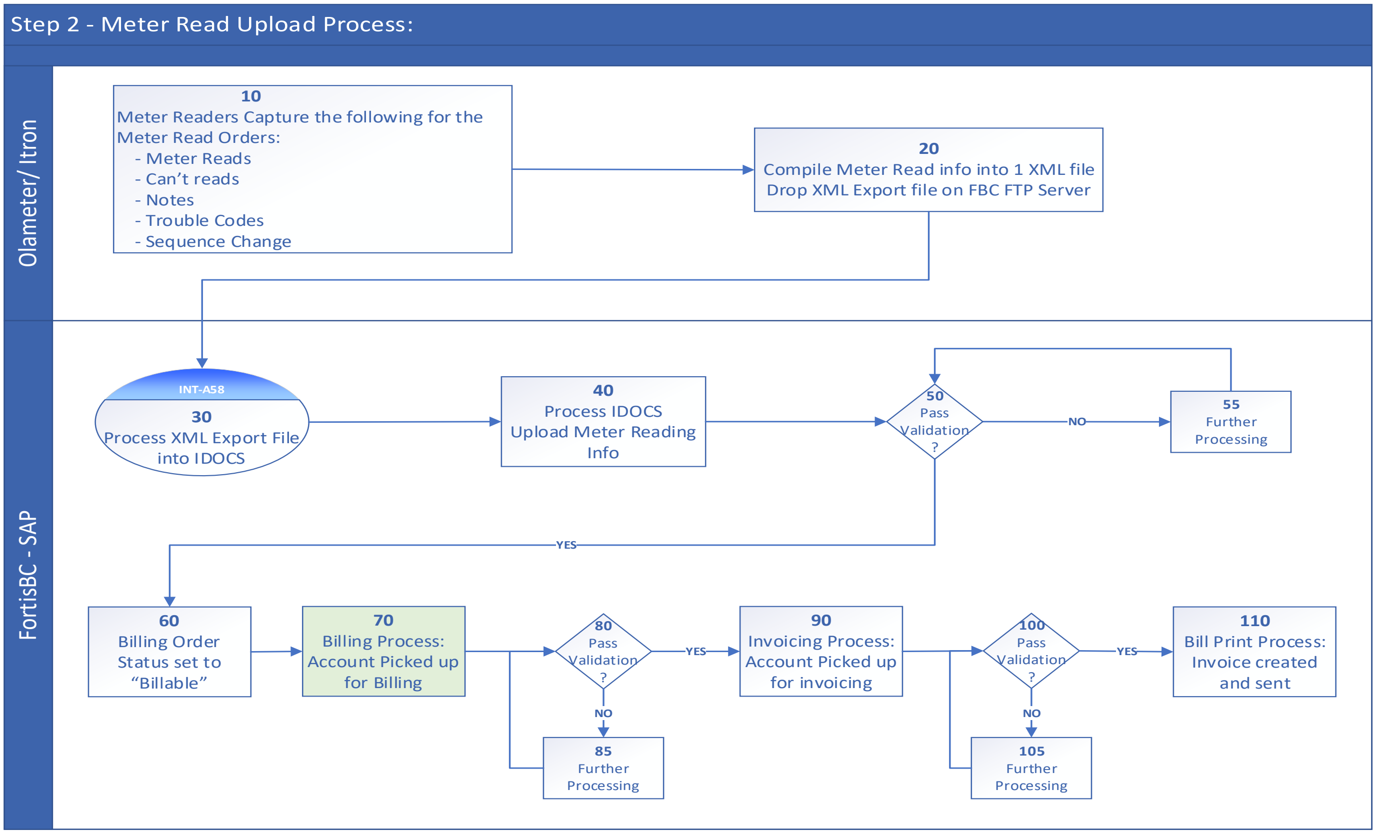
**<u>Response:</u>**

FEI clarifies that currently, the meter reading software does not calculate the amount billed to the customer. Meter readers enter meter reads manually into handheld devices. That data is then consolidated into an XML file and exported to an FEI server. The calculations to determine the amount billed to each customer occur within FEI's SAP system.

The flowchart below shows the detailed steps in the current process relating to meter read uploads and bill creation. FEI expects this process will remain mostly the same with the AMI Project, except for two differences:

1. In Box 10, the information for the meter read orders will be collected by the AMI system for the majority of customers, and not by meter readers. (The process in Box 10 will remain the same for any customers whose meters continue to be read manually.)
2. In Box 20, the premises points required for the XML file will be requested within the AMI system, and the AMI system will compile the file.

Please note that in the flowchart below IDOCS (short for Intermediate Documents) is an SAP object that carries and/or stores data from a business transaction from one system to another in the form of an electronic message.



Step 2 - Meter Read Upload Process:
Olameter/ Itron
FortisBC - SAP
10
Meter Readers Capture the following for the Meter Read Orders:
- Meter Reads
- Can't reads
- Notes
- Trouble Codes
- Sequence Change
20
Compile Meter Read info into 1 XML file
Drop XML Export file on FBC FTP Server
INT-A58
30
Process XML Export File into IDOCS
40
Process IDOCS
Upload Meter Reading Info
50
Pass Validation ?
NO
55
Further Processing
YES
60
Billing Order Status set to "Billable"
70
Billing Process: Account Picked up for Billing
80
Pass Validation ?
YES
NO
85
Further Processing
90
Invoicing Process: Account Picked up for invoicing
100
Pass Validation ?
YES
NO
105
Further Processing
110
Bill Print Process: Invoice created and sent


1

2

**CORE-FEI-2022JAN13-024**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 87, lines 29 - 32**

Issue: The Project Manager, Software & Integration is responsible for overseeing Sensus' design and delivery of the SaaS model including the definition of requirements, design, build, testing and integration of all associated enhancements to FEI's systems including the billing system, enterprise data repository, customer portal, and functionality for leak detection.

24.a Please provide FEI's rationale for choosing not to do a phased testing of the new technology(AMI technology)?

**Response:**

FEI has not developed its testing strategy for the AMI System; this strategy will be finalized during the Define and Design phases of the Project as discussed in Section 5.5.1 of the Application.

**CORE-FEI-2022JAN13-025**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 91, lines 23-26**

Issue: Health Canada's Safety Code 6 takes into account the scientific evidence related to the impact of thermal and non-thermal effects of radio frequency emissions on human health and provides an appropriate degree of precaution in setting the limits for these emissions.

25.a What is meant by the reference to "appropriate degree of precaution"? Please explain.

**Response:**

The referenced lines from Exhibit B-1 in the preamble to this IR are a summary of one of the "key findings" the BCUC described in the Executive Summary of its 2013 Decision and Order C-7-13 regarding a Certificate of Public Convenience and Necessity for FortisBC Inc. (FBC)'s Advanced Metering Infrastructure Project. The Executive Summary also states that one of the BCUC's "key decisions" was that, "The Project complies with Canadian safety standards as set out by Health Canada with respect to RF emissions".

The BCUC's decision and findings regarding "Radio Frequency Emissions and Health" are explained in section 10.0 of Decision and Order C-7-13. Section 10.3.3 of the decision, in particular, explains and expands on the BCUC's key finding that Safety Code 6 "provides an appropriate degree of precaution in setting the limits for [radio frequency] emissions". The BCUC's determination on this topic, at p. 113-114 of its decision, was as follows:

> The Panel notes in reviewing the evidence that there was general agreement during cross-examination of experts that the role of Health Canada is to protect the health of Canadians. Safety Code 6 is the result of the ongoing study by Health Canada on the health effects of RF emissions. With regard to thermal effects there is no evidence that Safety Code 6 does not adequately protect FortisBC customers. While there was disagreement over the adequacy of Safety Code 6 in dealing with non-thermal effects, the Panel agrees with FortisBC that the exposure limits in Safety Code 6 were established based upon a thorough evaluation of the scientific literature including potential non-thermal effects. No intervener provided scientific evidence that persuaded the Panel that Safety Code 6 fails to adequately protect FortisBC customers from non-thermal effects. Safety Code 6 has applied a significant safety factor to the allowable exposure levels and is subject to an ongoing evaluation of scientific literature by Health Canada. **For these reasons, the Panel finds that Safety Code 6 provides protection from thermal effects, non-thermal effects and incorporates an adequate degree of precaution.**

25.b What does the term "scientific evidence" in the above statement refer to? Please provide the details of the term "scientific evidence" referred to in this statement along with the publications relied upon.

**Response:**

The referenced statement regarding the "scientific evidence" Health Canada took into account for Safety Code 6 is from the Executive Summary of the BCUC's 2013 Decision and Order C-7-13 regarding a Certificate of Public Convenience and Necessity for FBC's Advanced Metering Infrastructure Project.

The BCUC quoted the following passage from the then applicable 2009 edition of Safety Code 6 regarding the process by which Health Canada evaluates the "scientific literature" to identify scientific evidence at pages 110-111 of Decision and Order C-7-13:

> The exposure limits specified in Safety Code 6 have been established based upon a thorough evaluation of the scientific literature related to the thermal and possible non-thermal effects of RF energy on biological systems. Health Canada scientists consider all peer-reviewed scientific studies, on an ongoing basis, and employ a weight-of-evidence approach when evaluating the possible health risks of RF energy. This approach takes into account both the quantity of studies on a particular endpoint (whether adverse or no effect), but more importantly, the quality of those studies. Poorly conducted studies (e.g. incomplete dosimetry or inadequate control samples) receive relatively little weight, while properly conducted studies (e.g. all controls included, appropriate statistics, complete dosimetry) receive more weight. The exposure limits in Safety Code 6 are based upon the lowest exposure level at which scientifically-established human health hazards occur. Safety factors have been incorporated into these limits to add an additional level of protection for the general public and personnel working near RF sources. The scientific approach used to establish the exposure limits in Safety Code 6 is comparable to that employed by other science-based international standards bodies. As such, the basic restrictions in Safety Code 6 are similar to those adopted by most other nations, since all recognized standard setting bodies use the same scientific data. It must be stressed that Safety Code 6 is based upon scientifically-established health hazards and should be distinguished from some municipal and/or national guidelines that are based on socio-political considerations.

The current 2015 edition of Safety Code 6 contains a comparable, substantially similar passage at page 7.

**CORE-FEI-2022JAN13-026**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 91, lines 27-29**

Issue: The radio frequency emissions generated by the Project are significantly below the levels set out in Safety Code 6 established by Health Canada to ensure such emissions are not harmful to human health;

26.a Please provide the evidence, including any peer-reviewed scientific research studies, of the most recent iteration of Safety Code 6 as it relates to emissions from the RFEMF emissions generated by the Project as being "significantly below" the levels set out in Safety Code 6.

**<u>Response:</u>**

The referenced lines from Exhibit B-1 in the preamble to this IR are a summary of one of the "key findings" the BCUC described in the Executive Summary of its 2013 Decision and Order C-7-13 regarding a Certificate of Public Convenience and Necessity for FBC's Advanced Metering Infrastructure Project. As noted in Exhibit B-1, the BCUC determined that, "The radio frequency emissions generated by the Project" – i.e., FBC's 2013 AMI Project – "are significantly below the levels set out in Safety Code 6 [2009] established by Health Canada to ensure such emissions are not harmful to human health".

The BCUC also stated in the Executive Summary that, "In reaching its decision, the Panel considered all of the evidence put before it". The evidentiary record that was before the BCUC in respect of FBC's previous AMI Project, and on which it determined that RF emissions generated by that Project were "significantly below" levels set out in Safety Code 6 is available on the BCUC's website. The BCUC's Decision and Order C-7-13 also contains a summary of the expert witnesses who provided evidence in that proceeding at sections 4.3 and 4.4. Sections 10.4.1 and 10.4.4 of the decision explain the BCUC's determination, and the evidence on which it was based, that RF emissions from FBC's AMI Project, including in the aggregate with RF from other sources was "far below" and "significantly below" the limits in Safety Code 6.

The following additional response regarding FEI's current AMI Project at issue in the present proceeding has been provided by Exponent.

Exponent's report in Exhibit B-1, Appendix F-1 "*Radiofrequency Fields in the Environment and from Advanced Metering Infrastructure. , May 3, 2021"* provides a comparison between the RF fields associated with operation of the Project's Sonix IQ gas meters and other components of the FlexNet network to the corresponding frequency-specific limits in the current edition of Safety Code 6 (2015).

As discussed in this report (Exhibit B-1, Appendix F-1) the limits for human exposure to RF are specified as Basic Restrictions by Health Canada Safety Code 6 (SC6). The Basic Restriction is measured in terms of the specific absorption rate (SAR), which is the rate of RF-energy absorption by bodily tissues. Estimating or measuring the SAR from a particular source is quite complex and is not easily accomplished outside a controlled laboratory environment. Therefore, to simplify the safety assessment, SC6 developed Reference Levels in units of power density (e.g., watts per square metre [$W/m^2$]) that are easy to compute and measure for a comparison to safety limits. SC6 also notes that “safety factors have been incorporated into the exposure limits” to ensure that demonstrated health effects are avoided and that “[t]he protection factors … are a factor of 10 (controlled) and 50 (uncontrolled)” (RSC, 2014; SC6, 2015). The Reference Level set out in SC6 (2015) for the frequency of operation of the Sonix IQ gas meters is 2.7 $W/m^2$.

At a distance of 1 metre behind the Sonix IQ gas meter (indoors) and a typical duty cycle (one transmission every 4 hours), the exposure would be approximately 0.00000011 $W/m^2$, or about 24 million times below the SC6 limit. At distances greater than 1 metre, where persons would be expected to spend more time, exposures are far lower.

**CORE-FEI-2022JAN13-027**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project, Exhibit B-1, page 91, lines 9-12**

Issue: The technology associated with AMI has been a topic of public discussion since at least 2011. Concerns have been expressed regarding the electromagnetic radio signals from the meters and collectors, as well as the privacy and security of consumption information recorded and transmitted by the meters.

27.a Please advise what security and privacy policy, if any, FEI has to protect FEI's customers. Please provide a copy of FEI's security and privacy policy.

**Response:**

Please refer to the response to BCUC IR2 43.1 and to Section 5.8.3 of the Application. FEI's privacy policy is publicly available at https://www.fortisbc.com/fortisbc-privacy-policy.

27.b Please advise, how can the customer be assured his/her meter and/or its data transmissions won't be hacked by someone?

**Response:**

Please refer to Section 5.8.3 of the Application and to the responses to BCUC IR1 19.3, BCUC IR2 43.1, CEC IR1 66.2, and RCIA IR1 43.2.

**CORE-FEI-2022JAN13-028**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 92, lines 7-11**

Issue: Under typical operation, the Sonix IQ gas meter transmits RF energy a total of approximately 0.34 seconds per day. This very short transmission time also means that the indoor RF exposure from the Sonix IQ gas meter is about 24 million times lower than the SC6 exposure limit, and substantially lower than the RF exposures from common natural and man-made sources.

28.a Please advise how the short transmission time of 0.34 seconds per day relates to the SC 6 limit.

**Response:**

The following response has been provided by Exponent.

To determine compliance with the Reference Level (please see response to CORE IR 2.26.a) specified in SC6, the source exposure must be averaged over a 6-minute period. A transmission of 0.34 seconds per day corresponds to a duty cycle of 0.00039%, meaning that to evaluate compliance with SC6, the exposure from the smart meter would be averaged over this low duty cycle.

28.b Please advise over what period of time were the emissions referenced in the above statement averaged.

**Response:**

The following response has been provided by Exponent.

The Sonix IQ meters communicate on a fixed schedule, most typically every 4 hours. Each transmission lasts approximately 52 milliseconds (52 thousandths of a second). Under typical operation, Sonix IQ gas meters send one message every 4 hours, as well as about three additional status update messages per week. The duty cycle of 0.00039% was calculated by dividing the 0.34 seconds of transmission per day by 24 hours in a day.

28.c Please advise what is being referred to by the statement "substantially lower than the RF exposures from common natural and man-made sources".

**Response:**

The following response has been provided by Exponent.

As quantified in Figure 5 of Exhibit B-1, Appendix F-1, the potential RF exposure from the Sonix IQ meter inside at a distance of 1 metre is approximately 2,100 times less than the natural RF exposure from the earth and as much as 500,000 or 1,800,000 times less than typical exposures from a cordless handheld phone or cell phone next to the head, respectively.

28.d Please advise whether FEI is aware of any peer-reviewed research studies that have measured the peak RF level of signals. If so, please provide a copy of those studies.

**Response:**

The following response has been provided by Exponent.

Exponent is not aware of any peer-reviewed *research* studies that have measured the peak RF level of signals from the Sonix IQ gas meters.

As described in Table 2 of Exhibit B-1, Appendix F-1, the Sonix IQ gas meter was certified for use by Industry Canada under ISED Identification No 2220A-SONIXIQV2 and FCC ID 2220A-SONIXIQV2. These certifications indicate a transmit power of 0.982 watts and an antenna gain of 1.995.

Measurement of peak RF signal strength is a required part of the certification and approval process by which all RF non-exempt devices, including advanced meters, are approved for use in Canada and the U.S.

**CORE-FEI-2022JAN13-029**

**Reference: FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 94, lines 1-3**

Issue: The information collected is sent automatically from the meter through encrypted wireless technology. The information transmitted is de-identified and must be re identified when received by FEI to determine which customer it is associated with; […]

29.a Please advise if FEI will be using 4G, 5G, and/or 6G technology.

**Response:**

As confirmed in the response to CORE IR1 11.0, the Sensus advanced meters themselves do not have the capability to use 4G/5G/6G technology.

FEI confirms it will use a number of wireless technologies including 4G, 5G, and in the future 6G technology, to backhaul aggregated data from the Sensus FlexNet Base Stations to the RNI. Please refer to Figure 4-2 in Section 4.3.1 of the Application (the backhaul appears as a cloud labelled WAN between the FlexNet Base Station and one of the routers in the AMI System block).

Please also refer to the response to RCIA IR1 46.4.

29.b Please advise and provide supporting evidence for the total amount of WiFi emissions resulting from the utility metres that is expected to be emitted during a typical billing cycle at a customer's home.

**Response:**

The following response has been provided by Exponent.

FEI's proposed AMI System does not use Wi-Fi; it operates on a dedicated licensed portion (approximately 900 Megahertz) of the radio spectrum. However, assuming the question meant to ask about total RF transmission power, a typical meter would transmit approximately 10 Joules during a typical billing cycle.

Per Table 2 of Exponent's report at Exhibit B-1, Appendix F-1, the Sonix IQ meter transmits 0.982 Watts of power during transmission. A Watt is a measure of energy (Joule) per unit of time (seconds); thus 1 Watt = 1 Joule per second.[9] Table 3 of the same report states that the meter

[9] Note that this 0.982 W should not be confused with the approximately 2 W of equivalent isotropic radiated power (EIRP) cited elsewhere in Exhibit B-1, Appendix F-1. The total power of 0.982 W is not transmitted equally in all

transmits for 0.34 seconds per day. FEI bills monthly; therefore, an average month (based on a 365.25 day year) is 30.4375 days per billing cycle. Therefore, the total transmission power per billing cycle (TPBC) is calculated as:

$$TPBC = 0.982\,\frac{Joules}{second} * 0.34\,\frac{seconds}{day} * 30.4375\,\frac{days}{billing\ cycle}$$

$$TPBC = 10.1\,\frac{Joules}{billing\ cycle}$$

As a point of reference, since 1 Watt is a Joule per second, the 10 Joules emitted by the typical Sonix IQ meter during a typical billing cycle is roughly equivalent to the energy used by a 60 watt light bulb turned on for one-sixth of a second.

29.c Please advise what regulatory standards govern the safe level of these total emissions.

**Response:**

Innovation, Science and Economic Development Canada (ISED), formerly Industry Canada, is the regulator responsible for governing the safe level of RF emissions resulting from RF device installations such as the advanced meters to be installed under the proposed AMI Project. Under RSS-102, ISED has adopted the RF exposure guidelines published in Health Canada's Safety Code 6.

directions, but rather is focused such that it transmits in the forward direction, away from the customer's house, thus reducing the amount of power transmitted toward the house. This focusing of energy is called an antenna "gain". As described in greater detail in Exhibit B-1, Appendix F-1, calculations of transmitted electromagnetic signal strength are often made using the EIRP, which conservatively assumes that this maximum (focused) power level is transmitted in all directions.

**CORE-FEI-2022JAN13-030**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, page 94, lines 28-33**

Issue: Where a customer is refusing the installation of the advanced meter due to its remote communicating capabilities, the customer will have the option to have an advanced meter installed with the internal communicating radio turned off for a fee. The advanced meter will continue to operate as a meter when deactivated; however, it will no longer communicate with Base Stations. Customers choosing to opt out will be required to pay for their meters to be manually read.

30.a Please confirm what the “fee” is for those customers who wish to have the advanced meter installed with the internal communicating radio turned off.

**Response:**

Please refer to the response to RCIA IR2 54.3.

30.b Please provide the evidence of the costing of such an option to ratepayers who refuse to have the smart meter installed. Also, please provide the evidence upon which FEI relies as to how this cost will be borne by ratepayers.

**Response:**

Please refer to the response to CORE IR2 30.a.

30.c Please advise whether all of FEI’s customers in BC will receive written notification that they can opt out and request manual reading.

**Response:**

FEI will be providing advance notification to customers of when it expects to be in a region to replace existing meters with AMI meters, as FEI will be required to set up appointments with customers for the meter replacement. As part of this process, customers will be made aware of the option to have the radio turned off in the meter along with the associated fees.

30.d Please advise whether the "radio turned off" meter will have all information transmissions turned off.

**Response:**

A radio-off meter will have all RF wireless transmissions turned off. FEI technicians will instead have to visit the site and communicate with the meter using a physical communications adapter. This device can be plugged into the meter to facilitate uploading and downloading data as well as to configure and view settings, alarms and events.

**CORE-FEI-2022JAN13-031**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project, Exhibit B-1, Appendix A, page 18**

Issue: Remote Shut-Off Remote shut off of meters for safety or other reasons is possible via radio-controlled valves, or else by AMI meters with integrated shut-off valves. This is a relatively new capability in the North American gas market, and processes for remote disconnection or reconnection of service needs to consider things like relighting appliances and safety checks. However, remote shut-off capabilities offer a wide range of benefits like reducing field labour, increasing safety for customers and utility personnel, and gives utilities options for improving response and safety in emergency situations. The ability to shut off individual meters or groups of meters affected by an emergency provides safety benefits for utility customers and the general public, while also giving utilities greater control and efficiencies, because they can manage outages and shut-offs down to the endpoint level, rather than at a distribution level only. At-risk meters can be shut off in response to an emergency situation, or they can be shut off proactively if an emergency or hazardous conditions are anticipated.

31.a Please advise if FEI has a site specific Emergency Response Plan in place at this time. If yes, please provide a copy of same. If not, please advise when a site specific Emergency Response Plans will be prepared.

**Response:**

FEI has not developed an Emergency Response Plan that considers the use of remote disconnects or reconnects, as it does not currently have this capability. If the Application is approved, FEI will begin the Define phase of Project implementation. During this phase of the Project FEI will determine under what circumstances this new functionality should be used and how.

**CORE-FEI-2022JAN13-032**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, Appendix F-1, page 6**

Issue: The FlexNet End Points send very short transmissions (typically about 55 milliseconds) at regular pre-programmed intervals of once every 4 hours. As discussed in more detail in Section 3, the typical duty cycle is 0.00039% (about 0.34 seconds per day).

32.a Please provide supporting evidence confirming that the meters will radiate 0.34 seconds per day.

**Response:**

This is how the AMI system has been designed by Sensus. Please also refer to the response to CORE IR2 33.a.

**CORE-FEI-2022JAN13-033**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project, Exhibit B-1, Appendix F-1, page 20**

Issue: In the FlexNet network, each End Point transmits a fixed amount of data during each transmission on a highly regular transmission schedule. This in turn means that the duty cycle of each End Point is well defined and controlled. The typical duty cycle and total transmission time per day for all endpoints is summarized in Table 3. During typical operation, the Sonix IQ gas meters transmit only for about 0.34 seconds per day total, with similarly short total transmission times for the other End Points. The total transmission time remains very short, even under the maximum expected duty cycle when an End Point goes through startup and connection to the network (see Appendix B, Table B-1).

33.a Please provide the mathematical calculations behind Exponent's statement that the Sensus meters will radiate .34 seconds a day with only 6 data signals/day

**Response:**

The following response has been provided by Exponent.

As summarized in Table B-1 of Exhibit B-1, Appendix F-1, each message from a Sonix IQ gas meter lasts 52.58 milliseconds (0.05258 seconds). Each gas meter sends one message every 4 hours or 6 transmissions per day. In addition, the footnote to Table B-1 indicates that in addition to the one message every 4 hours, that there are approximately 3 additional status update messages per week. The mathematical calculation is $[7 \times (6 \times 0.05258) + 3 \times 0.05258]/7 = 0.338$ seconds per day which was rounded to 0.34 seconds per day.

**CORE-FEI-2022JAN13-034**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, Appendix F-1, page 26 and 27**

Issue: Figure 5 RF exposure of a Sonix IQ meter relative to other RF sources

Figure 6 Comparison of RF exposure from End Points to other sources under typical use.

34.a Please advise why in Figure 5 and 6 “Natural RF from the Earth” and “Natural RF from the human body” has been used?

**Response:**

The following response has been provided by Exponent.

The figures are provided to compare RF exposure from Sonix IQ meters and End Points to a prominent subset of common sources in the environment, including human, other organisms, electronic devices, and other objects or materials capable of emitting or reflecting RF fields.

Such sources were used as illustrative examples of sources to help describe the very low level of RF emissions from the Sonix IQ gas meter. As described in the “Blackbody Radiation” portion of Exhibit B-1, Appendix F-1 (pg. 4), “[a]ny object (i.e., blackbody) that has a temperature above absolute zero gives off electromagnetic energy; the temperature of the object determines the frequency at which most of the electromagnetic energy is produced. Hotter objects emit both more energy and energy at higher frequencies than colder objects.”

The primary energy of these objects is in the infrared portion of the electromagnetic spectrum (i.e., above 300,000,000,000 Hz [300 GHz]; See Figure 2 and Table 4 in Exhibit B-1. However, the portion of the electromagnetic energy from the Earth and the human body also extends to lower frequencies in the RF portion (i.e., 3,000 Hz to 300 GHz). The total electromagnetic energy from Earth and the human body in *only* the RF portion of the electromagnetic spectrum (from 3,000 Hz to 300,000,000,000 Hz) is approximately 0.0090% or 0.018% of the SC6 limit, respectively.

34.b Please advise whether FEI agrees that “Natural RF from the Earth” and “Natural RF from the human body” should be categorized as DC EMR instead of AC EMR.

**Response:**

The following response has been provided by Exponent.

As described in response to CORE IR 2.34.a, the "Natural RF from Earth" and "Natural RF from the human body" were calculated based upon the radio frequency energy emitted by each source between frequencies of 3,000 Hz and 300 GHz. The DC magnetic field of Earth with a frequency of 0 Hz is not in the radiofrequency range and so was not considered in this evaluation.

34.c Please advise whether FEI is aware of the "window effects", where biological effects occur significantly below SC6, including Sonis IQ meter and other components of FlexN communication network.

**Response:**

The following response has been provided by Exponent.

There are scattered reports in the scientific literature that so called "effects" of RF may be limited to narrow bands of frequency or intensity. Overall, the evidence for such effects has not been reliable enough to persuade health and scientific agencies that such observations are relevant to human health considerations in standard setting.

34.d Please provide the RF exposures for all sources for both Figures 5 and 6 expressed as µW/m² (microWatts per square meter).

**Response:**

The following response has been provided by Exponent.

The data for both Figures 5 and 6 is summarized in Table 4 of Exponent's report, titled *Radiofrequency Fields in the Environment and from Advanced Metering Infrastructure,* Exhibit B-1, Appendix F-1, at page 24, which provides the following references in footnote 24:

> RF exposure can be heavily dependent upon situation, so exposure conditions are provided for each exposure value. For reference, see Mantiply et al. (1997); Foster (2007); Valberg et al. (2007); HPA, (2008); ICNIRP,(2009); Viel et al. (2009); and Abdulla and Badra (2010).

Table 4 from this report is replicated below with the addition of a "Power Density" column. Additional rows for Urban, Suburban and Rural settings (from Joseph et al., 2012), Broadcast Towers (from Mantiply, 1997) and for the Sonix IQ gas meter (from Exhibit B-1 Table B-2) also have been added. Exposure calculations for Smart Gateway, Sonix IQ outdoor, SmartPoint, and Base Station are provided in detail in Table B-2 of Appendix B to Exponent's report. Note that the SC6 limits vary with frequency so a power density does not provide an easily comparable metric to compare different sources. Additionally, not all values can be provided as a power density as some were reported in peer-reviewed literature in terms of specific absorption rate (SAR). The originally "Reported Value (% of SC6 Limit)" indicates that:

> RF exposure is presented as a percentage of the SC6 limit to keep these exposure values both consistent and accurate. The SC6 limit is defined as the applicable SAR limit, wave power density limit, or square of the field magnitude limit, all for uncontrolled environments. Both whole body exposure and spatial peak SAR for the head are used where appropriate. (footnote to Table 4 on pg. 24)

**Table 4. Frequency and representative RF exposure values for common man-made RF sources**

| Source | Frequency (MHz) | Reported Value (% of SC6 Limit)* | Power Density (μW/m²) | Exposure Conditions |
|---|---|---|---|---|
| Blackbody radiation from the earth | 0.003 – 3,000 | 0.009 | 1,300 | Typical |
| Blackbody radiation from humans | 0.003 – 3,000 | 0.018 | 3,000 | Typical |
| Cell Phone | 800 – 1,900 | 5 – 12† | N/A; Reported as SAR | Personal Call |
| Cordless Phone / Handheld Unit | 1,880 – 1,900 | 0.5 – 3.8 | N/A; Reported as SAR | Handheld Unit |
| Wi-Fi | 2,400 – 2,484 | 0.00007 – 0.75 | 3.8 – 40,000 | Typical |
| Bluetooth | 2,400 – 2,484 | 0.002 – 0.31 | 113 – 16,300 | At 0.25 – 3 meters |
| Microwave Oven | 2,450 | 0.01 – 2.4 | 663 – 130,000 | At 1 meter |
| Urban Setting | 1,350 | 0.04 | 1,450 | Median Exposure in this Setting |
| Suburban Setting | 1,350 | 0.016 | 560 | |
| Rural Setting | 1,350 | 0.0006 | 21 | |
| Broadcast Towers | 88-806 | 0.0026 | 39 | Typical |
| Sonix IQ gas meter | 900 | 0.0000042 | 0.11 | Inside at 1 m away |

* RF exposure is presented as a percentage of the SC6 limit to keep these exposure values both consistent and accurate. The SC6 limit is defined as the applicable SAR limit, wave power density limit, or square of the field magnitude limit, all for uncontrolled environments. Both whole body exposure and spatial peak SAR for the head are used where appropriate.

† An average value based upon Abdulla and Badra (2010) is approximately 7.6%

34.e Please advise of the specific accommodations FEI will put in place for those individuals who have electro-sensitive disability. If FEI does not have any specific accommodations in place for electro-sensitive disability, please explain why.

**Response:**

FEI is proposing an opt-out option for customers who prefer to have the radio turned off in their AMI meter for any reason.

**CORE-FEI-2022JAN13-035**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, Appendix F-2, page 21**

Issue: The limits established in SC6 are based upon limiting short-term biological responses to RF fields and do not contain any restriction for long-term or cumulative exposure […].

35.a Please advise what evidence FEI relies upon to support the assertion that the EMR emanating from its smart meters will not combine with EMR that customers are currently exposed to including, but not limited to: cell towers, satellites, WiFi, broadcasting studios, and FOC signal converters, which may make overall exposure greater than SC6 limits.

**Response:**

The following response has been provided by Exponent.

As specified in SC6, the RF measurement or calculation of the exposure contribution of *all* sources must be combined to make a final determination as to compliance with SC6 limits. However, calculations of the Sonix IQ gas meter for the typical in-home exposure scenario are approximately 24 million times below the SC6 limit. As is clear in our report, the exposure from common sources of RF in aggregate when added to that from a Sonix IQ gas meter in a particular location would not come close to exceeding the SC6 limit; we are unaware of normal uses of aggregate RF sources in the home that would cause their exposures to be so close to the SC6 limit that a Sonix IQ gas meter, contributing an RF exposure that is one 24 millionth of the SC6 limit, would cause an exceedance. The contribution of the Sonix IQ gas meter to any conceivable aggregate exposure scenario will result in a negligible overall contribution to the compliance or not with the SC6 limit. We also note that the BCUC's Decision and Order C-7-13 in 2013 approving the Fortis BC AMI electric meters addressed a similar question in section 10.4.4:

> Based on the evidence summarized in the table above, the Panel is satisfied that RF emissions from the proposed AMI system add a small fraction to the overall RF exposure of an individual, and this aggregate exposure is significantly below the limit established in Safety Code 6 (p. 125).

**CORE-FEI-2022JAN13-036**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-1, Appendix F-2, page 20**

Issue: SC6 applies to “*all individuals working at, or visiting, federally regulated sites*”

[…].

36.a Please advise whether SC6 does or does not apply to people living in residential areas, which are not “federally regulated sites”.

**<u>Response:</u>**

Safety Code 6 (SC6) applies in other areas, including residential areas, that are not “federally regulated sites” to the extent that the code is applicable to and mandatory for various radiocommunication apparatus operating in such areas. As the Preface to SC6 goes on to state, “This code has been adopted as the scientific basis for equipment certification and RF field exposure compliance specifications outlined in Industry Canada's regulatory documents (1-3), that govern the use of wireless devices in Canada, such as cell phones, cell towers (base stations) and broadcast antennas.”

Radio Standards Specification (RSS) 102, *Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)*, which is one of the regulatory documents issued by Industry Canada referred to in the above quoted passage from the Preface to SC6, states as follows:

> It is the responsibility of proponents and operators of antenna system installations to ensure that all radiocommunication and broadcasting installations comply at all times with Health Canada’s Safety Code 6, including the consideration of combined effects of nearby installations within the local radio environment.

Accordingly, the requirements in SC6 apply to various forms of radiofrequency emitting devices even when such devices are operating in residential areas that are not federally regulated sites. This includes the gas meters and other end points that are part of the proposed AMI Project.

The BCUC, in its 2013 Decision and Order C-7-13 approving FBC’s Advanced Metering Infrastructure Project, determined (at p. 108) that SC6 was the relevant standard for health effects from radio-frequency EMF produced by the AMI meter technology in that proceeding and that the electric AMI meters were not exempted from compliance with SC6, despite being exempted from routine evaluation as laid out in RSS-102.

The gas meters and other end points that are part of FEI’s proposed AMI Project operate in different frequency ranges than the electric AMI meters and, as a result, are not exempted from routine evaluation under RSS-102. The AMI Project gas meters and end points have received necessary certification from Innovation, Science and Economic Development Canada (formerly Industry Canada). Please also refer to Appendix F-1 of the Application, Table 2 at p. 20. The AMI Project gas meters and end points are subject to the requirements of RSS-102, including the requirement for compliance with SC6.

36.b Please advise whether the British Columbia Public Health Act, section 83 (1) would apply instead of SC6 for areas that are not “federally regulated sites”.

**Response:**

No, the *Public Health Act* does not apply “instead of” SC6. Please refer to the response to CORE IR2 36.a regarding the application of SC6 in areas that are not federally regulated sites.

In addition, section 83(1) of BC’s *Public Health Act*, which addresses the role of local government under the legislation, only applies in respect of a “health hazard” or “health impediment”. The definitions of these terms under the Act mostly involve conditions, things, or activities that are prescribed by regulation. Radiofrequency exposure is not a form of health hazard or health impediment prescribed by any regulation passed under the *Public Health Act*. Please see *Health Hazards Regulation*, B.C. Reg. 216/2011 and *Public Health Impediments Regulation*, B.C. Reg. 50/2009.

Section 83(1) of the *Public Health Act* could only theoretically apply if a local government “became aware” that radiofrequency exposure from a device was “a condition, a thing or an activity that ... endangers, or is likely to endanger, public health” and therefore a “health hazard” within the meaning of the statutory definition. Because devices like the AMI Project gas meters that comply with SC6 cannot be considered “likely to endanger public health”, this statutory provision does not have application in the circumstances of this proceeding.

36.c Please advise whether SC6 is mandatory or whether it is just a recommendation?

**Response:**

Please refer to the response to CORE IR2 36.a.

36.d Please advise what consideration and ongoing protection there will be for residents who cannot accept the new technology due to health problems.

**Response:**

Please refer to the response to CORE IR2 34.e.

**CORE-FEI-2022JAN13-037**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-10, page 17, lines 29-38**

Issue: 15.2 Please confirm that – independently from Exponent Testimony- SC6 does not consider **non-thermal** **biological effects** associated with electromagnetic radiation.

Response:

FEI does not have the qualified internal experts to comment specifically on the subject matter of CORE IRs 15.2, 15.13, 15.14, 15.15 and 23. However, FEI follows all Health Canada and other regulatory guidelines, standards and limits applicable to it. Furthermore, FEI notes that as discussed in Section 6 of Appendix F-1 to the Application, typical exposure from the Sonix IQ meters is 24 million times below the Safety Code 6 levels.

37.a Please advise whether FEI agrees that there are non-thermal biological effects associated with EMR and those (including window effects) are not dealt with in SC6.

**Response:**

FEI does not agree that non-thermal biological effects associated with RF exposure are not dealt with in Safety Code 6. The Introduction to Safety Code 6 (2015) states that, "The exposure limits specified in Safety Code 6 have been established based upon a thorough evaluation of the scientific literature related to the thermal and non-thermal health effects of RF fields." It also states that, "The exposure limits in Safety Code 6 are based upon the lowest exposure level at which any scientifically established adverse health effect occurs. Safety margins have been incorporated into the exposure limits to ensure that even worst-case exposures remain far below the threshold for harm."

In its 2013 decision regarding FBC's AMI Project (Decision and Order C-7-13), the BCUC also addressed the adequacy of Safety Code 6 in dealing with non-thermal effects from RF, concluding that, "While there was disagreement over the adequacy of Safety Code 6 in dealing with non-thermal effects, the Panel agrees with FortisBC that the exposure limits in Safety Code 6 were established based upon a thorough evaluation of the scientific literature including potential non-thermal effects. No intervener provided scientific evidence that persuaded the Panel that Safety Code 6 fails to adequately protect FortisBC customers from non-thermal effects."

The following additional response has been provided by Exponent.

Please refer to the responses to CORE IR2 4.a and 34.c. Note that exposures to static magnetic fields, ELF magnetic fields, and visible light are not within the scope of SC6 are reported to elicit non-thermal biological responses or, in some cases, responses most prominent or absent at some intensities or frequencies ('windows') that are known to be harmless.

**CORE-FEI-2022JAN13-038**

**Reference:** **FORTISBC ENERGY INC. (FEI) - Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Advanced Metering Infrastructure (AMI) Project dated May 5, 2021, Exhibit B-10, pages 40 & 41, lines 34-37 & 1-19 respectively (FEI's Responses to CORE)**

Issue: The BioInitiative report was originally issued on a website in 2007, with subsequent updates in 2012, 2014, and most recently in 2020. The original report and the updates are not based on proper and rigorous evaluation of the scientific evidence. The BioInitiative report suffers from several deficiencies: 1) the report was authored by a self-organized group of individuals from academic institutions and public interest groups, and not under the auspices of any recognized scientific organization; 2) the conclusions expressed in the individual chapters of the document <u>did not represent consensus opinions,</u> rather they were the opinions of the individual contributors; 3) the authors did not follow a weight-of-evidence approach, and selectively reported on studies that, in their opinions, showed some effect and supported their views; 4) the authors mostly disregarded studies that did not show an effect, including the entire body of literature on long term animal bioassays; and 5) the authors did not thoroughly assess the quality of studies they evaluated. These deficiencies likely explain why the BioInitiative report's conclusions are completely inconsistent with conclusions of other risk assessments that followed the generally accepted scientific methods of weight-of-evidence evaluations. Several scientific and governmental agencies strongly criticized the BioInitiative report. The Australian Centre for Radiofrequency Bioeffects Research wrote, "[a]s it stands it [the BioInitiative 2007 report] merely provides a set of views that <u>are not consistent with the consensus</u> of science, and it does not provide an analysis that is rigorous-enough to <u>raise doubts about the scientific consensus</u>" (ACRBR, 2008). The EMF-NET Steering Committee of the European Commission opined the report was "written in an alarmist and emotive language and the arguments have no scientific support from well-conducted EMF research" and "[t]here is a lack of balance in the report; no mention is made in fact of reports that do not concur with authors' statements and conclusions" (EMF-NET, 2007)

[Emphasis added]

38.a Please advise what explain what is meant by the words "consensus", "scientific consensus" and "consensus of opinions" as noted above.

**<u>Response:</u>**

The following response has been provided by Exponent.

As used in the referenced excerpt from Exhibit B-10 (Response to CORE IR 1.26.7), "consensus", "scientific consensus" and similar expressions were intended to refer to the "consensus" of positions by national and international health and scientific agencies, i.e., opinions that are similar and obtained by the application of rigorous, objective, scientific methods. As stated, the opinions expressed by the authors of the Bioinitiative report (2007) “are not consistent” with such scientific consensus. While the report is stated to be a “collaboration of international scientists”, the joint publication of individual chapters authored by one or two persons, who are dissatisfied with current standards for exposure to extremely-low-frequency fields associated with electricity and RF fields, does not represent a scientific consensus.

# Attachment 14.a

SAMPSON
RESEARCH

*Consulting Project*

# 2012 FEU Residential End-use Study

## Final

**Prepared for:**
**FortisBC Energy Inc.**

**By:**


**Sampson Research Inc.**

**With:**

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**July 16, 2014**


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**Note to Readers:**

All opinions and analyses presented in this report are the responsibility of Sampson Research and do not necessarily represent the views of FortisBC.

**Printing**

This document is formatted for double sided printing to save paper. Blank pages are inserted where necessary to preserve proper formatting.

**Currency Units**

All dollar figures presented in this report, unless stated otherwise, are expressed in Canadian funds.

## Acknowledgements

This Residential End-Use Study would not have been possible without the support and hard work of a team of individuals including FortisBC staff and members of the consultant team.

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# 1 EXECUTIVE SUMMARY

## 1.1 Introduction and Background

This report summarizes the results from a Residential End-Use Survey (REUS) of FortisBC Energy Utilities' (FEU) customers conducted in late 2012. Over 3,400 survey responses were received over the Internet or through the mail. Results were analyzed by FEU's five regions (Lower Mainland/Fraser Valley, Vancouver Island/Sunshine Coast, Interior (Inland and Columbia), Whistler and Fort Nelson). Comparisons were made with results from residential end-use studies conducted by FEU in 2008 and 2002. Survey estimates at the utility level for the 2012 REUS are accurate to +/- 2.4%, 19 times out of 20.

The 2012 REUS represents the first time the electric and gas divisions of FortisBC have combined resources to implement a joint REUS of their customers. To do this, the questionnaire and survey sample were structured to accommodate gas-only customers, electric-only customers, and customers who receive both their gas and electric services from FortisBC (i.e., shared services customers). REUS results for FortisBC's electric customers are published in a separate report.

Data from the 2012 FEU REUS and published third party sources were used to explore trends and factors contributing to the decline in residential natural gas use rates. These included developments and trends in new construction, gas appliance stocks and efficiencies, and changes in the demographic composition of FEU's residential customer base. Conditional demand analysis (CDA) modelling using REUS data and gas consumption records were used to derive Unit Energy Consumption (UEC) estimates for key gas end-uses by region and at the utility level. These estimates were compared to those generated by the utility in 2008 and 2002.

## 1.2 Highlights of the 2012 REUS

Highlights from the 2012 REUS of FEU's gas customers are organized by topic area. Readers are directed to the respective sections in the main report for a detailed presentation and discussion of results by region, dwelling type, and dwelling vintage.

### 1.2.1 Trends Influencing Residential Natural Gas Consumption

Use rates (weather normalized gas consumption per-household) have been declining across FEU's regions since 1999. Use rates are down 24% since 1999 and 4% since the last REUS (2008). The decline since 2008 is understated somewhat due to a change in the use rate calculation method for 2012.

Declining use rates are attributed to:

- The shift in new residential construction towards smaller, less energy-intensive dwellings including row houses, townhouses, and apartments.
- Improvements in the thermal envelope of all dwelling types (improved insulation, energy-efficient windows, etc.).
- Improvements in the efficiency of larger (thermal) gas end-uses including furnaces, boilers, domestic water heaters, and fireplaces.

- Changes in the penetration rates of gas appliances and equipment (convenience loads) in new and retrofit construction.
- Improvements in the efficiency of appliances that use hot water, including clothes washers and dishwashers.
- The long-term decline in the average number of occupants per-dwelling and an aging customer base.
- Long-run demand response to increases in the price of natural gas.

These trends are being partially offset by the long-run increase in the average size of the new single family detached dwellings.

### 1.2.2 Dwelling Characteristics and Renovations

- The average FEU residential customer has lived in their home for 17 years, up from 12 years in 2002. This increase is consistent with the aging of FEU's residential customer base. People are less likely to change residences as they get older.
- Average home size ($ft^2$) varies by dwelling type and vintage. The median size of a single family detached (SFD) dwelling with gas service built since 2005 is 2,900 $ft^2$, 32% larger than SFDs built in 1950-75 and 53% larger than SFDs constructed before 1950.
- Ceiling heights in newly constructed dwellings continue to increase, with ceilings of nine feet and higher present in 69% of dwellings constructed since 2005 compared to 14% of dwellings constructed during the 1950-75 period. Increased floor space and higher ceilings increase the overall load placed on space heating equipment.
- The likelihood of basements being completely finished has increased from 57% in 2008 to 62% in 2012.
- Consistent with changes to building codes, newer homes are more likely to have average or above average insulation, high efficiency windows, and insulated exterior doors.

### 1.2.3 Energy-Related Renovation Activities – Past and Planned

- Nearly half (46%) of FEU customers undertook one or more energy-related improvements to their home in the last five years. The top three energy-related renovations include installing programmable thermostats, energy-efficient windows, and weather stripping and caulking.
- Thirty-eight percent (38%) of households plan to undertake one or more energy-related renovations during the next two years. The top three energy-related renovations planned include installing energy-efficient windows, improving insulation, and weather stripping / caulking.
- Nine percent (9%) of FEU customers made changes involving fireplaces or heating stoves during the last five years, and 6% plan to undertake similar renovations in the next two years.

### 1.2.4 Space Heating

- The proportion of FEU customers using natural gas as either their main or secondary (supplementary) space heating fuel in 2012 is 95%, unchanged from 2008. The role of natural gas as a space heating fuel, however, has shifted somewhat to a secondary or supplementary fuel. This trend was identified in the 2008 REUS. It is due primarily to the long-term decline in the penetration of gas forced air furnaces in new construction (57% of FEU homes built since 2005 compared to 88% of homes constructed between 1950 and 1975), and, to a lesser degree, the increased penetration of air source heat pumps.
- Five percent (5%) of FEU households changed their main space heating fuel during the last five years, not statistically different from the rate observed in 2008.
- The top three main methods of space heating are forced air furnaces (70% of FEU homes), hot water radiant floor heat or air source heat pumps (tied for second place at 6% each), and gas fireplaces (4%). Data gathered elsewhere in the 2012 REUS survey suggest the penetration of air source heat pumps is closer to 12% of FEU homes.
- On average, 78% of FEU homes have a gas forced air furnaces. High efficiency models (AFUE of 90% or higher) account for 37% of gas furnaces in FEU's service region, up from 16% in 2008 while standard efficiency furnace (less than 78% AFUE) shares have fallen to 23% from 44% in 2008. As of 2012, 40% of furnaces were mid-efficiency units (78% to 85% AFUE).
- High efficiency boilers (AFUE of 90% or higher) now make up 36% of all boilers in use, up from 30% in 2008.
- The repair incidence for gas boilers is significantly higher than gas furnaces (31% versus 18% during the last three years); so too, the median cost of the repair ($400 for gas boilers versus $300 for gas furnaces). The incidence of repairs is highest for boilers and furnaces when they are between 15 and 19 years old.

### 1.2.5 Domestic Water Heating

- Penetration of gas domestic water heaters (any type) is currently estimated at 83%, down from 89% in 2008. The decline is largely attributed to the drop in the penetration of natural gas DWH systems in dwellings constructed since 2005 (66% for gas dwellings constructed since 2005 versus 80% to 88% for older dwellings).
- The incidence of DWH fuel switching among FEU customers during the last five years is low at 2%. Of those who switched, the net effect on natural gas fuel shares is neutral.
- Storage-type hot water tanks (any fuel) are used by 91% of FEU dwellings without centrally provided domestic hot water. On-demand DWH units, including tankless and hybrid versions equipped with a small expansion tank, represent three percent and one percent of all DWH units respectively in 2012.
- Forty-one percent (41%) of FEU customers installed a new DWH heater in the last five years. This proportion has not varied significantly over the last three REUS surveys.
- Two percent (2%) of households use solar energy systems to pre-warm or supplement their domestic water heating.

### 1.2.6 Fireplaces and Heating Stoves

- Eighty-four percent (84%) of FEU customers have one or more fireplaces and/or heater stoves, statistically unchanged from 2008.
- The three most popular fireplace types are heater style gas fireplaces (43% of FEU customers), wood burning fireplaces (22%), and decorative gas fireplaces (19%).
- Newer dwellings are more likely to have heater type gas fireplaces (fixed glass front), while older dwellings are more likely to have a decorative gas fireplace or a wood burning fireplace. Electric fireplaces have also become popular in new construction, present in 18% of homes constructed since 2005 compared to 8% for homes constructed during the previous 20 years.

### 1.2.7 Appliances

- Declines in the penetration of gas furnaces and gas hot water heaters (thermal loads) in new construction are being partially offset by the growing popularity (penetration) of smaller (convenience) gas loads like gas ranges (gas cook top and oven) or dual fuel ranges (gas cook top, electric oven). These appliances are displacing electric ranges (electric cook top and oven) and electric cook tops.
- The penetration of piped gas barbeques has also increased, currently present in 20% of FEU homes, up from 16% in 2008. Nearly half (45%) of gas homes constructed since 2005 have a piped gas barbecue.
- Energy-efficient front loading clothes washers are now present in 42% of FEU households, up from 27% in 2008.

### 1.2.8 Pools and Hot Tubs

- Three percent (3%) FEU households have a heated pool and 10% have a hot tub.
- The most common fuel used to heat swimming pools is natural gas (68% of heated pools). In contrast, only 10% of hot tubs use natural gas.

### 1.2.9 Behaviours

The frequency of a limited number of space heating and water heating behaviours were queried in the 2012 REUS.

- Space heating behaviours with the greatest room for improvement include draft proofing / leak sealing, closing vents / turning down the thermostat in unused rooms, and closing window coverings.
- Behaviours impacting domestic water heating with the greatest potential for improvement include turning off the water heater while away, doing laundry with full loads, and running dishwashers only when full.

- The frequency of water heating behaviours (e.g., showers, baths, dishwashing, clothes washing, etc.) is positively correlated with the number of people in the home, and, to a lesser extent, the presence of children or seniors.

### 1.2.10 Products and Services

- Thirty-seven percent (37%) of 2012 REUS respondents participated in an energy efficiency incentive program offered by a utility or government in the last five years. The proportion of renovations that were completed with assistance varied by renovation type.
- Based on a list of potential products and services designed to reduce energy use, survey respondents expressed the most interest in:
  - furnace or heat pump tune-up to ensure they are working safely and efficiently;
  - home energy audit to determine main energy uses in the home and identify opportunities to save energy; and
  - program to replace standard efficiency water heater with high efficiency water heater.

## 1.3 Conditional Demand Analysis Highlights

Conditional demand analysis (CDA) using data from the 2012 REUS, gas consumption records, and regional weather stations was used to estimate unit energy consumption (UEC) estimates for each of the major gas end-uses. Gas end-uses modelled included main and secondary space heating, water heaters, fireplaces, cook tops and ranges, pools, hot tubs, and piped gas barbeques.

Highlights from the CDA include:

- Primary and secondary space heating UECs of 52 GJ/year and 25 GJ/year, respectively. The UEC for primary space heating is down 9% from 2008, while secondary space heating UEC is up by 6%. Declines in the primary space heating UEC are consistent with the increasing efficiency of gas space heating equipment stocks and the shift of natural gas from a main to secondary heating fuel.
- UEC estimates for other gas end-uses include domestic water heating (26 GJ/year), decorative fireplaces (18 GJ/year), and heater type fireplaces (15 GJ/year).
- FEU customers in the Lower Mainland have higher UECs for primary space heating and domestic hot water use compared to other regions, most notably the Interior and Vancouver Island. These results are consistent with single family detached homes in the Lower Mainland being larger, on average, compared to other regions, and tending to have more occupants per dwelling compared to other FEU regions.

* * * * *

# 2 INTRODUCTION

This report presents detailed results and analyses from a comprehensive residential end-use study (REUS) of FortisBC Energy Utilities' (FEU) residential customers based on survey data collected in November of 2012. This study represents the fourth end-use survey of FortisBC's natural gas customers in British Columbia conducted since 1993, and the first to be conducted jointly with FortisBC's electric division (FBC).

Data, information, and analysis from residential end-use studies like the 2012 REUS are used to support a broad range of activities and processes for FortisBC's electric and gas divisions, including:

- Revenue requirement, rate design, and other applications to the British Columbia Utilities Commission
- Preparation and updating long-term resource plans
- Inputs for pricing models and tests for system extensions (mains and services)
- Reviews of conservation potential
- DSM opportunity assessments and program designs
- Inputs for load forecast models
- Development of marketing programs and advertising messaging

## 2.1 Research Objectives

Research objectives for the 2012 REUS are extensive and cover most aspects of documenting and understanding residential energy use, including equipment stocks, purchases and replacement behaviours, attitudes towards energy conservation, and other variables that influence the residential consumption of natural gas and electricity. Specifically, the research objectives for the 2012 study included:

- Collecting information on appliance end-use stocks including age, efficiency, and usage. End-uses include space heating and cooling, water heating, cooking, refrigeration, dishwashing, laundry, swimming pools, hot tubs, and saunas.
- Determining primary and secondary energy (fuel) sources for space and water heating.
- Determining dwelling characteristics that directly or indirectly influence energy consumption, including building envelope, vintage, heated floor space, number of stories, tenure, length of residency, ceiling heights, window types, and insulation levels.
- Identifying past and planned energy-related renovation activities.
- Understanding the factors that influence end-use fuel choices.
- Detailing energy conserving behaviours that affect energy use associated with heating, cooling, laundry, dishwashing, bathing, showers, draft proofing, furnace maintenance, food storage, lighting, and small appliance use.
- Discerning attitudes and beliefs regarding energy conservation and other energy-related issues.
- Assessing interest in potential utility programs and services and the likelihood of purchasing new appliances, or conducting upgrades to the building envelope.

- Performing a conditional demand analysis (CDA) to estimate unit energy consumption (UEC) estimates for major appliance and end-uses.
- Analyzing trends in gas end-uses and end-use combinations in new construction versus older housing stock.
- Comparing findings with previous surveys, where applicable, to assess market changes and trends. Analyzing past and future trends in housing type, appliances, efficiency levels, renovations, and demographic shifts.

### 2.2 Previous Gas REUS Studies

The 2012 REUS of FortisBC's natural gas customers builds upon end-use studies conducted by its predecessor companies Terasen Gas in 2008 and BC Gas in 2002 and 1993.

Regional coverage of the REUS surveys has expanded over time commensurate with expansion of the utility. The 1993 and 2002 studies presented results for three regions: Lower Mainland, Interior, and Fort Nelson. The 2008 and 2012 studies included these plus two additional regions: Vancouver Island/Sunshine Coast and Whistler.

The last three REUS surveys included conditional demand (CDA) analyses that estimated unit-energy consumption (UEC) figures for major gas end-uses. The 2002 and 2008 REUS studies also included psychographic segmentations of residential customers based on self-reported information on attitudes, behaviours, and socio-demographic characteristics.

### 2.3 Topic Coverage for the 2012 REUS

Topic coverage for FortisBC's residential end-use survey has expanded with each iteration of the study. The questionnaire has evolved over time, reflecting emerging trends in residential end-use equipment, building characteristics, and other market characteristics. Evolution of the questionnaire also reflects the ongoing effort to improve the accuracy and reliability of the results. While changes in topic coverage and/or question wording are sometimes required, considerable attention is paid to maintaining consistency and compatibility with past questionnaire designs. Doing this maximizes FortisBC's ability to identify and follow trends in residential energy use equipment and behaviours.

The 2012 REUS represents the first time the gas and electric divisions of FortisBC have conducted a joint end-use survey. The combined study provides data to each division about its respective residential customers. It also affords a holistic energy view of their shared customers. Achieving this goal meant the end-use questionnaire for shared customers had to be expanded to address the broader range of electrical end-uses and related behaviours, including lighting, air conditioning, and smaller end-uses such as DVD players and computers. Additionally, target number of survey completions was increased to 5,000 compared to 2,715 for the 2008 REUS. While the final number of responses fell below the target, the combined survey approach is considered a success and provides a rich dataset of information on the residential customers for each utility.

### 2.4 Report Organization

This report is organized into 15 sections plus a bibliography. Following this introduction, the Background and Methodology section addresses the sampling strategy, final sample design, questionnaire design, and final response statistics. Section 3 presents and discusses factors affecting long-run trends in natural gas use rates. The next nine sections address key findings from the 2012 REUS survey, organized by the respective topic areas of the survey instrument. Topic areas addressed are:

- Building Envelope and Renovations
- Space Heating
- Domestic Hot Water
- Fireplaces and Heating Stoves
- Appliances
- Pools, Hot Tubs, and Saunas
- Energy Use Behaviours
- Products and Services
- Demographics

Findings from the conditional demand analysis, including regional-specific Unit Energy Consumption (UEC) estimates by end-use, are provided in Section 14. The results of the gas end-use combinations analysis are summarized in Section 15. A bibliography of referenced research and articles is included in Section 16.

This document is accompanied with two appendices. Appendix A includes the 2012 REUS questionnaire. Appendix B presents background methodology and detailed equations used in the conditional demand analysis.

### 2.5 Using this Report

This report presents a substantial body of information and data about FortisBC's residential gas customers. Trends in the data are identified through comparisons with past REUS studies and/or using additional information and statistics from third party sources. Considerable effort has been made to ensure the data presented are accurate and statistically representative of the FortisBC's residential customer base. The quality of the analysis and interpretation of the data are dependent, in part, on the accuracy of the information provided by survey respondents. The technical nature of many of the questions in the REUS survey inevitably means that unintentional misclassifications or reporting errors by survey respondents are possible. Where evident, quality issues are identified, implications discussed, and remedies, if possible, provided.

The sheer volume of information contained in this report means its primary purpose is as a reference document; filling gaps in information about residential energy issues. Analyses and conclusions are meant to further discussion and understanding of residential energy trends and the factors influencing them.

# 3 BACKGROUND & METHODOLOGY

This section discusses the sampling plan, questionnaire topics, survey implementation, survey response, and representativeness of the survey results for the 2012 REUS. This section also provides a list of terms, definitions, and explanatory notes to assist the reader in the interpretation of the reported results.

## 3.1 Sample Frame and Sampling Plan

The sampling plan for the 2012 REUS was more complex than past studies because of the need to ensure representative samples of residential customers were obtained for both the natural gas (FEU) and electric (FBC) divisions of FortisBC. Additionally, the sampling plan needed to ensure representative samples for regions within each division, including the Interior region where approximately 50% of the customers were common to both divisions (i.e., shared services). Interior region customers were oversampled to ensure these needs were met.

For the FEU REUS, the sample plan required representative samples of natural gas customers from each of the FEU's five regions:

- Lower Mainland (LM)
- Interior (Inland and Columbia) (INT)
- Vancouver Island / Sunshine Coast (VI)
- Whistler (W)
- Fort Nelson (FN)

Customer counts for each of these regions (i.e., the sample frame) are provided in Table 1.

**Table 1: FEU Residential Customer Counts (Sample Frame)**

| Region / Business Unit | Customer Counts | Percent Distribution |
|---|---|---|
| Lower Mainland (LM) | 528,192 | 61.7% |
| Interior (Inland and Columbia) (INT) | 231,522 | 27.0% |
| Vancouver Island / Sunshine Coast (VI) | 92,067 | 10.8% |
| Whistler (W) | 2,271 | 0.3% |
| Fort Nelson (FN) | 1,947 | 0.2% |
| **Total (FEU)** | **855,999** | **100%** |

For reference purposes, customer counts for FBC's electric customers are provided in Table 2.

**Table 2: FBC Residential Customer Counts (Sample Frame)**

| Region / Business Unit | FBC Direct | FBC Indirect | FBC Total | Percent Distribution |
|---|---|---|---|---|
| Kelowna / Central Okanagan (KE) | 44,378 | 13,037 | 57,415 | 40% |
| South Okanagan (SO) | 20,994 | 20,542 | 41,536 | 29% |
| Kootenay / Kootenay Boundary (KB) | 33,713 | 10,406 | 44,119 | 31% |
| **Total (FBC)** | **99,085** | **43,985** | **143,070** | **100%** |

### 3.2 Sample Sizes and Sample Preparation

FEU's 2008 REUS had targeted 2,715 survey completions but realized 2,221 completed surveys. The target for the 2012 REUS (gas customers) was set at 5,000 surveys. The decision to increase the target number of survey completions for the 2012 REUS was attributed to FortisBC's desire to:

- reduce the standard errors of point estimates, especially for less common end-uses, behaviours, and building types;
- accommodate analysis of FBC customer results by its three regions ((Central Okanagan, South Okanagan / Similkamee, West Kootenay / Kootenay Boundary), and whether these customers were directly or indirectly served by FBC;
- improve the accuracy and reliability of conditional demand analysis estimates of unit energy consumption (UEC) for each of the major gas regions; and
- accommodate oversampling in regions with a history of low response rates (e.g., Lower Mainland).

Similar to that of past REUS surveys, eligibility for inclusion in the sample was restricted to customers with a minimum of two years of uninterrupted gas billing history. This was a requirement of the conditional demand analysis (CDA). As a result, customers whose residence was constructed since fall of 2010 or who changed residences in the two years leading up to the survey were excluded from the REUS sample frame.

Assuming an average survey response of 20%, achieving 5,000 completed surveys required a mail-out of 25,000 questionnaires. This target was expected to yield an overall accuracy of +/- 1.4% at the combined utility level using a 95% confidence interval. The sampling plan sought to achieve accuracy levels in the major FEU regions of +/- 3% or less.

All customer samples, with the exception of FBC's indirectly served customers[1], were randomly drawn from FEU's customer accounts. For customers in the shared services region, FBC drew a random sample of direct customers which was then merged with FEU's customer accounts to identify customers with a gas account. Finally, a third party sample of households located in areas serviced by municipal (wholesale) utilities was purchased and merged with FEU gas accounts to complete the sample frame for the Interior.

### 3.3 Questionnaire Design and Topics

The 2012 REUS questionnaire was designed with strong emphasis on ensuring comparability and consistency with past REUS surveys. Any modifications to questions and/or response categories were made to either improve question performance or accommodate trends in residential end-use equipment. Additionally, the order in which some questions were asked on the questionnaire was changed from the previous REUS to improve flow. The 2012 REUS questionnaire expanded its use of graphics and explanatory text boxes to help respondents correctly categorize their equipment and household features. In situations where several different models of a particular end-use are possible (e.g., differing types of domestic hot water heaters), questions were worded using visual clues or identifiers to improve respondents' ability to correctly classify their equipment through observation.

[1] Indirect customers receive their electrical service from a municipal electric utility (e.g., Kelowna, Summerland, Penticton, Grand Forks, or Nelson). These municipal utilities resell electricity supplied by FortisBC.

Table 3 summarizes the major subject areas addressed by the 2012 REUS with comparisons to past FEU and FBC REUS surveys.

**Table 3: REUS Survey Topics – Comparisons to Past REUS Surveys**

| Survey Topic Group | FEU 2012 | FEU 2008 | FEU 2002 | FEU 1993 | FBC 2012 | FBC 2009 |
|---|---|---|---|---|---|---|
| Dwelling characteristics | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Space heating | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Fireplaces | ◆ | ◆ | ◆ | ◆ | ◆ | |
| Domestic water heating | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Appliances | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Indoor and outdoor lighting | | | | | ◆ | ◆ |
| Pools and hot tubs | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Energy-related renovations | ◆ | ◆ | ◆ | ◆ | ◆ | |
| Rates and tariffs | | | ◆ | | | |
| Energy use behaviours | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |
| Products and services | ◆ | ◆ | ◆ | ◆ | ◆ | |
| Communications with FortisBC | | | ◆ | | | |
| Energy attitudes & preferences | ◆ | ◆ | ◆ | | ◆ | ◆ |
| Socio-demographics | ◆ | ◆ | ◆ | ◆ | ◆ | ◆ |

### 3.3.1 New Topics

The following topics were new to the 2012 REUS:

- Part-time or full-time use of the residence for a home-based business
- Value of any repairs made to furnaces or boilers in the last three years
- Hot water tank size
- Proximity of hot water tank to an electrical outlet
- Presence of a drain water heat recovery system
- Faucet aerators and instant hot water dispensers
- Use of high efficiency (ECM) motors for swimming pools
- Presence of saunas and sauna fuels
- Presence of gas outdoor fireplace or fire pit
- Likelihood of purchasing air conditioning in the upcoming year
- Sources of information used for major appliance purchase decisions
- Person(s) in the household making the most effort to conserve energy
- Familiarity with utility energy conservation initiatives
- Respondent's role in major appliance purchase decisions
- Access to the internet
- Presence of secondary suites, detached garages/workshops, other buildings, and well pumps
- Installation of an ENERCHOICE fireplace in the past five years

### 3.3.2 Other Questionnaire Changes

Expansions / modifications of existing questions / topics in the 2012 FEI REUS questionnaire included:

- inclusion of electric forced air furnace as a space heating method;

- inclusion of two types of on-demand hot water heaters (with or without an expansion tank), and hybrid (heat pump) hot water heaters; and
- an expanded appliance section.

Two versions of the REUS questionnaire were developed. Customers identified as having both gas and electric (direct or indirect) service provided by FortisBC or the possibility of shared services received an expanded questionnaire with sections dedicated to electrical end-uses such as lighting. The questionnaire received by gas-only customers excluded these dedicated electric-only sections.

The final version of the 2012 FEU (gas) questionnaire is included in Appendix A.

### 3.4 Survey Implementation

The Vancouver office of IPSOS Reid was responsible for implementing the survey, data cleaning, tabulating results, and incentive management. The survey was mailed to households in hardcopy form, accompanied by a self-addressed return envelope. Recipients could either complete the hardcopy survey and return by mail, or complete an online version of the survey. Each recipient was assigned a unique entry code which allowed the marketing research firm to control the possibility of duplicate surveys from the same households. Incentives to complete the survey included a chance at winning of one of four $1,000 gift certificates to a home improvement store. To encourage online responses, respondents completing their survey online had their name entered in the prize draw an additional time, effectively doubling their chances of winning.

A total of 25,400 questionnaires were mailed out in the fourth week of November 2012. Reminder cards were mailed out a week later. Respondents were given four weeks to complete the survey.

A total of 3,441 valid surveys were received, of which 41% were completed online. The overall response rate was 13.7%, considerably lower than the 20% achieved in 2008. The lower than expected response rate is attributed to the length of the survey, the technically challenging nature of many of the survey questions, and the timing of the survey's release (last week of November). Survey response rates by region are summarized in Table 4.

**Table 4: FEU REUS Survey Response Summary (%)**

| Region / Business Unit | Surveys Mailed | Completed Surveys | Response Rate (%) | Surveys Completed Online (%) |
|---|---|---|---|---|
| Lower Mainland (LM) | 6,250 | 793 | 12.7 | 45.0 |
| Interior (Inland and Columbia) (INT) | 12,171* | 1,707 | 14.0 | 41.7 |
| Vancouver Island / Sunshine Coast (VI) | 3,704 | 752 | 20.3 | 36.7 |
| Whistler (W) | 1,650 | 85 | 5.2 | 41.7 |
| Fort Nelson (FN) | 1,294 | 107 | 8.3 | 41.0 |
| **Total (FEU)** | **25,069** | **3,444** | **13.7** | **41.3** |

* Joint sample of gas and electric customers

## 3.5 Weighting of Results

Weights were used to restore the relative proportions of the five regions to that of the FEU customer population. The weights were calculated using equation (1):

$$W^r = (P^r/P^{FEU}) / (S^r/S^{FEU}) \qquad (1)$$

W = weight
P = population (sample frame)
S = survey returns
r = FEU region
FEU = total of all FEU regions

Table 5 presents the weights calculated using this formula and used in analyses of the 2012 REUS data:

**Table 5: FEU 2012 REUS Weights**

| FEU Region | Weight |
|---|---|
| Lower Mainland / Fraser Valley | 2.6773 |
| Interior / Kootenay | 0.5455 |
| Vancouver Island / Sunshine Coast | 0.4919 |
| Whistler | 0.1053 |
| Fort Nelson | 0.0761 |

## 3.6 Accuracy of Survey Estimates

The margin of error (accuracy level) for 2012 REUS questions varies by region and the degree of consensus. Table 6 summarizes accuracy levels at the 95% confidence level for a typical range of "yes-no" type questions for each of the five FEU regions and the five region total (FEU). Comparable margins of error at the FEU level for the 2008 REUS survey are provided, as are margins of error for the subset of Lower Mainland, Interior and Fort Nelson regions (FEI) for 2012, 2008 and 2002. The latter are provided to allow comparison with the 2002 REUS which did not include Vancouver Island or Whistler.

**Table 6: Accuracy Levels for Proportional Responses by Region (%)**
**Percent Plus or Minus at the 95% Confidence Level**

| Accuracy / Proportional Response | LM +/- | INT +/- | VI +/- | W +/- | FN +/- | FEU 2012 +/- | FEU 2008 +/- | FEI 2012 +/- | FEI 2008 +/- | FEI 2002 +/- |
|---|---|---|---|---|---|---|---|---|---|---|
| 50% | 3.5 | 2.4 | 3.6 | 10.6 | 9.6 | 2.3 | 3.2 | 2.5 | 3.5 | 2.4 |
| 40% or 60% | 3.4 | 2.3 | 3.5 | 10.4 | 9.4 | 2.2 | 3.2 | 2.5 | 3.4 | 2.4 |
| 30% or 70% | 3.2 | 2.2 | 3.3 | 9.7 | 8.8 | 2.1 | 3.0 | 2.3 | 3.2 | 2.2 |
| 20% or 80% | 2.8 | 1.9 | 2.9 | 8.5 | 7.7 | 1.8 | 2.6 | 2.0 | 2.8 | 2.0 |
| 10% or 90% | 2.1 | 1.4 | 2.1 | 6.4 | 5.8 | 1.4 | 1.9 | 1.5 | 2.1 | 1.5 |
| **Number of respondents (unweighted)** | **793** | **1707** | **752** | **85** | **104** | **3441** | **2221** | **2604** | **1446** | **1610** |

At the FEU company level, a typical question with a "50-50" response (e.g., 50% answering yes, 50% answering no) will have an accuracy of plus or minus 2.3%, 19 times out of 20. The margin of error varies by region, reflecting differing proportions of completed surveys to the sample population. Regardless of region, margins of error decrease as the consensus of the survey estimate increases. Thus, a yes-no type question with 90% answering "yes" will have an accuracy at the FEU level of plus or minus 1.4%, 19 times out of 20.

### 3.7 Abbreviations, Definitions & Explanatory Notes

The following definitions and notes are included to aid in the interpretation of survey results and the general readability of the report.

**Conditional Demand Analysis (CDA) –** A statistical method for proportioning total household natural gas consumption by individual gas end-uses (e.g., space heating, domestic hot water, cooking, etc.). CDA requires data on the penetration and saturation of end-uses by customer, matched to their billing consumption data. As an indirect approach to estimating end-use consumption[2], diversity in the penetration, saturation, and usage of the end-uses within the sample population is required for the model to isolate the consumption of any particular end-use.

**Data presentation –** Data and statistics are presented in a variety of formats, including tabular, graphical, and within descriptive paragraphs. The expression of percentages in the form of ratios (e.g., one-in-ten, one-in-five, etc.) within the text of this report reflects the style preferences of FortisBC.

**Don't Know (DK) Responses** – Some survey questions include a "don't know" (DK) response category. The relative proportion of respondents who answered DK provides useful information, and often is related to the complexity of question's subject. In some cases, it is legitimate to recalculate proportions for the question excluding DK responses. Effectively, this recalculation assumes the distribution of the DK responses is proportional to those who provided a response. Re-proportioning DK responses is not valid in cases where the "proportionate distribution" assumption does not apply. For example, uncertainty regarding furnace efficiency may be proportionately higher for households with older mid- or standard efficiency furnaces than for those with high efficiency furnaces. In cases such as these, a DK response should be treated as a legitimate response and included in the base for calculating the relative proportions of the other response categories.

**DWH** – Domestic water heater

**FAF** – Forced air furnace

**FEU (FortisBC Energy Utilities)** – Represents the collective name of the three corporate utilities that make up FortisBC's Gas Utility, including FortisBC Energy Inc., FortisBC Energy (Vancouver Island) Inc. and FortisBC Energy (Whistler) Inc.

**FEU 2008** – Represents data from FortisBC Energy Utilities' (FEU) 2008 residential end-use survey including customers from the Lower Mainland/Fraser Valley, Vancouver Island / Sunshine Coast, Interior and Columbia, Whistler, and Fort Nelson. These data were published in the 2008 REUS report under the designation "2008 TG" (Sampson Research 2009).

[2] As opposed to a more direct method of metering of individual end-uses.

**FEU 2012** – Represents data from FEU's 2012 residential end-use survey including gas customers from the Lower Mainland/Fraser Valley, Vancouver Island / Sunshine Coast, Interior and Columbia, Whistler, and Fort Nelson.

**FEI (FortisBC Energy Inc.)** – Represents a subset of FEU gas customers, including those in the Lower Mainland, Interior, Columbia, and Fort Nelson regions. Excludes customers in Vancouver Island / Sunshine Coast and Whistler.

**FEI 2002 –** Represents utility level data from FEU's 2002 residential end-use survey for gas customers in the Lower Mainland, Interior, Columbia, and Fort Nelson regions. Excludes customers in Vancouver Island / Sunshine Coast and Whistler. Comparisons to 2002 REUS results use data that were originally published in the 2003 REUS report (Habart 2003). These data were republished in the 2008 REUS report under the designation "2002 TGI" (Sampson Research 2009).

**FEI 2008 –** Represents utility level data from FEU's 2008 residential end-use survey for gas customers in the Lower Mainland, Interior, Columbia, and Fort Nelson regions. Excludes customers in Vancouver Island / Sunshine Coast and Whistler. These data were published in the 2008 REUS report under the designation "2008 TGI" (Sampson Research 2009).

**FEI 2012 –** Represents utility level data from FEU's 2012 residential end-use survey for gas customers in the Lower Mainland, Interior, Columbia, and Fort Nelson regions. Excludes customers in Vancouver Island / Sunshine Coast and Whistler.

**Footnotes** – With the exception of footnotes in data tables, footnotes referenced in the text of the report are found at the bottom of the page. Footnotes pertaining to data in tables are situated immediately below the table in question.

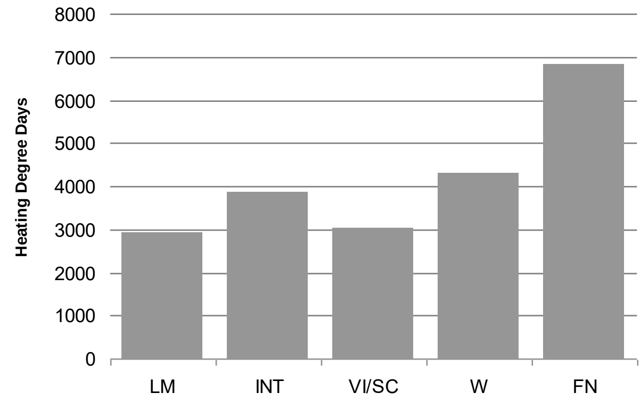
**FN** – Fort Nelson

**Natural Gas vs. Piped Propane** – Geographic coverage for the 2012 REUS survey included a small number of customers in areas serviced by piped propane systems (e.g., Revelstoke). Unless otherwise stated, all references to "piped gas" in the report refer to either piped gas or piped propane.

**Heating Degree Day (HDD)** - Defined as the difference between a reference value of 18°C and the average outside temperature for that day. The number of HDDs reflect the amount by which the outside temperature falls below 18 degrees Celsius and length of time below that temperature. The number of HDDs provides a good indication of the amount of heating required to maintain a comfortable indoor temperature.

Figure 1 (next page) shows the relative severity of a typical winter for each of FEU's five regions, as indicated by 30 year HDD averages. Lower Mainland (LM) and Vancouver Island / Sunshine Coast (VI) regions have the warmest winters (each with approximately 3,000 HDDs per year), while winters in the Interior (INT) and Whistler (W) regions are colder (approximately 3,800 and 4,300 HDDs per year respectively). The northerly Fort Nelson (FN) region is the coldest, recording more than 6,800 HDDs per year.

**Figure 1: Typical Annual Heating Degree Days by Region**




Source: Environment Canada, 1971-2000 Climate Normals

**INT** –Interior region including Inland and Columbia

**LM** – Lower Mainland / Fraser Valley

**Non-Response (NR)** – Sometimes categorized as missing values, they refer to cases where a respondent chose not to answer a question. In these cases, non-responses are treated differently from "Don't Know" (DK) responses as they imply neither uncertainty nor certainty of a response. Indeed, they provide no information from which to extrapolate a response. All calculations in this report, unless stated or otherwise indicated, exclude missing or NR values. This is done to avoid distorting the proportions assigned to the response categories based on those who answered the question.

The 2002 REUS report represents an exception to this assumption. Missing data and Don't Know responses were often reported as a combined statistic and reported as DK/NR. In cases where the 2002 survey questionnaire did not provide a separate DK response category (e.g., check box), it was assumed that all responses in the DK/NR category represented missing values. In these situations, proportions were restated to exclude the missing values, making them consistent to the approach used in the 2008 and 2012 REUS reports. In all other situations, the DK/NR estimate from the 2002 REUS was left unchanged and footnoted in the tables.

**Penetration** – Defined as the number of households with a particular appliance or end-use divided by the total number of households with or without the appliance or end-use. Penetration is used to understand the proportion of FEU's residential customer base with the appliance or end-use in question. Penetration does not concern itself with how many of the appliances or end-uses an individual household has, only the presence of at least one. Commensurately, the upper limit on any penetration estimate is 100%.

**Saturation** – Defined as the total number of appliances or end-uses divided by the number of households with and without the appliance or end-use. Saturation provides an estimate of the average number of specific appliances or end-uses per typical FEU residential customer. Saturation estimates are influenced by the number of appliances present in user households and the penetration of the appliance in the general population. For example, the saturation of low flow shower heads is a function of how many households use them and the number installed. As homes may have more than one appliance or end-use there is no theoretical upper limit on saturation estimates.

**SFD –** Single family detached dwelling

**Significant Digit Conventions –** Except where otherwise indicated, all data placed in the text of this report have been rounded to the nearest significant digit. To facilitate analyses and calculations by FEU, data presented in tables and figures are expressed to one decimal place, and in some cases (e.g., saturation rates) two decimal places. This also allows tables to accommodate the occasional small response proportion (i.e., penetrations of less than 1%).

**Unit Energy Consumption (UEC) –** The annual energy consumed by a piped gas or propane end-use in a given year. UECs for gas utilities are estimated by conditional demand analysis. The size of an UEC estimate is determined, in part, by the purpose of the end-use (e.g., cooking, space heating, etc.), the efficiency of the end-use equipment, and its use (occupant behaviours). UECs for some end-uses, particularly space and water heating, are also weather (HDD) dependent.

**Unweighted Base** – All tables whose data and/or calculations share the same base will have the unweighted base for the statistics indicated. These numbers reflect the actual number of surveys where a valid response to the question was received. The size of the unweighted base is useful to help guide comparisons with other data and understanding the relative accuracy of the estimates. Unless indicated otherwise, unweighted bases indicated in this report exclude non-responses or missing values (see definition of non-response, below). The unweighted base may change somewhat from question to question depending upon the degree of non-response.

**VI** – Vancouver Island / Sunshine Coast

**Weighted Results** – All utility level results (FEU, FEI) are based on weighted data to ensure proportionate representation from the respective regions.

**W** – Whistler

**Additional Notes to Tables**

**n/a** Not Applicable – Used when data are unavailable for comparison.

**--** No responses were received for the particular category or cell.

**0.0*** Value less than 0.1 or 0.1%

**0.00*** Value less than 0.01

# 4 TRENDS

This section presents and discusses key trends in household formation and composition, end-use penetration rates, equipment efficiency, and construction trends that are influencing natural gas consumption for FortisBC's residential customers. The primary objective of this section is to provide context for understanding and interpreting the findings from the 2012 REUS, particularly when its findings are compared with those from past REUS surveys. Implications of these trends and developments on the residential demand for natural gas over the medium-term are discussed.

## 4.1 Trends in Natural Gas Consumption

### 4.1.1 Use Rates

Natural gas consumption on a per-FEU household (per-account) basis, normalized for year-to-year variations due to temperature, is down significantly (24%) since 1999 (Table 7). Since the last REUS (2008), use rates have continued to decline, although the amount of the decline is understated somewhat due to a recent change in the definition of a valid customer account.[3] Declines in use rates have occurred in all FEU regions, most notably Vancouver Island (down 32% since 1999), the Interior (down 27%), and the Lower Mainland (down 19%). Declining residential consumption of natural gas is a North American-wide phenomenon.

**Table 7: FEU Weather Normalized Gas Use Rates by Region – 1999-2012**

| Year | LM | INT | VI | W | FN | FEU |
|---|---|---|---|---|---|---|
| 1999 | 121.9 | 104.5 | 71.9 | 94.8 | 161.4 | 114.1 |
| 2000 | 116.9 | 99.5 | 68.4 | 91.8 | 158.0 | 109.2 |
| 2001 | 105.2 | 88.1 | 66.2 | 87.9 | 167.3 | 98.4 |
| 2002 | 118.4 | 89.5 | 66.6 | 89.4 | 156.5 | 107.1 |
| 2003 | 111.5 | 89.2 | 61.8 | 90.6 | 162.3 | 102.3 |
| 2004 | 108.3 | 86.1 | 59.0 | 85.7 | 166.4 | 99.1 |
| 2005 | 103.6 | 82.4 | 58.7 | 93.4 | 153.7 | 95.0 |
| 2006 | 103.2 | 82.0 | 60.2 | 85.6 | 141.5 | 94.7 |
| 2007 | 102.6 | 80.8 | 57.0 | 95.7 | 141.9 | 93.8 |
| 2008 | 99.5 | 76.5 | 56.1 | 95.2 | 139.6 | 90.5 |
| 2009 | 99.8 | 76.3 | 52.6 | 80.0 | 138.4 | 88.3 |
| 2010 | 99.3 | 74.9 | 51.8 | 99.1 | 140.1 | 87.5 |
| 2011 | 96.7 | 74.1 | 51.2 | 93.6 | 136.9 | 85.6 |
| 2012 [1] | 98.3 | 76.3 | 49.0 | 88.0 | 138.3 | 86.9 |
| **Change 1999-2012** | **-19.4%** | **-27.0%** | **-31.9%** | **-7.2%** | **-14.3%** | **-23.8%** |

[1] Increase over 2011 due, in part, to a change in the definition of a valid customer account.

### 4.1.2 Natural Gas Intensities (GJ/ft$^2$)

Declines in natural gas use rates are consistent with the long-term decline in average gas intensities (GJ consumption per square foot) of residential construction.

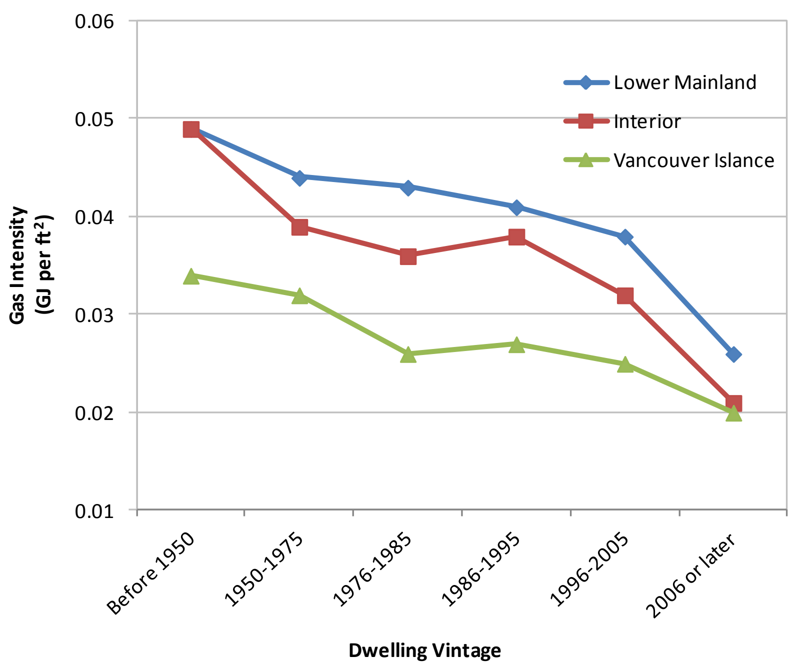
[3] Source: Email correspondence from Walter Wright, FEU. This change affects use rate calculations for 2012 going forward.

## TRENDS

Figure 2 shows the gas intensity (GJ/ft$^2$) trend for single family detached homes constructed in the Lower Mainland since 2005 is lower by almost half (47%) than homes constructed prior to 1950. The relationship also holds true for more recent vintages. Lower Mainland homes constructed since 2005, as an example, use 40% less natural gas per square foot than homes constructed between 1976 and 1985. Similar trends have occurred in the Interior and, to a lesser extent, on Vancouver Island.

The declines in residential gas intensity per-square foot reflect the net effect of improvements in thermal envelope and end-use equipment efficiency, trends in penetration rates for gas end-uses, the demand response to higher gas prices, plus other factors affecting both new and existing dwellings.

**Figure 2: Gas Intensity Trend**
**Single Family Detached Dwellings – 2012 REUS Data**




### 4.2 Factors Influencing Natural Gas Use and Intensity

Factors influencing natural gas use rates over time include:

- changes in the mix of dwelling types in new construction;
- changes in the penetration rates of gas appliances and equipment in new and retrofit construction;
- increasing efficiency of gas furnaces, boilers, water heaters, and other gas-related appliance stocks;
- improvements in thermal efficiency of the building envelope;
- changing demographic characteristics of FortisBC's residential customer base; and
- other factors, including short- and long-term responses to changes in the price of natural gas (demand elasticities) and cross effects.

Some trends influencing natural gas consumption are short-term and transient, such as behavioural responses to short-lived increases or decreases in the price of natural gas. Others are long-term and are more sustained, such as long-run trends in new housing construction and legislated improvements in the efficiency of gas furnaces and hot water-using appliances. Some trends partly or wholly offset each other, while other trends complement each other. An example of an offsetting trend is the improvement in the efficiency of natural gas furnaces which is being partially offset by the increase in overall home size (square footage). An example of a complementary trend is the increased efficiency of domestic water heaters and the reduced demand for hot water associated with an aging customer base.

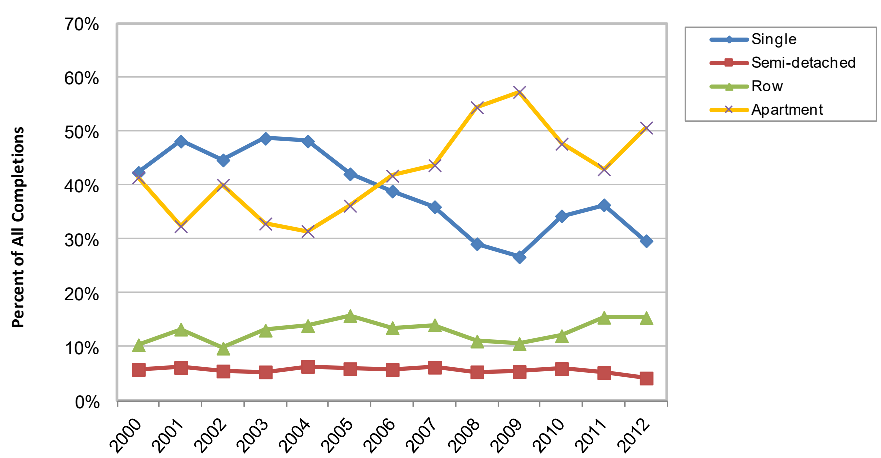
It is not the purpose of this section of the 2012 REUS report to quantify the relative contribution of the factors underpinning the long-run decline in natural gas use rates.[4] Rather, it is to provide an overview of key trends and developments influencing gas use rates for FortisBC's residential natural gas customer base.

Published research on natural gas use trends and influencing factors from other North American jurisdictions are referenced in this section where relevant. Third party research on gas trends, although less voluminous compared to that devoted to understanding the forces driving electricity use, confirms that many of the factors and trends influencing natural gas consumption in British Columbia are occurring across North America.

### 4.2.1 Trends in New Construction – Dwelling Type Mix

Canada Mortgage and Housing Corporation (CMHC) data show that residential construction in urban areas of British Columbia has been shifting away from single family detached dwellings towards apartments and row/townhouses for the last ten years (Figure 3).

**Figure 3: Dwelling Type Shares - Housing Completions in Urban BC**



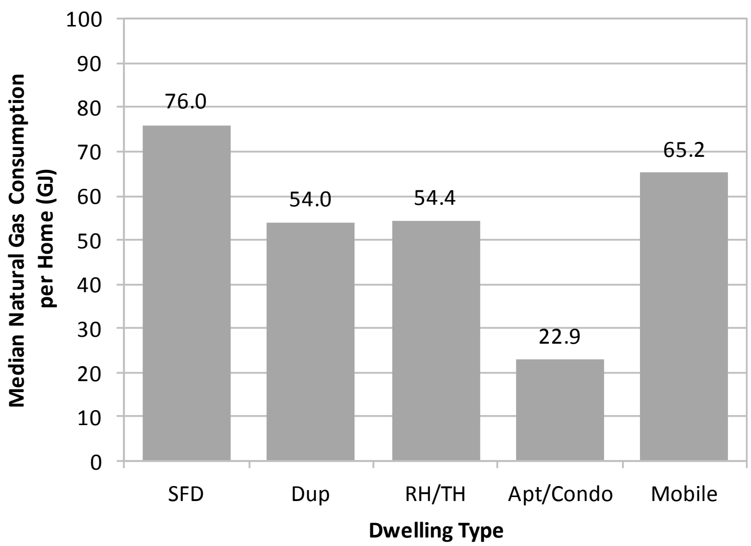

Data source: CMHC

[4] Natural Resources Canada's *Energy Efficiency Trends in Canada, 1990 to 2009*, (Cat. No. M141-1/2009E-PDF), December 2011 provides a good discussion of the relative impact of the various trends and factors influencing energy use in the residential sector. The long-term change in energy use (all fuels) by Canadian homes is explained by quantifying five different contributing factors including changes in the number of households and floor space (activity), changes in the mix of dwelling types (structure), changes in the relative penetration of various appliances and end-uses (service level), differences in heating and cooling degree days (weather), and improvements in appliance efficiency and the thermal envelope of homes (energy efficiency).

Single family detached dwellings have seen their share of new construction decline from nearly half (49%) of all dwelling completions in 2003 to just three-in-ten (30%) in 2012. In contrast, apartments (CMHC data is for individual apartment units regardless of whether they have gas) represented more than half of all new construction in 2012. As newly built dwellings represent only a one to two percent increase in the total stock of housing in British Columbia in a given year, new construction trends influence the relative composition of the stock of housing relatively slowly over the long-term.

The changing mix of dwelling types constructed in British Columbia will influence natural gas use rates in the long run as the amount of gas consumed by duplexes, townhouses, apartments / condominiums and mobile homes is typically less than single family detached units. Using data from the 2012 REUS, the median annual consumption for single family detached homes in FEU's service region is 76 GJ, compared to 54 GJ for row houses/townhouses, and 23 GJ for individually metered apartments /condominiums (Figure 4).

**Figure 4: Median Annual Natural Gas Consumption by Dwelling Type – 2012 REUS**

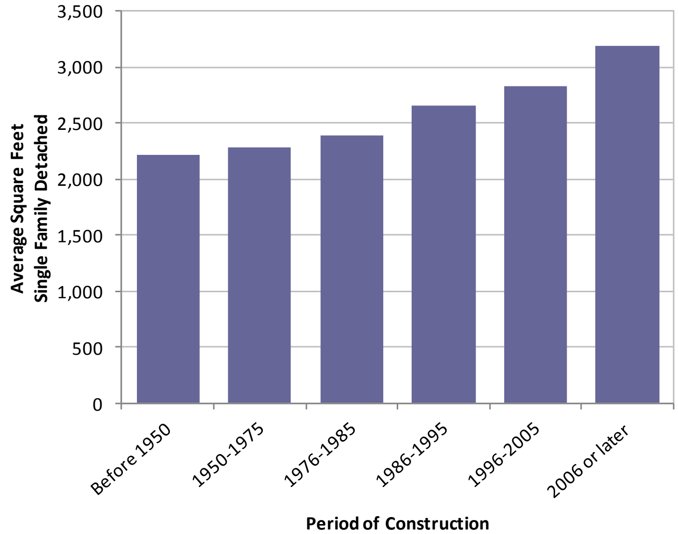



### 4.2.2 Trends in New Construction - Dwelling Sizes and Ceiling Heights

While the changing mix of dwelling types in new construction is placing downward pressure on gas intensities, the tendency for newer single family detached homes to be larger (greater floor area and internal volumes) is countering this trend to some degree. This increase in interior volume creates more demand for space heating and cooling.

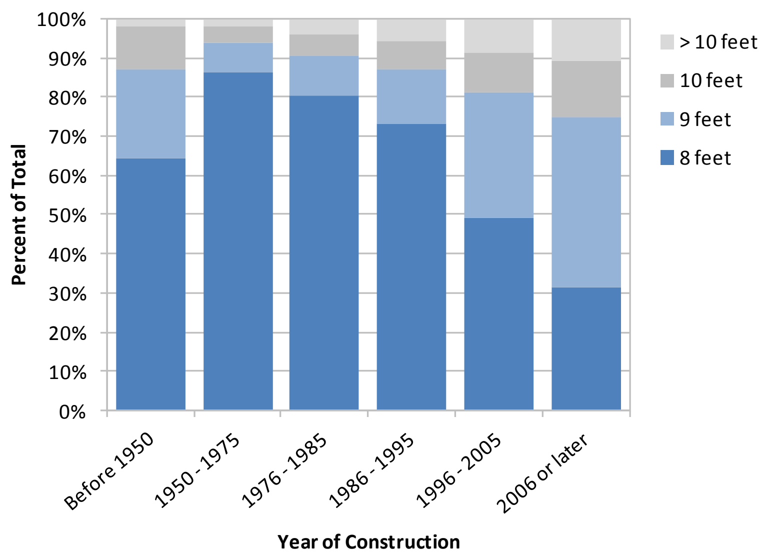
Figure 5 (next page) illustrates the trend towards the increasing square footage of single family detached dwellings as indicated in data collected by the 2012 REUS. Including basements in the calculation of square footage, the average single family detached dwelling constructed since 2005 is 40% larger than those constructed in the 1950-75 period.

**Figure 5: Floor Space Trends in New Construction Single Family Detached Dwellings**




Accompanying the trend toward increased floor space, average ceiling heights have been increasing, with a shift towards ceilings of nine and ten feet among homes built since 1985 (Figure 6).

**Figure 6: Ceiling Height Trends in New Construction**




### 4.2.3 Penetration Rates for Gas Appliances and Equipment

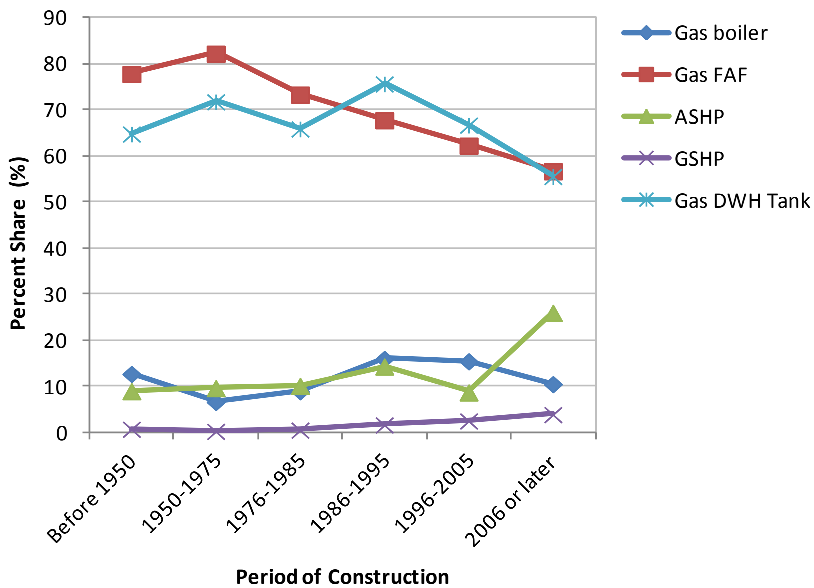
There are several trends in new and retrofit construction affecting penetration rates for gas appliances and equipment. These trends, in turn, impact average gas consumption per home. These trends include:

- a shift away from thermal gas end-uses (e.g., space heating, domestic water heating) to smaller, convenience gas end-uses (e.g., gas cooking, etc.) in newer construction;

- increasing efficiency of gas furnaces and boilers; and
- increasing popularity of air source heat pumps and, to a lesser degree, ground source heat pumps.

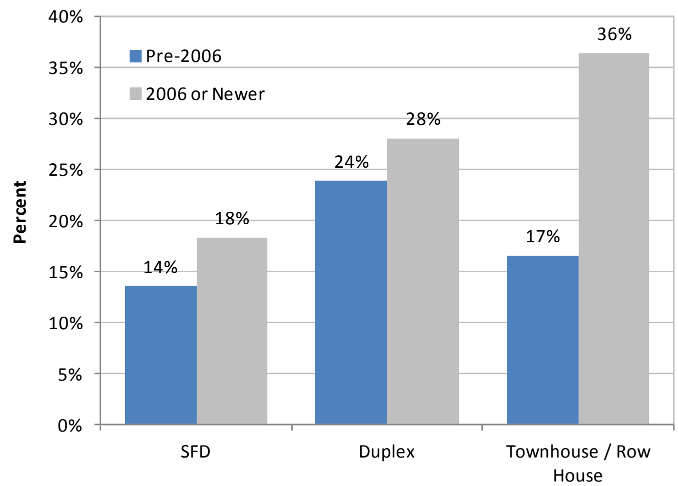
Figure 7 compares penetration rates for major gas space and water heating equipment from the 2012 REUS. The penetration of gas forced air furnaces in homes constructed since 2005 is 25 percentage points lower compared to homes built during the 1950-75 period. Gas hot water tanks have lost share as well, although the decline is more recent (decline in share of 20 percentage points since the mid-1990s). The increase in the penetration of air source heat pumps in homes constructed since 2005 (up 17 percentage points from 1996-2005) is noteworthy, as many of these units are paired with a gas furnace. The net effect is to reduce the amount of gas used for space heating. A modest upward trend in the ground source heat pumps is evident, but penetration is still quite low.

**Figure 7: Penetration Rates – Larger Gas End-Uses & Heat Pumps**



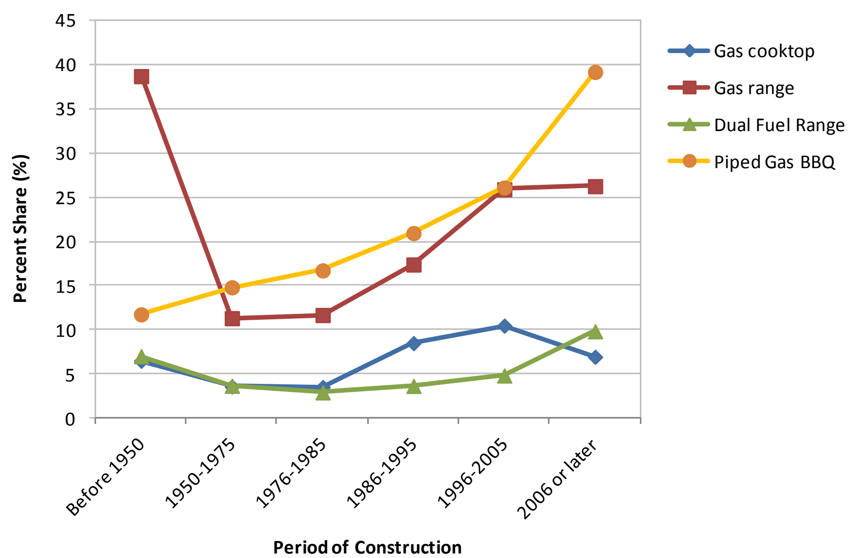

While some of the changes observed in penetration rates will be due to retrofits and renovations, the majority come from decisions taken at the time of new construction. This is evident in Figure 8 (next page) which illustrates the decline of the traditional pairing of gas furnace (or boiler) and gas DWH. Homes constructed since 2006 with a gas furnace or boiler are significantly less likely to use gas for DWH compared to those built prior to 2006. The size of the decline is particularly notable for row/townhouses (17% for homes built before 2006 versus 36% for homes built since this time).

**Figure 8: Penetration Rates – Dwellings with Gas Furnaces or Boilers but No Gas DWH**



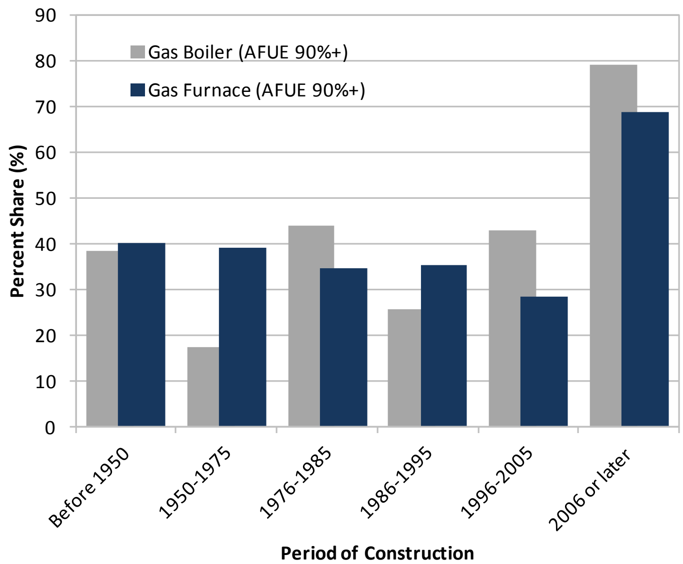

Declines in penetration rates for larger gas end-uses in new construction are being partially offset by increasing penetration of gas end-uses that represent smaller loads for FEU, notably gas ranges (gas cook top and oven), dual fuel ranges (gas cook top and electric oven), and piped gas barbeques (Figure 9).

**Figure 9: Penetration Rates – Gas Cooking End-Uses**




Legislation mandating the use of higher efficiency furnaces and boilers in new and retrofit construction is transforming the market for gas space heating equipment. When combined with declining penetration rates, this is accentuating the decline in gas load for space heating. Figure 10 (next page) shows the impact of legislated standards for homes constructed since 2005. Stocks of gas furnaces and boilers in older dwellings are gradually becoming more efficient as older, less efficient, units wear out and are replaced with high efficiency units.

**Figure 10: Penetration Rates – Energy-Efficient Gas Furnaces and Boilers**




### 4.2.4 Appliance Efficiency Trends

Several developments have influenced improvements in the energy efficiency of major home appliances that either use natural gas directly (e.g., gas furnaces) or indirectly through the demand for hot water heating (e.g., horizontal axis clothes washing machines, dishwashers, etc.). They include:

- legislated minimum efficiency standards for gas and gas related appliances;
- increase in market share captured by ENERGY STAR® appliances; and
- demand-side management initiatives.

#### Legislated Appliance Efficiency Standards

At the national level, the Energy Efficiency Act (1995) regulates a broad range of energy-using appliances, although the vast majority were initially subject to testing and/or reporting requirements only, rather than minimum energy efficiency criteria. Energy efficiency standards have been also been enacted provincially by British Columbia, most recently under its Energy Efficiency Act (2008).

Table 8 (next page) summarizes past and proposed changes in the energy efficiency standards and regulations for:

- gas furnaces
- gas boilers
- gas water heaters
- gas ranges
- automatic clothes washing machines
- gas fireplaces and free standing stoves
- dishwashers

**Table 8: Summary of Energy Efficiency Standards by Appliance Type**

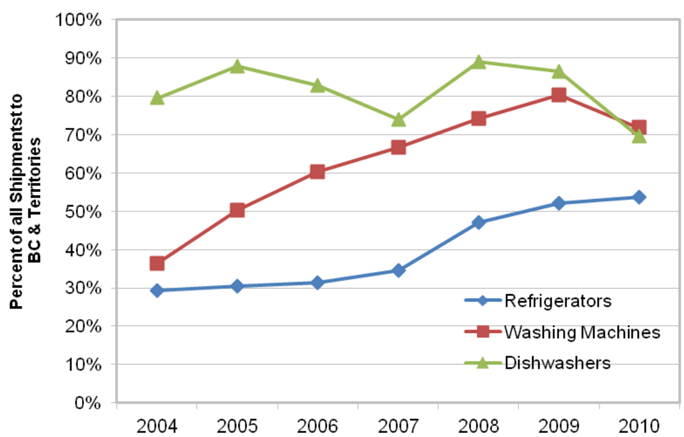
| Appliance | Energy Efficiency Standards |
|---|---|
| Gas furnaces of less than 225,000 Btu/hour | Test Standard: CSA P.2-07<br><br>Canada:<br>February 3, 1995: minimum AFUE of 78%, all furnaces<br>December 31, 2009: minimum AFUE of 90%, except thru-the-wall furnaces<br>December 31, 2012: minimum AFUE of 90% for thru-the-wall furnaces<br><br>British Columbia:<br>January 1, 2008: minimum AFUE of 90% for new residential construction<br>December 31, 2009: minimum AFUE of 90% for all furnaces – new construction or existing dwellings<br><br>Energy Star Models<br><br>Version 3 in effect February 1, 2012. Furnaces must have an AFUE rating of 95% or higher to qualify as ENERGY STAR.<br><br>April 1, 2007 to March 1, 2009: Energy Star qualified residential forced air furnaces or boilers (gas-fired and oil-fired), air source heat pumps and ground source heat pumps are eligible for a provincial tax exemption if purchased or leased for residential purposes. |
| Gas boilers with input rating of less than 300,000 Btu/hour | Test Standard: CSA P.2-07<br><br>May 1, 1996: AFUE of 80% for hot water systems – non condensing<br>May 1, 1996: AFUE of 75% for low pressure steam systems<br>September 1, 2010: AFUE of 82% or higher, no constant burning pilot, automatic means for adjusting water temperature<br><br>Proposed updates to the Energy Efficiency Act affecting boilers can be found at:<br>http://www.empr.gov.bc.ca/EEC/Strategy/EEA/Pages/CurrentConsultations.aspx |
| Gas water heaters with inputs of less than 75,000 Btu/h or less, and storage capacity of 76 litres to 320 litres. | Test Standard: CAN/CSA P.3-04<br><br>September 1, 2004: Minimum efficiency factor (EF) of 0.67 – 0.0005V (where V=rated storage capacity in litres)<br><br>Energy Star Models:<br>Voluntary participation by manufacturers. Current Energy Star qualified models use 5% less energy than those meeting the minimum federal energy performance standard.<br><br>January 1, 2009: minimum qualifying EF ≥ 0.62 and first hour rating (FHR) of ≥ 254 litres per hour for gas storage water heaters<br><br>September 1, 2010:<br>Gas tankless water heaters: EF ≥ 0.82, LPM ≥ 9.5 over 42.8°C rise<br>Condensing gas storage water heater: EF ≥ 0.80, FHR ≥ 254 litres per hour<br>Heat pump water heater: EF ≥ 2.0, FHR ≥ 190 litres per hour |
| Gas ranges | February 3, 1995: No minimum performance or test standards; regulations govern reporting only. No continuous burning pilot light if product has electrical power source<br><br>*continued next page…* |

| Appliance | Energy Efficiency Standards |
|---|---|
| Clothes washers – top loading, front loading, and compact | Test Standards:<br>CAN/CSA-C360-M89, CAN/CSA-C360-92, CAN/CSA-C360-03<br><br>British Columbia (testing only):<br>May 1, 1991: E = 1.5 V + 30.5, where E=kWh/month and V= volume (litres)<br>May 1, 1995: E = 1.5 V + 30.5, where E=kWh/month and V= volume (litres)<br><br>Canada:<br>May 1, 1995: testing and EnerGuide label<br>January 1, 2004:<br>• Vertical axis standard (45L or greater): minimum EF of 29.45 (Litres / kWh / cycle)<br>• Horizontal axis: min EF of 29.45<br>January 1, 2007:<br>• Vertical axis standard (45L or greater): minimum EF of 35.68 (Litres / kWh / cycle)<br>• Horizontal axis: min EF of 35.68<br>• EnerGuide label required<br><br>Energy Star Models:<br><br>Voluntary participation by manufacturers. Current Energy Star qualified models are 36% more efficient than the minimum federal energy performance standard and use 35% to 50% less water.<br><br>January 1, 2007: modified energy factor (MEF*) of at least 48.45 L/kWh/cycle (1.72 cu. ft./kWh/cycle) and maximum water factor (WF) = 1.07 L/cycle per L of tub capacity (8.0 gal./cycle/cu. ft.)<br>January 1, 2009: MEF ≥ 1.8 cu. ft./kWh/cycle and WF ≤ 7.5<br>January 1, 2011: MEF ≥ 2.0 cu. ft./kWh/cycle and WF ≤ 6.0 |
| Gas fireplaces including inserts and free standing stoves | Test Standard: CAN/CSA P.4.1-02<br><br>September 25, 2003: no minimum performance levels; regulations govern testing and reporting standards only.<br><br>The Canadian Gas Fireplace Efficiency Standard, CGA-P.4, uses a laboratory procedure similar to the Annual Fuel Utilization Efficiency procedure for furnaces to measure the seasonal performance of gas fireplaces as they are normally installed in Canadian housing.<br><br>This standard has already been utilized in British Columbia to determine eligibility for their Clean Choice Program, and it has resulted in P.4 efficiencies being developed for a large number of gas fireplaces. |
| Dishwashers – standard and compact | Test Standards:<br>CAN/CSA-C373-92, CAN/CSA-C373-04<br><br>February 3, 1995: testing and EnerGuide label required<br>January 1, 2004: minimum EF (energy factor = cycles per kilowatt hour) of 0.46 for standard dishwashers<br><br>Energy Star Models:<br><br>Voluntary participation by manufacturers. Current Energy Star qualified dishwashers must achieve energy efficiency levels at least 41% higher than the minimum regulated Canadian standard. Prior to 2007, ES models were required to be 25% more efficient than the standard at the time.<br><br>January 1, 2007: minimum EF of 0.65 for standard dishwashers<br>January 1, 2007: minimum EF of 0.65 for standard dishwashers<br>August 11, 2009: maximum TEAC (kWh/yr) of 324, and maximum WF (Litres / cycle) of 21.96<br><br>January 1, 2011: maximum TEAC (kWh/yr) of 307, and maximum WF (Litres / cycle) of 18.93 |
| Sources:<br>Natural Resources Canada (http://oee.nrcan.gc.ca)<br>*Energy Efficiency Act of British Columbia*, Energy Efficiency Standards Regulation, B.C. Reg. 389/93 | |

### ENERGY STAR® Appliances

There is no single measure that adequately summarizes the efficiency trends in new appliances, or the general improvement in efficiency of the stock of appliances. The now defunct Canadian Appliance Manufacturers Association (CAMA) tracked shipments of ENERGY STAR qualifying models to British Columbia for three appliances: dishwashers, washing machines, and refrigerators.[5] Summarized in Figure 11, these data show that the proportion of refrigerators shipped to British Columbia that are ENERGY STAR qualified has risen from 29% in 2004 to 54% in 2010. ENERGY STAR qualified shares of washing machines increased from 36% to 72% over the same period. The share of dishwashers rated ENERGY STAR has been generally high, varying between 70% and 89% depending on the year. These data understate the impact on residential energy savings as minimum standards for ENERGY STAR, for some appliances, have been revised upward over time.

**Figure 11: ENERGY STAR® Share of Appliance Shipments to British Columbia 2004 - 2010**




Data source: NR Canada / CAMA

### Demand-Side Management Initiatives

Demand-side management (DSM) initiatives operated by utilities, governments, or others use financial or other incentives to encourage households to adopt energy-efficient equipment and appliances, and/or adopt energy conserving behaviors. Some programs seek to transform the market by working with manufacturers, distributors, and retailers to move the market towards a specific energy efficiency target. Changes to municipal, provincial, and/or federal legislation and regulations governing efficiency standards for equipment and structures are sometimes used to ensure the market cannot retreat from the high efficiency target. Past and present DSM programs targeting British Columbia households have contributed to improvements of household energy use and intensities.

While it is not reasonable to provide a comprehensive list of past and present DSM initiatives that may have impacted energy use of FEU residential customers, FortisBC has operated a number of initiatives directly targeting equipment and appliances that use natural gas either directly (e.g., gas furnaces) or indirectly (e.g., (hot water for dishwashers). These include:

[5] With the opening of a Canadian branch office of the Association of Home Appliance Manufacturers (AHAM) effective July 1st, 2012, Electro-Federation Canada (EFC) announced the closure of its Canadian Appliance Manufacturers Association (CAMA) council.

- Heating system upgrade programs (various years) - incentives to purchase high efficiency furnaces and boilers
- Fireplace upgrade programs – incentives to upgrade from decorative natural gas fireplaces to EnerChoice energy-efficient fireplaces
- ENERGY STAR® water heaters and clothes washers
- Tune up programs for furnaces and fireplaces
- Home weatherization programs (insulation, air sealing)

Other notable energy efficiency initiatives during the past five years include the federal government's ecoENERGY Retrofit Homes Program[6] and its provincial companion program LiveSmart BC: Efficiency Incentive program.[7]
Other utilities, the Government of British Columbia, and the Government of Canada have, individually or in partnership, implemented market transformation programs to improve the energy efficiency standards for windows and appliances, including dishwashers and front loading clothes washing machines.

While assessing the collective impact of these programs on long-run trends in gas consumption is beyond the scope of this document, the 2012 REUS survey addressed the adoption of energy-efficient equipment, and behaviours affecting the efficient use of energy.

### 4.2.5 Improvements in Thermal Efficiency - Construction Codes and Standards

Changes to residential construction codes and standards have contributed to declining energy use in new construction.

In British Columbia, residential building codes and standards have expanded their scope over time from the initial focus on health and safety to specific provisions for energy and water efficiency. There are two distinct jurisdictions governing building codes within the province. Within the City of Vancouver, the Vancouver Building Bylaw (VBBL) defines the minimum performance requirements for construction within municipal boundaries. In all other areas of the province, the BC Building Code (BCBC) regulates construction.

In addition to building codes, the BC Energy Efficiency Act[8] and the national Energy Efficiency Act[9] regulate the performance of a broad range of residential energy-using equipment and end-uses.

Recent changes to the British Columbia Building Code (BCBC) and the British Columbia Energy Efficiency Act apply to construction of small buildings and residential detachments (up to 600 square meters or 6,500 square feet). These requirements generally pertain to single family dwellings, duplexes and smaller row houses.

The BCBC defines minimum building practices in all areas of British Columbia except Vancouver. The 2012 BCBC came into effect in December 2012. There are no changes in the 2012 BCBC relative to energy

[6] http://oee.nrcan.gc.ca/residential/6551

[7] http://www.livesmartbc.ca/homes/index.html

[8] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96114_01

[9] http://laws-lois.justice.gc.ca/eng/acts/E-6.4/page-1.html

compared with the previous version of the Code (defined by the 2006 BCBC plus the Part 10 amendment enacted in September 2008). The 2012 changes pertained primarily to seismic upgrading.

The Province of British Columbia has completed a public review of proposed changes to energy requirements for residential buildings.[10] Due to come into effect in December 2014, they will require new residential construction in British Columbia to meet the requirements of the National Energy Code of Canada for Buildings (NBC), 2011.[11] These changes are expected to provide some increase in energy efficiency across British Columbia. The ventilation requirements in the NBC are expected to be updated to meet the special requirements in British Columbia, and will likely have an impact on energy use in houses, but this change will not be confirmed until 2014. Finally, equipment efficiency requirements will now be embedded in the building code rather than in a separate legislative act.

The City of Vancouver has its own Charter and has not adopted the BC Building Code. New construction within city boundaries is regulated by the Vancouver Building Bylaw (VBBL). Requirements in the City of Vancouver are more stringent than the provincial building code. New homes are required to achieve an EnerGuide 80 rating, in part via increased insulation requirements. The VBBL also requires installation of heat recovery ventilators and, when using gas fireplaces, that they be direct-vented and use electronic ignition.

The City of Vancouver plans to update the VBBL. These changes are expected to be approved late in 2013 with an effective date in early 2014. These additional requirements include:

- increased requirements for insulation (primarily by changing from nominal values to effective values) and operation of heat recovery ventilators
- increased attic insulation from RSI 7.0 to RSI 8.8
- improved window performance from USI 2.0 to 1.4 W/(K•m²)
- skylights with maximum thermal transmittance value of 2.6 W/(K•m²)

In the case of retrofit construction, changes to the VBBL are proposed based on the level of retrofit activity. Acquiring a building permit for retrofits over $5,000 to existing one- and two-family dwellings will require an EnerGuide for Houses (EGH) Report completed in the last 3 years. If the report indicates an air leakage rate greater than six air changes per hour (ACH), retrofits over $25,000 will required a minimum of $800 in weatherisation of the home. If the report indicates less than RSI 5.3 (R 30) thermal insulation in the attic, retrofits exceeding $50,000 will also be required to provide additional attic insulation to a minimum of RSI 8.8 (R 50).

### Apartments

Apartment buildings larger than 600 square meters (~6,500 square feet) are generally regulated under Part Three of the BCBC. Since September 5, 2008, new apartments outside the City of Vancouver have been required to meet ASHRAE 90.1-2004.[12] Within the City of Vancouver ASHRAE 90.1-2007 is required. Both the City of Vancouver and the Province of British Columbia have expressed a commitment to adopting ASHRAE 90.1-2010. For the province, this code will come into effect in December 2013, while

[10] http://www.housing.gov.bc.ca/building/green/energy/Part%2010%20code%20change.pdf

[11] http://www.nrc-nrc.gc.ca/eng/publications/codes_centre/2011_national_energy_code_buildings.html

[12] This is a standard developed by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), and has been adopted by over 30 states in the USA.

the City of Vancouver is expecting to approve this change in late 2013 with an effective date in early 2014. The impact of this change will likely result in a savings of 8% to 10% in energy use, relative to current code requirements. In addition, both the City of Vancouver and the Province have adopted an alternate compliance path using the National Energy Code for Buildings (2011).

### 4.2.6 Demographic Trends

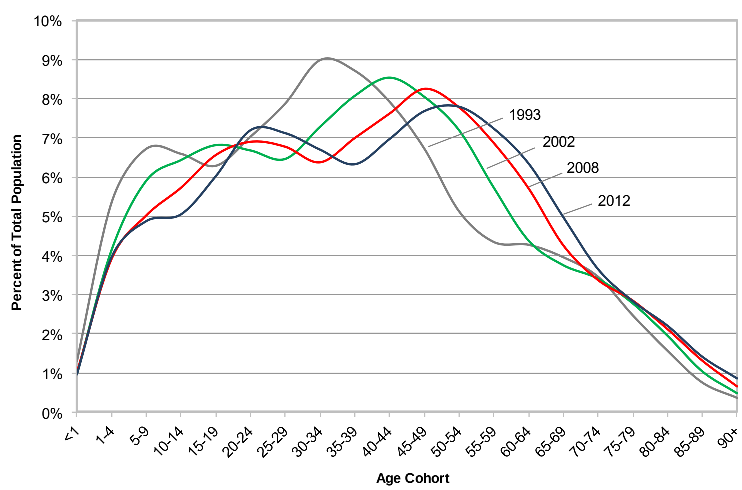
Consistent with trends identified in the 2008 REUS, ForticBC's residential customer base is aging and the number of people per-household is declining. These are two key demographic trends contributing to the decline in natural gas consumption over the long run.

#### Aging Population

As FortisBC's residential customer base ages, it impacts average household gas consumption. This is because older individuals differ from their younger counterparts in their demands for space heating and domestic water heating. A 2005 US Energy Information Administration (EIA) study found that natural gas use for space heating was 13% higher in homes with seniors compared to those without. Conversely, gas consumption for water heating was 13% lower in homes with seniors than those without. The presence of children between 5 and 16 years of age was found to increase gas consumption for space heating and water heating by 5% and 39% respectively.[13]

The age profiles of British Columbia's population corresponding to each of the past four REUS survey years are illustrated in Figure 12.

**Figure 12: British Columbia Age Profiles – 1993 to 2012**




Data source: BC Stats

Several trends are evident:

- Individuals between the ages of 25 and 44, the age segment typically associated with household formation (buying their first home, raising a family, etc.) have proportionately decreased since 1993 (27% versus 34% in 1993).

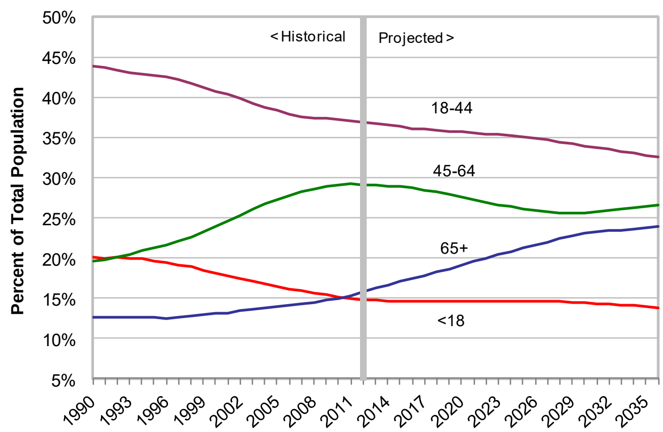
[13] Source: Energy Information Administration, *2005 Residential Energy Consumption Survey*, U.S. Department of Energy.

- The proportion of the population aged 45 to 64 increased over the same period (21% to 29%).
- Individuals now aged 65 years and older has increased (16% versus 13% in 1993).

The aging of the baby boomer generation (individuals born after the Second World War and up to 1966) is clearly evident in the graph. Increasingly, this large age cohort has raised their families and is entering retirement.

Population projections by age group (cohort) made by BC Stats show the cohorts comprised of children and young adults as a share of the total population will continue to decline during the next quarter-century (Figure 13). The relative share of the population made up of seniors (those aged 65 years or older) is expected to increase to nearly one quarter of the population by 2035. These changes will be reflected in FEU's residential customer base.

**Figure 13: Population Projections by Age Cohort – British Columbia**



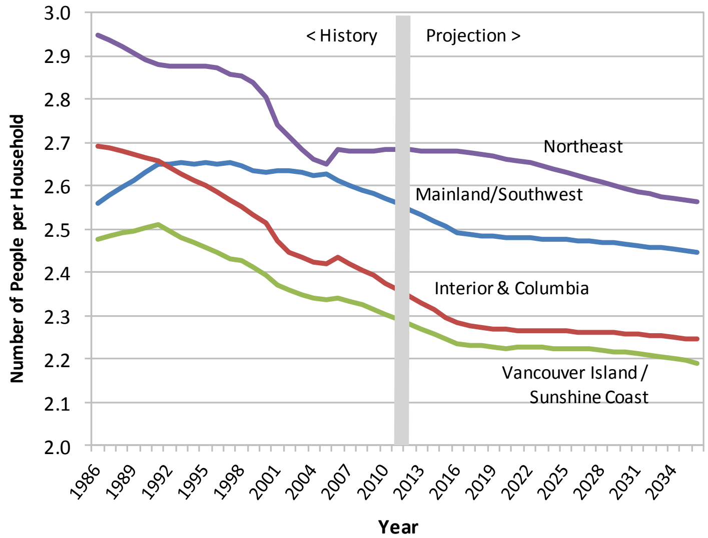

Data source: BC Stats

## Number of Occupants per Dwelling

The aging of the population is being accompanied by a slow but consistent decline in the number of occupants per dwelling. Fewer people in the home means reduced demand for hot water from activities such as showering, clothes washing, and dishwashing.

Figure 14 (next page) shows the long-run decline in the average number of people per-household for the Census areas corresponding to FEU's regions. Further declines are expected, with rate of decline moderating somewhat towards the end of the current decade.

**Figure 14: Average Number of People per-Household – History and Projection**

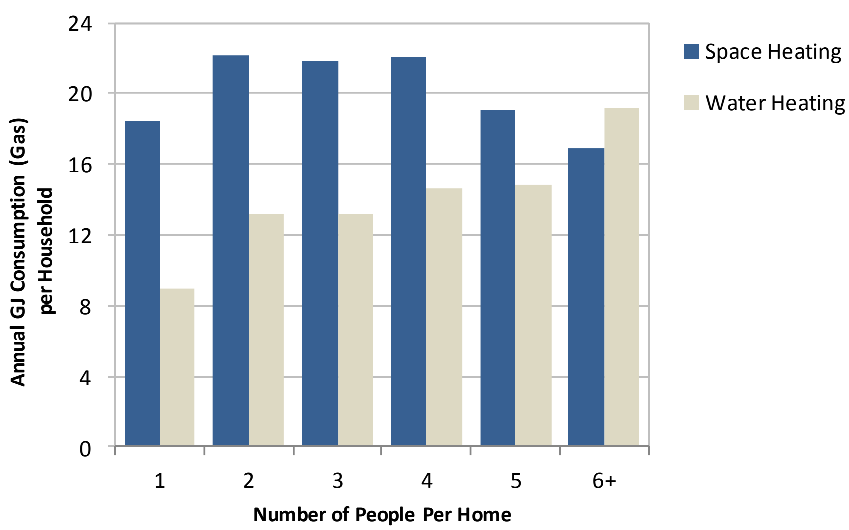



Source: BC Stats

The decline in the average number of people per-household stems, in part, from the long-run societal trend towards smaller family sizes, but also from the growing proportion of older households where the children have grown up and left home.

The decline in the average number of people per household has implications for energy required for space and water heating. Figure 15 summarizes the results from the 2009 US Department of Energy (DOE) residential energy use study that found that natural gas consumption for space and water heating generally increases as the number of people in the home increases.

**Figure 15: Gas Consumption by Number of People in the Home**



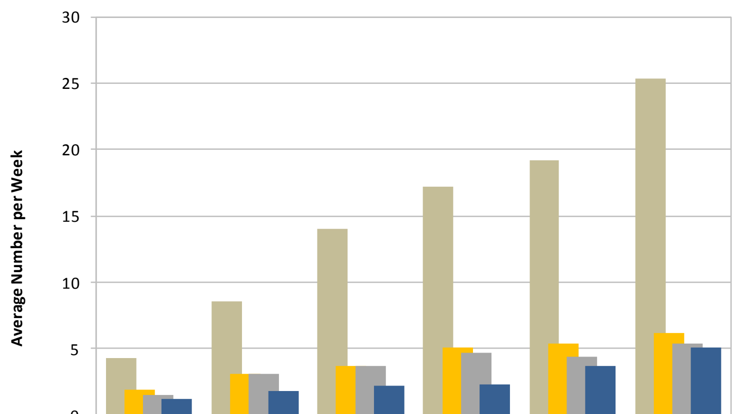

Source: 2009 Residential Endergy Consumption Survey, US DOE

The relationship between space heating and household size is not strictly linear. Indeed, the amount of energy to keep a two person household warm did not vary that much from that of a four person household. Natural gas use for water heating shows a much stronger relationship between household size and consumption, rising from 8 GJ for a one person household to 18 GJ for households with six or more people.

These findings are consistent with the results of a 1999 study on residential water use by the American Water Works Association (AWWA). Their research found that family size influences hot water use as does the mix of age groups present in the home.[14] For example, both the number of people in the home and the presence of children and teens were positively correlated with increased water use for showers, baths, and clothes washing. Faucet use was positively correlated with household size, and the square footage of the home. Interestingly, they found water consumption for showers, baths and dishwashers was positively correlated with the number of persons employed outside the home. These findings strongly suggest that the demand for hot water, and thus energy needed for water heating, will, everything else held constant, decline over time as the baby boom demographic ages, retires, and increasingly live in childless homes.[15]

Data from the 2012 REUS support many of the AWWA findings, including the relationship between the number of occupants per home and the demand for hot water. Figure 16 shows that as the number of people per household increases, so does the number of showers, laundry loads, dishwasher loads and baths. Additional discussion is provided in Section 11 of this report.

**Figure 16: Effect of Household Size on Hot Water Using Activities**




| | 1 | 2 | 3 | 4 | 5 | 6 or more |
|---|---|---|---|---|---|---|
| Showers | 4.3 | 8.5 | 14.0 | 17.2 | 19.2 | 25.3 |
| Laundry Loads | 1.9 | 3.1 | 3.7 | 5.1 | 5.4 | 6.2 |
| Dishwasher Loads | 1.5 | 3.1 | 3.7 | 4.6 | 4.4 | 5.4 |
| Baths | 1.2 | 1.8 | 2.2 | 2.3 | 3.7 | 5.1 |

Household Size (People)

### 4.2.7 Demand Response to Price Changes

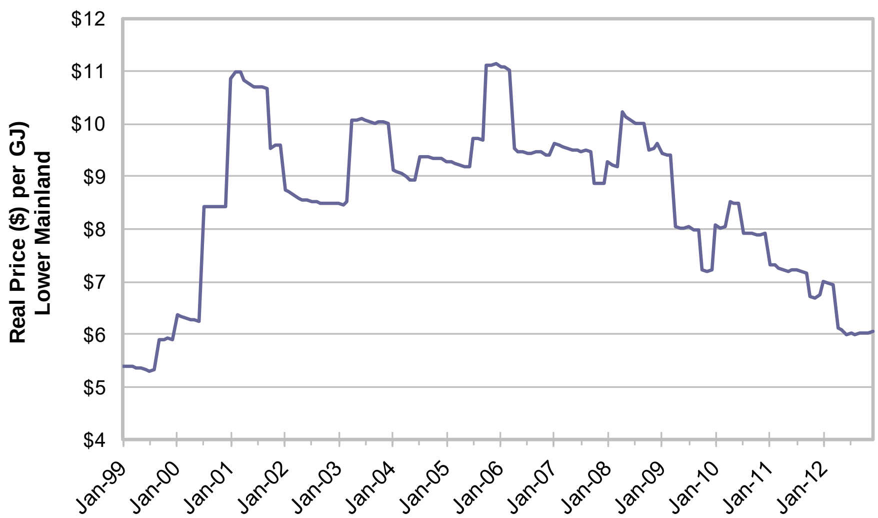
The trend towards declining natural gas use rates is, in part, the result of the demand response to changes in the real price of natural gas (nominal prices adjusted for inflation).

[14] Mayer, P.W., W.B. DeOreo et al. (1999).

[15] According to the AWWA website, an update to this research is expected by late 2013.

Figure 17 illustrates the inflation-adjusted price of natural gas (variable rate component) for FEU's Lower Mainland residential customers from January 1999 to December 2012. A significant increase in prices occurred in late 2000, followed by a period of variable but consistently high prices, after which prices begin to decline around the spring of 2008.[16] By the end of 2012, inflation-adjusted natural gas prices were at levels last experienced in December 1999.[17] Price trends in the other FEU regions have followed a similar trajectory.

**Figure 17: Inflation-Adjusted Residential Natural Gas Prices Variable Rate Portion ($/GJ) – FEU Lower Mainland**




Reactions to changes in the real price of natural gas differ in the short-term from the long-term. Short-term reactions to a change in the price of natural gas will be mostly behavioural: changes to thermostat settings, hot water temperatures, and use of alternative fuel space heating options (e.g., fireplaces, portable electric space heaters, etc.). Long-term reactions to a sustained increase or decrease in price includes sustained (ingrained) changes in behaviour and structural changes affecting the home's thermal envelope (e.g., whether or not to improve insulation, upgrade windows, etc.), appliance purchases (e.g., efficiency decisions for furnaces, washing machines, dishwashers, etc.), and fuel switching (e.g., from gas to electric hot water heating, etc.). Structural changes permanently reduce the energy requirements of a home.

The strength and nature of the reaction to price changes depends on other factors including household income and prices of competing fuels. Lower income households are restricted by the lack of financial resources in their ability to undertake structural improvements to reduce exposure to higher energy prices. Changes in the price of competing fuels (e.g., electricity), everything else held constant, can influence both short term and longer term fuel switching decisions.

[16] The variable rate portion of the FEU tariff for residential customers reflects the price of natural gas purchased at prices set by the market and does not include any mark-up.

[17] Prices were adjusted for inflation using the consumer price index (CPI) for the Greater Vancouver areas. Data source: Statistics Canada CANSIM.

Generally speaking, there is a paucity of published research into the price elasticity of natural gas for the residential sector. Of the few published studies, short-term price elasticities for natural gas are generally quite low, in the order of -0.3 or smaller.[18] A 2006 study by the Colorado-based National Renewable Energy Laboratory (NREL) estimated the short-run price elasticity for natural gas in the Pacific Coast region of the U.S. (Washington and Oregon) to be -0.18 and the long-run price elasticity to be -0.63.[19] A more recent (2012) study by the University of Ottawa estimated the long-run price elasticity for natural gas in British Columbia to be -0.67.[20]

While natural gas prices in the short-term may increase or decrease, expectations regarding the future direction of prices will influence major appliance purchases over the medium term. In particular, recent declines in the price of natural gas for FEU residential customers have come after an extended period of high and volatile prices. The medium to longer term response to lower prices will depend, in part, on whether they are sustained enough to change expectations formed by the past decade of high and volatile prices. Changes to building codes and regulations governing the efficiency choices available to consumers, combined with structural improvements already made by households, will limit upward pressure on natural gas use rates from an extended period of low gas prices.

### 4.2.8 Cross Effects / Interaction Effects

Cross effects (also known as interaction effects) affecting space heating refer to the heating penalty associated with the adoption of energy-efficient technologies that, due to their more efficient use of energy, produce less waste heat than their inefficient counterparts. As a result, space heating systems compensate, to some degree, for the lost heat. For homes with natural gas space heating, this lost heat represents an offsetting factor to declining use rates.

The displacement of incandescent lighting with compact fluorescent lighting is one example where the heating penalty may be significant. The extent of the heating penalty is subject to considerable debate, and published estimates vary greatly.[21] The need for replacement heat has also been identified with the increased penetration of variable speed motors with high efficiency condensing gas furnaces. Variable speed motors, known as electronically commutated motors (ECM), give off significantly less waste heat than their lesser-efficient fixed-speed counterparts.[22]

[18] Interpreted as a 0.3% decline in gas consumption per every 1% increase in real prices. An overview of short- and long-term price elasticities for natural gas can be found in Wade, Steven, H., *Price Responsiveness in the AEO2003 NEMS Residential and Commercial Building Sector Models*, Energy Information Administration, U.S. Department of Energy.

[19] Bernstein, M.A., and Griffin, J. (2006)

[20] Ryan, D, and Razek, N.A (2012)

[21] A 2004 study using Natural Resources Canada's test houses found that during the heating season, 80% to 96% of the energy savings from replacing incandescent lighting with CFLs was offset by the increased need for space heating. (CANMET (2004). In contrast, the Washington-based New Buildings Institute estimated the cross effects of lighting at 13% for the Pacific Northwest (New Buildings Institute (2003).

[22] The operating temperature of a variable speed or ECM motor is constant and typically at or near ambient temperature, whereas the operating temperature of a fixed speed or PSC motor can range from 32 to 77 degrees Celsius.

# 5 DWELLING CHARACTERISTICS

This section provides detail on the dwelling characteristics of FEU residential homes including:

- Dwelling type, size, vintage, number of stories, tenure, maintenance fees, and length of residency;
- Characteristics of the building envelope including insulation levels, window glazing and frame material, and exterior door materials;
- Renovations undertaken during the past five years, and planned for the next two years, by type of renovation; and
- Who performs the renovations – homeowner, contractor, or a combination of the two.

## 5.1 Dwelling Characteristics

### 5.1.1 Dwelling Types and Vintages

Single family detached (SFD) dwellings dominate the residential customer base for FEU, accounting for over eight-in-ten (82%) of all dwelling types in 2012 (Table 9). This proportion is unchanged from previous REUS surveys (i.e., differences are not statistically significant). Shares for other dwelling types in 2012 also remained effectively the same as those in the 2008 REUS. Changes in shares for FEI over the 2002 to 2012 period show some minor fluctuations, all of which fall within the accuracy bounds of the survey estimates.

Notable differences in dwelling type shares between FEU's five regions include:

- proportionately more row / townhouses in the Lower Mainland (11%) and Whistler (29%);
- proportionately more single family detached homes Interior and Vancouver Island regions; and
- significantly more mobile homes in the Fort Nelson and the Interior regions (25% and 7% respectively).

**Table 9: Residential Dwelling Types by Region (%)**

| Dwelling Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1,707* | *752* | *85* | *104* | *3441* | *2217* | *2604* | *1444* | *1610* |
| Single Family Detached | 80.3 | 84.3 | 85.9 | 54.2 | 67.4 | 81.9 | 83.0 | 81.5 | 83.0 | 80.7 |
| Duplex | 5.5 | 3.7 | 4.8 | 12.0 | 2.8 | 5.0 | 5.0 | 5.0 | 4.9 | 4.5 |
| Row / Townhouse | 11.1 | 3.1 | 5.2 | 28.9 | 5.1 | 8.4 | 8.2 | 8.7 | 8.3 | 10.5 |
| Apt / Condominium | 0.8 | 2.2 | 1.5 | 2.4 | 0.0 | 1.2 | 1.1 | 1.2 | 1.0 | 0.4 |
| Mobile Home / Other | 2.3 | 6.7 | 2.6 | 2.4 | 24.7 | 3.6 | 2.7 | 3.7 | 2.8 | 3.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 10 (next page) summarizes the distribution of residential gas customers by dwelling vintage (period of construction). Data from past REUS studies are not provided as the age of the two studies makes comparisons with the current survey invalid.[23] Overall, nearly six-in-ten (55%) of dwellings were built prior to 1986, over one-quarter (27%) built between 1950 and 1975 and one-tenth (11%) built prior to 1950. Slightly more than one-fifth (22%) of all gas homes were built since 1995.[24] Comparing the regions shows that the Lower Mainland and the Interior regions have the largest shares of older homes (those built prior to 1996) (79% and 77% respectively). Regions with the newest housing stock (i.e., 1996 or newer) include Whistler and Vancouver Island (63% and 31% of dwellings). The latter reflects the relatively more recent arrival of natural gas service on the island.

**Table 10: Residential Dwelling Stocks by Period of Construction (%)**

| Year of Construction | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *777* | *1685* | *731* | *82* | *104* | *3379* |
| Before 1950 | 10.6 | 10.4 | 12.0 | 0.0 | 4.8 | 10.6 |
| 1950-1975 | 26.1 | 30.4 | 23.1 | 6.2 | 28.5 | 26.9 |
| 1976-1985 | 17.9 | 18.8 | 11.5 | 13.6 | 23.7 | 17.5 |
| 1986 -1995 | 24.2 | 17.3 | 21.5 | 17.3 | 13.3 | 22.0 |
| 1996 -2005 | 14.3 | 15.0 | 20.9 | 56.8 | 23.1 | 15.3 |
| 2006 or later | 5.3 | 6.6 | 10.4 | 6.2 | 3.8 | 6.2 |
| DK | 1.7 | 1.5 | 0.5 | 0.0 | 2.8 | 1.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Built prior to 1996 | 78.8 | 76.9 | 68.1 | 37.0 | 70.2 | 77.0 |
| Built since 1995 | 19.6 | 21.6 | 31.3 | 63.0 | 26.9 | 21.5 |

Totals may not sum due to rounding.

### 5.1.2 Residency and Tenure

The vast majority (99%) of respondents to the 2012 REUS survey indicated their home was their principal residence (Table 11). This share is statistically unchanged from that recorded in 2008. Whistler had the lowest percentage of homes as a principal residence (82%).

**Table 11: Principal Residence by Region (%)**

| Principal Residence? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *775* | *1674* | *732* | *83* | *103* | *3367* | *2221* | *2514* | *1444* | *1610* |
| Yes | 99.2 | 98.2 | 99.5 | 81.7 | 96.8 | 98.9 | 98.5 | 98.9 | 98.7 | 98.3 |
| No | 0.8 | 1.8 | 0.5 | 18.3 | 3.2 | 1.1 | 1.5 | 1.1 | 1.3 | 1.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 12 (next page) summarizes FEU's residential customers according to whether they rent or own their residence. The vast majority (97%) of FEU residential customers owned their home in 2012, statistically unchanged from 2008 (96%). Renters made up three percent of FEU residential customers. Comparing

[23] The 2002 REUS included only residences constructed prior to, or including, 2000. The 2008 REUS included only dwellings constructed prior to, or including, 2006. Each survey excluded the two most recent years of construction due to the billing requirements of the conditional demand analyses.

[24] The relative proportion of homes built since 2005 understates the true (FEI population) proportion because the REUS sample excludes residences with a minimum of two years of uninterrupted billing history. The latter was a requirement for the conditional demand analysis conducted using the 2012 REUS results.

results from the past three REUS surveys suggests a downward trend in the proportion of customers renting homes (3% of FEI customers in 2012 compared to 7% in 2002).

**Table 12: Ownership Status by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *758* | *1652* | *713* | *81* | *102* | *3306* | *2211* | *2574* | *1439* | *1578* |
| Own | 97.3 | 97.7 | 97.3 | 96.4 | 98.1 | 97.4 | 95.6 | 97.4 | 95.4 | 93.4 |
| Rent | 2.7 | 2.3 | 2.7 | 3.6 | 1.9 | 2.6 | 4.4 | 2.6 | 4.6 | 6.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Data on home ownership by dwelling type are summarized in Table 13. The proportion of dwellings that are rented is highest for apartments/condominiums and duplexes (15% and 11% respectively).

**Table 13: Ownership Status by Dwelling Type (%)**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2,792* | *154* | *207* | *55* | *118* | *59* |
| Own | 98.4 | 89.2 | 94.9 | 85.1 | 99.1 | 92.0 |
| Rent | 1.6 | 10.8 | 5.1 | 14.9 | 0.9 | 8.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

### 5.1.3 Secondary Suites

Twelve percent (12%) of respondents to the 2012 REUS indicated their home has a secondary suite (Table 14). Regionally, Whistler and Lower Mainland customers are more likely to have a secondary suite (20% and 14% respectively). The incidence of secondary suites is likely underreported as some survey respondents with secondary suites may not want to share this information.[25]

**Table 14: Homes with Secondary Suites by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *84* | *105* | *3441* |
| Secondary Suite | 14.0 | 7.8 | 10.0 | 20.3 | 6.2 | 11.9 |

Totals may not sum due to rounding.

### 5.1.4 Length of Residency

FEU residential customers have lived an average of 16.5 years in their current residence, up from 15.2 years in 2008 (Table 15, next page). Average length of residence for customers in the FEI service regions increased from 12.4 years in 2002 to 16.8 years in 2012. Both trends are consistent with the aging of the population and the reduced tendency for older individuals to change homes.

[25] A 2009 study by the City of Vancouver estimated that 35% of single family dwellings in Vancouver had a secondary suite. Vancouver (2009), p.17.

Consistent with the findings from the 2008 REUS, the 2012 survey found highest average length of residence to be among LM customers (17 years), while Whistler and Fort Nelson has the lowest (12 years).

**Table 15: Average Length of Residence (Years) by Region**

| Length of Residence (years) | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *84* | *105* | *3441* | *2180* | *2605* | *1419* | *1610* |
| Mean | 17.2 | 16.0 | 14.5 | 12.1 | 12.3 | 16.5 | 15.2 | 16.8 | 15.0 | 12.4 |
| Standard Deviation | 20.7 | 9.0 | 8.0 | 2.5 | 2.7 | 12.4 | 12.3 | 13.6 | 12.4 | 11.7 |

The average length of residence varies with the type of dwelling (Table 16). FEU customers living in single family detached dwellings have the longest average tenure (17.9 years), whereas customers in row houses / townhouses and apartments/condominiums have average tenures of 9.7 years and 6.6 years respectively. There is a relationship between length of tenure, dwelling type, and resident age.

**Table 16: Average Length of Residence (Years) by Dwelling Type**

| Length of Residence (years) | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2723* | *150* | *198* | *55* | *116* | *57* |
| Mean | 17.9 | 11.6 | 9.7 | 6.6 | 11.0 | 12.3 |
| Standard Deviation | 12.8 | 9.0 | 8.1 | 4.5 | 6.5 | 8.7 |

Data supporting the relationship between dwelling type and resident ages are summarized in Table 17. Of note, respondents 55 years of age or older are significantly more likely to live in SFDs, duplexes, or mobile homes (66%, 68% and 81% respectively). Respondents under 35 are more likely to live in row houses/townhouses and apartments/condominiums (7% and 13% respectively). Typically, younger customers are more likely to reside in townhouses and apartments/condominiums, while older adults reside in single family detached dwellings or mobile homes.[26]

**Table 17: Age of Respondents by Dwelling Type (%)**

| Age of Respondent (years) | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other | 2012 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *2723* | *150* | *198* | *55* | *116* | *57* | *3299* |
| 24 yrs or less | 0.3 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| 25 to 34 | 3.4 | 3.7 | 6.0 | 12.9 | 4.6 | 6.2 | 3.8 |
| 35 to 44 | 10.0 | 12.5 | 14.7 | 10.4 | 6.0 | 2.0 | 10.3 |
| 45 to 54 | 20.6 | 16.1 | 19.9 | 23.7 | 8.6 | 9.4 | 20.0 |
| 55 to 64 | 28.6 | 23.0 | 22.4 | 11.4 | 28.0 | 16.7 | 27.4 |
| 65 & older | 37.1 | 44.7 | 35.9 | 41.6 | 52.8 | 65.6 | 38.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| 34 yrs and younger | 3.7 | 3.7 | 7.0 | 12.9 | 4.6 | 6.2 | 4.1 |
| 55 yrs and older | 65.7 | 67.7 | 58.4 | 53.0 | 80.8 | 82.3 | 65.6 |

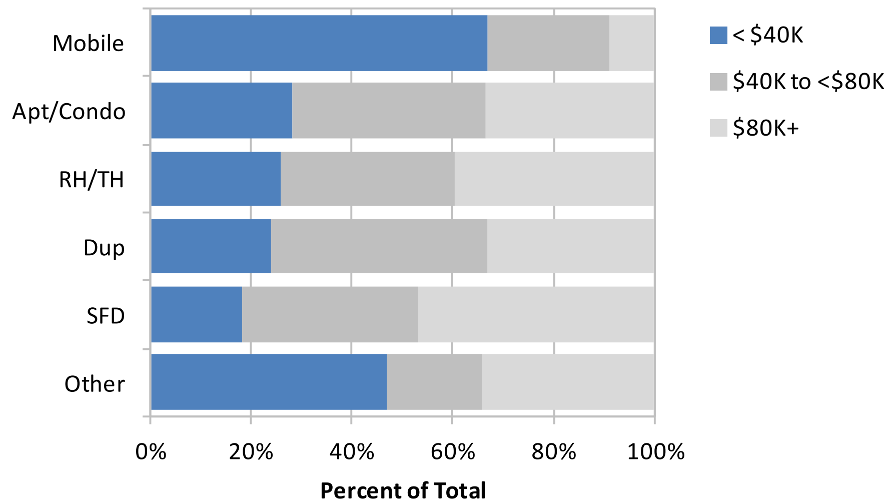
Totals may not sum due to rounding.

Dwelling type and household income are also related, especially when low income and high income households are compared. Figure 18 (next page) illustrates how respondents with household incomes of

[26] The 2008 REUS found that, as individuals age, the average length of residency increases and the likelihood of changing residences decreases. Source: REUS (2008), p. 4-5.

less than $40,000 are significantly more likely to live in a mobile home. Conversely, respondents with annual household incomes of $80,000 or more are most likely to live in single family detached dwellings.

**Figure 18: Household Income by Dwelling Type**




### 5.1.5 Rent and Maintenance Fees

Nearly one-in-five (18%) respondents to the 2012 REUS indicated they either pay rent or maintenance fees (Table 18). Regional variations in this percentage are consistent with the proportion of respondents living in rental accommodations, condominiums, or co-operative housing. For example, 43% of Whistler respondents paid rent or maintenance fees, the highest of the five regions, but consistent with the high proportion of row / townhouses. Differences between the 2012 REUS and 2008 REUS results are not statistically significant.

**Table 18: Households Paying Rent or Maintenance Fees by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *755* | *1617* | *724* | *82* | *95* | *3273* | *2211* | *2467* | *1,439* | *1,578* |
| Pay rent or maintenance fee | 20.1 | 14.7 | 15.2 | 42.9 | 16.5 | 18.1 | 17.3 | 18.4 | 17.7 | 14.3 |

Respondents paying rent or maintenance fees were asked to indicate which services (heat, hot water, electricity) and fuels (i.e., for gas fireplaces, gas clothes dryers, gas cooking) are included in these fees. The results are summarized in Table 19 (next page). Previous REUS surveys did not ask about electricity so historical comparisons regarding this service are not possible.

**Table 19: Services and Fuels Covered by Rent / Maintenance Fees by Region (%)**
**Percent of respondents paying rent or maintenance fees**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *161* | *256* | *113* | *37* | *20* | *587* | *765* | *437* | *502+* | *n/a* |
| Heat | 17.0 | 25.1 | 20.2 | 5.5 | 40.3 | 19.0 | 6.4 | 19.0 | 6.2 | 2.1 |
| Hot water | 17.6 | 29.1 | 23.7 | 5.5 | 40.3 | 20.6 | 8.8 | 20.4 | 8.7 | 3.0 |
| Fuel for gas fireplace | 10.1 | 8.4 | 10.5 | 5.5 | 5.7 | 9.7 | 5.1 | 9.6 | 5.0 | 1.9 |
| Fuel for gas cooking | 5.7 | 5.2 | 3.5 | 2.8 | 11.5 | 5.4 | 2.1 | 5.6 | 2.2 | n/a |
| Fuel for gas clothes drying | 0.6 | 4.0 | 1.8 | -- | 5.7 | 1.5 | 3.2 | 1.5 | 2.5 | n/a |
| Electricity | 13.8 | 22.7 | 18.4 | 8.3 | 28.8 | 16.2 | n/a | 16.0 | n/a | n/a |
| DK | 0.6 | 0.8 | 0.9 | -- | -- | 0.7 | n/a | 0.7 | n/a | n/a |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only

Among the base of those paying rent or maintenance fees, the three most common services covered by rent or maintenance fees include hot water (21% of those paying rent or fees), heat (19%), and electricity (16%). These percentages are influenced, in part, by whether the service or end-use is present in the suite or dwelling. This would explain, in part, the relatively lower percentages of respondents indicating that their rent or maintenance fees include fuel for gas fireplaces, gas cooking or gas dryers.

Comparing the results of the 2012 REUS survey with previous REUS surveys highlights a discrepancy in the data series, with most percentages being considerably lower than those recorded in 2012. The 2008 dataset was reviewed, and the components and weighting of the calculations confirmed as correct. The remaining possible reason for the discrepancy rests with a change to the order of the rent and maintenance fee questions in the 2012 REUS.

## 5.2 Dwelling Size

Dwelling size is defined as the total floor area of the dwelling including the basement and any unfinished areas, but excluding garages or carports. As the data include a small number of responses considered unrealistically high or low, an outlier analysis was used to remove the bottom 0.5% and top 0.5% of the estimates, ranked from lowest to highest. This affected 1% of the unweighted sample.

Average dwelling size in the 2012 REUS is 2,209 square feet, statistically unchanged from the average recorded in the 2008 survey (Table 20). Differences between the means for 2008 and 2002 are not statistically significant at the 95% confidence level.

**Table 20: Dwelling Sizes (Square Feet) by Region**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *755* | *1617* | *724* | *82* | *95* | *3273* | *2044* | *2467* | *1305* | *1416* |
| Mean [1] | 2395 | 2181 | 2116 | 2311 | 1952 | 2209 [2] | 2220 | 2235 | 2239 | 2199 |
| Median | 2200 | 2100 | 2000 | 2000 | 1800 | 2100 | 1800 | 2200 | 1800 | n/a |
| Standard Deviation | 2107 | 839 | 651 | 493 | 258 | 1221 | 806 | 1355 | 950 [3] | 950 [4] |

[1] Mean excludes the 0.5% largest and smallest values
[2] Untrimmed mean is 2394 square feet.
[3] The standard deviation of 949.9 square feet.
[4] Standard deviation of 949.8 square feet.

Table 21 (next page) summarizes key floor space statistics by dwelling type. On average, single family detached dwellings are the largest (average of 2,347 ft$^2$) and mobile homes the smallest (1,076 ft$^2$). The median size for single family detached homes is 2,200 $ft^2$, compared to 1,500 $ft^2$ for row / townhouses and 1,200 $ft^2$ for apartments / condominiums.

**Table 21: Dwelling Sizes (Square Feet) by Type of Dwelling**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2723* | *150* | *198* | *55* | *116* | *57* |
| Mean [1] | 2347 | 1980 | 1613 | 1379 | 1076 | 1964 |
| Median | 2200 | 1765 | 1500 | 1200 | 1024 | 1750 |
| Standard Deviation | 1182 | 1775 | 618 | 901 | 197 | 2085 |

[1] Mean excludes the 0.5% largest and smallest values

The average size of new single family detached dwellings has been increasing over time (Table 22). For example, the median size for a SFD built before 1950 was 1,900 $ft^2$. During the mid-1970s to mid-1980s this increased to 2,200 $ft^2$. The median size of dwellings constructed since 2005 is 2,900 $ft^2$, up 21% from 1986-95 and up 53% from those built prior to 1950.

**Table 22: Floor Space of Single Family Detached Dwellings by Vintage**

| | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *314* | *786* | *462* | *486* | *419* | *170* | *27* |
| Mean [2] | 1958 | 2180 | 2293 | 2486 | 2661 | 2920 | 2534 |
| Median | 1900 | 2200 | 2200 | 2400 | 2560 | 2900 | 2000 |
| Standard Deviation | 1334 | 937 | 1142 | 1333 | 1016 | 1489 | 776 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only
[2] Mean excludes the 0.5% largest and smallest values

### 5.2.1 Number of Heated Floors

The number of heated floors for a residential dwelling provides important information to understand the space conditioning load per square foot, with multi-story dwellings having different space heating and cooling profiles than their single story counterparts.

The 2012 REUS queried the number of floors of heated living space, including basements if heated. Past REUS surveys tended to ask respondents to indicate the number of "stories" in the home, sometimes including basements and at other times not. Counting a basement as a story has been problematic in the past as respondents' interpretations of what constitutes the basement level of a home varies. In particular, some consider the first floor of their home as the basement, although it may be fully above ground.[27] Detailed information regarding the characteristics of basements for REUS 2012 respondents is presented later in this section.

Table 23 (next page) summarizes the number of heated floors including heated basements for residential gas dwellings in the five FEU regions.

[27] The categorization of the first floor of a house as the "basement" is particular to Lower Mainland respondents, and is likely associated with the popularity of some residential building types (e.g., "Vancouver Specials").

**Table 23: Number of Heated Floors Including Basements by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *84* | *105* | *3441* |
| **Distribution (%)** | | | | | | |
| One floor | 14.1 | 19.8 | 29.4 | 8.3 | 36.4 | 17.3 |
| Two floors | 53.7 | 61.3 | 56.4 | 33.3 | 49.8 | 56.0 |
| Three floors | 30.2 | 16.2 | 12.1 | 50.0 | 12.8 | 24.4 |
| More than three floors | 2.0 | 2.7 | 2.1 | 8.3 | 1.0 | 2.3 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Overall, the majority of FEU homes have two heated floors (56% of all FEU dwellings), but 24% have three. Seventeen percent (17%) of dwellings have one heated floor.

Table 24 summarizes the number of heated floors by dwelling type for FEU residential dwellings, regardless of region. SFDs and duplexes are most likely to have two heated floors, while townhouses are equally likely to have two or three heated floors. Apartments, condominiums and mobile homes, not surprisingly, are most likely to have only one heated floor. Data that suggest more than two floors for apartments / condominiums and, notably, mobile homes should be treated as suspect.

**Table 24: Number of Heated Floors Including Basements by Dwelling Type (%)**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2796* | *154* | *207* | *56* | *119* | *59* |
| **Distribution (%)** | | | | | | |
| One floor | 14.9 | 11.1 | 19.4 | 76.6 | 86.8 | 31.6 |
| Two floors | 58.8 | 68.4 | 39.2 | 15.0 | 2.7 | 47.2 |
| Three floors | 24.4 | 15.2 | 39.3 | 7.1 | 0.9 | 19.1 |
| More than three floors | 2.0 | 5.3 | 2.1 | 1.4 | 9.6 | 2.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

## 5.3 Basements and Crawlspaces

Eight-in-ten (81%) of FEU households indicated their home has a basement or crawlspace, statistically unchanged from the proportion recorded during the 2008 REUS (79%) (Table 25, next page). Basements or crawlspaces are most common in dwellings in the Interior region (91% of Interior dwellings), followed by Vancouver Island (83%) and Whistler (80%). Dwellings in Whistler and Vancouver Island are more likely than other regions to have a crawlspace (53% and 37% respectively).

**Table 25: Incidence of Basements and Crawlspaces by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI |
|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2108* | *2604* | *1357* |
| Full basement | 47.0 | 60.6 | 38.2 | 15.7 | 55.0 | 49.7 | 52.0 | 51.2 | 53.6 |
| Partial basement | 9.7 | 12.7 | 8.2 | 10.8 | 5.1 | 10.3 | 12.2 | 10.6 | 12.1 |
| Crawlspace | 19.0 | 17.2 | 36.6 | 53.0 | 12.3 | 20.5 | 15.0 | 18.5 | 13.7 |
| No basement or crawlspace | 24.3 | 9.5 | 17.1 | 20.5 | 27.5 | 19.5 | 20.8 | 19.8 | 20.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Basement or crawlspace | 75.7 | 90.5 | 82.9 | 79.5 | 72.5 | 80.5 | 79.2 | 80.2 | 79.4 |

Totals may not sum due to rounding.

Table 26 summarizes the incidence of basements and crawlspaces by dwelling type. Single family detached homes and duplexes were most likely to have a basement or crawlspace (86% and 72% respectively), compared to row / townhouses (55%), and apartments / condominiums (57%). The numbers suggest that some apartments or condominiums do not strictly adhere to the conventional definition of being part of a mid-rise or high-rise building.

**Table 26: Incidence of Basements and Crawlspaces by Dwelling Type (%)**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Full basement | 54.2 | 41.7 | 28.0 | 16.7 | 0.9 | 37.4 |
| Partial basement | 11.1 | 7.2 | 9.5 | 0.0 | 0.0 | 8.1 |
| Crawlspace | 20.6 | 23.1 | 17.8 | 7.7 | 34.9 | 14.9 |
| No basement or crawlspace | 14.2 | 27.9 | 44.7 | 75.6 | 64.1 | 39.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Basement or crawlspace | 85.8 | 72.1 | 55.3 | 24.4 | 35.9 | 60.4 |

Totals may not sum due to rounding.

Basements, if present, can be completely below ground, partially above ground or completely above ground (Table 27, next page). Topography, soil conditions, and the dwelling design often influence vertical positioning of the basement. Of FEU dwellings with basements:

- Three-quarters (73%) have a basement that is partially above ground;
- Over one-in-eight either have a basement completely below ground (14%), or have a basement completely above ground 13%;
- Regionally, homes with basements in Whistler, Lower Mainland, and Vancouver Island were the most likely to have basements situated completely above ground (17% to 18%); and
- Homes in the Interior and Fort Nelson regions were most likely to have basements completely below ground (17% and 21% respectively).

There are no significant differences between 2008 and 2012 data for either FEU or FEI totals. Data from 2002 are not presented due to differences in question wording

**Table 27: Basement Elevation by Region (%)**

| Homes with basements | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI |
|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *440* | *1233* | *340* | *23* | *62* | *2098* | *1055* | *1735* | *753* |
| Completely below ground | 13.4 | 17.4 | 6.2 | 4.5 | 20.5 | 14.2 | 14.0 | 14.9 | 14.5 |
| Partially above ground | 69.3 | 76.8 | 77.4 | 77.3 | 77.9 | 72.5 | 69.7 | 72.1 | 69.6 |
| Completely above ground | 17.3 | 5.8 | 16.5 | 18.2 | 1.6 | 13.3 | 16.3 | 13.1 | 15.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only
Totals may not sum due to rounding.

Six-in-ten (61%) of FEU residential dwellings with a basement have fully finished basements (Table 28). Another three-in-ten (31%) have partially finished basements. The remainder (8%) of basements are unfinished. Although some of the survey to survey changes are small, the trend has been towards finishing the basement level.

**Table 28: Basement Finishing by Region (%)**

| Homes with basements | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *440* | *1233* | *340* | *23* | *62* | *2098* | *1272* | *1735* | *894* | *1089* |
| Unfinished | 6.9 | 8.1 | 9.1 | 18.2 | 4.8 | 7.5 | 8.9 | 7.3 | 8.5 | 10.8 |
| Partially finished | 26.4 | 38.0 | 40.6 | 13.6 | 32.1 | 31.4 | 33.7 | 30.6 | 33.2 | 32.4 |
| Completely finished | 66.7 | 53.9 | 50.3 | 68.2 | 63.1 | 61.1 | 57.3 | 62.1 | 58.3 | 56.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only
Totals may not sum due to rounding.

Eight-in-ten (80%) of FEU dwellings with a basement or crawlspace usually heat these spaces during the heating season, up from 2008 (74%) (Table 29). Regionally, dwellings on Vancouver Island are least likely to heat their basement or crawlspace (69% heated), while dwellings in the Fort Nelson region are most likely to heat these spaces (89% heated).

**Table 29: Heating of Basements and Crawlspaces by Region (%)**

| Basement/Crawlspace Heating | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI |
|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | 583 | 1516 | 605 | 67 | 74 | 2845 | 1473 | *2173* | *934* |
| Usually heated during heating season | 79.9 | 82.3 | 68.9 | 83.3 | 89.4 | 79.5 | 74.2 | 80.8 | 75.3 |
| Not heated | 20.1 | 17.7 | 31.1 | 16.7 | 10.6 | 20.5 | 25.8 | 19.2 | 24.7 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
[1] Excludes homes without basements.

Table 30 (next page) summarizes the above data by basements versus crawlspaces. Of note, slightly less than half (49%) of crawl spaces are heated during the heating season, up from 2008 (42%). Crawl spaces are least likely to be heated in the Fort Nelson and Interior regions (38% and 44% respectively). In comparison, 90% of basements are heated, up from 82% in 2008. The increase in the proportion of basements that are heated is consistent with the longer term trend towards finishing the basement level.

**Table 30: Heating of Basements vs. Crawlspaces (%)**

| Basement /Crawlspace Heating | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| Percent of basements heated | 89.4 | 91.3 | 86.1 | 90.9 | 100.0 | 89.8 | 81.6 |
| Percent of crawl spaces heated | 51.7 | 43.5 | 47.2 | 79.6 | 38.5 | 49.2 | 41.5 |

Totals may not sum due to rounding.
[1] Excludes homes without basements or crawlspaces.

## 5.4 Ceiling Heights

Ceiling heights affect the total interior volume of the home that needs to be heated or cooled. Survey respondents were asked to indicate the proportions of their dwelling that have 8, 9, 10 and more than 10 foot ceiling heights. These data, summarized in Table 31 show that 8 foot ceilings continue to be most common ceiling height, accounting for seven-in-ten (71%) of all ceilings in a typical residence. Next most common are 9 foot ceilings and 10 foot ceilings (17% and 7% respectively). Five percent (5%) of ceilings were greater than 10 feet. Dwellings in Whistler are notable in that they have a significantly higher incidence of ceilings exceeding 8 feet (56%). All differences between the 2012 and 2008 results are not statistically significant.

**Table 31: Ceiling Heights by Region (Mean %)**

| Ceiling Height | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *1952* |
| 8 feet | 69.5 | 74.5 | 68.1 | 43.9 | 79.2 | 70.7 | 71.8 |
| 9 feet | 17.9 | 14.8 | 19.1 | 20.8 | 9.4 | 17.1 | 17.5 |
| 10 feet | 7.4 | 6.8 | 8.0 | 13.2 | 6.9 | 7.3 | 6.5 |
| More than 10 feet | 5.2 | 3.9 | 4.8 | 22.0 | 4.6 | 4.8 | 4.0 |

Totals may not sum due to rounding.

Ceiling heights in new construction have been increasing. Table 32 illustrates this trend by summarizing the data on ceiling heights by dwelling vintage. Indeed, ceiling heights in new homes have been increasing since the mid-1970s. Ceilings of nine feet or higher account for seven-in-ten (69%) of ceilings in dwellings constructed since 2005 compared to just slightly over one-in-eight (14%) of dwellings constructed during the 1950-75 period. Indeed, one-quarter (25%) of all ceilings in homes built since 2005 are 10 feet high or higher.

**Table 32: Ceiling Heights by Dwelling Vintage (Mean %)**

| Ceiling Height | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 – 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *346* | *904* | *569* | *648* | *582* | *234* | *346* |
| 8 feet | 64.2 | 86.2 | 80.3 | 73.0 | 49.2 | 31.2 | 68.9 |
| 9 feet | 22.9 | 7.9 | 10.3 | 14.0 | 32.2 | 43.7 | 8.3 |
| 10 feet | 10.8 | 4.1 | 5.3 | 7.4 | 9.9 | 14.2 | 11.8 |
| More than 10 feet | 2.0 | 1.9 | 4.1 | 5.6 | 8.7 | 10.9 | 11.0 |

## 5.5 Insulation

Collecting credible data on home insulation levels using self-reported methods is challenging. Respondents' ability to accurately describe insulation levels is hindered by the fact that many of the areas of a home that are traditionally insulated are not accessible. Additionally, knowing the insulating value (R-value) is challenging for many. The 2012 REUS survey and past REUS surveys have tried to address this latter issue by categorizing insulation levels by both R-value and wall thickness. Despite efforts to improve the ability of respondents to answer this question, up to one-quarter (25%) of respondents to the 2012 REUS survey did not know the insulation level in their dwelling's walls, attic, or basement. As a result, caution is advised in the interpretation of these data.

The 2012 REUS survey first asked whether insulation was present in each of three areas of the home (attics, walls, basements or crawlspaces). If present, respondents were asked to indicate the level or amount of insulation present in each area using one of the following three categorizations:

- Below average (about R6 or 1.75 inches of insulation or less)
- Average (about R12 or 3.5 inches of insulation)
- Above average (about R18 or 5.25 inches of insulation or more)

Those who indicated an area was not insulated or were unsure whether it was insulated were not asked to rate the insulation level.

This approach differs from past REUS surveys which did not query the presence (yes or no) of insulation. Past REUS surveys implicitly included respondents without insulation as part of the "below average" insulation category. As a result of this difference, comparisons with past REUS survey results were not made.

Insulation levels for attics are summarized by region in Table 33. The "Don't Knows" are included in the presentation of results because it cannot be assumed that they are proportionately distributed among those who indicated one of the three insulation levels.[28]

**Table 33: Attic Insulation Levels by Region (%)**

| Attics | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *760* | *1640* | *721* | *83* | *100* | *3304* |
| Attic not insulated | 3.7 | 1.6 | 1.1 | 3.7 | 2.1 | 2.8 |
| Unsure attic is insulated | 6.5 | 5.1 | 3.7 | 6.1 | 6.2 | 5.8 |
| **Insulated:** | | | | | | |
| Below average | 5.2 | 4.3 | 3.4 | 3.7 | 4.1 | 4.7 |
| Average | 30.8 | 26.4 | 30.6 | 20.7 | 29.8 | 29.6 |
| Above average | 31.1 | 44.9 | 38.6 | 48.8 | 42.1 | 35.7 |
| DK | 22.7 | 17.6 | 22.7 | 17.1 | 15.8 | 21.3 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

As standards for insulating homes have improved over time, newer homes are expected to be better insulated than older homes. Table 34 (next page) summarizes insulation levels for attics by dwelling vintage and the data confirm that attics are less likely to be insulated if built before 1950, and insulation levels are generally higher in newer homes than older homes. The relationship between insulation levels and dwelling vintage also reflects the likelihood that older homes may have upgraded their attic insulation.

[28] For example, respondents who are unsure of their home's insulation levels may be more likely to have below average insulation levels.

**Table 34: Attic Insulation Levels by Dwelling Vintage (%)**

| Attics | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Attic not insulated | 5.0 | 2.9 | 2.2 | 2.6 | 2.0 | 0.8 | 16.9 |
| Unsure attic is insulated | 6.9 | 4.7 | 4.1 | 7.5 | 5.1 | 5.1 | 28.2 |
| **Insulated:** | | | | | | | |
| Below average | 31.1 | 28.1 | 35.0 | 31.1 | 28.4 | 16.8 | 15.5 |
| Average | 28.5 | 38.6 | 33.7 | 32.5 | 39.8 | 49.1 | 18.0 |
| Above average | 19.1 | 17.5 | 21.0 | 22.8 | 24.5 | 26.8 | 20.3 |
| DK | 11.9 | 7.6 | 6.3 | 10.1 | 7.1 | 5.9 | 45.1 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Table 35 summarizes the data for wall insulation for the five FEU regions and the overall utility average.

**Table 35: Exterior Wall Insulation Levels by Region (%)**

| Exterior Walls | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *760* | *1640* | *721* | *83* | *100* | *3304* |
| Walls not insulated | 3.3 | 1.1 | 2.0 | 0.0 | 1.0 | 2.6 |
| Unsure walls are insulated | 8.7 | 6.6 | 6.1 | 4.9 | 6.0 | 7.8 |
| Insulated: | | | | | | |
| Below average | 5.9 | 6.1 | 5.0 | 4.9 | 8.1 | 5.8 |
| Average | 42.9 | 40.4 | 40.3 | 31.7 | 39.2 | 41.9 |
| Above average | 12.4 | 24.2 | 21.8 | 40.2 | 26.2 | 16.7 |
| DK | 26.8 | 21.6 | 24.9 | 18.3 | 19.5 | 25.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Exterior wall insulation levels by dwelling vintage are summarized in Table 36 (next page). Compared to attic insulation levels, the relationship between dwelling vintage and exterior wall insulation levels is much more pronounced. This is likely due to the degree of difficulty to upgrade wall insulation once construction of the dwelling is complete. Thirteen percent (13%) of respondents with dwellings built before 1950 indicated their walls are not insulated plus another one-in-ten (10%) indicated they are unsure whether the walls were insulated. The proportion of respondents unsure whether their walls are insulated tends to decline with newer dwellings, as does the likelihood that walls are not insulated. The higher rates of uncertainty associated with older homes may reflect the tendency for these homes to have had multiple owners, meaning that the current owner may be unaware of past efforts to improve insulation levels.

For homes with some form of wall insulation, the proportion of dwellings with below average insulation in their walls increases with the age of the dwelling. For example, nearly one-half (47%) of respondents living in dwellings constructed between 1950 and 1975 indicated their home has below average wall insulation, compared to almost one-quarter (23%) of respondents living in dwellings constructed since 2006. Conversely, only one-in-ten (10%) of homes built prior to 1950 were felt to have average wall insulation levels compared to nearly one-half (45%) of homes built since 2005.

**Table 36: Exterior Wall Insulation Levels by Dwelling Vintage (%)**

| Exterior Walls | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Walls not insulated | 12.5 | 2.8 | 0.5 | 1.6 | 0.5 | -- | 1.0 |
| Unsure walls are insulated | 9.6 | 9.4 | 5.7 | 7.8 | 6.4 | 5.4 | 22.9 |
| **Insulated:** | | | | | | | |
| Below average | 32.0 | 46.9 | 54.1 | 40.0 | 36.9 | 22.6 | 33.9 |
| Average | 10.1 | 7.5 | 10.8 | 19.3 | 30.3 | 45.0 | 6.8 |
| Above average | 21.3 | 22.9 | 25.4 | 27.8 | 25.4 | 26.8 | 33.1 |
| DK | 22.1 | 12.2 | 6.2 | 9.4 | 7.0 | 5.4 | 23.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Basements without insulation can account for 20% to 35% of the total heat loss of a house.[29] Insulation for basements and crawl spaces by FEU region are summarized in Table 37.

**Table 37: Basement or Crawl Space Insulation Levels by Region ((%)**

| Basements or Crawl Space | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *760* | *1640* | *721* | *83* | *100* | *3304* |
| Basement / crawl space not insulated | 19.9 | 14.4 | 18.1 | 6.3 | 11.9 | 18.1 |
| Unsure basement / crawl space is insulated | 11.0 | 7.1 | 8.4 | 5.1 | 10.8 | 9.6 |
| **Insulated:** | | | | | | |
| Below average | 5.4 | 8.0 | 5.5 | 5.1 | 5.4 | 6.1 |
| Average | 31.8 | 35.2 | 31.5 | 27.9 | 37.9 | 32.7 |
| Above average | 11.2 | 18.8 | 17.6 | 35.4 | 21.7 | 14.1 |
| DK | 20.7 | 16.5 | 19.0 | 20.3 | 12.3 | 19.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 38 (next page) summarizes basement and crawl space insulation by dwelling vintage. Similar to data on attic and wall insulation levels, newer homes are more likely than older homes to have insulation in their basement or crawl space and have insulation that is average or above average. As an example, just one percent of homes constructed since 2005 have below average amounts of insulation compared to one-in-ten (11%) of homes built prior to 1950. Similarly, four-in-ten (41%) of homes built since 2005 have above average insulation compared to one-in-eight (13%) of those built prior to 1950.

[29] Natural Resources Canada, *Keeping the Heat In – EnerGuide*, 2004.

**Table 38: Basement or Crawl Space Insulation Levels by Dwelling Vintage (%)**

| Basement or Crawl Space | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Basement / crawl space not insulated | 25.9 | 17.4 | 18.8 | 22.7 | 10.7 | 9.8 | 19.9 |
| Unsure basement / crawl space is insulated | 8.7 | 9.1 | 9.4 | 10.7 | 9.8 | 7.0 | 27.9 |
| **Insulated:** | | | | | | | |
| Below average | 11.2 | 8.1 | 6.0 | 5.8 | 1.0 | 1.1 | 7.0 |
| Average | 28.9 | 40.5 | 34.5 | 29.4 | 30.2 | 18.9 | 15.5 |
| Above average | 12.6 | 6.9 | 8.7 | 12.8 | 26.1 | 41.1 | 1.4 |
| DK | 12.8 | 18.0 | 22.6 | 18.7 | 22.0 | 22.1 | 28.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

## 5.6 Draft Proofing Effectiveness

Draft proofing / leak sealing is an activity best performed at least once a year, and is especially important in older homes. When asked how successful their draft proofing is for their residence, slightly less than one-half (48%) of respondents indicated their home was sometimes or always drafty, slightly higher than 2008 (44%) (Table 39). Regionally, the results are likely influenced by climate, the age and composition of the dwelling stock. For example, homes on Vancouver Island and Whistler are considered the least drafty (40% and 44%) while the draftiest homes are in Fort Nelson (63%).

**Table 39: Draftiness of the Home by Region (%)**

| How effective is your draft proofing? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *84* | *105* | *3441* | *2182*[1] |
| Not at all drafty | 49.1 | 54.2 | 59.9 | 56.1 | 37.1 | 51.6 | 55.6 |
| Sometimes drafty | 45.5 | 41.0 | 37.7 | 43.9 | 54.2 | 43.5 | 41.1 |
| Always drafty | 5.4 | 4.7 | 2.4 | -- | 8.7 | 4.9 | 3.3 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Sometimes or always drafty | 50.9 | 45.8 | 40.1 | 43.9 | 62.9 | 48.4 | 44.4 |

[1] Rebased to exclude DK responses
Totals may not sum due to rounding.

## 5.7 Windows

Respondents to the 2012 REUS were asked to specify the percentage of their windows that matched the following descriptions:

- Single pane regular (clear) glass
- Double pane regular (clear) glass
- Double pane low-e
- Triple pane regular (clear) glass
- Triple pane low-e
- Other

Respondents with double and/or triple glazed windows were also asked whether the windows had argon gas fill between the panes. These window descriptions are the same as those used in the 2008 REUS. The 2002 REUS also used similar window categories but did not ask for percentages. Rather, the survey asked respondents to indicate which of the window types were in the majority of window openings. This prevents direct comparison of the 2002 data with 2008 and 2012.

Average (mean) percentages for the five window types and "other" by FEU region are provided in Table 40. Highlights include:

- double pane regular glass windows continue to be most common window type present in FEU residential dwellings in 2012 (62% of all windows in 2012 versus 66% in 2008);
- the share of double pane windows with low-e coating is highest in the Interior and Fort Nelson regions (27% and 26% respectively);
- consistent with the 2008 REUS, residential dwellings in the Lower Mainland region continue to have significantly more single pane windows than other regions (18%); and
- triple pane windows, with or without low-e coatings, represent a very small percentage of windows, regardless of region.

**Table 40: Window Glazing - Mean % of all Windows by Region**

| Window Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *781* | *1662* | *738* | *80* | *101* | *3362* | *1993* |
| Single pane regular glass | 17.7 | 8.8 | 10.0 | 0.8 | 11.2 | 14.5 | 18.2 |
| Double pane regular glass | 62.0 | 60.7 | 68.3 | 72.6 | 59.7 | 62.3 | 66.3 |
| Double pane with low-e coat | 18.5 | 26.9 | 19.3 | 23.4 | 25.5 | 20.9 | 13.5 |
| Triple pane regular glass | 0.4 | 0.7 | 0.5 | 0.1 | 1.1 | 0.5 | 0.5 |
| Triple pane with low-e coat | 0.6 | 1.5 | 0.4 | 0.1 | -- | 0.8 | 0.4 |
| Other | 0.8 | 1.4 | 1.4 | 3.0 | 2.5 | 1.0 | 0.7 |

Of note, the percentage of double pane windows with low-e coating increased from 2008 (14% versus 21% in 2012). This result is attributable to both newer homes in the 2012 REUS but also due to significant home renovation activity during the past four years, in part, due to rebate programs offered by governments and utilities.

Data on window types by dwelling vintage are summarized in Table 41 (next page). Unsurprisingly, the data show that the older the dwelling, the more likely it has single pane windows. Homes constructed in the 1986-95 period are most likely to have double pane windows with regular glass, and this percentage decreases with dwellings that are both older and newer. The effects of renovation activity among the older housing stock are evident from the percentage of windows for homes constructed prior to 2006 that have double pane windows with low-e coating (ranges from 14% to 24%).

**Table 41: Window Glazing - Mean % of all Windows by Dwelling Vintage**

| Window Type | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 – 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *343* | *903* | *563* | *654* | *574* | *230* | *46* |
| Single pane regular (clear) glass | 34.8 | 24.1 | 12.5 | 5.1 | 3.3 | 1.2 | 23.7 |
| Double pane regular (clear) glass | 46.9 | 48.5 | 63.3 | 80.1 | 71.5 | 61.2 | 54.7 |
| Double pane with low-e coat | 15.4 | 24.1 | 22.8 | 13.6 | 23.3 | 33.3 | 14.5 |
| Triple pane regular (clear) glass | 0.7 | 0.2 | 0.2 | 0.4 | 0.9 | 1.7 | 0.5 |
| Triple pane with low-e coat | 0.9 | 1.4 | 0.4 | 0.3 | 0.4 | 2.3 | 0.5 |
| Other | 1.3 | 1.7 | 0.9 | 0.5 | 0.6 | 0.3 | 6.0 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

The presence of argon gas fill in double or triple glazed windows is summarized in Table 42. The likelihood of double or triple pane windows having argon gas fill increases with the presence of low-e coatings. For example, one-in-ten (11%) of respondents indicated their double paned windows (no low e coating) were equipped with argon gas compared to over one-half (54%) of respondents with double paned windows that had a low-e coating. These data are remarkable because of the high degree of respondents who were unsure (answered “don’t know”). Don’t know responses ranged from one-third (31 %) for “other” windows to over one-half (53%) for triple pane windows with clear glass.

**Table 42: Windows with Argon Gas Fill by Window Type**
**Percent (%) Share Across**

| | Filled with Argon Gas? | | | | |
|---|---|---|---|---|---|
| Window Type | Yes | No | Don’t Know | Total | *Un-weighted Base [1]* |
| Double pane regular (clear) glass | 10.8 | 37.9 | 51.3 | 100.0 | *2108* |
| Double pane with low-e coat | 53.8 | 13.5 | 32.7 | 100.0 | *928* |
| Triple pane regular (clear) glass | 23.2 | 23.5 | 53.3 | 100.0 | *35* |
| Triple pane with low-e coat | 47.1 | 14.2 | 38.7 | 100.0 | *46* |
| Other | 4.2 | 64.5 | 31.3 | 100.0 | *36* |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

### 5.7.1 Window Frames

Each respondent to the 2012 REUS was asked to estimate the percentage of their dwelling’s windows by frame material (e.g., aluminum, wood, vinyl, and/or fibreglass). An open ended “other” frame category was also provided. Averages by frame type, by region, are summarized in Table 43. The data show that vinyl framed windows are most common, accounting for nearly one-half (47%) of all windows, followed by aluminum (31%), and wood (20%).

**Table 43: Window Frame Material - Mean % of all Windows by Region**

| Window Frame Material | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | 781 | 1670 | 741 | 83 | 102 | 3377 |
| Aluminum | 50.0 | 20.5 | 34.8 | 33.1 | 17.3 | 30.6 |
| Wood | 11.1 | 27.6 | 10.8 | 40.5 | 26.8 | 20.4 |
| Vinyl | 37.1 | 49.7 | 52.9 | 25.4 | 54.8 | 47.1 |
| Fibreglass | 1.3 | 1.6 | 1.1 | -- | 0.2 | 1.3 |
| Other | 0.5 | 0.6 | 0.4 | 1.0 | 1.0 | 0.6 |

The popularity of different window frame materials tends to vary by when the home was built (Table 44).

- Homes built prior to 1950 are most likely to have wood window frames (46% of windows).
- Window frames in homes constructed from the mid-1970s to mid-1990s are more likely to be made from aluminum (40% to 43%).
- Homes constructed since the mid-1990s are most likely to have vinyl window frames (66% to 72%).

While some homes continue to use their original window frames, evidence of the use of newer style vinyl windows in older homes (those built prior to the mid-1990s) is consistent with window upgrades to existing structures.

**Table 44: Window Frame Material - Mean % of all Windows by Dwelling Vintage**

| Window Frame Material | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *343* | *903* | *570* | *655* | *574* | *230* | *43* |
| Aluminum | 17.7 | 29.7 | 40.2 | 43.2 | 19.5 | 15.6 | 54.5 |
| Wood | 45.7 | 21.5 | 19.7 | 18.9 | 11.2 | 8.9 | 12.8 |
| Vinyl | 35.2 | 47.3 | 38.2 | 36.9 | 66.4 | 71.7 | 28.5 |
| Fibreglass | 0.8 | 1.1 | 1.1 | 0.8 | 2.0 | 3.0 | 4.2 |
| Other | 0.6 | 0.4 | 0.8 | 0.4 | 0.8 | 0.7 | -- |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

## 5.8 Exterior Doors

REUS 2012 respondents were asked to itemize (count) their exterior (outside) doors by door material and design. Table 45 (next page) summarizes the relative popularity of door materials including wood, steel, fibreglass and glass. Insulated steel or fibreglass doors are the most common outer door materials for FEU customers, representing four-in-ten (39%) of all exterior doors in 2012, up from 2008 (34%). Wood doors (23%) and aluminum framed doors with glass (13%) are the next two most popular door types. Commensurate with the increased share represented by insulated steel or fibreglass doors, the shares for wood and aluminum framed glass doors has declined relative to 2008.

Notable regional differences include a significantly higher share for insulated steel or fibreglass doors in the Fort Nelson and Interior regions (55% and 44% respectively). Dwellings in Whistler and the Lower Mainland are significantly more likely to use exterior doors made of wood compared to the other regions. In Whistler's case, the use of wood exterior doors is likely influenced the architectural conventions common to the resort's housing stock. The use of wood for exterior doors in the Lower Mainland is attributable to the mix of older homes and newer, character style homes.

**Table 45: Exterior Door Material by Region (%)**

| Exterior Door Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *778* | *1655* | *741* | *83* | *102* | *3359* | *2074* |
| Wood doors | 28.2 | 19.8 | 21.4 | 34.4 | 17.8 | 22.5 | 27.2 |
| Wood doors with aluminum storm doors | 6.4 | 7.0 | 4.8 | 1.6 | 7.7 | 6.2 | 7.7 |
| Insulated steel or fibreglass doors | 30.7 | 43.5 | 37.4 | 15.8 | 55.2 | 38.6 | 33.8 |
| Glass doors with wooden frames | 7.1 | 9.5 | 9.4 | 28.7 | 8.7 | 9.4 | 8.5 |
| Glass doors with aluminum frames | 18.5 | 10.1 | 15.8 | 14.8 | 5.2 | 13.4 | 16.7 |
| Glass doors with vinyl frames | 9.0 | 10.1 | 11.3 | 4.7 | 5.2 | 9.8 | 6.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 46 summarizes the popularity of different exterior door types by dwelling vintage. As expected, wooden exterior doors are typical of older dwellings (e.g., 40% of exterior doors in homes built before 1950). However, wooden doors have shown some signs of resurgence in newer dwellings (16% of dwellings constructed since 2005). Despite this, newer homes are most likely to use insulated steel or fibreglass doors and glass doors with vinyl frames. Wooden doors with aluminum storm doors are most common among homes constructed prior to 1975 and are present in only three percent of homes constructed since 2005.

**Table 46: Exterior Door Material by Dwelling Vintage (%)**

| Exterior Door Type | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | 342 | 906 | 568 | 649 | 565 | 224 | 44 |
| Wood doors | 39.6 | 31.6 | 21.2 | 13.3 | 12.5 | 16.3 | 29.3 |
| Wood doors with aluminum storm doors | 8.4 | 9.4 | 5.3 | 5.3 | 2.6 | 3.2 | 10.0 |
| Insulated steel or fibreglass doors | 28.5 | 32.6 | 40.0 | 44.9 | 46.5 | 39.0 | 29.3 |
| Glass doors with wooden frames | 10.9 | 6.3 | 7.7 | 11.0 | 10.6 | 15.4 | 6.4 |
| Glass doors with aluminum frames | 8.4 | 12.2 | 16.0 | 15.8 | 14.0 | 11.7 | 14.3 |
| Glass doors with vinyl frames | 4.3 | 8.0 | 9.8 | 9.6 | 13.8 | 14.5 | 10.7 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Table 47 summarizes the average number of exterior doors per dwelling, by door material.

**Table 47: Average Number of Exterior Doors per Dwelling**

| Exterior Door Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *778* | *1655* | *741* | *83* | *102* | *3359* | *2074* |
| Wood doors | 1.0 | 0.7 | 0.8 | 1.3 | 0.5 | 0.8 | 1.0 |
| Wood doors with aluminum storm doors | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 |
| Insulated steel or fibreglass doors | 1.1 | 1.5 | 1.3 | 0.6 | 1.5 | 1.3 | 1.2 |
| Glass doors with wooden frames | 0.3 | 0.3 | 0.3 | 1.1 | 0.2 | 0.3 | 0.3 |
| Glass doors with aluminum frames | 0.7 | 0.3 | 0.6 | 0.6 | 0.1 | 0.5 | 0.6 |
| Glass doors with vinyl frames | 0.3 | 0.3 | 0.4 | 0.2 | 0.1 | 0.3 | 0.2 |
| **Average # per dwelling (all types)** | **3.6** | **3.4** | **3.6** | **3.8** | **2.8** | **3.5** | **3.6** |

## 5.9 Energy-Related Renovations

Respondents to the 2012 REUS were provided a list of renovations that could affect energy use. They were asked to indicate whether they had undertaken the renovation in the last five years. Additionally, they were asked whether they undertook the renovation with the help of a government or utility rebate. For renovations where no government or utility rebate was available, respondents only had to indicate whether they had undertaken the activity in the last five years. All respondents were also asked whether they planned to undertake any or all of the renovations during the next two years. Analysis of the results from the 2008 REUS had found a strong relationship between stated renovation intentions and actions.[30] Thus, activities indicated for the next two years from the 2012 REUS, while speculative, are considered reasonable indicators as to which renovations are most likely to be undertaken by FEU residential customers.

Past (rebate and no-rebate) and planned (expected) renovations for FEU customers are summarized in Table 48. Of note, nearly one-half (46%) undertook at least one of the listed renovation activities. The three most frequently undertaken renovations were: installing programmable thermostats (undertaken by 21% of REUS 2012 respondents); installing energy-efficient windows (20%), and weather stripping or caulking (19%). Appliance specific renovations included: installed a high efficiency hot water tank (10%), and installed an on-demand hot water heater (3%).

**Table 48: Renovation Activity - Last Five Years and Next Two Years (%)**

| | Last Five Years | | | | |
|---|---|---|---|---|---|
| Type of Renovation | Did This – With or Without Rebate | Did This - With Rebate | Did This - Without Rebate | Percent Using Rebate | Plan to do This – Next Two Years |
| Install programmable thermostat(s) | 20.5 | 3.6 | 16.9 | 17.5 | 4.6 |
| Install energy-efficient window(s) | 20.1 | 7.2 | 12.9 | 35.6 | 9.2 |
| Install weather stripping or caulking | 18.6 | 2.6 | 16.0 | 13.8 | 8.4 |
| Install low flow showerhead(s) | 16.7 | 2.1 | 14.6 | 12.5 | 4.6 |
| Improve insulation in walls, attic, basement, or crawlspace | 16.2 | 5.2 | 11.0 | 31.8 | 9.0 |
| Install insulated exterior door(s) or storm doors | 13.6 | 3.8 | 9.9 | 27.7 | 5.6 |
| Completed EcoENERGY or LiveSmart BC energy audit | 10.4 | n/a | 10.4 | n/a | 2.9 |
| Install high efficiency hot water tank | 10.1 | 2.5 | 7.6 | 24.4 | 7.0 |
| Install pipe wrap | 9.4 | 1.0 | 8.4 | 10.6 | 4.8 |
| Install on-demand (tankless or hybrid) water heater | 3.0 | 0.8 | 2.2 | 28.0 | 5.2 |
| Install hot water heater blanket | 2.9 | 0.6 | 2.4 | 18.9 | 5.9 |
| Install hot tub | 1.8 | n/a | 1.8 | n/a | 1.5 |
| Install drain pipe waste heat recovery system | 0.9 | 0.3 | 0.6 | 29.2 | 2.1 |
| Install a sauna | 0.8 | n/a | 0.8 | n/a | 0.7 |
| Install heated swimming pool | 0.5 | n/a | 0.5 | n/a | 0.6 |
| At least one of the above (%) | 46.3 | | | n/a | 38.4 |

Calculated using weighted base of n = 3,341
n/a = not applicable

The percent of renovations completed with the aid of a government or utility rebate, where available, ranged from one-in-ten (11%) for installing pipe wrap to nearly four-in-ten (36%) for installing energy-efficient windows. One-in-ten (10%) of respondents indicated they completed an ecoENERGY / LiveSmart BC home energy audit.

[30] Terasen Gas (2008), p. 4-20.

The percent of respondents that undertook one or more energy-related renovations to their home in the last five years varies, in part, with the vintage of their home (Table 49).

**Table 49: Renovations in Last Five Years by Dwelling Vintage**
**Percent of Respondents**

| Energy-Related Renovation – Last Five Years | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Improve insulation in walls, attic, basement, or crawlspace | 27.0 | 22.6 | 15.2 | 11.3 | 8.0 | 6.0 | 16.8 |
| Install energy-efficient window(s) | 25.1 | 32.2 | 27.9 | 10.3 | 4.8 | 4.3 | 16.6 |
| Install insulated exterior door(s) or storm doors | 18.7 | 20.6 | 16.1 | 8.1 | 6.2 | 3.9 | 4.1 |
| Install low flow showerhead(s) | 19.3 | 19.7 | 22.1 | 15.3 | 8.6 | 7.7 | 10.4 |
| Install programmable thermostat(s) | 22.6 | 23.5 | 21.6 | 22.7 | 13.5 | 9.4 | 9.4 |
| Install pipe wrap | 13.4 | 12.4 | 8.4 | 4.1 | 4.2 | 1.6 | 5.2 |
| Install weather stripping or caulking | 28.5 | 23.1 | 20.2 | 12.7 | 14.4 | 5.9 | 6.3 |
| Install hot water heater blanket | 3.6 | 4.6 | 3.1 | 1.4 | 2.4 | 1.0 | 2.0 |
| Install drain pipe waste heat recovery system | 1.3 | 1.0 | 1.3 | 0.6 | 0.7 | 0.1 | 0.0 |
| Install on-demand (tankless or hybrid) water heater | 5.1 | 3.6 | 3.8 | 2.2 | 1.1 | 2.1 | 0.0 |
| Install high efficiency hot water tank | 8.8 | 10.3 | 12.5 | 11.1 | 9.2 | 2.4 | 4.3 |
| Completed EcoENERGY or LiveSmart BC energy audit | 12.9 | 13.1 | 11.1 | 11.3 | 4.8 | 2.7 | 1.1 |
| Install a sauna | 2.1 | 0.3 | 0.6 | 0.1 | 2.0 | 0.5 | 0.0 |
| Install heated swimming pool | 0.7 | 0.2 | 0.6 | 0.1 | 1.0 | 0.5 | 0.0 |
| Install hot tub | 1.3 | 2.4 | 1.2 | 1.7 | 1.7 | 3.2 | 0.0 |
| At least one of the above | 51.0 | 55.4 | 54.2 | 44.6 | 33.3 | 21.6 | 37.4 |

The data confirm that the older the home, the more likely it received one or more energy-related renovations during the past five years. For example, one-half (51%) of homes built before 1950 had at least one energy-related renovation compared to only one-in-five (22%) of homes constructed since 2005. The likelihood of any specific renovation activity being completed during the last five years typically increased with the age of the dwelling, although there is a commonality of renovation incidence for windows, doors, programmable thermostats, and weather stripping for homes built prior to 1986. This group of homes were also comparable in terms of their likelihood of having an ecoENERGY / LiveSmart BC energy audit.

Overall, four-in-ten (38%) households plan to undertake one or more energy-related renovations during the next two years. The top three energy-related renovations planned include installing energy-efficient windows, improving insulation and weather stripping / caulking.

Table 50 (next page) shows the likelihood undertaking one or more energy impacting renovations in the next two years also varies, in part, with the vintage of the home.

**Table 50: Renovations in Next Two Years by Dwelling Vintage**
**Percent of Respondents**

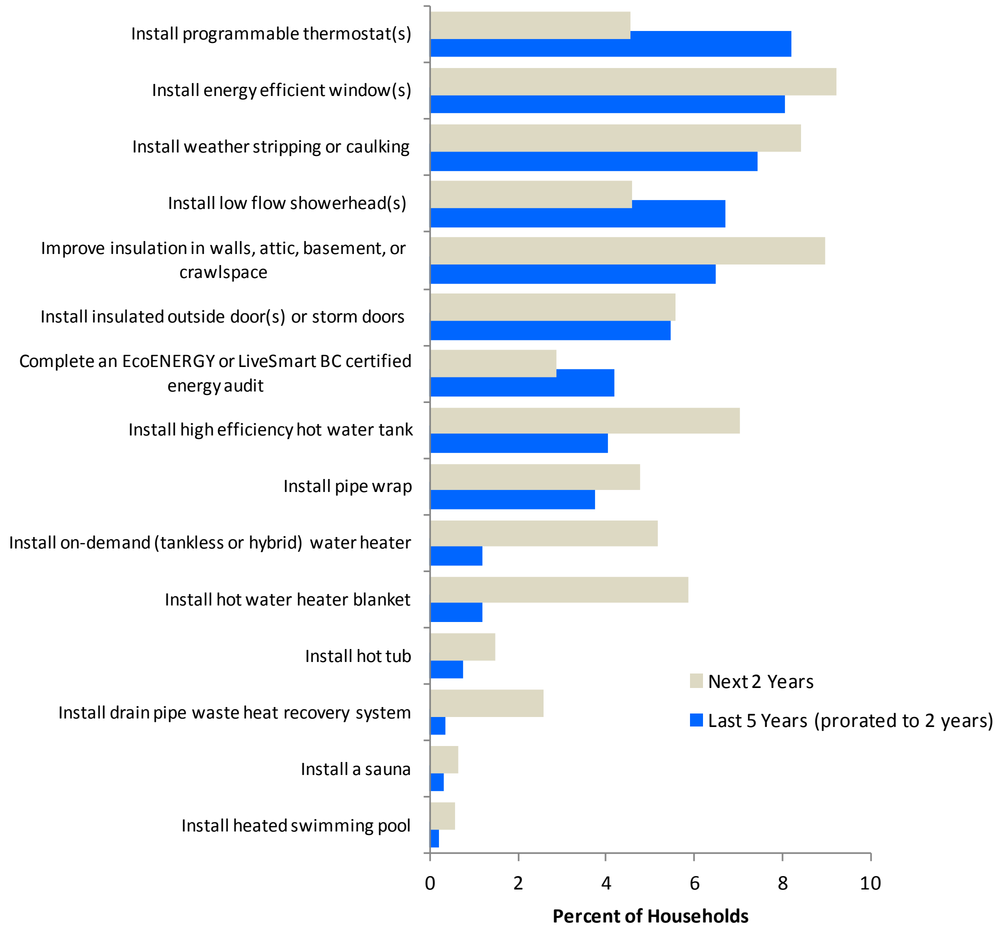
| Energy-Related Renovation – Next Two Years | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Improve insulation in walls, attic, basement, or crawlspace | 14.7 | 11.2 | 11.5 | 7.1 | 4.5 | 4.6 | 0.1 |
| Install energy-efficient window(s) | 13.7 | 12.6 | 13.4 | 6.8 | 2.8 | 3.1 | 6.4 |
| Install insulated exterior door(s) or storm doors | 7.2 | 7.5 | 5.8 | 5.8 | 2.5 | 1.0 | 6.4 |
| Install low flow showerhead(s) | 5.5 | 5.5 | 4.0 | 4.3 | 4.3 | 3.9 | 1.1 |
| Install programmable thermostat(s) | 2.4 | 5.3 | 4.4 | 5.0 | 3.8 | 4.9 | 6.3 |
| Install pipe wrap | 5.8 | 6.0 | 4.1 | 5.7 | 3.2 | 2.2 | 0.0 |
| Install weather stripping or caulking | 9.2 | 7.3 | 7.9 | 11.9 | 6.6 | 8.3 | 5.2 |
| Install hot water heater blanket | 8.6 | 6.0 | 7.4 | 6.6 | 3.5 | 2.0 | 0.0 |
| Install drain pipe waste heat recovery system | 1.2 | 4.1 | 3.0 | 2.5 | 1.8 | 1.0 | 0.0 |
| Install on-demand (tankless or hybrid) water heater | 4.5 | 7.1 | 5.4 | 4.4 | 5.0 | 2.5 | 1.0 |
| Install high efficiency hot water tank | 5.6 | 8.3 | 6.5 | 7.3 | 9.4 | 1.0 | 6.2 |
| Have an EcoENERGY or LiveSmart BC energy audit | 1.5 | 3.5 | 2.7 | 4.2 | 1.9 | 1.6 | 2.0 |
| Install a sauna | 0.2 | 1.1 | 0.3 | 1.0 | 0.3 | 0.5 | 0.0 |
| Install heated swimming pool | 0.3 | 1.0 | 0.4 | 0.7 | 0.2 | 0.5 | 0.0 |
| Install hot tub | 2.8 | 2.4 | 0.9 | 1.0 | 0.5 | 1.0 | 1.1 |
| At least one of the above | 40.8 | 42.5 | 46.3 | 36.9 | 31.6 | 27.7 | 23.2 |

Over four-in-ten respondents living in dwellings built prior to 1986 are planning to undertake at least one energy-related renovation, compared to three-in-ten of respondents living in homes built since 1995. Additionally, the nature of the renovations planned varies by vintage, with respondents in older dwellings planning to install energy-efficient windows, insulated doors, hot water heater blankets, and pipe wrap. Respondents with newer homes are more likely to upgrade weather stripping and caulking, improve insulation levels, install programmable thermostats, and install low flow shower heads. Of particular note, homes constructed during the mid-1970s to mid-1980s (28 to 38 years old) are expected to undergo the most renovation activity during the next two years, with nearly half (46%) of households in these homes planning at least one energy-related renovation.

Figure 19 (next page) compares the frequency of past energy-related renovations with planned renovations, ordered by renovations undertaken during the past five years. Data for the latter variable have been prorated to two years to allow comparison with the planned renovations.

Some renovations undertaken in the past are less likely to occur in the next two years. These include installing programmable thermostats and low flow showerheads. Some renovations are more likely to occur in the next two years than they did in the past, including installing a high efficiency hot water tank or on-demand water heater, installing a hot water heater blanket, and improving insulation. There also appears to be some interest in drain pipe waste heat recovery systems.

**Figure 19: Comparison of Past and Planned Energy-Related Renovations**




### 5.9.1 Renovations Involving Fireplaces and Heater Stoves

One-in-eight (14%) of REUS 2012 respondents indicated they had either undertaken renovations or changes to their fireplaces or heater stoves during the last five years or planned to do so in the next two years (Table 51). Regionally, residents of Fort Nelson and Whistler were less likely to make or plan changes but the small samples for these regions mean the differences are not statistically significant.

**Table 51: Renovations / Changes to Fireplaces or Heating Stoves (%)**

| Fireplace or Heater Stove Renovations | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *769* | *1624* | *717* | *81* | *104* | *3295* |
| Yes - Renovations / changes last 5 years or next 2 years | 14.2 | 13.4 | 13.4 | 11.2 | 8.5 | 13.9 |

Past and planned renovations involving fireplaces or heating stoves, by type of renovation, are summarized in Table 52 (next page). Respondents having made a renovation involving fireplaces or heating stoves in the last five years were asked whether the renovation(s) were done with or without a government or utility rebate.

**Table 52: Fireplace or Heating Stove Renovations - Last Five Years and Next Two Years (Population %)**

| Type of Fireplace or Heating Stove Renovation | Did This – With or Without Rebate | Did This - With Rebate | Did This - Without Rebate | Percent Using Rebate | Plan to do this – Next 2 Years |
|---|---|---|---|---|---|
| Install gas heater type fireplace insert in an existing wood fireplace | 3.6 | 0.7 | 2.9 | 20.6 | 1.2 |
| Install free standing gas fireplace or heating stove | 1.8 | 0.5 | 1.3 | 28.8 | 0.9 |
| Replace decorative gas fireplace with gas heater type insert | 1.5 | 0.9 | 0.7 | 55.1 | 0.8 |
| Remove wood fireplace or wood stove | 1.0 | n/a | 1.0 | n/a | 0.2 |
| Install decorative gas fireplace | 1.0 | n/a | 1.0 | n/a | 0.2 |
| Install wood stove | 0.9 | 0.1 | 0.7 | 16.4 | 0.5 |
| Install electric fireplace | 0.9 | n/a | 0.9 | n/a | 0.4 |
| Remove or disconnect gas fireplace | 0.5 | n/a | 0.5 | n/a | 0.2 |
| At least one of the above (population) | 8.9 | | | n/a | 6.2 |

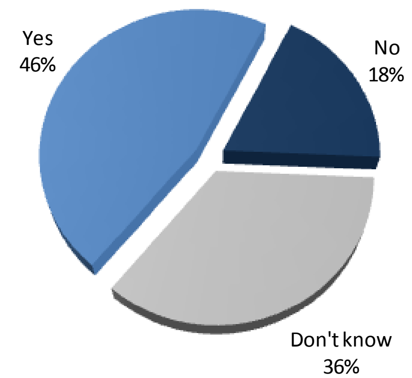
n/a = not applicable

Overall, one-in-ten (9%) of FEU residential customers undertook one of the listed renovations to a fireplace or heater stove during the last five years. The top three renovations were: installing a gas heater type fireplace insert in an existing wood fireplace (3.6% of respondents); installing a free standing gas fireplace or heater stove (1.8%), and replacing a decorative gas fireplace with a gas heater type insert (1.5%). Over one-half (55%) of decorative gas fireplace replacements were done with a government or utility rebate.

Only six percent (6%) of FEU customers indicated they plan to undertake one or more of the eight listed fireplace or heater stove renovations during the next two years with the most frequently planned renovation is to install a gas heater type fireplace insert into an existing wood fireplace (1.2% of the respondents).

Respondents who installed a gas fireplace or heater stove during the last five years were asked whether the unit was an EnerChoice model. The EnerChoice logo and a brief description were provided to help with recognition. The results, summarized in Figure 20, show that less than one-half (46%) of those who installed a fireplace or heater stove indicated it was EnerChoice model; however, over one-in-three (35%) were unsure whether it was an EnerChoice model. Regional results are not presented due to small sample sizes.

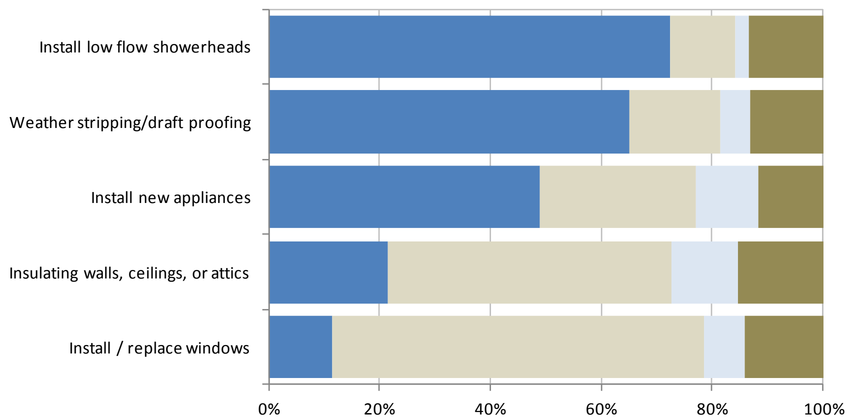
**Figure 20: Was Fireplace or Heater Stove an EnerChoice Model?**



## 5.10 Energy-Related Home Improvements – DIY Versus Using Contractors

Respondents to the 2012 REUS survey were asked to indicate who typically performs a variety of common energy-related improvements to their home, including installing new appliances, installing/replacing windows, installing low flow showerheads, weather stripping and draft proofing, and improving insulation in walls, ceilings, and attics. The results, summarized in Figure 21, show that the more complex the task, the greater likelihood that a contractor would undertake the task.

**Figure 21: Who Typically Completes Energy-Related Home Improvements?**




| | Install / replace windows | Insulating walls, ceilings, or attics | Install new appliances | Weather stripping/draft proofing | Install low flow showerheads |
|---|---|---|---|---|---|
| Homeowner | 11.4 | 21.6 | 48.8 | 65.0 | 72.3 |
| Contractor | 67.3 | 51.2 | 28.2 | 16.6 | 11.8 |
| Both | 7.2 | 11.9 | 11.4 | 5.3 | 2.5 |
| Not Applicable / No Answer | 14.1 | 15.3 | 11.6 | 13.1 | 13.4 |

**Percent of Respondents (n=3,441)**

Between 12% to 15% of respondents indicated the home improvement in question was not applicable to them or did not answer the question. Some may not have made the improvement in question or someone else may be responsible for these improvements in their home. This latter would be typical for condominiums and rental properties where many renovations and capital upgrades are responsibility of someone other than the resident.

# 6 SPACE HEATING

This section presents and analyzes data on space heating fuels and methods (appliances and equipment), fuel switching behaviours, furnace and boiler efficiencies, heating equipment replacement, repair and maintenance behaviours, and furnace fan operating behaviours.

## 6.1 Determining How Dwellings are Heated

Determining how people heat their homes requires identifying two components:  fuels and methods (equipment and appliances). As some space heating methods (e.g., forced air furnaces) may be used with a number of different fuels depending upon their design, the 2012 REUS and all previous FortisBC REUS surveys asked respondents to identify space heating fuels separately from the methods. An alternative approach is to provide a list of space heating equipment and fuel combinations (e.g., electric forced air furnace, natural gas forced air furnace, combination wood and electric forced air furnace, etc.) and have respondents pick their system(s) from this list. The drawback to this approach has always been the sheer number of equipment-fuel combinations that exist and need to be listed to be comprehensive. Each approach has merits and weaknesses. While accurately cataloguing heating methods and fuels is important, it equally important to understand how homeowners and renters use their heating systems. This includes whether they have switched from one to another as their preferred heating method (i.e., in homes with more than one method of space heating) or through equipment replacement.

## 6.2 Space Heating Fuels

Respondents to the 2012 REUS survey were asked to identify the main space heating fuel used to heat their home, all other fuels used for space heating, and the most used secondary or other fuel used for space heating. The main space heating fuel was described as the fuel "that provides most of the heat in the home during a typical year". The following sections discuss main fuels and secondary fuels separately, and then summarize all fuels used regardless of whether they are main or secondary.

### 6.2.1 Main Space Heating Fuel

Natural gas is the main (primary) space heating fuel for nine-in-ten (87%) of FEU residential customers, down from 91% in 2008 (Table 53, next page). The loss of natural gas share corresponds with an increase in the use of electricity as the main fuel (11% versus 7% in 2008) .All other space heating fuels have not experienced a statistically significant increase or decrease compared to 2008.

Regionally, the use of natural gas as a main space heating fuel is highest in the Fort Nelson (96%) and the Lower Mainland (92%) regions, and lowest in Whistler (57%).

The decline in the share of natural gas as a main space heating fuel at the utility level may have occurred because of changes to the stock of space heating equipment in FEU homes (e.g., permanent replacement of one system for another, or via new construction trends) and/or because of a switch in the role of natural gas as the main fuel to a secondary space heating fuel in homes that have more than one space heating equipment-fuel option. These two possible effects are explored further throughout this section.

**Table 53: Main Space Heating Fuel by Region (%)**

| Main Space Heating Fuel | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI [1] |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *786* | *1695* | *752* | *85* | *102* | *3420* | *2209* | *2583* | *1439* | *1610* |
| Electricity | 7.4 | 11.3 | 33.8 | 38.1 | 1.9 | 11.4 | 6.9 | 8.6 | 4.7 | 3.5 |
| Natural gas | 91.5 | 84.7 | 63.0 | 57.1 | 96.1 | 86.5 | 91.1 | 89.4 | 93.6 | 92.9 |
| Piped propane | -- | 0.2 | -- | -- | -- | 0.0* | 0.4 | 0.1 | 0.2 | 0.6 |
| Bottled propane | -- | 0.9 | -- | -- | -- | 0.3 | 0.1 | 0.3 | 0.1 | -- |
| Oil | -- | -- | 1.5 | -- | -- | 0.2 | 0.2 | -- | 0.0 | 0.1 |
| Wood | 0.4 | 2.2 | 0.9 | 4.8 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 1.4 |
| Other | 0.6 | 0.6 | 0.8 | -- | -- | 0.7 | 0.2 | 0.6 | 0.2 | 0.3 |
| DK [1] | 0.1 | -- | -- | -- | 1.0 | 0.1 | 0.3 | 0.1 | 0.3 | 1.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **--** |

[1] Data for 2002 included multiple responses on the main space heating fuel. Data may also include non-responses (missing values).
* Value less than 0.1%
Totals may not sum due to rounding.

Main space heating fuel shares by dwelling type are summarized in Table 54. The percentage of dwellings using natural gas as the main space heating fuel varies from a high of nine-in-ten (91%) for duplexes and mobile homes to seven-in-ten (69%) for apartments / condominiums. The vast majority (87%) of single family detached dwellings use natural gas as their main space heating fuel.

**Table 54: Main Space Heating Fuel by Dwelling Type (%)**

| Main Space Heating Fuel | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Electricity | 10.9 | 8.4 | 16.5 | 31.2 | 3.2 | 6.8 |
| Natural gas | 87.0 | 90.9 | 81.6 | 68.8 | 91.2 | 81.9 |
| Piped propane | 0.0* | -- | -- | -- | 0.8 | -- |
| Bottled propane | 0.2 | -- | -- | -- | 3.2 | 3.1 |
| Oil | 0.2 | -- | -- | -- | -- | 0.9 |
| Wood | 1.1 | -- | -- | -- | 1.6 | 1.0 |
| Other | 0.6 | 0.6 | 1.9 | -- | -- | 1.0 |
| DK | 0.0* | -- | -- | -- | -- | 5.1 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

* Value less than 0.1%
Totals may not sum due to rounding.

### 6.2.2 Supplementary Space Heating Fuel

After identifying their main space heating fuel, respondents were asked to indicate all other fuels used for space heating. Of these other space heating fuels, respondents were asked which one they use the most (i.e., which fuel they use the most after their primary or main space heating fuel).

Six-in-ten (58%) of respondents indicated they have a supplementary space heating fuel, meaning that four-in-ten (42%) of FEU customers use only one fuel to heat their home (Table 55, next page). The difference in incidence of supplementary heating fuel between 2012 and 2008 is not statistically significant at the 95% confidence interval.

Regionally, Whistler customers are most likely to use a supplementary heating fuel (91% of respondents), while Fort Nelson residents are the least likely to use a supplementary fuel (46%).

**Table 55: Supplementary Space Heating Fuel Use by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* | *2604* | *1439* | *1610* |
| Use supplementary fuel(s) | 57.0 | 57.0 | 68.1 | 90.5 | 45.9 | 58.3 | 55.6 | 57.0 | 54.6 | 52.8 |

When analyzed by dwelling type, the incidence of secondary space heating fuels is highest among duplexes (62%), followed by single family detached (59%) and apartments/condominiums (58%) (Table 56).

**Table 56: Supplementary Space Heating Fuel Use by Dwelling Type (%)**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Use supplementary fuel(s) | 59.0 | 62.3 | 53.3 | 57.5 | 46.6 | 50.6 |

Detailed data on all space heating fuels supplementing the main space heating fuel are provided in Table 57. Electricity represents the most common supplementary heating fuel, used by three-quarters (73%) of FEU customers who use a supplementary fuel. The next most common supplementary fuels are wood (17%) and natural gas (16%). For natural gas, the decline in its use as a main space heating fuel appears to have been accompanied by its increased use as a supplementary fuel (up from 12% in 2008). The use of wood as a supplementary heating fuel appears relatively stable at 17%, statistically unchanged from 2008 (18%).

**Table 57: Supplementary Space Heating Fuel(s) by Region (%)**
**Dwellings Using More than One Heating Fuel**
**Multiple Responses Allowed**

| Supplementary Space Heating Fuels | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *452* | *973* | *512* | *76* | *48* | *2061* | *1319* | *1473* | *765* | *850* |
| Electricity | 79.2 | 69.6 | 49.8 | 56.6 | 79.3 | 72.9 | 70.8 | 76.3 | 73.0 | 57.9 |
| Natural gas | 10.6 | 14.9 | 45.1 | 38.2 | 2.1 | 16.2 | 11.9 | 11.9 | 9.0 | 27.0 |
| Piped propane | 0.4 | 0.9 | 0.8 | 2.6 | -- | 0.6 | 0.1 | 0.6 | 0.0 | 0.5 |
| Bottled propane | 0.4 | 1.2 | 0.2 | -- | 2.1 | 0.6 | 0.3 | 0.7 | 0.4 | 0.3 |
| Oil | 0.2 | 0.4 | 0.8 | -- | 2.1 | 0.3 | 0.6 | 0.3 | 0.7 | 0.3 |
| Wood | 16.6 | 21.8 | 10.7 | 17.1 | 18.6 | 17.2 | 18.2 | 18.2 | 18.5 | 23.5 |
| Other | 0.7 | 1.1 | 0.4 | 1.3 | -- | 0.8 | 0.8 | 0.8 | 0.8 | 1.4 [1] |
| DK | 2.2 | 2.1 | 0.6 | -- | 6.2 | 2.0 | 6.1 | 2.2 | 6.7 | 4.5 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Columns do not sum to 100% because of multiple responses.

Table 58 (next page) summarizes data on which supplementary or other fuels are the most used supplementary space heating fuel. Of note, electricity remains the most used supplementary fuel at seven-in-ten (70%) of households using a supplementary space heating fuel, statistically unchanged from 2008 (i.e., within the margins of error for the estimates). Sixteen percent (16%) of dwellings with a supplementary heating fuel identified natural gas as their most used supplementary fuel, up from 11% in 2008. These data, combined with the main space heating fuel shares, appear to confirm a modest shift in the use of natural gas in space heating.

Electricity's share of supplementary fuels varies regionally from Vancouver Island (45%) to the Lower Mainland (74%). Use of natural gas as the most used supplementary fuel ranged from four-in-ten (44%) of Vancouver Island customers to just three percent of Fort Nelson customers. One-in-ten (11%) of FEU customers indicated wood is the most used supplementary fuel used for space heating.

**Table 58: Most Used Supplementary Space Heating Fuel by Region (%)**
**Dwellings Using More than One Heating Fuel**

| Most Used Supplementary Space Heating Fuel | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *296* | *622* | *354* | *51* | *33* | *1356* | *1293* |
| Electricity | 76.4 | 65.2 | 47.1 | 56.2 | 76.3 | 69.7 | 67.1 |
| Natural gas | 10.5 | 14.2 | 43.9 | 38.4 | 2.2 | 15.8 | 11.1 |
| Piped propane | 0.5 | 0.6 | 0.8 | 1.4 | -- | 0.6 | 0.1 |
| Bottled propane | -- | 0.8 | -- | -- | -- | 0.2 | 0.4 |
| Oil | 0.2 | 0.3 | 0.8 | -- | 2.2 | 0.3 | 0.5 |
| Wood | 9.4 | 16.5 | 6.6 | 4.1 | 15.1 | 10.9 | 14.2 |
| Other | 0.5 | 0.6 | 0.4 | -- | -- | 0.5 | 0.4 |
| DK | 2.5 | 1.7 | 0.4 | -- | 4.3 | 2.0 | 6.3 |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Data on most used supplementary space heating fuel by dwelling types are summarized in Table 59. Electricity is their most used supplementary fuel but the shares range from nine-in-ten (91%) of mobile homes using a supplementary heating fuel to six-in-ten (59%) for apartments / condominiums. The incidence of natural gas as the most used supplementary fuel ranges from of single family detached dwellings (15%) to apartments / condominiums (39%). Single family detached dwellings are notable in that one-in-eight (13%) with supplementary space heating fuels use wood as the most used supplementary space heating fuel. Sample sizes for apartments, condominiums, mobile homes and others are small so caution is advised on interpreting the supplemental fuel data for these dwelling types.

**Table 59: Most Used Supplementary Space Heating Fuel by Dwelling Type (%)**
**Dwellings Using More than One Heating Fuel**

| Most Used Supplementary Space Heating Fuel | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *1146* | *50* | *69* | *21* | *37* | *15* |
| Electricity | 69.3 | 78.2 | 64.3 | 59.0 | 91.0 | 76.1 |
| Natural gas | 14.8 | 13.2 | 26.7 | 38.6 | -- | 21.7 |
| Piped propane | 0.5 | -- | 1.9 | -- | -- | -- |
| Bottled propane | 0.2 | -- | -- | -- | 1.7 | -- |
| Oil | 0.2 | -- | 1.8 | -- | -- | -- |
| Wood | 12.7 | 2.1 | 1.8 | -- | 5.5 | 2.3 |
| Other | 0.4 | 3.2 | -- | -- | -- | -- |
| DK | 1.9 | 3.2 | 3.6 | 2.5 | 1.7 | -- |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

### 6.2.3 Net Space Heating Fuels

Fuels used for space heating, regardless of whether they are used as the main or supplemental heating fuel, are summarized in Table 60. These data confirm that while there has been a moderate decline in the percentage of customers using natural gas as their primary heating fuel, the proportion of FEU gas customers using natural gas as either a main or supplemental space heating fuel (95%), is statistically unchanged from 2008. Similarly, the proportion of households in FEI regional grouping using natural gas for space heating in 2012 also remains unchanged when compared to 2008 and 2002 (all within the margins of error).

**Table 60: Net Space Heating Fuel(s) by Region (%)**
**Multiple Responses Allowed**

| Main or Supplementary Space Heating Fuel | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* | *2604* | *1446* | *1610* |
| Electricity | 52.5 | 50.9 | 67.7 | 89.4 | 37.5 | 53.7 | 41.1 | 51.9 | 40.9 | 36.1 |
| Natural gas | 96.7 | 92.6 | 93.7 | 91.8 | 95.2 | 95.3 | 96.3 | 95.5 | 97.0 | 96.0 |
| Piped propane | 0.3 | 0.7 | 0.5 | 2.3 | -- | 0.4 | 0.0* | 0.4 | 0.0* | 0.8 |
| Bottled propane | 0.3 | 1.6 | 0.1 | -- | 1.0 | 0.6 | 0.2 | 0.7 | 0.2 | -- |
| Oil | 0.1 | 0.2 | 2.0 | -- | 1.0 | 0.4 | 0.4 | 0.2 | 0.4 | 0.0* |
| Wood | 9.8 | 14.6 | 8.2 | 20.0 | 9.6 | 11.0 | 10.1 | 11.3 | 10.1 | 13.5 |
| Other | 1.0 | 1.3 | 1.1 | 1.2 | -- | 1.1 | 0.4 | 1.1 | 0.4 | 0.7 |
| DK | 2.1 | 1.9 | 0.4 | -- | 4.8 | 1.9 | 3.4 | 2.1 | 3.7 | 3.8 |

Columns do not sum to 100% because of multiple responses.
* Value less than 0.1%.

On a regional basis, natural gas usage for space heating by FEU customers is lowest in the Whistler region (92%), and highest in the Lower Mainland (97%). The relatively few dwellings that do not use natural gas for space heating, must, by default, use natural gas for some other end-use or end-uses in the home (e.g., hot water heating, cooking, etc.).

### 6.2.4 Change in Space Heating Fuel – Last Five Years

All survey respondents were asked whether they had changed from one main space heating fuel to another during the last five years. Those who indicated yes to this question were asked to identify the previous main space heating fuel. The primary purpose of these two questions is to understand the incidence and outcomes of space heating fuel switching behaviors.

Table 61 (next page) shows that only one-in-twenty (5%) of FEU customers reported a change in their main space heating fuel in the last five years. This is statistically unchanged from the three percent who changed in the five years prior to the 2008 REUS survey. Regionally, one-in-three (36%) of Whistler respondents changed their fuel, consistent with the community's system-wide conversion from piped propane to natural gas. Respondents from Vancouver Island also had an above average rate of change (8%). Of the remaining three regions, the Interior was on par with the FEU average (5%) while the Lower Mainland and Fort Nelson regions were below average (3% and 1% respectively).

A change in main space heating fuel may come about because of the installation of a new or different space heating equipment, a decision to use one fuel-specific system more than another (e.g., switch to using a wood stove more while using less electric baseboard heat), or because access to a fuel not previously available in the area.

**Table 61: Change in Main Space Heating Fuel in Last Five Years (%)**

| Changed Main Fuel used for Space Heating? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *785* | *1687* | *750* | *85* | *101* | *3408* | *2179* | *2943* | *1416* | *1610* |
| Yes | 3.3 | 5.3 | 8.4 | 35.7 | 1.0 | 4.5 | 2.8 | 3.9 | 1.9 | 4.1 |
| No | 96.7 | 94.7 | 91.6 | 64.3 | 99.0 | 95.5 | 97.2 | 96.1 | 98.1 | 93.2 |
| DK/NR | -- | -- | -- | -- | -- | -- | -- | -- | -- | 2.7 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Continuing a trend observed in the 2008 REUS[31], there has been a gradual move from natural gas to electricity as the main space heating fuel (Table 62). One-half (49%) of FEU customers who changed their main space heating fuel in the last five years switched from natural gas to another fuel. In 2008, less than six-in-ten (57%) of fuel switchers had moved away from natural gas. In comparison, one-quarter (26%) of fuel switchers in 2012 moved away from electricity as their main space heating fuel during the last five years.

**Table 62: Previous Main Space Heating Fuel by Region (%)**

| Previous Main Space Heating Fuel | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *25* | *88* | *61* | *29* | *1* | *204* | *82* | *114* | *29* | *74* |
| Electricity | 28.0 | 26.1 | 24.6 | 6.9 | -- | 26.3 | 16.8 | 27.2 | 19.7 | 41.6 |
| Natural gas | 52.0 | 52.3 | 42.6 | 3.4 | -- | 49.2 | 56.5 | 52.1 | 72.7 | 28.5 |
| Piped propane | -- | -- | -- | 89.6 | -- | 1.8 | 0.1 | -- | -- | 2.0 |
| Bottled propane | -- | 2.3 | -- | -- | -- | 0.7 | 1.0 | 0.9 | -- | 0.8 |
| Oil | 8.0 | 4.5 | 26.2 | -- | 100.0 | 10.5 | 19.2 | 6.6 | -- | 13.9 |
| Wood | 4.0 | 11.4 | 6.6 | -- | -- | 6.8 | 6.5 | 7.1 | 7.6 | 20.2 |
| DK | 4.0 | 1.1 | -- | -- | -- | 2.2 | -- | 2.8 | -- | 1.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **--** |

Totals may not sum due to rounding.
[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Multiple responses recorded so total does not sum to 100%.

The relative movement away from natural gas varies between regions due, in part, to regional-specific circumstances. For example, Vancouver Island continues its switch from heating oil (26% of fuel switchers) and wood (7%). Ninety-percent (90%) of Whistler households that switched, moved from piped propane to natural gas, consistent with the system-wide conversion for their community. Regional sample sizes are small so caution is advised in the interpretation of their data.

## 6.3 Space Heating Methods

There are a variety of methods (equipment) used to provide space heating for the residential sector. Respondents to the 2012 REUS were asked to identify their main space heating method, their second most used method, and all other methods used to heat their home. Methods differ from fuels in that they refer to an appliance or technology (e.g., portable electric heaters, air source heat pumps, etc.) regardless of the fuel used. Respondents selected their responses from a list of space heating equipment.

[31] Sampson Research (2008), p. 5-5.

### 6.3.1 Number of Space Heating Methods

The majority (73%) of respondents to the 2012 REUS indicated they use more than one space heating method (Table 63). Nearly one-half (45%) use two space heating methods and another one-quarter (24%) use three methods. A further five percent of respondents use more than three or more methods to heat their home. The overall average is 2.0 methods per household. Regionally, homes in the Whistler region are the most likely to use more than one method (average of 2.5 methods per dwelling) versus dwellings in Fort Nelson which were the least likely (average of 1.8 methods).

**Table 63: Number of Space Heating Methods Used by Region (%)**

| Number of Space Heating Methods | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *782* | *1684* | *736* | *83* | *103* | *3388* |
| 1 | 27.0 | 29.2 | 17.9 | 4.9 | 46.0 | 26.6 |
| 2 | 43.7 | 44.0 | 53.3 | 47.6 | 30.7 | 44.8 |
| 3 | 24.6 | 22.1 | 23.2 | 32.9 | 19.5 | 23.8 |
| 4 | 4.0 | 3.4 | 4.5 | 12.2 | 3.8 | 3.9 |
| 5 | 0.6 | 1.0 | 1.0 | 2.4 | -- | 0.8 |
| 6 | 0.1 | 0.2 | 0.1 | -- | -- | 0.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Two or more methods | 73.0 | 70.8 | 82.1 | 95.1 | 54.0 | 73.4 |
| Average | 2.1 | 2.0 | 2.1 | 2.5 | 1.8 | 2.0 |
| Standard Deviation | 1.5 | 0.7 | 0.6 | 0.3 | 0.2 | 0.9 |

Totals may not sum due to rounding.

As expected, the number of space heating methods varies by type of dwelling. Single family detached dwellings are more likely to use more than one method (76%), while mobile homes are the least likely (53%). Data on the number of different space heating methods for these and the other dwelling types are presented in Table 64.

**Table 64: Number of Space Heating Methods Used by Dwelling Type (%)**

| Number of Space Heating Methods | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2750* | *152* | *206* | *56* | *119* | *58* |
| 1 | 24.4 | 37.4 | 34.3 | 42.4 | 46.8 | 27.9 |
| 2 | 44.8 | 41.9 | 42.6 | 52.5 | 41.6 | 49.7 |
| 3 | 25.5 | 20.3 | 19.3 | 5.1 | 11.6 | 16.1 |
| 4 | 4.3 | 0.4 | 2.8 | -- | 0.1 | 6.3 |
| 5 | 0.9 | -- | 0.9 | -- | -- | -- |
| 6 | 0.2 | -- | -- | -- | -- | -- |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Two or more methods | 75.6 | 62.6 | 65.7 | 57.6 | 53.2 | 72.1 |
| Average | 2.1 | 1.8 | 1.9 | 1.6 | 1.7 | 2.0 |
| Standard Deviation | 0.9 | 0.8 | 1.0 | 0.5 | 0.5 | 0.8 |

Totals may not sum due to rounding.

Finally, the number of space heating methods was examined by dwelling vintage (Table 65, next page). The results show only relatively modest variations between vintages. Dwellings constructed since 2005, however, are significantly more likely to use two or more heating methods (79%) compared to other vintages (71% to 76%).

**Table 65: Number of Space Heating Methods Used by Dwelling Vintage (%)**

| Number of Space Heating Methods | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *340* | *903* | *569* | *656* | *580* | *236* | *46* |
| 1 | 24.2 | 28.6 | 25.6 | 26.4 | 27.2 | 21.3 | 39.2 |
| 2 | 39.5 | 41.3 | 48.7 | 44.5 | 45.9 | 51.5 | 44.0 |
| 3 | 29.5 | 24.3 | 21.3 | 24.5 | 24.1 | 21.5 | 16.8 |
| 4 | 4.9 | 4.4 | 3.7 | 4.0 | 2.2 | 5.2 | -- |
| 5 | 1.2 | 1.2 | 0.6 | 0.6 | 0.4 | 0.5 | -- |
| 6 | 0.8 | 0.1 | 0.1 | 0.1 | 0.1 | -- | -- |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Two or more methods | 75.8 | 71.4 | 74.4 | 73.6 | 72.8 | 78.7 | 60.8 |
| Average | 2.2 | 2.1 | 2.1 | 2.1 | 2.0 | 2.1 | 1.8 |
| Standard Deviation | 0.9 | 0.9 | 0.8 | 0.4 | 0.7 | 0.7 | 0.8 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

### 6.3.2 Main Space Heating Methods

Main space heating methods used by FEU residential customers are summarized by region in Table 66.

**Table 66: Main Space Heating Method by Region (%)**

| Main Heating Method | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *782* | *1681* | *734* | *83* | *102* | *3382* | *2175* | *2565* | *1043* | *1610* |
| Central forced air furnace | 69.8 | 78.3 | 48.1 | 36.6 | 93.8 | 69.8 | 73.4 | 72.5 | 76.0 | 76.2 |
| Multi-fuel forced air furnace | 0.4 | 0.8 | 0.3 | -- | -- | 0.5 | n/a | 0.5 | n/a | n/a |
| Wired-in electric heater (baseboards) | 2.8 | 3.0 | 18.5 | 30.5 | -- | 4.6 | 2.6 | 2.9 | 1.7 | 1.6 [1] |
| Wired-in electric wall heater (fan forced) | 0.1 | 0.1 | 1.0 | -- | -- | 0.2 | 0.7 | 0.1 | 0.4 | n/a |
| Heat pump - air source | 4.2 | 6.4 | 10.6 | -- | -- | 5.5 | 3.0 | 4.9 | 2.4 | 0.6 [2] |
| Heat pump - ground source (geothermal) | 0.4 | 1.4 | 0.8 | 2.4 | -- | 0.7 | 0.2 | 0.7 | 0.2 | |
| Hot water baseboards | 7.3 | 1.9 | 2.7 | 1.2 | 1.0 | 5.3 | 5.0 | 5.6 | 5.0 | 4.8 |
| Hot water radiant floor heat | 8.7 | 1.6 | 2.5 | 9.8 | 1.0 | 6.1 | 7.1 | 6.5 | 7.5 | 6.1 |
| Electric radiant heat | 0.4 | 0.2 | 1.2 | 2.4 | -- | 0.4 | 1.1 | 0.3 | 1.0 | 0.3 |
| Gas wall heater | 0.5 | 0.4 | 0.3 | -- | -- | 0.5 | 0.5 | 0.5 | 0.6 | 2.1 |
| Portable electric heaters | 0.5 | 0.5 | 0.3 | -- | -- | 0.5 | 0.2 | 0.5 | 0.2 | 0.8 |
| Gas fireplace | 4.0 | 2.0 | 9.8 | 12.2 | 1.3 | 4.1 | 3.9 | 3.4 | 3.1 | |
| Gas heater stove | 0.1 | 0.4 | 2.0 | 1.2 | -- | 0.4 | 0.6 | 0.2 | 0.3 | n/a |
| Wood stove | 0.4 | 2.1 | 0.8 | 2.4 | 1.9 | 0.9 | 0.7 | 0.9 | 0.7 | 1.5 |
| Wood burning fireplace | 0.1 | 0.1 | 0.1 | 1.2 | -- | 0.1 | 0.2 | 0.1 | 0.2 | 5.6 [3] |
| Electric fireplace | -- | 0.1 | -- | -- | 1.0 | 0.0* | 0.1 | 0.0* | 0.1 | |
| Other | 0.3 | 0.7 | 1.0 | -- | -- | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
[1] Adjusted for multiple reporting (Habart 2003)
[2] Not differentiated in 2002 REUS. Includes both air source and ground source heat pumps.
[3] Not differentiated in 2002 REUS. Includes wood, electric, and gas fireplaces.
[*] Value less than 0.1%.

Central forced air furnaces are the most common main heating method, used by seven-in-ten (70%) of respondents, down from 2008 (73%). Next most common methods include hot water radiant floor heat and air source heat pumps (6% each), and wired-in electric and hot water baseboard heaters (5% each). Gas fireplaces are used by four percent of FEU households as their main space heating method.

Regional differences in main space heating methods are evident. Whistler and Vancouver Island customers are significantly more likely than other regions to use electric baseboard heaters (31% and 19% respectively). These two regions are also notable for their use of gas fireplaces as the main space heating method (12% and 10% respectively). Vancouver Island and Interior homes are most likely to use air source heat pumps as their main method of space heating (11% and 6% respectively).

The main space heating methods by dwelling type are summarized in Table 67. The data show that single family detached dwellings predominately use forced air furnaces (71% of all single family detached dwellings), followed by air source heat pumps or hot water baseboards (6% each), and hot water radiant floor heat (5%). Forced air furnaces are used as the main method in duplexes (63%) and row/townhouses (67%). These two dwelling types, plus apartments/condominiums, are more likely than single family detached dwellings to use hot water radiant floor heat and wired-in electric baseboard heaters. Over three-in-ten (32%) apartments / condominiums use a gas fireplace as their main space heating method. A similar finding for apartments/condominiums was noted in the 2008 REUS.[32]

**Table 67: Main Space Heating Method by Dwelling Type (%)**

| Main Space Heating Method | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2744* | *152* | *206* | *56* | *119* | *58* |
| Central forced air furnace | 70.7 | 62.6 | 67.3 | 30.9 | 90.5 | 54.1 |
| Multi-fuel forced air furnace | 0.4 | 0.3 | 0.9 | -- | 1.6 | -- |
| Wired-in electric heater (baseboards) | 3.5 | 6.1 | 12.0 | 21.8 | 1.5 | 2.9 |
| Wired-in electric wall heater (fan forced) | 0.2 | -- | -- | -- | -- | 0.9 |
| Heat pump - air source | 6.3 | 1.5 | 2.1 | 1.3 | 1.6 | 1.0 |
| Heat pump - ground source (geothermal) | 0.8 | 1.3 | -- | -- | 0.8 | 0.9 |
| Hot water baseboards | 5.8 | 4.8 | 0.9 | 2.6 | -- | 12.2 |
| Hot water radiant floor heat | 5.3 | 11.5 | 10.6 | 8.7 | -- | 17.4 |
| Electric radiant heat | 0.5 | -- | 0.2 | 1.2 | -- | -- |
| Gas wall heater | 0.4 | -- | 0.9 | -- | 0.8 | 1.0 |
| Portable electric heaters | 0.4 | 2.3 | -- | -- | -- | 2.1 |
| Gas fireplace | 3.4 | 9.2 | 4.8 | 32.2 | -- | 5.1 |
| Gas heater stove | 0.5 | 0.3 | -- | -- | -- | 0.2 |
| Wood stove | 1.1 | -- | -- | -- | 1.6 | 1.0 |
| Wood burning fireplace | 0.1 | -- | -- | -- | -- | -- |
| Electric fireplace | 0.0* | -- | -- | -- | 0.8 | -- |
| Other | 0.5 | -- | 0.2 | 1.3 | 0.8 | 0.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

* Value less than 0.1%
Totals may not sum due to rounding.

The main space heating method used by single family detached dwellings was explored by dwelling vintage in Table 68 (next page).

[32] Sampson Research (2008), p. 5-7.

**Table 68: Main Space Heating Method by Dwelling Vintage – Single Family Detached Dwellings (%)**

| Main Space Heating Method | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *340* | *898* | *569* | *655* | *580* | *236* | *31* |
| Central forced air furnace | 76.3 | 81.2 | 70.1 | 64.7 | 60.7 | 49.6 | 72.4 |
| Wired-in electric heater (baseboards) | 4.5 | 1.6 | 5.6 | 3.0 | 4.3 | 4.5 | 9.6 |
| Heat pump-air source | 4.7 | 4.8 | 4.6 | 7.0 | 7.8 | 20.4 | 1.7 |
| Heat pump - ground source (geothermal) | -- | 0.1 | 0.1 | 0.6 | 1.7 | 6.4 | -- |
| Hot water baseboards | 8.7 | 4.4 | 7.3 | 8.0 | 3.0 | 1.8 | 1.7 |
| Hot water radiant floor heat | 1.1 | 0.5 | 1.1 | 9.3 | 15.9 | 13.3 | -- |
| Gas fireplace | 0.6 | 3.3 | 6.1 | 3.3 | 3.6 | 1.0 | 1.5 |
| All other methods | 4.0 | 4.1 | 5.1 | 4.2 | 3.0 | 2.9 | 13.1 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Central forced air furnaces (CFAF), as a percent of all main space heating methods, is highest among homes constructed during the 1950-75 period (81%) and declines successively with newer construction. Notably, CFAF's are the main space heating method in only one half (50%) of the SFDs constructed since 2005. The role of furnaces as a main method is being eroded by air source and ground source heat pumps, and hot water radiant heat. In particular, air source heat pumps are used as a main method in five percent of homes built prior to 1986 but two-in-ten (20%) of homes constructed since 2005. Ground source heat pumps are used as main method in six percent of homes constructed since 2005, but less than one percent of homes constructed before this. Additional developments of note include the decline of hot water baseboard heat and gas fireplaces as main methods. For additional discussion of heat pumps, including their underreporting, please see Sections 6.3.4 and 9.4.1.

### 6.3.3 Secondary Space Heating Methods

Respondents were asked about the use of secondary space heating methods, including which one is used the most. This approach was followed in the 2012 and 2008 REUS surveys. Secondary methods were queried in the 2002 REUS but without qualification as to which are used more than others. As a result, comparisons with 2002 were not made.

The most used secondary space heating methods are summarized in Table 69 (next page). The three most commonly used secondary methods are: gas fireplaces (25% of all FEU customers); electric baseboard heaters (13%), and portable electric heaters (11%). These methods were also the top three methods identified in the 2008 REUS, although the percentage of homes using gas fireplaces is significantly less in 2012 than in 2008 (25% versus 29%).

The proportion of dwellings using gas fireplaces as the most used secondary method is highest on Vancouver Island (40%) and lowest in Fort Nelson (16%). Electric baseboard heaters are an important secondary space heating method for Whistler (32%), Vancouver Island (16%), and the Lower Mainland (14%).

Data on the most used secondary heating methods are summarized by dwelling type in Table 70 (next page). Of note, the use of gas fireplaces as a secondary space heating method is highest in row/townhouses and apartments /condominiums (28% and 29% respectively). The use of portable electric space heaters is highest in mobile homes (20%) compared to just one percent of apartments/condominiums.

### Table 69: Second Most Used Space Heating Method by Region (%)

| Second Most Used Heating Method | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *782* | *1681* | *734* | *83* | *102* | *3382* | *2175* |
| Central forced air furnace | 4.0 | 5.2 | 3.1 | 1.2 | 1.0 | 4.2 | 3.1 |
| Multi-fuel forced air furnace | 0.8 | 0.2 | 0.4 | -- | 1.0 | 0.6 | n/a |
| Wired-in electric heater (baseboards) | 13.9 | 8.9 | 15.9 | 31.7 | 3.9 | 12.8 | 10.7 |
| Wired-in electric wall heater (fan forced) | 1.0 | 1.6 | 2.6 | 1.2 | -- | 1.3 | 4.2 |
| Heat pump - air source | 1.0 | 3.5 | 1.0 | -- | -- | 1.7 | 0.8 |
| Heat pump - ground source (geothermal) | -- | 0.2 | -- | -- | -- | 0.0* | 0.1 |
| Hot water baseboards | 1.0 | 0.2 | 0.3 | -- | 1.0 | 0.7 | 0.9 |
| Hot water radiant floor heat | 1.7 | 0.5 | 0.7 | 2.4 | 2.9 | 1.2 | 0.3 |
| Electric radiant heat | 2.8 | 2.4 | 2.6 | 14.6 | 2.3 | 2.7 | 1.6 |
| Gas wall heater | 0.1 | 0.6 | 0.5 | -- | -- | 0.3 | 0.2 |
| Portable electric heaters | 11.9 | 10.4 | 5.2 | 1.2 | 9.7 | 10.7 | 10.0 |
| Gas fireplace | 23.5 | 20.5 | 40.2 | 32.9 | 15.5 | 24.5 | 28.9 |
| Gas heater stove | 0.5 | 1.7 | 2.2 | 1.2 | 1.0 | 1.0 | 1.1 |
| Wood stove | 2.2 | 4.8 | 1.6 | 1.2 | 3.9 | 2.8 | 2.1 |
| Wood burning fireplace | 3.7 | 3.4 | 2.0 | 4.9 | 2.9 | 3.4 | 5.9 |
| Electric fireplace | 1.8 | 3.4 | 1.6 | 1.2 | 6.8 | 2.2 | 2.2 |
| Other | 0.8 | 1.0 | 0.5 | 1.2 | 1.0 | 0.8 | 0.9 |
| **No second method** | **29.3** | **31.6** | **19.5** | **4.9** | **47.4** | **28.9** | **27.0** |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

* Value less than 0.1%
Totals may not sum due to rounding.

### Table 70: Second Most Used Space Heating Method by Dwelling Type (%)

| Second Most Used Heating Method | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2744* | *152* | *206* | *56* | *119* | *58* |
| Central forced air furnace | 4.8 | 1.6 | 2.1 | 1.3 | 1.6 | 1.0 |
| Multi-fuel forced air furnace | 0.5 | -- | 2.1 | -- | -- | -- |
| Wired-in electric heater (baseboards) | 12.2 | 19.4 | 16.6 | 16.8 | 4.2 | 10.3 |
| Wired-in electric wall heater (fan forced) | 1.4 | 0.9 | 1.1 | -- | 0.8 | 0.9 |
| Heat pump - air source | 2.0 | 0.3 | -- | -- | 0.8 | -- |
| Heat pump - ground source (geothermal) | 0.1 | -- | -- | -- | -- | -- |
| Hot water baseboards | 0.8 | -- | 0.2 | -- | -- | 5.1 |
| Hot water radiant floor heat | 1.4 | -- | -- | -- | -- | 5.1 |
| Electric radiant heat | 2.7 | 1.6 | 2.1 | 7.7 | -- | 5.1 |
| Gas wall heater | 0.3 | 0.6 | 0.2 | -- | 1.5 | -- |
| Portable electric heaters | 11.2 | 7.7 | 7.4 | 1.3 | 20.4 | 15.4 |
| Gas fireplace | 24.5 | 20.8 | 28.3 | 29.2 | 12.2 | 25.1 |
| Gas heater stove | 1.2 | -- | 0.2 | -- | 0.1 | -- |
| Wood stove | 3.4 | 0.3 | -- | -- | 1.7 | 1.0 |
| Wood burning fireplace | 4.0 | 0.9 | 0.9 | -- | 0.8 | -- |
| Electric fireplace | 2.1 | 2.6 | 2.1 | 1.3 | 7.4 | -- |
| Other | 0.9 | 0.3 | 0.2 | -- | 0.8 | 1.0 |
| **No second method** | **26.5** | **42.8** | **36.5** | **42.4** | **47.7** | **30.0** |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 71 summarizes the relative popularity of all secondary space heating methods. Comparable data from 2008 and 2002 are provided. Caution is advised in the interpretation of the 2002 data, as this study found that households over-reported their forced air furnaces as either primary or secondary heat sources (Habart 2003).

**Table 71: All Secondary Space Heating Methods by Region (%)**

| All Secondary Space Heating Methods | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *782* | *1681* | *734* | *83* | *102* | *3382* | *2175* | *2565* | *1043* | *1610* |
| Central forced air furnace | 4.6 | 5.6 | 3.8 | 1.2 | 1.0 | 4.8 | 3.2 | 4.9 | 3.0 | 19.7 |
| Multi-fuel forced air furnace | 1.0 | 0.5 | 0.4 | -- | 1.0 | 0.8 | 3.2 | 0.9 | n/a | n/a |
| Wired-in electric heater (baseboards) | 17.5 | 12.6 | 19.6 | 37.8 | 7.1 | 16.4 | 12.8 | 16.0 | 12.2 | 16.6 |
| Wired-in electric wall heater (fan forced) | 1.7 | 2.4 | 5.4 | 7.3 | 1.0 | 2.3 | 5.5 | 1.9 | 5.2 | n/a |
| Heat pump-air source | 1.4 | 3.8 | 1.4 | -- | -- | 2.0 | 0.9 | 2.1 | 1.0 | 0.6[2] |
| Heat pump - ground source (geothermal) | 0.3 | 0.2 | -- | -- | -- | 0.2 | 0.1 | 0.2 | 0.1 | |
| Hot water baseboards | 1.3 | 0.2 | 0.3 | -- | 1.0 | 0.9 | 1.0 | 1.0 | 1.1 | 2.5 |
| Hot water radiant floor heat | 2.3 | 0.8 | 1.0 | 2.4 | 3.9 | 1.7 | 0.4 | 1.8 | 0.4 | 2.9 |
| Electric radiant heat | 5.8 | 4.8 | 5.9 | 28.1 | 3.3 | 5.6 | 2.9 | 5.5 | 2.9 | 1.1 |
| Gas wall heater | 0.6 | 0.8 | 1.0 | -- | 1.0 | 0.7 | 0.6 | 0.7 | 0.5 | 3.6 |
| Portable electric heaters | 19.4 | 17.1 | 11.3 | 9.8 | 20.3 | 17.9 | 16.8 | 18.7 | 17.3 | 16.8 |
| Gas heater stove | 0.9 | 2.4 | 2.9 | 2.4 | 1.9 | 1.5 | 1.3 | 1.3 | 1.2 | n/a |
| Wood stove | 3.8 | 6.7 | 3.0 | 4.9 | 4.8 | 4.5 | 2.7 | 4.7 | 2.7 | 5.0 |
| Gas fireplace | 36.1 | 30.4 | 52.0 | 51.2 | 20.3 | 36.2 | 39.2 | 34.3 | 38.4 | |
| Wood burning fireplace | 9.8 | 6.8 | 5.7 | 9.8 | 2.9 | 8.6 | 10.0 | 8.9 | 9.9 | 37.1[3] |
| Electric fireplace | 4.1 | 7.6 | 3.5 | 3.6 | 10.6 | 5.0 | 3.5 | 5.2 | 3.4 | |
| Other (Specify) | 1.3 | 1.6 | 1.1 | 1.2 | 2.9 | 1.4 | 1.8 | 1.4 | 1.7 | **2.3** |
| **No Secondary Heating** | **29.3** | **31.6** | **19.5** | **4.9** | **47.4** | **28.9** | **27.0** | **30.0** | **28.0** | **23.7** |

Columns do not sum to 100% because of multiple responses.
[1] All customers answering QB5 (main space heat).
[2] Not differentiated in 2002 REUS. Includes both air source and ground source heat pumps.
[3] Not differentiated in 2002 REUS. Includes wood, electric, and gas fireplaces.

### 6.3.4 Heat Pump Underreporting

The presence of heat pumps (both air source and ground source) was addressed in the space heating methods and appliance sections of the 2012 REUS questionnaire. A review of the data on heat pumps from the two sections of the report strongly suggests that heat pumps are underreported as a main or secondary space heating method.

Data on air source heat pumps from the appliance section of the REUS survey indicate that 12% of FEU households have an ASHP, in contrast to 8% of households from the space heating methods section of the survey. The lower estimate from the space heating section may be because some households consider their ASHP a space cooling (air conditioning) method rather than a space heating method. It may also be due to the nature in which the questions were posed in the two sections of the REUS questionnaire. Based on the discussion in Section 9.4, page 125 of this report, it is likely that the incidence of ASHPs, as suggested by the space heating method section of the 2012 REUS, understates the true incidence of heat pumps among FEU's residential customer base. The more accurate estimate of the penetration of ASHPs is assumed to be 12% of FEU households.

### 6.4 Furnaces and Boilers

In addition to the space heating method questions, respondents to the 2012 REUS were asked whether their home had a natural gas furnace, natural gas boiler, electric furnace, or neither of these three systems. Respondents with gas furnaces and boilers were then asked to provide additional information on the efficiency of their equipment, repair costs, and replacement behaviours.

Upon review of the data, it was noted that the proportion of dwellings with a gas furnace in the 2012 survey was significantly below that recorded by the 2008 survey. While a decline in the use of furnaces as a space heating method in newer dwellings has been noted, the data suggest a broad-based decline across most other dwelling vintages. This is confounding. Major renovations that eliminate the gas furnace for some other form of space heating method are possible but other data from the 2012 REUS did not support this as an explanation for the significant drop in furnace shares among older dwellings. Further investigation was conducted to understand whether this was a legitimate trend, an underreporting bias, or other misclassification issue.

#### 6.4.1 Adjustments to Furnace and Boiler Data

Data on furnaces and boilers for each 2012 REUS respondent (question B6) were reviewed and compared with the space heating fuels (questions B1, B4a, and B4b) and methods (questions B5a, B5b, and B5c). The purpose of the comparison was to assess the likelihood that a gas furnace, gas boiler, or electric furnace, if indicated, was correct. The comparison also assessed the likelihood that a gas furnace, gas boiler, or electric furnace was present in the home but not reported in question B6. Specifically, the assessment considered the following:

- whether natural gas was indicated as either a main or secondary space heating fuel (consistency with either gas boilers or gas forced air furnaces);
- whether a central forced air furnace or multi-fuel forced air furnace was identified as either a main, secondary, or other space heating method (indicator of a gas, electric, oil, or propane forced air furnace);
- whether hot water baseboards or hot water radiant in-floor/under-floor heat was identified as either a main, secondary, or other space heating method (indicator of a gas boiler); and
- whether an air source or ground source heat pump was identified as a main, secondary, or other space heating method (heat pumps in northern climates are often paired with an electric or gas forced air furnace).

As no method based on self-reported survey data can conclusively confirm whether a respondent has a gas furnace, electric furnace or gas boiler, the data combinations were analyzed on the basis of the most likely heating method. In all cases, the respondent's original answer to question B6 was retained unless compelling evidence suggested a different method. All results were expressed in terms of two likelihoods – probable (strong likelihood of being the correct answer) or possible (a moderate likelihood of being the correct response). In cases where the respondent's data suggested that more than one method might be present (e.g., gas furnace and a gas boiler), one of the two methods was typically assigned as the probable result.

The results of the analysis, summarized in Table 72 (next page), confirmed the majority of gas furnaces (97%), gas boilers (87%), and electric furnaces (89%) were most likely correct. The analysis found that some methods were most likely misclassified or unspecified. For example, approximately 13% of respondents who indicated they had a gas boiler most likely have a gas forced air furnace. It may be that these respondents confused their gas domestic water heater with being a gas boiler. A similar issue was believed to have occurred in the 2002 REUS.[33] The analysis also found that over one-quarter (27%) of respondents who did not answer question B6 most likely have a gas forced air furnace (FAF) and another five percent of non-responders likely have a gas boiler. There were situations where a natural gas forced air furnace and a natural gas boiler were both suggested which is possible for larger homes. However, this combination is unlikely to be present in significant quantities.

**Table 72: Reclassification Results for Furnaces and Boilers – 2012 REUS**

| 2012 REUS | Original Classification | | | |
|---|---|---|---|---|
| Reclassified Results | Gas Boiler | Gas FAF | Electric FAF | No Answer |
| *Unweighted base* | *258* | *2430* | *138* | *615* |
| Electric FAF | 0.1 | -- | 89.4 | 0.5 |
| Electric – Multi-fuel FAF | -- | -- | 3.2 | -- |
| Gas Boiler | 87.1 | 1.9 | 7.4 | 5.3 |
| Gas FAF | 12.7 | 97.3 | -- | 27.5 |
| Gas – Multi-fuel FAF | -- | 0.8 | -- | 0.1 |
| Oil FAF | -- | -- | -- | 0.8 |
| Propane FAF | -- | -- | -- | 0.2 |
| No Answer | -- | -- | -- | 65.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

To ensure compatibility with the previous REUS, survey data for furnaces and boilers from the 2008 REUS were similarly reviewed and reclassified using the same algorithm and assumptions applied to the 2012 REUS dataset. The degree of misclassification for the two surveys is similar. Highlights from the reclassification, summarized in Table 73, include:

- 97% of gas forced air furnaces confirmed
- 89% of gas boilers were confirmed
- 11% of gas boilers misclassified

**Table 73: Reclassification Results for Furnaces and Boilers – 2008 REUS**

| 2008 REUS | Original Classification | | | |
|---|---|---|---|---|
| Reclassified Results | Gas Boiler | Gas FAF | Electric FAF | No Answer |
| *Unweighted base* | *241* | *1463* | -- | *478* |
| Electric FAF | -- | -- | -- | 5.8 |
| Gas Boiler | 88.9 | 2.7 | -- | 6.4 |
| Gas FAF | 11.1 | 97.3 | -- | 13.0 |
| No Answer | -- | -- | -- | 74.8 |
| **Total** | **100.0** | **100.0** | -- | **100.0** |

Totals may not sum due to rounding.

Electric forced air furnaces were not specifically queried in the 2008 REUS although an estimated six percent (6%) of the non-responses most likely represented dwellings with electric furnaces.

[33] Habart (2003)

The findings of the two analyses were used to reclassify the 2012 and 2008 REUS data for gas furnaces and gas boilers. Data for electric furnaces from the 2012 REUS were also reclassified but this did not affect the 2008 results as they were not specifically queried in the 2008 survey.

### 6.4.2 Reclassified Boiler and Furnace Data

After analysis and reclassification, an estimated three-quarters (76%) of FEU customers in 2012 had a gas furnace, down slightly from 2008 (79%). As shown in Table 74, the incidence of gas furnaces is highest in the Interior (86%) and Fort Nelson (85%) and lowest in Whistler (37%). One-in-eight (12%) of FEU customers have a gas boiler, unchanged from 2008 (within the margins of error). Gas boilers are most common in the Lower Mainland (17%) and Whistler (13%). Only three percent (3%) of FEU customers have an electric furnace and almost one-in-ten (9%) indicated they had something other than a gas furnace, gas boiler, or electric furnace. All results are based on revised furnace and boiler data.

**Table 74: Furnaces and Boilers by Region (%)**
**Using Reclassified Data for 2012 and 2008**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* | *2604* | *1446* | *1610* |
| Gas boiler | 16.8 | 4.3 | 6.9 | 13.1 | 5.7 | 12.3 | 13.1 | 12.9 | 13.4 | 27.7 [1] |
| Gas furnace | 76.3 | 85.5 | 50.4 | 36.9 | 85.4 | 75.9 | 79.3 | 79.1 | 81.6 | 85.7 |
| Electric furnace | 1.6 | 3.6 | 7.0 | 2.4 | 6.6 | 2.8 | n/a | 2.3 | n/a | n/a |
| None of the above | 5.3 | 6.6 | 35.6 | 47.6 | 2.3 | 9.0 | 7.6 | 5.7 | 5.0 | -- |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Data for 2008 and 2012 adjusted for misclassification error.
Totals may not sum due to rounding.
[1] Overstated as some respondents confused boilers with hot water tanks (Habart 2003).

The incidence of furnaces and boilers by dwelling type is presented in Table 75. Mobile homes are the most likely to have a gas furnace (95%) and apartments/condominiums the least likely (19%). Apartments/condominiums are also the most likely to indicate some method other than a furnace or boiler (41%). The incidence of gas boilers ranges from a zero for mobile homes to a high of almost one-in-five for duplexes (18%) and apartment / condominiums (19%). Gas boilers are present in one-in-eight (12%) of single family detached dwellings.

**Table 75: Furnaces and Boilers by Dwelling Type (%)**
**Using Reclassified Data for 2012**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Gas boiler | 11.9 | 18.1 | 12.0 | 19.0 | -- | 30.4 |
| Gas furnace | 77.5 | 67.9 | 70.1 | 29.6 | 94.3 | 58.7 |
| Electric furnace | 2.8 | 2.5 | 1.5 | 10.3 | 2.6 | 0.9 |
| None of the above | 7.7 | 11.4 | 16.3 | 41.1 | 3.1 | 10.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Table 76 (next page) summarizes the incidence of restated furnaces and boilers by dwelling vintage. Of note, homes constructed since 1975 are progressively less likely to have a gas furnace. Indeed, only six-in-ten (57%) of FEU dwellings constructed since 2005 have a gas furnace, compared to over three-quarters

(77%) of homes constructed during 1976-85. This trend is partly explained by the increasing share of row/townhomes in new construction but the decline in furnace shares has occurred across all dwelling types.

**Table 76: Furnaces and Boilers by Dwelling Vintage (%)**
**Using Reclassified Data for 2012**

| | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Year Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Gas boiler | 13.0 | 5.1 | 9.4 | 16.8 | 20.8 | 15.4 | 1.1 |
| Gas furnace | 80.0 | 88.1 | 76.8 | 72.5 | 64.2 | 56.5 | 71.8 |
| Electric furnace | 0.3 | 1.9 | 3.1 | 1.3 | 3.8 | 10.3 | 11.5 |
| None of the above | 6.7 | 4.8 | 10.7 | 9.3 | 11.3 | 17.7 | 15.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

### 6.4.3 Gas Boiler Efficiencies

Respondents to the 2012 REUS who indicated they had a gas boiler or gas furnace were asked to indicate the efficiency of their gas heating system. Respondents with boilers were asked to indicate their boiler's efficiency based on the following descriptions:

- Low efficiency (60% efficient)
- Mid-efficiency (80% to 85% efficient)
- High efficiency (90% efficient or higher)

**Figure 22: Gas Boiler Types**

**Gas Boiler Types**

**Low Efficiency Gas Boilers:**
- 13 years old or older
- 60% efficient
- uses a standing pilot light

**Mid-Efficiency Gas Boilers:**
- 80% to 85% efficient
- no pilot light, uses igniter instead
- uses induced draft fan or damper

**High Efficiency Gas Boilers:**
- 90% efficient or higher
- no pilot light, uses igniter instead
- uses plastic exhaust pipe that exits the roof or side of house

Additional information on the typical characteristics of gas boilers by efficiency type was provided to survey respondents on the survey questionnaire (hardcopy and online) to improve the likelihood they would correctly identify their boiler's efficiency (example provided in Figure 22).

The efficiency breakdowns using the reclassified boiler data for 2012 are summarized in Table 77. The breakdown is almost neatly divided into quarters: low efficiency (25%); mid-efficiency (23%); high efficiency (27%); Don't Know (25%). Caution is advised with interpreting regional results as all samples are small.

**Table 77: Natural Gas Boiler Efficiency by Region Including DK Responses (%)**
**Using Reclassified Gas Boiler Data for 2012**

| Boiler Efficiency | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *109* | *54* | *34* | *9* | *5* | *211* |
| Low efficiency (60%) | 23.9 | 40.7 | 17.6 | 22.2 | 40.0 | 25.0 |
| Mid-efficiency (80% to 85%) | 22.9 | 16.7 | 29.4 | 22.2 | 20.0 | 22.7 |
| High efficiency (90% or higher) | 27.5 | 25.9 | 20.6 | 33.4 | 20.0 | 27.1 |
| DK | 25.7 | 16.7 | 32.4 | 22.2 | 20.0 | 25.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

To allow comparisons of boiler efficiency among regions using a common base, and to improve the ability to compare with 2008 and 2002 data, Table 78 removes respondents who were unsure of their boiler's efficiency and rebases the results.[34] Note, 2008 and 2002 REUS surveys provided only two efficiency categories (standard and high efficiency), thereby making direct comparisons with anything other than high efficiency boilers difficult.

The incidence of high efficiency boilers in 2012 (36%) is up over 2008 (30%). Caution is advised when interpreting regional differences as sample sizes are small for most regions.

**Table 78: Natural Gas Boiler Efficiency by Region Excluding DK Responses (%)**
**Using Reclassified Gas Boiler Data for 2012 and 2008**

| Boiler Efficiency | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *81* | *45* | *23* | *7* | *4* | *160* | *111* | *130* | *64* | *236* |
| Low efficiency (60%) | 32.1 | 48.9 | 26.1 | 28.5 | 50.0 | 33.5 | 69.8 [2] | 33.8 | 69.9 [2] | 69.6 [2] |
| Mid-efficiency (80% to 85%) | 30.9 | 20.0 | 43.5 | 28.5 | 25.0 | 30.4 | | 29.8 | | |
| High efficiency (90% or higher) | 37.0 | 31.1 | 30.4 | 42.9 | 25.0 | 36.2 | 30.2 | 36.4 | 30.1 | 30.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] As no low efficiency category was provided in 2008 REUS, this value captures both low and mid efficiency boilers.
Totals may not sum due to rounding.

### 6.4.4 Gas Boiler Ages

Table 79 summarizes the median and mean (average) ages of gas boilers by region. The average age of gas boilers is 14 years, while the median age is 13 years. Caution is advised in the interpretation of differences among regions, particularly outside of the Lower Mainland, as sample sizes are small.

**Table 79: Ages of Gas Boilers by Region (Years)**
**Using Reclassified Gas Boiler Data**

| Age of Gas Boiler (years) | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *102* | *51* | *33* | *9* | *4* | *199* |
| Median | 13.0 | 14.0 | 11.0 | 11.0 | 15.0 | 13.0 |
| Mean | 14.2 | 15.7 | 12.3 | 10.3 | 15.0 | 14.2 |
| Standard deviation | 17.6 | 9.3 | 6.6 | 2.2 | 0.2 | 13.7 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

### 6.4.5 Gas Furnace Efficiencies

Respondents with a gas furnace were asked to indicate whether the furnace was a low efficiency, mid-efficiency or high efficiency unit. Respondents were provided with the following responses categories:

- Low (standard) efficiency – less than 78% efficient
- Mid-efficiency – 78% to 85% efficient
- High efficiency – 90% efficient or higher

[34] Rebasing by excluding "don't know" responses implicitly assumes that the mix of boiler efficiencies for those unsure of their boiler's efficiency is comparable to those who knew their unit's efficiency. This assumption will be invalid if the mix of boiler efficiencies within the don't know response differs from those who knew the efficiency of their furnace.

To assist survey respondents in correctly classifying their furnace by efficiency level, additional information on the characteristics of furnaces in each of the three efficiency categories was provided on the survey questionnaire. A copy of this additional information is provided in Figure 23.

The distribution of gas furnaces by efficiency level using restated furnace data are summarized in Table 80. Highlights include.

- One-in-five (19%) of households with a gas furnace in 2012 indicated it was a low efficiency unit, down significantly from two-in-five (39%) in 2008.
- The proportion of households with a high efficiency gas furnace more than doubled from 2008 (14%) to 2012 (32%).

**Figure 23: Gas Furnace Types**

**Gas Furnace Types**

**Low (Standard) Efficiency Gas Furnaces:**
- 18 years old or older
- less than 78% efficient
- typically uses a pilot light
- uses metal flue that exits the roof

**Mid-Efficiency Gas Furnaces:**
- 78% to 85% efficient
- no pilot light, uses igniter instead
- uses a metal flue that exits the roof

**High Efficiency Gas Furnaces:**
- 90% efficient or higher
- no pilot light, uses igniter instead
- uses plastic exhaust pipe that exits the side of the house.
- ENERGY STAR qualified

**Table 80: Furnace Efficiency by Region Including DK Responses (%)**
**Using Reclassified Furnace Data for 2012 and 2008**

| Gas Furnace Efficiency | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *549* | *1350* | *342* | *27* | *83* | *2351* | *1411* | *1982* | *1056* | *1279* |
| Low (standard) efficiency (< 78% AFUE) | 21.5 | 16.1 | 11.1 | -- | 28.9 | 19.1 | 38.6 | 19.7 | 40.3 | 40.1 |
| Mid-efficiency (78% to 85% AFUE) | 33.3 | 34.7 | 35.7 | 25.9 | 33.7 | 33.9 | 34.3 | 33.8 | 33.3 | 21.3 |
| High efficiency (90% AFUE or higher) | 29.1 | 37.0 | 30.7 | 51.9 | 18.1 | 31.7 | 14.1 | 31.7 | 13.6 | 12.2 |
| DK | 16.0 | 12.1 | 22.5 | 22.2 | 19.3 | 15.3 | 13.0 | 14.7 | 12.8 | 26.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

It was noted in the 2008 REUS report that the proportion of high efficiency furnaces was likely understated[35], so this may have exaggerated the increase in high efficiency shares between 2008 and 2012. Regardless, the increase in high efficiency shares is consistent with the high incidence of furnace replacements that has occurred in the last four years (see Section 6.4.7). It is also consistent with the retirement of older, low efficiency furnaces as part of the replacement cycle.

Comparable to 2008, over one-in-seven (15%) of respondents in 2012 were unsure of their furnace efficiency level. Regionally this proportion varied between one-in-eight (12%) in the Interior to nearly one-quarter (23%) on Vancouver Island making regional comparisons difficult. To address this, the data was rebased excluding these don't know responses. These data are summarized in Table 81 (next page).

Excluding respondents who did not know the efficiency of their gas furnace, the proportion of FEU customers with a high efficiency furnace in 2012 (37%) is more than double the proportion in 2008 (16%). Regionally, high efficiency furnaces represented anywhere between less than a quarter (22%) of homes with gas furnaces in Fort Nelson to two-thirds (67%) of gas furnaces in Whistler. Conversely, the share of homes with low efficiency furnaces ranged from nil (Whistler) to somewhat more than two-thirds (36%) of Fort Nelson households with a gas furnace.

[35] Sampson Research (2009), p 5-13.

**Table 81: Furnace Efficiency by Region excluding DK Responses (%)**
**Using Reclassified Furnace Data for 2012 and 2008**

| Gas Furnace Efficiency | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *461* | *1187* | *265* | *21* | *67* | *2001* | *1210* | *1715* | *913* | *942* |
| Low (standard) efficiency (< 78% AFUE) | 25.6 | 18.4 | 14.3 | -- | 35.8 | 22.5 | 44.4 | 23.1 | 46.2 | 54.5 |
| Mid-efficiency (78% to 85% AFUE) | 39.7 | 39.5 | 46.0 | 33.3 | 41.8 | 40.0 | 39.4 | 39.6 | 38.2 | 28.9 |
| High efficiency (90% AFUE or higher) | 34.7 | 42.1 | 39.6 | 66.7 | 22.4 | 37.4 | 16.2 | 37.2 | 15.6 | 16.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

The median and average age of gas furnaces by region are provided in Table 82. The average age is 12 years old but the median age is 10 years. Regionally, the oldest furnaces are in the Lower Mainland (13 years old on average).

**Table 82: Age of Gas Furnaces by Region**
**Using Reclassified Furnace Data for 2012**

| Age of Gas Furnace (years) | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *452* | *1096* | *284* | *22* | *59* | *1913* |
| Median | 8.0 | 9.0 | 12.0 | 10.5 | 8.0 | 10.0 |
| Mean | 12.7 | 11.4 | 11.7 | 8.9 | 11.0 | 12.2 |
| Standard deviation | 13.8 | 6.5 | 4.3 | 1.8 | 2.5 | 10.2 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Furnace vintages are summarized by dwelling vintage in Table 83. The data reflect the replacement cycle for furnaces. For example, the average age of furnaces in homes constructed between 1986 and 1995 is 13 years, but the median age is 17 years, suggesting a significant proportion of furnaces for these dwellings have replaced a furnace (i.e., the distribution of furnace ages is skewed towards younger furnaces).

**Table 83: Age of Gas Furnaces by Dwelling Vintage**
**Using Reclassified Furnace Data for 2012**

| Age of Gas Furnace (years) | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 – 2005 | 2006 or later | Year Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *182* | *571* | *313* | *377* | *315* | *115* | *12* |
| Median | 10.0 | 9.0 | 7.0 | 17.0 | 11.0 | 5.0 | 4.0 |
| Mean | 11.9 | 12.8 | 13.3 | 13.0 | 11.1 | 5.1 | 6.1 |
| Standard deviation | 10.1 | 12.2 | 12.4 | 9.0 | 3.8 | 1.6 | 5.8 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

### 6.4.6 ENERGY STAR® Furnaces & Boilers

Table 84 (next page) summarizes the proportion of gas furnaces rated ENERGY STAR® as indicated by survey respondents. On average, over one-third (36%) of FEU customers indicated their furnace is ENERGY STAR rated, while another three-in-ten (31%) indicated they were unsure.

**Table 84: Incidence of ENERGY STAR Gas Furnaces by Region (%)**

| Is Gas Furnace ENERGY STAR? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *563* | *1343* | *344* | *27* | *78* | *2355* |
| Yes | 35.9 | 36.4 | 32.0 | 48.2 | 28.2 | 35.8 |
| No | 35.2 | 31.1 | 23.8 | 29.6 | 35.9 | 33.1 |
| DK | 29.0 | 32.5 | 44.2 | 22.2 | 35.9 | 31.1 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

ENERGY STAR shares for gas boilers are summarized in Table 85. As was the case with gas furnaces, the proportion of respondents unsure whether their gas furnace is ENERGY STAR qualified is high (37%). Regional comparisons are provided but small sample sizes are noted for most regions.

**Table 85: Incidence of ENERGY STAR Gas Boilers by Region (%)**

| Is Gas Boiler ENERGY STAR? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *122* | *66* | *41* | *9* | *8* | *246* |
| Yes | 29.5 | 27.3 | 31.7 | 33.3 | 37.5 | 29.4 |
| No | 33.6 | 39.4 | 29.3 | 33.3 | 37.5 | 33.9 |
| DK | 36.9 | 33.3 | 39.0 | 33.3 | 25.0 | 36.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

### 6.4.7 Furnace & Boiler Replacement Behaviours

On average, nearly one-third (31%) of FEU customers reported installing a gas furnace or boiler in the last five years, up significantly from one-in-five (22%) who indicated they did so in the five years prior to the 2008 REUS. Lower Mainland dwellings experienced the highest installation rates (33%), followed by the Interior (29%) and Whistler (28%).

**Table 86: Installed Gas Furnace or Boiler in Last Five Years by Region (%)**

| Installed last five years? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1,2]* | *568* | *1365* | *346* | *27* | *83* | *2389* | *1665* | *2016* | *1225* | *1550* |
| Yes | 32.7 | 28.5 | 22.6 | 27.8 | 20.9 | 30.8 | 21.7 | 31.4 | 22.1 | 19.5 |
| No | 65.4 | 69.7 | 75.3 | 69.4 | 78.0 | 67.3 | 76.5 | 66.7 | 76.0 | 77.4 |
| DK | 1.9 | 1.8 | 2.1 | 2.8 | 1.1 | 1.9 | 1.7 | 1.9 | 1.8 | 3.1 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Asked only of those with a gas furnace or boiler.
Totals may not sum due to rounding.

Reasons why a furnace or boiler was installed during the last five years are summarized in Table 87 (next page).

As was the case in 2008 and 2002, three reasons dominate: wanting a more efficient furnace or boiler (mentioned by 38% of 2012 REUS respondents replacing a furnace or boiler in last five years), failure of the existing furnace or boiler (24%), and anticipation that the furnace or boiler would fail (16%).

**Table 87: Reason for Installing Gas Furnace or Boiler by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1,2]* | *219* | *403* | *85* | *10* | *18* | *735* | *310* | *640* | *237* | *312* |
| Wanted more efficient furnace or boiler | 37.0 | 42.7 | 20.0 | 10.0 | 22.2 | 37.6 | 44.3 | 38.5 | 45.2 | 25.7 |
| Furnace or boiler had failed | 26.5 | 17.1 | 25.9 | 40.0 | 22.2 | 24.0 | 21.8 | 23.9 | 22.0 | 35.6 |
| Anticipated furnace or boiler failure | 15.5 | 18.1 | 11.8 | 10.0 | 33.4 | 16.0 | 18.2 | 16.3 | 18.4 | 20.8 |
| New home | 10.0 | 8.7 | 20.0 | 10.0 | 11.1 | 10.2 | 8.6 | 9.7 | 8.4 | 15.3 |
| Wanted a lower cost fuel | 1.8 | 5.5 | -- | -- | -- | 2.7 | 0.8 | 2.8 | 0.8 | 6.5 |
| Wanted to change to gas | -- | 0.7 | 16.5 | 10.0 | -- | 1.0 | 1.2 | 0.2 | -- | 5.9 |
| Wanted an environmentally friendly fuel | 0.5 | 0.7 | 2.4 | -- | -- | 0.6 | 2.2 | 0.5 | 2.3 | 1.9 |
| House was too cold | -- | -- | -- | -- | -- | -- | 1.1 | -- | 1.1 | 3.1 |
| Heated floor area increased | -- | -- | -- | -- | -- | -- | 0.6 | -- | 0.7 | 1.4 |
| Other | 8.7 | 6.5 | 3.5 | 19.9 | 11.1 | 7.9 | 1.2 | 8.1 | 1.1 | 1.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Asked only of those with a gas furnace or boiler.
Totals may not sum due to rounding.

The efficiency of the furnaces installed during the last five years is summarized in Table 88. When compared to the 2008 results, the proportion of high efficiency models installed is, as expected, significantly higher (65% for 2012 versus 40% for 2008). Efficiency levels for boilers installed in the last five years are not reported due to small sample sizes.

**Table 88: Efficiency of Gas Furnace Installed in Last Five Years by Region (%)**

| Efficiency of New Furnace | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *186* | *383* | *72* | *7* | *16* | *664* | *264* |
| Low (standard) efficiency (< 78% AFUE) | 4.3 | 1.6 | 1.4 | -- | -- | 3.4 | 0.8 |
| Mid-efficiency (78% to 85% AFUE) | 30.1 | 23.5 | 19.4 | -- | 56.2 | 27.8 | 51.3 |
| High efficiency (90% AFUE or higher) | 61.8 | 71.8 | 69.4 | 100.0 | 43.8 | 65.0 | 39.5 |
| Efficiency unknown | 3.8 | 3.1 | 9.7 | -- | -- | 3.9 | 8.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

### 6.4.8 Furnace & Boiler Repairs and Maintenance

The 2012 REUS survey queried respondents with furnaces and boilers about repairs and repair costs during the last three years, and the frequency of common maintenance procedures. Table 89 (next page) shows nearly one-in-five (18%) of respondents made repairs to their gas furnace during the last three years. Regionally, Whistler stands out, with three-in-ten (29%) indicating they repaired their furnace, considerably higher than the five region average, and likely attributable to the conversion from piped propane to natural gas.[36] For homes with gas boilers, three-in-ten (31%) on average, indicated they had to repair their boiler in the last five years. Fort Nelson households had the highest incidence (37%).

[36] While any modifications to furnaces required to convert from piped propane to natural gas were paid by FortisBC, the question did not specifically state that repairs had to be paid by the homeowner.

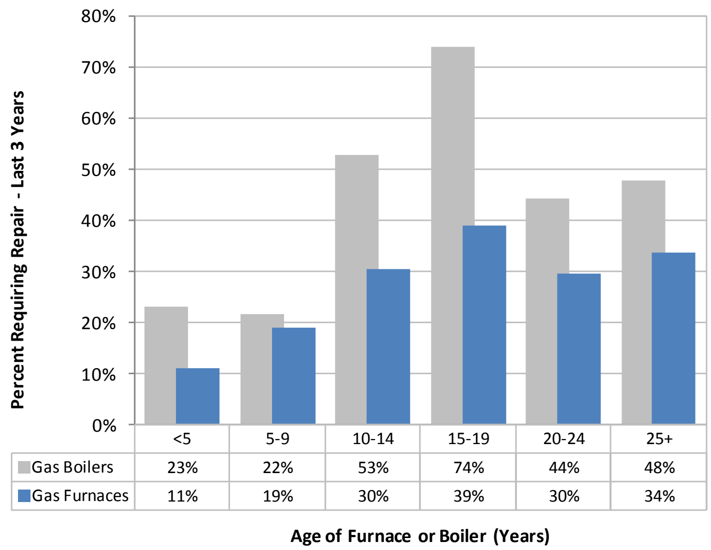
**Table 89: Made Repairs to Gas Furnaces in the Last Three Years by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| Yes – Gas furnaces [1] | 19.1 | 15.9 | 17.0 | 28.6 | 21.7 | 18.0 |
| Yes – Gas boilers [2] | 32.3 | 24.3 | 19.6 | 20.0 | 37.4 | 30.7 |

[1] Base – households with gas furnaces (Base =2,430).
[2] Base – households with gas boilers (Base = 258)

Figure 24 shows that unsurprisingly the likelihood of gas furnaces and gas boilers needing repair increases with the age of the space heating unit. While only one-in-ten (11%) of gas furnaces less than 5 years old had some form of repair during the last 3 years, the repair rate for for furnaces 5 to 9 years old was two-in-ten (19%), and three-in-ten (30%) for furnaces that are 10 to 14 years old. The need for repairs peaks for gas furnaces aged 15 and 19 years, with four-in-ten (39%) of furnaces in this age group having had repairs in the last three years. Possibly because they already incurred repairs that extended their lifespan, the likelihood of repair declines somewhat for furnaces 20 years and older. All calculations use the revised furnace and gas boiler data.

**Figure 24: Incidence of Gas Furnace and Boiler Repairs by Equipment Vintage**
**Repairs Made Within the Last Three Years**




Compared to gas furnaces, the incidence of repairs for gas boilers is higher, in some cases considerably higher, for most equipment age ranges. Almost one-quarter (23%) of gas boilers less than 10 years of age required repairs during the last three years. The incidence of repair jumps for boilers aged 10-14 years (53%) and 15-19 years (74%). Similar to gas furnaces, the incidence of repair for boilers in their third decade of service declines.

### Furnace and Boiler Repair Costs

Respondents with gas furnaces or gas boilers that required repair during the last three years were asked to indicate how much was spent on repairs during that period.

A first pass of the data for gas furnaces show expenditures ranging from a low of a few dollars to thousands of dollars. Further review of the data by age of furnace strongly suggested that some respondents had counted the installation cost for a new furnace as a repair cost. To counter this, Tukey's method was used to determine outliers in the repair cost data set. The result of this analysis led to the exclusion of amounts exceeding $1,500 from the analysis.

Median and mean (average) repair costs, excluding outliers, for gas furnaces are summarized in Table 90. The average cost of furnace repairs during the last three years for FEU customers was $377, with the median repair cost being $300.

**Table 90: Repair Costs Last Three Years – Gas Furnaces ($)**

| Repair Costs | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1,2]* | *157* | *228* | *80* | *8* | *24* | *994* |
| Median | $300 | $300 | $300 | $350 | $300 | $300 |
| Mean | $395 | $334 | $357 | $380 | $402 | $377 |
| Standard deviation | $496 | $186 | $203 | $47 | $98 | $306 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Excludes extreme outliers (expenditures exceeding $1,500)

Repair costs for gas boilers were analyzed for outliers in a manner consistent with that used for gas furnaces. Extreme outliers (expenditures of $2,000 or more based on Tukey's method of outlier determination) were removed. Median and mean (average) repair costs, excluding outliers, for gas furnaces are summarized in Table 91. The average cost of gas boiler repairs during the last three years was $588, with the median repair cost being $400. Regional results are not provided due to small sample sizes.

**Table 91: Repair Costs Last Three Years – Gas Boilers ($)**

| Repair Costs | 2012 FEU |
|---|---|
| *Unweighted base [1,2]* | *82* |
| Median | $400 |
| Mean | $588 |
| Standard deviation | $652 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Excludes extreme outliers (expenditures exceeding $2,000)

## Heating System Maintenance Behaviours

The frequency with which households undertake several common maintenance behaviours for gas furnaces were queried:

- changing the furnace filter regularly
- servicing the heating system annually using a contractor
- servicing the heating system annually without using a contractor (homeowner)

Respondents were asked to indicate whether they always, usually, occasionally or never did each of the three behaviours. Respondents were allowed to specify "don't know" or "not applicable". The findings are summarized in Table 92 (next page).

**Table 92: Frequency of Heating System Maintenance Behaviours (%)**
**Rows Sum Across**

| Heating System Maintenance | Always | Usually | Occasion-ally | Never | DK | Total |
|---|---|---|---|---|---|---|
| Change furnace filter regularly | 62.1 | 22.9 | 9.9 | 3.9 | 1.2 | 100.0 |
| Service heating system annually by contractor | 24.0 | 19.5 | 30.6 | 23.5 | 2.4 | 100.0 |
| Service heating system annually myself | 14.5 | 10.1 | 14.0 | 59.8 | 1.6 | 100.0 |

A minority of respondents (39%) had their heating system serviced annually, either by a contractor (24%) or by servicing the equipment themselves (15%). Over one-in-seven (15%) never had the equipment serviced.

### 6.4.9 Furnace Fan Blower Motors – Types and Operations

Respondents with gas furnaces were asked a series of questions about their furnace blower motors to better understand both the type of blower motors in use and how they are used during the year.

Three-in-ten (29%) of FEU respondents with a natural gas furnace indicated their furnace has a variable speed or electronically controlled blower motor (Table 93). Of note, four-in-ten (41%) did not know the type of blower motor on their furnace.

**Table 93: Incidence of Variable Speed Furnace Fan Motors by Region (%)**

| Does furnace have a VSD blower motor? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1,2]* | *554* | *1332* | *337* | *27* | *82* | *2332* |
| Yes | 29.8 | 31.7 | 16.3 | 22.2 | 17.1 | 29.4 |
| No | 30.3 | 28.6 | 31.2 | 18.5 | 29.3 | 29.8 |
| DK | 39.9 | 39.7 | 52.5 | 59.3 | 53.7 | 40.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] Asked only of those with a gas furnace or boiler.

Regardless of whether they knew the furnace blower motor type, respondents with gas furnaces were asked about how often their furnace blower motor operates (runs). Respondents were asked to choose the best answer from the following list:

- only when furnace is operating
- only when furnace or air conditioning is operating
- continuously during the heating season
- continuously during the heating and cooling season
- continuously year round

The results, summarized in Table 94 (next page), show that a majority (63%) of respondents with gas furnaces only operate their furnace blower motors when the furnace is providing heat. The next most frequent response was when either the furnace or the air conditioner (AC) is operating (19%). Six percent (6%) indicated their furnace fan operates continuously all year. Some regional variations are worth noting, particular for the Interior and Fort Nelson regions where the higher incidence of central air conditioning is evident.

**Table 94: Furnace Fan Blower Motor Operating Behaviours by Region (%)**
**Gas Furnaces Only**

| When does your furnace fan operate? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base*[1] | *567* | *1353* | *345* | *27* | *82* | *2374* |
| Only when furnace is operating | 70.2 | 45.6 | 78.8 | 81.5 | 69.5 | 63.4 |
| Only when furnace or AC is operating | 9.7 | 39.7 | 8.7 | 3.7 | 15.8 | 18.7 |
| Continuously during the heating season | 3.9 | 2.1 | 1.4 | 3.7 | 7.3 | 3.2 |
| Continuously during heating and cooling season | 3.4 | 2.8 | 2.9 | -- | 1.2 | 3.1 |
| Continuously year round | 6.5 | 5.5 | 3.8 | 7.4 | 2.4 | 6.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Those respondents who indicated the blower fan on their gas furnace did not operate continuously all year were asked whether they sometimes turned on the furnace fan to provide ventilation in the house. Those who indicated they did this were then asked to indicate the approximate number of weeks in the year that they manually used their fan to provide ventilation. The findings for these two questions are summarized in Table 95 and Table 96.

Approximately one-in-five (18%) of households with a gas furnace sometimes turn on their furnace blower motor to provide ventilation for part of the year.

**Table 95: Use of Furnace Fan for Ventilation for Part of the Year by Region (%)**
**Gas Furnaces Only**

| Furnace fan used for ventilation? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *567* | *1353* | *345* | *27* | *82* | *2374* |
| Yes | 17.3 | 20.2 | 21.4 | 23.1 | 18.3 | 18.4 |
| No | 76.0 | 74.2 | 74.8 | 69.3 | 79.3 | 75.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding.

Respondents with gas furnaces used their furnace fans to provide ventilation for an average of one-quarter (13 weeks) of the year. The median value was 8 weeks. Average usage is similar among all regions (12 to 14 weeks) with the exception of Whistler (very small sample).

**Table 96: Use of Furnace Fan for Ventilation by Region (Number of Weeks)**
**Gas Furnaces**

| Furnace fan used for ventilation (weeks) | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *94* | *255* | *69* | *6* | *15* | *439* |
| Median | 8.0 | 8.0 | 5.0 | 4.0 | 10.0 | 8.0 |
| Mean | 13.9 | 12.3 | 12.9 | 6.0 | 12.3 | 13.3 |
| Standard deviation | 24.0 | 9.8 | 11.8 | 1.4 | 3.6 | 14.2 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

## 6.5 Programmable Thermostats

Six-in-ten (61%) of FEU residential customers use a programmable thermostat in their home, up from 2008 (55%) (Table 97). Regionally, usage is highest in the Interior and Lower Mainland (63% and 62%), while Whistler has the lowest use of programmable thermostats (44%).

**Table 97: Use of Programmable Thermostats by Region (%)**

| Use programmable thermostat? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *778* | *1689* | *727* | *83* | *103* | *3380* | *2188* |
| Yes | 62.2 | 62.9 | 53.1 | 43.9 | 47.9 | 61.3 | 54.6 |
| No | 36.8 | 36.2 | 46.1 | 52.4 | 51.1 | 37.7 | 44.2 |
| DK | 1.0 | 0.9 | 0.8 | 3.7 | 1.0 | 1.0 | 1.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Data on programmable thermostat use by dwelling type and tenancy status (own versus rent) is summarized in Table 98. Usage among the six dwelling types is highest among single family detached homes (63%) while apartments / condominiums have proportionately fewer units with programmable thermostats (29%). Owners are significantly more likely than renters to use a programmable thermostat (62% versus 33%). The incidence of programmable thermostats is influenced, in part, by the type of heating system present.

**Table 98: Use of Programmable Thermostats by Dwelling Type and Tenancy Status (%)**

| Use programmable thermostat? | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other | Own | Rent |
|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *2746* | *151* | *205* | *54* | *118* | *58* | *3250* | *84* |
| Yes | 63.1 | 54.3 | 60.7 | 28.7 | 48.6 | 38.7 | 62.1 | 33.1 |
| No | 35.9 | 42.4 | 39.3 | 69.9 | 49.8 | 60.3 | 36.9 | 63.2 |
| DK | 1.0 | 3.3 | -- | 1.4 | 1.6 | 1.0 | 0.9 | 3.7 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

# 7 DOMESTIC HOT WATER

Domestic water heating (DWH) represents the system of providing hot water for domestic uses such as clothes washing, dish washing, showers, baths, and the like. Respondents to the 2012 REUS were asked a series of questions regarding their hot water heating system, including type and age of equipment, fuels, and replacement and fuel switching behaviours. Findings from past FEU REUS surveys strongly suggested that some survey respondents had difficulty in accurately identifying the fuel used for domestic water heating and the type of hot water heater equipment used to provide hot water. Given this, the DWH section of the 2012 REUS questionnaire was restructured and refined to improve the ability of respondents to accurately describe their DWH systems. As will be discussed, the results show that improvements to this end have been made but the topic remains a difficult one for some survey respondents.

## 7.1 Penetration and Saturation

The proportion of households with in-home DWH systems (any fuel), including penetration and saturation rates for domestic water heaters, are summarized in Table 99. Over nine-in-ten (93%) of respondents indicated their dwelling has a domestic water heater. The remainder (7 %) have their domestic hot water centrally provided (i.e., from outside their unit). This proportion of centrally provided hot water is significantly higher than that recorded in 2008 (4%), but comparable to the proportion recorded in the 2002 survey. Differences in the proportion of households without a domestic hot water heater between 2008 and 2012 may be due to differences in the sample plan for the two surveys and/or differences in the proportion of non-responses for the two surveys.[37]

**Table 99: Hot Water Heater (Any Fuel) Penetration and Saturation by Region**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | *793* | *1707* | *752* | *85* | *104* | *3441* | *2186* | *2604* | *1423* | *1610* |
| Penetration (%) | 92.1 | 94.3 | 96.1 | 97.6 | 94.3 | 93.1 | 96.5 | 92.7 | 96.3 | 94.6 |
| Saturation [2] | 1.03 | 1.04 | 1.05 | 1.35 | 1.03 | 1.04 | 1.03 | 1.03 | 1.03 | 1.03 |
| Households with >1 water heater (%) [2] | 2.7 | 3.7 | 5.0 | 31.7 | 3.0 | 3.3 | 3.1 | 3.0 | 3.0 | 2.7 |
| Installed new water in past five years (%) [2] | 41.0 | 37.8 | 43.8 | 53.8 | 28.2 | 40.5 | 38.3 | 40.0 | 37.6 | 37.2 |
| No hot water heater in residence (%) | 7.9 | 5.7 | 3.9 | 2.4 | 5.7 | 6.9 | 3.5 | 7.3 | 3.7 | 5.4 [3] |

[1] Treats missing responses as zeros. This ensures consistency with past surveys.
[2] Excludes missing responses and respondents living in apartments, row houses and townhouses where hot water is centrally provided.
[3] Treated non-response as zero. When non-responses are excluded, the percentage of FEI customers with no water heater decreases to 4.9%.

Regionally, Vancouver Island customers have statistically significant higher penetration of DWH heaters than the Lower Mainland (96% versus 92%). All other differences in penetration between regions are not statistically significant.

Saturation rates for households with at least one DWH heater are comparable to those observed in 2008 (1.04 units, on average, per home in 2012 versus 1.03 in 2008). The saturation rates reflect a small

[37] The 2008 REUS survey treated non-responses the same as if the respondent had indicated domestic hot water was centrally provided. In contrast, the 2002 REUS treated non-responses as non-responses (i.e., did not assume it meant centrally provided domestic hot water). It is not possible to isolate non-responses from the “no water heater” responses in the 2008 REUS dataset.

proportion of homes that have more than one DWH unit three percent of FEU residential customers). As observed in the 2008 REUS, Whistler dwellings are significantly more likely to have multiple DWH units (32%). In 2008, this was attributed to the high proportion of homes in the community that have a secondary suite.[38] Indeed, one-in-five (20%) of Whistler respondents to the 2012 REUS indicated their dwelling has a secondary suite, significantly higher than other regions. Saturation rates for FEI customers in 2012 are unchanged from 2002.

Four-in-ten (41%) of FEU residential customers installed a domestic hot water heater in the last five years, not significantly different from the 2008 REUS (38%). This is equivalent to an average replacement rate of 8% per year, and an average water heater life of over 13 years.

Penetration and saturation rates for hot water heaters (any fuel) by dwelling type are presented in Table 100. As was the case in the 2008 REUS, a small percentage of respondents (5%) in single family detached dwellings indicated they do not have a hot water heater in their residence.[39]A similar result was observed for mobile homes (8%). In some cases, this may be due to the presence of combination boilers (a single unit providing both heat and domestic hot water).

In contrast to SFDs and mobile homes, it was expected that a proportion of apartments / condominiums, row and townhouses, and to a much lesser degree, duplexes, would not have a DWH heater in their residence. Indeed, six-in-ten (58%) of apartments / condominiums and one-in-eight (12%) of row / townhouses indicated their unit does not have a DWH heater. Of note, over one-in-eight (14%) of respondents living in duplexes indicated they do not have a domestic hot water heater. The latter, like that of SFDs, may reflect a degree of misclassification by the survey respondent.

**Table 100: Hot Water Heater (Any Fuel) Penetration and Saturation by Dwelling Type**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Penetration (%) | 94.9 | 86.0 | 87.9 | 42.2 | 91.7 | 84.9 |
| Saturation [2] | 1.04 | 1.03 | 1.00 | 1.00 | 1.02 | 1.04 |
| Households with >1 water heater (%) [2] | 3.8 | 3.1 | 0.0 | 0.0 | 1.7 | 3.6 |
| Installed new water in past five years (%) [2] | 40.9 | 40.0 | 38.2 | 53.7 | 32.0 | 29.1 |
| No hot water heater in residence (%) | 5.1 | 14.0 | 12.1 | 57.8 | 8.3 | 15.1 |

[1] Treats missing responses as zeros. This ensures consistency with past surveys.
[2] Excludes missing responses and respondents living in apartments, row houses and townhouses where hot water is centrally provided.
*

Questions about domestic hot water equipment and fuels from this point on in the survey were directed only to households with an in-home DWH system. Respondents living in apartments, townhouses and other complexes where DWH is provided centrally were skipped forward in the survey and, for obvious reasons, not asked questions about their DWH equipment or fuels.

[38] Sampson Research (2008), p. 7-1.

[39] The 2008 REUS survey had 3% of respondents in SFDs that reported not having a hot water heater in the dwelling.

## 7.2 Average Age of Hot Water Heaters

Table 101 summarizes the mean (average) age of the first and second hot water heaters, regardless of type or fuel. The average age of the first water heater in the FEU service region is 6.6 years, with regional variations from a low of 5.0 years for Whistler customers to a high of 7.4 years for Fort Nelson customers.

**Table 101: Average Age of Hot Water Heaters (Any Fuel) by Region (Years)**

| DWH Age | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *634* | *1384* | *649* | *76* | *76* | *2819* | *1656* | *2094* | *1026* | *1528* |
| Average age of first water heater (years) | 6.4 | 7.1 | 6.0 | 5.0 | 7.4 | 6.6 | 7.1 | 6.7 | 7.3 | 7.5 |
| Average age of second water heater (years) | 11.9 | 7.5 | 7.3 | 5.3 | 7.3 | 8.1 | 6.7 | 8.2 | 6.2 | 8.5 |

[1] Unweighted base for first water heater only.

The mean (average) age of the first water heater is significantly lower than the average from the 2008 REUS.

## 7.3 Water Heater Fuels

Results from the 2008 REUS strongly suggested that some respondents with conventional storage tank hot water heaters either incorrectly specified the fuel used by their DWH tank, or the type of tank (vented or not vented).[40] The 2012 REUS questionnaire was redesigned to improve the quality of the fuel and equipment data collected for DWH equipment by asking about tank venting in a question separate from the type (shape) of DWH equipment. Specifically, respondents who indicated their home had a conventional storage-style DWH tank were asked to indicate whether the tank had one of the following venting configurations:

- vent through the side wall
- vent through the roof
- no vent (electric tank)

The no vent category description deliberately included the term “electric tank” because tanks using natural gas, propane, or oil require a vent to exhaust combustion gases, whereas electric tanks do not. A similar question was asked of respondents who indicated they had on-demand (tankless or hybrid) water heaters. Again, if no vent was present, the default assumption is that the water heater uses electricity.

When data on fuels and equipment characteristics for water heaters were compared on a respondent-by-respondent basis, some degree of fuel misspecification for storage style tanks, like that identified in the 2008 REUS, was apparent. The misspecification took the form of a mismatch between fuel (e.g., electricity versus natural gas) and equipment (vent or no vent) for conventional storage (tank) style DWH heaters. In situations where the dwelling had more than one domestic water heater, extra caution was used to compare first, second and third units in the order specified in the survey.[41]

[40] Sampson Research (2008), p.7-5.

[41] To improve the pairings of fuels with equipment for homes with more than one water heater, the 2012 REUS questionnaire asked respondents to treat the water heater that provides most of the hot water for the home as the main water heater. All subsequent questions provided response categories for multiple units organized by heater 1 (main), heater 2, and heater 3.

Assuming the information provided on the presence (or lack) of a vent was the most likely to be correct because it could be observed by the survey respondent, data on water heater fuels for conventional storage tanks were adjusted for two types of misspecification:

- Specifying natural gas, piped propane, or oil as the DWH fuel but indicating the tank did not have a vent (i.e., it is an electric tank).
- Specifying electricity as the DWH fuel but indicating their tank had either a vent through the roof or side wall of the dwelling (tank uses natural gas, oil or propane).

In situations where a vent was present and electricity was indicated as the fuel, the reassignment of the fuel to natural gas, propane or oil was first confirmed by the presence of the same fuel for space heating. In situations where an electric tank (no vent) was indicated but natural gas, piped propane, oil, or geothermal specified as the fuel, the DWH fuel was changed to electricity. In the end, 63 cases had their DWH fuel changed from electricity to natural gas, 16 cases had their DWH fuel changed from natural gas to electricity, four cases changed from geothermal to electricity, and one case changed from a non-response to electricity.

The soundness of this adjustment methodology depends entirely upon the assumption that respondents were able to correctly classify their hot water heating equipment based on its outward appearance. The fact that some respondents could not answer the question regarding the venting of their storage tank (e.g., answered “don’t know”) suggests they either could not easily view their DWH equipment, or chose not to, while completing the survey.

### 7.3.1 Restated Domestic Hot Water Heater Fuels

Data on DWH fuels, with adjustments, are summarized in Table 102. No adjustments were made to 2008 or 2002 data because the questions are not directly comparable between surveys, making the reclassification methodology unsuitable for these datasets. As a result, caution is advised in comparing past REUS data with the 2012 adjusted results.

**Table 102: Hot Water Heater Fuels (Corrected) by Region (%)**
**First DWH Unit**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *730* | *1609* | *723* | *83* | *98* | *3243* | *2026* | *2437* | *1291* | *1528* |
| Electricity | 10.5 | 25.8 | 28.8 | 64.6 | 13.5 | 16.9 | 10.8 | 15.3 | 9.7 | 14.3 |
| Natural gas | 89.0 | 73.3 | 70.5 | 34.1 | 86.5 | 82.5 | 88.8 | 84.2 | 90.1 | 84.7 |
| Piped propane | 0.1 | -- | -- | -- | -- | 0.1 | 0.1 | 0.1 | 0.0* | 0.2 |
| Other [1] | -- | 0.4 | 0.4 | 1.2 | -- | 0.2 | 0.2 | 0.1 | 0.2 | -- |
| NR | 0.3 | 0.5 | 0.3 | -- | -- | 0.3 | -- | 0.3 | -- | 0.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

* Value less than 0.1%
[1] Includes bottled propane, solar, geothermal, and oil.
Totals may not sum due to rounding.

Natural gas is the most common DWH fuel for FEU customers (83% of first DWH heaters). Natural gas shares by region vary from Whistler (34%) to the Lower Mainland (89%). One-in-six (17%) of FEU customers use electricity for DWH. Fuels other than electricity or natural gas, included piped propane, bottled propane, oil, solar, and geothermal, individually and collectively. These other fuels accounted for one percent (1%) or less of all DWH heaters.

To better understand whether DWH fuel shares are changing in new construction, the relationship between dwelling vintage and DWH fuel shares were explored for single family detached (SFD) dwellings in Table 103. The proportion of SFDs that use natural gas as their DWH fuel (first unit) is highest for SFDs constructed between 1986 and 2005 (87%). Over eight-in-ten SFDs constructed prior to this time use natural gas for their DWH; however, SFDs constructed since 2005 are significantly less likely to use natural gas (66%) for DWH heating and more likely to use electricity (33%). DWH fuel shares by dwelling vintage for dwelling types other than SFDs are not reported because of small sample sizes.

**Table 103: Hot Water Heater Fuels (Corrected) for First DWH Unit – SFDs by Vintage (%)**

| | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* [1] | 329 | 782 | 473 | 497 | 367 | 140 | *29* |
| Electricity | 19.5 | 15.4 | 19.8 | 12.2 | 15.2 | 33.2 | 23.9 |
| Natural gas | 80.2 | 84.5 | 79.7 | 87.7 | 84.7 | 65.8 | 76.1 |
| Piped propane | -- | -- | 0.5 | -- | -- | -- | -- |
| Other [2] | 0.3 | 0.1 | -- | 0.1 | 0.1 | 1.0 | -- |
| NR | 0.1 | 0.6 | 0.1 | 0.4 | 0.2 | 0.3 | -- |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only
[2] Includes bottle propane, solar, geothermal, and oil.
Totals may not sum due to rounding

### 7.3.2 Solar Pre-Warming and DWH

A very small percentage (2%) of FEU customers (any DWH fuel) use solar energy to pre-warm or supplement their main DWH water heating process (Table 104). A similarly small percentage was recorded in 2008. Differences between the regions are not significant at the 95% confidence level.

**Table 104: Solar Assist for Pre-Warming the First DWH Unit (Any Fuel) by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *718* | *1562* | *701* | *82* | *96* | *3159* | *1928* |
| Use solar assist | 2.2 | 1.2 | 1.3 | -- | -- | 1.8 | 0.8 |
| No assist | 97.8 | 98.8 | 98.7 | 100.0 | 100.0 | 98.2 | 99.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

## 7.4 Fuel Switching

All respondents with DWH equipment in their home or suite were asked whether they switched the fuel used to provide domestic hot water in the last five years. In past end-use surveys, the proportion that switched fuels was small (typically 5% or less). The 2012 REUS, however, recorded an incidence of switching several magnitudes greater than the historical estimates, suggesting a problem with the question wording and/or its interpretation by respondents.

All respondents who switched fuels were asked to indicate their previous DWH fuel. This allowed comparison with the current DWH fuel to see whether a change had occurred. These comparisons confirmed that the vast majority of respondents who reported a fuel change did not change their DWH fuel. It is not clear why the question was misinterpreted. Its wording was the same as the 2008 questionnaire although placement of the question in the DWH section in the 2012 questionnaire was changed. The data on fuel switching were adjusted to exclude respondents whose current and past fuels were the same.

Table 105 summarizes the restated data on DWH fuel switching. Two percent (2%) of FEU customers switched DWH fuels in the last five years, up from one percent (1.1%) in 2008. Regionally, the percent that switched DWH fuels varies from a low of two percent in the Lower Mainland, Interior, and Fort Nelson to one-in-five (21%) in Whistler. The higher percentage for Whistler is most likely due to the town's recent switch to natural gas from piped propane. Four percent of Vancouver Island gas customers reported switching DWH fuels in the last five years.

**Table 105: Change in DWH Fuel Last Five Years by Region (%)**
**Restated Data**

| Changed DWH Fuel Last Five Years? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *728* | *1595* | *715* | *82* | *97* | *3217* | *2004* | *2420* | *1278* | *1516* |
| Yes | 1.9 | 2.3 | 3.9 | 21.0 | 2.0 | 2.3 | 1.1 | 2.0 | 0.5 | 5.7 |
| No | 98.1 | 97.7 | 96.1 | 79.0 | 98.0 | 97.7 | 98.9 | 98.0 | 99.5 | 94.3 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
* Value less than 0.1%

The relative proportions of current versus previous DWH fuels for households who switched DWH fuel in the last five years are summarized in Table 106. All data are expressed as a percent of all respondents who changed DWH fuels in the last five years.

**Table 106: Change in Water Heating Fuel during Past Five Years (%)**

| Previous fuel ▸ / Current fuel ▾ | Electricity | Natural Gas | Piped Propane | Oil | All Previous Fuels |
|---|---|---|---|---|---|
| *Unweighted base* [1] | *42* | *34* | *11* | *2* | *89* |
| Electricity | -- | 42.2 | 0.3 | -- | 42.5 |
| Natural gas | 52.7 | -- | 1.5 | 1.6 | 55.8 |
| Oil | -- | 0.8 | -- | -- | 0.8 |
| Other | 0.9 | -- | -- | -- | 0.9 |
| All Current Fuels | 53.6 | 43.0 | 1.9 | 1.6 | 100.0 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Fifty-four percent (54%) of households who changed DWH fuels switched from electricity to something else. Of these, almost all (53%) switched from electricity to natural gas. In comparison, over four-in-ten (43%) switched from natural gas to something else with the majority (42%) switching to electricity. All remaining current and previous fuel combinations are small (representing 2% or less of DWH fuel switchers). While the number of fuel switchers is low (n=89), the data show the proportion switching from natural gas to something else only somewhat outweighed the proportion switching to natural gas. The data suggest the impact of fuel switching for DWH is effectively neutral.

## 7.5 Water Heater Equipment

Respondents to the 2012 REUS were asked to identify the equipment used to provide their domestic hot water. A list of common and less common DWH equipment types was provided. These included:

- Conventional storage (tank)

- On-demand (tankless)
- Hybrid on-demand (uses small storage tank)
- Combined space and water heater
- Hybrid heat pump water heater (tank)

To help in the correct classification of some newer DWH equipment types, participants in the 2012 REUS were provided with additional information about on-demand water heaters and hybrid heat pump water heaters (Figure 25).

Respondents with conventional storage (tank) water heaters (first, second and/or third units) were asked whether the units had a vent (metal or plastic) and where the vent discharged (roof or sidewall).

**Figure 25: Explanatory Text Box – Water Heater Types**

**Tankless & Hybrid On-Demand Water Heaters**

On-demand (tankless) water heaters, also known as instantaneous water heaters, are compact units that provide hot water on demand. Hybrid on-demand models use a small storage tank to reduce temperature fluctuations during use.

Hybrid heat pump water heaters combine a heat pump with an electric hot water tank to improve energy efficiency.

### 7.5.1 Penetration Rates

Penetration rates for domestic hot water heater equipment, regardless of whether they are the household's main, secondary or tertiary unit, are summarized in Table 107 with comparison to 2008 data. Slight differences between the two surveys exist so some caution is advised in the interpretation of changes between the two years.

**Table 107: Hot Water Heater Type Penetration Rates by Region (%)**
**Includes First, Second and Third Water Heaters**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *730* | *1609* | *723* | *83* | *98* | *3243* | *1963* |
| Conventional storage tank ▼ | 90.6 | 93.6 | 91.0 | 91.8 | 96.1 | 91.4 | 82.9 |
| Vent through side-wall | 15.0 | 9.6 | 16.8 | 12.0 | 10.4 | 12.3 | 12.4 [1] |
| Vent through roof | 51.8 | 48.4 | 37.3 | 14.8 | 62.5 | 45.7 | 56.5 |
| No vent (electric) | 9.2 | 24.2 | 27.4 | 57.5 | 12.3 | 22.0 | 14.0 |
| DK | 14.5 | 11.3 | 9.5 | 7.4 | 12.3 | 11.4 | n/a |
| On-demand (tankless) | 3.5 | 2.4 | 5.0 | 2.7 | 1.2 | 3.4 | 2.7 [2] |
| Hybrid on-demand (small tank) | 0.8 | 0.5 | 0.9 | -- | -- | 0.7 | |
| Combined space and water heater | 1.3 | 0.4 | 0.7 | 0.9 | -- | 1.0 | 0.7 |
| Hybrid heat pump heater (tank) | 0.4 | 0.4 | 0.1 | 0.9 | -- | 0.4 | n/a |
| DK [3] | 3.4 | 2.6 | 2.3 | 3.7 | 1.2 | 3.0 | 13.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Includes condensing hot water heaters
[2] On-demand water heaters with and without small tanks not differentiated in the 2008 REUS
[3] Represents uncertainty across all DWH types, including conventional storage tanks.
Totals may not sum due to rounding.

Over nine-in-ten (91%) FEU customers had a conventional storage tank. This style of water heater dominates in all regions. When detail on the presence and type of vent is considered, just under one-half (46%) have a traditional roof vent; one-in-eight (12%) have a side vent, and over one-in-five (22%) have no vent (electric tank implied). One-in-ten (11%) of respondents with a conventional storage tank did not know whether their tank was vented.

Tankless on-demand units (3%) and hybrid (1%) versions equipped with a small expansion tank represent a tiny portion of the overall DHW market. Venting data for on-demand water heaters are not reported due to the small number of responses received. Data from the 2008 REUS indicated on-demand units (no differentiation by tankless or small expansion tank) represented less than three percent (2.7%) of units in 2008, suggesting only a slight increase in the penetration of these units in the last four years

### 7.5.2 Saturation Rates by Type of Water Heater

Saturation rates for hot water heaters, by water heater type, are summarized in Table 108 with comparisons to 2008. As the 2008 REUS identified difficulties that respondents had in correctly identifying the venting for the conventional tanks, caution is advised in comparing the 2012 results with those of 2008.

**Table 108: Hot Water Heater Type Saturation by Region**
**Includes First, Second and Third Water Heaters**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base [5]* | *698* | *1543* | *695* | *80* | *96* | *3112* | *1692* |
| Conventional storage tank ▼ | 0.96 | 1.00 | 0.97 | 1.27 | 1.01 | 0.97 | 0.97 |
| Vent through side-wall | 0.19 | 0.12 | 0.20 | 0.18 | 0.12 | 0.15 | 0.15 [1] |
| Vent through roof | 0.66 | 0.59 | 0.45 | 0.22 | 0.74 | 0.56 | 0.67 |
| No vent (electric) | 0.12 | 0.29 | 0.33 | 0.86 | 0.15 | 0.27 | 0.17 |
| On-demand (tankless) | 0.04 | 0.03 | 0.05 | 0.04 | 0.02 | 0.04 | 0.03 [2] |
| Hybrid on-demand (small tank) | 0.01 | 0.01 | 0.01 | -- | -- | 0.01 | |
| Combined space and water heater | 0.01 | 0.00* | 0.01 | 0.01 | -- | 0.01 | 0.01 |
| Hybrid heat pump heater (tank) | 0.00* | 0.00* | 0.00* | 0.01 | -- | 0.00* | n/a |

* Saturation less than 0.01
[1] Includes condensing hot water heaters
[2] On-demand water heaters with and without small tanks not differentiated in the 2008 REUS
Totals may not sum due to rounding.

The saturation rate for conventional storage style tanks is 0.97, unchanged from 2008. Saturation rates for conventional tanks by region, varies from a low of 0.96 for Lower Mainland to 1.27 for Whistler. Saturation rates for on-demand water heaters remain low (less than 0.05).

### 7.5.3 Water Heater Sizes

Table 109 summarizes the distribution of conventional storage water heater tank sizes by units with either a side or roof vent, no vent (electric) and those not specifying their tank's vent specifics. Respondents were asked to answer this question thinking about the largest tank in the house.

**Table 109: DWH Tank Sizes – Largest Tank in the Home (%)**

| | With Roof Vent | With Side-Wall Vent | No Vent (Electric) | Venting Unknown | 2012 FEU |
|---|---|---|---|---|---|
| *Unweighted base* | *1476* | *379* | *661* | *351* | *2867* |
| 10 imperial gallons (46 litres) | 0.6 | 3.2 | 1.1 | 1.5 | 1.2 |
| 33 imperial gallons (150 litres) | 28.0 | 21.7 | 11.5 | 16.7 | 22.8 |
| 40 imperial gallons (182 litres) | 49.7 | 42.6 | 47.8 | 22.3 | 44.4 |
| 60 imperial gallons (273 litres) | 10.3 | 12.5 | 15.3 | 7.5 | 11.0 |
| Other | 2.7 | 5.4 | 5.7 | 3.4 | 3.7 |
| DK | 8.7 | 14.5 | 18.7 | 48.6 | 16.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

The most common size is 40 gallons (44% of all responses), followed by 33 gallon tanks (23%), and 60 gallon tanks (11%). Of note, nearly one-in-five (17%) of respondents did not know the size of their tank.

## 7.6 Water Heater Installations

Table 110 shows that the proportion of households installing domestic hot water heaters during the last five years (41%) is statistically unchanged from that recorded during the last two REUS surveys (38% - 39%).

**Table 110: New DWH Heater Installations Last Five Years by Region (%)**

| Installed Water Heater Last Five Years? | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *727* | *1588* | *714* | *81* | *98* | *3208* | *2011* | *2413* | *1283* | *1525* |
| Yes | 41.0 | 37.8 | 43.8 | 53.8 | 28.2 | 40.5 | 38.3 | 40.0 | 37.6 | 39.3 |
| No | 59.0 | 62.2 | 56.2 | 46.2 | 71.8 | 59.5 | 61.7 | 60.0 | 62.4 | 57.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.
* Value less than 0.1%

Reasons for installing a water heater are summarized in Table 111. Consistent with past REUS surveys in 2008 and 2002, the most common reasons are water heater failure (60% of respondents who installed a hot water heater in the last five years), and anticipation that the water heater would fail (23%).

The proportion (9%) installing a new water heater because they wanted a more efficient unit remained the same as in 2008 and 2002. The 2002 REUS data includes multiple responses so comparisons with 2008 and 2012 data should be made with caution.

**Table 111: Reasons for Installing a New Water Heater in Last Five Years (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *296* | *595* | *311* | *42* | *27* | *1271* | *730* | *918* | *421* | *583* |
| Water heater had failed | 61.1 | 58.2 | 56.6 | 52.4 | 55.6 | 59.8 | 65.1 | 60.3 | 66.1 | 67.3 |
| Anticipated water heater failure | 22.0 | 23.4 | 24.1 | 33.3 | 25.9 | 22.6 | 17.5 | 22.4 | 17.5 | 16.8 |
| Wanted more efficient water heater | 9.1 | 8.7 | 5.1 | -- | 11.1 | 8.5 | 9.2 | 9.0 | 9.6 | 3.7 |
| New home | 2.4 | 3.4 | 4.8 | 7.1 | 3.7 | 2.9 | 4.4 | 2.7 | 4.1 | 6.7 |
| Needed more hot water | 1.0 | 1.2 | 1.3 | -- | -- | 1.1 | 0.8 | 1.1 | 0.7 | 2.9 |
| Wanted to change to gas | 0.3 | 0.3 | 1.9 | -- | -- | 0.5 | 1.5 | 0.3 | 0.6 | 2.3 |
| Wanted faster hot water recovery | 0.3 | 0.2 | -- | -- | -- | 0.3 | 0.3 | 0.3 | 0.3 | 1.0 |
| Wanted an environmentally friendly fuel | -- | 0.3 | 0.6 | -- | -- | 0.2 | -- | 0.1 | -- | 0.5 |
| Wanted a cheaper fuel | -- | 0.3 | 0.3 | 2.4 | -- | 0.1 | 0.2 | 0.1 | 0.1 | 0.8 |
| Other | 3.7 | 4.0 | 5.1 | 4.8 | 3.7 | 4.0 | 1.0 | 3.8 | 0.9 | 2.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **--** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only
Totals may not sum due to rounding.

### 7.7 Showerheads, Aerators, and Miscellaneous Hot Water Appliances

The 2012 REUS asked respondents to indicate how many showerheads, low flow showerheads, water heater blankets, instant hot water dispensers, and bathroom and kitchen aerators are installed in their home. The results, expressed in terms of penetration and saturation rates, are summarized in Table 112.

**Table 112: Hot Water Appliances by Region (%)**

| Hot Water Appliance | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| Unweighted base | *793* | *1707* | *752* | *85* | *104* | *3441* | *2187* | *2604* | *1423* | *1610* |
| **Showerheads** | | | | | | | | | | |
| Penetration (%) | 98.4 | 98.1 | 98.4 | 97.6 | 99.0 | 98.3 | 99.4 | 98.3 | 99.4 | 98.6 |
| Saturation | 2.23 | 2.01 | 2.05 | 2.57 | 1.84 | 2.15 | 2.15 | 2.16 | 2.16 | 1.95 |
| **Low flow showerheads** | | | | | | | | | | |
| Penetration (%) | 37.1 | 43.5 | 43.0 | 35.7 | 28.8 | 39.4 | 46.9 | 39.0 | 46.4 | 61.6 |
| Saturation | 0.69 | 0.80 | 0.82 | 0.68 | 0.53 | 0.74 | 0.85 | 0.73 | 0.84 | 1.08 |
| **Water heater blankets** | | | | | | | | | | |
| Penetration (%) | 5.2 | 6.8 | 5.1 | 3.6 | 0.9 | 5.6 | 6.4 | 5.7 | 6.1 | 15.2 |
| Saturation | 0.06 | 0.07 | 0.06 | 0.05 | 0.03 | 0.06 | 0.08 | 0.06 | 0.08 | 0.16 |
| **Instant Hot Water Dispensers** | | | | | | | | | | |
| Penetration (%) | 3.2 | 1.9 | 3.3 | 7.1 | 7.6 | 2.8 | n/a | n/a | n/a | n/a |
| Saturation | 0.05 | 0.03 | 0.05 | 0.07 | 0.14 | 0.05 | n/a | n/a | n/a | n/a |
| **Bathroom & Kitchen Aerators** | | | | | | | | | | |
| Penetration (%) | 45.5 | 46.3 | 47.1 | 45.2 | 45.0 | 45.9 | n/a | n/a | n/a | n/a |
| Saturation | 1.46 | 1.35 | 1.45 | 1.49 | 1.42 | 1.43 | n/a | n/a | n/a | n/a |

Data for instant hot water dispensers and aerators were new to the 2012 REUS so no data are available for 2008 or 2002 survey years. Additionally, respondents to the 2002 REUS with more than four showerheads, low flow shower heads, and/or water heater blankets could only indicate this by checking a box labelled “4+”. The 2008 and 2012 surveys did not constrain respondents’ answers. As a result, the 2002 REUS saturation estimates may be understated.

There are no statistically significant differences between survey years for showerhead (any type, including low flow) penetration and saturation. Data on low flow showerheads are provided but are considered to be less reliable than other data as the interpretation of “low flow” showerhead is subjective.[42]

The penetration of water heater blankets has not varied significantly for the past three surveys. The relatively low incidence of water heater blankets is consistent with the gradual replacement of older water heaters with more efficient units. Newer water heaters are built with higher insulation levels and, as a result, the addition of a water heater blanket is not as cost-effective as it was with older units.

The penetration of instant hot water dispensers is low at three percent (3%) of households. Bathroom and kitchen faucet aerators were identified in almost half (46%) of homes. Like that of low flow shower heads, the penetration and saturation rates for aerators are considered less reliable as most new faucets come equipped with aerators. There may also be an awareness issue for some households as to what is an aerator.

[42] The other issue confounding the interpretation of what is a low flow showerhead is that the volume of new and replacement showerheads has been declining over time, effectively altering what constitutes a low flow model.

### 7.7.1 Drain Water Heat Recovery Systems

Three percent (3%) of REUS 2012 respondents indicated their home has a drain water heat recovery (DWHR) system (Table 113). These systems typically use small diameter copper piping wrapped around the main or most used drain pipe to capture heat from activities requiring hot water (e.g., baths, showers, dishwashing, etc.). The re-captured heat is then used to reduce the energy needed by DWH water. As these systems are relatively new, the 2012 REUS questionnaire included both a photograph and brief description to aid the respondents.

The incidence of DWHR is highest in the Lower Mainland (4%) and lowest in Fort Nelson (1%). A significant proportion of respondents were uncertain (18%) as to whether their home has such a system.

**Table 113: Drain Water Heat Recovery Systems by Region (%)**

| Drain Water HR? | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *718* | *1562* | *708* | *80* | *97* | *3165* |
| Yes | 3.9 | 1.9 | 2.3 | 1.3 | 1.0 | 3.1 |
| No | 76.9 | 83.6 | 81.9 | 89.9 | 77.6 | 79.3 |
| DK | 19.2 | 14.5 | 15.8 | 8.9 | 21.3 | 17.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

# 8 FIREPLACES AND HEATER STOVES

This section summarizes data on the penetration, saturation, and use of fireplaces and heater stoves. Up to seven fireplace and heater stove types were queried in the 2012 REUS. They included:

- Gas (decorative)
- Gas (heater type)
- Gas (free standing)
- Electric
- Wood burning fireplace
- Wood burning stoves
- Other

To assist respondents in correctly identifying the type(s) of fireplaces and heater stoves in their home, the survey questionnaire included the following descriptions:

- **Decorative fireplaces** – Provide ambiance but have little or no heating ability. The firebox is typically steel or masonry, and the hearth is often open to the room or equipped with opening glass doors.
- **Heater type fireplaces (built-ins and inserts)** – These fireplaces are efficient heaters with fixed glass fronts and may have features such as fans and thermostatic control. They may be built-in at the time of construction, or inserted into an existing masonry or other fireplace as an upgrade.
- **Free standing fireplaces and heater stoves** – These are stand-alone units that that can be used for both ambiance and heating. Gas heater stoves resemble wood stoves in appearance but use gas instead of wood.

The same fireplace and heater stove types were queried in the 2008 REUS.

## 8.1 Penetration and Saturation – Any Fuel

Past REUS studies based the penetration and saturation of fireplaces and heater stoves on only households with a fireplace or heater stove. Penetration and saturation statistics for fireplaces and heater stoves in the 2012 REUS are now calculated using the total population regardless of whether or not they have a fireplace or heater stove. This places penetration and saturation data on a basis comparable to other end-uses discussed and analyzed in this report. Data for fireplaces and heater stoves from the 2008 REUS survey were restated to ensure consistency.[43]

Table 114 (next page) summarizes the penetration and saturation rates for all fireplaces and heater stoves regardless of type or fuel. Overall, over four-in-five (84%) of FEU residential customers have at least one fireplace or heater stove, statistically unchanged from 2008. Regional data show that penetration is highest in Whistler (100% of respondents), followed by Vancouver Island (89%), and the Lower Mainland (88%).

[43] As a result, penetration and saturation rates for fireplaces and heater stoves for 2008 will differ from those reported in the 2008 REUS report.

# Fireplaces and Heater Stoves

**Table 114: Fireplaces and Heater Stoves by Region**
**Any Type, Any Fuel**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | 783 | 1684 | 732 | 84 | 101 | 3384 | 2167 | *2568* | 1960 | 1610 |
| Penetration (%) | 87.7 | 72.4 | 89.1 | 100.0 | 56.0 | 83.7 | 84.8 | 83.0 | 84.5 | 81.0 |
| Saturation | 1.65 | 1.44 | 1.44 | 1.36 | 1.23 | 1.58 | 1.52 | 1.60 | 1.50 | 1.31 |

Table 115 summarizes the penetration and saturation of fireplaces and heater stoves (any type, any fuel) by dwelling type. With the exception of mobile homes for which only one-third reported having a fireplace or heater stove, the penetration rate for all other dwelling types exceeds eight-in-ten (80%) with single family detached dwellings and row houses / townhouses being the most likely to have at least one unit (86%).

**Table 115: Fireplaces and Heater Stoves by Dwelling Type**
**Any Type, Any Fuel**

| | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2750* | *152* | *206* | *53* | *118* | *57* |
| Penetration (%) | 85.0 | 80.1 | 86.3 | 81.5 | 33.0 | 77.5 |
| Saturation | 1.39 | 1.14 | 1.09 | 1.02 | 0.35 | 1.30 |

Table 116 provides detail on the distribution of FEU customers on the basis of the number of fireplaces and heating stoves per dwelling. Sixteen percent (16%) of FEU residential customers do not have a fireplace or heating stove. Regionally, the proportion of customers without this end-use was highest in Fort Nelson (46%).

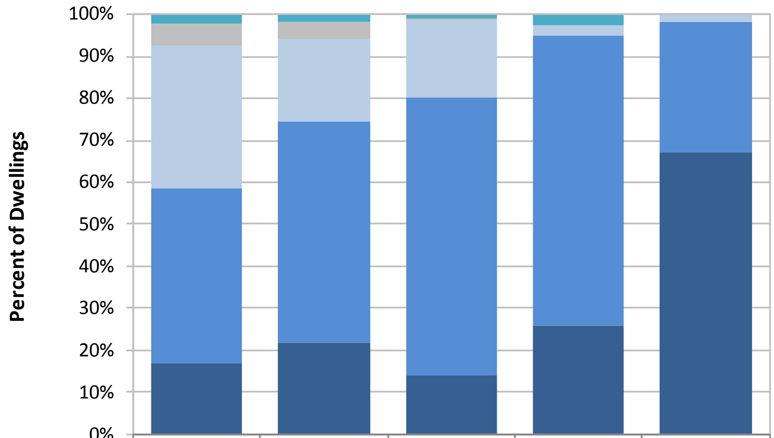
**Table 116: Number of Fireplaces and Heater Stoves per Dwelling by Region (%)**
**Any Type, Any Fuel**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *783* | *1684* | *732* | *84* | *101* | *3384* |
| None | 12.3 | 27.6 | 10.9 | 0.0 | 43.9 | 16.3 |
| 1 unit | 43.2 | 45.0 | 56.7 | 75.3 | 45.3 | 45.2 |
| 2 units | 36.5 | 22.9 | 26.7 | 16.0 | 9.8 | 31.7 |
| 3 units | 5.7 | 3.5 | 4.4 | 3.7 | -- | 4.9 |
| More than 3 units | 2.3 | 1.0 | 1.2 | 4.9 | 1.0 | 1.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding

Figure 26 (next page) summarizes the number of fireplaces and heater stoves by dwelling type. The data show that four-in-ten (42%) of single family detached dwellings have only one fireplace or heater stove, while over three-in-ten (34%) have two, and under one-in-ten (8%) have three or more units. By comparison approximately two-thirds of row / townhouses (66%) and apartments / condominiums (69%) have only one unit.

**Figure 26: Number of Fireplaces / Heater Stoves by Dwelling Type**




| | SFD | Dup | RH/TH | Apt/Condo | Mobile |
|---|---|---|---|---|---|
| >3 | 2.0 | 1.9 | 0.9 | 2.6 | 0.0 |
| 3 | 5.5 | 3.9 | 0.4 | 0.0 | 0.0 |
| 2 | 33.8 | 19.8 | 18.3 | 2.6 | 1.6 |
| 1 | 41.7 | 52.6 | 66.3 | 69.1 | 31.4 |
| None | 16.9 | 21.8 | 14.0 | 25.7 | 67.0 |

## 8.2 Penetration and Saturation – by Fuel

Penetration and saturation rates for gas fireplaces and heater stoves are summarized in Table 117. The data show that over four-in-ten (43%) FEU homes have heater type gas fireplaces, statistically unchanged from 2008. Decorative gas fireplaces are present in one-in-five (19%) of homes. Finally, less than one-in-ten (7%) of homes reported having a free standing gas model. Regionally, dwellings in Vancouver Island and Whistler have the highest penetration of heater type units (60% and 59% of homes respectively). In both regions one-in-ten use their fireplaces as the primary heat source. Older, gas decorative models are most common in the Lower Mainland (23%).

**Table 117: Gas Fireplace and Heater Stove Details by Region**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *783* | *1684* | *732* | *84* | *101* | *3384* | *2167* |
| **Gas (decorative)** | | | | | | | |
| Penetration (%) | 23.0 | 12.8 | 12.0 | 10.8 | 8.8 | 19.0 | 18.3 |
| Saturation | 0.30 | 0.15 | 0.14 | 0.16 | 0.10 | 0.24 | 0.35 |
| **Gas (heater type)** | | | | | | | |
| Penetration (%) | 44.2 | 34.2 | 60.4 | 59.0 | 21.9 | 43.2 | 42.5 |
| Saturation | 0.59 | 0.42 | 0.71 | 0.73 | 0.23 | 0.56 | 0.61 |
| **Gas (free standing)** | | | | | | | |
| Penetration (%) | 5.6 | 7.2 | 12.4 | 8.4 | 4.9 | 6.8 | 6.0 |
| Saturation | 0.07 | 0.08 | 0.14 | 0.10 | 0.05 | 0.08 | 0.08 |

Table 118 (next page) presents gas fireplace and heater stove penetration and saturation rates by dwelling type. For gas units, decorative fireplaces are most common among row houses/townhouses

(32%), followed by duplexes (25%) and single family dwellings (18%). Conversely, heater type gas fireplaces are most common in apartments / condominiums (61%).

**Table 118: Gas Fireplace and Heater Stove Details by Dwelling Type**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2750* | *152* | *206* | *53* | *118* | *57* |
| **Gas (decorative)** | | | | | | |
| Penetration (%) | 17.8 | 24.9 | 32.2 | 18.9 | 0.0* | 16.5 |
| Saturation | 0.23 | 0.30 | 0.35 | 0.19 | -- | 0.30 |
| **Gas (heater type)** | | | | | | |
| Penetration (%) | 44.3 | 42.4 | 40.1 | 61.4 | 9.4 | 38.9 |
| Saturation | 0.58 | 0.52 | 0.45 | 0.64 | 0.10 | 0.54 |
| **Gas (free standing)** | | | | | | |
| Penetration (%) | 7.6 | 5.2 | 1.4 | 5.6 | 6.4 | 2.2 |
| Saturation | 0.09 | 0.06 | 0.01 | 0.08 | 0.06 | 0.02 |

* Value less than 0.01

Table 119 presents penetration and saturation rates of gas fireplaces by dwelling vintage. The data show that gas heater type fireplaces are more common in newer dwellings. For example, heater type fireplaces are present in approximately one-third (31%) of homes built before 1950 and two-thirds (67%) of homes constructed since 2005. Conversely, the popularity (penetration) of decorative gas fireplaces is declining from 34% for dwellings constructed during 1986-95 to 15% for those constructed since 2005. These data reflect both new construction trends and retrofits to existing dwellings.

**Table 119: Gas Fireplace and Heater Stove Details by Dwelling Vintage**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Year Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base*[1] | 350 | 919 | 576 | 664 | 586 | 238 | 46 |
| **Gas (decorative)** | | | | | | | |
| Penetration (%) | 8.4 | 12.1 | 12.6 | 33.6 | 26.4 | 15.0 | 12.7 |
| Saturation | 0.08 | 0.15 | 0.15 | 0.44 | 0.32 | 0.20 | 0.30 |
| **Gas (heater type)** | | | | | | | |
| Penetration (%) | 30.6 | 33.2 | 40.4 | 47.4 | 61.0 | 66.9 | 13.7 |
| Saturation | 0.38 | 0.41 | 0.48 | 0.63 | 0.85 | 0.84 | 0.30 |
| **Gas (free standing)** | | | | | | | |
| Penetration (%) | 6.6 | 7.6 | 7.5 | 5.5 | 6.2 | 5.6 | 15.9 |
| Saturation | 0.07 | 0.08 | 0.09 | 0.06 | 0.07 | 0.07 | 0.37 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Table 120 (next page) summarizes penetration and saturation rates for fireplaces and heater stoves that use fuels other than natural gas. Wood burning fireplaces are the most common non-gas type, present in over one-in-five (22%) of FEU homes in 2012, with penetration of wood fireplaces highest in the Lower Mainland (27%). After wood fireplaces, the next most common non-gas fireplace or heater stove types are electric units (8% of homes) and wood stoves (5%). There has been a statistically significant increase in the penetration and saturation of electric fireplaces since 2008.

**Table 120: Fireplace and Heater Stove Details by Region – Fuels Other Than Natural Gas**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *783* | *1684* | *732* | *84* | *101* | *3384* | *2167* |
| **Electric** | | | | | | | |
| Penetration (%) | 7.5 | 9.9 | 6.7 | 1.2 | 13.7 | 8.1 | 5.6 |
| Saturation | 0.10 | 0.11 | 0.10 | 0.01 | 0.14 | 0.10 | 0.08 |
| **Wood burning fireplace** | | | | | | | |
| Penetration (%) | 26.7 | 16.1 | 11.5 | 22.9 | 12.7 | 22.2 | 24.0 |
| Saturation | 0.34 | 0.19 | 0.14 | 0.25 | 0.13 | 0.28 | 0.33 |
| **Wood burning stove** | | | | | | | |
| Penetration (%) | 3.8 | 7.8 | 4.4 | 9.6 | 4.9 | 5.0 | 4.7 |
| Saturation | 0.04 | 0.08 | 0.05 | 0.11 | 0.05 | 0.05 | 0.06 |
| **Other** | | | | | | | |
| Penetration (%) | 0.6 | 1.2 | 0.7 | -- | -- | 0.8 | 0.6 |
| Saturation | 0.01 | 0.01 | 0.01 | -- | -- | 0.01 | 0.00* |

* Value less than 0.01

Dwelling type specific data for fireplaces and heater stoves using fuels other than natural gas are provided in Table 121. Among non-gas fireplaces and heater stoves, single family detached dwellings are most likely to have a wood burning fireplace (25% of all SFDs), followed by other (18%), and duplexes (13%). Electric fireplaces are notable in their penetration in row/townhouses (14%) and mobile homes (13%). The absence of a venting requirement and portability has made them an attractive choice.

**Table 121: Fireplace and Heater Stove Details by Dwelling Type – Fuels Other Than Natural Gas**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2750* | *152* | *206* | *53* | *118* | *57* |
| **Electric** | | | | | | |
| Penetration (%) | 7.4 | 8.1 | 14.3 | 4.3 | 13.1 | 7.1 |
| Saturation | 0.09 | 0.09 | 0.19 | 0.04 | 0.14 | 0.07 |
| **Wood burning fireplace** | | | | | | |
| Penetration (%) | 25.0 | 12.5 | 7.8 | 1.4 | 1.6 | 17.7 |
| Saturation | 0.31 | 0.14 | 0.08 | 0.01 | 0.02 | 0.33 |
| **Wood burning stove** | | | | | | |
| Penetration (%) | 5.9 | 2.2 | 0.0* | 1.4 | 1.7 | 3.3 |
| Saturation | 0.06 | 0.02 | -- | 0.01 | 0.02 | 0.03 |
| **Other** | | | | | | |
| Penetration (%) | 0.9 | 0.3 | 0.2 | 1.4 | 0.8 | -- |
| Saturation | 0.01 | 0.00* | 0.00* | 0.03 | 0.01 | -- |

* Value less than 0.01

Finally, penetration and saturation rates for non-gas fireplaces and heater stoves by dwelling vintage are summarized in Table 122 (next page). The data show a decline in penetration of wood burning fireplaces, driven by municipal by-laws, and heater stoves (present in only 1% to 2% of homes built since 2005) and a jump in the penetration of electric fireplaces (18% of homes built since 2005).

**Table 122: Fireplace and Heater Stove Details by Dwelling Vintage – Fuels other than Natural Gas**
**Base includes all households with and without a fireplace or heater stove**

| Fireplace / Heater Stove Type | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Year Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | 350 | 919 | 576 | 664 | 586 | 238 | 46 |
| **Electric** | | | | | | | |
| Penetration (%) | 11.6 | 5.7 | 6.9 | 7.7 | 8.1 | 17.8 | 8.3 |
| Saturation | 0.17 | 0.07 | 0.08 | 0.09 | 0.10 | 0.24 | 0.25 |
| **Wood burning fireplace** | | | | | | | |
| Penetration (%) | 30.5 | 35.8 | 31.7 | 11.8 | 3.6 | 1.7 | 24.3 |
| Saturation | 0.36 | 0.45 | 0.40 | 0.15 | 0.05 | 0.02 | 0.45 |
| **Wood burning stove** | | | | | | | |
| Penetration (%) | 4.8 | 7.7 | 6.4 | 3.6 | 2.4 | 1.3 | 8.5 |
| Saturation | 0.05 | 0.08 | 0.07 | 0.04 | 0.02 | 0.02 | 0.24 |
| **Other** | | | | | | | |
| Penetration (%) | 1.2 | 1.3 | 1.3 | 0.2 | 0.3 | 0.3 | -- |
| Saturation | 0.01 | 0.01 | 0.02 | 0.00 | 0.00 | 0.01 | -- |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

## 8.3 Gas Fireplaces - Ages and Features

Respondents with gas fireplaces were asked to indicate the ages of their fireplaces and whether the fireplaces had a fixed glass front, glass doors that open, or an open hearth (no glass). These data help assess the efficiency level of the fireplace unit, with newer, more efficient units having fixed glass fronts.

Data on the age of the first gas fireplace are summarized in Table 123. The average (mean) age of gas fireplaces for FEU customers is 13 years. Only slight differences in mean age between regions are observed, with fireplaces in Whistler and Vancouver Island tending to be younger (11 years on average for both) and fireplaces in Lower Mainland tending to be somewhat older (13 years).

**Table 123: Age of First Gas Fireplace (Years)**

| Age of Gas Fireplace (years) | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *429* | *693* | *455* | *49* | *24* | *1650* |
| Mean | 13.4 | 12.9 | 11.4 | 11.2 | 12.4 | 13.0 |
| Standard deviation | 12.3 | 5.2 | 4.0 | 1.6 | 1.6 | 7.4 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Age statistics for second gas fireplaces are provided in Table 124. Samples are smaller due to the lower incidence of homes with second gas fireplaces or heater stoves so caution is advised when making regional comparisons. Overall, the average age of the second gas fireplace is 14 years.

**Table 124: Age of Second Gas Fireplace (Years)**

| Age of Gas Fireplace (years) | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *153* | *163* | *107* | *12* | *3* | *438* |
| Mean | 14.5 | 12.8 | 12.1 | 11.7 | 16.0 | 14.0 |
| Standard deviation | 12.1 | 5.2 | 4.0 | 2.0 | 0.3 | 8.1 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Of the three possible designs for gas fireplaces, three-quarters (76%) of fireplaces have a fixed glass front, significantly higher than fireplaces with glass doors that open (16%) , and open hearth models (8%). As suggested by their design, these latter two types are older, less efficient units. These data are summarized in Table 125.

**Table 125: Gas Fireplace Characteristics by Region**
**Percent of All Gas Fireplaces[1]**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| Fixed glass front | 72.3 | 79.7 | 89.8 | 86.7 | 93.2 | 76.2 |
| Glass doors that open | 16.2 | 16.8 | 10.1 | 8.3 | 6.8 | 15.5 |
| No glass (open hearth) | 11.5 | 3.4 | 0.2 | 5.0 | -- | 8.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Includes homes with more than one gas fireplace
Totals may not sum due to rounding

## 8.4 Usage Behaviours

Household use of fireplaces and heater stoves was explored in the 2012 REUS from a number of perspectives including weekly hours-of-use by season, role (heating, ambiance, or combination of heating and ambiance), and contribution to the home's space heating load.

### 8.4.1 Hours-of-Operation

Average weekly hours-of-use for fireplaces and heater stoves by season and region are summarized in Table 126, with comparisons to 2008 and 2002. The data are consistent with past surveys and show that usage is highest during the fall and winter and lowest during the spring and summer. Winter usage averages 18 hours per week and fall usage averages 14 hours per week. Compared to 2008, fall usage is higher while winter and spring usage estimates are lower. Overall, average operating hours for fireplaces and heater stoves is 472 hours per year, statistically unchanged from 2008 (460).

**Table 126: Weekly Average Hours of Fireplace / Heater Stove Operation by Region**

| Season [1] | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *673* | *1177* | *634* | *82* | *56* | *2622* | *2167* | *1906* | *1960* | *1259* |
| Summer | 0.2 | 0.7 | 0.3 | 0.4 | 0.9 | 0.3 | 0.3 | 0.3 | 0.3 | 0.6 |
| Fall | 11.8 | 16.1 | 20.9 | 15.7 | 25.2 | 13.8 | 7.6 | 12.9 | 7.3 | 10.1 |
| Winter | 15.0 | 21.6 | 26.0 | 31.8 | 33.6 | 17.9 | 20.1 | 16.8 | 20.1 | 20.8 |
| Spring | 3.6 | 4.3 | 8.5 | 7.0 | 6.6 | 4.3 | 7.4 | 3.7 | 7.0 | 9.3 |
| **Annual Average Hours [2]** | **397** | **555** | **725** | **713** | **862** | **472** | **460** | **439** | **451** | **530** |

[1] Assumes each season is 13 weeks long.
[2] Average hours of operation per year

Regionally, customers in Fort Nelson have the highest average annual operating hours (862 hours), followed by Vancouver Island (725), and Whistler (713). Lower Mainland homes with fireplaces or heater stoves used them the least (397 hours).

Respondents to the 2012 REUS were not asked to provide hours-of-use estimates for individual fireplaces or heater stove types because the request it was considered onerous, particularly for homes with more than one fireplace or heater stove. However, over three-quarters (77%) of all dwellings with a fireplace or heater stove in the 2012 REUS survey have only one unit, implying the hours of operation, by season, for these dwellings can be solely attributable to one particular type of fireplace or heater stove. Data for this subset of households are summarized in Table 127.

**Table 127: Average Weekly Hours of Fireplace / Heater Stove Operation by Fireplace Type Dwellings with only one fireplace or heater stove**

| Fireplace Type [1] | Summer | Fall | Winter | Spring | Annual Average Hours [2] |
|---|---|---|---|---|---|
| Gas (decorative) | 0.2 | 6.8 | 10.5 | 1.5 | 248 |
| Gas (heater type) | 0.4 | 16.9 | 21.5 | 6.5 | 590 |
| Gas (free standing) | 0.3 | 26.3 | 32.5 | 6.7 | 855 |
| Electric | 0.3 | 10.9 | 13.9 | 2.5 | 358 |
| Wood burning fireplace | 0.0 | 7.4 | 9.0 | 0.9 | 225 |
| Wood burning stove | 0.4 | 31.0 | 41.0 | 4.9 | 1004 |
| Other | 0.0 | 19.2 | 34.8 | 13.4 | 877 |

[1] Dwellings with only one of any fireplace / heater stove type (n=2016)
[2] Annual hours of operation

As expected, wood stoves are used the most, averaging 1,004 hours per year, followed by free standing gas heater stoves at 855 hours per year. Gas heater type fireplaces are used 590 hours per year and decorative gas fireplaces, consistent with a design oriented to ambiance rather than heating, are used 248 hours per year. As a reminder, these data are only for dwellings with only one fireplace or heating stove. Operating hours for homes with more than one fireplace or heater stove type will likely be higher.

### 8.4.2 Fireplace and Heater Stoves - Uses

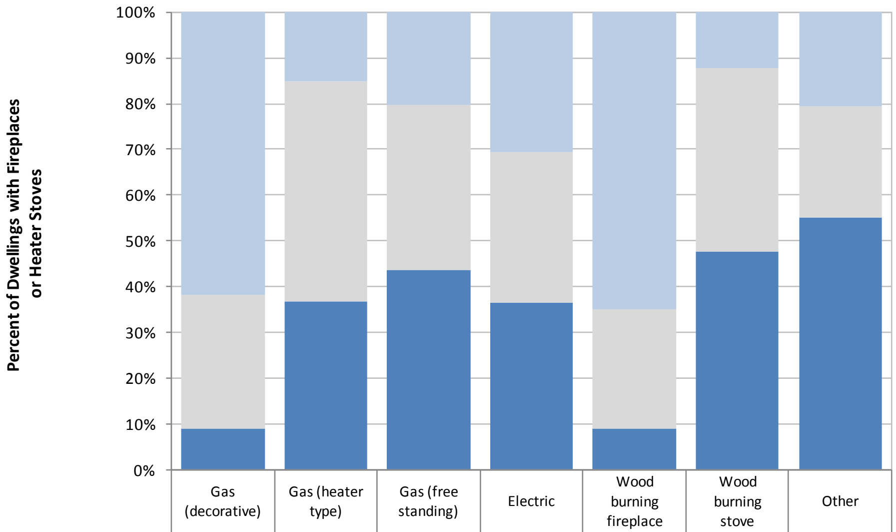
Fireplaces and heater stoves can be used to provide heat, ambiance, and for many of these units, a combination of heating and ambiance. For each fireplace or heater stove type, respondents to the 2012 REUS were asked to indicate the unit's primary purpose. The results, by fireplace / heater stove type are summarized in Figure 27 (next page).

For gas units, heater type fireplaces and stand-alone units are used considerably more for space heating (85% heating or heating and ambiance for gas heater type fireplaces, and 80% for stand-alone gas units) than the traditional decorative gas fireplaces (38%). Wood burning fireplaces are used very little for heating (35%). Wood burning stoves, in contrast, are specifically designed for space heating and the data confirm they are used for that purpose (88%).

The 2012 REUS asked households with a fireplace or heater stove to estimate the contribution of their fireplace or heater stove to their dwelling's space heating requirements. Answering this question was expected to be challenging for respondents with more than one space heating method, so the response categories were selected to improve response rates while explicitly acknowledging that precise estimates are not reasonable given the challenging nature of the question.

- 0% (none)
- Up to 10%
- Up to 25%
- Up to 50%
- Up to 75%
- Up to 100%

**Figure 27: Primary Purpose of Fireplaces and Heater Stoves**




| | Gas (decorative) | Gas (heater type) | Gas (free standing) | Electric | Wood burning fireplace | Wood burning stove | Other |
|---|---|---|---|---|---|---|---|
| Ambiance | 61.9 | 15.1 | 20.2 | 30.6 | 65.0 | 12.1 | 20.4 |
| Heating & Ambiance | 29.3 | 48.1 | 36.1 | 32.9 | 26.1 | 40.2 | 24.5 |
| Heating | 8.8 | 36.8 | 43.7 | 36.5 | 8.9 | 47.6 | 55.1 |

Table 128 summarizes the results for this question. One-third (33%) of FEU gas customers with a fireplace or heater stove indicated the unit(s) do not contribute to their home's heating requirements. A further third (31%) indicated their fireplace or heater stove contributed as much as ten percent (10%) of their home's space heating load, while one-in-six (16%) indicated it was as much as 25% percent. Smaller numbers of respondents indicated the contribution to space heating was higher than this. However, one-in-six (15%) of REUS respondents with a fireplace or heater stove indicated their unit(s) met anywhere from one-half to their dwelling's entire space heating load.

**Table 128: Fireplace and Heater Stove Contribution to Space Heating Load by Region (%)**

| Share of Space Heating Load | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *686* | *1202* | *646* | *83* | *56* | *2673* |
| 0% | 37.5 | 29.2 | 17.5 | 13.4 | 27.9 | 33.2 |
| Up to 10% | 30.3 | 33.4 | 29.4 | 30.5 | 27.9 | 30.9 |
| Up to 25% | 14.4 | 16.7 | 24.1 | 19.5 | 26.2 | 16.1 |
| Up to 50% | 6.1 | 8.9 | 11.1 | 17.1 | 7.0 | 7.4 |
| Up to 75% | 3.4 | 4.2 | 7.6 | 8.5 | 4.1 | 4.1 |
| Up to 100% | 2.6 | 3.2 | 6.0 | 9.8 | 5.2 | 3.2 |
| DK | 5.7 | 4.4 | 4.2 | 1.2 | 1.7 | 5.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding

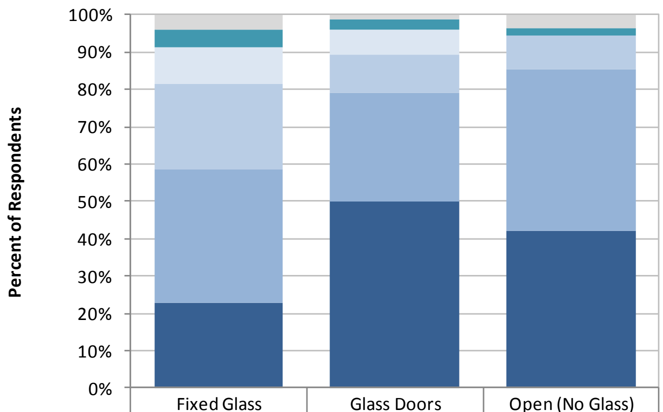
Regional differences are apparent and consistent with other data on fireplaces and heater stoves collected in the 2012 REUS. For example, Vancouver Island and Whistler households were most likely to indicate their units contributed to their home's space heating load and to indicate contributions of up to 50% or more. Lower Mainland customers were the most likely to indicate no contribution to space heating at all (38%), but the proportion of customers in this region with contributions of up to 10% and

25% were comparable to those in the Interior. The proportion of respondents that could not answer the question averaged one-in-twenty.

This question was not asked in previous REUS surveys so comparisons with past data are not possible.

Figure 28 explores the relationship between the design of gas fireplaces and heater stoves and their use to provide heat to the home. While the presence of a fixed glass front does not ensure the fireplace is energy-efficient, these units are more likely to be used to provide heat compared to those with opening glass doors or no glass (open).

**Figure 28: Contribution to Space Heating by Gas Fireplace Type**

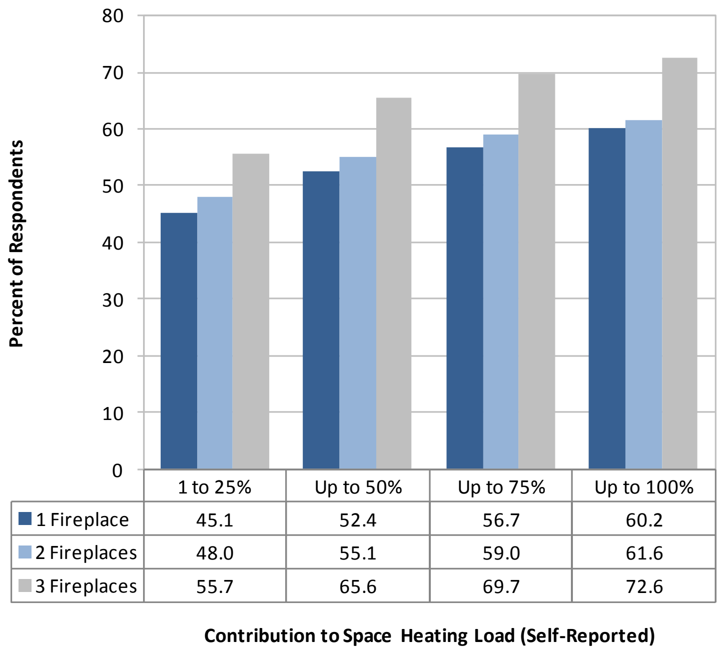



| | Fixed Glass | Glass Doors | Open (No Glass) |
|---|---|---|---|
| Up to 100% | 3.6 | 1.3 | 3.4 |
| Up to 75% | 4.5 | 2.6 | 1.9 |
| Up to 50% | 9.4 | 6.3 | 0.0 |
| Up to 25% | 21.6 | 9.9 | 8.4 |
| Up to 10% | 33.8 | 28.3 | 40.2 |
| 0% | 21.4 | 47.9 | 38.9 |

It is reasonable to expect that as the number of fireplaces or heater stoves within a home increases, their overall contribution to space heating would increase. To explore the validity of this hypothesis, data on the number of fireplaces and heater stoves per home (any fuel) were compared to respondents' assessments of their contribution to space heating. The results, visually summarized in Figure 29 (next page), suggests that there is very little difference in the contribution made to space heating between homes with one fireplace or heater stove versus those with two units.

There are two possible explanations for this result. The first is that homes with two fireplaces and/or heater stoves split the contribution to space heating relatively equally between the two units. The second explanation is that one of the two units is used more than the other. This could be because one unit is more suited to space heating than the other or because one of the two units is located in a room or area of the home that is used relatively more than where the other unit is located. While representing considerably fewer homes, the presence of three gas fireplaces / heater stoves results in a modest increase in contribution to space heating load. Clearly, the relationship between the number of gas fireplaces and heating stoves in the home, and the contribution to space heating load, is not linear.

**Figure 29: Contribution to Space Heating by Number of Fireplaces / Heater Stoves**




Data on the contribution of fireplaces and heater stoves to space heating requirements were explored by dwelling type. These data are summarized in Table 129. They show that the proportion of homes that indicated their fireplace contributes up to 50% of their space heating requirements does not vary greatly between the dwelling types. However, apartment dwellers are more likely to say their fireplace contributes up to 100% of their space heating. This latter outcome is consistent with the findings of the 2008 REUS which showed that fireplaces and heater stoves play an important role in space heating for apartments / condominiums and, to a lesser extent, row and townhouses.[44]

**Table 129: Fireplace and Heater Stove Details by Dwelling Type (%)**

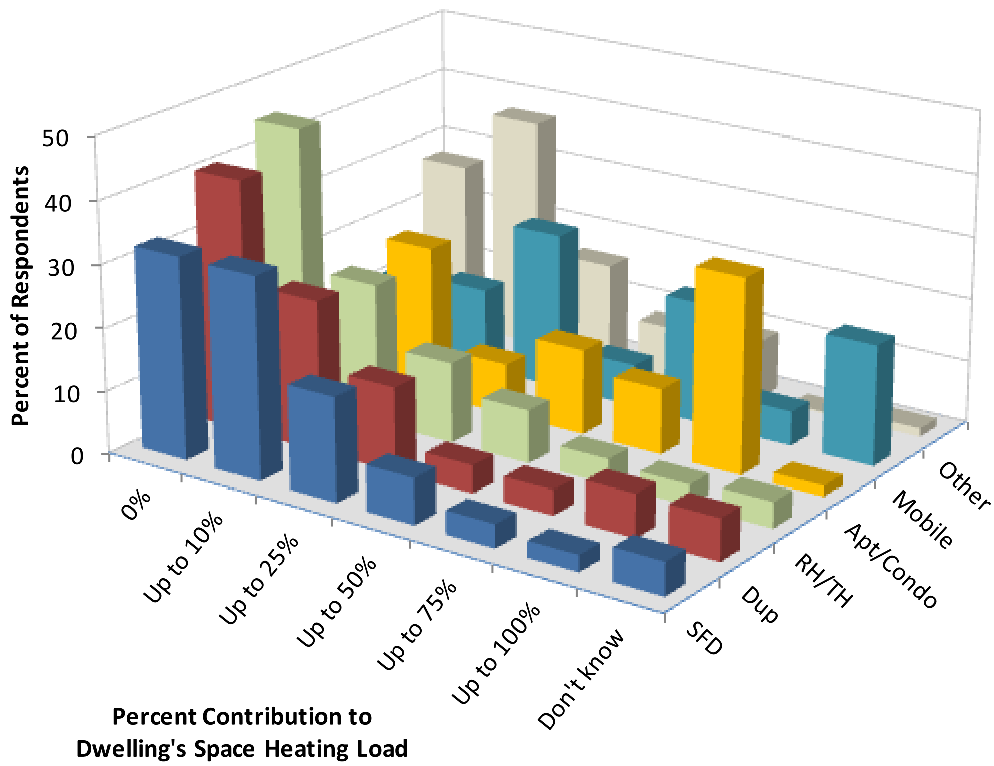
| Share of Space Heating Load | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *2227* | *109* | *170* | *44* | *45* | *38* |
| 0% | 32.2 | 40.3 | 44.7 | 10.5 | 10.7 | 27.4 |
| Up to 10% | 32.1 | 24.0 | 22.3 | 24.2 | 13.1 | 37.3 |
| Up to 25% | 16.6 | 13.5 | 12.9 | 8.3 | 25.1 | 16.0 |
| Up to 50% | 7.4 | 4.5 | 8.5 | 13.7 | 6.8 | 8.1 |
| Up to 75% | 3.8 | 4.1 | 4.0 | 10.5 | 19.4 | 9.5 |
| Up to 100% | 2.6 | 6.9 | 3.4 | 31.1 | 5.5 | 0.3 |
| DK | 5.3 | 6.7 | 4.1 | 1.8 | 19.3 | 1.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding

[44] The 2008 REUS found that 28% of vertical subdivision homes (apartments) considered their gas fireplace as their primary method of space heating. Another 39% indicated the fireplace was their second most used method of space heating. Source: Sampson Research (2008), pp 5-6 to 5-9.

Figure 30 visually compares the contribution of fireplaces and heater stoves to space heating load of the different dwelling types.

**Figure 30: Fireplace and Heater Stove Contribution to Space Heating Load by Dwelling Type**




### 8.5 Pilot Lights

Over nine-in-ten (93%) of respondents with either one or two gas fireplaces indicated the fireplaces have a pilot light (Table 130). Approximately two to three percent did not know whether their fireplace had a pilot light.

**Table 130: Percent of Gas Fireplaces with a Pilot Light by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| First fireplace | 91.5 | 93.8 | 96.7 | 98.3 | 96.6 | 92.7 |
| Second fireplace | 91.9 | 93.1 | 96.8 | 84.6 | 100.0 | 92.6 |
| Third fireplace | 87.1 | 82.4 | 90.9 | 75.1 | -- | 86.8 |

Seven-in-ten (68%) of households with a gas fireplace equipped with a pilot light indicated they turned off the pilot light at least one month during the year (Table 131, next page). This compares to six-in-ten (61%) who reported this behaviour in the 2008 REUS. Regionally, FEU customers in the Fort Nelson (small sample) and Lower Mainland are the least likely to turn off their pilot lights (56% and 65% respectively), while Interior and Vancouver Island customers are most likely (74% and 73% respectively). Including those who do not turn off their fireplace pilot light, the pilot lights for fireplaces are turned off an average of 4.2

months per year. For just those households who turn off their pilot lights, the lights are turned off an average of 6.5 months per year. The latter value is significantly lower than that calculated from the 2008 REUS. There are slight differences in question structure and wording between the two surveys so this may explain some the difference. Regardless, caution is advised in attributing the decrease to changes in household behaviour.

**Table 131: Gas Fireplace Pilot Light Behaviours by Region (%)**

| Gas Fireplace Pilot Light Usage | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| Unweighted base [1] | 466 | 772 | 532 | 61 | 27 | 1858 | 1314 |
| Never turn off (%) | 34.6 | 25.0 | 26.3 | 32.8 | 43.6 | 31.4 | 28.2 |
| Turn off, one or more months per year (%) | 64.8 | 74.2 | 73.0 | 67.2 | 56.4 | 67.9 | 60.7 |
| Average # of months turned off (All fireplaces with pilots) | 3.9 | 4.9 | 4.2 | 3.7 | 3.4 | 4.2 | 4.7 |
| Average # of months turned off (Fireplaces turned off at least one month) | 6.5 | 6.8 | 5.8 | 5.7 | 6.3 | 6.5 | 8.5 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Lighting a pilot light on a gas fireplace, furnace or hot water tank can be intimidating for some households. The 2012 REUS asked respondents with fireplaces that have a pilot light who typically relights the pilot light. Table 132 summarizes whether it is the survey respondent, another member in the household, contractor, or someone else.

**Table 132: Who Typically Lights the Fireplace Pilot Light by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *297* | *561* | *379* | *39* | *16* | *1292* |
| Myself | 81.5 | 80.6 | 80.7 | 76.9 | 62.5 | 81.1 |
| Contractor | 1.7 | 4.6 | 5.3 | 2.6 | 12.5 | 2.9 |
| Other member of the household | 13.1 | 10.3 | 9.5 | 18.0 | 25.0 | 12.0 |
| Other | 3.0 | 4.3 | 4.2 | 2.6 | -- | 3.5 |
| DK | 0.7 | 0.2 | 0.3 | -- | -- | 0.5 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
Totals may not sum due to rounding

Eighty-one percent (81%) of respondents indicated they did it themselves, while another 12% indicated someone else in the household relit the pilot light. Only three percent indicated they use a contractor.

# 9 APPLIANCES

Respondents to the 2012 REUS were provided with a list of cooking, refrigeration, cleaning, space heating, and space cooling appliances, and asked to indicate the number (quantity), and ages for each present in the home. The list of appliances queried in the 2012 survey is more extensive than the 2008 and 2002 surveys, so a multi-year analysis of penetration and saturation trends is not possible for all appliances.

## 9.1 Cooking Appliances

Penetration and saturation rates for cooking appliances are summarized in Table 133.

**Table 133: Penetration and Saturation of Cooking and Related Appliances by Region**

| Cooking Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2213* | *2604* | *1439* | *1610* |
| **Electric range (cook top & oven)** | | | | | | | | | | |
| Penetration (%) | 67.6 | 74.9 | 69.3 | 50.0 | 73.4 | 69.7 | 75.5 | 69.8 | 76.1 | 81.8 |
| Saturation | 0.77 | 0.82 | 0.76 | 0.55 | 0.77 | 0.78 | 0.86 | 0.79 | 0.87 | 0.92 |
| **Gas range (cook top & oven)** | | | | | | | | | | |
| Penetration (%) | 21.4 | 15.0 | 18.0 | 22.6 | 20.9 | 19.3 | 17.6 | 19.5 | 16.8 | 15.7 |
| Saturation | 0.23 | 0.16 | 0.18 | 0.23 | 0.21 | 0.21 | 0.19 | 0.21 | 0.19 | 0.17 |
| **Dual fuel range (gas cook top, electric oven)** | | | | | | | | | | |
| Penetration (%) | 5.0 | 3.1 | 4.5 | 19.0 | 2.8 | 4.5 | n/a | 4.4 | n/a | n/a |
| Saturation | 0.05 | 0.03 | 0.05 | 0.19 | 0.03 | 0.05 | n/a | 0.05 | n/a | n/a |
| **Electric cook top** | | | | | | | | | | |
| Penetration (%) | 9.8 | 8.8 | 9.0 | 10.7 | 5.7 | 9.5 | 12.7 | 9.5 | 12.9 | 16.6 |
| Saturation | 0.11 | 0.09 | 0.10 | 0.11 | 0.06 | 0.10 | 0.13 | 0.10 | 0.14 | 0.19 |
| **Gas cook top** | | | | | | | | | | |
| Penetration (%) | 7.1 | 4.8 | 6.9 | 15.5 | 3.8 | 6.4 | 9.6 | 6.4 | 9.6 | 7.0 |
| Saturation | 0.08 | 0.05 | 0.07 | 0.15 | 0.04 | 0.07 | 0.11 | 0.07 | 0.11 | 0.07 |
| **Electric wall oven** | | | | | | | | | | |
| Penetration (%) | 14.9 | 10.1 | 11.7 | 23.8 | 3.8 | 13.3 | 13.5 | 13.4 | 13.6 | n/a |
| Saturation | 0.16 | 0.11 | 0.13 | 0.32 | 0.04 | 0.15 | 0.16 | 0.15 | 0.16 | n/a |
| **Gas wall oven** | | | | | | | | | | |
| Penetration (%) | 0.9 | 0.8 | 1.2 | 1.2 | 0.9 | 0.9 | 2.6 | 0.9 | 2.7 | n/a |
| Saturation | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.04 | 0.01 | 0.04 | n/a |
| **Microwave oven** | | | | | | | | | | |
| Penetration (%) | 82.0 | 83.2 | 82.7 | 82.1 | 72.5 | 82.4 | 86.4 | 82.3 | 86.4 | 92.7 |
| Saturation | 0.93 | 0.91 | 0.91 | 0.92 | 0.81 | 0.92 | 0.98 | 0.92 | 0.98 | 1.01 |
| **Gas barbeque (piped gas) [1]** | | | | | | | | | | |
| Penetration (%) | 16.4 | 24.1 | 25.7 | 45.2 | 15.2 | 19.6 | 15.5 | 18.7 | 14.5 | 9.7 |
| Saturation | 0.17 | 0.24 | 0.26 | 0.46 | 0.16 | 0.20 | 0.16 | 0.19 | 0.15 | 0.10 |
| **Gas barbeque (bottled gas) [2]** | | | | | | | | | | |
| Penetration (%) | 48.0 | 46.6 | 41.6 | 34.5 | 56.0 | 47.0 | 48.8 | 47.6 | 49.6 | 63.0 |
| Saturation | 0.50 | 0.48 | 0.43 | 0.36 | 0.56 | 0.49 | 0.51 | 0.49 | 0.52 | 0.65 |
| **Commercial grade range hood** | | | | | | | | | | |
| Penetration (%) | 15.9 | 15.1 | 17.8 | 20.2 | 16.1 | 15.9 | n/a | 15.7 | n/a | n/a |
| Saturation | 0.17 | 0.16 | 0.18 | 0.20 | 0.16 | 0.17 | n/a | 0.17 | n/a | n/a |

[1] This category was described as "NG barbeque" in the 2002 REUS questionnaire.
[2] This category was described as "propane barbeque" in the 2002 REUS questionnaire.
n/a = appliance not queried

Data from the 2008 REUS survey strongly suggested that some respondents had trouble differentiating between ranges (both cook top and oven) and cook tops and ovens as separate items.[45] The 2012 REUS clarified the category descriptions for ranges to include the words "cook top and oven" next to the category (e.g., "electric range (cook top and oven)" and "gas range (cook top and oven)"). Other changes made to the 2012 survey included the addition of dual fuel ranges consisting of a gas cook top and an electric oven. Despite introducing some inconsistencies with past REUS results, these changes provide a more accurate profile of gas cooking appliances.

Reviewing the 2012 results confirms a number of trends observed in 2008. Notably, the penetration of electric ranges (electric cook top and oven) continues to decline in FEI homes (70% versus 76% in 2008 and 82% in 2002). Electric cook tops are also experiencing a similar decline in popularity, (10% in 2008 versus 17% in 2002). The decline in penetration of electric ranges and electric cook-tops appears to have been a direct result of the increasing popularity of gas ranges (gas cook top and gas oven) which are now present in one-in-five of both FEU and FEI homes.. Dual fuel ranges (gas cook top and an electric oven) are present in 5% of FEU households. While their relatively popularity over time is not known, their inclusion in the 2012 REUS for the first time likely means that some of the decline observed in the penetration of gas cook tops and electric ranges may reflect more accurate classification of the respective appliances.

Other noteworthy findings from the cooking appliance data include:

- continuing decline in the popularity of microwave ovens (currently present in 82% of FEI homes, versus 93% in 2002), and
- continuing growth in the penetration of piped gas barbeques (currently 19% of FEI customers, versus 10% in 2002)

Sixteen percent (16%) of FEU customers indicated they have a commercial grade range hood, a question added to the REUS for the first time in 2012. At first glance, the penetration rate for this appliance is surprisingly high. While home improvement shows, new housing development promotions, and the DIY movement in general have associated the use commercial grade kitchen appliances as the *de rigueur* for premium kitchen design, the result likely overstates the true penetration rate for range hoods with the air flow capacity and designs comparable to those of a commercial kitchen.

### 9.1.1 Cooking Appliances by Dwelling Vintage

To explore how trends in new construction and renovation activity might be influencing the popularity of different cooking appliances, data on the penetration and saturation of cooking and related appliances are summarized by dwelling vintage in Table 134 (next page).

The data show that homes constructed since 1995 are more likely than older homes to have a gas range (cook top and oven) or dual fuel range (gas cook top, electric oven) and commensurately less likely to have an electric range. Finally, the penetration of piped gas barbeques increases with the newness of the home.

[45] A detailed review of the data from the 2008 REUS found some respondents with gas ranges (gas cook top with either a gas or electric oven below) indicated having a both a gas cook top (standalone) and gas range. It was strongly suspected that these respondents did not have a gas cook top in addition to their gas range, but rather were unclear as to which category best represented their cooking appliance.

Smaller samples for some vintages, particularly homes constructed since 2005, mean that some differences in penetration rates between construction periods that appear counterintuitive are not statistically significant (i.e., within the margins of error of the estimates). This is the case with the penetration of gas cook tops for homes constructed since 2005 compared to homes constructed during the previous ten years (7.9% versus 11.9%).

**Table 134: Penetration and Saturation of Cooking and Related Appliances by Dwelling Vintage**

| Cooking Appliances | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Unknown |
|---|---|---|---|---|---|---|---|
| *Unweighted base[1]* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| **Electric range (cook top & oven)** | | | | | | | |
| Penetration (%) | 60.2 | 76.3 | 79.1 | 72.8 | 57.9 | 55.6 | 65.3 |
| Saturation | 0.71 | 0.84 | 0.86 | 0.79 | 0.66 | 0.74 | 0.77 |
| **Gas range (cook top & oven)** | | | | | | | |
| Penetration (%) | 37.8 | 11.5 | 11.4 | 15.6 | 29.4 | 29.9 | 26.4 |
| Saturation | 0.42 | 0.12 | 0.12 | 0.16 | 0.30 | 0.34 | 0.32 |
| **Dual fuel range (gas cook top, electric oven)** | | | | | | | |
| Penetration (%) | 6.9 | 3.7 | 2.9 | 3.3 | 5.5 | 11.2 | 5.2 |
| Saturation | 0.07 | 0.04 | 0.03 | 0.03 | 0.05 | 0.11 | 0.10 |
| **Electric cook top** | | | | | | | |
| Penetration (%) | 2.5 | 11.0 | 8.8 | 9.3 | 8.8 | 11.8 | 27.2 |
| Saturation | 0.03 | 0.12 | 0.09 | 0.10 | 0.09 | 0.16 | 0.32 |
| **Gas cook top** | | | | | | | |
| Penetration (%) | 6.4 | 3.6 | 3.5 | 7.6 | 11.9 | 7.9 | 11.5 |
| Saturation | 0.06 | 0.04 | 0.03 | 0.08 | 0.12 | 0.08 | 0.17 |
| **Electric wall oven** | | | | | | | |
| Penetration (%) | 9.9 | 11.8 | 10.4 | 15.5 | 16.5 | 11.3 | 15.7 |
| Saturation | 0.11 | 0.13 | 0.12 | 0.18 | 0.18 | 0.12 | 0.21 |
| **Gas wall oven** | | | | | | | |
| Penetration (%) | 1.0 | 0.8 | 1.0 | 0.1 | 0.7 | 0.8 | 15.7 |
| Saturation | 0.01 | 0.01 | 0.01 | 0.00* | 0.01 | 0.01 | 0.21 |
| **Microwave oven** | | | | | | | |
| Penetration (%) | 77.4 | 82.5 | 82.2 | 84.2 | 83.3 | 85.5 | 88.2 |
| Saturation | 0.89 | 0.90 | 0.89 | 0.92 | 0.97 | 1.05 | 0.95 |
| **Gas barbeque (piped gas) [2]** | | | | | | | |
| Penetration (%) | 11.5 | 15.0 | 16.3 | 18.8 | 29.6 | 44.6 | 12.7 |
| Saturation | 0.11 | 0.15 | 0.16 | 0.19 | 0.30 | 0.45 | 0.18 |
| **Gas barbeque (bottled gas) [3]** | | | | | | | |
| Penetration (%) | 45.8 | 49.3 | 54.5 | 48.3 | 37.9 | 36.2 | 42.9 |
| Saturation | 0.47 | 0.51 | 0.56 | 0.51 | 0.38 | 0.37 | 0.48 |
| **Commercial grade range hood** | | | | | | | |
| Penetration (%) | 39.2 | 27.2 | 30.4 | 29.4 | 25.4 | 19.5 | 35.5 |
| Saturation | 0.55 | 0.35 | 0.40 | 0.40 | 0.33 | 0.26 | 0.53 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] This category was described as “NG barbeque” in the 2002 REUS questionnaire.
[3] This category was described as “propane barbeque” in the 2002 REUS questionnaire.
n/a = appliance not queried
* Value less than 0.01

Table 135 (next page) presents the average ages of the different cooking appliances. In the interest of brevity, age data for second or third appliances are not reported.

The average age of the appliance stock reflects the rate of stock turnover due to failure (influenced by the durability and typical lifespan of the appliance[46]) but also the relative popularity of the appliance in renovations and new construction. For example, the recent popularity of dual fuel ranges (gas cook top, electric oven) is reflected by the relatively young age of the appliance stock (average of 5.6 years versus 11.6 years for electric cook tops). Similarly, the relatively young stock of gas ranges (cook top and oven) is consistent with their recent popularity in renovations and new construction.

**Table 135: Average Age (Years) of Cooking and Related Appliances by Region**
**First Appliance Only**

| Cooking Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| Electric range (cook top & oven) | 11.0 | 9.6 | 9.4 | 11.2 | 8.3 | 10.4 | 9.8 | 10.5 | 9.9 | 10.6 |
| Gas range (cook top & oven) | 8.7 | 9.0 | 8.6 | 11.0 | 6.4 | 8.7 | 8.5 | 8.7 | 8.6 | 9.2 |
| Dual fuel range (gas cook top, electric oven) | 5.4 | 6.0 | 6.0 | 6.5 | 5.7 | 5.6 | n/a | 5.5 | n/a | n/a |
| Electric cook top | 11.7 | 11.4 | 10.8 | 13.8 | 14.9 | 11.6 | 9.2 | 11.6 | 9.0 | 10.0 |
| Gas cook top | 9.2 | 10.2 | 7.8 | 11.4 | 6.8 | 9.3 | 7.0 | 9.4 | 6.8 | 8.5 |
| Electric wall oven | 11.2 | 10.2 | 8.8 | 10.3 | 17.0 | 10.8 | 9.7 | 11.0 | 9.7 | n/a |
| Gas wall oven | 8.0 | 7.1 | 7.9 | 1.0 | -- | 7.8 | 6.4 | 7.8 | 5.8 | n/a |
| Microwave oven | 7.6 | 7.1 | 7.7 | 8.4 | 5.9 | 7.4 | 6.9 | 7.4 | 6.9 | 7.9 |
| Gas barbeque (piped gas) [1] | 5.4 | 6.5 | 6.0 | 6.2 | 5.6 | 5.8 | 6.5 | 5.8 | 6.7 | 5.6 |
| Gas barbeque (bottled gas) [2] | 6.2 | 5.9 | 5.3 | 4.9 | 5.5 | 6.0 | 5.4 | 6.1 | 5.4 | 6.7 |
| Commercial grade range hood | 10.2 | 9.8 | 9.8 | 9.3 | 11.3 | 10.1 | n/a | 10.1 | n/a | n/a |

[1] This category was described as "NG barbeque" in the 2002 REUS questionnaire.
[2] This category was described as "propane barbeque" in the 2002 REUS questionnaire.
n/a = appliance not queried

## 9.2 Refrigerators and Freezers

Table 136 (next page) summarizes penetration and saturation rates for manual and automatic defrost refrigerators, and chest and upright stand-alone freezers. Manual defrost refrigerators are considerably less common than auto-defrost models. Chest-style freezers are more common than upright models, and the penetration of freezers (any type) is highest in the Interior and Fort Nelson and lowest in Whistler.

The 2008 and 2002 surveys did not query refrigerators by defrost method (e.g., auto defrost versus manual defrost, etc.). While the 2012 data for the two styles of refrigerators and freezers have been summed to allow comparison with previous survey years, caution should be advised in comparing the 2012 aggregate results with previous years due to differences in the question design.

[46] For example, the average age of ranges and refrigerators will be higher than that of microwave ovens, in part, because they last longer.

**Table 136: Penetration and Saturation of Refrigerators and Freezers by Region**

| Refrigerators & Freezers | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2213* | *2604* | *1439* | *1610* |
| **Refrigerator – manual defrost** | | | | | | | | | | |
| Penetration (%) | 16.0 | 14.4 | 10.8 | 17.9 | 26.6 | 15.0 | n/a | n/a | n/a | n/a |
| Saturation | 0.20 | 0.17 | 0.13 | 0.21 | 0.31 | 0.19 | n/a | n/a | n/a | n/a |
| **Refrigerator – auto defrost** | | | | | | | | | | |
| Penetration (%) | 87.6 | 88.3 | 89.2 | 83.3 | 73.4 | 87.9 | n/a | n/a | n/a | n/a |
| Saturation | 1.14 | 1.13 | 1.11 | 1.06 | 0.83 | 1.13 | n/a | n/a | n/a | n/a |
| **Refrigerator – any type** | | | | | | | | | | |
| Penetration (%)[1] | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 97.7 |
| Saturation | 1.34 | 1.29 | 1.24 | 1.27 | 1.14 | 1.32 | 1.34 | 1.36 | 1.33 | 1.32 |
| **Stand-alone freezer – upright** | | | | | | | | | | |
| Penetration (%) | 20.6 | 27.4 | 25.5 | 14.3 | 23.7 | 22.9 | n/a | n/a | n/a | n/a |
| Saturation | 0.21 | 0.29 | 0.27 | 0.14 | 0.27 | 0.24 | n/a | n/a | n/a | n/a |
| **Stand-alone freezer – chest style** | | | | | | | | | | |
| Penetration (%) | 47.4 | 56.7 | 51.2 | 23.8 | 60.1 | 50.3 | n/a | n/a | n/a | n/a |
| Saturation | 0.53 | 0.67 | 0.56 | 0.26 | 0.69 | 0.57 | n/a | n/a | n/a | n/a |
| **Stand-alone freezer – any type** | | | | | | | | | | |
| Penetration (%) | 68.0 | 84.1 | 76.7 | 38.1 | 83.9 | 73.2 | 66.7 | 67.1 | 72.9 | 69.4 |
| Saturation | 0.74 | 0.96 | 0.83 | 0.40 | 0.95 | 0.81 | 0.76 | 0.77 | 0.80 | 0.76 |

n/a = appliance not queried
[1] 100% is the default penetration

The average ages of refrigerators and stand-alone freezers are summarized by region in Table 137.

**Table 137: Average Age (Years) of Refrigerators and Freezers by Region**
**First Appliance Only**

| Refrigerators & Freezers | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| Refrigerator – manual defrost | 12.8 | 13.4 | 12.3 | 14.7 | 6.7 | 12.9 |
| Refrigerator – auto defrost | 9.0 | 8.3 | 8.1 | 9.3 | 7.4 | 8.7 |
| Stand-alone freezer – upright | 10.0 | 8.0 | 8.0 | 11.6 | 6.8 | 9.1 |
| Stand-alone freezer – chest style | 14.3 | 13.5 | 12.2 | 13.5 | 10.9 | 13.9 |

n/a = appliance not queried

## 9.3 Cleaning Appliances

Cleaning appliances are defined to include automatic dishwashers; top loading and front loading (horizontal axis) clothes washers; and electric and gas clothes dryers. Penetration and saturation rates for these appliances for the 2012, 2008, and 2002 survey years are summarized in Table 138 (next page).

The penetration of front loading (horizontal axis) clothes washers has increased from one-in-ten (9%) of all FEI customers in 2002 to four-in-ten (41%) in 2012.[47] Commensurate with this increase, the penetration of top loading clothes washers has declined from nearly nine-in-ten (88%) of FEI households

[47] ENERGY STAR clothes washers use about 75 percent less water than a standard washer used 20 years ago. Source: US EPA (2012).

in 2002 to under six-in-ten (57%) in 2012. Traditionally, top loading clothes washers have not been energy-efficient. However, ENERGY STAR® qualified high efficiency top loading clothes washers have come onto the market since the last REUS. While still considerably less efficient than horizontal axis washers, their presence means that implying efficiency shares for clothes washers based on differentiating top versus front loading models is now less reliable than it was in 2008.[48]

**Table 138: Penetration and Saturation of Cleaning Appliances by Region**

| Cleaning Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2213* | *2604* | *1439* | *1610* |
| **Dishwasher** | | | | | | | | | | |
| Penetration (%) | 87.4 | 83.2 | 86.7 | 95.2 | 73.4 | 86.2 | 81.9 | 86.1 | 81.4 | 81.2 |
| Saturation | 0.93 | 0.86 | 0.91 | 1.08 | 0.74 | 0.91 | 0.87 | 0.91 | 0.86 | 0.83 |
| **Clothes washer - top loading** | | | | | | | | | | |
| Penetration (%) | 58.4 | 54.7 | 50.8 | 58.3 | 52.6 | 56.6 | 70.7 | 57.3 | 71.0 | 88.3 |
| Saturation | 0.61 | 0.56 | 0.52 | 0.64 | 0.53 | 0.59 | 0.74 | 0.60 | 0.75 | 0.90 |
| **Clothes washer - front loading** | | | | | | | | | | |
| Penetration (%) | 40.6 | 42.6 | 45.9 | 45.2 | 43.6 | 41.7 | 27.4 | 41.2 | 26.8 | 9.4 |
| Saturation | 0.43 | 0.44 | 0.47 | 0.48 | 0.46 | 0.43 | 0.30 | 0.43 | 0.29 | 0.10 |
| **Electric clothes dryer** | | | | | | | | | | |
| Penetration (%) | 88.0 | 89.6 | 87.0 | 90.5 | 86.7 | 88.3 | 87.1 | 88.5 | 87.7 | 89.6 |
| Saturation | 0.93 | 0.93 | 0.90 | 1.04 | 0.90 | 0.93 | 0.91 | 0.93 | 0.92 | 0.91 |
| **Gas clothes dryer** | | | | | | | | | | |
| Penetration (%) | 4.5 | 4.0 | 7.2 | 3.6 | 9.5 | 4.7 | 5.9 | 4.4 | 5.1 | 5.3 |
| Saturation | 0.05 | 0.04 | 0.08 | 0.04 | 0.09 | 0.05 | 0.07 | 0.05 | 0.06 | 0.05 |

The average ages of cleaning appliances (first unit only) are summarized by appliance and region in Table 139.

**Table 139: Average Age (Years) of Cleaning Appliances by Region**
**First Appliance Only**

| Cleaning Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| Dishwasher | 8.4 | 7.8 | 8.1 | 8.8 | 6.0 | 8.2 | 7.7 | 8.2 | 7.8 | 8.4 |
| Clothes washer - top loading | 10.8 | 9.9 | 10.2 | 11.0 | 9.0 | 10.5 | 9.6 | 10.6 | 9.5 | 8.7 |
| Clothes washer - front loading | 4.8 | 5.2 | 5.2 | 5.4 | 4.5 | 4.9 | 4.7 | 4.9 | 4.8 | 5.0 |
| Electric clothes dryer | 8.9 | 8.4 | 8.3 | 8.2 | 7.0 | 8.7 | 8.8 | 8.8 | 8.7 | 9.4 |
| Gas clothes dryer | 12.5 | 11.4 | 10.5 | 14.0 | 10.1 | 12.0 | 9.2 | 12.3 | 9.2 | 8.9 |

Table 140 (next page) summarizes the average number of clothes washing, drying, and dishwashing loads per household during a typical week. Specifically, the number of loads per week per household are provided for dishwashing, clothes washing (any temperature and using cold water wash and rinse, laundry loads dried in the dryer, on a clothes line or rack (summer versus winter). All averages are calculated using the base of all REUS respondents. All six activities will be influenced, in part, by the number of occupants of the house.

[48] While the accuracy of self-reported data on appliance efficiency using the presence or lack thereof of the ENERGY STAR logo in past surveys has been suspect, a return to using this method to differentiate high efficiency units from standard efficiency units may be required in future REUS surveys.

**Table 140: Dishwasher and Laundry Loads per Week**

| Average number of loads per week per household | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* |
| Dishwasher loads | 3.4 | 3.2 | 3.5 | 3.5 | 3.1 | 3.4 |
| Loads of laundry – any temp | 3.6 | 3.5 | 3.5 | 3.6 | 4.1 | 3.6 |
| Loads of laundry – cold water wash and rinse | 2.3 | 2.0 | 1.9 | 1.8 | 2.8 | 2.2 |
| Dryer loads | 4.0 | 3.8 | 3.9 | 3.8 | 5.3 | 3.9 |
| Loads dried on clothes line or rack – Summer | 1.4 | 1.4 | 1.4 | 1.2 | 1.2 | 1.4 |
| Loads dried on clothes line or rack – Winter | 0.8 | 0.7 | 0.6 | 0.7 | 0.5 | 0.7 |

## 9.4 Heating Appliances

Penetration and saturation rates for a range of space heating equipment and appliances are presented in Table 141. Specific equipment types queried included heat pumps (both air source and ground source), heat recovery ventilators (make-up air units), outdoor heaters (bottled and piped gas), and gas outdoor fireplaces or fire pits. The latter are a relatively new trend in home design and were not queried in past REUS surveys.

**Table 141: Penetration and Saturation of Heating Related Appliances by Region**

| Heating Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2213* | *2604* | *1439* | *1610* |
| **Air source heat pump** | | | | | | | | | | |
| Penetration (%) | 10.6 | 13.9 | 13.3 | 1.2 | 4.8 | 11.8 | 4.2 | 11.6 | 3.7 | 1.2 |
| Saturation | 0.12 | 0.14 | 0.13 | 0.01 | 0.05 | 0.12 | 0.04 | 0.12 | 0.04 | 0.01 |
| **Ground source heat pump** | | | | | | | | | | |
| Penetration (%) | 1.5 | 1.7 | 0.7 | 2.4 | 0.9 | 1.5 | 0.3 | 1.6 | 0.2 | 1.1 |
| Saturation | 0.02 | 0.02 | 0.01 | 0.05 | 0.01 | 0.02 | 0.00* | 0.02 | 0.00* | 0.01 |
| **Heat recovery ventilator / make-up air unit** | | | | | | | | | | |
| Penetration (%) | 1.9 | 2.9 | 4.5 | 8.3 | 2.8 | 2.5 | 1.9 | 2.2 | 1.6 | 1.8 |
| Saturation | 0.02 | 0.03 | 0.05 | 0.11 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 |
| **Portable electric heaters** | | | | | | | | | | |
| Penetration (%) | 31.8 | 25.0 | 22.1 | 19.0 | 29.4 | 28.9 | n/a | 29.7 | n/a | n/a |
| Saturation | 0.43 | 0.33 | 0.27 | 0.27 | 0.39 | 0.39 | n/a | 0.40 | n/a | n/a |
| **Gas outdoor heater (piped gas)** [1] | | | | | | | | | | |
| Penetration (%) | 1.5 | 1.8 | 2.1 | 2.4 | 0.9 | 1.7 | 1.3 | 1.6 | 1.3 | 0.9 |
| Saturation | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 |
| **Gas outdoor heater (bottled gas)** [2] | | | | | | | | | | |
| Penetration (%) | 4.8 | 2.8 | 3.5 | 5.9 | 0.9 | 4.1 | 1.6 | 4.2 | 1.5 | 1.1 |
| Saturation | 0.05 | 0.03 | 0.04 | 0.06 | 0.02 | 0.04 | 0.02 | 0.04 | 0.02 | 0.01 |
| **Gas outdoor fire pit or fireplace** | | | | | | | | | | |
| Penetration (%) | 3.2 | 1.9 | 2.9 | 5.9 | 1.9 | 2.8 | n/a | 2.8 | n/a | n/a |
| Saturation | 0.04 | 0.02 | 0.03 | 0.06 | 0.02 | 0.03 | n/a | 0.03 | n/a | n/a |

* Value smaller than 0.01
[1] Queried as natural gas outdoor heater in the 2002 REUS.
[2] Queried as propane outdoor heater in the 2002 REUS.
n/a = appliance not queried

The data indicate that one-in-eight (12%) of FEU households have an ASHP, up from four percent in 2008. On a regional basis, penetration of ASHP is highest in the Interior (14% of FEU customers), Vancouver Island (13%) and Lower Mainland (11%). The proportion of households with a ground source heat pump

(GSHP), also referred to as a geothermal system, remains low at one and a half percent of households. The penetration was less than one percent in 2008.

Residential building codes now require tighter building envelopes than in the past, meaning that there is considerably less opportunity for outside air to enter through seams, joints, and other areas of the building shell. Heat recovery ventilators (HRVs)[49] allow pre-heated fresh air to be introduced to the home, preventing depressurization of the home by range hoods and exhaust fans. HRVs are present in three percent (3%) of FEU homes, statistically unchanged from two percent (2%) of FEU homes in 2008.

The penetration rate for gas outdoor heaters (piped gas) among FEU residential customers is low at two percent (1.7%). Gas outdoor fire pits or fireplaces are estimated at three percent (2.8%) of FEU households.

Penetration and saturation rates for heating equipment by dwelling vintage are summarized in Table 142.

**Table 142: Penetration and Saturation of Heating Equipment by Dwelling Vintage**

| Heating Appliances | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Unknown |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| **Air source heat pump** | | | | | | | |
| Penetration (%) | 8.8 | 9.8 | 10.0 | 12.9 | 9.9 | 29.6 | 18.8 |
| Saturation | 0.09 | 0.10 | 0.10 | 0.15 | 0.10 | 0.32 | 0.24 |
| **Ground source heat pump** | | | | | | | |
| Penetration (%) | 0.7 | 0.3 | 0.5 | 1.5 | 2.9 | 4.5 | 10.5 |
| Saturation | 0.01 | 0.00* | 0.01 | 0.02 | 0.03 | 0.05 | 0.16 |
| **Heat recovery ventilator / make-up air unit** | | | | | | | |
| Penetration (%) | 2.3 | 0.5 | 0.8 | 3.3 | 4.4 | 6.9 | 10.6 |
| Saturation | 0.02 | 0.00* | 0.01 | 0.03 | 0.05 | 0.07 | 0.16 |
| **Portable electric heaters** | | | | | | | |
| Penetration (%) | 39.2 | 27.2 | 30.4 | 29.4 | 25.4 | 19.5 | 10.5 |
| Saturation | 0.55 | 0.35 | 0.40 | 0.40 | 0.33 | 0.26 | 0.21 |
| **Gas outdoor heater (piped gas)** | | | | | | | |
| Penetration (%) | 1.9 | 1.3 | 0.7 | 1.1 | 2.4 | 3.1 | 10.5 |
| Saturation | 0.03 | 0.01 | 0.01 | 0.01 | 0.02 | 0.06 | 0.21 |
| **Gas outdoor heater (bottled gas)** | | | | | | | |
| Penetration (%) | 3.0 | 2.8 | 5.6 | 2.2 | 7.6 | 3.6 | 6.3 |
| Saturation | 0.04 | 0.03 | 0.06 | 0.02 | 0.08 | 0.04 | 0.12 |
| **Gas outdoor fire pit or fireplace** | | | | | | | |
| Penetration (%) | 2.5 | 1.5 | 3.1 | 1.3 | 4.8 | 9.0 | 5.2 |
| Saturation | 0.02 | 0.02 | 0.03 | 0.01 | 0.05 | 0.12 | 0.10 |

* Value less than 0.01

Of note:

- the penetration of ASHPs is highest among dwellings constructed since 2005 (26% of dwellings);
- the penetration of ground source heat pumps, while still relatively small, also shows a greater penetration among newer dwellings (4% of homes constructed since 2005 versus less than 1% for homes constructed prior to 1986);

[49] Also known as make up air units or mechanical ventilation.

- HRVs are also more likely to be present in newer homes (6% of homes built since 2005 compared to less than one percent of homes constructed prior to 1986); and
- gas outdoor fireplaces or fire pits also appear to be more common among newer dwellings (8% of homes constructed since 2005).

Dwelling-specific detail on air source heat pumps, ground source heat pumps and heat recovery ventilators is provided in Table 143. Sample sizes for some dwelling types, particularly apartments / condominiums, are small, so caution is advised in the interpretation of these data. The data show the penetration of air source heat pumps is highest among single family detached dwellings and row / townhouses (13% and 10% respectively). The penetration of ground source heat pumps (GSHPs) among these and other dwelling types is considerably lower. Differences in the penetration of GSHPs between the dwelling types are not statistically significant at the 95% confidence level.

**Table 143: Penetration and Saturation of Heat Pumps and Make-Up Air Units by Dwelling Type**

| Heat Pumps & HRVs | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *2796* | *154* | *207* | *56* | *119* | *59* |
| **Air source heat pump** | | | | | | |
| Penetration (%) | 12.8 | 4.4 | 10.0 | 3.9 | 4.9 | 2.1 |
| Saturation | 0.14 | 0.04 | 0.10 | 0.04 | 0.05 | 0.02 |
| **Ground source heat pump** | | | | | | |
| Penetration (%) | 1.5 | 2.9 | 1.1 | -- | -- | 1.0 |
| Saturation | 0.02 | 0.03 | 0.01 | -- | -- | 0.01 |
| **Heat recovery ventilator / make-up air unit** | | | | | | |
| Penetration (%) | 2.7 | 0.4 | 2.1 | -- | 0.9 | 7.0 |
| Saturation | 0.03 | 0.00* | 0.02 | -- | 0.01 | 0.07 |

* Value less than 0.01

The average ages of the different heating equipment are summarized in Table 144. Comparable data, where it exists, from the 2002 and 2008 REUS surveys are provided. Differences between the current and past surveys are expected, as the average age of the heating equipment stock reflects both the aging of the stock present in 2008 and the introduction of new stock via replacements or new construction.

**Table 144: Average Age (Years) of Heating Equipment by Region**

| Heating Appliances | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| Air source heat pump | 8.3 | 6.8 | 6.5 | -- | 11.4 | 7.5 | 4.4 | 7.7 | 3.7 | 1.2 |
| Ground source heat pump | 7.8 | 7.2 | 4.0 | 3.0 | 10.0 | 7.5 | 14.2 | 7.7 | 14.2 | 8.6 |
| Heat recovery ventilator / make-up air unit | 12.9 | 7.4 | 11.8 | 13.0 | 12.5 | 10.9 | 9.1 | 10.6 | 8.4 | 6.5 |
| Portable electric heater | 4.6 | 4.9 | 4.4 | 4.1 | 4.7 | 4.7 | n/a | 4.7 | n/a | n/a |
| Gas outdoor heater (piped gas) [1] | 10.0 | 8.5 | 8.9 | 5.0 | -- | 9.3 | 8.7 | 9.4 | 9.2 | 4.4 |
| Gas outdoor heater (bottled gas) [2] | 5.9 | 4.9 | 4.8 | 9.0 | -- | 5.7 | 4.0 | 5.7 | 4.2 | 2.1 |
| Gas outdoor fire pit or fireplace | 4.1 | 4.2 | 7.1 | 1.5 | -- [3] | 4.5 | n/a | 4.1 | n/a | n/a |

[1] Queried as natural gas outdoor heater in the 2002 REUS.
[2] Queried as propane outdoor heater in the 2002 REUS.
[3] Data not reported due to insufficient sample

### 9.4.1 ASHPs – Additional Discussion

While data from the appliance section of the survey, as reported in Table 141, page 125, indicate that 12% of FEU households have an ASHP, only 8% of households indicated they use an ASHP as either a main or secondary space heating method under the space heating section of the survey (Sections 6.3.2 and 6.3.1, page 74). The lower penetration rate under the space heating section may be that some households associate an ASHP with space cooling (air conditioning) rather than space heating and thus underreport these units when asked about space heating methods. It may also be due to the nature in which the questions in the two sections were posed. In the space heating section of the survey, respondents were asked to indicate the main, secondary, and any other methods used to heat the home from a list of several possible space heating methods including ASHPs. In contrast, the appliance section of the survey asked respondents to indicate the quantity, including none, for each of 26 different appliances, including ASHPs. Being required to indicate the presence or quantity of individual end-uses may have improved the likelihood that respondents would indicate the presence of an ASHP regardless of its role in providing heating or cooling.

In light of these findings, the incidence of ASHPs is considered to be underreported in the space heating methods section of the report. The more accurate estimate of the penetration of ASHPs is assumed to be 12% of FEU households.

## 9.5 Cooling and Miscellaneous Appliances

Penetration and saturation rates for a variety of common household cooling appliances ranging from central air conditioners to ceiling fans are presented in Table 145 (next page). Data are also provided for miscellaneous end-uses including humidifiers and dehumidifiers.

Three types of air conditioning equipment were queried: central systems (typically paired with a forced air furnace); portable air conditioners, and room window air conditioners. Slight differences exist in the descriptions used for air conditioners between the 2012 REUS and previous REUS surveys, so caution in comparing the 2012 results with earlier years is advised.

The data show that homes in the Interior are most likely to have air conditioning, either in the form of central air conditioning or room window air conditioners (50% and 11% of Interior households respectively).

Research on residential new construction trends conducted for FEU in 2010[50] identified an underreporting issue for air conditioning for homes with heat pumps (either air source or ground source). In particular, some respondents did not indicate their home had air conditioning despite having a heat pump; the latter, by the nature of its technology, can provide both heating and cooling. A review of the 2012 REUS data revealed a similar underreporting of air conditioning in homes with heat pumps. To address this issue in the 2012 REUS, penetration and saturation data for central air conditioners are presented two ways. The first as supplied by respondents (which may or may not include air conditioning provided by air source or ground source heat pumps). The second includes air conditioning provided by traditional central air conditioning units or via air source and ground source heat pumps. As it is not possible to identify air source heat pumps by type (i.e., paired with a forced air furnace or stand-alone mini-split units, etc.), the

[50] Sampson Research (2011).

amended central air conditioning data may somewhat overstate the penetration of "central" air conditioning.[51]

**Table 145: Penetration and Saturation of Cooling Equipment by Region**

| Cooling Equipment | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2213* | *2604* | *1439* | *1610* |
| **Central air conditioner [1]** | | | | | | | | | | |
| Penetration (%) | 9.1 | 50.4 | 9.3 | 4.8 | 13.3 | 20.3 | 15.2 | 21.7 | 16.7 | 15.1 |
| Saturation | 0.10 | 0.52 | 0.10 | 0.05 | 0.14 | 0.21 | 0.15 | 0.23 | 0.17 | 0.16 |
| **Central air conditioning including heat pumps [2]** | | | | | | | | | | |
| Penetration (%) | 15.8 | 55.1 | 15.4 | 5.9 | 18.0 | 26.3 | 18.6 | n/a | n/a | n/a |
| Saturation | 0.16 | 0.57 | 0.16 | 0.06 | 0.19 | 0.27 | 0.19 | n/a | n/a | n/a |
| **Portable air conditioner** | | | | | | | | | | |
| Penetration (%) | 13.5 | 8.3 | 7.7 | 2.4 | 12.3 | 11.4 | 10.4 | 11.9 | 10.9 | n/a |
| Saturation | 0.16 | 0.10 | 0.08 | 0.02 | 0.14 | 0.14 | 0.12 | 0.14 | 0.13 | n/a |
| **Room window air conditioner [3]** | | | | | | | | | | |
| Penetration (%) | 8.3 | 10.6 | 2.8 | 1.2 | 8.5 | 8.3 | 10.3 | 9.0 | 10.5 | 9.1 |
| Saturation | 0.10 | 0.14 | 0.04 | 0.01 | 0.11 | 0.10 | 0.16 | 0.11 | 0.16 | 0.13 |
| **Portable Fan** | | | | | | | | | | |
| Penetration (%) | 59.6 | 42.4 | 52.1 | 38.1 | 55.0 | 54.1 | n/a | 54.4 | n/a | n/a |
| Saturation | 1.10 | 0.69 | 0.84 | 0.62 | 0.99 | 0.96 | n/a | 0.97 | n/a | n/a |
| **Humidifier** | | | | | | | | | | |
| Penetration (%) | 4.3 | 11.9 | 2.5 | 13.1 | 21.8 | 6.2 | 4.8 | 6.6 | 5.0 | 7.0 |
| Saturation | 0.05 | 0.13 | 0.03 | 0.19 | 0.26 | 0.07 | 0.05 | 0.07 | 0.05 | 0.07 |
| **Dehumidifier** | | | | | | | | | | |
| Penetration (%) | 4.9 | 4.3 | 7.4 | 3.6 | 3.8 | 5.0 | 4.4 | 4.7 | 4.1 | n/a |
| Saturation | 0.05 | 0.04 | 0.08 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | n/a |

[1] Queried as "electric central air conditioner" in 2002 and 2008
[2] Includes air conditioning provided by air source and ground source heat pumps
[3] Queried as "electric wall unit" in 2002 and 2008
n/a = appliance not queried

## 9.6 Cooling and Miscellaneous Appliances – Operating Hours

REUS 2012 respondents were asked to indicate the average daily operating hours for each of the nine cooling appliances. These averages are presented in Table 146 (next page) and refer to the units only when in use (e.g., air conditioners will only be used in the cooling months).

[51] Ductless or mini-split air source heat pumps consist of an outdoor compressor/condenser and an indoor air-handling unit (head). They are typically installed in dwellings or rooms within dwellings where ductwork is not available. For larger dwellings, ductless units with multiple "heads" are available and allow greater cooling coverage. Regardless, ductless ASHPs are not typically considered to provide "central" air conditioning. Central air conditioning usually refers to a dedicated air conditioning unit paired with a ducted furnace or a heat pump paired with a ducted furnace.

**Table 146: Cooling Equipment Average Daily Hours of Use by Region**

| Cooling Equipment | LM | INT | VI | W* | FN* | 2012 FEU |
|---|---|---|---|---|---|---|
| Central air conditioner [1] | 7.7 | 7.8 | 6.9 | 9.2 | 13.8 | 7.7 |
| Portable air conditioner | 5.2 | 5.7 | 6.6 | 5.5 | 11.9 | 5.4 |
| Room window air conditioner [2] | 5.7 | 6.6 | 4.1 | 10.0 | 8.0 | 6.0 |
| Portable Fan | 5.4 | 6.4 | 5.7 | 6.1 | 7.5 | 5.7 |
| Humidifier | 4.7 | 12.0 | 6.4 | 12.9 | 13.7 | 8.6 |
| Dehumidifier | 9.1 | 7.5 | 6.8 | 2.5 | 18.7 | 8.4 |
| Portable electric heater | 4.6 | 4.9 | 4.4 | 4.1 | 4.7 | 4.7 |

* Small samples – caution is advised
[1] Queried as “electric central air conditioner” in 2002 and 2008
[2] Queried as “electric wall unit” in 2002 and 2008

# 10 Pools, Hot Tubs & Saunas

This section presents and discusses the incidence of swimming pools, hot tubs, and saunas among FEU households. Information is provided on their heating fuels, months of operation, and energy saving behaviours such as the use of pool and hot tub covers. As in the 2008 REUS, the 2012 survey asked detailed questions about fuels and behaviours only for households that had exclusive use of the facilities. Respondents who shared a swimming pool, hot tub, and/or sauna with other residences, as is the case in some condominium or townhouse complexes, were skipped past this section of the survey. The 2012 REUS represents the first FEU REUS survey to collect details (albeit limited) on exclusive-use saunas.

## 10.1 Penetration Rates

Penetration rates of exclusive-use only pools, hot tubs and saunas are provided in Table 147. Saturation figures are not presented, as homes with more than one of any of these end-uses would be very uncommon.

Four percent (4%) of FEU gas customers, on average, reported having a swimming pool for their exclusive use. Compared to 2008, the incidence is unchanged (difference between 2008 and 2012 is not statistically significant at the 95% confidence level). Regionally, customers in the Interior had the highest incidence of an exclusive-use pool (8%).

**Table 147: Penetration of Pools, Hot Tubs, and Saunas by Region (%)**

| Exclusive use only | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2189* | *2604* | *1426* | *1610* |
| Swimming pool | 3.2 | 7.9 | 1.8 | -- | 2.0 | 4.3 | 5.2 | 4.6 | 5.6 | n/a |
| Hot tub | 7.3 | 15.3 | 9.2 | 39.0 | 6.8 | 9.7 | 13.3 | 9.7 | 13.5 | n/a |
| Sauna | 3.8 | 4.1 | 2.5 | 12.2 | 2.0 | 3.8 | n/a | 3.9 | n/a | n/a |

n/a =data not available

On average, one-in-ten (10%) of FEU customers have a hot tub for their exclusive use. Regionally, Whistler, and to a lesser extent the Interior, stand out as having a significantly higher proportion of households with an exclusive hot tub compared to the other regions (39% and 15% respectively). The incidence of hot tubs in other regions varied from 7% (Lower Mainland and Fort Nelson) to 9% (Interior).

Four percent (4%) of FEU customers reported having a sauna that was for their exclusive use. As with the case for hot tubs, the incidence of saunas was highest for Whistler customers (12%). The 2008 and 2002 surveys did not query the presence of saunas.

Table 148 (next page) summarizes the penetration of exclusive-use pools, hot tubs, and saunas by dwelling type. Not surprisingly, penetration for the three end-uses was highest among single family detached homes and lowest among apartments / condominiums.

**Table 148: Penetration of Pools, Hot Tubs, and Saunas by Dwelling Type (%)**

| Exclusive use only | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *2796* | *154* | *207* | *56* | *119* | *59* |
| Swimming pool | 5.2 | -- | 1.0 | 1.4 | 0.9 | 0.0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Hot tub | 11.5 | 3.2 | 0.7 | -- | 4.3 | 2.0 |
| Sauna | 4.2 | 2.6 | 0.2 | -- | -- | 7.8 |

## 10.2 Heating Fuels – Pools, Hot Tubs, and Saunas

Respondents to the 2012 REUS were asked to indicate the fuel(s) used to heat their exclusive-use heated pools, hot tubs and/or saunas. In the case of pools and hot tubs, fuel use is compared with 2002 and 2008 REUS results.

Table 149 summarizes the fuels used to heat exclusive-use swimming pools. Natural gas is the most common fuel used to heat pools, heating almost seven-in-ten (68%) of all exclusive-use pools. The next most common heating fuel is solar (27%). More than one-quarter (27%) indicated their pool is not heated. Regional comparisons are not presented due to small sample sizes.

**Table 149: Fuels used to Heat Swimming Pools by Region (%)**
**Exclusive-use pools only**

| Main pool heater fuel | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI [2] |
|---|---|---|---|---|---|
| *Unweighted base [1]* | *169* | *63* | *156* | *50* | *98* |
| Solar | 26.5 | 15.0 | 18.8 | 14.6 | 20.7 |
| Natural gas | 68.3 | 43.4 | 50.6 | 43.6 | 56.0 |
| Electric | 4.7 | 5.2 | 3.2 | 3.9 | 1.4 |
| Other | 0.4 | -- | 0.4 | -- | -- |
| Not heated | 27.2 | 36.4 | 27.0 | 37.9 | 24.1 |
| DK/NR | -- | -- | -- | -- | 2.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **--** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] includes non-responses (NR)
Totals may not sum due to rounding

Households that use either natural gas, electricity or some other fuel to heat their pool were asked whether they supplement the primary fuel with solar energy. The results by fuel type are summarized in Table 150.

**Table 150: Use of Solar Heating to Supplement Heating for Swimming Pools**
**Percent using solar heating by fuel type**

| | 2012 FEU |
|---|---|
| *Unweighted base [1]* | *24* |
| Natural gas | 25.9 |
| Electric | 44.9 |
| Other | 100.0 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

One-quarter (26%) of respondents who use natural gas indicated they also use solar heating. Nearly half (45%) of respondents using electricity to heat their pools reported using solar heating as a supplementary heating source. Regional results are not presented due to insufficient sample.

The vast majority of hot tubs (90%) are heated using electricity (Table 151). The remainder (10%) use natural gas. Regionally, small sample sizes mean that regional differences are not significant with the exception of the Interior and Lower Mainland (96% of Interior hot tubs use electricity versus 84% in the

Lower Mainland). Differences in fuel use between the 2012 and 2008 REUS are statistically different using a 90% confidence interval but not at the 95% confidence level.

**Table 151: Hot Tub Fuels by Region (%)**

| Exclusive use only | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI [2] |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base [1]* | *56* | *246* | *66* | *32* | *7* | *407* | *269* | *309* | *142* | *185* |
| Natural gas | 16.1 | 3.7 | 4.5 | 3.1 | 14.3 | 9.6 | 15.0 | 10.2 | 16.2 | 13.1 |
| Electric | 83.9 | 96.3 | 95.5 | 96.9 | 85.7 | 90.4 | 83.4 | 89.8 | 82.2 | 86.3 |
| Other | -- | -- | -- | -- | -- | -- | 1.6 | -- | 1.6 | 1.2 |
| DK/NR | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.9 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **--** |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] includes non-responses (NR)
Totals may not sum due to rounding

Data on sauna fuels are summarized in Table 152. Predominately, saunas are heated using electricity (95% of all exclusive use saunas). A very small proportion use natural gas or some other fuel (1% each).Regional results are not presented due to small samples in all regions except the Interior.

**Table 152: Sauna Fuels (%)**

| Exclusive use only | 2012 FEU |
|---|---|
| *Unweighted base* | *122* |
| Natural gas | 1.1 |
| Electric | 95.4 |
| Other | 0.9 |
| DK | 2.6 |
| **Total** | **100.0** |

Totals may not sum due to rounding0

## 10.3 Heating Behaviours – Pools and Hot Tubs

Table 153 (next page) summarizes the mean number of months that pools and hot tubs are heated. Data for pools are for heated pools only. On average, exclusive use swimming pools are heated 3.5 months of the year. This average is not statistically different than that recorded in 2008. Four percent (4%) of gas customers indicated they heat their pool year round.

Hot tubs are heated, on average, 9 months of the year. Nearly half (46%) heat them all year round.

**Table 153: Pools and Hot Tubs – Average Number of Months Heated**

| Pool and Hot Tub Heating | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| Heated Pools( (*Unweighted base* [1]) | *20* | *80* | *8* | -- | *2* | *110* | *45* |
| Months heated (mean) | 3.5 | 3.4 | 4.6 | -- | 4.5 | 3.5 | 3.7 |
| Heated all year (%) | 5.0 | 1.2 | 12.5 | -- | -- | 3.7 | 7.1 |
| Hot tubs (*Unweighted base* [1]) | *56* | *245* | *65* | *32* | *7* | *405* | *261* |
| Months heated (mean) | 7.6 | 9.4 | 8.2 | 9.5 | 9.9 | 8.5 | 8.2 |
| Heated all year (%) | 41.1 | 51.8 | 41.5 | 62.5 | 71.5 | 45.9 | 42.4 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.

Using some sort of insulated cover on a pool or hot tub when it is not in use (heating season only) saves energy by minimizing heat losses.[52] On average, three-quarters (75%) of FEU households with heated pools use a cover when not in use (i.e., during the months when the pool is heated). This proportion has varied somewhat during the past three REUS surveys (Table 154). However, the small number of homes with heated pools in the 2008 and 2012 surveys (n=45 and n=115 respectively) means the difference between the 2008 and 2012 estimates is not statistically significant at the 95% confidence level.

**Table 154: Use of Pool and Hot Tub Covers by Region (%)**
**Heated Pools and all Hot Tubs**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| Cover pool when not in use | 60.0 | 95.2 | 55.6 | -- | 50.0 | 75.2 | 68.5 | 76.1 | 66.7 | 79.7 |
| Cover hot tub when not in use | 92.7 | 99.2 | 95.3 | 96.8 | 85.7 | 95.8 | 94.7 | 95.8 | 94.3 | 95.3 |

The incidence of covering a hot tub when not in use is considerably higher than that for pools. Almost all (96%) households with a hot tub cover their hot tub when not in use. Differences among the regions are not statistically significant, nor are differences at the utility level between the 2008 and 2012 surveys.

Data on the incidence of high efficiency motors (i.e., variable speed or electrically controlled) for pool pumps are summarized in Table 155 (next page). Nearly two-in-five (18%) indicated their pool was equipped with a high efficiency pump motor. However, more than one-quarter (27%) were unsure. Three percent (3%) indicated the question was not applicable (i.e., pool not heated and/or no method of circulating the water). Regional results are not provided due to small sample sizes. This question was not asked in the 2008 or 2002 surveys.

**Table 155: Incidence of High Efficiency Pool Pump Motors (%)**

| Have HE Pool Pump Motor? | 2012 FEU |
|---|---|
| *Unweighted base* | *166* |
| Yes | 17.8 |
| No | 52.0 |
| DK | 27.2 |
| Not applicable | 3.0 |
| **Total** | **100.0** |

Totals may not sum due to rounding

[52] According to the US Department of Energy (DOE), evaporation accounts for 70% of the energy loss from outdoor swimming pools, while radiation to the sky (temperature differential between the pool temperature and the outside air) accounts for another 20%. Ground and other losses account for the remaining 10%. Using a pool cover, especially one that continues to permit solar gain, can reduce energy losses by 50% to 70%. Source: http://energy.gov/energysaver/articles/swimming-pool-covers

# 11 Energy Use Behaviours

This section summarizes a series of questions posed to 2012 REUS respondents regarding the behaviours they take or not take to conserve energy associated with natural gas end-uses in the home. This information is supplemented with additional information on the frequency of a number of common behaviours affecting the demand for space and hot water heating. Developing a comprehensive understanding of behaviours influencing natural gas use and the myriad of factors that influence these behaviours requires a considerably more involved research process than that allowed by the 2012 REUS. Limitations to survey length restricted the number of behaviours that could be queried and the degree to which barriers and opportunities for saving energy were explored. Information presented in this section is intended to provide a broad baseline of key energy use behaviours only.

## 11.1 Behaviours Influencing Natural Gas Consumption

To better understand the potential for energy savings in natural gas consumption through changes in behaviours in the home, respondents to the 2012 REUS were asked to rate their frequency of undertaking a variety of behaviours related to space heating and domestic hot water consumption. Respondents were asked to indicate how often they did each behaviour using a four point scale including always, usually, occasionally and never. Each behaviour also allowed respondents to answer “don’t know” or indicate the behaviour was “not applicable”. The latter response category is required, as not all behaviours will apply to all households (e.g., ability to use storm windows is specific to homes with older style single pane windows that accept storm windows).

Behaviours were analyzed from two perspectives. The first perspective was the proportion of households that already do the behaviour (i.e., indicated “always” or “usually”). These households are the least likely to deliver incremental energy savings from undertaking (increasing) these behaviours. The second perspective is the proportion of households that occasionally or never undertake the energy saving behaviour, or are unsure how often they undertake the behaviour. The latter defines the outstanding market potential for behavioural change in terms of the proportion of residential customers that could contribute energy savings from a sustained change in their behaviours. Market potential figures exclude those who indicated the behavioural was not applicable (e.g., storm windows). Some respondents, however, may have selected “never” rather than the more appropriate “not applicable” for some behaviours, so the reader is cautioned that the market potential may be somewhat overstated for some behaviours. This is more likely to be the case where the behaviour is linked to a technology that has less than 100% penetration.[53]

No attempt has been made to estimate or otherwise quantify the energy savings associated with any specific behaviour, nor the amount of the outstanding market that could be realistically captured through utility programming. These are issues outside of the scope of the 2012 REUS.

[53] As an example, respondents who do not have an automatic dishwasher may choose “never” for how often they undertake conserving behaviours associated with the use of automatic dishwashers rather than selecting “not applicable”. In this case, their answer would be included with other households who suggest there is room for improvement.

### 11.1.1 Space Heating Behaviours

Respondents were asked to indicate the temperature they usually keep their residence in the winter (heating) season for three common situations:

- When someone is at home
- When no one is at home
- During the night

The results (averages) are summarized in Table 156. All data reported are for FEU households that undertake the set-back behaviours during winter, either occasionally or regularly. Data on how many households undertake set-back behaviours, are reported further on in this section. The results show that respondents turn down their thermostat by an average of 3.1 degrees Celsius when no one is at home. During the night, the average turn down in thermostat is 2.9 degrees. There are no statistically significant differences in the averages between electrically heated versus gas (natural gas or piped propane). [54]

**Table 156: Winter (Heating Season) Room Temperatures (Degrees Celsius)**

| | | | | | | | Main SH Fuel | |
|---|---|---|---|---|---|---|---|---|
| | LM | INT | VI | W | FN | 2012 FEU | Electric | Gas |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| When someone is at home | 20.4 | 20.7 | 20.2 | 20.0 | 20.9 | 20.5 | 20.4 | 20.5 |
| When no one is at home | 17.3 | 17.6 | 16.9 | 16.3 | 18.8 | 17.3 | 17.3 | 17.3 |
| During the night | 17.6 | 17.7 | 16.8 | 17.1 | 18.9 | 17.5 | 17.7 | 17.5 |
| Daytime set-back[1] | 3.1 | 3.1 | 3.3 | 3.8 | 2.1 | 3.1 | 3.1 | 3.1 |
| Night time set-back[2] | 2.8 | 3.0 | 3.4 | 2.9 | 2.0 | 2.9 | 2.8 | 3.0 |

[1]Difference in daytime temperature when someone is at home versus no one is at home
[2]Difference between night-time temperature and daytime temperature when someone is at home

Most FEU households (81%) have the ability to reduce the temperature in unused rooms by turning down individual room thermostats or by closing registers or vents (Table 157). As expected, FEU homes that use electricity as their main space heating fuel are more able to control the temperature in individual rooms than homes where natural gas is their main space heating fuel (89% versus 79%). This is consistent with the tendency for electric space heat to be provided by baseboard heaters that have zoned temperature control (either via a wall-mounted rheostat or at the register itself).

**Table 157: Ability to Reduce Temperature in Unused Rooms by Region (%)**

| | | | | | | | Main SH Fuel | |
|---|---|---|---|---|---|---|---|---|
| | LM | INT | VI | W | FN | 2012 FEU | Electric | Gas |
| *Unweighted base* | 773 | 1652 | 739 | 83 | 104 | 3351 | *538* | *2779* |
| Yes | 79.8 | 80.3 | 85.5 | 93.9 | 73.4 | 80.6 | 89.0 | 79.4 |
| No | 17.7 | 17.2 | 13.3 | 6.1 | 24.7 | 17.1 | 9.0 | 18.2 |
| DK | 2.5 | 2.5 | 1.2 | -- | 1.9 | 2.3 | 2.0 | 2.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding

[54] Data for main space heating fuels other than natural gas, piped propane, and electricity are not reported due to very small sample sizes.

Table 158 summarizes the percentage of REUS respondents who answered always or usually to eight different behaviours that save energy associated with space heating. The frequency of leaving windows open during the winter, an action sometimes used to improve ventilation, was also queried. Results are presented by each of the five FEU regions, the overall FEU average, and by main space heating fuel (electric versus natural gas or piped propane). Results for renters versus owners were reviewed but are not presented because the sample of renters (n=85) is too small to provide meaningful results for a majority of the questions (i.e., most differences between renters and owners will not be statistically significant). The base for all responses is the same which means that behaviours that are not applicable to all residential customers (e.g., storm windows) will have, by default, lower percentages of respondents indicating they always or usually undertake these behaviours.

**Table 158: Space Heating Behaviours**
**Percent who always or usually undertake the behaviour**

| | | | | | | | Main SH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Behaviours Impacting Space Heating** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Turn down heat - at night | 80.4 | 86.3 | 86.5 | 79.5 | 71.2 | 82.6 | 78.1 | 83.6 |
| Turn down heat - no one at home | 77.7 | 83.0 | 82.2 | 79.5 | 67.1 | 79.6 | 75.5 | 80.3 |
| Close window coverings | 70.7 | 71.9 | 68.3 | 69.5 | 66.7 | 70.7 | 67.2 | 71.4 |
| Close vents / turn down thermostats in unused rooms | 61.0 | 62.4 | 68.4 | 74.7 | 50.7 | 62.2 | 72.2 | 61.3 |
| Draft proof at least once a year | 33.5 | 46.0 | 35.6 | 38.6 | 45.5 | 37.1 | 37.5 | 37.0 |
| Install plastic window coverings during winter months | 6.8 | 12.4 | 4.8 | 5.0 | 23.9 | 8.1 | 5.2 | 8.4 |
| Install storm windows (single pane windows only) | 4.2 | 7.7 | 3.4 | 1.3 | 6.0 | 5.0 | 4.5 | 5.1 |
| Leave one or more windows open during winter [1] | 78.2 | 83.6 | 79.5 | 86.7 | 96.2 | 79.8 | 82.4 | 79.4 |

[1] Respondents who occasionally, never, or unsure they leave windows open

When ranked by the percentage of households reporting they always or usually undertake the behaviour, the top ranked behaviours are:

- turning down the heat at night (83% always or usually);
- turning down the heat when no one is home (80%), and
- closing window coverings to keep in the heat (71%).

Interior and Fort Nelson respondents are more likely to conduct annual draft proofing compared to other regions (46% each compared to the five region average of 37%). While the sample is small, Fort Nelson scores lower on many behaviours with the exception of draft proofing (already mentioned), installing storm windows, and using plastic window coverings.

When responses are expressed according to main space heating fuel (electricity versus natural gas or piped propane), some differences appear:

- Respondents using electricity as their main space heating fuel are more likely to say they always or usually close vents or turn down room thermostats than homes using natural gas (72% versus 61%).

- Homes using gas as their main space heating fuel are somewhat more likely than electrically heated homes to turn down the thermostat at night or when no one is at home (significantly different at the 90% confidence level).

The difference in frequency of window opening between gas versus electric main space heating is not statistically significant at the 95% confidence interval.

Table 159 summarizes the market potential for each of the seven space heating behaviours. Behaviours with the largest remaining potential include:

- draft proofing (60% of respondents could do more);
- installing plastic window coverings (46%), and
- closing vents or turning down thermostats in unused rooms (30%).

Homes whose main space heating fuel is natural gas have less remaining potential than their electric counterparts for closing window coverings and turning down the heat at night, but have greater potential to close vents / turn down the thermostat in unused rooms, and installing storm windows.

**Table 159: Space Heating Behaviours – Remaining Potential**
**Percent who occasionally, never or are unsure they undertake the behaviour**

| | | | | | | | Main SH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Behaviours Impacting Space Heating** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Draft proof at least once a year | 64.1 | 51.0 | 60.2 | 60.2 | 53.6 | 60.2 | 59.5 | 60.4 |
| Install plastic window coverings during winter months | 50.3 | 38.1 | 41.7 | 41.2 | 49.2 | 46.1 | 46.6 | 46.5 |
| Close vents / turn down thermostats in unused rooms | 30.5 | 31.6 | 25.4 | 20.5 | 44.5 | 30.3 | 23.7 | 31.1 |
| Close window coverings | 26.1 | 25.8 | 28.2 | 28.0 | 27.5 | 26.2 | 29.3 | 25.8 |
| Install storm windows (single pane windows only) | 28.6 | 19.1 | 20.6 | 7.6 | 22.1 | 25.1 | 18.0 | 26.2 |
| Leave one or more windows open during winter [1] | 21.3 | 15.3 | 19.9 | 13.3 | 3.8 | 19.5 | 17.2 | 19.8 |
| Turn down heat - no one at home | 20.2 | 15.2 | 15.1 | 16.9 | 29.1 | 18.3 | 22.6 | 18.0 |
| Turn down heat - at night | 18.2 | 12.6 | 12.0 | 20.5 | 26.0 | 16.1 | 20.6 | 15.2 |

[1] Respondents who always or usually leave windows open during winter

One-in-five (20%) of FEU customers indicated they always or usually leave one or more windows open during the winter. Regionally, this behaviour was most prevalent in the Lower Mainland (21%) and Vancouver Island (20%), but less so in regions where the winters are colder. The provision of fresh air via other means (heat recovery ventilators or make up air units, etc.) represents an area of opportunity for these households.

### 11.1.2 Laundry and Other Domestic Hot Water Use Behaviours

A number of activities directly affect the amount of energy associated with heating water for domestic use. They include baths, showers, clothes washing, dish washing, and general faucet use. A study of hot water use in Seattle homes (Mayer 2000) provides interesting insight into the relative contribution of these activities to overall hot water consumption. The study found that general faucet use, showers, and baths used the most hot water on a per-capita basis, and approximately three-quarters (73% to 78%) of the water used by these activities was hot water (Table 160). Hot water used on a per-capita basis by clothes washers was comparable to that of bathing. Twenty-eight percent (28%) of the water used for clothes washing is unheated.

**Table 160: Household Per Capita Hot Water Use by Activity**

| | Per Capita Hot Water Use (L/day) | Hot Water Portion (%) |
|---|---|---|
| Faucets | 32.6 | 72.7 |
| Showers | 23.8 | 73.1 |
| Baths | 15.9 | 78.2 |
| Clothes Washers | 14.8 | 27.8 |
| Leaks | 4.5 | 26.8 |
| Dishwashers | 3.4 | 100.0 |

Source: Mayer, P.W., DeOreo, W.B.(1999)

Due to limitations on survey length, the 2012 REUS limited domestic hot water behavioural potential questions to:

- Turning off the water heater or use its “vacation setting” when no one is home for more than 2 or 3 days
- Doing laundry with full loads
- Doing laundry using cold water
- Running the dishwasher when full

Additionally, the survey collected data on the number of showers, average length of showers, baths, dishwasher loads, and laundry loads (by water temperature) per week.

Table 161 summarizes the percent of respondents who always or usually turn off their water heaters when away, only do laundry with full loads, and only run the dishwasher when full.

**Table 161: Domestic Hot Water Behaviours**
**Percent who always or usually undertake the behaviour**

| | | | | | | | Main DWH Fuel | |
|---|---|---|---|---|---|---|---|---|
| Behaviours Impacting DWH | LM | INT | VI | W | FN | 2012 FEU | Electric | Gas |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Turn off water heater when away | 35.0 | 42.8 | 37.2 | 34.9 | 26.0 | 37.3 | 31.2 | 39.6 |
| Only do laundry with full loads | 91.0 | 93.4 | 93.1 | 86.7 | 89.6 | 91.9 | 93.8 | 91.4 |
| Only run dishwasher when full | 86.1 | 83.1 | 87.1 | 90.4 | 70.6 | 85.4 | 85.9 | 85.7 |

The results show the majority (92%) of households always or usually do laundry with full loads and run the dishwasher when full (85%). While 37% of households turn off the water heater when no one is at home for a few days, homes with gas hot water heaters are significantly more likely than those with electric hot water heaters to turn off the water heater when away for more than a couple of days (40% versus 31%).

Consistent with the proportion of households who already do the hot water saving activities, Table 162 (next page) shows the market potential for saving energy from changes to hot water use behaviours are:

- turning off the water heater while away (53%);
- doing laundry with full loads (8%), and
- running dishwashers only when full (3%).

**Table 162: Domestic Hot Water Behaviours – Remaining Potential**
**Percent who occasionally, never or are unsure they undertake the behaviour**

| | | | | | | | Main DWH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Behaviours Impacting DWH** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Turn off water heater when away | 55.7 | 47.9 | 52.4 | 59.0 | 66.4 | 53.3 | 61.6 | 52.2 |
| Only do laundry with full loads | 8.3 | 6.2 | 6.4 | 12.0 | 9.5 | 7.6 | 5.9 | 8.0 |
| Only run dishwasher when full | 2.6 | 1.8 | 2.4 | 3.6 | 3.8 | 2.4 | 1.2 | 2.4 |

Again, these estimates represent the potential market for a behavioural program, not the potential energy savings from implementing the programming.

Table 163 summarizes the frequency of a number of hot water-using activities including dishwashing, laundry, bathing, and showering. All data are expressed per average household. Some behaviours occur more frequently than others. For example, showers are considerably more common than baths (average of 11.4 showers per-week versus 2.1 baths). On average, FEU households do 3.6 loads of laundry per-week, of which 2.2 or 61% are done using cold water wash and rinse.

**Table 163: Hot Water Use Activities – Number Per-Household**

| | | | | | | | Main DWH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Behaviours Impacting DWH** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Average # of people per home | 2.9 | 2.4 | 2.4 | 2.7 | 2.6 | 2.7 | 2.6 | 2.7 |
| Dishwasher loads per week | 3.4 | 3.2 | 3.5 | 3.5 | 3.1 | 3.4 | 3.3 | 3.5 |
| Laundry loads per week (any temperature) | 3.6 | 3.5 | 3.5 | 3.6 | 4.1 | 3.6 | 3.5 | 3.6 |
| Laundry loads using cold water | 2.3 | 2.0 | 1.9 | 1.8 | 2.8 | 2.2 | 2.4 | 2.2 |
| Baths per week | 2.3 | 1.9 | 1.8 | 1.4 | 2.6 | 2.1 | 2.4 | 2.1 |
| Showers per week | 12.4 | 9.6 | 10.0 | 11.0 | 12.9 | 11.4 | 10.2 | 11.6 |
| Average shower duration (minutes) | 23.9 | 18.0 | 17.7 | 19.8 | 26.9 | 21.6 | 16.7 | 20.5 |

One-in-five (20%) respondents felt they could do more cold water wash and rinse than they do at present (Table 164). These households felt they could 2.5 more laundry loads in cold water, on average, per week.

**Table 164: Clothes Washing Behaviours – Cold Water Wash Potential**

| | | | | | | | Main DWH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Cold Water Wash and Rinse** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Able or willing to do more (% of households) | 20.2 | 19.6 | 18.4 | 15.5 | 16.1 | 19.8 | 18.7 | 20.2 |
| Average number of extra loads (per week) [1] | 2.7 | 2.3 | 2.2 | 1.8 | 3.9 | 2.5 | 2.7 | 2.4 |

[1] Based on small samples for Whistler and Fort Nelson

The number and frequency of most hot water use activities for a household typically varies with the number of people in the home. Table 165 (next page) restates data on hot water using behaviours on a per-person basis.

**Table 165: Hot Water Usage Behaviours – Per Person**

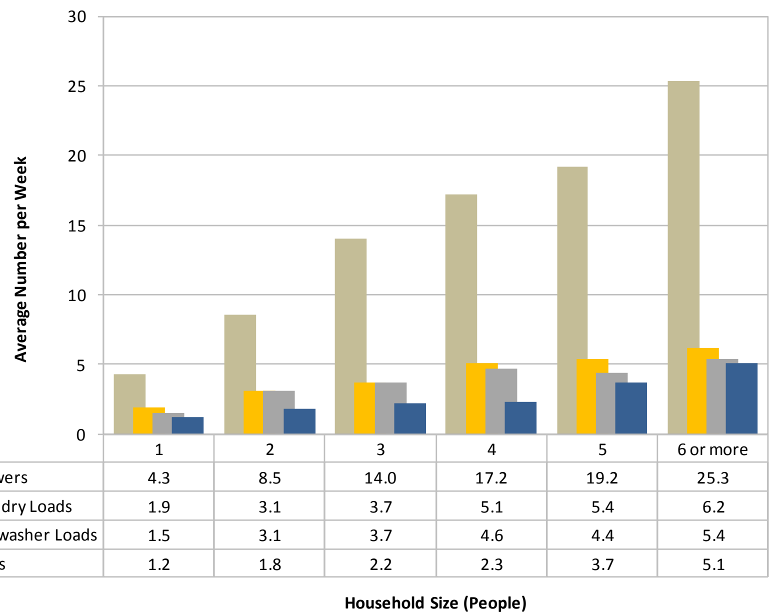
| | | | | | | | Main DWH Fuel | |
|---|---|---|---|---|---|---|---|---|
| **Behaviours Impacting DWH** | **LM** | **INT** | **VI** | **W** | **FN** | **2012 FEU** | **Electric** | **Gas** |
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *538* | *2779* |
| Average # of people per home | 2.9 | 2.4 | 2.4 | 2.7 | 2.6 | 2.7 | 2.6 | 2.7 |
| Dishwasher loads per week | 1.2 | 1.4 | 1.5 | 1.3 | 1.2 | 1.3 | 1.3 | 1.3 |
| Laundry loads per week (any temperature) | 1.3 | 1.5 | 1.5 | 1.3 | 1.6 | 1.3 | 1.4 | 1.3 |
| Laundry loads using cold water | 0.8 | 0.9 | 0.8 | 0.7 | 1.0 | 0.8 | 0.9 | 0.8 |
| Baths per week | 0.8 | 0.8 | 0.8 | 0.5 | 1.0 | 0.8 | 0.9 | 0.8 |
| Showers per week | 4.3 | 4.0 | 4.3 | 4.1 | 4.9 | 4.2 | 3.9 | 4.3 |
| Average shower duration (minutes) | 8.2 | 7.5 | 7.5 | 7.3 | 10.2 | 8.0 | 6.5 | 7.6 |

The relationship between the frequency and duration of these activities and the number of occupants in the home is explored in the next section.

### 11.1.3 Household Characteristics Influencing Domestic Hot Water Use

Figure 31 shows the relationship between the number of people in the household and the average number of showers, laundry loads, dishwasher loads and baths per week. As expected, household size affects how many of each activity is performed and the demand for hot water. The rate of increase in the activity as household size increases varies by activity.

**Figure 31: Effect of Household Size on Hot Water Using Activities**




The results are largely consistent with the 1999 AWWA study on residential water use that found family size and the presence of children and teens increased water consumption associated with showers, baths, faucet use, and clothes washing.[55] The study also found water consumption for showers, baths and

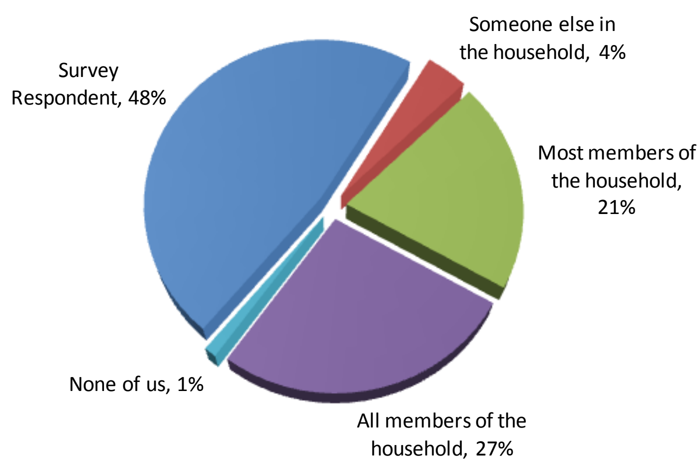
[55] Mayer, P.W., W.B. DeOreo et al. (1999).

dishwashers was positively correlated with the number of persons employed outside the home. The 2012 REUS did not ask about employment so similar relationships using the 2012 REUS were not possible. Water use associated with dishwashers was found to be positively correlated with household size but not necessarily the presence of teenagers or children. The AWWA data are presented to place scale and scope of energy use associated with a variety of common household water use behaviours. Comparable numbers for FortisBC customers are not available but could vary from these estimates for a variety of reasons including, but not exclusive of, differences in the stock and efficiency of end-use equipment, retail prices of natural gas, and cultural factors.

### 11.1.4 Contribution of Household Members to Conserving Energy

Energy conserving behaviours may vary by household member. Some members may be energy conscious and diligent while others are less so. To explore this dynamic, respondents were asked to indicate who in their household makes the most effort to conserve energy. The results, illustrated in Figure 32, show nearly half (48%) indicated it was themselves and one-in-five (21%) indicating it was most members of their household. Approximately, three-in-ten (27%) indicated it was all members of their household.

**Figure 32: Who in the Household Makes the Most Effort at Conserving Energy?**



# 12 PRODUCTS AND SERVICES

This section summarizes the results of a series of questions regarding awareness of utility and government energy efficiency brand names, participation in utility and government energy efficiency programs; interest in energy-related products and services, and various energy-related attitudes and beliefs. This section also summarizes data on access to the Internet, comfort navigating the Internet, and who most influences decisions for major appliance purchases.

## 12.1 Awareness of Utility and Government Energy Brand Names

Simple awareness of four different energy efficiency related brand names was tested using a five point scale where one meant “not at all familiar” and five meant “very familiar”. The distribution of responses for each brand is presented in Table 166. When the top two response categories (4 or 5) are summed, respondents were most familiar ENERGY STAR® (63% scoring either a 4 or 5), followed by BC Hydro’s Power Smart initiative (61%), and in third place, FortisBC’s PowerSense brand (37%). Last place is occupied by the LiveSmart BC brand. While this question tests recall of brand names, it does not test the respondent’s understanding, depth of knowledge or experience with the brand. Typically, the proportion recalling initiative brand will be higher, sometimes considerably higher, than the proportion that have a solid understanding of the brand’s offerings and other attributes.

**Table 166: Awareness of Energy Efficiency Initiatives**

| Energy Efficiency Initiative | Not at all familiar (1) | (2) | (3) | (4) | Very Familiar (5) | Very or Somewhat Familiar (4 or 5) |
|---|---|---|---|---|---|---|
| ENERGY STAR® | 12.2 | 7.0 | 17.8 | 21.5 | 41.5 | 63.0 |
| Power Smart (BC Hydro) | 11.3 | 8.7 | 19.0 | 20.8 | 40.1 | 60.9 |
| PowerSense (FortisBC) | 26.5 | 14.9 | 21.7 | 16.0 | 21.0 | 37.0 |
| LiveSmart BC | 39.0 | 17.2 | 19.8 | 11.4 | 12.7 | 24.1 |

The average familiarity score of the five energy efficiency brands in each of the five FEU regions is provided in Table 167. The familiarity score is calculated as the simple average of the 1 to 5 scores, with the lowest possible score being 1 (i.e., no one is familiar with the brand). The highest possible score is 5 (everyone is very familiar with the brand). This type of scoring incorporates all responses, not just those most familiar with the brand. ENERGY STAR and BC Hydro’s Power Smart brand names tied with each having a familiarity score of 3.6 out of 5.0. PowerSense ranked third with a 2.9 score. LiveSmart BC took fourth place with a score of 2.0 out of 5.0. Power Smart had the highest region to region variability.

**Table 167: Awareness Score for Energy Efficiency Brands by Region**
**Score (Min = 1, Max = 5)**

| Energy Efficiency Initiative | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* |
| ENERGY STAR® | 3.7 | 3.4 | 3.5 | 3.4 | 3.1 | 3.6 |
| Power Smart (BC Hydro) | 3.8 | 3.0 | 3.7 | 3.8 | 3.1 | 3.6 |
| PowerSense (FortisBC) | 2.8 | 3.1 | 2.8 | 2.5 | 2.6 | 2.9 |
| LiveSmart BC | 2.0 | 2.1 | 2.1 | 1.8 | 1.5 | 2.0 |

## 12.2 Past Participation in Energy Efficiency Rebate Programs

Respondents to the 2012 REUS were asked to indicate whether their household had, over the last five years, participated in energy efficiency programs offered by either BC Hydro (Power Smart), ecoENERGY / LiveSmart BC, FortisBC Energy (formerly Terasen Gas), or FortisBC Electric (PowerSense). The results, summarized in Table 168, should be interpreted with caution as they reflect a wide range of influencing factors, including, but not exclusive of:

- overall geographic coverage of the utility's programs (e.g., FortisBC Electric's PowerSense program is offered only to their electric customers in the Interior region);
- the range of different residential programs offered by the utility (e.g., the number of different programs available to households and whether these programs were offered in one or more of the last five years);
- awareness of the utility or government program (influenced, in part, by the amount of marketing); and
- relative popularity of the program (influenced by a range of factors, including the amount of the incentive relative to the energy-efficient appliance or activity promoted).

**Table 168: Participation in Energy Efficiency Rebate Programs in the Last Five Years by Region (%)**

| Energy Efficiency Rebate Program | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *745* | *1601* | *716* | *81* | *101* | *3244* |
| Power Smart (BC Hydro) | 20.8 | 7.7 | 21.8 | 19.0 | 9.5 | 17.3 |
| ecoENERGY/LiveSmart BC | 13.9 | 12.1 | 10.0 | 7.1 | 0.9 | 12.9 |
| FortisBC Energy (formerly Terasen Gas) | 9.1 | 11.0 | 6.2 | 7.1 | 2.8 | 9.3 |
| PowerSense (FortisBC Electric) | 3.5 | 9.2 | 2.4 | 1.2 | 0.0 | 4.9 |
| None of the above | 61.2 | 65.6 | 64.4 | 69.0 | 85.8 | 62.8 |

Multiple responses allowed.

The largest share of respondents participating in a rebate program said they had participated in a BC Hydro Power Smart program (17% in the last five years), followed by the ecoENERGY / LiveSmart BC program (13%), and FortisBC Energy (formerly Terasen Gas)(9%). Regional results reflect, in part, the utility service coverage. For example, participation in BC Hydro's Power Smart program is lowest in the Interior region (8% versus 17% overall) while participation in a FortisBC Electric PowerSense program is highest in the Interior (9%). Interestingly, small percentages of customers in regions outside of the Interior reported participating in a FortisBC Electric program. This result may reflect some incorrect association of another utility's program with the FortisBC Electric program. Notably, two-thirds (63%) of respondents to the 2012 REUS did not participate in any of the programs during the past five years.

Table 169 (next page) explores the participation in utility or government rebate programs by the vintage of the respondent's dwelling. The results suggest that, regardless of program, participation does not necessarily depend upon whether the home is older or newer.

**Table 169: Participation in Energy Efficiency Rebate Programs in the Last Five Years by Dwelling Vintage (%)**

| Energy Efficiency Rebate Program | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| Power Smart (BC Hydro) | 11.8 | 16.4 | 19.5 | 17.8 | 19.0 | 18.1 | 14.6 |
| ecoENERGY/LiveSmart BC | 14.9 | 13.8 | 16.8 | 13.2 | 7.5 | 10.2 | 2.1 |
| FortisBC Energy (formerly Terasen Gas) | 11.7 | 9.1 | 7.7 | 12.8 | 6.5 | 6.9 | 2.1 |
| PowerSense (FortisBC Electric) | 4.8 | 5.9 | 4.0 | 3.6 | 6.1 | 5.9 | 5.3 |
| None of the above | 64.9 | 61.5 | 59.4 | 61.0 | 66.8 | 68.6 | 80.0 |

Multiple responses allowed. Totals may not sum to 100%

## 12.3 Interest in Products and Services

Interest in a number of products and services that could be offered by FortisBC was queried using a four point scale where one meant "not at all interested" and a four meant "very interested". The results, ranked by the proportion that indicated an interest level of 3 or 4, are summarized in Table 170. As no financial obligation or commitment is implied or associated with a respondent's answer, caution is advised in over-interpreting interest in any particular product or service as indicative of program uptake that would occur if the product or service was offered.

**Table 170: Interest in Products and Services (%)**
**Ordered by % Very or Somewhat Interested**

| Product / Service | Not at all Interested (1) | (2) | (3) | Very Interested (4) | Interested (3 or 4) |
|---|---|---|---|---|---|
| Furnace or heat pump tune-up to ensure they are working safely and efficiently | 31.3 | 16.3 | 26.8 | 25.6 | **52.4** |
| Home energy audit to determine main energy uses in the home and identify opportunities to save energy | 29.2 | 20.6 | 24.2 | 26.0 | **50.2** |
| Program to replace standard efficiency water heater with high efficiency water heater | 35.8 | 15.8 | 22.6 | 25.8 | **48.4** |
| Program to install an in-home display that allows you to monitor your home's energy usage | 34.9 | 19.2 | 21.9 | 24.0 | **45.9** |
| Program to compare your home's energy use with homes of comparable size and type | 33.9 | 20.3 | 24.9 | 21.0 | **45.8** |
| Program to improve draft proofing | 35.4 | 19.3 | 24.4 | 20.9 | **45.3** |
| Do-it-yourself online energy audit | 32.9 | 22.1 | 24.6 | 20.4 | **45.0** |
| Program that allows you to pay for energy-efficient improvements to your home via instalments on your utility bill | 39.2 | 19.9 | 23.7 | 17.2 | **40.9** |
| Program to upgrade attic and wall insulation | 43.3 | 17.7 | 18.4 | 20.7 | **39.1** |
| Program to replace a low efficiency furnace with a high efficiency furnace | 48.3 | 12.9 | 16.6 | 22.1 | **38.8** |
| Program to replace standard efficiency clothes washer with high efficiency clothes washer | 48.2 | 17.3 | 18.0 | 16.5 | **34.5** |
| Program to install high efficiency gas fireplace | 53.8 | 13.6 | 14.6 | 18.1 | **32.7** |
| Program to install programmable thermostats | 57.1 | 14.5 | 14.3 | 14.1 | **28.4** |
| Program to purchase an electric automobile | 56.7 | 16.1 | 14.1 | 13.1 | **27.1** |

The top three programs include a furnace tune-up program, a program offering home energy audit, and a program to encourage replacement of standard efficiency hot water heaters.

### 12.4 Attitudes toward Energy Use

Attitudes and behaviours can influence how households use energy or respond to programming designed to reduce energy consumption. Table 171 represents the first of two tables that summarize the relative agreement or disagreement of REUS 2012 respondents with a broad range of statements. Agreement with the statement is represented by those who indicated either a 4 or 5, while disagreement is represented by either a 1 or 2 on the scale. Those undecided, unsure or with no strong opinion (neutral) are represented by a 3. The responses to these questions can be used in psychographic segmentation studies.

**Table 171: Attitudes and Beliefs (%) – Part I**

| Attitudes and Beliefs – Part I | Strongly Disagree (1) | (2) | Neither Agree or Disagree (3) | (4) | Strongly Agree (5) | Disagree (1 or 2) | Agree (4 or 5) |
|---|---|---|---|---|---|---|---|
| There are many ways that a person can save energy. When you add them up, they result in substantial savings | 1.0 | 2.7 | 13.3 | 37.8 | 45.2 | 3.7 | 83.0 |
| By making my home more energy-efficient, I am helping to do my part for the environment | 1.1 | 2.6 | 12.8 | 34.8 | 48.6 | 3.7 | 83.5 |
| I think natural gas is a clean and efficient energy source | 1.1 | 2.7 | 16.2 | 35.2 | 44.8 | 3.8 | 80.0 |
| Members of my household regularly limit the length of their showers to save energy | 5.9 | 12.2 | 32.2 | 28.2 | 21.5 | 18.1 | 49.7 |
| I don't want to think about natural gas or electricity, I just want it to work | 18.4 | 17.9 | 28.9 | 19.3 | 15.5 | 36.3 | 34.8 |
| I consider natural gas to be a safe energy source | 1.2 | 3.1 | 19.6 | 36.2 | 39.8 | 4.3 | 76.0 |
| When something needs to be done around home, I usually hire someone | 23.2 | 21.5 | 27.8 | 16.4 | 11.1 | 44.6 | 27.5 |
| I almost always have a home renovation on the go | 32.4 | 23.7 | 23.9 | 13.3 | 6.7 | 56.1 | 20.0 |
| It is cheaper to heat a home with natural gas than it is with electricity | 2.7 | 4.1 | 32.5 | 24.8 | 35.8 | 6.9 | 60.7 |
| Our household has reduced its energy use by as much as reasonably possible | 3.3 | 12.2 | 30.2 | 33.7 | 20.5 | 15.5 | 54.3 |
| I am a busy person with little or no time to research ways to save energy | 15.9 | 20.8 | 42.4 | 14.8 | 6.1 | 36.6 | 20.9 |
| I conserve energy because it saves money, not because it helps the environment | 12.7 | 17.2 | 36.0 | 20.8 | 13.2 | 29.9 | 34.0 |

Notable observations include:

- somewhat more than eight-in-ten (83%) respondents agree that natural gas is a clean and efficient energy source;
- approximately equal proportions of customers wish not to think about their natural gas or electrical service as those that do (35% and 36% respectively); and
- six-in-ten (61%) feel that is cheaper to heat a home with natural gas than it is with electricity.

Table 172 presents the results for the second set of attitude and behaviour questions. As before, respondents were asked to rate their agreement or disagreement with a series of statements.

**Table 172: Attitudes and Beliefs (%) – Part II**

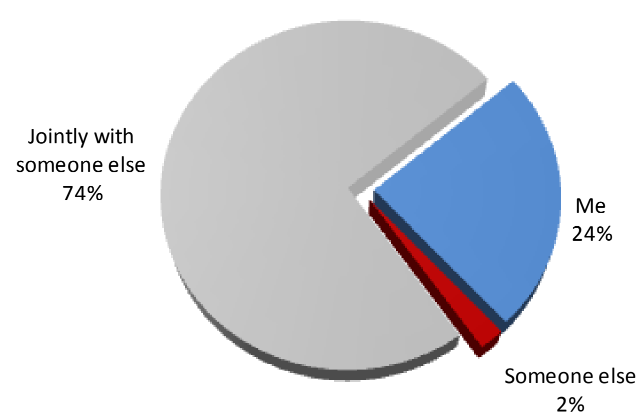
| Attitudes and Beliefs – Part II | Strongly Disagree (1) | (2) | Neither Agree or Disagree (3) | (4) | Strongly Agree (5) | Disagree (1 or 2) | Agree (4 or 5) |
|---|---|---|---|---|---|---|---|
| I am usually the first one to try new products | 14.5 | 16.3 | 47.8 | 14.6 | 6.9 | 30.8 | 21.4 |
| I am usually willing to pay more for brand name items | 14.7 | 16.5 | 31.6 | 29.1 | 8.1 | 31.2 | 37.2 |
| I prefer dealing with British Columbia based companies | 2.2 | 4.9 | 28.6 | 37.1 | 27.2 | 7.1 | 64.3 |
| I always look for the best price when buying products or services | 1.9 | 5.1 | 19.8 | 37.2 | 36.0 | 7.0 | 73.2 |
| I usually take time to research issues thoroughly before making a decision | 1.7 | 3.6 | 19.1 | 42.7 | 33.0 | 5.3 | 75.7 |
| I am the type of person to have good insurance coverage | 1.7 | 2.4 | 12.4 | 37.6 | 45.9 | 4.1 | 83.5 |

## 12.5 Major Appliance Purchases – Factors Influencing Decisions

The 2012 REUS explored a small number of factors that can influence decisions for major appliance purchases, including who in the home makes the purchase decision, access to the Internet, comfort navigating the Internet, and sources of information used to make a decision.

When asked who in their household makes major appliance purchase decisions, nearly three-quarters (74%) of survey respondents indicated it was them along with someone else in the home, and one-quarter (24%) said they, alone, make the major appliance purchase decisions (Figure 33). Only two percent (2%) said someone else in the household makes the decisions.

**Figure 33: Who Makes the Decision Regarding Major Appliance Purchases?**



### 12.6 Internet Access & Comfort Navigating the Internet

The vast majority (92%) of FEU residential customers responding to the 2012 REUS indicated they have high speed access to the Internet from their residence, while another two percent (1.7%) have access via dial up modem (Table 173). On average, under one-in-ten (7%) of respondents indicated they do not have Internet access at their residence.

**Table 173: Residential Internet Access by Region (%)**

| Type of Access | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *776* | *1664* | *740* | *85* | *103* | *3368* |
| High speed | 92.9 | 88.8 | 91.8 | 94.1 | 92.3 | 91.7 |
| Dial-up modem | 1.5 | 2.3 | 1.4 | -- | -- | 1.7 |
| No Internet Access | 5.5 | 8.9 | 6.9 | 5.9 | 7.7 | 6.6 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Respondents were asked to rate their comfort with navigating the Internet as either “very comfortable”, “somewhat comfortable”, “not very comfortable”, or “not at all comfortable”. The distribution of responses by the five regions, presented in Table 174, shows the majority (61%) of FEU residential customers are comfortable with navigating the Internet, while another one-quarter (25%) are somewhat comfortable. One-in-eight (13%) indicated they were either not very comfortable or not at all comfortable. Regionally, Whistler has the smallest proportion of customers that are either not very or not at all comfortable (7%), while the Interior has the highest (16%).

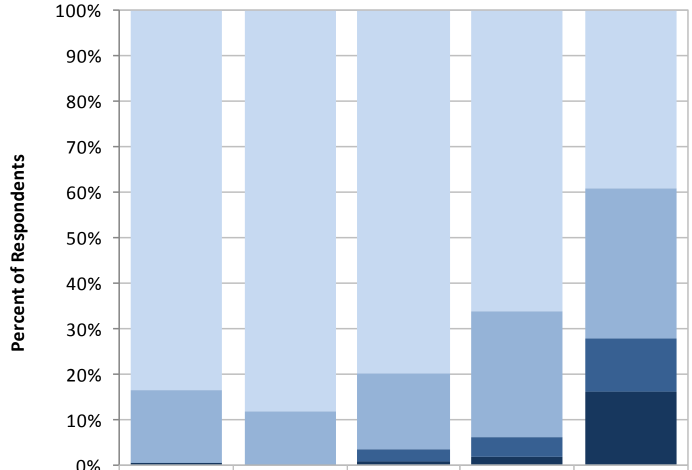
**Table 174: Comfort with Navigating the Internet by Region (%)**

| Comfort Level | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *774* | *1641* | *728* | *84* | *103* | *3330* |
| Not at all comfortable | 6.2 | 8.6 | 6.0 | 2.4 | 6.7 | 6.8 |
| Not very comfortable | 6.1 | 7.6 | 5.6 | 4.8 | 5.8 | 6.4 |
| Somewhat comfortable | 24.4 | 27.2 | 26.6 | 14.5 | 28.1 | 25.4 |
| Very comfortable | 63.3 | 56.6 | 61.7 | 78.3 | 59.4 | 61.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Figure 34 (next page) shows the proportion of respondents that are very comfortable with navigating the Internet progressively shrinks as the respondent age increases. For example, nine-in-ten (88%) of those in the 35-44 age cohort indicated they were very comfortable with navigating the Internet compared to just four-in-ten (39%) of those aged 65 or older.

**Figure 34: Comfort with Navigating the Internet – By Age Group**




| | < 35 years | 35-44 years | 45-54 years | 55-64 years | 65 years + |
|---|---|---|---|---|---|
| Very comfortable | 83.4 | 88.0 | 79.8 | 66.3 | 39.3 |
| Somewhat comfortable | 16.1 | 11.8 | 16.5 | 27.6 | 32.8 |
| Not very comfortable | 0.1 | 0.0 | 2.9 | 4.2 | 11.9 |
| Not at all comfortable | 0.4 | 0.2 | 0.8 | 1.9 | 16.0 |

There are no statistically significant differences in relative comfort navigating the Internet based on respondent gender (data not shown).

### 12.6.1 Sources of Information Used in Appliance Purchase Decisions

To better understand what sources of information are used to make a purchase decision for a major appliance, respondents to the 2012 REUS were asked to rate the influence different (potential) information sources using a five point scale, where one meant "not at all influential" and five meant "very influential". Respondents were asked to rate seven sources of information, including:

- Contractors / tradespersons
- Customer ratings
- Expert reviews (e.g., magazines, websites, TV)
- Electric or gas utilities
- Government
- Appliance salespeople
- Knowledgeable family member, friend, or neighbour

Table 175 (next page) summarizes respondent answers by three metrics: not influential (either a 1 or 2 on the five point scale), influential (4 or 5), and the weighted average influence score (maximum score of 5). Generally speaking, the relative influence that an individual source of information has will be related to the trustworthiness of the information source.

**Table 175: Influential Sources of Information for Purchasing a Major Appliance**

| Sources of Information | Not Influential (1 or 2) % | Influential (4 or 5) % | Average Score (max=5) |
|---|---|---|---|
| Customer ratings | 16.6 | 56.9 | 3.6 |
| Knowledgeable family member, friend, or neighbour | 16.3 | 55.8 | 3.5 |
| Expert reviews (e.g., magazines, websites, TV) | 20.6 | 52.8 | 3.4 |
| Electric or gas utilities | 32.8 | 37.7 | 3.0 |
| Contractors / tradespersons | 43.7 | 29.2 | 2.7 |
| Appliance salespeople | 42.1 | 22.7 | 2.7 |
| Government | 54.5 | 19.8 | 2.4 |

Customer ratings, knowledgeable family members, friends or neighbours, and expert reviews are considered the most influential of the seven sources, with weighted average influence scores ranging from 3.4 to 3.6. Least influential are appliance salespeople and government (scores of 2.7 and 2.4 respectively). Electric or gas utilities were in the middle, with four-in-ten (38%) of respondents indicating they are influential in their appliance choice decision (score of 3.0).

While the question design and presentation of data evaluate each source individually, it is realistic to assume that appliance purchase decisions may require input from more than one source of information.

When average influence scores were analyzed by age and gender of the survey respondent (Table 176), there were no significant differences by age or age grouping. When compared on the basis of gender, women were more likely to rate all sources of information as being more influential to their decisions than their male counterparts.

**Table 176: Influential Sources of Information for Purchasing a Major Appliance – Gender Differences Average Influence Score (Max =5)**

| | Average Score (Max = 5) | |
|---|---|---|
| Sources of Information | Women | Men |
| *Unweighted base* | *1,443* | *1,898* |
| Customer ratings | 4.3 | 4.1 |
| Knowledgeable family member, friend, or neighbor | 4.3 | 3.8 |
| Expert reviews (e.g., magazines, websites, TV) | 4.1 | 4.0 |
| Electric or gas utilities | 3.9 | 3.7 |
| Contractors / tradespersons | 3.6 | 3.2 |
| Appliance salespeople | 3.4 | 3.1 |
| Government | 3.3 | 3.1 |

# 13 DEMOGRAPHICS

This section summarizes demographic and socio-demographic characteristics of respondents to the 2012 REUS and their households, with comparisons to the 2008 and 2002 REUS surveys.

## 13.1 Survey Respondent Characteristics

### 13.1.1 Age Cohorts

The distribution of survey respondents by age cohort is summarized in Table 177. Comparisons are provided with the 2008 and 2002 surveys. Of note, the proportion of respondents 45 years or older responding to the REUS surveys has increased from slightly greater than seven-in-ten (72%) in 2002 to nearly nine-in-ten (85%) in 2012. This is consistent with the aging of the general population base (see Section 3).

**Table 177: REUS Respondents by Age Group by Region (%)**

| Age Cohort | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *773* | *1658* | *726* | *82* | *102* | *3341* | *2186* | *2533* | *1424* | *1491* |
| 18 yrs or younger | -- | 0.1 | -- | -- | -- | 0.0* | -- | 0.0* | -- | 0.1 |
| 19 – 24 yrs | 0.4 | 0.1 | -- | -- | -- | 0.3 | 0.4 | 0.3 | 0.5 | 0.6 |
| 25 – 34 yrs | 4.0 | 3.5 | 3.2 | 1.2 | 10.6 | 3.8 | 4.2 | 3.9 | 4.5 | 8.1 |
| 35 – 44 yrs | 11.1 | 9.5 | 7.9 | 13.6 | 19.3 | 10.4 | 13.7 | 10.6 | 14.5 | 19.6 |
| 45 – 54 yrs | 21.1 | 18.5 | 15.0 | 25.9 | 31.9 | 19.8 | 20.4 | 20.3 | 20.3 | 25.6 |
| 55 – 64 yrs | 27.3 | 27.8 | 27.1 | 28.4 | 25.2 | 27.4 | 28.9 | 27.4 | 29.0 | 21.6 |
| 65 yrs and older | 36.1 | 40.6 | 46.8 | 30.9 | 12.9 | 38.4 | 32.4 | 37.4 | 31.1 | 24.3 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| 44 yrs or younger | 15.5 | 13.1 | 11.0 | 14.8 | 30.0 | 14.4 | 18.3 | 14.8 | 19.5 | 28.4 |
| 45 yrs or older | 84.5 | 86.9 | 89.0 | 85.2 | 70.0 | 85.6 | 81.7 | 85.2 | 80.5 | 71.6 |

Totals may not sum due to rounding.
* Value less than 0.01%

### 13.1.2 Gender

The gender of the survey respondents, by region, is provided in Table 178. Overall, more males than females responded to the 2012 survey (57% versus 40%). Significantly more males in the Lower Mainland and Whistler regions responded to the survey.

**Table 178: Survey Respondent Gender by Region (%)**

| Gender | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* |
| Female | 38.3 | 43.2 | 43.2 | 29.8 | 49.7 | 40.2 |
| Male | 59.0 | 54.0 | 53.3 | 67.9 | 48.4 | 57.0 |
| No answer | 2.6 | 2.9 | 3.5 | 2.4 | 1.9 | 2.8 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

### 13.1.3 Marital Status

A summary of the survey respondents by marital status is provided in Table 179. There are no significant differences when compared to those who responded to the 2008 REUS.

**Table 179: Marital Status by Region (%)**

| Marital Status | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2174* | *2604* | *1415* | *1481* |
| Single | 6.1 | 6.3 | 4.3 | 12.2 | 14.5 | 6.0 | 6.7 | 6.2 | 6.8 | 6.8 |
| Married / common law | 82.1 | 76.7 | 77.6 | 75.6 | 71.0 | 80.1 | 79.7 | 80.4 | 79.9 | 79.9 |
| Divorced / separated | 5.5 | 7.3 | 6.6 | 7.3 | 11.6 | 6.1 | 5.8 | 6.1 | 5.6 | 7.3 |
| Widowed | 6.4 | 9.7 | 11.6 | 4.9 | 2.9 | 7.8 | 7.8 | 7.4 | 7.7 | 6.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

### 13.1.4 Educational Attainment

The distribution of survey respondents by the highest level of educational attainment is provided in Table 180. Changes from 2008 include significantly more respondents with a post-graduate degree (13% in 2012 versus 10% in 2008), and proportionately fewer respondents with a high school degree as their highest educational attainment (13% versus 17%).

**Table 180: Respondent Education Status by Region (%)**
**Highest Level of Education Achieved**

| Education | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* | *2604* | *1446* | *1610* |
| Some high school | 4.8 | 6.7 | 4.9 | 1.2 | 4.8 | 5.3 | 4.7 | 5.4 | 4.6 | 9.2 |
| Completed high school | 12.2 | 15.9 | 14.1 | 5.9 | 19.9 | 13.4 | 16.9 | 13.4 | 16.7 | 14.4 |
| Some trade / technical school | 5.9 | 7.7 | 5.6 | 5.9 | 10.4 | 6.4 | 7.4 | 6.5 | 7.7 | 15.4 |
| Completed trade / technical school | 12.4 | 15.5 | 12.4 | 8.3 | 18.0 | 13.2 | 14.4 | 13.3 | 14.7 | 14.9 |
| Some university / college | 18.4 | 18.4 | 19.0 | 10.7 | 17.1 | 18.4 | 18.0 | 18.4 | 17.9 | 7.3 |
| Completed university / college | 28.5 | 24.7 | 25.3 | 38.1 | 19.3 | 27.1 | 25.8 | 27.3 | 25.9 | 23.7 |
| Post graduate | 14.9 | 8.6 | 14.8 | 27.4 | 8.5 | 13.2 | 9.8 | 12.9 | 9.6 | 6.1 |
| No response | 2.9 | 2.5 | 4.0 | 2.4 | 1.9 | 2.9 | 3.1 | 2.8 | 3.0 | 9.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

## 13.2 Household Characteristics

### 13.2.1 Number of Occupants per-Dwelling

Table 181 (next page) summarizes the average number of occupants per dwelling, including the proportion of homes with two occupants or less, between three and five occupants, and six or more occupants. Overall, the average is 2.8 occupants per-dwelling. Household sizes tend to be larger in the Lower Mainland (average of 2.9 occupants per dwelling) and smaller in the Interior and Vancouver Island (2.4 occupants each). At the utility level, there is no statistically significant change in the overall average between 2012 and 2008.

**Table 181: Average Number of Occupants per Dwelling by Region (%)**

| Number of Occupants per-Dwelling | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2174* |
| Average per home | 2.9 | 2.4 | 2.4 | 2.7 | 2.6 | 2.8 | 2.8 |
| Standard Deviation | 2.34 | 0.84 | 0.81 | 0.58 | 0.36 | 1.22 | 1.60 |
| Homes by size: | | | | | | | |
| 2 occupants or less (%) | 51.9 | 69.8 | 72.5 | 60.5 | 58.0 | 58.9 | 55.3 |
| 3 - 5 occupants (%) | 43.2 | 28.5 | 25.6 | 34.6 | 39.1 | 37.3 | 39.1 |
| 6 occupants or more (%) | 4.9 | 1.7 | 1.9 | 4.9 | 2.9 | 3.7 | 5.6 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

When analyzed by the number of occupants, homes with two people or less represent the majority (59%) of all FEU households, followed by those with between three and five people (37%). Homes with six or more people are significantly less common (4% of households) and are more likely to occur in the Lower Mainland. Homes in the Interior and Whistler regions are more likely than other regions to have two occupants or less.

The composition of FEU homes by age of the home's occupants is provided in Table 182. The data are expressed in terms of the number of occupants by age group per the base of all homes in the region. To illustrate using an example, there are an average of 0.11 occupants five years of age or younger per FEU household in 2012, compared to 0.46 occupants per-household for those aged 25 to 44 years.

**Table 182: Average Number of Occupants in the Home by Age Cohort and Region**

| Age Cohort | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* |
| 5 years or younger | 0.12 | 0.08 | 0.07 | 0.12 | 0.16 | 0.11 |
| 6 – 12 yrs | 0.17 | 0.11 | 0.10 | 0.16 | 0.19 | 0.15 |
| 13 – 18 yrs | 0.20 | 0.13 | 0.11 | 0.12 | 0.24 | 0.17 |
| 19 – 24 yrs | 0.21 | 0.13 | 0.11 | 0.22 | 0.14 | 0.18 |
| 25 – 44 yrs | 0.55 | 0.32 | 0.33 | 0.49 | 0.71 | 0.46 |
| 45 – 64 yrs | 0.99 | 0.91 | 0.80 | 1.14 | 0.98 | 0.95 |
| 65 yrs and older | 0.66 | 0.71 | 0.83 | 0.47 | 0.22 | 0.69 |

The incidence of occupants by age cohort is summarized in Table 183 (next page). The data show that, on average, less than one-in-ten (7%) of FEU households have at least one pre-school aged child (five years of age or younger), one-in-ten have pre-teens, and one-in-eight (13%) have teenagers at home. Regionally, FEU households in the Lower Mainland and Fort Nelson are more likely to have children (any age under 19 years old) compared to the other regions. Consistent with a population dominated by the aging baby boom cohort, over four-in-ten (44%) of FEU households have at least one household member who is 65 years or older (e.g., a senior). Vancouver Island households have the highest incidence of seniors (53%) versus Fort Nelson with the lowest (16%).

**Table 183: Incidence of Household Members by Age Cohort by Region (%)**

| Age Cohort of Home's Occupants | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* |
| 5 years or younger | 8.3 | 5.8 | 5.1 | 8.6 | 9.8 | 7.3 |
| 6 – 12 yrs | 12.2 | 7.5 | 7.3 | 13.6 | 11.7 | 10.4 |
| 13 – 18 yrs | 15.1 | 9.5 | 8.5 | 7.4 | 17.6 | 12.9 |
| 19 – 24 yrs | 15.9 | 9.2 | 8.3 | 11.1 | 9.8 | 13.2 |
| 25 – 44 yrs | 33.8 | 21.0 | 19.1 | 30.9 | 43.0 | 28.8 |
| 45 – 64 yrs | 58.2 | 56.1 | 50.0 | 65.4 | 59.6 | 56.8 |
| 65 yrs and older | 42.4 | 45.2 | 53.0 | 32.1 | 16.0 | 44.2 |
| Households with children (<19 yrs) % | 27.7 | 18.0 | 16.6 | 21.4 | 32.3 | 23.9 |
| Households without children (<19 yrs) % | 72.3 | 82.0 | 83.4 | 78.6 | 67.7 | 76.1 |

Columns do not sum to 100%

To explore the relationship between dwelling type and occupant characteristics, the incidence of individuals by age cohort by dwelling type is provided Table 184. While sample sizes for some dwelling types, especially apartments /condominiums, are small, the data show relatively few differences among the dwelling types. Apartments/condominiums and mobile homes are notable in that they are the least likely to have children at home (0% and 10% respectively). Mobile homes tend to have older residents, including the highest incidence of seniors (55%).

**Table 184: Incidence of People in the Home by Age Cohort by Dwelling Type (%)**

| Age Cohort of Home's Occupants | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2,792* | *154* | *207* | *55* | *118* | *59* |
| 5 years or younger | 7.4 | 6.5 | 8.7 | 0.0 | 1.8 | 15.6 |
| 6 – 12 yrs | 10.4 | 11.4 | 13.0 | 0.0 | 2.5 | 11.3 |
| 13 – 18 yrs | 13.5 | 10.7 | 13.7 | 0.0 | 6.7 | 12.5 |
| 19 – 24 yrs | 14.3 | 8.9 | 8.8 | 0.0 | 8.0 | 22.6 |
| 25 – 44 yrs | 28.5 | 32.9 | 31.8 | 23.7 | 16.1 | 35.0 |
| 45 – 64 yrs | 59.0 | 51.1 | 47.2 | 36.8 | 45.0 | 52.0 |
| 65 yrs and older | 43.1 | 50.8 | 41.1 | 45.9 | 55.2 | 71.8 |
| Households with children (<19 yrs) | 24.4 | 24.2 | 27.8 | 0.0 | 10.2 | 28.5 |
| Households without children (<19 yrs) | 75.6 | 75.8 | 72.2 | 100.0 | 89.8 | 71.5 |

As discussed in Section 3, the number of occupants in the home affects household energy use particularly for domestic hot water uses (clothes washing, dishwashing, showers, etc.). Table 185 (next page) summarizes the proportion of FEU households that saw an increase, decrease, or a combination of increase and decrease in the number of occupants during the last two years.

**Table 185: Changes in the Number of People in the Home by Region (%)**
**Change in Number of Occupants during the Last 2 Years**

| Number of Occupants | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | 2181 | *2604* | 1420 | 1610 |
| Yes – changed in last two years | 21.9 | 20.0 | 17.7 | 14.6 | 32.2 | 21.0 | 32.2 | 21.4 | 33.2 | 32.1 |
| Yes – more people in the past | 12.1 | 11.2 | 10.7 | 8.5 | 15.6 | 11.7 | 17.8 | 11.8 | 18.4 | 19.3 |
| Yes – fewer people in the past | 7.0 | 6.2 | 4.5 | 2.4 | 11.7 | 6.5 | 7.1 | 6.8 | 7.3 | 11.9 |
| Yes – both fewer and more people in the past | 1.9 | 2.4 | 1.9 | 3.7 | 2.9 | 2.1 | 7.1 | 2.1 | 7.2 | 4.6 |

One-in-five (21%) of FEU customers indicated the number of people in the home had changed in the last two years, down from two-thirds (32%) of households in 2008. One-in-eight (12%) had experienced a decrease in household size during the last two years and under one-in-ten (7%) had experienced an increase in household size in the last two years. Two percent (2%) said their home had experienced both an increase and decrease. These results are consistent with aging of the population and the commensurate decline of household size due, in part, to adult children leaving home.

### 13.2.2 Household Income

The distribution of 2012 REUS respondents by annual household income is provided in Table 186. The data are useful in providing context to income-driven differences between consumers regarding behaviours, attitudes, and equipment purchase decisions. The proportion of respondents who chose to not answer the question is higher than in past surveys (31% in 2012 versus 25% in 2008). The dataset was not rebased to show only those who answered the question. This was done primarily because there is no a priori reason non-responses would be distributed across the income categories in the same relative proportions as responses. Regional comparisons can be made, but with caution as the proportion choosing not to answer the question does vary from region to region.

**Table 186: Annual Household Income before Taxes by Region (%)**

| Household Income | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU | 2012 FEI | 2008 FEI | 2002 FEI |
|---|---|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* | *2604* | *1446* | *1610* |
| Less than $20,000 | 2.9 | 4.2 | 1.7 | 1.2 | 2.8 | 3.1 | 3.7 | 3.3 | 3.8 | 6.1 |
| $20,000 to $29,999 | 3.9 | 7.7 | 4.8 | 3.6 | 1.9 | 5.0 | 16.7[1] | 5.0 | 16.6[1] | 17.2[1] |
| $20,000 to $39,999 | 4.9 | 8.7 | 8.1 | -- | 2.8 | 6.3 | | 6.1 | | |
| $40,000 to $49,999 | 5.9 | 7.7 | 7.0 | 2.4 | 4.8 | 6.5 | 17.6[2] | 6.5 | 17.5[2] | 17.6[2] |
| $50,000 to $59,999 | 6.6 | 7.3 | 8.2 | 3.6 | 6.6 | 6.9 | | 6.8 | | |
| $60,000 to $79,999 | 9.7 | 13.1 | 10.4 | 4.8 | 8.5 | 10.7 | 15.1 | 10.7 | 15.5 | 14.9 |
| $80,000 to $99,999 | 10.0 | 9.4 | 9.3 | 9.5 | 6.6 | 9.7 | 10.8 | 9.8 | 10.7 | 10.8 |
| $100,000 to $124,999 | 9.1 | 9.0 | 8.5 | 11.9 | 12.3 | 9.0 | 11.5 | 9.1 | 11.8 | 6.7 |
| $125,000 or more | 13.9 | 7.5 | 10.1 | 23.8 | 17.4 | 11.8 | 9.6 | 11.9 | 9.5 | 7.3 |
| No response / Prefer not to answer | 33.2 | 25.4 | 31.8 | 39.3 | 36.1 | 30.9 | 24.6 | 30.8 | 24.2 | 19.2 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Households with less than $40K | 11.7 | 20.6 | 14.6 | 4.8 | 7.6 | 14.4 | 20.4 | 14.4 | 20.4 | 23.3 |
| Households with less than $60K | 24.2 | 35.6 | 29.9 | 10.7 | 19.0 | 27.9 | 38.0 | 27.7 | 37.9 | 40.9 |
| Households with $100K or more | 23.0 | 16.5 | 18.6 | 35.7 | 29.8 | 20.8 | 21.1 | 21.0 | 21.3 | 14.0 |

[1] Represents household incomes of $20,000 to $39,999
[2] Represents household incomes of $40,000 to $59,999
Totals may not sum due to rounding.

Household incomes by dwelling type are summarized in Table 187. Occupants of mobile homes stand out as having proportionately lower household income compared to occupants in other dwelling types.

**Table 187: Annual Household Income before Taxes by Dwelling Type (%)**

| Household Income | Single Family Detached | Duplex | Row / Town-house | Apt / Condo-minium | Mobile Home | Other |
|---|---|---|---|---|---|---|
| *Unweighted base* | *2792* | *154* | *207* | *55* | *118* | *59* |
| Less than $20,000 | 2.4 | 2.5 | 8.3 | 7.9 | 11.0 | 4.0 |
| $20,000 to $29,999 | 4.0 | 4.7 | 6.1 | 7.8 | 27.0 | 23.2 |
| $30,000 to $39,999 | 6.1 | 11.4 | 3.1 | 8.9 | 12.8 | 9.0 |
| $40,000 to $49,999 | 6.6 | 9.9 | 4.9 | 9.0 | 5.1 | 2.1 |
| $50,000 to $59,999 | 7.0 | 9.1 | 4.2 | 7.7 | 6.6 | 9.1 |
| $60,000 to $79,999 | 10.3 | 14.7 | 14.1 | 16.9 | 6.7 | 3.1 |
| $80,000 to $99,999 | 9.8 | 8.6 | 11.5 | 10.2 | 5.7 | 10.4 |
| $100,000 to $124,999 | 9.2 | 10.5 | 9.0 | 5.1 | 0.9 | 2.9 |
| $125,000 or more | 13.0 | 6.9 | 6.2 | 13.8 | 0.2 | 13.1 |
| No response / Prefer not to answer | 31.7 | 21.8 | 32.5 | 12.7 | 23.9 | 23.0 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| Households with less than $40K | 12.5 | 18.6 | 17.6 | 24.6 | 50.9 | 36.3 |
| Households with less than $60K | 26.0 | 37.6 | 26.7 | 41.3 | 62.6 | 47.5 |
| Households with $100K or more | 22.2 | 17.4 | 15.2 | 18.9 | 1.1 | 16.0 |

Totals may not sum due to rounding.

### 13.2.3 Spoken Languages

The majority (92%) of respondents to the 2012 REUS indicated that English was the main language spoken in the home (Table 188). Mandarin and Cantonese are second and third most common, representing 3.1% of households. All other languages each represented less than one percent of REUS respondents.

**Table 188: Main Language Spoken in the Home by Region (%)**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* |
| English | 88.5 | 97.1 | 94.3 | 94.1 | 95.2 | 91.5 | 88.8 |
| Mandarin | 1.5 | 0.1 | -- | -- | -- | 0.9 | 1.4 |
| Cantonese | 3.5 | 0.1 | 0.1 | -- | -- | 2.2 | 3.6 |
| Hindi | -- | -- | -- | 1.2 | -- | 0.0 | 0.3 |
| Punjabi | 0.6 | 0.2 | 0.3 | -- | 0.9 | 0.5 | 0.4 |
| Tagalog | 0.1 | 0.1 | -- | -- | -- | 0.1 | 1.0 |
| Farsi (Persian) | 0.6 | -- | -- | -- | -- | 0.4 | -- |
| French | 0.4 | 0.4 | 0.7 | -- | 0.9 | 0.4 | 0.4 |
| German | -- | 0.2 | 0.4 | -- | -- | 0.1 | 0.6 |
| Other | 0.9 | 0.4 | 0.3 | -- | 0.9 | 0.7 | 2.1 |
| No response | 3.8 | 1.5 | 4.0 | 4.8 | 1.9 | 3.2 | 1.4 |
| **Total** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |

Totals may not sum due to rounding.

Other languages spoken in the home are listed in Table 189. All responses are expressed as a percent of the base of REUS respondents and include multiple responses.

**Table 189: All Other Languages Spoken in the Home – by Region**
**Multiple Responses Allowed**

| | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2174* |
| English | 5.4 | 0.2 | 2.4 | -- | -- | 3.7 | 3.7 |
| Mandarin | 2.6 | 0.1 | 0.5 | -- | -- | 1.7 | 0.7 |
| Cantonese | 2.6 | 0.1 | 1.1 | -- | -- | 1.8 | 1.4 |
| Hindi | 0.9 | -- | 0.8 | -- | -- | 0.6 | 0.5 |
| Punjabi | 1.1 | 0.1 | 0.8 | -- | -- | 0.8 | 0.7 |
| Tagalog | 0.6 | 0.1 | 0.5 | -- | -- | 0.5 | 0.6 |
| Farsi (Persian) | 0.2 | -- | 0.8 | -- | -- | 0.3 | 0.0* |
| French | 4.8 | 2.7 | 12.7 | 11.3 | -- | 5.1 | 4.3 |
| German | 3.8 | 1.3 | 10.5 | 11.3 | -- | 3.8 | 2.4 |
| Other | 6.5 | 1.2 | 9.7 | -- | -- | 5.4 | 2.9 |

* Value less than 0.01%

# 14 CONDITIONAL DEMAND ANALYSIS

FortisBC Energy Utilities (FEU) use information on end-use gas consumption for power system planning, load forecasting, marketing and demand side management. End-use consumption refers to the energy used for space heating, water heating, cooking and other specific uses, as opposed to total consumption. The Unit Energy Consumption (UEC) for an end-use is defined as the quantity of energy consumed by that end-use in a given period of time.

This section summarizes the results of a Conditional Demand Analysis (CDA) applied to the 2012 REUS data to estimate UEC values for major residential gas end-uses. CDA is a multivariate regression technique which combines utility billing data with weather information and customer survey data. A detailed presentation of the methodology, equation specifications, and equation results for the CDA are included in Appendix B.

## 14.1 Research Objectives

The objectives of the 2012 CDA analysis for FEU natural gas customers are to:

- estimate weather-normalized UEC values for major residential gas end-uses, including space heating, water heating, fireplaces, cooking and other specific uses;
- estimate UEC values for each of the following regions: Lower Mainland, Interior, Vancouver Island, Whistler and Fort Nelson;
- disaggregate UECs for key end-uses by the following dwelling types: single family dwellings, multi-family dwellings and vertical subdivisions; and
- compare the results with past CDA studies.

Gas end-uses modelled include:

- Primary space heating
- Secondary space heating (excluding fireplaces)
- Domestic water heating
- Fireplaces (heater type, free standing, and decorative)
- Cooking (gas range, cook top, oven, duel fuel range)
- Gas clothes dryers
- Hot tubs
- Piped gas BBQs
- Swimming pools

Attempts were made to model piped gas outdoor heaters and gas saunas. However, these end-uses were not retained in the conditional demand analysis because they produced unreasonable results, likely due to the small number of households possessing these end-uses.

## 14.2 CDA Sample

The sample used for the gas CDA consisted of households in FEU's service territory who participated in the 2012 Residential End-use Study. Consistent with the 2008 CDA, customers living in mobile homes or "other" dwelling types, as well as customers who have not lived in their residence for at least two years, were excluded from the analysis. There were a total of 3,109 customers in the resulting sample (Table 190).

**Table 190: Sample used in the 2012 FEU Conditional Demand Analysis**

| | LM | INT | VI | W | FN | 2012 FEU |
|---|---|---|---|---|---|---|
| Single family detached | 608 | 616 | 1382 | 43 | 69 | 2718 |
| Semi-detached | 122 | 71 | 109 | 32 | 7 | 341 |
| Apartments / Condominiums | 5 | 9 | 34 | 2 | -- | 50 |
| **Total 2012 CDA Sample** | **735** | **696** | **1525** | **77** | **76** | **3109** |

The survey data from these customers were used in combination with two year's worth of monthly billing data for each customer and regional specific weather data for the same period. The two-year period used was December 2010 to November 2012. Customers with missing billing data were not used in the estimation of the conditional demand models.

The conditional demand models were estimated using ordinary least squares. The regression models performed well. The adjusted R-squared values were high, and most of the regression coefficients had the correct sign and were significant at the five percent level or better (see Appendix B for the detailed regression outputs).

The regression coefficients were used to calculate Unit Energy Consumption (UEC) values for major residential end-uses. UECs were calculated for each household possessing the end-use by substituting household variables into the end-use equations. Normal heating degree days were substituted to generate weather-normalized UECs for space heating, fireplaces and water heating. Weighted average UECs were then calculated across all households possessing the end-use (weighted by region).

### 14.3 Utility Level UECs

An overall conditional demand model was constructed to estimate UECs for FEU's service territory. The weather-normalized, weighted UECs are shown in Table 191 (next page). As expected, the main end-uses are primary space heating at 52.4 GJ per year and water heating at 26.3 GJ per year. Other key end-uses are decorative fireplaces (17.7 GJ per year), heater type fireplaces (14.6 GJ per year) and gas cooking appliances (12.5 GJ per year). Secondary gas space heating (excluding fireplaces), gas heated pools and hot tubs are also heavy users of natural gas, but they have lower penetration rates than other major end-uses.

The average energy consumption per household (HEC) is calculated by multiplying each end-use's UEC by its penetration rate and summing across end-uses. The HEC is a measure of the average consumption of a household in FEU's service territory. The weather-normalized, weighted HEC was estimated to be 81.2 GJ per year. In comparison, the actual weighted consumption for the sample was 89.5 GJ per year. Part of the reason that estimated, weather-normalized consumption is lower than actual consumption levels is because normal weather conditions were warmer than during the two-year period from December 2010 to November 2012. However, Conditional Demand Analysis tends to underestimate actual consumption levels.[56]

**Table 191: Penetration Rates and Unit Energy Consumption by End-use – Overall Service Area**

| | Sample Size (unweighted) | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Avg. Consumption per Household (GJ/year) | | UECs in 2008 (GJ/year) | UECs in 2002 (GJ/year) |
|---|---|---|---|---|---|---|---|
| Primary Space Heating | 2511 | 86% | 52.4 | 44.9 | 55% | 57.8 | 67.8 |
| Secondary Space Heating | 111 | 3% | 24.5 | 0.7 | 1% | 23.2 | - |
| Water Heating | 2259 | 78% | 26.3 | 20.6 | 25% | 19.8 | 20.8 |
| Decorative Fireplace | 469 | 19% | 17.7 | 3.4 | 4% | 20.9 | 16.8^ |
| Heater Fireplace | 1331 | 43% | 14.6 | 6.3 | 8% | 17.4 | 15.8^^ |
| Free Standing Fireplace | 252 | 7% | 7.0 | 0.5 | 1% | - | - |
| Range, Cook Top, Oven | 826 | 29% | 12.5 | 3.6 | 4% | 5.4 | 8.5 |
| BBQ | 734 | 20% | 0.3 | 0.1 | <1% | 8.1 | 3.1 |
| Dryer | 159 | 5% | ** | ** | ** | 3.9 | 4.0 |
| Pool | 56 | 2% | 43.1 | 0.9 | 1% | 38.5 | 53.5 |
| Hot Tub | 21 | 1% | 21.3* | 0.2* | <1% | 19.5 | 17.9 |
| **Household Consumption** | | | | | | | |
| Estimated | | | | **81.2** | | **85.8** | **96.1** |
| Actual | | | | **89.5** | | **98.9** | **104.9** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** An attempt was made to include gas dryers in the CDA, but it was not retained in the model because the estimated UEC value was negative.
^ 2002 data represents log fireplaces
^^ 2002 data represents inserts

The table also shows a comparison between this study's UEC estimates and those produced in two previous conditional demand analyses, conducted as part of the 2002 and 2008 Residential End-Use Studies.[57] It is important to note the service territory analyzed in the 2002 study excluded Vancouver Island and Whistler. Vancouver Island now forms a sizable portion of FEU's service territory, but has lower natural gas consumption than the Lower Mainland or the Interior (e.g. space and water heating consumption tends to be lower for Vancouver Island). As a result, comparisons with the 2002 study may not be entirely valid.

The weather-normalized UEC for primary space heating has dropped from 57.8 GJ per year in the 2008 study to 52.4 GJ per year in this study. This decrease can be explained by improvements in heating efficiency over time.

In contrast, the weather-normalized UEC for water heating has increased from 19.8 GJ per year in the 2008 study to 26.3 GJ per year in the current analysis. This is mainly due to a higher UEC value estimated for the Lower Mainland region (see the following section for an explanation).

The UECs for many of the other end-uses are relatively consistent between studies, with the exception of gas cooking and BBQs. The UEC for gas cooking appliances (gas ranges, cook tops, ovens and duel fuel

[56] In CDA, the model's intercept term is forced to be zero to ensure it does not capture the effects of the individual end-uses. However, forcing the intercept to zero often results in underestimated total household consumption because non-modelled end-uses (e.g. outdoor heaters) and behaviours (e.g. heating use in the summer) are not captured.

[57] Habart (2003), Sampson Research (2009).

ranges) appears to be over-estimated and BBQs appears to be under-estimated in the current study. This may be due to the fact these two end-used provide the same service (i.e., cooking). It may be more meaningful to consider these end-uses in the aggregate when comparing the results.[58]

Finally, an attempt was made to include gas dryers in the CDA, but it was not retained in the final model because the estimated UEC value was negative.

## 14.4 Regional UECs

Individual CDA models were estimated for the Lower Mainland, Vancouver Island and Interior regions. For the two smaller regions of Whistler and Fort Nelson, the overall conditional demand model constructed at the utility level was used to estimate UECs. The results are presented in the following sections.

### 14.4.1 Lower Mainland

Table 192 shows the weather-normalized UECs for the Lower Mainland region. The major end-uses are primary space heating at 55.0 GJ per year and water heating at 29.9 GJ per year. For both these end-uses, the UEC values are greater than in the Vancouver Island or Interior regions. One reason the demand for space and water heating is higher in the Lower Mainland is that dwellings are larger on average. As well, the average number of people living in the household is greater in the Lower Mainland compared to the other regions, which particularly affects the demand for water heating (see Section 11.1.3).

**Table 192: Penetration Rates and Unit Energy Consumption by End-use – Lower Mainland**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Avg. Consumption per Household (GJ/year) | | UECs in 2008 (GJ/year) | UECs in 2002 (GJ/year) |
|---|---|---|---|---|---|---|---|
| Primary Space Heating | 664 | 90% | 55.0 | 49.7 | 56% | 62.0 | 65.3 |
| Secondary Space Heating | 15 | 2% | 41.5* | 0.8* | 1% | 18.1 | - |
| Water Heating | 610 | 83% | 29.9 | 24.8 | 28% | 20.4 | 21.0 |
| Decorative Fireplace | 171 | 23% | 12.9 | 3.0 | 3% | 21.4 | 16.2^ |
| Heater Fireplace | 321 | 44% | 10.5 | 4.6 | 5% | 18.3 | 14.9^^ |
| Free Standing Fireplace | 41 | 6% | 5.3 | 0.3 | <1% | - | - |
| Range, Cook Top, Oven | 236 | 32% | 9.2 | 3.0 | 3% | 5.6 | 8.6 |
| BBQ | 122 | 17% | 5.2 | 0.9 | 1% | 8.1 | 3.4 |
| Dryer | 36 | 5% | ** | ** | ** | 4.2 | 4.0 |
| Pool | 18 | 2% | 37.1* | 0.9* | 1% | 38.5 | 53.6 |
| Hot Tub | 8 | 1% | 21.6* | 0.2* | <1% | 19.5 | 17.8 |
| **Household Consumption** | | | | | | | |
| Estimated | | | | **88.2** | | **92.1** | **93.8** |
| Actual | | | | **98.1** | | **108.9** | **109.0** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** An attempt was made to include gas dryers in the CDA, but it was not retained in the model because the estimated UEC value was negative.
^ 2002 data represents log fireplaces
^^ 2002 data represents inserts

[58] In the 2008 study, these two end-uses were also challenging to model, with the gas cooking UEC underestimated and BBQs overestimated. However, the sum of the UECs appears to be consistent between studies.

The estimated UEC for secondary gas space heating is also high, but this value appears to be over-estimated. Only 15 households in the Lower Mainland sample used gas for secondary space heating (excluding fireplaces). Due to the small sample size, this UEC estimate may not be reliable.

The UECs for gas cooking appliances and BBQs appear to be more reasonable than in the overall model. An attempt was made to include gas dryers in the CDA, but it was not retained in the final model because the estimated UEC value was negative.

The weather-normalized annual energy consumption per household (HEC) was estimated to be 88.2 GJ per year. In comparison, the actual average consumption for the sample was 98.1 GJ per year.

The UEC for primary space heating decreased from 62.0 GJ per year in the 2008 study to 55.0 GJ per year in this study. Such a drop is consistent with improvements in heating efficiency, as well as a trend towards smaller households in the region. In contrast, the UEC for water heating in this study was significantly greater than in the 2008 study. Some of this change may be due to a rise in average dwelling size over time, though efficiency improvements and smaller households are thought to counteract this trend overall.

One explanation for the higher water heating UEC value is the methodological differences between studies. In the 2008 study, UEC estimates for the individual regions were derived from the overall conditional demand model constructed at the utility level. With this approach, the overall model was able to capture some regional variation in water heating by including variables that naturally varied by region (e.g., weather, household size, etc.) Still, the UEC estimates for water heating did not vary much between regions. In contrast, the individual condition demand models estimated for each region in the current study were better able to capture regional variation in end-use demand. Though the water heating UEC may be somewhat overestimated in the current analysis, it is likely more robust than in past studies.

UEC estimates for fireplaces are significantly lower than in the 2008 study. As with water heating, this change is mainly due to methodological differences between the studies. In the 2008 study, the overall model assumed a constant UEC specification for fireplaces across all regions based simply on the number of fireplaces in use. The resulting UEC estimates were very similar between regional subgroups. By developing individual conditional demand models for each region, and by incorporating data on heating degree days into the specifications, the current UEC estimates for fireplaces are considered to be more credible than in past studies.

### 14.4.2 Vancouver Island

Table 193 (next page) shows the weather-normalized UECs for the Vancouver Island region. The major end-uses are primary space heating at 43.0 GJ per year and water heating at 18.3 GJ per year. For both these end-uses, the estimated UECs are lower than in the Lower Mainland or Interior regions. Compared to the Lower Mainland, customers in Vancouver Island tend to have lower demand for space and water heating because dwellings are smaller, and because there are fewer people per-household on average. Weather conditions largely explain the difference in heating demand between Vancouver Island and the Interior, since the average size of homes and the number of household members is similar.

The weather-normalized annual energy consumption per household (HEC) was estimated to be 51.9 GJ per year. In comparison, the actual average consumption for the sample was 56.1 GJ per year.

**Table 193: Penetration Rates and Unit Energy Consumption by End-use – Vancouver Island**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Average Consumption per Household (GJ/year) | | UECs in 2008 (GJ/year) |
|---|---|---|---|---|---|---|
| Primary Space Heating | 445 | 64% | 43.0 | 27.5 | 53% | 43.0 |
| Secondary Space Heating | 25 | 4% | 6.9* | 0.2* | <1% | 19.9 |
| Water Heating | 476 | 68% | 18.3 | 12.5 | 3% | 18.8 |
| Decorative Fireplace | 81 | 12% | 12.0 | 1.4 | 12% | 19.7 |
| Heater Fireplace | 406 | 58% | 10.6 | 6.2 | 3% | 16.1 |
| Free Standing Fireplace | 89 | 13% | 12.8 | 1.6 | 24% | - |
| Range, Cook Top, Oven | 193 | 28% | 5.7 | 1.6 | 3% | 4.7 |
| BBQ | 181 | 26% | 1.1 | 0.3 | 1% | 8.1 |
| Dryer | 49 | 7% | 3.7 | 0.3 | 1% | 3.4 |
| Pool | 4 | 1% | ** | ** | ** | 38.5 |
| Hot Tub | 3 | <1% | *** | *** | *** | 19.5 |
| **Household Consumption** | | | | | | |
| Estimated | | | | **51.9** | | **64.8** |
| Actual | | | | **56.1** | | **67.2** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates (less than 5 households with end-use present).
*** An attempt was made to include hot tubs in the CDA, but it was not retained in the model because the estimated UEC value was negative.

The UECs for space and water heating did not change significantly from the 2008 study. Even with a trend towards larger dwellings, one would expect UECs for these end-uses to decrease over time because of efficiency improvements and smaller household sizes. As noted in the previous section, comparisons between years are complicated by the methodological differences between studies. In general, the estimates for space and water heating in the current study are considered to be more robust.

UEC estimates for fireplaces were significantly less than in the 2008 study, again because of key methodological differences. The current UEC estimates for fireplaces are thought to be more credible than in the 2008 study. In the current analysis, UECs for fireplaces were similar between Vancouver Island and the Lower Mainland, but lower than in the Interior.

As with the Lower Mainland, the sample used for Vancouver Island did not contain many households from vertical subdivisions. Consequently, the UEC values may be somewhat overestimated for end-uses that are influenced by dwelling type. Note the sample used in the 2008 study also under-represented vertical subdivisions in Vancouver Island.

### 14.4.3 Interior

Table 194 shows the weather-normalized UECs for the Interior region. The main end-uses are primary space heating at 53.0 GJ per year and water heating at 21.3 GJ per year. For both these end-uses, unit energy consumption is less than in the Lower Mainland, but greater than in Vancouver Island. Heater fireplaces (19.2 GJ per year) and decorative fireplaces (18.7 GJ per year) are also major users of natural gas in the Interior. These UEC values are higher than in the Lower Mainland or Vancouver Island regions.

The UECs for space and water heating were slightly larger than in the 2008 study. As noted in the previous sections, the current estimates for space and water heating are considered to be more robust because of the methodological approach used.

The weather-normalized annual energy consumption per household (HEC) was estimated to be 75.4 GJ per year. In comparison, the actual average consumption for the sample was 79.2 GJ per year.

**Table 194: Penetration Rates and Unit Energy Consumption by End-use – Interior**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Avg. Consumption per Household (GJ/year) | | UECs in 2002 (GJ/year) | UECs in 2008 (GJ/year) |
|---|---|---|---|---|---|---|---|
| Primary Space Heating | 1287 | 84% | 53.0 | 44.7 | 59% | 74.1 | 51.6 |
| Secondary Space Heating | 68 | 4% | 18.5 | 0.8 | 1% | - | 39.3 |
| Water Heating | 1081 | 71% | 21.3 | 15.1 | 20% | 20.3 | 18.8 |
| Decorative Fireplace | 201 | 13% | 18.7 | 2.5 | 3% | 18.6^ | 19.8 |
| Heater Fireplace | 543 | 36% | 19.2 | 6.8 | 9% | 18.3^^ | 15.9 |
| Free Standing Fireplace | 113 | 7% | 10.8 | 0.8 | 1% | - | - |
| Range, Cook Top, Oven | 333 | 22% | 11.1 | 2.4 | 3% | 7.8 | 5.1 |
| BBQ | 386 | 25% | 1.9 | 0.5 | 1% | 2.8 | 8.1 |
| Dryer | 63 | 4% | 11.1 | 0.5 | 1% | 4.0 | 3.6 |
| Pool | 34 | 2% | 58.6 | 1.3 | 2% | 53.3 | 38.5 |
| Hot Tub | 8 | <1% | * | * | * | 17.9 | 19.5 |
| **Household Consumption** | | | | | | | |
| Estimated | | | | **75.4** | | **101.7** | **78.5** |
| Actual | | | | **79.2** | | **96.7** | **86.7** |

* An attempt was made to include hot tubs in the CDA, but it was not retained in the model because the estimated UEC value was unreasonable.
^ 2002 data represents log fireplaces
^^ 2002 data represents inserts

### 14.4.4 Whistler

The overall conditional demand model constructed at the utility level was used to estimate UECs for the Whistler region. Table 195 (next page) shows the resulting UEC values. These results should be interpreted with caution because of the small sample size and the low penetration rates for many of the end-uses. As well, applying the overall model to a small region like Whistler may produce misleading results because the model parameters are so heavily affected by the larger regions. For example, the high UEC estimate for water heating is largely influenced by the effect of the Lower Mainland data on the overall model.

The weather-normalized annual energy consumption per household (HEC) was estimated to be 67.4 GJ per year. In comparison, the actual average consumption for the sample was 75.4 GJ per year. The significant drop in gas consumption from the 2008 study is mainly from a decline in penetration rates for many of the end-uses.

**Table 195: Penetration Rates and Unit Energy Consumption by End-use – Whistler**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Average Consumption per Household (GJ/year) | | UECs in 2008 (GJ/year) |
|---|---|---|---|---|---|---|
| Primary Space Heating | 44 | 57% | 60.5 | 34.6 | 51% | 66.9 |
| Secondary Space Heating | 2 | 3% | ** | ** | ** | 33.6 |
| Water Heating | 25 | 32% | 34.8* | 11.3* | 17% | 18.5 |
| Decorative Fireplace | 8 | 10% | 26.2* | 2.7* | 4% | 22.2 |
| Heater Fireplace | 46 | 60% | 17.8 | 10.6 | 16% | 15.8 |
| Free Standing Fireplace | 6 | 8% | 10.2* | 0.8* | 1% | - |
| Range, Cook Top, Oven | 42 | 55% | 11.5 | 6.3 | 9% | 4.8 |
| BBQ | 34 | 44% | 0.3 | 0.1 | <1% | 7.9 |
| Dryer | 2 | 3% | *** | *** | *** | 3.3 |
| Pool | 0 | 0% | - | - | - | - |
| Hot Tub | 1 | 1% | ** | ** | ** | 19.5 |
| **Household Consumption** | | | | | | |
| Estimated | | | | **67.4** | | **92.6** |
| Actual | | | | **75.4** | | **96.6** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates (less than 5 households with end-use present).
*** An attempt was made to include gas dryers in the CDA, but it was not retained in the model because the estimated UEC value was negative.

### 14.4.5 Fort Nelson

The overall conditional demand model constructed at the utility level was used to estimate UECs for the Fort Nelson region. Table 196 (next page) shows the weather-normalized UECs. These results should be interpreted with caution because of the small sample size and the low penetration rates for many of the end-uses, as well as the methodological approach used. In particular, the UEC value for water heating appears to be over-estimated, due to the effect of the Lower Mainland data on the overall model.

The weather-normalized average annual energy consumption per household (HEC) was estimated to be 143.7 GJ per year. In comparison, the actual average consumption for the sample was 150.7 GJ per year. Average gas consumption was similar to the 2008 study.

**Table 196: Penetration Rates and Unit Energy Consumption by End-use – Fort Nelson**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Average Consumption per Household (GJ/year) | | UECs in 2008 (GJ/year) |
|---|---|---|---|---|---|---|
| Primary Space Heating | 71 | 93% | 94.6 | 88.4 | 62% | 113.4 |
| Secondary Space Heating | 1 | 1% | ** | ** | ** | - |
| Water Heating | 67 | 88% | 48.4 | 42.5 | 30% | 22.7 |
| Decorative Fireplace | 8 | 10% | 28.5* | 3.0* | 2% | 19.3 |
| Heater Fireplace | 15 | 20% | 22.3* | 4.5* | 3% | 14.7 |
| Free Standing Fireplace | 3 | 4% | ** | ** | ** | - |
| Range, Cook Top, Oven | 22 | 29% | 13.2* | 3.8* | 3% | 5.3 |
| BBQ | 11 | 14% | 0.3* | 0.04* | <1% | 7.9 |
| Dryer | 9 | 12% | *** | *** | *** | 3.3 |
| Pool | 0 | 0% | - | - | - | - |
| Hot Tub | 1 | 1% | ** | ** | ** | - |
| **Household Consumption** | | | | | | |
| Estimated | | | | **143.7** | | **130.2** |
| Actual | | | | **150.7** | | **150.4** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates (less than 5 households with end-use present).
*** An attempt was made to include gas dryers in the CDA, but it was not retained in the model because the estimated UEC value was negative.

## 14.5 UECs by Dwelling Type

Exogenous variables were incorporated into the CDA models for primary space heating and water heating to disaggregate by the following dwelling types: single family dwellings, multi-family dwellings (duplexes, row houses, townhouses) and apartments/condominiums.

### 14.5.1 Primary Space Heating

Table 197 shows estimated weather-normalized UECs for primary gas space heating by geographic region and housing type. Note that estimates could not be produced for apartments/condominiums due to the small sample sizes.

**Table 197: Primary Gas Space Heating UECs (GJ/year) by Dwelling Type**

| | Lower Mainland^ | Vancouver Island^ | Interior^ | Whistler^^ | Fort Nelson^^ | Overall (weighted) |
|---|---|---|---|---|---|---|
| Single Family Dwelling | 57.2 | 44.9 | 55.5 | 80.1* | 97.6 | 54.4 |
| Multi-Family Dwelling | 43.3 | 23.4 | 21.8 | 34.9* | ** | 38.8 |
| Apts/Condos | ** | ** | ** | ** | ** | ** |
| **Overall** | **55.0** | **43.0** | **53.0** | **60.5** | **94.6** | **52.4** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates.
^ UECs estimated from individual regional conditional demand model.
^^ UECs estimated from overall conditional demand model.

### 14.5.2 Water Heating

Table 198 shows estimated weather-normalized UECs for water heating by region and dwelling type. Reasonable estimates could not be produced for vertical subdivisions because of the small sample sizes.

**Table 198: Water Heating UECs (GJ/year) by Dwelling Type**

| | Lower Mainland^ | Vancouver Island^ | Interior^ | Whistler^^ | Fort Nelson^^ | Overall (weighted) |
|---|---|---|---|---|---|---|
| Single Family Dwelling | 30.0 | 18.4 | 21.5 | 33.7* | 48.5 | 26.5 |
| Multi-Family Dwelling | 29.3 | 17.7 | 19.9 | ** | ** | 25.0 |
| Apts/Condos | ** | ** | ** | ** | ** | ** |
| **Overall** | **29.9** | **18.3** | **21.3** | **34.8*** | **48.4** | **26.3** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates.
^ UECs estimated from individual regional conditional demand model.
^^ UECs estimated from overall conditional demand model.

## 14.6 UECs for Newer Homes (Constructed Since 1995)

The larger sample sizes in the 2012 REUS allowed exploration of UECs for newer homes. This is of particular interest as findings elsewhere in the 2012 REUS clearly indicated significant changes in the penetration and efficiency of gas space heating and domestic water heating equipment for newer homes. While many of these developments are evident in homes constructed since 2005, the available sample of homes constructed since this time was too small to develop a conditional demand model. The decision was made to expand the analysis to include homes constructed since 1995. While the final specification of the model with this expanded sample (n=734) was able to capture some regional variation in the key space and DWH end uses, constant UEC specifications were assumed for most other end uses.

A specific objective of the analysis of newer homes was to explore the effect of high efficiency gas furnaces, high efficiency boilers, and high efficiency domestic water heaters (e.g., condensing and on-demand) on annual gas consumption.[59]

### 14.6.1 Utility Level Results

Table 199 (next page) shows the weather-normalized, weighted UECs for newer homes in FEU's service territory, with comparison made to UEC estimates for the overall stock of homes, taken from Table 191. Unit energy consumption for primary space heating in newer homes is estimated at 40.5 GJ per year and consumption associated with domestic water heating is estimated at 29.4 GJ per year. Heater fireplaces (21.0 GJ per year) and decorative fireplaces (17.1 GJ per year) are also major users of natural gas in newer homes. Overall, the weather-normalized, weighted energy consumption per household (HEC) was estimated to be 78.1 GJ per year. In comparison, the actual weighted consumption for the sample of newer homes was 84.1 GJ per year. As expected, the average gas consumption per household is lower for newer homes than for the overall stock of residential gas dwellings.

[59] Despite attempts to model the effect of high-efficiency gas water heaters including on-demand (tankless) water heaters. These variables were not retained in the conditional demand analysis because they were not statistically significant or produced unreasonable results.

**Table 199: Penetration Rates and Unit Energy Consumption by End-use – Newer Homes**

| | Sample Size | Penetration (% presence) | Unit Energy Consumption (GJ/year) | Average Consumption per Household (GJ/year) | | UECs – All Dwelling Vintages (GJ/year) |
|---|---|---|---|---|---|---|
| Primary Space Heating | 520 | 78% | 40.5 | 31.6 | 40% | 52.4 |
| Secondary Space Heating | 27 | 3% | 23.9* | 0.7* | 1% | 24.5 |
| Water Heating | 504 | 75% | 29.4 | 21.9 | 28% | 26.3 |
| Decorative Fireplace | 148 | 24% | 17.1 | 4.1 | 5% | 17.7 |
| Heater Fireplace | 453 | 63% | 21.0 | 13.2 | 17% | 14.6 |
| Free Standing Fireplace | 50 | 6% | 11.0 | 0.7 | 1% | 7.0 |
| Range, Cook Top, Oven | 299 | 46% | 10.8 | 5.0 | 6% | 12.5 |
| BBQ | 313 | 35% | 1.1 | 0.4 | <1% | 0.3 |
| Dryer | 40 | 5% | *** | *** | *** | ** |
| Pool | 11 | 1% | 29.5* | 0.4* | <1% | 43.1 |
| Hot Tub | 3 | 1% | ** | ** | ** | 21.3* |
| **Household Consumption** | | | | | | |
| Estimated | | | | **78.1** | | **81.2** |
| Actual | | | | **84.1** | | **89.5** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates (less than 5 households with end-use present).
*** An attempt was made to include gas dryers in the CDA, but it was not retained in the model because the estimated UEC value was negative.

The lower space heating UEC is explained, in part, to improvements in space heating equipment efficiency and improvements in the building envelope (more efficient windows, better insulation in walls, ceilings, and doors). Improved furnace efficiencies are due to the higher penetration of mid-efficiency furnaces in newer homes compared to the overall stock of homes (53% versus 40%) rather than the relatively higher penetration of high efficiency furnaces (39% for newer homes versus 37% for the stock). Information from the 2012 REUS strongly suggests that the lower space heating UEC for newer homes is attributable, in part, to the presence of air source heat pumps. Of note, 16% of newer homes have an ASHP compared to 12% of the stock of homes.[60] This equipment appears to be offsetting some of the space heating load borne by traditional systems.

Newer homes also have a higher penetration of heater style gas fireplaces relative to the stock of homes (63% versus 43%). Heater style fireplaces (fixed glass front) are much more likely than traditional decorative style fireplaces to be used for space heating (e.g., annual hours of use for heater style fireplaces is 2.4 times that of decorative units).[61] The relatively higher incidence and use of heater style fireplaces is consistent with the higher UEC obtained for heater fireplaces in newer homes (21.0 GJ per year versus 14.6 GJ per year for the stock).

While not quantified, the tendency for newer single family detached homes to be larger (more square feet, higher ceilings) will offset some of the decline attributable to improvements in equipment efficiency and changes in the mix of space heating equipment. In effect, newer single family detached dwellings have larger volume of interior required for space heating compared to older detached dwellings.[62]

[60] Even more notable is the fact that 30% of FEU homes constructed since 2005 are equipped with an ASHP.
[61] Section 8.4.
[62] Exogenous variables were incorporated into the conditional demand model for newer homes in an attempt to estimate the UEC for high-efficiency gas furnaces. Among the 159 households in the newer home CDA sample that indicated they had a high

The UEC for water heating is slightly larger for newer homes (29.4 GJ per year) than for the overall stock of homes (26.3 GJ per year). Water heating demand may be higher in newer homes because of differences in household size and composition. Notably, average household size is larger for newer homes than for the overall stock of homes (2.9 individuals versus 2.7). Residents in newer homes are also more likely to have children or teenagers at home. These two demographic characteristics are associated with higher (hot) water use.

UECs for all other end-uses are relatively consistent between newer homes and the overall sample.

### 14.6.2 Regional Results – Newer Homes

Interpretation of the results presented in this section should be made with caution as sample sizes are small. Results are to be considered directional in nature only.

#### Primary Space Heating

Table 200 shows estimated weather-normalized UECs for primary gas space heating by region and dwelling type for the newer home sample. Note that estimates could not be produced for apartments / condominiums due to small sample sizes.

**Table 200: Primary Gas Space Heating UECs (GJ/year) – Newer Homes**

| | Lower Mainland^ | Vancouver Island^ | Interior^ | Whistler^ | Fort Nelson^ | Overall (weighted) |
|---|---|---|---|---|---|---|
| Single Family Dwelling | 42.7 | 34.5 | 42.3 | 76.1* | 78.3* | 42.0 |
| Multi-Family Dwelling | 36.9* | 32.6* | 36.4* | 45.0* | ** | 36.7 |
| Apts/Condos | ** | ** | ** | ** | ** | ** |
| **Overall** | **41.2** | **33.3** | **40.7** | **60.9*** | **78.5*** | **40.5** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates.
^ UECs estimated from conditional demand model developed for newer homes.

#### Water Heating

Table 201 (next page) shows estimated weather-normalized UECs for water heating by region and dwelling type for the newer home sample. Reasonable estimates could not be produced for apartments / condominiums because of the small sample sizes.

efficiency furnace, their weather-normalized, weighted UEC for primary space heating was 32.2 GJ per year. As the analysis of space heating in newer homes has suggested that furnace consumption is being influenced by the presence of air source heat pumps and heater style fireplaces, it is reasonable to assume that the UEC estimate for high efficiency furnaces is also being influenced, to some degree, by this equipment.

**Table 201: Water Heating UECs (GJ/year) – Newer Homes**

| | Lower Mainland^ | Vancouver Island^ | Interior^ | Whistler^ | Fort Nelson^ | Overall (weighted) |
|---|---|---|---|---|---|---|
| Single Family Dwelling | 29.7 | 25.1 | 32.4 | 38.3* | 62.4* | 29.7 |
| Multi-Family Dwelling | 25.9* | 26.8* | 30.9* | 36.9* | ** | 26.9 |
| Apts/Condos | ** | ** | ** | ** | ** | ** |
| **Overall** | **29.2** | **25.3** | **32.3** | **37.9*** | **62.2*** | **29.4** |

* Small sample size (less than 30 households with end-use present). These results should be interpreted with caution.
** Insufficient sample to produce meaningful estimates.
^ UECs estimated from conditional demand model developed for newer homes.

## 14.7 Limitations

The results of these conditional demand analyses should be interpreted with some caution due to several important limitations:

- The estimated consumption levels of high-penetration end-uses may mask the effects of other end-uses and/or partially capture the base consumption load of a household.
- The effects of low-penetration end-uses (e.g. gas dryers or hot tubs) are difficult to estimate because of small sample sizes.
- The effects of certain end-uses (e.g. gas cooking appliances and BBQs) may be confounded because of a high correlation of ownership.
- Unit energy consumption values could not be accurately estimated for some regions and dwelling types due to small sample sizes.
- Some information collected through the self-reported customer surveys may be unreliable.
- The rich model specifications originally developed for some end-uses had to be simplified because of unreasonable regression results.
- The composition of the sample used to develop the conditional demand model may skew the results (e.g. under-representation of vertical subdivisions, especially in the Lower Mainland).

# 15 GAS END-USE COMBINATIONS

This section presents and discusses the findings from an analysis of gas end-use pairings (combinations). Results are compared to a similar analysis conducted using data from the 2010 Residential New Homes Survey (2010 RNHS) and the 2008 Residential End-use Survey (2008 REUS). The main purpose of the analysis in this report is to explore the number and types of gas end-uses present in the homes of FortisBC's residential customers and how they vary by dwelling type, vintage, and square footage. As a word of caution, discussion about losses or gains in gas end-use penetrations apply only to residential dwellings with gas service. They do not address the loss or gain of gas market share in new residential construction or retrofits.

## 15.1 Methodology and Data Preparations

The 2012 REUS dataset was used to identify nine different gas end-use groupings present in survey respondent's dwellings. They include space heating, domestic water heating, fireplaces and heater stoves, indoor cooking, outdoor cooking (piped gas BBQs), clothes drying, heated pools, hot tubs, and miscellaneous outdoor applications (outdoor heaters and fire pits). Table 202 provides greater detail on the composition of each group with corresponding data sources from the 2012 REUS identified.

**Table 202: Gas End-use Groupings – 2012 REUS**

| Gas End-Use Short Name | Gas End-Use Long Name | Detailed Description | Question Number: 2012 REUS |
|---|---|---|---|
| SH | Gas space heating | Natural gas furnace, boiler, or wall heater | B6, B5-10 |
| DWH | Gas domestic water heating | Natural gas domestic water heater – any type | D2 |
| FP | Gas fireplace or heater stove | Gas fireplace or heater stove | C2 |
| C-I | Gas indoor cooking | Gas range (gas cook top and oven), dual fuel gas range (gas cook top, electric oven), gas cook top, and/or gas wall oven | F1-2, F1-3, F1-5, F1-7 |
| C-O | Gas outdoor cooking | Piped gas barbeque | F1-9 |
| CD | Gas clothes dryer | Gas clothes dryer | F1-20 |
| Pool | Gas heated pool | Indoor or outdoor pool heated by natural gas | E-2 |
| HT | Piped gas hot tub | Indoor or outdoor hot tub heated with natural gas | E9-1 |
| OTH | Piped gas outdoor heater or fire pit | Outdoor heater or fire pit heated via piped natural gas | F1-24, F1-26 |

The analysis was concerned with the presence of gas-end-use rather than the quantities of the end-use. For example, homes with two gas fireplaces are treated the same as those with only one gas fireplace. While it was possible that a dwelling could have all nine gas end-uses, nine-in-ten had between one and four end-uses.

The presence of gas space heating was initially defined based on specification of natural gas as either the main or supplementary space heating fuel. This approach was rejected in favour of the presence of a gas furnace, gas boiler or gas wall heater. This was required because some survey respondents with gas fireplaces and no other gas space heating method indicated that gas was either their main or supplemental space heating fuel. In these cases, it is likely that the gas fireplace is being treated as a space heating method (and fuel). Since gas fireplaces are treated distinctly from space heating in the combination analysis, using space heating fuel as an indicator of gas space heating would double count the number of gas end-uses for these respondents.

### 15.1.1 Comparisons with Previous Combination Analyses

Analysis of gas end-use combinations was first conducted using data from the 2008 REUS and 2010 RNHS surveys.[63] To allow comparison with the 2012 results, end-use data for these earlier studies were restated using the current nine end-use definitions. This was required because the 2008 and 2010 studies treated gas cooking appliances as individual gas end-uses (gas cook top, gas range, gas wall oven, etc.). In contrast, the 2012 analysis defined only two cooking categories – indoor cooking appliances (gas range, gas cook top, gas wall oven, dual fuel range, etc.) and outdoor cooking appliances (piped gas barbeque). All data from the 2008 and 2010 studies presented in this report reflect reclassification of the end-use categories to the 2012 definitions.

## 15.2 Findings

### 15.2.1 Gas End-Use Counts by Region

Table 203 summarizes the distribution of FEU residential customers by number of gas end-uses, the overall average, and the upper and lower bounds of the average based on a 95% confidence interval. Data are summarized by FortisBC region and the utility aggregate (FEU 2012). The table also includes comparable data at the utility level from the 2008 REUS.

**Table 203: Average Number of Gas End-uses by Region**
**Percent Share of All Dwelling Types**

| Number of Gas End-Uses | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *793* | *1707* | *752* | *85* | *104* | *3441* | *2221* |
| 1 | 7.6 | 15.6 | 14.8 | 25.6 | 13.9 | 10.6 | 8.9 |
| 2 | 24.6 | 32.1 | 30.4 | 15.9 | 38.7 | 27.3 | 36.3 |
| 3 | 37.6 | 29.8 | 31.1 | 29.3 | 25.2 | 34.7 | 36.2 |
| 4 | 20.9 | 15.4 | 16.2 | 14.6 | 16.4 | 18.9 | 14.2 |
| 5 | 6.9 | 5.2 | 6.1 | 12.2 | 3.9 | 6.3 | 3.9 |
| 6+ | 2.4 | 1.9 | 1.3 | 2.4 | 1.9 | 2.2 | 0.5 |
| **Total (%)** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** | **100.0** |
| **Average Number per-Dwelling** | **3.0** | **2.7** | **2.7** | **2.8** | **2.6** | **2.9** | **2.7** |
| Standard Deviation | 1.8 | 0.9 | 0.8 | 0.5 | 0.3 | 1.2 | 1.0 |
| Lower conf. interval (95%) | 2.9 | 2.6 | 2.7 | 2.7 | 2.6 | 2.9 | 2.7 |
| Upper conf. interval (95%) | 3.2 | 2.7 | 2.8 | 2.9 | 2.7 | 2.9 | 2.7 |

Totals may not sum due to rounding.

Overall, the average FEU residential customer in 2012 had 2.9 gas end-uses, up slightly from an average of 2.7 in 2008. Compared to 2008, the number of homes with 4 or more end-uses increased and the proportion with three or less declined.

Regional differences in the distribution of gas-end-use counts and overall averages are evident in the 2012 data. Of note, residential gas customers in the Lower Mainland have more gas end-uses on average (3.0) compared to the other regions (2.6 to 2.7). FEU residential customers in the Lower Mainland are less likely to have only one gas end-use and more likely to have three or four gas end-uses compared to FEU

[63] Sampson Research (2011).

customers in the Interior and Vancouver Island regions. Approximately one-in-seven (15%) of homes in these regions have only one gas end-use, double the rate of Lower Mainland homes.

The average number of gas end-uses varies by type of dwelling, construction period, and size (square footage). These data are discussed next.

### 15.2.2 Gas End-Use Counts by Dwelling Type

The average number of gas end-uses for single family detached dwellings, duplexes, and row houses / townhouses is summarized in Table 204. Regardless of region, single family detached dwellings have more gas end-uses than duplexes or row houses/townhouses (average of 3.0 versus 2.7 and 2.8 respectively). Regionally, single family detached dwellings in the Lower Mainland have a higher average number of gas end-uses (3.1) than comparable dwellings in the Interior, Vancouver Island and Fort Nelson regions (average of 2.8 each). SFDs in Whistler represent an exception with an average of 3.3 gas end-uses.

**Table 204: Average Number of Gas End-uses by Dwelling Type**

| Selected Dwelling Types | LM | INT | VI | W | FN | 2012 FEU | 2008 FEU |
|---|---|---|---|---|---|---|---|
| **Single Family Detached** | | | | | | | |
| Average | 3.1 | 2.8 | 2.8 | 3.3 | 2.8 | 3.0 | 2.7 |
| Std Deviation | 1.9 | 0.9 | 0.8 | 0.4 | 0.3 | 1.1 | 1.2 |
| **Duplex** | | | | | | | |
| Average | 3.0 | 2.5 | 2.4 | 3.1 | 2.3 | 2.7 | 2.8 |
| Std Deviation | 1.9 | 0.7 | 0.8 | 0.4 | 0.2 | 0.5 | 0.8 |
| **Townhouse / Row House** | | | | | | | |
| Average | 2.6 | 2.8 | 2.3 | 1.8 | 1.9 | 2.8 | 2.7 |
| Std Deviation | 1.6 | 0.9 | 0.8 | 0.4 | 0.3 | 0.7 | 0.4 |
| **All Dwellings** | | | | | | | |
| Average | 3.0 | 2.7 | 2.7 | 2.8 | 2.6 | 2.9 | 2.7 |
| Std Deviation | 1.8 | 0.9 | 0.8 | 0.5 | 0.3 | 1.2 | 1.0 |

At the utility level, the average number of gas end-uses for SFDs increased from 2.7 to 3.0 since the 2008 REUS. This increase is statistically significant at the 95% confidence level. The difference is attributed to the tendency for newer SFDs (those constructed since 2005) to have more gas end-uses than older SFDs. Differences in the average number of end-uses for duplexes and townhouses between the 2008 and 2012 studies are not statistically significant.

The tendency for SFDs to have more gas end-uses than duplexes and row houses/townhouses is consistent with their tendency to be larger in square footage terms. Indeed, the number of gas end-uses typically increases as the square footage of the dwelling increases. This relationship for single family detached dwellings is shown in Figure 35 (next page). Of note, the relative number of homes with four or more gas end-uses begins to increase once the dwelling size exceeds 3,000 square feet. Similar relationships exist for duplexes (not shown) and row houses / townhouses (Figure 36, next page). There were no row houses / townhouses in the 2012 REUS survey exceeded 3,500 square feet.

**Figure 35: Number of Gas End-Uses by Square Footage**
**Single Family Detached Dwellings**

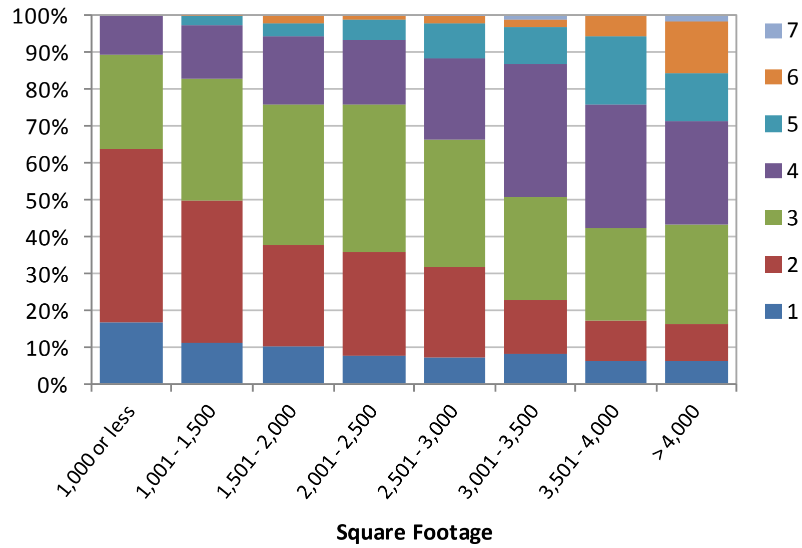



**Figure 36: Number of Gas End-Uses by Square Footage**
**Townhouses / Row Houses**

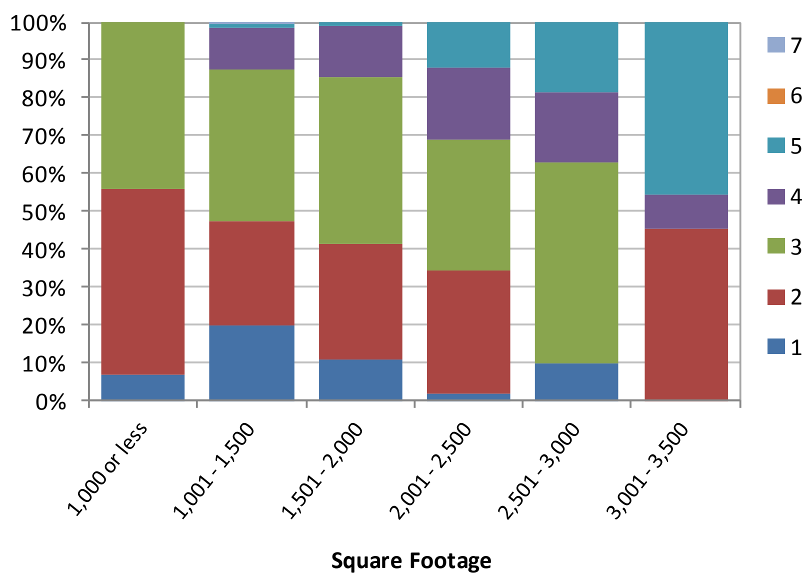



Table 205 (next page) expresses these data in terms of average number of end-uses for each of the three detachment types. The data show the average number of gas end-uses for single family detached dwellings ranges from a low of 2.1 for homes with 1,000 square feet or less, to a high of 3.6 for homes exceeding 4,000 square feet. Townhouses range from 1.8 gas end-uses on average for the smallest units to 3.7 for units exceeding 3,000 square feet.

For all dwelling types including single family detached, duplexes, row houses / townhouses, apartments and mobile homes, the average number of end-uses ranges from a low of 1.9 for those with 1,000 square feet or less to a high of 3.5 for those 4,000 square feet or greater.

**Table 205: Average Number of Gas End-Uses by Size ($ft^2$) of Dwelling**

| | 1,000 or less | 1,001 - 1,500 | 1,501 - 2,000 | 2,001 - 2,500 | 2,501 - 3,000 | 3,001 - 3,500 | 3,501 - 4,000 | > 4,000 |
|---|---|---|---|---|---|---|---|---|
| *Unweighted base* | *185* | *590* | *765* | *746* | *502* | *232* | *129* | *124* |
| **Single Family Detached** | | | | | | | | |
| Average | 2.1 | 2.5 | 2.7 | 2.8 | 3.0 | 3.3 | 3.4 | 3.6 |
| Std Deviation | 0.8 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 |
| **Duplex** | | | | | | | | |
| Average | 2.2 | 2.4 | 2.6 | 3.3 | 3.1 | 2.8 | 4.0 | 3.3 |
| Std Deviation | 0.9 | 1.2 | 1.1 | 1.2 | 1.0 | 0.4 | 0.0 | 0.5 |
| **Townhouse / Row House** | | | | | | | | |
| Average | 1.8 | 2.4 | 2.5 | 3.1 | 3.0 | 3.7 | -- | -- |
| Std Deviation | 0.8 | 1.1 | 1.0 | 1.2 | 1.4 | 1.5 | -- | -- |
| **All Dwellings** | | | | | | | | |
| Average | 1.9 | 2.4 | 2.7 | 2.9 | 3.0 | 3.3 | 3.4 | 3.5 |
| Std Deviation | 0.8 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 |

### 15.2.3 Gas End-Use Counts by Dwelling Vintage

Table 206 summarizes the average number of gas end-uses for all dwelling types by period of construction, with additional detail for single family detached dwellings, duplexes, and townhouses/row houses. The data show the average home constructed during 1950-1985 has between 2.6 and 2.8 gas end-uses. Homes built during the next 20 years have a higher number of gas end-uses (average of 3.0 to 3.4 end-uses). The number of gas end-uses in homes constructed during the 2006-2010 period declined somewhat (average of 3.2 end-uses).

**Table 206: Average Number of Gas End-Uses by Dwelling Vintage**

| | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known |
|---|---|---|---|---|---|---|---|
| *Unweighted base* | *350* | *919* | *576* | *664* | *586* | *238* | *46* |
| **Single Family Detached** | | | | | | | |
| Average | 2.8 | 2.7 | 2.7 | 3.2 | 3.6 | 3.3 | 2.7 |
| Std Deviation | 1.2 | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.5 |
| **Duplex** | | | | | | | |
| Average | 3.3 | 2.5 | 2.3 | 3.0 | 3.1 | 3.2 | 5.0 |
| Std Deviation | 1.8 | 1.2 | 1.3 | 1.2 | 0.9 | 1.0 | 0.8 |
| **Townhouse / Row House** | | | | | | | |
| Average | 3.0 | 2.1 | 2.3 | 2.7 | 2.9 | 2.5 | -- |
| Std Deviation | -- | 1.0 | 1.0 | 1.2 | 1.1 | 1.6 | 1.2 |
| **All Dwellings** | | | | | | | |
| Average | 2.8 | 2.7 | 2.6 | 3.0 | 3.4 | 3.2 | 2.7 |
| Std Deviation | 1.2 | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.4 |

Totals may not sum due to rounding.

The decline in gas end-uses for gas homes constructed since 2005 is attributed in large part to the increased share of new home construction represented by townhouses / row houses. Prior to 2006, the ratio of gas townhouses to gas single family dwellings was one in ten. In the period since 2005, this ratio increases to an average of 1.7 gas townhouses per every ten gas SFD homes. This is consistent with the trend observed in CMHC new construction data. Their data show the ratio of new row houses /

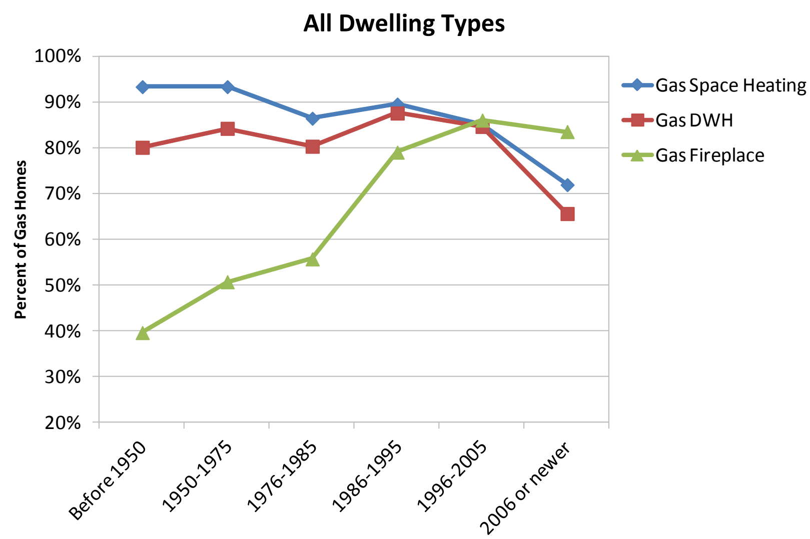
townhouses to new SFDs in British Columbia more than doubling between 2000 and 2012.[64] While the average number of gas end-uses for SFDs increased to 3.5 during this period compared to 3.0 for older SFDs, the increased market share of townhouses / row houses in new construction, along with their corresponding smaller number of gas end-uses, brought the overall average down.

Of particular note, the time trend in gas end-use counts masks the shift away from traditional gas end-uses of space and domestic water heating towards smaller gas loads such as indoor and outdoor gas cooking appliances. This is discussed in detail in the next section.

### 15.2.4 Trends in End-Use Penetration

Figure 37 summarizes the penetration of thermal residential gas end-uses by period of construction. Thermal end-uses or loads include space heating, domestic water heating, and fireplaces.

**Figure 37: Gas End-Use Penetrations by Dwelling Vintage – Thermal Loads**




The data show a decline in the penetration of gas space heating (furnaces, boilers or wall heaters) and gas domestic water heaters, most notably among dwellings constructed since 2005. The decline in gas DWH is more severe than that of space heating, falling from just under 80% of homes in 1996-2005 to 56% of homes in the post-2005 period.[65] The penetration of gas space heating end-uses declined from 85% to 72% over the same period but, at its peak in homes constructed prior to 1976, penetration exceeded 90%.

In contrast to the other thermal loads, gas fireplaces have become increasing common over the last fifty years. Their penetration has risen from just under 40% of residential gas dwellings constructed prior to 1950, to 86% of gas homes built during 1996-2005. The slight decline for homes built since 2005 is not statistically significant. Data from the 2012 conditional demand analysis (CDA) strongly suggests that gas fireplaces are increasingly being used as a method of space heating. This is consistent with the shift from

[64] From 2.4 row houses / townhouses per ten SFDs to 5.2 per ten SFDs. Source: CMHC urban housing construction statistics for British Columbia, 2002-2012

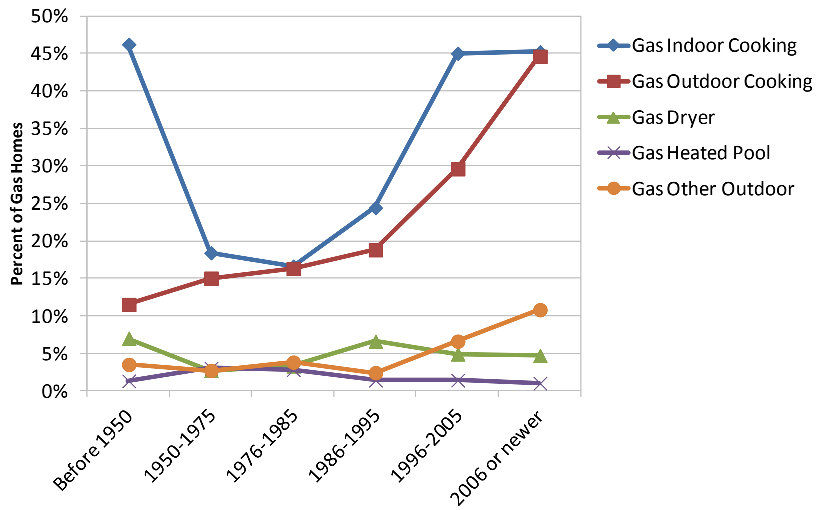
[65] To maintain consistency with how penetration rates are calculated for other gas end-uses, the base for DWH penetration rates in this analysis includes dwellings where domestic hot water is centrally provided (i.e., no DWH equipment in the unit). Penetration and saturation data reported in Chapter 7, in contrast, exclude these dwellings from the calculation base. Correspondingly, DWH penetration rates reported here are somewhat higher than stated in Chapter 7.

decorative to heater style fireplace models in new and retrofit construction and their higher hours of use (2.8 times that of decorative gas fireplace models). Some gas fireplaces for FEU customers may have been original to the house, added, or retrofitted sometime after the construction of the home was complete.

Figure 38 summarizes the penetration of gas “convenience” end-uses by period of construction. Convenience end-uses or loads include gas indoor and outdoor cooking appliances, gas dryers, gas heated swimming pools, and miscellaneous other outdoor gas end-uses (e.g., space heaters and fire pits).

**Figure 38: Gas End-Use Penetrations by Dwelling Vintage – Convenience Loads**

**All Dwelling Types**




Indoor and outdoor gas cooking end-uses (cook tops, ranges, wall ovens, dual fuel ranges, piped gas BBQs) have increased in popularity since the 1980s. Penetration of indoor and outdoor gas cooking appliances in new construction is tied at 45%. Penetration of outdoor heaters and fire pits in newer construction is currently 11%, up from low single digits for homes constructed prior to 1996.

Single family detached homes are similar to row houses / townhouses in that the two dwelling types share similar trends in the penetration of space and domestic water heating in new construction. However, the decline in DWH penetration for new townhouses began in the mid-1990s compared to a decade later for SFDs. Also, the penetration of gas fireplaces declined in townhouses built since 2005 while the penetration rate for this end-use held steady for new single family detached dwellings.

### 15.2.5 Common Gas End-Use Combinations

Analysis of gas end-use combinations by dwelling type, region, and vintage reveals considerable diversity. When all dwelling types are considered, over 112 unique combinations of the nine gas end-use groups are recorded. Fifty-five unique combinations are present in homes constructed since 2005. These counts likely underestimate the total number of unique gas appliance combinations due to the grouping of space heating, cooking, and miscellaneous outdoor gas equipment.

The next two tables present the ten most common end-use combinations for gas homes by region, based on their proportion (percentage) of all gas end-use combinations present. Depending upon the region, these ten combinations represent 68% to 83% of all combinations.

## GAS END-USE COMBINATIONS

The top two most common end-use combinations for all regions, except Whistler, is the traditional pairing of gas space heating (SH), gas DWH, and gas fireplaces.

**Table 207: Top Ten Gas End-Use Combinations by Region – Part I (%)**
**Lower Mainland, Interior, Vancouver Island**

| Lower Mainland | | Interior | | Vancouver Island | |
|---|---|---|---|---|---|
| **Combination** | **%** | **Combination** | **%** | **Combination** | **%** |
| SH DWH FP | 28.0 | SH DWH | 23.3 | SH DWH FP | 16.8 |
| SH DWH | 17.9 | SH DWH FP | 18.0 | DWH FP | 10.8 |
| SH DWH FP C-I | 11.3 | SH | 10.9 | FP | 10.5 |
| SH | 5.6 | SH DWH FP C-O | 6.4 | SH DWH | 7.9 |
| SH DWH FP C-O | 4.4 | SH FP | 4.1 | SH DWH FP C-O | 4.7 |
| SH DWH C-I | 3.8 | SH DWH FP C-I C-O | 3.6 | SH FP | 4.4 |
| SH DWH FP C-I C-O | 3.7 | SH DWH FP C-I | 3.3 | SH DWH FP C-I | 3.3 |
| SH FP | 3.0 | FP | 2.9 | SH | 3.1 |
| SH FP C-I | 1.8 | SH DWH C-O | 2.4 | FP C-O | 3.1 |
| FP | 1.6 | SH DWH C-I | 2.3 | DWH FP C-I C-O | 2.9 |
| **Total (%)** | **81.2** | **Total (%)** | **77.2** | **Total (%)** | **67.6** |

**LEGEND:**
**SH** = space heating (gas boiler or gas furnace)
**DWH** = gas domestic water heater
**FP** = gas fireplace
**C-I** = indoor gas cooking
**C-O** = outdoor gas cooking (BBQ)
**CD =** gas clothes dryer
**OTH** = outdoor gas fire pit or gas heater

Totals may not sum due to rounding

**Table 208: Top Ten Gas End-Use Combinations by Region – Part II (%)**
**Whistler, Fort Nelson, FEU Total**

| Whistler | | Fort Nelson | | All Regions (FEU 2012) | |
|---|---|---|---|---|---|
| **Combination** | **%** | **Combination** | **%** | **Combination** | **%** |
| FP | 20.7 | SH DWH | 32.9 | SH DWH FP | 24.0 |
| SH DWH FP C-I C-O | 9.8 | SH DWH FP | 13.5 | SH DWH | 18.3 |
| FP C-I C-O | 9.8 | SH | 7.7 | SH DWH FP C-I | 8.2 |
| SH FP C-I C-O | 7.3 | SH DWH C-I | 7.7 | SH | 6.7 |
| SH FP C-I | 4.9 | SH DWH FP C-I | 4.8 | SH DWH FP C-O | 5.0 |
| SH DWH FP | 3.7 | SH DWH C-I CD | 3.9 | SH DWH FP C-I C-O | 3.5 |
| SH DWH | 3.7 | SH DWH FP C-O | 3.9 | SH FP | 3.5 |
| FP OTH | 3.7 | OTH | 2.9 | SH DWH C-I | 3.3 |
| SH C-I C-O | 3.7 | SH FP | 2.9 | FP | 3.0 |
| DWH FP | 2.4 | SH DWH C-O | 2.9 | DWH FP | 1.7 |
| **Total (%)** | **69.5** | **Total (%)** | **83.2** | **Total (%)** | **77.3** |

**LEGEND:**
**SH** = space heating (gas boiler or gas furnace)
**DWH** = gas domestic water heater
**FP** = gas fireplace
**C-I** = indoor gas cooking
**C-O** = outdoor gas cooking (BBQ)
**CD =** gas clothes dryer
**OTH** = outdoor gas fire pit or gas heater

Totals may not sum due to rounding

Table 209 (next page) presents the top ten gas end-use combinations for the three main dwelling types – single family detached, duplexes, and row houses / townhouses. The data show that single family dwellings and duplexes share similar gas end-use profiles with the traditional combinations of space heating, DWH, and fireplaces dominating the ten most common end-use combinations. The top ten combinations for row houses / townhouses are more likely to exclude gas DWH.

**Table 209: Top Ten Gas End-Use Combinations by Dwelling Type (%)**

| Single Family Detached | | Duplexes | | Row Houses / Townhouses | | All Dwelling Types | |
|---|---|---|---|---|---|---|---|
| Combination | % | Combination | % | Combination | % | Combination | % |
| SH DWH FP | 24.3 | SH DWH FP | 22.3 | SH DWH FP | 32.5 | SH DWH FP | 24.0 |
| SH DWH | 18.8 | SH DWH | 13.4 | SH DWH | 14.3 | SH DWH | 18.3 |
| SH DWH FP C-I | 8.6 | SH DWH FP C-I | 10.7 | SH DWH FP C-I | 7.0 | SH DWH FP C-I | 8.2 |
| SH | 5.6 | SH | 9.1 | SH | 6.5 | SH | 6.7 |
| SH DWH FP C-O | 5.5 | SH DWH FP C-O | 5.8 | FP | 6.4 | SH DWH FP C-O | 5.0 |
| SH DWH FP C-I C-O | 3.9 | SH DWH FP C-I CD | 4.9 | SH FP | 6.4 | SH DWH FP C-I C-O | 3.5 |
| SH DWH C-I | 3.6 | FP | 3.8 | SH FP C-I | 4.7 | SH FP | 3.5 |
| SH FP | 2.8 | DWH FP | 3.7 | DWH FP | 4.2 | SH DWH C-I | 3.3 |
| FP | 2.5 | SH FP C-I | 3.6 | FP C-I | 2.9 | FP | 3.0 |
| SH DWH C-I C-O | 1.6 | SH DWH C-I | 2.9 | SH DWH FP C-I C-O | 2.9 | DWH FP | 1.7 |
| **Total (%)** | **77.1** | **Total (%)** | **80.3** | **Total (%)** | **87.9** | **Total (%)** | **77.3** |

**LEGEND:**
**SH** = space heating (gas boiler or gas furnace)
**DWH** = gas domestic water heater
**FP** = gas fireplace
**C-I** = indoor gas cooking
**C-O** = outdoor gas cooking (BBQ)
**CD =** gas clothes dryer
**OTH** = outdoor gas fire pit or gas heater

Totals may not sum due to rounding

Table 210 summarizes the top ten end-use combinations for gas dwellings constructed prior to 2006 and homes constructed during 2006 to 2010. Compared to older homes, the top ten end-use combinations for newer homes reflect the higher penetration of indoor and outdoor gas cooking, and gas fireplaces. They also highlight the reduced incidence of gas DWH and the increased prevalence of single end-uses (e.g., fireplace only, space heating only, etc.).

**Table 210: Top Ten Gas End-Use Combinations (%) – Newer versus Older Homes**

| Older Homes (2005 or older) | | New Homes (2006 - 2010) | | All Vintages | |
|---|---|---|---|---|---|
| Combination | % | Combination | % | Combination | % |
| SH DWH FP | 25.1 | SH DWH FP | 12.0 | SH DWH FP | 24.0 |
| SH DWH | 19.0 | SH DWH FP C-O | 8.3 | SH DWH | 18.3 |
| SH DWH FP C-I | 8.3 | SH DWH FP C-I C-O | 8.2 | SH DWH FP C-I | 8.2 |
| SH | 6.9 | SH DWH FP C-I | 8.0 | SH | 6.7 |
| SH DWH FP C-O | 4.9 | FP | 6.8 | SH DWH FP C-O | 5.0 |
| SH FP | 3.5 | SH | 5.2 | SH DWH FP C-I C-O | 3.5 |
| SH DWH C-I | 3.4 | SH FP | 3.8 | SH FP | 3.5 |
| SH DWH FP C-I C-O | 3.2 | SH FP C-I C-O | 3.6 | SH DWH C-I | 3.3 |
| FP | 2.7 | FP C-I | 3.3 | FP | 3.0 |
| DWH FP | 1.8 | DWH FP C-I C-O | 3.0 | DWH FP | 1.7 |
| **Total (%)** | **78.8** | **Total (%)** | **62.1** | **Total (%)** | **77.3** |

**LEGEND:**
**SH** = space heating (gas boiler or gas furnace)
**DWH** = gas domestic water heater
**FP** = gas fireplace
**C-I** = indoor gas cooking
**C-O** = outdoor gas cooking (BBQ)
**CD =** gas clothes dryer
**OTH** = outdoor gas fire pit or gas heater

Totals may not sum due to rounding

### 15.2.6 Additional Analysis - Incidence of Gas Space Heat and Gas DWH Pairings

The analysis up to this point has provided insight into trends in the number and penetration of gas end-uses and end-use combinations. This section explores trends in the traditional pairing of gas space heat and gas DWH.

Table 211 summarizes the incidence of homes with gas furnaces or boilers paired with gas DWH or electric DWH for SFDs, row houses/townhouses, and all dwellings.[66] Data for homes with electric space heat and DWH are also provided. These data confirm there has been a significant reduction in the number of new homes that are using gas for domestic water heating. For example, 56% of SFDs constructed since 2005 have the traditional pairing of gas space heat and gas DWH, down from 81% for SFDs built prior to this. Seventy-three percent (73%) of townhouses / row houses built prior to 2006 have gas space heat (gas furnace or boiler) and gas DWH, compared to 54% of townhouses / row houses constructed since. Overall, the proportion of FEU residential dwellings with gas space and domestic water heating for new construction has fallen to 48%.

**Table 211: Gas Space Heat and DWH Combinations by Dwelling Type and Vintage (%)**

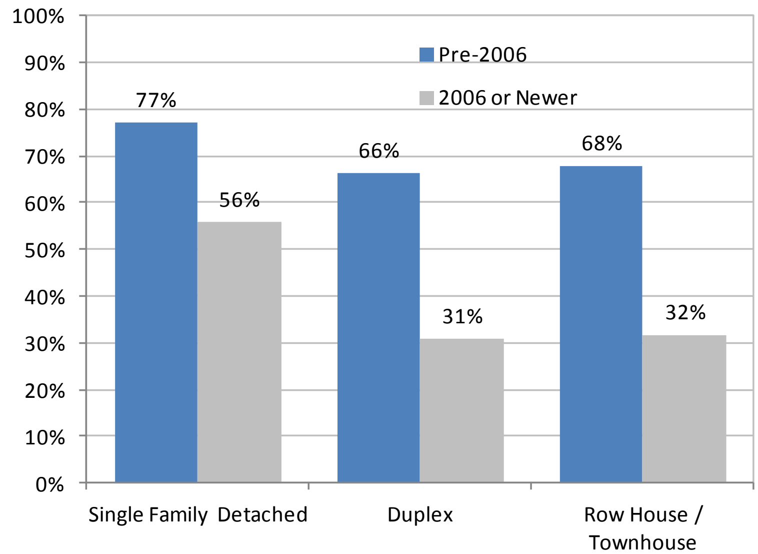
| | Before 1950 | 1950 - 1975 | 1976 - 1985 | 1986 - 1995 | 1996 - 2005 | 2006 or later | Age Un-known | 2012 FEU |
|---|---|---|---|---|---|---|---|---|
| *Unweighted base[1,2]* | *343* | *903* | *563* | *654* | *574* | *230* | *46* | *3441* |
| **Single Family Detached** | | | | | | | | |
| Gas space heat & gas DWH | 74.7 | 77.4 | 74.9 | 77.9 | 80.1 | 55.8 | 70.8 | 75.9 |
| Gas space heat & electric DWH | 19.8 | 15.8 | 11.0 | 12.6 | 7.4 | 18.3 | 13.1 | 13.5 |
| Electric space heat & gas DWH | 3.1 | 3.2 | 4.6 | 4.9 | 7.7 | 7.4 | 1.5 | 4.6 |
| Electric space heat & electric DWH | 2.4 | 3.6 | 9.5 | 4.6 | 4.8 | 18.5 | 14.6 | 6.0 |
| **Townhouse / Row House** | | | | | | | | |
| Gas space heat & gas DWH | -- | 73.2 | 64.2 | 74.3 | 57.4 | 31.7 | -- | 63.4 |
| Gas space heat & electric DWH | 100.0 | 22.5 | 20.3 | 9.9 | 23.4 | 36.3 | 19.9 | 16.6 |
| Electric space heat & gas DWH | -- | -- | -- | 6.6 | 8.7 | 12.7 | -- | 5.9 |
| Electric space heat & electric DWH | -- | 4.3 | 15.5 | 9.2 | 10.5 | 19.3 | 80.1 | 14.1 |
| **All Dwellings** | | | | | | | | |
| Gas space heat & gas DWH | 73.1 | 75.8 | 72.1 | 75.9 | 71.8 | 48.4 | 55.9 | 72.4 |
| Gas space heat & electric DWH | 20.2 | 17.5 | 14.4 | 13.6 | 13.2 | 23.5 | 16.1 | 15.6 |
| Electric space heat & gas DWH | 3.9 | 2.9 | 3.8 | 5.3 | 7.4 | 7.5 | 1.0 | 4.7 |
| Electric space heat & electric DWH | 2.8 | 3.8 | 9.7 | 5.2 | 7.6 | 20.6 | 27.0 | 7.3 |

[1] Caution is advised in interpreting data for samples of less than 50. Results are directional only.
[2] All dwelling types.
Totals may not sum due to rounding.

Figure 39 (next page) compares the percentages of detachments with gas space heating and gas DWH for two periods – homes constructed prior to 2006 and those built afterwards. The data show the decline in this traditional pairing of gas end-uses.

[66] These homes may have other gas end-uses. However, this analysis concentrates on the largest gas loads which traditionally have been space and domestic water heating.

**Figure 39: Share of FEU Dwellings with Gas Space Heating and Gas DWH**



# 16 BIBLIOGRAPHY


Bernstein, M.A., and Griffin, J. (2006), Regional *Differences in the Price-Elasticity of Demand for Energy*, Subcontract Report for National Renewable Energy Laboratory, NREL/SR-620-39512.

California Climate Change Center (2009), *Price Impact on the Demand for Water and Energy in California Residences*, draft report prepared for the California Energy Commission.

CANMET (2004)*, Benchmarking of Energy Savings Associated with Energy Efficient Lighting in Houses*, Sustainable Buildings and Communities, CANMET Energy Technology Centre, Energy Technology and Programs Sector, April 20, 2004.

Vancouver (2009), *The Role of Secondary Suites: Rental Housing Strategy – Study 4*, Social Development – Housing Policy, Community Services Group, City of Vancouver, December 2009.

Energy Information Administration (2005)*, Residential Energy Consumption Survey*, US Department of Energy.

Habart (2003), *BC Gas Residential End-use Survey Results*, Consultant report prepared for BC Gas by Habart and Associates Consulting Inc., December 2003

Mayer, P.W., W.B. DeOreo et al. (1999), *Residential End-Uses of Water*, AWWA Research Foundation and American Water Works Association.

Natural Resources Canada (2009), *National Energy Use Database*, Available online: oee.nrcan.gc.ca/corporate/statistics.

Natural Resources Canada (2012), *Energy Consumption of Major Household Appliances Shipped in Canada*, Cat. No M141-16/1-2010E-PDF, Available online: oee.nrcan.gc.ca/publications

Natural Resources Canada (2004), *Keeping the Heat In*, EnerGuide.

New Buildings Institute Inc. (2003), Advanced Lighting Guidelines, Vancouver, Washington.

New Buildings Institute (2003), *Advanced Lighting Guidelines: 2003 Edition*, New Buildings Institute, Inc., Vancouver, WA).

Province of British Columbia, Energy Efficiency Act of British Columbia, Energy Efficiency Standards Regulation, B.C. Reg. 389/93.

Ryan, D, and Razek, N.A (2012). *Background Report: The Likely Effect of Carbon Pricing on Energy Consumption in Canada*, Sustainable Prosperity, University of Ottawa.

Sampson Research (2009), *2008 Residential End-Use Survey*, report prepared for Terasen Gas Inc. by Sampson Research Inc., November 2009.

# BIBLIOGRAPHY

Sampson Research (2011), *Residential New Construction Research: Analysis and Highlights*, report prepared for FortisBC by Sampson Research Inc.

US EPA (2012), "Energy Star Products" 20 Years of Helping America Save Energy, Save Money, and Protect the Environment", United States Environmental Protection Agency. Available online: www.energystar.gov/ia/products/downloads

Wade, Steven (2003), H., *Price Responsiveness in the AEO2003 NEMS Residential and Commercial Building Sector Models*, Energy Information Administration, U.S. Department of Energy.

# Appendix A

2012 REUS Questionnaire

FORTIS BC™

Residence (Site) Address

& ID Code

November 5, 2012

Dear Customer,

At FortisBC, we're committed to providing a range of energy services to meet your needs today and tomorrow. Planning for your future needs means understanding how residential customers like you currently use energy and if you plan to change how you use energy in the future.

This survey is an important tool for understanding how energy is used in homes, the types of space and water heating appliances installed, how those appliances are used, the energy efficiency of homes and attitudes about energy issues.

This information is used to:

- forecast future demand for natural gas
- design energy efficiency programs to help you save money on your energy bills
- protect the environment by lowering greenhouse gas emissions

**How to complete the survey**

This survey should be completed by the person most responsible for the maintenance and repair of your home. Also please ensure that the survey responses refer to the residence located at the address shown above.

1. You can complete the enclosed survey and return it in the postage paid envelope provided; or

2. You can complete the survey online at, www.websurveys.ca/fbcreus by entering the survey id included at the top of this page.

**You could win a $1,000 home improvement gift certificate**

Return your completed survey by **December 24, 2012** and you'll be entered into a draw to **win one of four $1,000 gift certificates to a home improvement store near you.**

**Complete the survey online and double your chances of winning.** Full contest rules are at the back of the survey.

**Privacy**

The survey will tell us how you use energy in your home. To meet the goals of this survey, FortisBC will also analyze how much natural gas your home has used over the past two years.*

To protect your privacy, Ipsos, the national market research company that is conducting this survey on behalf of FortisBC, will not have access to your account information. As well, FortisBC will not see your individual responses. The information collected will be treated confidentially and in accordance with the provisions of the *Personal Information Protection* Act (British Columbia). The information collected will not be used for any marketing or sales purpose.

If you have any questions, please contact Walter Wright, Market Research, at 604-592-7653 or walter.wright@fortisbc.com.

Yours truly,

Tom Loski
Vice-President, Customer Service
FortisBC

**FortisBC Energy Inc. is administering this survey on behalf of FortisBC Energy Inc., FortisBC Energy (Vancouver Island) Inc. and FortisBC Energy (Whistler) Inc. By participating in this survey, I agree that the aforementioned FortisBC utilities may use and disclose between the FortisBC utilities, the consumption information for my home for the past two years.*

**Instructions for Completing the Mail Survey**
Some questions require you to place an "X" in the appropriate box, for example:

Do you rent or own this residence? Rent ☒ Own ☐

Some questions require you to fill in a number, for example: *" 23 "* years

Some questions allow you to check several answers. These questions will have the instruction "check all that apply."

When you have completed the survey, please put the questionnaire in the enclosed envelope. No postage is needed. Surveys are due by December 24, 2012.

If you have mislaid the return envelope, please mail the questionnaire to:

Ipsos
200 - 1285 West Pender
Vancouver, BC V6E 4B1

**Dear Participant:**

Throughout this questionnaire, when we ask about your home or residence, we are referring to area covered by your FortisBC bill**.** If you live in an apartment or townhouse complex, please do not include building hallways or outside lighting which are not covered by your own bill.

## A. About This Residence

**A1. Do you own or rent this residence?**

- ☐ 1 Own/co-op → **CONTINUE**
- ☐ 2 Rent → **GO TO QUESTION A3**

**A2. Do you pay maintenance fees?**

- ☐ 1 Yes
- ☐ 2 No → **GO TO QUESTION A4**

**A3. Which of the following are included in your rent or maintenance fees?**

- ☐ 1 Heat
- ☐ 2 Hot water
- ☐ 3 Fuel for gas fireplace
- ☐ 0 None of the above
- ☐ 9 Don't know
- ☐ 4 Fuel for gas cooking
- ☐ 5 Fuel for gas clothes drying
- ☐ 6 Electricity

**A4. Is this residence a…**

- ☐ 1 Single family dwelling (detached)
- ☐ 2 Duplex
- ☐ 3 Row/townhouse (3 or more units attached each with separate entrance)
- ☐ 4 Apartment / Condominium
- ☐ 5 Mobile home
- ☐ 6 Other (please specify): __________

**A5. When was this residence built?**

- ☐ 1 Before 1950
- ☐ 2 1950-1975
- ☐ 3 1976-1985
- ☐ 4 1986-1995
- ☐ 5 1996-2005
- ☐ 6 2006 or later
- ☐ 9 Don't know

**A6. Is this your principal residence?**

- ☐ 1 Yes
- ☐ 2 No

**A7. How many weeks per year is this residence occupied?**

______ weeks ☐ 1 Always occupied

**A8. How many years have you lived in this residence?**

______ years

**A9. What are the heights of the ceilings in this residence, excluding the basement? Please indicate the percentage of the residence with each ceiling height. Choose the closest height. Your answers should sum to 100%.**

| | |
|---|---|
| 8 feet | ______ |
| 9 feet | ______ |
| 10 feet | ______ |
| More than 10 feet | ______ |
| **TOTAL** | **100%** |

**A10. What type of basement does your residence have?**

- ☐ 1 No basement → **GO TO QUESTION A14**
- ☐ 2 Full basement
- ☐ 3 Crawl space → **GO TO QUESTION A13**
- ☐ 4 Partial basement

**A11. Is the basement area of this residence…**

- ☐ 1 Completely below ground
- ☐ 2 Completely above ground
- ☐ 3 Partially above ground

**A12. Is the basement area of this residence unfinished, partly finished, or completely finished?**

☐ 1 Unfinished ☐ 2 Partly finished ☐ 3 Completely finished

**A13. During the heating season, is your basement or crawl space usually heated?**

☐ 1 Yes ☐ 2 No

**A14. What is the total floor area of this residence, including the basement and unfinished areas but excluding the garage or carport?**

_________ Square feet OR _________ Square meters

**A15. How many floors of heated living space does this residence have? (include basement if heated)**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+

**A16. Does the electric bill for this residence cover any of the following, and if so, how many:**

| | Yes | No | Don't Know | Number | | | |
|---|---|---|---|---|---|---|---|
| Secondary suite(s) | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4+ |
| Detached garage / workshop | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4+ |
| Other buildings (e.g., sheds, farm buildings) | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4+ |
| Pumps (e.g., wells, irrigation, etc.) | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4+ |

**A17. Please indicate which areas of this residence have insulation and if you know whether the insulation is below average, average or above average.**

| Location | Have insulation? Yes | No | Don't Know | Below Average (R6 or 1.75" fiberglass or less) | Average (R12 or 3.5" fiberglass or less) | Above Average (R20 or 6" fiberglass or more) | Don't know |
|---|---|---|---|---|---|---|---|
| In the attic | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 9 |
| In your walls | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 9 |
| In your basement / crawl space | ☐ 1 | ☐ 2 | ☐ 9 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 9 |

**A18. How effective is the draft proofing in this residence?**

☐ 1 Not at all drafty ☐ 2 Sometimes drafty ☐ 3 Always drafty

**A19. Please estimate what percentage of your windows are:**

| | % of Total Windows | Argon Gas Filled? | | |
|---|---|---|---|---|
| Single pane regular (clear) glass | _______% | | | |
| Double pane regular (clear) glass | _______% | ☐ 1 Yes | ☐ 2 No | ☐ 9 Don't know |
| Double pane low-E* | _______% | ☐ 1 Yes | ☐ 2 No | ☐ 9 Don't know |
| Triple pane regular (clear) glass | _______% | ☐ 1 Yes | ☐ 2 No | ☐ 9 Don't know |
| Triple pane low-E* | _______% | ☐ 1 Yes | ☐ 2 No | ☐ 9 Don't know |
| Other – Specify: ______________________ | _______% | ☐ 1 Yes | ☐ 2 No | ☐ 9 Don't know |
| | **Total 100%** | | | |

** Low-E coated glass has a slight shading or tint when compared to standard windows.*

**A20. Please estimate the percentage of your windows that have the following frames:**

| | % of Total Windows |
|---|---|
| Aluminum frames | ________% |
| Wood frames | ________% |
| Vinyl frames | ________% |
| Fiberglass frames | ________% |
| Other (please specify): ______________ | ________% |
| Total | 100% |

**A21. Please indicate the number of outside doors in this residence. If this residence is an apartment or condominium, please count only doors in your unit that open directly to the outdoors.**

| | Number | | Number |
|---|---|---|---|
| Wood doors | ____ 1 | Glass doors with wooden frames | ____ 4 |
| Wood doors with aluminum storm doors | ____ 2 | Glass doors with aluminum frames | ____ 5 |
| Insulated steel or fibreglass doors | ____ 3 | Glass doors with vinyl frames | ____ 6 |

**A22. Do you or anyone in your household use part of this residence as a full-time or part-time office from which they conduct a business?**

☐ 1 Yes, full-time business ☐ 2 Yes, part-time business ☐ 3 No

## B. Space Heating

**B1. What is the main fuel used to heat this residence? The main fuel is the one that provides most of the heat in the home during a typical year. (Check one fuel only.)**

Electricity ☐ 1 Bottled propane ☐ 4 Other ☐ 7
Natural gas ☐ 2 Oil ☐ 5 Don't know ☐ 9
Piped propane ☐ 3 Wood ☐ 6

**Do I have piped natural gas or piped propane service?**

If you are a gas customer of FortisBC and live anywhere in British Columbia *other than Revelstoke*, your residence uses *natural gas*. Customers in Revelstoke receive their gas service in the form of piped propane. Propane from a refillable tank is considered "bottled" propane.

**B2. Have you changed from one main fuel to another to heat this residence over the past five years?**

Yes ☐ 1 → **CONTINUE**
No ☐ 2 → **GO TO QUESTION B4**

**B3. What was the previous main space heating fuel? (check one fuel only)**

Electricity ☐ 1 Bottled propane ☐ 4 Other ☐ 7
Natural gas ☐ 2 Oil ☐ 5 Don't know ☐ 9
Piped propane ☐ 3 Wood ☐ 6

**B4. Please indicate any OTHER fuel(s) used to heat this residence (check all that apply) and which OTHER fuel is used the most (check one only). Note: both air source and ground source (geothermal) heat pumps require electricity to operate.**

| | **All OTHER Fuels** *(check all that apply)* | **Most commonly used OTHER Fuel** *(check one only)* |
|---|---|---|
| Electricity | ☐ 1 | ☐ 1 |
| Natural gas | ☐ 2 | ☐ 2 |
| Piped propane | ☐ 3 | ☐ 3 |
| Bottled propane | ☐ 4 | ☐ 4 |
| Oil | ☐ 5 | ☐ 5 |
| Wood | ☐ 6 | ☐ 6 |
| Other | ☐ 7 | ☐ 7 |
| Don't know | ☐ 9 | ☐ 9 |

**UNLESS OTHERWISE STATED, ANY REFERENCES TO "GAS" FROM THIS POINT FORWARD IN THE SURVEY MEAN EITHER NATURAL GAS OR PROPANE GAS.**

**B5. There are several methods that can be used to heat a home. Please check the main method used to heat this residence, then the second most used method, and then all other methods used to heat this residence.**

| | **Main method** *(check one only)* | **Second most used method** *(check one only)* | **All other methods** *(check all that apply)* |
|---|---|---|---|
| Central forced air furnace | ☐ 1 | ☐ 1 | ☐ 1 |
| Multi-fuel forced air furnace | ☐ 2 | ☐ 2 | ☐ 2 |
| Wired-in electric heater (baseboards) | ☐ 3 | ☐ 3 | ☐ 3 |
| Wired-in electric wall heater (fan forced) | ☐ 4 | ☐ 4 | ☐ 4 |
| Heat pump–air source | ☐ 5 | ☐ 5 | ☐ 5 |
| Heat pump – ground source (geothermal) | ☐ 6 | ☐ 6 | ☐ 6 |
| Hot water baseboards | ☐ 7 | ☐ 7 | ☐ 7 |
| Hot water radiant in-floor / underfloor heat | ☐ 8 | ☐ 8 | ☐ 8 |
| Electric radiant heat (floors, walls, and/or ceilings) | ☐ 9 | ☐ 9 | ☐ 9 |
| Gas wall heater | ☐ 10 | ☐ 10 | ☐ 10 |
| Portable electric heaters | ☐ 11 | ☐ 11 | ☐ 11 |
| Gas fireplace | ☐ 12 | ☐ 12 | ☐ 12 |
| Gas heater stove | ☐ 13 | ☐ 13 | ☐ 13 |
| Wood stove | ☐ 14 | ☐ 14 | ☐ 14 |
| Wood burning fireplace | ☐ 15 | ☐ 15 | ☐ 15 |
| Electric fireplace | ☐ 16 | ☐ 16 | ☐ 16 |
| Other (Specify) _______________ | ☐ 17 | ☐ 17 | ☐ 17 |

**IF THIS RESIDENCE DOES NOT HAVE A GAS FURNACE, ELECTRIC FURNACE, OR GAS BOILER, GO TO QUESTION B18**

**B6. Which of the following does this residence have?**

- ☐ 1 Gas boiler → **GO TO QUESTION B7**
- ☐ 2 Gas furnace → **GO TO QUESTION B8**
- ☐ 3 Electric furnace → **GO TO QUESTION B12**
- ☐ 0 None of the above → **GO TO QUESTION B18**

**B7. Boiler efficiency refers to how much useful heat your boiler extracts from the gas. The higher the efficiency of the boiler, the less fuel is required to heat your house. Boilers are categorized as low efficiency, mid-efficiency, or high efficiency.**

**What is the efficiency of your boiler?**

- ☐ 1 Low efficiency – 60% efficient
- ☐ 2 Mid-efficiency – 80% to 85% efficient
- ☐ 3 High efficiency – 90% efficient or higher
- ☐ 9 Don't know

} → **GO TO QUESTION B9**

**B8. Furnace efficiency refers to how much useful heat your furnace extracts from the gas. The higher the efficiency of the furnace, the less fuel is required is to heat your house. Furnaces are categorized as low (standard) efficiency, mid-efficiency, or high efficiency.**

**What is the efficiency of your gas furnace?**

- ☐ 1 Low (standard) efficiency – less than 78% efficient
- ☐ 2 Mid-efficiency – 78% to 85% efficient
- ☐ 3 High efficiency – 90% efficient or higher
- ☐ 9 Don't know

**Gas Boiler Types**

**Low Efficiency Gas Boilers:**
- 13 years old or older
- 60% efficient
- uses a standing pilot light

**Mid-Efficiency Gas Boilers:**
- 80% to 85% efficient
- no pilot light, uses igniter instead
- uses induced draft fan or damper

**High Efficiency Gas Boilers:**
- 90% efficient or higher
- no pilot light, uses igniter instead
- uses plastic exhaust pipe that exits the roof or side of house

**Gas Furnace Types**

**Low (Standard) Efficiency Gas Furnaces:**
- 18 years old or older
- less than 78% efficient
- typically uses a pilot light
- uses metal flue that exits the roof

**Mid-Efficiency Gas Furnaces:**
- 78% to 85% efficient
- no pilot light, uses igniter instead
- uses a metal flue that exits the roof

**High Efficiency Gas Furnaces:**
- 90% efficient or higher
- no pilot light, uses igniter instead
- uses plastic exhaust pipe that exits the side of the house.
- ENERGY STAR qualified

**B9. Is your gas furnace or boiler an ENERGY STAR® qualified model?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't Know

ENERGY STAR® qualified products are some of the most energy-efficient products that you can buy today. ENERGY STAR products will display the ENERGY STAR logo on the product or its packaging when new.

**B10. Has a gas furnace or gas boiler been installed in this residence in the past five years?**

Yes ☐ 1 → **CONTINUE**
No ☐ 2 } → **GO TO QUESTION B12**
Don't know ☐ 9 }

**B11. What was the main reason for installing a natural gas furnace or natural gas boiler? (Check one reason only)**

☐ 1 New home
☐ 2 Wanted to change to gas
☐ 3 Wanted more efficient furnace or boiler
☐ 4 Existing furnace or boiler had failed
☐ 5 Anticipated furnace or boiler failure
☐ 6 Wanted an environmentally friendly fuel
☐ 7 Wanted a lower cost fuel
☐ 8 Other (please specify): ___________________

**B12. How old is your furnace or boiler?** _____ years ☐ 9 Don't know

## RESIDENCES WITH GAS OR ELECTRIC FURNACES

**B13. How often does your furnace fan blower operate? Choose the best answer.**

☐ 1 Only when furnace is operating
☐ 2 Only when furnace or air conditioning is operating
☐ 3 Continuously during the heating season
☐ 4 Continuously during the heating and cooling season
☐ 5 Continuously year round → **GO TO QUESTION B15**
☐ 9 Don't know

**B14. In addition to the above, do you also turn on the furnace fan to provide ventilation for part of the year?**

☐ 1 Yes → **How many weeks per year does the furnace fan operate in this mode?** ______ weeks
☐ 2 No

**B15. Does your furnace have a high efficiency blower motor (often called a variable speed motor or electronically controlled motor (ECM))?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't know

**B16. Have you undertaken any repairs to your furnace or boiler during the past three years?**

Yes ☐ 1
No ☐ 2 } → **GO TO QUESTION B18**
Don't know ☐ 9 }

**B17. In total, how much did you spend on repairs to your furnace or boiler over the past three years?**

$ _______ ☐ 999 Don't know

**B18. Please indicate whether you always, usually, occasionally or never do the following (check one box per row).**

| | Always | Usually | Occasion-ally | Never | Don't know | Not Applicable |
|---|---|---|---|---|---|---|
| Change the furnace filter regularly | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| Have the heating system serviced annually by a contractor | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| Service the heating system annually myself | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |

**B19. How many rooms in this residence are heated? (Exclude bathrooms, closets and hallways)**

Number of rooms that are always heated _____
Number of rooms that are sometimes heated _____
Number of rooms that are rarely or never heated _____

**B20. Do you use programmable thermostat(s) in this residence?** ☐ 1 Yes ☐ 2 No ☐ 9 Don't Know

## C. Fireplaces and Heater Stoves

**Many homes are equipped with fireplaces or heater stoves. Some provide ambiance but little or no heat, while others can be used to heat one or more rooms.**

**C1. Do you have a fireplace or heating stove in this residence?**

Yes ☐ 1 → **CONTINUE**
No ☐ 2 → **GO TO SECTION D**

**Gas Fireplace and Stove Types**

**Decorative fireplaces** – Provide ambiance but have little or no heating ability. The firebox is typically steel or masonry, and the hearth is often open to the room or equipped with opening glass doors.

**Heater type fireplaces (built-ins and inserts)** – These fireplaces are efficient heaters with fixed glass fronts and may have features such as fans and thermostatic control. They may be built-in at the time of construction, or inserted into an existing masonry or other fireplace as an upgrade.

**Free standing fireplaces and heater stoves** – These are stand alone units that that can be used for both ambiance and heating. Gas heater stoves resemble wood stoves in appearance but use gas instead of wood.

**C2. How many of the following types of fireplaces and heater stoves do you have? For each type, please indicate whether they are used primarily for heating, ambiance or both.**

| | Number (Check one) type that you have) | | | | Used primarily for: | | |
|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4+** | **Heating** | **Ambiance** | **Both** |
| Gas (decorative) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Gas (heater type) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Gas (free standing) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Electric | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Wood burning fireplace | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Wood burning stove | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |
| Other: ________________ | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 1 | ☐ 2 | ☐ 3 |

**C3. How many hours are the fireplaces and heater stoves in use during a typical week in each of the following seasons? Please sum the total hours for ALL fireplaces and heater stoves used in a typical week in each season.**

Summer (July – September) _____ hours per week
Fall (October – December) _____ hours per week
Winter (January – March) _____ hours per week
Spring (April – June) _____ hours per week

**C4. Approximately, what share of this residence's space heating requirements are provided by your fireplace or heater stove? Please include all fireplaces and heater stoves at this residence in your answer.**

0% (none) ☐ 0
Up to 10% ☐ 1
Up to 25% ☐ 2
Up to 50% ☐ 3
Up to 75% ☐ 4
Up to 100% ☐ 5
Don't know ☐ 9

**IF THIS RESIDENCE DOES NOT HAVE A GAS FIREPLACE, GO TO SECTION D**

**C5. How old is (are) your gas fireplace(s)?**

Gas fireplace 1 _____ years Don't know ☐ 99
Gas fireplace 2 _____ years Don't know ☐ 99
Gas fireplace 3 _____ years Don't know ☐ 99

**C6. For each gas fireplace you have, please indicate whether it has a fixed glass front, glass doors that open, or an open hearth design (no glass) by checking the appropriate box.**

| | Gas Fireplace 1 | Gas Fireplace 2 | Gas Fireplace 3 |
|---|---|---|---|
| Fixed glass front | ☐ 1 | ☐ 1 | ☐ 1 |
| Glass doors that open | ☐ 2 | ☐ 2 | ☐ 2 |
| No glass (open hearth) | ☐ 3 | ☐ 3 | ☐ 3 |

**C7. For each gas fireplace you have, please indicate whether it has a pilot light? The pilot light is a small flame that is used to ignite the fireplace.**

| | Gas Fireplace 1 | Gas Fireplace 2 | Gas Fireplace 3 |
|---|---|---|---|
| Yes | ☐ 1 | ☐ 1 | ☐ 1 |
| No | ☐ 2 | ☐ 2 | ☐ 2 |
| Don't know | ☐ 3 | ☐ 3 | ☐ 3 |

**C8. GAS FIREPLACES WITH PILOT LIGHTS ONLY: Do you typically turn off your fireplace pilot light? If yes, how many months is the pilot light typically turned off?**

Yes ☐ 1 → **Number of months per year pilot light off: ______**
No ☐ 2 } → **GO TO SECTION D**
Don't know ☐ 9 }

**C9. Who typically re-lights the pilot light for your gas fireplace?**

☐ 1 Myself
☐ 2 Contractor
☐ 3 Some other member of my household
☐ 4 Other: __________________
☐ 9 Don't' Know

## D. Domestic Water Heating

**D1. How many water heaters are there in this residence? If you live in an apartment, townhouse, or row house where hot water is centrally provided to all units (from outside your unit), please check "none".**

1 ☐
2 ☐
3 ☐
None ☐ → **GO TO QUESTION D15**

**D2. What type of fuel does your water heater(s) use? Homes with more than one water heater usually have one water heater that provides more hot water than the others. For classification purposes, consider this unit your main water heater.**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Electricity | ☐ 1 | ☐ 1 | ☐ 1 |
| Natural gas | ☐ 2 | ☐ 2 | ☐ 2 |
| Piped propane | ☐ 3 | ☐ 3 | ☐ 3 |
| Bottled propane | ☐ 4 | ☐ 4 | ☐ 4 |
| Solar | ☐ 5 | ☐ 5 | ☐ 5 |
| Oil | ☐ 6 | ☐ 6 | ☐ 6 |
| Geothermal | ☐ 7 | ☐ 7 | ☐ 7 |
| Other | ☐ 8 | ☐ 8 | ☐ 8 |

**Water Heater Fuels: Hint**

Most hot water heaters use gas, oil or electricity. If your hot water heater has a flue/vent then it uses gas or oil. If there is no vent then it uses electricity. Please consider the fuels used in your house when completing this question.

**D3. Please indicate whether the water heater(s) uses solar energy to pre-warm or supplement the water heating process.**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Yes | ☐ 1 | ☐ 1 | ☐ 1 |
| No | ☐ 2 | ☐ 2 | ☐ 2 |

**D4. Have you changed the water heating fuel at this residence within the past five years?**

Yes ☐ 1 → **CONTINUE** No ☐ 2 → **GO TO QUESTION D6**

**D5. What was the previous water heater fuel?**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Electricity | ☐ 1 | ☐ 1 | ☐ 1 |
| Natural gas | ☐ 2 | ☐ 2 | ☐ 2 |
| Piped propane | ☐ 3 | ☐ 3 | ☐ 3 |
| Bottled propane | ☐ 4 | ☐ 4 | ☐ 4 |
| Solar | ☐ 5 | ☐ 5 | ☐ 5 |
| Oil | ☐ 6 | ☐ 6 | ☐ 6 |
| Geothermal | ☐ 7 | ☐ 7 | ☐ 7 |
| Other | ☐ 8 | ☐ 8 | ☐ 8 |

**D6. What types of water heater(s) are there in this residence?**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Conventional storage (tank) | ☐ 1 | ☐ 1 | ☐ 1 |
| On-demand (tankless) | ☐ 2 | ☐ 2 | ☐ 2 |
| Hybrid on-demand (uses small storage tank) | ☐ 3 | ☐ 3 | ☐ 3 |
| Combined space and water heater | ☐ 4 | ☐ 4 | ☐ 4 |
| Hybrid heat pump water heater (tank) | ☐ 5 | ☐ 5 | ☐ 5 |
| Don't know | ☐ 9 | ☐ 9 | ☐ 9 |

**Tankless & Hybrid On-Demand Water Heaters**

On-demand (tankless) water heaters, also known as instantaneous water heaters, are compact units that provide hot water on demand. Hybrid on-demand models use a small storage tank to reduce temperature fluctuations during use.

Hybrid heat pump water heaters combine a heat pump with an electric hot water tank to improve energy efficiency.

**D7. If this residence has a conventional storage (tank) water heater, does it have a:**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Vent through the side wall | ☐ 1 | ☐ 1 | ☐ 1 |
| Vent through the roof | ☐ 2 | ☐ 2 | ☐ 2 |
| No vent (electric tank) | ☐ 3 | ☐ 3 | ☐ 3 |
| Don't know | ☐ 9 | ☐ 9 | ☐ 9 |

**D8. If this residence has an on-demand (tankless or hybrid) water heater, does it have a:**

| | Heater 1 (Main Unit) | Heater 2 | Heater 3 |
|---|---|---|---|
| Metal vent | ☐ 1 | ☐ 1 | ☐ 1 |
| Plastic vent | ☐ 2 | ☐ 2 | ☐ 2 |
| No vent (electric tankless) | ☐ 3 | ☐ 3 | ☐ 3 |
| Don't know | ☐ 9 | ☐ 9 | ☐ 9 |

**D9. How old is (are) your water heater(s)?**

| | | |
|---|---|---|
| Heater 1 (Main Unit) | ______ years | Don't know ☐ 99 |
| Heater 2 | ______ years | Don't know ☐ 99 |
| Heater 3 | ______ years | Don't know ☐ 99 |

**D10. What is the size (volume) of the largest hot water tank in your home? The size is printed on the label attached to your tank.**

☐ 1 On-demand (tankless or hybrid)
☐ 2 10 imperial gallons (46 litres)
☐ 3 33 imperial gallons (150 litres)
☐ 4 40 imperial gallons (182 litres)
☐ 5 60 imperial gallons (273 litres)
☐ 6 Other (please specify): _______________
☐ 9 Don't know

**D11. Have you installed a water heater within the past five years**?

Yes ☐ 1 → **CONTINUE**
No ☐ 2 → **GO TO QUESTION D13**

**D12. What was the main reason you installed the water heater? (Check one only)**

New home ☐ 1
Wanted to change to gas ☐ 2
Wanted more efficient water heater ☐ 3
Water heater had failed ☐ 4
Anticipated water heater failure ☐ 5
Needed more hot water ☐ 6
Wanted faster hot water recovery ☐ 7
Wanted an environmentally friendly fuel ☐ 8
Wanted a cheaper fuel ☐ 9
Other ☐ 10

**D13. Some energy-efficient gas water heaters require access to an electrical outlet. Is there an electrical outlet within 5 feet (1.5 metres) of your current water heater?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't know

**D14. Drain water heat recovery systems capture heat from drain pipes in the home and use this heat to reduce the amount of energy used by the water heater. Does this home use a drain water heat recovery system?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't know

**Drain Heat Recovery System**

**D15. Please indicate the total number of the following for your residence:**

| | **Number** |
|---|---|
| Showerheads (all kinds) | ______ |
| Low flow showerheads | ______ |
| Water heater blankets | ______ |
| Instant hot water dispensers | ______ |
| Bathroom and kitchen faucet aerators | ______ |

**D16. Please indicate the total number of the following for all members of your household:**

| | **Number** |
|---|---|
| Number of dishwasher loads per week | ______ |
| Number of baths per week | ______ |
| Number of showers per week | ______ |

**D17. Please estimate the total amount of time that shower(s) are used on a typical weekday (total for all members of this residence).**

_____ minutes per day ☐ 1 No showers – take baths only

### *A FRIENDLY REMINDER*

Please ensure your survey responses refer to the residence at the address identified on the front page of this survey. Your responses will be kept strictly confidential.

To ensure you are eligible to win one of the four $1,000 gift certificates, make sure you return your survey by December 24, 2012 using the self-addressed postage-paid return envelope included with your survey package. Easier still, complete your survey online by December 24, 2012 and double your chance at winning a $1,000 gift certificate. Only one survey (paper or online) will be accepted per household.

***Thank you for completing this important survey.***

## E. Swimming Pools & Hot Tubs

**E1. Do you have a swimming pool at this residence?**

Yes, indoor ☐ 1 } → **CONTINUE**
Yes, outdoor ☐ 2 }
No ☐ 3 → **GO TO QUESTION E7**

**E2. Is this pool for the exclusive use of this residence (example: backyard pools in single family dwellings) or shared with other residences (example: pools in apartments / condominiums / townhouse complexes)?**

Exclusive use only ☐ 1 → **CONTINUE**
Share with others ☐ 2 → **GO TO QUESTION E7**

**E3. Which fuel do you use to heat the water in your pool and do you use solar energy to help heat the water?**

| | Main pool heater fuel | Supplemented with solar heating |
|---|---|---|
| Solar | ☐ 1 | |
| Natural gas | ☐ 2 | ☐ 2 |
| Electricity | ☐ 3 | ☐ 3 |
| Propane | ☐ 4 | ☐ 4 |
| Other | ☐ 5 | ☐ 5 |

Pool not heated ☐ 6 → **GO TO QUESTION E6**

> **Solar Heating**
>
> There are two main types of solar heating. Photovoltaic panels which use light to power an electric appliance and thermal solar which uses the sun's heat to warm tubes filled with water or diluted antifreeze.

**E4. How many months per year is your pool heated?** ______ months per-year

**E5. During the months when you heat your pool, do you cover it when not in use?** Yes ☐ 1 No ☐ 2

**E6. Does your pool pump use a high efficiency motor (often called a variable speed motor or electronically controlled motor (ECM))?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't know ☐ 3 Not applicable

**E7. Do you have a hot tub at this residence?**

Yes, indoor ☐ 1 } → **CONTINUE**
Yes, outdoor ☐ 2 }
No ☐ 3 → **GO TO QUESTION E12**

**E8. Is this hot tub for the exclusive use of this residence (example: hot tubs in single family dwellings) or shared with other residences (example: hot tubs in apartments / condominiums / townhouse complexes)?**

Exclusive use only ☐ 1 → **CONTINUE**
Share with others ☐ 2 → **GO TO QUESTION E12**

**E9. What fuel is used to heat the hot tub?**

Natural gas ☐ 1 Solar ☐ 3 Other ☐ 5
Propane ☐ 2 Electricity ☐ 4

**E10. How many months per year is your hot tub heated?** _____ months

**E11. During the months when you heat your hot tub, do you cover it when not in use?** Yes ☐ 1 No ☐ 2

**E12. Does this residence have a sauna that is for your exclusive use?**

Yes ☐ 1 → **CONTINUE**
No ☐ 2 → **GO TO SECTION F**

**E13. What fuel is used to heat the sauna?**

Electricity ☐ 1 Propane ☐ 3 Don't know ☐ 9
Natural gas ☐ 2 Other ☐ 4

## F. Appliances

**F1. Please indicate the number of each of the following appliances in use in this residence. For each appliance please indicate the approximate age (your best guess is fine). If you do not have the appliance, please check the "0" box.**

| | Number in Use 0 | 1 | 2 | 3+ | Age of Appliance (in years) #1 | #2 | #3 |
|---|---|---|---|---|---|---|---|
| **COOKING** | | | | | | | |
| Electric range (cook top and oven) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas range (cook top and oven) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Dual fuel range (gas cook top, electric oven) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Electric cook top | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas cook top | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Electric wall oven | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas wall oven | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Microwave oven | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas barbeque (piped gas) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas barbeque (bottled gas) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Commercial grade range hood | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| **REFRIGERATION** | | | | | | | |
| Refrigerator – manual defrost | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Refrigerator – automatic defrost | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Stand alone freezer – upright | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Stand alone freezer – chest style | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| **CLEANING** | | | | | | | |
| Dishwasher | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Clothes washer - top load | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Clothes washer - front load | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Electric clothes dryer | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas clothes dryer | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| **HEATING** | | | | | | | |
| Air source heat pump | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Ground source heat pump | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Heat recovery ventilator/ make up air unit | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas outdoor heater (piped gas) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas outdoor heater (bottled gas) | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Gas outdoor fire pit or fireplace | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |

**F2. Please indicate below the number of each appliance in this residence, the months of the year the appliance is regularly used, and the average number of hours per day when in use. If an appliance is in use year-round, write in Jan – Dec for the months in use.**

| | Number in Use 0 | 1 | 2 | 3+ | Used in a typical year From (month) | To (month) | Average # hours per day when used |
|---|---|---|---|---|---|---|---|
| Central air conditioner | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Portable air conditioner | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Room window air conditioner | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Portable fan | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Humidifier | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Dehumidifier | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Portable electric heater | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Rotating ceiling fans without light fixtures | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |
| Rotating ceiling fans with light fixtures | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ____ | ____ | ____ |

**F3. How likely are you to buy a portable, room, or central air conditioner in the next 12 months?**

| | Definitely will | Most likely will | Might or might not | Most likely will not | Definitely will not |
|---|---|---|---|---|---|
| Portable air conditioner | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Room or window air conditioner | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| Central air conditioner | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**SECTIONS G AND H APPLY TO FORTISBC ELECTRICITY CUSTOMERS ONLY. THESE SECTIONS HAVE BEEN OMITTED FROM YOUR SURVEY.**

## I. Renovations & Energy Use

**I1. Please indicate renovations or actions you have undertaken at this residence <u>during the past five years,</u> whether you received a government or utility rebate to complete them, and the renovations you plan to undertake within the <u>next two years</u>.**

| | Did this – past 5 years | | Plan to do this – next 2 years |
|---|---|---|---|
| | With rebate | Without rebate | |
| Improve insulation in walls, attic, basement, or crawlspace | ☐ 1 | ☐ 1 | ☐ 1 |
| Install energy-efficient window(s) | ☐ 2 | ☐ 2 | ☐ 2 |
| Install insulated outside door(s) or storm doors | ☐ 3 | ☐ 3 | ☐ 3 |
| Install low flow showerhead(s) | ☐ 4 | ☐ 4 | ☐ 4 |
| Install programmable thermostat(s) | ☐ 5 | ☐ 5 | ☐ 5 |
| Install pipe wrap | ☐ 6 | ☐ 6 | ☐ 6 |
| Install weather stripping or caulking | ☐ 7 | ☐ 7 | ☐ 7 |
| Install hot water heater blanket | ☐ 8 | ☐ 8 | ☐ 8 |
| Install drain pipe waste heat recovery system | ☐ 9 | ☐ 9 | ☐ 9 |
| Install on-demand (tankless or hybrid) water heater | ☐ 10 | ☐ 10 | ☐ 10 |
| Install high efficiency hot water tank | ☐ 11 | ☐ 11 | ☐ 11 |
| EcoENERGY or LiveSmart BC certified energy audit completed | ☐ 12 | ☐ 12 | ☐ 12 |
| Install a sauna | | ☐ 13 | ☐ 13 |
| Install heated swimming pool | | ☐ 14 | ☐ 14 |
| Install hot tub | | ☐ 15 | ☐ 15 |
| None of the above | ☐ 0 | | ☐ 0 |

**I2. Did you undertake any renovations that involve fireplaces or heating stoves at this residence in the past five years, or plan to do so in the next two years?**

☐ 1 Yes → **CONTINUE**
☐ 2 No → **GO TO QUESTION I5**

**I3. Please indicate the renovations that involve fireplaces or heating stoves that you did at this residence during the past five years, whether you received a government or utility rebate to complete them, and those you plan to undertake within the next two years.**

**Note: there several types of fireplaces available in the market today. Please read carefully and select the category that best describes your renovation plan involving fireplaces.**

| | Did this – past 5 years | | Plan to do this – next 2 years |
|---|---|---|---|
| | With rebate | Without rebate | |
| Install free standing gas fireplace or heating stove | ☐ 1 | ☐ 1 | ☐ 1 |
| Install wood stove | ☐ 2 | ☐ 2 | ☐ 2 |
| Install gas heater type fireplace insert in an existing wood fireplace | ☐ 3 | ☐ 3 | ☐ 3 |
| Replace decorative gas fireplace with gas heater type insert | ☐ 4 | ☐ 4 | ☐ 4 |
| Remove or disconnect gas fireplace | | ☐ 5 | ☐ 5 |
| Remove wood fireplace or wood stove | | ☐ 6 | ☐ 6 |
| Install decorative gas fireplace | | ☐ 7 | ☐ 7 |
| Install electric fireplace | | ☐ 8 | ☐ 8 |
| None of the above | ☐ 0 | | ☐ 0 |

**I4. IF YOU INSTALLED A GAS FIREPLACE IN THE PAST FIVE YEARS: Was this gas fireplace an ENERCHOICE model?**

☐ 1 Yes ☐ 2 No ☐ 9 Don't know

**EnerChoice Gas Fireplaces**

All new fireplaces and heater stoves are required to be CSA approved and display an EnerGuide label which shows how much energy they consume.

Fireplaces and heater stoves that also display an **ENERCHOICE** label are the most energy-efficient models on the market today.

ENERCHOICE.ORG

**I5. Which of the following home renovations would you typically do yourself, use a contractor, or both do it yourself and use a contractor?**

| | Do it myself | Use a contractor | Both |
|---|---|---|---|
| Install new appliances (dishwashers, laundry machines, other) | ☐ 1 | ☐ 2 | ☐ 3 |
| Install / replace windows | ☐ 1 | ☐ 2 | ☐ 3 |
| Install low flow showerheads | ☐ 1 | ☐ 2 | ☐ 3 |
| Improve weather stripping / draft proofing | ☐ 1 | ☐ 2 | ☐ 3 |
| Improve insulation in walls, ceilings or attics | ☐ 1 | ☐ 2 | ☐ 3 |

**I6. How influential are the following sources of information when purchasing a major appliance.**

| | | Not at all Influential 1 | 2 | 3 | 4 | Very Influential 5 |
|---|---|---|---|---|---|---|
| a. | Contractors / tradespeople | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| b. | Customer ratings | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| c. | Expert reviews (e.g., magazines, websites, TV) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| d. | Electric or gas utilities | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| e. | Government | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| f. | Appliance salespeople | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| g. | Knowledgeable family member, friend, or neighbour | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**Thank you for participating in this important survey. You have completed about 70% of the survey.**

## J. Managing Energy Use

**This section is intended to help FortisBC understand how you use / manage energy at this residence.**

**J1. At what temperature do you usually keep this residence during the winter (heating) season? If this residence has air conditioning (central, window, portable, or heat pump), also tell us what temperature you usually keep this residence during the summer (cooling) season.**

| | Winter (Heating) | | | Summer (Cooling) | | |
|---|---|---|---|---|---|---|
| | Degrees C | or | Degrees F | Degrees C | or | Degrees F |
| When someone is at home | ___ | | ___ | ___ | | ___ |
| When no one is home | ___ | | ___ | ___ | | ___ |
| During the night | ___ | | ___ | ___ | | ___ |

☐ Do not use air conditioning

**Next, we would also like to understand the types of actions that you take to manage energy usage at this residence. Please check the answer that best describes what you normally do.**

**J2. Space Heating**

| | | Always | Usually | Occasionally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Close window coverings to keep in heat | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| b. | Turn down the heat at night either manually or using a programmable thermostat | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| c. | Turn down the heat either manually or using a programmable thermostat when no one is at home | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| d. | Reduce temperature in unused rooms by closing vents or turning down room thermostats | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| e. | Check and re-seal air leaks in the house at least once a year (weather stripping and caulking) | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| f. | If single pane windows, install storm windows each fall | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| g. | Install plastic window coverings on drafty windows during winter months | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |

**J3. Are you able to reduce the temperature in unoccupied rooms at this residence? This could be done by turning down individual room thermostats, closing doors, and closing vents?**

☐ Yes ☐ No ☐ Don't Know

**J4. Air Conditioning / Cooling**

| | | Always | Usually | Occasion-ally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Set the thermostat at 26 degrees C (78°F) or higher during the summer to save energy | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| b. | Close the window coverings (drapes, blinds, etc.) during hot weather to reduce heat in the dwelling | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| c. | Clean the air conditioner filter and coils at least once per season | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |
| d. | Turn on air conditioning only when very hot and natural ventilation is insufficient | ☐1 | ☐2 | ☐3 | ☐4 | ☐5 | ☐6 |

**J5. Have you done either of the following to keep this residence cool:**

| | Yes | No | Don't know |
|---|---|---|---|
| Planted trees or other vegetation | ☐ 1 | ☐ 2 | ☐ 9 |
| Installed shading devices (i.e., awnings, pergolas) | ☐ 1 | ☐ 2 | ☐ 9 |

**J6. Water Usage**

| | | Always | Usually | Occasion-ally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Turn off the water heater or use its "vacation setting" when no one is home for more than 2 or 3 days | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| b. | Only do laundry with full loads | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| c. | Clean the dryer lint filter before drying clothes | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| d. | Use the dryer's temperature / moisture sensor to turn off the dryer rather than using timed dry | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| e. | Hang clothes to dry rather than machine dry | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| f. | Only run dishwasher when full | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| g. | Air dry the dishes in the dishwasher rather than use the dry cycle | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |

**J7. How many loads of laundry does your household do per week?**

Number of loads done in cold, warm or hot water _____ per week
Number of loads using cold water wash and rinse only _____ per week
Number of dryer loads _____ per week
Number of loads dried using a clothes line or drying rack during SUMMER _____ per week
Number of loads dried using a clothes line or drying rack during WINTER _____ per week

**J8. How much extra cold water wash and rinse could you do?**

Number of loads more _____ per week ☐ 0 None, already doing all I can

**J9. Lighting**

| | | Always | Usually | Occasion-ally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Only have the minimum number of lights on in a room for what I am doing | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| b. | Turn off the lights when on one is in the room | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| c. | Leave outdoor lights on at night (exclude those you do not control) | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| d. | Check timers to reflect daylight savings time | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |

**J10. Refrigeration**

| | | Always | Usually | Occasion-ally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Clean the refrigerator coils at least once a year | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| b. | Check the temperature of the refrigerator to ensure food is not too cold or warm | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| c. | Check the temperature of your freezer to ensure food remains frozen, but that the freezer is not too cold | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |

**J11. Other**

| | | Always | Usually | Occasion-ally | Never | Don't Know | Not Applicable |
|---|---|---|---|---|---|---|---|
| a. | Turn off TV / entertainment systems when no one is in the room and actively using them | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| b. | Turn off the computer and printers when not in use | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| c. | Unplug or use a power bar to turn off TVs, entertainment systems, and computers when not in use? | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |
| d. | Leave one or more windows open during winter | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 | ☐ 6 |

**J12. What, if anything, would encourage you to use less energy at this residence?**

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**J13. What prevents you from using less energy at this residence?**

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**J14. Who makes the most effort to conserve electricity / gas in your household? Choose the most appropriate answer.**

- ☐ 1 Myself
- ☐ 2 Someone else in the household
- ☐ 3 Most members of the household
- ☐ 4 All members of the household
- ☐ 0 None of us

## K. Products & Services

**K1. How familiar are you with the following brand names?**

| | Not at all familiar 1 | 2 | 3 | 4 | Very familiar 5 |
|---|---|---|---|---|---|
| PowerSense (FortisBC) | ☐ | ☐ | ☐ | ☐ | ☐ |
| PowerSmart (BC Hydro) | ☐ | ☐ | ☐ | ☐ | ☐ |
| ENERGY STAR | ☐ | ☐ | ☐ | ☐ | ☐ |
| LiveSmart BC | ☐ | ☐ | ☐ | ☐ | ☐ |

**K2. During the last five years, did your household participate in any of the following programs that offered rebates to reduce energy use in your home?**

**Check all that apply**

- ecoENERGY / LiveSmart BC ☐ 1
- PowerSense (FortisBC Electric) ☐ 2
- FortisBC Energy (formerly Terasen Gas) ☐ 3
- PowerSmart (BC Hydro) ☐ 4
- None of the above ☐ 0

**K3. On a scale of one to four, where one is not at all interested and four is very interested, how interested would you be in the following products and services?**

| | | Not at all Interested 1 | 2 | 3 | Very Interested 4 |
|---|---|---|---|---|---|
| a. | Home energy audit to determine main energy uses in the home and identify opportunities to save energy | ☐1 | ☐2 | ☐3 | ☐4 |
| b. | Do-it-yourself online energy audit | ☐1 | ☐2 | ☐3 | ☐4 |
| c. | Furnace or heat pump tune-up to ensure they are working safely and efficiently | ☐1 | ☐2 | ☐3 | ☐4 |
| d. | Program to replace a low efficiency furnace with a high efficiency furnace | ☐1 | ☐2 | ☐3 | ☐4 |
| e. | Program to install high efficiency gas fireplace | ☐1 | ☐2 | ☐3 | ☐4 |
| f. | Program to replace standard efficiency clothes washer with high efficiency clothes washer | ☐1 | ☐2 | ☐3 | ☐4 |
| g. | Program to replace standard efficiency water heater with high efficiency water heater | ☐1 | ☐2 | ☐3 | ☐4 |
| h. | Program to upgrade attic and wall insulation | ☐1 | ☐2 | ☐3 | ☐4 |
| i. | Program to improve draft proofing | ☐1 | ☐2 | ☐3 | ☐4 |
| j. | Program to install programmable thermostats | ☐1 | ☐2 | ☐3 | ☐4 |
| k. | Program to install an in-home display that allows you to monitor your home's energy usage | ☐1 | ☐2 | ☐3 | ☐4 |
| l. | Program to purchase an electric automobile | ☐1 | ☐2 | ☐3 | ☐4 |
| m. | Program to compare your home's energy use with homes of comparable size and type | ☐1 | ☐2 | ☐3 | ☐4 |
| n. | Program that allows you to pay for energy-efficient improvements to your home via instalments on your utility bill | ☐1 | ☐2 | ☐3 | ☐4 |

**K4. Thinking about major appliance purchase decisions for this residence, please indicate your role in the decision making process.**

- ☐1 I am the sole decision maker
- ☐2 Someone else in the house makes the decision
- ☐3 Decisions are made jointly between myself and another person

**K5. Does this residence have access to the Internet?**

- ☐1 Yes, high speed (ADSL, cable, smart phone, other)
- ☐2 Yes, dial up modem
- ☐3 No Internet access

**K6. How comfortable are you with navigating the Internet?**

- ☐1 Very comfortable
- ☐2 Somewhat comfortable
- ☐3 Not very comfortable
- ☐4 Not at all comfortable

## L. Attitudes Towards Energy Use

**L1. In order to serve you better, we would like to understand your views on a number of energy-related issues. For the following set of statements, please check the answer that most accurately reflects your agreement or disagreement with the statement.**

**On a scale of one to five, where one means that you strongly disagree and five means that you strongly agree, please indicate how much you agree or disagree with the following statements on energy and natural gas usage.**

| | | Strongly Disagree 1 | 2 | Neither Agree or Disagree 3 | 4 | Strongly Agree 5 |
|---|---|---|---|---|---|---|
| a. | There are many ways that a person can save energy when you add them up, they result in substantial savings | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| b. | By making my home more energy-efficient, I am helping to do my part for the environment | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| c. | I think natural gas is a clean and efficient energy source | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| d. | Members of my household regularly limit the length of their showers to save energy | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| e. | I don't want to think about natural gas or electricity, I simply want it to work | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| f. | I consider natural gas to be a safe energy source | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| g. | When something needs to be done around home, I usually hire someone | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| h. | I almost always have a home renovation on the go | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| i. | It is cheaper to heat a home with natural gas than it is with electricity | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| j. | Our household has reduced its energy use by as much as reasonably possible | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| k. | I am a busy person with little or no time to research ways to save energy | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| l. | I conserve energy because it saves money not because it helps the environment | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

**L2. On a scale of one to five, where one means that you strongly disagree and five means that you strongly agree, please indicate how much you agree or disagree with the following statements.**

| | | Strongly Disagree 1 | 2 | Neither Agree or Disagree 3 | 4 | Strongly Agree 5 |
|---|---|---|---|---|---|---|
| a. | I am usually the first one to try new products | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| b. | I am usually willing to pay more for brand name items | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| c. | I prefer dealing with British Columbia based companies | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| d. | I always look for the best price when buying products or services | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| e. | I usually take time to research issues thoroughly before making a decision | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| f. | I am the type of person to have good insurance coverage | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |

## M. About your Household

**The final questions are for classification purposes only and are completely confidential, as are all your answers.**

**QUESTIONS M1 & M2 APPLY TO FORTISBC ELECTRICITY CUSTOMERS ONLY. THESE QUESTIONS HAVE BEEN OMITTED FROM YOUR SURVEY.**

**M3. Into which of the following age categories do you fit?**

18 years or under ☐ 1
19-24 years ☐ 2
25-34 years ☐ 3
35-44 years ☐ 4
45-54 years ☐ 5
55-64 years ☐ 6
65 years and older ☐ 7

**M4. You are:** Female ☐ 1 Male ☐ 2

**M5. What is your marital status?**

Single ☐ 1
Married/common law ☐ 2
Divorced/separated ☐ 3
Widowed ☐ 4

**M6. How many people, including yourself, are currently living at this residence (please include any boarders or renters covered under your FortisBC account)**

______ number

**M7. Please indicate the number of occupants by age categories**

| | 0 | 1 | 2 | 3 | 4 | 5 | 6+ |
|---|---|---|---|---|---|---|---|
| 0 – 5 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6 - 12 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13 - 18 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19 - 24 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 25 - 44 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 45 - 64 years | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 65 years and older | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**M8. Has the number of people in this residence changed in the last two years?**

Yes ☐ 1 No ☐ 2 → **GO TO QUESTION M10**

**M9. How has the number of people in this residence changed over the past two years (please check the best answer)?**

In the past there were more people in this residence ☐ 1
In the past there were fewer people in this residence ☐ 2
In the past there were sometimes more people and sometimes fewer people in this residence ☐ 3

**M10. What is the highest level of education you have completed?**

Some high school ☐ 1
Completed high school ☐ 2
Some trade/technical school ☐ 3
Completed trade/technical school ☐ 4
Some university/college ☐ 5
Completed university/college ☐ 6
Post graduate ☐ 7

**M11. What was your total household income before taxes in 2011?**

| | | | |
|---|---|---|---|
| Less than $20,000 | ☐ 1 | $60,000 to $79,999 | ☐ 6 |
| $20,000 to $29,999 | ☐ 2 | $80,000 to $99,999 | ☐ 7 |
| $30,000 to $39,999 | ☐ 3 | $100,000 to $124,999 | ☐ 8 |
| $40,000 to $49,999 | ☐ 4 | $125,000 or more | ☐ 9 |
| $50,000 to $59,999 | ☐ 5 | Prefer not to answer | ☐ 10 |

**M12. What are the languages spoken at this residence?**

| | **Main language** *(check one only)* | **Other languages** *(check all that apply)* |
|---|---|---|
| English | ☐ 1 | ☐ 1 |
| Mandarin | ☐ 2 | ☐ 2 |
| Cantonese | ☐ 3 | ☐ 3 |
| Hindi | ☐ 4 | ☐ 4 |
| Punjabi | ☐ 5 | ☐ 5 |
| Tagalog | ☐ 6 | ☐ 6 |
| Farsi (Persian) | ☐ 7 | ☐ 7 |
| French | ☐ 8 | ☐ 8 |
| German | ☐ 9 | ☐ 9 |
| Other (please specify): | ☐ 10 _______________ | ☐ 10 _________________ |

**M13. From time to time, FortisBC hires market research contractors to conduct research. This is done to better understand our customers' needs and gather information to design programs to help you save money on your energy bill.**

**Do we have your permission to contact you in the future for the purpose of additional market research? If yes, please provide your name and telephone number below. This is only permission to contact you. You are not obligated to participate if contacted by us or a market research company we hire.**

☐ 1 YES - it is OK to contact me for follow-up research

First name: _______________________

Last name: _______________________

Telephone: ____ - ____ - _______

Email: _______________________________ (optional)

**FortisBC and Ipsos would like to thank you for your help and assistance.**
**If you have any questions please contact Walter Wright, Market Research, FortisBC, at 604-592-7653 or walter.wright@fortisbc.com.**

# Win a $ 1000 Gift Certificate

# Contest Rules

1. All entries must be received by Ipsos by December 24, 2012. Limit of one entry per eligible entrant. A contestant's name will be determined by a random draw on January 21, 2013 from all entries received. To win, the selected contestant must answer a time limited mathematical skill-testing question, without mechanical or other assistance.
2. The selected contestant will be notified by telephone by Ipsos. Ipsos will attempt to reach the selected contestant no more than 3 times. If Ipsos is unable to contact him or her within 5 days of the draw date, Ipsos may draw the name of another contestant to be eligible for the prize.
3. Contestants who complete and return the survey form by mail will have their name entered once in the draw. Contestants who complete the survey form online will have their name entered into the draw twice.
4. Contestants must be residents of British Columbia.
5. FortisBC customers who have completed and returned the FortisBC 2012 Residential End-Use Survey by December 24, 2012 are automatically entered and no further action is required on the part of the customer. To enter without completing the survey, mail a letter with your name, telephone number and address to Ipsos, 1285 West Pender Street, 2nd Floor, Vancouver, BC, V6E 4B1. Mark the envelope "Residential Survey Contest".
6. Chances of winning are based on the number of eligible entries received via mail and online.
7. Employees or agents of FortisBC and their immediate families are not eligible to win.
8. There are four $1,000 prizes to be awarded, each prize is a $1,000 gift certificate from a home improvement store located near the prize winner.
9. FortisBC and Ipsos assume no responsibility for lost or misdirected entry forms.
10. By entering, contestants agree to abide by the contest rules and that the decision of the judge shall be final.

# Appendix B

2012 REUS Conditional Demand Analysis
Equations and Detailed Estimates

# APPENDIX B

## 2012 REUS Conditional Demand Analysis Detailed Methodology

Conditional Demand Analysis (CDA) was used to disaggregate total household consumption into UECs for several residential end-uses. CDA is based on the notion that total household consumption is directly related to the stock of end-uses present in the dwelling and the energy consumption levels associated with these end-uses (UECs). The basic conditional demand model can be represented as:

$$HEC_{ht} = \sum_{all\ a} UEC_{aht} S_{ah}$$

where $HEC_{ht}$ is the total energy consumption by household *h* in month *t*, $UEC_{aht}$ is the energy consumption through end-use *a* by household *h* in month *t*, and $S_{ah}$ is the presence or absence of end-use *a* in household *h*.

The UECs for these end-uses are modelled as functions of appropriate exogenous variables, such as end-use features, dwelling characteristics and household utilization patterns. In the remainder of this section, we describe the functional forms for each end-use.

### B1. Primary Gas Space Heating

The primary gas space heating usage for household *h* in month *t* is based on a balance equation:

$$UEC_{gasheat,ht} = \frac{HEATLOSS_{ht} - SECHT_{ht}}{EFFH_h}$$

where $HEATLOSS_{ht}$ is the net heat loss, $SECHT_{ht}$ is the heat loss replaced by non-gas secondary heating systems, and $EFFH_h$ is the system efficiency.

### B1.1 Net Heat Loss

The net heat loss of a structure can be expressed as:

$$HEATLOSS_{ht} = SURFLOSS_{ht} - SOLGAIN_{ht} - INTGAIN_{ht}$$

where $SURFLOSS_{ht}$ is the heat loss through envelope surfaces, $SOLGAIN_{ht}$ is the solar gain through all surfaces during heating periods, and $INTGAIN_{ht}$ is the internal gains during heating periods.

#### B1.1.1 Heat Loss through Envelope

The heat loss through envelope surfaces is given by:

$$SURFLOSS_h = \alpha_1 U_h AREA_h TDIFF_{ht}$$

where $U_h$ is the overall conductivity of the shell, $AREA_h$ is the total surface area, and $TDIFF_{ht}$ is the differential between inside and outside temperature levels.

### B1.1.2 Shell Conductivity

The conductivity of the shell is assumed to depend on dwelling type, the percentage of windows and doors that are insulated, and whether or not the attic, walls and basement are insulated:

$$U_h = \begin{cases} \alpha_1 + \alpha_2 MFD_h + \alpha_3 VS_h + \alpha_4 INSULA_h + \alpha_5 INSULW_h + \alpha_6 BASEMENT_h INSULB_h \\ + \alpha_7 DOORS_h + \alpha_8 WINDBL_h + \alpha_9 WINDBEST_h \end{cases}$$

where $MFD_h$ equals one if the household dwelling is a multi-family dwelling (duplex or row/townhouse), $VS_h$ equals one if the dwelling is a vertical subdivision (apartment/condominium), $INSULA_h$ equals one if the attic is insulated, $INSULW_h$ equals one if the walls are insulated, $BASEMENT_h$ equals one if a basement or crawl space is present, $BASEINSUL_h$ equals one if the basement or crawl space is insulated, $DOORS_h$ is the proportion of exterior doors that are insulated (aluminium storm doors or insulated doors), $WINDBL_h$ is the percentage of windows with double pane glass, and $WINBEST_h$ is the percentage of windows with more insulation than double pane (double pane low-E or triple pane, regular or low-E).

### B1.1.3 Surface Area

The surface area of the structure is modelled as a function of the total floor area:

$$AREA_h = \alpha_1 SQFT_h^{\beta}$$

where $SQFT_h$ is the square footage of the household and $\beta$ is the elasticity of surface area with respect to square footage. We assumed that β equals 0.5 (i.e. the square root) because the surface area of the building shell increases less than proportionately with floor area for standard shaped buildings.

### B1.1.4 Temperature Differential

The differential between inside and outside temperature levels is modelled as a function of heating degree days and household heating behaviour[67]:

$$TDIFF_{ht} = HDD_{ht}\left(\alpha_1 + \alpha_2 TDNIGHT_h + \alpha_3 TDDAY_h + \alpha_4 TDUNUSED_h + \alpha_5 WINTER_t WINCVR_h\right)$$

where $HDD_{ht}$ is heating degree days, $TDNIGHT_h$ is the frequency of turning down the heat at night either manually or using a programmable thermostat, $TDDAY_h$ is the frequency of turning down the heat either manually or using a programmable thermostat when no one is at home, $TDUNUSED_h$ is the frequency of reducing the temperature in unused rooms by closing vents or turning down room thermostats, and $WINCVR_{ht}$ is the frequency of using plastic window coverings on drafty windows during winter months.

[67] An attempt was made to include household income, but the variable was not retained in the final model because it was not statistically significant.

### B1.1.5 Solar Gain

The solar gain through all surfaces during heating periods is modelled as a function of the surface area of the home:

$$SOLGAIN_{ht} = \alpha_1 AREA_h WINTER_t$$

where $WINTER_t$ equals one if $t$ is a winter month (December, January or February).

### B1.1.6 Internal Gain

The internal gain during heating periods is also modelled as a function of the surface area of the home:

$$INTGAIN_{ht} = \alpha_1 AREA_h WINTER_t$$

## B1.2 Non-gas Secondary Heating System

The heat loss replaced by a non-gas secondary heating system, given that a primary gas heating system is present, can be expressed as:

$$SECHT_{ht} = HDD_{ht} AREA_h \left(\alpha_1 NONGASSEC_h + \alpha_2 HEATPUMPSEC_h\right)$$

where $NONGASSEC_h$ equals one if non-gas secondary space heating is present (e.g. non-gas fireplace, woodstove, electric baseboards, etc.) and $HEATPUMPSEC_h$ equals one if a heat pump (air or ground) is used for secondary space heating.

## B1.3 System Efficiency

An attempt was made to model system efficiencies in terms of the efficiency level of the gas furnace or boiler. However, this variable was not retained in the final model because there were too many missing values. Therefore, we assumed that $EFFH_h$ is constant across households.

## B1.4 Overall Primary Gas Space Heating Model

Combining the preceding equations gives the overall model of primary gas space heating usage:

$$UEC_{gasheat,ht} = \begin{cases} HDD_{ht} AREA_h (\alpha_1 + \alpha_2 MFD_h + \alpha_3 VS_h + \alpha_4 INSULA_h + \alpha_5 INSULW_h \\ + \alpha_6 BASEMENT_h INSULB_h + \alpha_7 DOORS_h + \alpha_8 WINDBL_h + \alpha_9 WINBEST_h \\ + \alpha_{10} TDNIGHT_h + \alpha_{11} TDDAY_h + \alpha_{12} TDUNUSED_h + \alpha_{13} WINTER_t WINCVR_h \\ + \alpha_{14} NONGASSEC_h + \alpha_{15} HEATPUMPSEC_h ) + \alpha_{16} AREA_h WINTER_t \end{cases}$$

In the specification above, most of the interaction terms are not shown because they were not statistically significant or produced unreasonable results.

### B2. Secondary Gas Space Heating

Secondary gas space heating includes any additional or supplementary use of gas to heat the residence (e.g., furnaces, gas wall heaters, etc.) The use of gas fireplaces and heater stoves is modelled separately.

The secondary gas space heating usage is modelled simply as a function of heating degree days, total surface area and dwelling type:

$$UEC_{gassecheat,ht} = HDD_{ht} AREA_{h} (\alpha_1 + \alpha_2 MFD_h + \alpha_3 VS_h)$$

### B3. Fireplaces and Heater Stoves

The energy usage by gas fireplaces and heater stoves (decorative, heater type and freestanding) is assumed to depend on the number of fireplaces in use and heating degree days[68]:

$$UEC_{gasfiredec,ht} = GASFIREDEC_h (\alpha_1 + \alpha_2 HDD_{ht})$$

$$UEC_{gasfireheat,ht} = GASFIREHEAT_h (\alpha_1 + \alpha_2 HDD_{ht})$$

$$UEC_{gasfirefree,ht} = GASFIREFREE_h (\alpha_1 + \alpha_2 HDD_{ht})$$

where $GASFIREDEC_h$ is the number of declarative gas fireplaces, $GASFIREHEAT_h$ is the number of heater type gas fireplaces, and $GASFIREFREE_h$ is the number of free standing fireplaces or heater stoves in use.

### B4. Water Heating

Gas water heating energy usage can be expressed as:

$$UEC_{gaswheat,ht} = \frac{WHLOSS_{ht} + VUSE_{ht}}{EFFWH_h}$$

where $WHLOSS_{ht}$ is the heat losses associated with standby losses from the heating unit, $VUSE_{ht}$ is the heat losses tied to water usage, and $EFFWH_h$ is the efficiency of the unit.

#### B4.1 Standby Losses

The heat losses associated with standby losses is assumed to depend on whether or not the home is new, whether solar energy is used to pre-warm or supplement the water heating process, whether an on-demand (tankless) water heater is used, and the temperature differential between the tank temperature and the inlet temperature[69]:

[68] An attempt was made to include variables representing the average number of hours in use, the percentage of space heating requirements provided by the fireplace, and if the fireplace is used primarily for heating, ambiance or both. These variables were not retained in the final model because they were not statistically significant or produced unreasonable results.

[69] An attempt was made to include variables involving dwelling type, the size of the main hot water tank, number of household members (a proxy for tank size), and the presence or absence of water heater blankets. These variables were not retained in the final model because they were not statistically significant or produced unreasonable results.

$$WHLOSS_{ht} = WHTDIFF_{ht}(\alpha_1 + \alpha_2 NEWHOME_h + \alpha_3 SOLARSUP_h + \alpha_4 ONDEMAND_h)$$

where $WHTDIFF_{ht}$ is the differential between the tank temperature and the inlet temperature, $NEWHOME_h$ equals one if the home is new (2006 or later), $SOLARSUP_h$ equals one if the water heater uses solar energy to pre-warm or supplement the water heating process, and $ONDEMAND_h$ equals one if an on-demand (tankless) water heater is used.

The differential between tank temperature and inlet temperature is modelled simply as a function of heating degree days:

$$WHTDIFF_{ht} = \alpha_1 HDD_{ht}$$

### B4.2 Water Usage

The heat losses tied to water usage is assumed to depend on the average number of dishwasher and clothes washer loads, the average number of baths and showers taken, whether or not a front loading clothes washer is present, the proportion of low-flow showerheads, and whether or not instant hot water dispensers are present:

$$VUSE_{ht} = \begin{cases} \alpha_1 DWASHLOADS_h + \alpha_2 CWASHLOADS_h + \alpha_3 BATHS_h + \alpha_4 SHOWERS_h \\ + \alpha_5 CWASHERFRONT_h + \alpha_6 PROPLOWFLOW_h + \alpha_7 INHOTWATERDISP_h \end{cases}$$

where $DWASHLOADS_h$ is the number of dishwasher loads per week, $CWASHLOADS_h$ is the number of clothes washer loads per week, $BATHS_h$ is the number of baths taken per week, $SHWRS_h$ is the number of showers taken per week, $CWASHERFRONT_h$ equals one if a front loading clothes washer is used, $PROPLOWFLOW_h$ is the proportion of low-flow showerheads, and $INHOTWATERDISP_h$ equals one if instant hot water dispensers are used.

### B4.3 System Efficiency

An attempt was made to model system efficiencies in terms of the age of the water heater. However, this variable was not retained in the final model because there were too many missing values. Therefore, we assumed that $EFFWH_h$ is constant across households.

### B4.4 Overall Gas Water Heating Model

Combining the preceding equations gives the overall model for gas water heating energy usage:

$$UEC_{gaswheatht} = \begin{cases} HDD_{ht}(\alpha_1 + \alpha_2 NEWHOME_h + \alpha_3 SOLARSUP_h + \alpha_4 ONDEMAND_h) \\ + \alpha_5 DWASHLOADS_h + \alpha_6 CWASHLOADS_h + \alpha_7 BATHS_h + \alpha_8 SHOWERS_h \\ + \alpha_9 CWASHERFRONT_h + \alpha_{10} PROPLOWFLOW_h + \alpha_{11} INHOTWATERDISP_h \end{cases}$$

### B5. Cooking

Energy consumption of gas cooking appliances (gas ranges, cook tops, ovens and duel fuel ranges) is assumed to depend on the number of these appliances in use[70]:

$$UEC_{gascook,ht} = \alpha_1 GASCOOK_h$$

where $GASCOOK_h$ is the number of gas ranges, cook tops, ovens and duel fuel ranges in use.

### B6. Gas BBQs

Energy consumption of piped gas BBQs is modelled as a function of the number in use[71]:

$$UEC_{gasbbqht} = \alpha_1 GASBBQ_h$$

where $GASBBQ_h$ is the number of piped gas barbeques in use.

### B7. Gas Dryers

Energy consumption of gas dryers is modelled as a function of the number in use[72]:

$$UEC_{gasdryer,ht} = \alpha_1 GASDRYER_h$$

where $GASDRYER_h$ is the number of gas dryers in use.

### B8. Swimming Pools

Energy consumption through the operation of swimming pools is assumed to be constant for those households with gas-heated swimming pools[73]:

$$UEC_{gasheatpool,ht} = \alpha_1$$

[70] An attempt was made to include variables involving household size, income and the presence of a microwave. These variables were not retained in the final model because they were not statistically significant or produced unreasonable results.

[71] An attempt was made to include a variable involving household size. This variable was not retained in the final model because it was not statistically significant.

[72] An attempt was made to model the number of dryer loads done per week. This variable was not retained in the final model because it was not statistically significant.

[73] An attempt was made to model whether or not the pool is covered when not in use and whether or not solar supplementary heating is used. These variables were not retained in the final model because they were not statistically significant or produced unreasonable results.

### B9. Hot Tubs

Energy consumption through the operation of hot tubs is assumed to be constant for those households with gas-heated hot tubs[74]:

$$UEC_{gashottub,ht} = \alpha_1$$

### B10. Regional Analysis

CDA models typically require large sample sizes and depend on a mix or diversity of end-uses among survey respondents to isolate their UECs statistically. In contrast to the 2008 CDA[75], the larger sample sizes in the 2012 REUS allowed us to develop individual conditional demand models for the Lower Mainland, Vancouver Island and Interior regions. The benefit of this approach is that different model parameters are estimated for each region allowing for more robust UEC estimates.

The small sample sizes for Whistler and Fort Nelson, combined with low penetration rates for many of the end-uses, led to large variation and uncertainty in the UEC estimates for these regions. To ensure more stable and robust results, it was decided to revert to the overall conditional demand model constructed at the utility level to estimate UECs for these two smaller regions. With this approach, the overall model was able to capture some regional variation for key end-uses like space and water heating, but assumed constant UEC specifications for most other end-uses.

[74] An attempt was made to model whether or not the hot tub is covered when not in use. This variable was not retained in the final model because it was not statistically significant.

[75] In the 2008 study, a single overall model was developed for all regions, and then space and water heating UECs were derived for each region by using regional dummy (binary) variables, and other variables that naturally varied by region (e.g., weather, dwelling sizes, etc.)

## B11. Regression Models

### B11.1 Regression Model – FEU

**Model Fit**
Adjusted R-squared: 0.791
F statistic: 6,427.6

| | Coefficient | SE | t-value | P-value |
|---|---|---|---|---|
| HDD x AREA x $S_{gasheat}$ | 0.001119 | 0.000012 | 91.7 | 0.000 |
| HDD x AREA x MFD x $S_{gasheat}$ | -0.000082 | 0.000004 | -18.7 | 0.000 |
| HDD x AREA x VS x $S_{gasheat}$ | -0.000404 | 0.000018 | -22.8 | 0.000 |
| HDD x AREA x INSULA x $S_{gasheat}$ | -0.000160 | 0.000010 | -16.0 | 0.000 |
| HDD x AREA x INSULW x $S_{gasheat}$ | -0.000329 | 0.000010 | -34.6 | 0.000 |
| HDD x AREA x BASEMENT x INSULB x $S_{gasheat}$ | -0.000088 | 0.000003 | -27.9 | 0.000 |
| HDD x AREA x DOORS x $S_{gasheat}$ | -0.000087 | 0.000004 | -24.9 | 0.000 |
| HDD x AREA x WINDBL x $S_{gasheat}$ | -0.000001 | 0.000000 | -32.1 | 0.000 |
| HDD x AREA x WINBEST x $S_{gasheat}$ | -0.000001 | 0.000000 | -24.5 | 0.000 |
| HDD x AREA x TDNIGHT x $S_{gasheat}$ | -0.000061 | 0.000005 | -12.0 | 0.000 |
| HDD x AREA x TDDAY x $S_{gasheat}$ | -0.000027 | 0.000005 | -5.5 | 0.000 |
| HDD x AREA x TDUNUSED x $S_{gasheat}$ | * | * | * | * |
| HDD x AREA x WINTER x WINCVR x $S_{gasheat}$ | -0.000080 | 0.000005 | -17.0 | 0.000 |
| HDD x AREA x NONGASSEC x $S_{gasheat}$ | -0.000014 | 0.000003 | -5.4 | 0.000 |
| HDD x AREA x HEATPUMPSEC x $S_{gasheat}$ | -0.000074 | 0.000007 | -10.3 | 0.000 |
| AREA x WINTER x $S_{gasheat}$ | 0.054095 | 0.001848 | 29.3 | 0.000 |
| HDD x AREA x $S_{gassecheat}$ | 0.000141 | 0.000007 | 20.1 | 0.000 |
| HDD x AREA x MFD x $S_{gassecheat}$ | 0.000300 | 0.000031 | 9.8 | 0.000 |
| HDD x AREA x VS x $S_{gassecheat}$ | -0.000150 | 0.000057 | -2.6 | 0.009 |
| GASFIREDEC x $S_{gasfiredec}$ | 0.413238 | 0.057313 | 7.2 | 0.000 |
| GASFIREHEAT x $S_{gasfireheat}$ | 0.279512 | 0.039778 | 7.0 | 0.000 |
| GASFIREFREE x $S_{gasfirefree}$ | -0.311960 | 0.097043 | -3.2 | 0.001 |
| HDD x GASFIREDEC x $S_{gasfiredec}$ | 0.003050 | 0.000187 | 16.3 | 0.000 |
| HDD x GASFIREHEAT x $S_{gasfireheat}$ | 0.002626 | 0.000126 | 20.8 | 0.000 |
| HDD x GASFIREFREE x $S_{gasfirefree}$ | 0.003051 | 0.000298 | 10.2 | 0.000 |
| HDD x $S_{gaswheat}$ | 0.005070 | 0.000147 | 34.4 | 0.000 |
| HDD x NEWHOME x $S_{gaswheat}$ | -0.003633 | 0.000320 | -11.4 | 0.000 |
| HDD x SOLARSUP x $S_{gaswheat}$ | * | * | * | * |
| HDD x ONDEMAND x $S_{gaswheat}$ | -0.001623 | 0.000348 | -4.7 | 0.000 |
| DWASHLOADS x $S_{gaswheat}$ | 0.079778 | 0.008521 | 9.4 | 0.000 |
| CWASHLOADS x $S_{gaswheat}$ | 0.029257 | 0.007888 | 3.7 | 0.000 |
| BATHS x $S_{gaswheat}$ | * | * | * | * |
| SHOWERS x $S_{gaswheat}$ | 0.058524 | 0.002450 | 23.9 | 0.000 |
| CWASHERFRONT x $S_{gaswheat}$ | -0.133411 | 0.042909 | -3.1 | 0.002 |
| PROPLOWFLOW x $S_{gaswheat}$ | -0.543639 | 0.044223 | -12.3 | 0.000 |
| INHOTWATERDISP x $S_{gaswheat}$ | 1.130273 | 0.120449 | 9.4 | 0.000 |
| GASCOOK x $S_{gascook}$ | 0.894339 | 0.032261 | 27.7 | 0.000 |
| GASBBQ x $S_{gasbbq}$ | 0.022567 | 0.047206 | 0.5 | 0.633 |
| GASDRYER x $S_{gasdryer}$ | * | * | * | * |
| $S_{gasheatpool}$ | 3.591481 | 0.125215 | 28.7 | 0.000 |
| $S_{gashottub}$ | 1.777150 | 0.195747 | 9.1 | 0.000 |

* Variable not retained in the final model because its regression coefficient was the wrong sign or insignificant.

## B11.2 Regression Model – Lower Mainland

**Model Fit**
Adjusted R-squared: 0.781
F statistic: 1,500.0

| | Coefficient | SE | t-value | P-value |
|---|---|---|---|---|
| HDD x AREA x $S_{gasheat}$ | 0.001102 | 0.000024 | 45.7 | 0.000 |
| HDD x AREA x MFD x $S_{gasheat}$ | -0.000058 | 0.000010 | -6.0 | 0.000 |
| HDD x AREA x VS x $S_{gasheat}$ | -0.000376 | 0.000062 | -6.1 | 0.000 |
| HDD x AREA x INSULA x $S_{gasheat}$ | -0.000172 | 0.000020 | -8.7 | 0.000 |
| HDD x AREA x INSULW x $S_{gasheat}$ | -0.000350 | 0.000020 | -17.5 | 0.000 |
| HDD x AREA x BASEMENT x INSULB x $S_{gasheat}$ | -0.000060 | 0.000007 | -8.3 | 0.000 |
| HDD x AREA x DOORS x $S_{gasheat}$ | -0.000035 | 0.000009 | -4.0 | 0.000 |
| HDD x AREA x WINDBL x $S_{gasheat}$ | -0.000001 | 0.000000 | -14.5 | 0.000 |
| HDD x AREA x WINBEST x $S_{gasheat}$ | -0.000001 | 0.000000 | -5.1 | 0.000 |
| HDD x AREA x TDNIGHT x $S_{gasheat}$ | -0.000056 | 0.000012 | -4.6 | 0.000 |
| HDD x AREA x TDDAY x $S_{gasheat}$ | -0.000007 | 0.000012 | -0.6 | 0.554 |
| HDD x AREA x TDUNUSED x $S_{gasheat}$ | * | * | * | * |
| HDD x AREA x WINTER x WINCVR x $S_{gasheat}$ | -0.000052 | 0.000013 | -4.1 | 0.000 |
| HDD x AREA x NONGASSEC x $S_{gasheat}$ | 0.000000 | 0.000006 | 0.1 | 0.950 |
| HDD x AREA x HEATPUMPSEC x $S_{gasheat}$ | * | * | * | * |
| AREA x WINTER x $S_{gasheat}$ | 0.037974 | 0.004427 | 8.6 | 0.000 |
| HDD x AREA x $S_{gassecheat}$ | 0.000271 | 0.000023 | 11.7 | 0.000 |
| HDD x AREA x MFD x $S_{gassecheat}$ | 0.000305 | 0.000067 | 4.6 | 0.000 |
| HDD x AREA x VS x $S_{gassecheat}$ | * | * | * | * |
| GASFIREDEC x $S_{gasfiredec}$ | 0.431131 | 0.121198 | 3.6 | 0.000 |
| GASFIREHEAT x $S_{gasfireheat}$ | 0.277730 | 0.090108 | 3.1 | 0.002 |
| GASFIREFREE x $S_{gasfirefree}$ | -0.202058 | 0.237760 | -0.8 | 0.395 |
| HDD x GASFIREDEC x $S_{gasfiredec}$ | 0.001733 | 0.000431 | 4.0 | 0.000 |
| HDD x GASFIREHEAT x $S_{gasfireheat}$ | 0.001618 | 0.000318 | 5.1 | 0.000 |
| HDD x GASFIREFREE x $S_{gasfirefree}$ | 0.002381 | 0.000828 | 2.9 | 0.004 |
| HDD x $S_{gaswheat}$ | 0.008088 | 0.000410 | 19.7 | 0.000 |
| HDD x NEWHOME x $S_{gaswheat}$ | -0.003156 | 0.000902 | -3.5 | 0.000 |
| HDD x SOLARSUP x $S_{gaswheat}$ | * | * | * | * |
| HDD x ONDEMAND x $S_{gaswheat}$ | -0.003380 | 0.000874 | -3.9 | 0.000 |
| DWASHLOADS x $S_{gaswheat}$ | 0.100555 | 0.018624 | 5.4 | 0.000 |
| CWASHLOADS x $S_{gaswheat}$ | 0.007190 | 0.017018 | 0.4 | 0.673 |
| BATHS x $S_{gaswheat}$ | * | * | * | * |
| SHOWERS x $S_{gaswheat}$ | 0.035921 | 0.005093 | 7.1 | 0.000 |
| CWASHERFRONT x $S_{gaswheat}$ | -0.110545 | 0.096188 | -1.1 | 0.250 |
| PROPLOWFLOW x $S_{gaswheat}$ | -0.677407 | 0.097483 | -6.9 | 0.000 |
| INHOTWATERDISP x $S_{gaswheat}$ | 0.941486 | 0.254580 | 3.7 | 0.000 |
| GASCOOK x $S_{gascook}$ | 0.648572 | 0.071241 | 9.1 | 0.000 |
| GASBBQ x $S_{gasbbq}$ | 0.424672 | 0.116599 | 3.6 | 0.000 |
| GASDRYER x $S_{gasdryer}$ | * | * | * | * |
| $S_{gasheatpool}$ | 3.088034 | 0.272635 | 11.3 | 0.000 |
| $S_{gashottub}$ | 1.796595 | 0.402498 | 4.5 | 0.000 |

* Variable not retained in the final model because its regression coefficient was the wrong sign or insignificant.

## B11.3 Regression Model – Vancouver Island

**Model Fit**
Adjusted R-squared: 0.843
F statistic: 1,830.6

| | Coefficient | SE | t-value | P-value |
|---|---|---|---|---|
| HDD x AREA x $S_{gasheat}$ | 0.000935 | 0.000028 | 32.9 | 0.000 |
| HDD x AREA x MFD x $S_{gasheat}$ | -0.000140 | 0.000008 | -17.2 | 0.000 |
| HDD x AREA x VS x $S_{gasheat}$ | -0.000111 | 0.000024 | -4.6 | 0.000 |
| HDD x AREA x INSULA x $S_{gasheat}$ | -0.000223 | 0.000023 | -9.9 | 0.000 |
| HDD x AREA x INSULW x $S_{gasheat}$ | -0.000063 | 0.000017 | -3.6 | 0.000 |
| HDD x AREA x BASEMENT x INSULB x $S_{gasheat}$ | -0.000024 | 0.000005 | -4.4 | 0.000 |
| HDD x AREA x DOORS x $S_{gasheat}$ | -0.000084 | 0.000006 | -13.1 | 0.000 |
| HDD x AREA x WINDBL x $S_{gasheat}$ | -0.000001 | 0.000000 | -15.0 | 0.000 |
| HDD x AREA x WINBEST x $S_{gasheat}$ | -0.000002 | 0.000000 | -16.9 | 0.000 |
| HDD x AREA x TDNIGHT x $S_{gasheat}$ | -0.000068 | 0.000010 | -7.0 | 0.000 |
| HDD x AREA x TDDAY x $S_{gasheat}$ | -0.000028 | 0.000009 | -3.2 | 0.002 |
| HDD x AREA x TDUNUSED x $S_{gasheat}$ | -0.000046 | 0.000006 | -8.3 | 0.000 |
| HDD x AREA x WINTER x WINCVR x $S_{gasheat}$ | -0.000028 | 0.000009 | -3.0 | 0.003 |
| HDD x AREA x NONGASSEC x $S_{gasheat}$ | -0.000087 | 0.000005 | -19.0 | 0.000 |
| HDD x AREA x HEATPUMPSEC x $S_{gasheat}$ | -0.000126 | 0.000016 | -7.9 | 0.000 |
| AREA x WINTER x $S_{gasheat}$ | 0.029855 | 0.003057 | 9.8 | 0.000 |
| HDD x AREA x $S_{gassecheat}$ | 0.000068 | 0.000009 | 7.3 | 0.000 |
| HDD x AREA x MFD x $S_{gassecheat}$ | -0.000187 | 0.000043 | -4.4 | 0.000 |
| HDD x AREA x VS x $S_{gassecheat}$ | -0.000117 | 0.000046 | -2.6 | 0.011 |
| GASFIREDEC x $S_{gasfiredec}$ | 0.141570 | 0.107539 | 1.3 | 0.188 |
| GASFIREHEAT x $S_{gasfireheat}$ | 0.077017 | 0.053833 | 1.4 | 0.153 |
| GASFIREFREE x $S_{gasfirefree}$ | -0.132509 | 0.111928 | -1.2 | 0.236 |
| HDD x GASFIREDEC x $S_{gasfiredec}$ | 0.002856 | 0.000372 | 7.7 | 0.000 |
| HDD x GASFIREHEAT x $S_{gasfireheat}$ | 0.002779 | 0.000190 | 14.6 | 0.000 |
| HDD x GASFIREFREE x $S_{gasfirefree}$ | 0.004549 | 0.000387 | 11.8 | 0.000 |
| HDD x $S_{gaswheat}$ | 0.003948 | 0.000202 | 19.5 | 0.000 |
| HDD x NEWHOME x $S_{gaswheat}$ | -0.001468 | 0.000353 | -4.2 | 0.000 |
| HDD x SOLARSUP x $S_{gaswheat}$ | -0.002912 | 0.000903 | -3.2 | 0.001 |
| HDD x ONDEMAND x $S_{gaswheat}$ | * | * | * | * |
| DWASHLOADS x $S_{gaswheat}$ | 0.018252 | 0.012110 | 1.5 | 0.132 |
| CWASHLOADS x $S_{gaswheat}$ | 0.085303 | 0.011127 | 7.7 | 0.000 |
| BATHS x $S_{gaswheat}$ | 0.068738 | 0.009358 | 7.3 | 0.000 |
| SHOWERS x $S_{gaswheat}$ | 0.013968 | 0.004641 | 3.0 | 0.003 |
| CWASHERFRONT x $S_{gaswheat}$ | -0.285933 | 0.056073 | -5.1 | 0.000 |
| PROPLOWFLOW x $S_{gaswheat}$ | * | * | * | * |
| INHOTWATERDISP x $S_{gaswheat}$ | * | * | * | * |
| GASCOOK x $S_{gascook}$ | 0.432258 | 0.046026 | 9.4 | 0.000 |
| GASBBQ x $S_{gasbbq}$ | 0.090033 | 0.053304 | 1.7 | 0.091 |
| GASDRYER x $S_{gasdryer}$ | 0.294242 | 0.085035 | 3.5 | 0.001 |
| $S_{gasheatpool}$ | 4.275273 | 0.300897 | 14.2 | 0.000 |
| $S_{gashottub}$ | * | * | * | * |

* Variable not retained in the final model because its regression coefficient was the wrong sign or insignificant.

## B11.4 Regression Model – Interior

**Model Fit**
Adjusted R-squared: 0.865
F statistic: 3,747.8

| | Coefficient | SE | t-value | P-value |
|---|---|---|---|---|
| HDD x AREA x $S_{gasheat}$ | 0.000841 | 0.000025 | 34.3 | 0.000 |
| HDD x AREA x MFD x $S_{gasheat}$ | -0.000178 | 0.000006 | -30.9 | 0.000 |
| HDD x AREA x VS x $S_{gasheat}$ | -0.000416 | 0.000015 | -27.2 | 0.000 |
| HDD x AREA x INSULA x $S_{gasheat}$ | -0.000248 | 0.000019 | -12.8 | 0.000 |
| HDD x AREA x INSULW x $S_{gasheat}$ | -0.000160 | 0.000015 | -10.5 | 0.000 |
| HDD x AREA x BASEMENT x INSULB x $S_{gasheat}$ | -0.000042 | 0.000004 | -10.6 | 0.000 |
| HDD x AREA x WINDBL x $S_{gasheat}$ | * | * | * | * |
| HDD x AREA x WINBEST x $S_{gasheat}$ | 0.000000 | 0.000000 | -6.2 | 0.000 |
| HDD x AREA x DOORS x $S_{gasheat}$ | -0.000037 | 0.000004 | -10.2 | 0.000 |
| HDD x AREA x TDNIGHT x $S_{gasheat}$ | -0.000007 | 0.000006 | -1.2 | 0.225 |
| HDD x AREA x TDDAY x $S_{gasheat}$ | -0.000071 | 0.000005 | -13.0 | 0.000 |
| HDD x AREA x TDUNUSED x $S_{gasheat}$ | * | * | * | * |
| HDD x AREA x WINTER x WINCVR x $S_{gasheat}$ | -0.000010 | 0.000005 | -2.1 | 0.039 |
| HDD x AREA x NONGASSEC x $S_{gasheat}$ | -0.000040 | 0.000003 | -15.1 | 0.000 |
| HDD x AREA x HEATPUMPSEC x $S_{gasheat}$ | -0.000124 | 0.000006 | -20.4 | 0.000 |
| AREA x WINTER x $S_{gasheat}$ | 0.028021 | 0.002767 | 10.1 | 0.000 |
| HDD x AREA x $S_{gassecheat}$ | 0.000100 | 0.000006 | 16.9 | 0.000 |
| HDD x AREA x MFD x $S_{gassecheat}$ | 0.000008 | 0.000045 | 0.2 | 0.864 |
| HDD x AREA x VS x $S_{gassecheat}$ | * | * | * | * |
| GASFIREDEC x $S_{gasfiredec}$ | 0.292616 | 0.092004 | 3.2 | 0.001 |
| GASFIREHEAT x $S_{gasfireheat}$ | 0.397299 | 0.056256 | 7.1 | 0.000 |
| GASFIREFREE x $S_{gasfirefree}$ | -0.299528 | 0.125451 | -2.4 | 0.017 |
| HDD x GASFIREDEC x $S_{gasfiredec}$ | 0.003202 | 0.000227 | 14.1 | 0.000 |
| HDD x GASFIREHEAT x $S_{gasfireheat}$ | 0.002782 | 0.000138 | 20.1 | 0.000 |
| HDD x GASFIREFREE x $S_{gasfirefree}$ | 0.003311 | 0.000302 | 11.0 | 0.000 |
| HDD x $S_{gaswheat}$ | 0.003015 | 0.000149 | 20.2 | 0.000 |
| HDD x NEWHOME x $S_{gaswheat}$ | -0.003979 | 0.000320 | -12.4 | 0.000 |
| HDD x SOLARSUP x $S_{gaswheat}$ | -0.006273 | 0.000637 | -9.9 | 0.000 |
| HDD x ONDEMAND x $S_{gaswheat}$ | * | * | * | * |
| DWASHLOADS x $S_{gaswheat}$ | 0.035500 | 0.012196 | 2.9 | 0.004 |
| CWASHLOADS x $S_{gaswheat}$ | 0.059119 | 0.011800 | 5.0 | 0.000 |
| BATHS x $S_{gaswheat}$ | 0.017867 | 0.009323 | 1.9 | 0.055 |
| SHOWERS x $S_{gaswheat}$ | 0.062782 | 0.004301 | 14.6 | 0.000 |
| CWASHERFRONT x $S_{gaswheat}$ | -0.177154 | 0.056509 | -3.1 | 0.002 |
| PROPLOWFLOW x $S_{gaswheat}$ | -0.315270 | 0.060475 | -5.2 | 0.000 |
| INHOTWATERDISP x $S_{gaswheat}$ | * | * | * | * |
| GASCOOK x $S_{gascook}$ | 0.822360 | 0.047730 | 17.2 | 0.000 |
| GASBBQ x $S_{gasbbq}$ | 0.154308 | 0.056500 | 2.7 | 0.006 |
| GASDRYER x $S_{gasdryer}$ | 0.899920 | 0.111738 | 8.1 | 0.000 |
| $S_{gasheatpool}$ | 4.886988 | 0.155597 | 31.4 | 0.000 |
| $S_{gashottub}$ | * | * | * | * |

* Variable not retained in the final model because its regression coefficient was the wrong sign or insignificant.

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# 2015 Commercial End-Use Study

Prepared For: **FortisBC**

Prepared By: **Discovery Research**

Date: **July 2015**

# Table of Contents:

# 1. Background and objectives

Research was undertaken to help FortisBC understand how commercial customers use energy in their businesses for the purposes of forecasting future electrical demand and also to design Demand Side Management and Marketing and Communications programs. Discovery Research was contracted by FortisBC to complete the study. The specific objectives of this study is to collect information about customers businesses, but most importantly, the characteristics and features of the buildings they occupy, as well as the different ways in which electricity and other fuels are used in the buildings. Area of interest include, but are not limited to:

- Determine building envelope characteristics that impact the energy efficiency of the building such as building type, use, size, age, height (stories), and length of occupancy
- Determine building envelope characteristics such as exterior wall and roof construction; window types and percentage of overall surface area, age and condition of building envelope elements.
- Collect information on appliances including, but not limited to, those used for: space heating and cooling; water heating; air distribution; commercial cooking; refrigeration; dishwashing and laundry. Also includes hot tubs, saunas and swimming pools and miscellaneous uses.
- Determine primary and secondary energy sources for space and water heating. Understand the split between primary and secondary sources and the split between different fuels. In particular in the SST, a whole building view of energy consumption is required.
- Collect information about lighting applications (indoor and outdoor); electronics including computers and other electronic equipment; elevators and escalators.
- Collect information about motor and non-motor processes.
- Determine attitudes towards energy use and energy efficiency; assess the degree and types of energy conserving behaviours followed in the building and by whom.
- Support revenue requirement applications to the British Columbia Utilities Commission ("BCUC");
- Design DSM programs;
- Update short-term demand forecasts;
- Make decisions regarding capital expenditure

# 2. *Methodology*

Given the amount and detail of the information to be collected, the methodology utilized for this research was a self-administered mail survey coupled with an equivalent online version of the survey.

**Mailed Survey:**

On July 2, 2015 a total of 10000 surveys were mailed to a random sample of FortisBC Commercial customers. The total sample of 10,000 consisted of 6000 Direct FortisBC Gas customer and 4000 Gas and Electric Customers. The 4000 Gas and Electric customers consisted of 3500 Direct Gas and Electric Customers and 500 Indirect Gas and Electric customers. Indirect customers serviced through city wholesalers. The 9500 customers were randomly selected from the entire FortisBC direct commercial customer base. The 500 Indirect customers were randomly selected from the regions serviced by City wholesalers (Nelson, Grand Forks, Penticton and Summerland).

| CEUS Surveys Mailed out | Direct Customers | Indirect (Nelson, Grand Forks, Penticton and Summerland) |
|---|---|---|
| **Gas only** | 6000 | |
| **Gas and electric** | 3500 | 500 |

Each potential respondent was mailed a survey package which included a survey with cover letter and a postage paid return envelope. Respondents were offered two ways to participate in this study:

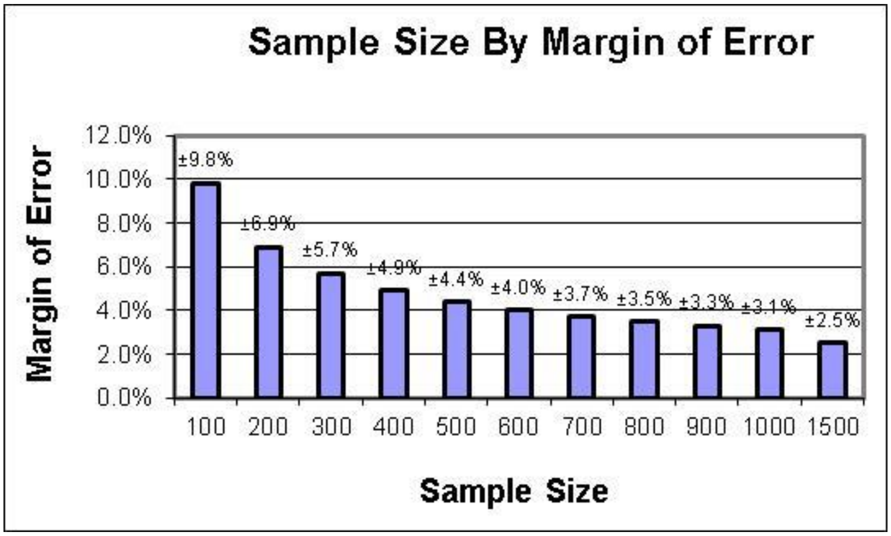
- Complete the survey and return it in the postage paid envelope via regular mail
- Complete the survey on the Internet and submit it electronically

As an incentive for completion, respondents were entered into a draw for one of ten $400 prepaid visa gift cards and 1 $1000 visa gift card. Respondents were offered an additional entry into the prize draw as an added incentive to complete the survey on-line.

## *Response Rate*

Of the 10000 surveys that were mailed a total of 1048 were returned: 651 via Canada Post and 397 via the Online version; yielding a total response rate of **10.5%.**

## *Margin of error*




This bar graph displays the margin of error associated with various sample sizes.

Statistics generated from sample size of 1048 will be accurate within **±3.0%,** at the 95% confidence interval (19 times out of 20).

## *Weighting the Data*

The sample was weighted by region to ensure the collected sample matched the true composition of FortisBC's commercial customer base.

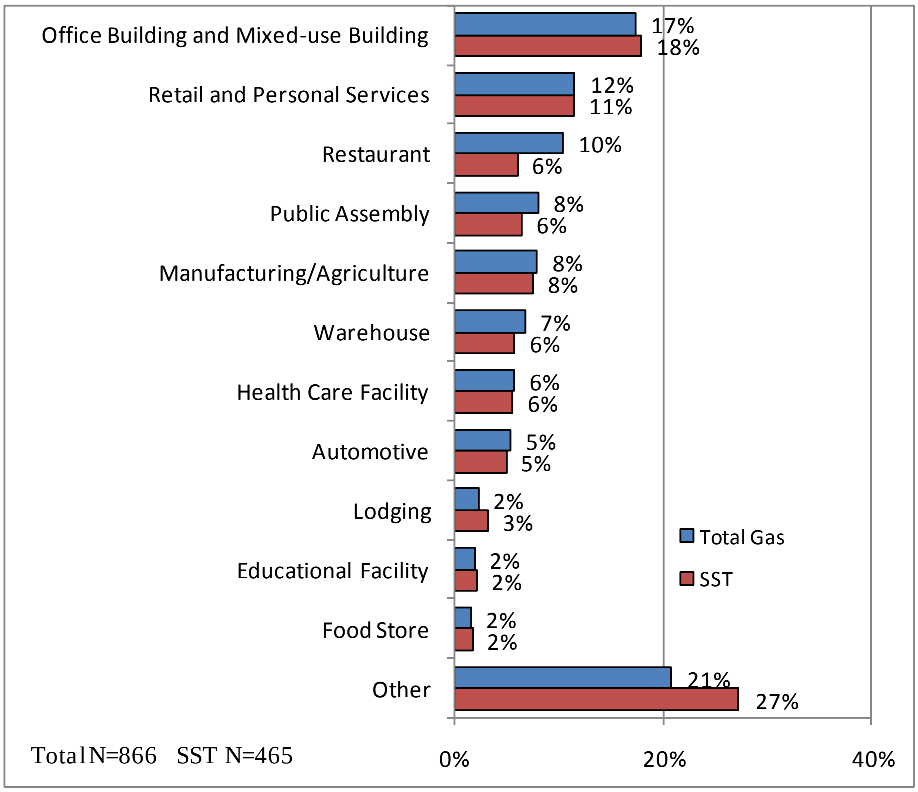
| | **Gas Customers** | | |
|---|---|---|---|
| | **Population** | **Unweighted Sample** | **Weighted Sample** |
| Interior and Shared Service Territory | **26.9%** | 47.70% | **26.9%** |
| Lower Mainland | **62.8%** | 39.20% | **62.8%** |
| Vancouver Island | **10.3%** | 13.10% | **10.3%** |
| Total | **100.0%** | 100.0% | **100.0%** |

After applying the weights, the regional proportions in the weighted sample match the regional proportions in the Population of FortisBC Commercial Gas Customers.

# 3. Detailed Findings

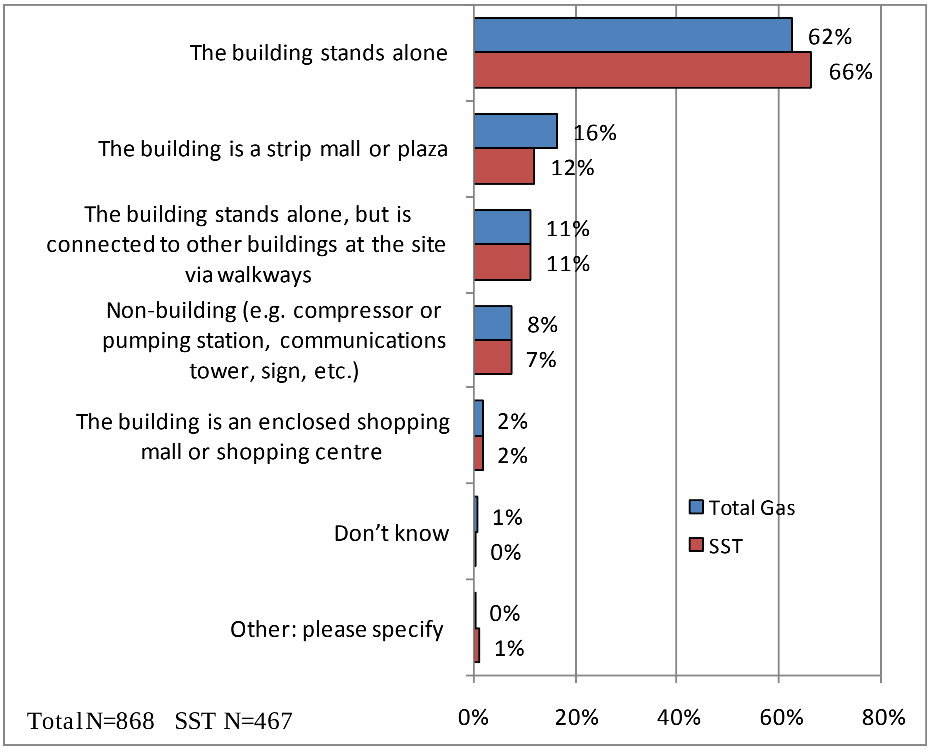
## A. About Your Building

***A1. Which one of the following best describes the type of building, facility or business served by your FortisBC account?***



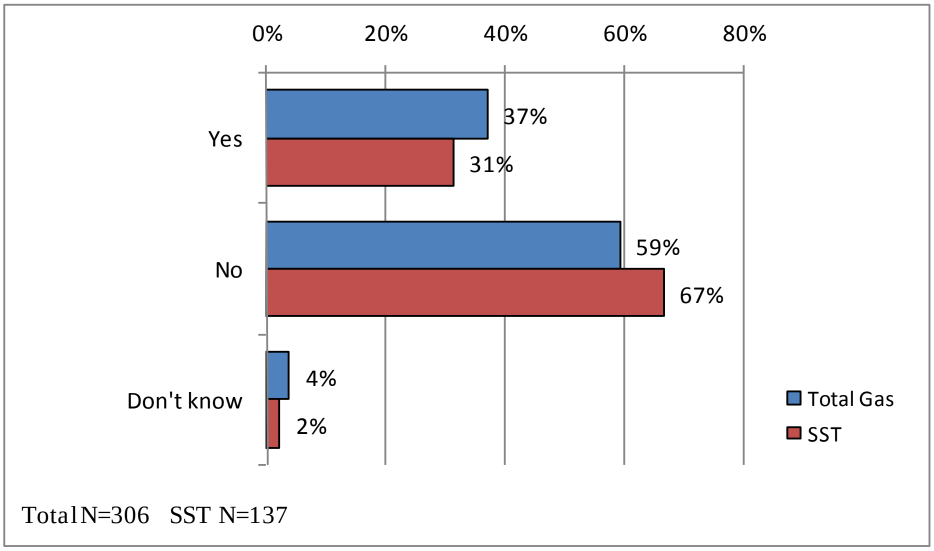

Offices are the only building type with more than 10% representation in the sample. Essentially both the *total* and *shared service territory* (SST) building types show similar distribution.

### *A2. Which of the following best describes the physical nature of the building that your organization occupies at this address?*




The majority of the buildings that were reported were stand-alone.

### *A3. Are there any other organizations or tenants in the building?*

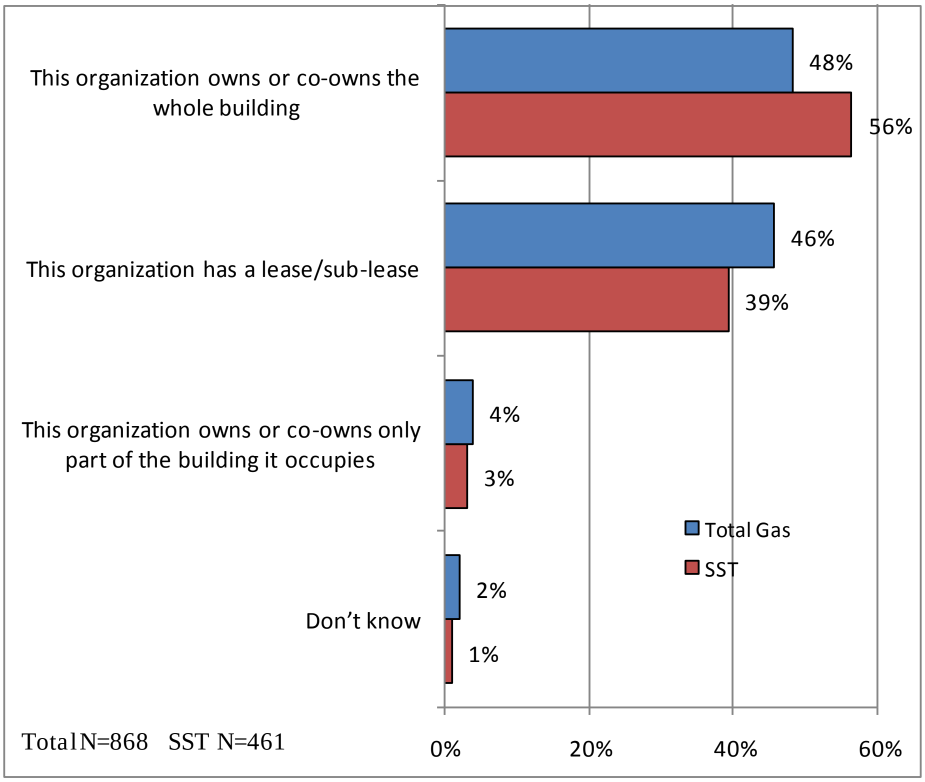



Thirty-one percent *of total* buildings having more than one tenant in the building.

| | | Total Gas | SST |
|---|---|---|---|
| A3. Are there any other organizations or tenants in the building? | Mean (estimated) | 5.8 | 8.5 |

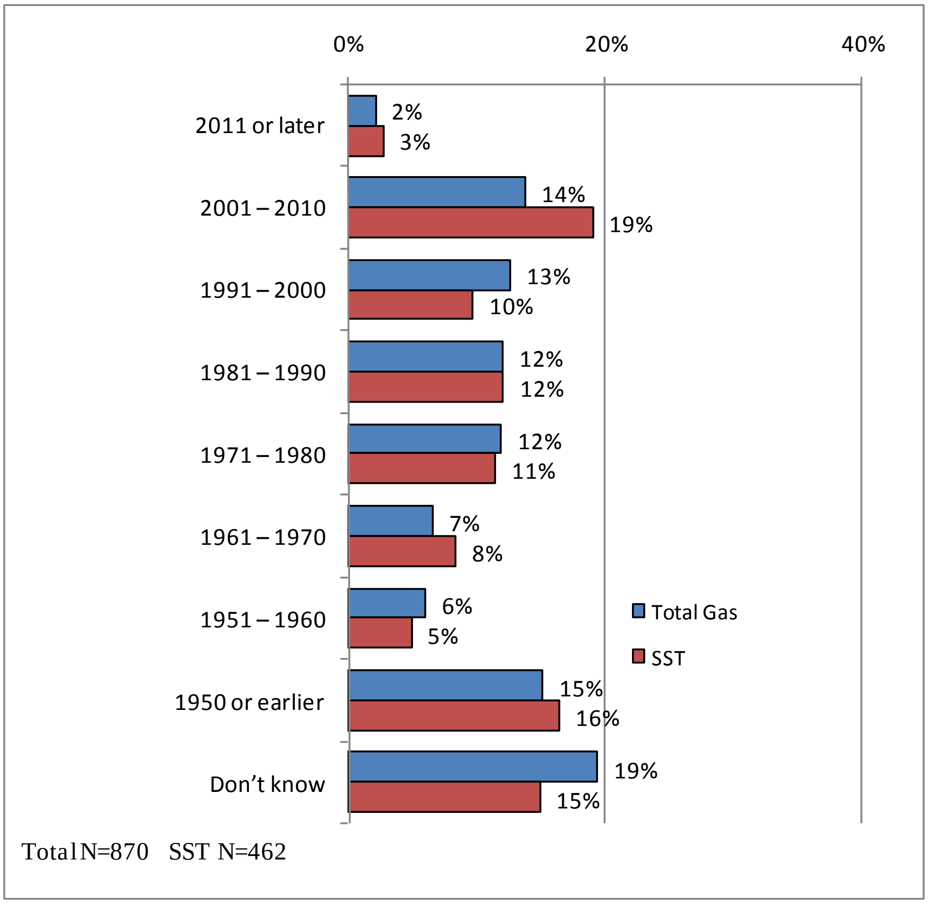
Among buildings with more than one Tenant, the average number of tenants was 5.8 for *total* gas customers and 8.5 for the *shared service territory*.

***A4. Which of the following best describes the relationship between the organization at this address and the building it is located in?***




Almost half of all organizations own their buildings with *shared service territory* being slightly more likely to be owners. Almost all the other building space occupied by the *total* sample is rented.

### *A5. When was the building at this address built?*



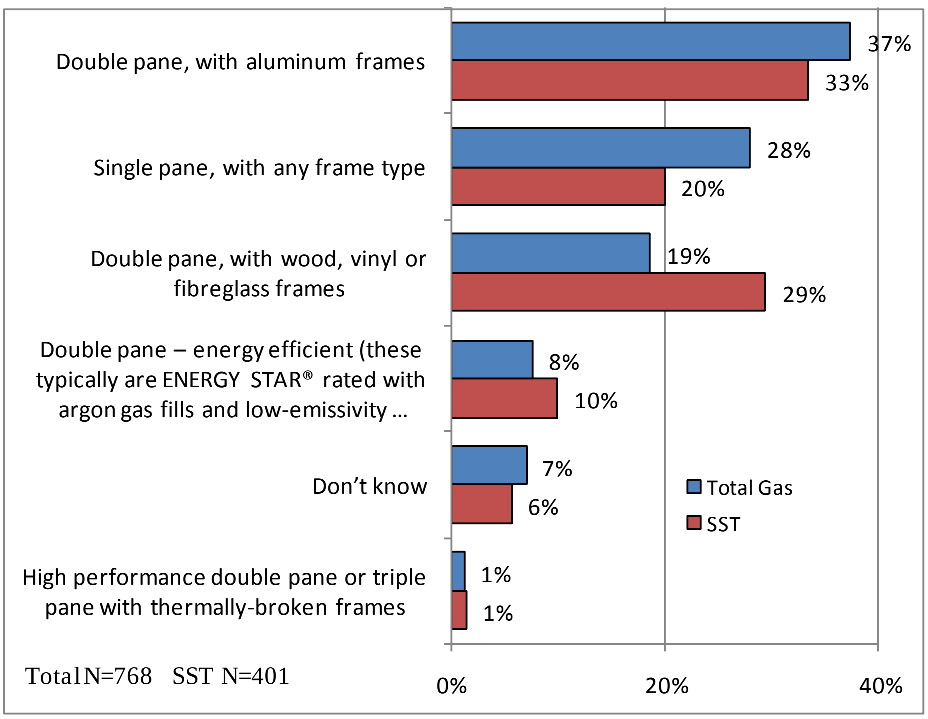

Although the age of both the *total* and *shared service territory* buildings were essentially similar, *shared service territory* buildings had a median building year of 1976 compared to 1973 for the *total* sample.

*A6. Approximately what percentage of the exterior walls of the building are windows?*

| | | Total Gas | SST |
|---|---|---|---|
| A6. Approximately what percentage of the exterior walls of the building are windows? | Mean | 23.3% | 20.8% |
| | No exterior windows | 14.1% | 31.7% |

*Total* sample buildings have more exterior windows than those in the *shared service territory* sample.

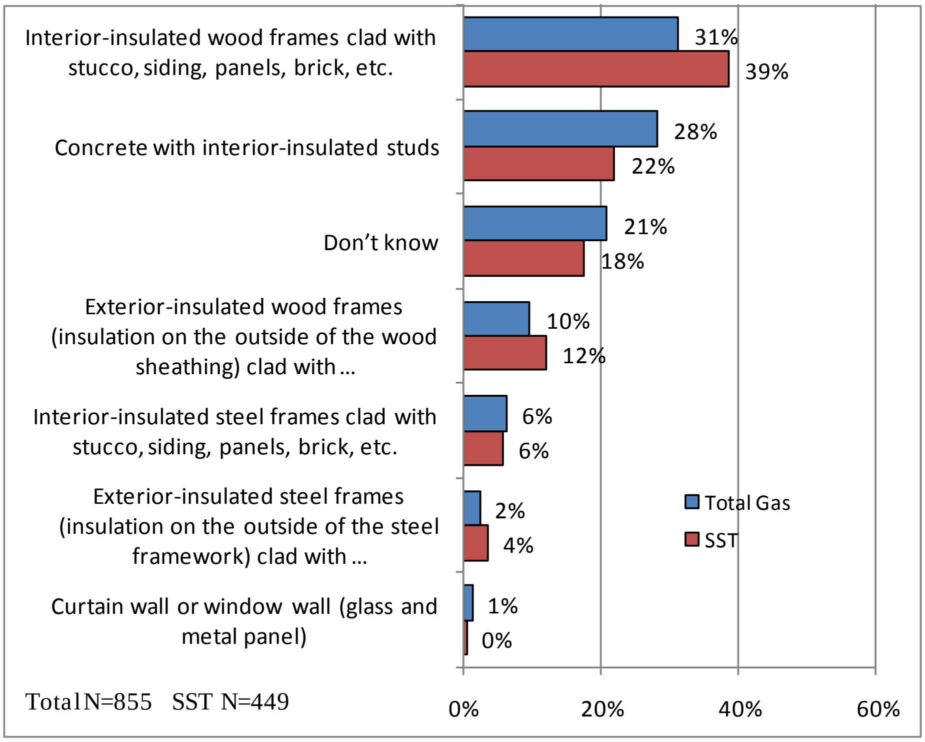
*A7. What is the main type of exterior window in the building?*




*Shared service territory* buildings have more double pane windows with non-aluminum frames installed than their *total* building counterparts, and fewer single and double pane aluminium windows.

Fewer than 10% have Energy Star windows.

### *A8. Which of the following best describes the exterior wall construction of the building?*




Exterior walls are wood frame with stucco, etc. or concrete interior insulated studs.

### *A9. Excluding parking levels, how many floors (stories) does the building have in total at or above ground level?*

| | | Total Gas | SST |
|---|---|---|---|
| A9. Excluding parking levels, how many floors (storeys) does the building have in total at or above ground level? | Mean | 2 | 2 |
| | Don't know | 5.7% | 5.9% |

Most buildings in the two samples have an average of two floors.

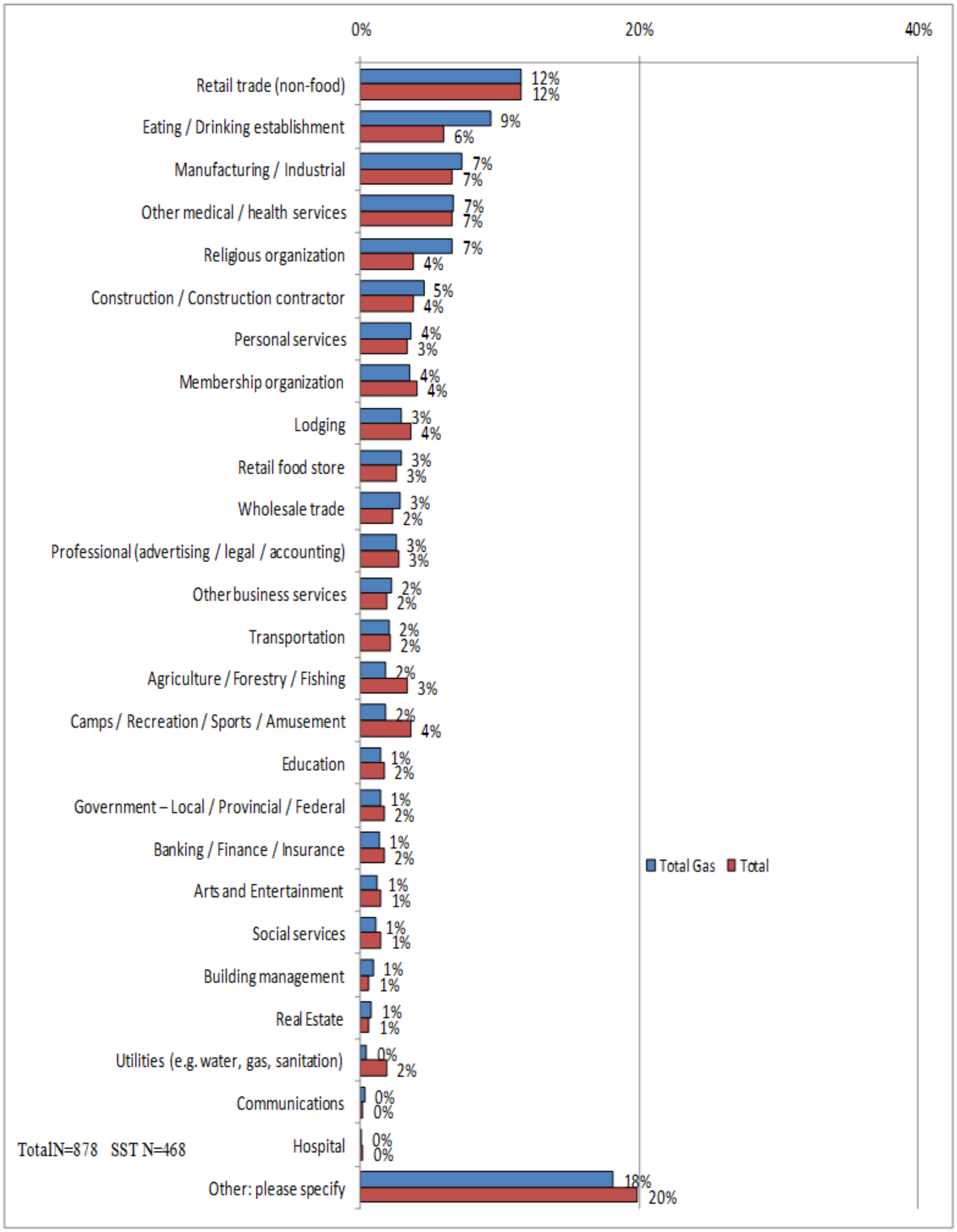
***A10. Excluding parking levels, parking structures and garages, please estimate the total square footage at or above ground level of the building at this address.***

| | | | Total Gas | SST |
|---|---|---|---|---|
| A10. Square feet | Mean | | 9341 | 9555 |
| A10. Square meters | Mean | | 4816 | 883 |
| | Don't know | % | 94.0% | 92.9% |

*Shared service territory* buildings are similar in size on average to those in the *total* sample.

# B. About Your Organization

### *B1. Please check the box that indicates the primary activity or industry of the organization at this address*




Although the business activities conducted in both *total* and *shared service territory* are generally similar, there are some slight exceptions:

<u>Higher *total* building activities</u>:

- Eating/Drinking
- Religious organization

<u>Higher *shared service territory* building activities</u>:

- Camps / Recreation / Sports / Amusement
- Agriculture / Forestry / Fishing
- Utilities

***B2. Which of the following best describes the ownership of the organization at this location?***

| | | Total Gas | SST |
|---|---|---|---|
| B2. Which of the following best describes the ownership of the organization at this location? | Government or public sector | 3.4% | 4.6% |
| | Non-governmental organization (non-profit) | 20.3% | 20.8% |
| | For profit | 73.2% | 71.8% |
| | Don't know | 3.1% | 2.8% |

For-profit organizations are almost ¾ of both samples.

***B3. How many floors (stories) at or above ground level does your organization currently occupy at this address?***

| | | | Total Gas | SST |
|---|---|---|---|---|
| Floor(s) | Mean | | 4 | 11 |
| | Don’t know | % | 26.4% | 17.2% |
| | Not applicable | % | 73.6% | 82.8% |

*Shared service territory* companies occupy almost 3 times as many floors as those in the *total* group.

***B4. Excluding parking levels, parking structures and garages, please estimate the total square footage at or above ground level that your organization currently occupies at this address.***

| | | | Total Gas | SST |
|---|---|---|---|---|
| Square feet | Mean | | 5980 | 4995 |
| square meters | Mean | | 4955 | 883 |
| | Don’t know | % | 80.2% | 70.1% |
| | Not applicable | % | 19.8% | 29.9% |

Although they occupy more floors, the *shared service territory* overall square footage is significantly less than the *total* sample.

***B5. Please indicate which fuels your organization uses at this address and what percentage of your annual operating costs each fuel represents.***

| | | Total Gas | SST |
|---|---|---|---|
| Electricity | Yes | 78.1% | 86.8% |
| | No | 2.5% | 2.3% |
| | Don't know | 19.4% | 10.9% |
| Natural Gas | Yes | 78.9% | 70.8% |
| | No | 2.2% | 17.5% |
| | Don't know | 18.9% | 11.7% |
| Heating Oil | Yes | 2.8% | 2.0% |
| | No | 90.3% | 93.0% |
| | Don't know | 7.0% | 5.0% |
| Piped Propane | Yes | 3.0% | 3.0% |
| | No | 89.6% | 92.5% |
| | Don't know | 7.4% | 4.5% |
| Purchased Steam (Central Steam) | Yes | .9% | .5% |
| | No | 92.5% | 95.0% |
| | Don't know | 6.6% | 4.5% |
| Wood Waste (Biomass) | Yes | 1.9% | 5.8% |
| | No | 91.6% | 90.3% |
| | Don't know | 6.5% | 3.9% |
| Other: Please specify | Yes | 2.0% | 7.7% |
| | No | 89.5% | 87.2% |
| | Don't know | 8.4% | 5.1% |

Most companies, *total* and *shared service territory*, have electricity followed by natural gas.

*...And what percentage of your annual operating costs each fuel represents:*

| | | Total Gas | SST |
|---|---|---|---|
| Electricity (% of annual operating costs) | Mean | 24.4% | 33.9% |
| Natural Gas (% of annual operating costs) | Mean | 23.5% | 23.8% |
| Heating Oil (% of annual operating costs) | Mean | 38.1% | 45.0% |
| Piped Propane (% of annual operating costs) | Mean | 15.4% | 16.7% |
| Bottled Propane (% of annual operating costs) | Mean | 5.8% | 11.1% |
| Purchased Steam (Central Steam) (% of annual operating costs) | Mean | 10.7% | - |
| Wood Waste (Biomass) (% of annual operating costs) | Mean | 19.3% | 32.3% |
| Other: Please specify (% of annual operating costs) | Mean | 24.3% | 18.2% |

Heating oil is the largest single expense for both *shared service territory* and *total* organizations. *Total* sample companies are less likely to use most of the energy sources compared to the *shared service territory* sample, especially electricity and wood waste.

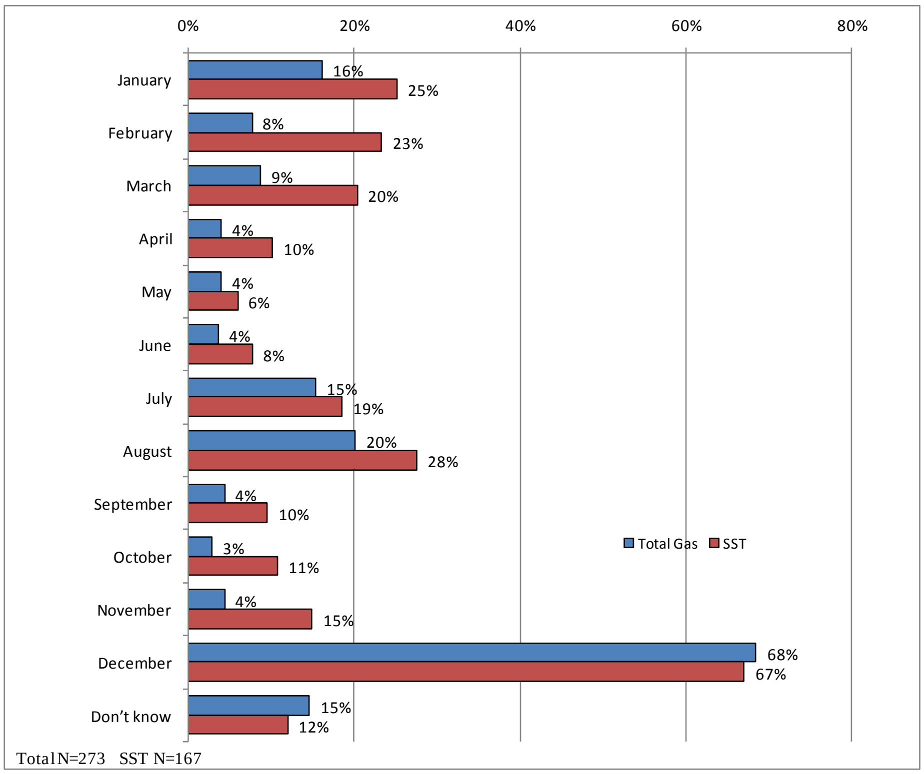
## C. Operating Schedule

### C1. How many weeks per year is the organization at this address closed?

| | | Total Gas | SST |
|---|---|---|---|
| C1. How many weeks per year is the organization at this address closed? (Weeks) | Mean | 4.97 | 4.60 |

Most companies close down for just under 5 weeks a year.

### C2. During which months is the organization at this address closed for a week or more?



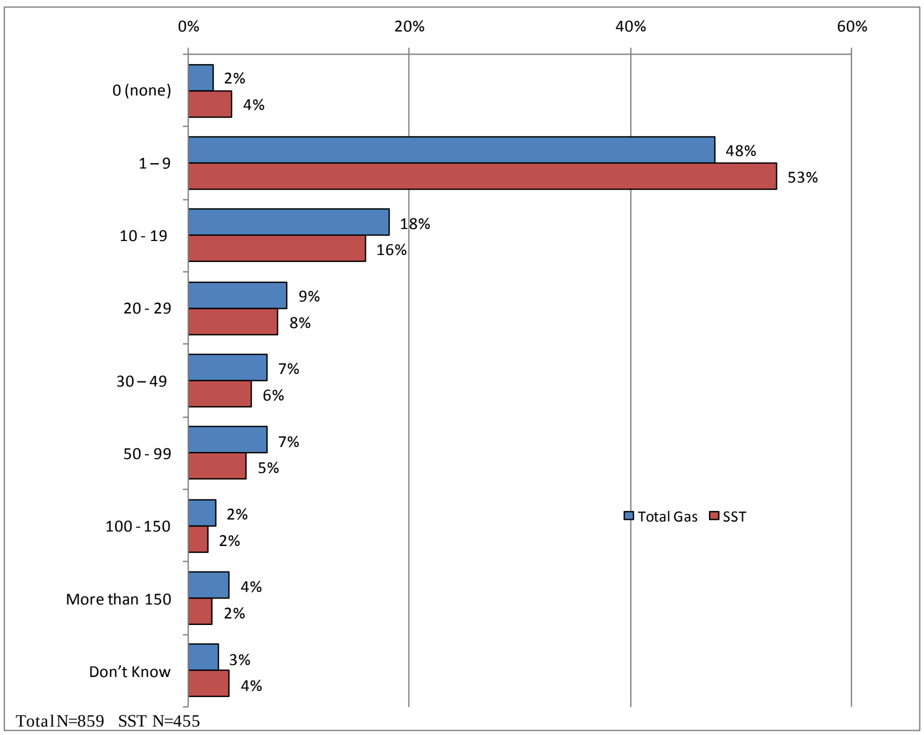

*Total* companies close down in either January, July, August, or December. *Shared service territory* companies spread their closing across all months of the year.

## *C3. Please indicate the typical number of hours per week that you operate at this location.*

| | | Total Gas | SST |
|---|---|---|---|
| C3. Please indicate the typical number of hours per week that you operate at this location (Hours) | Mean | 105 | 153 |

*Shared service territory* companies operate for 50% more hours than the *total* companies reporting.

## *C4. On a typical work day how many people would be present (employees, customers, visitors, patients at this address at any given time?*




Both *total* and *shared service territory* companies have under 10 people present on a typical work day.

## D. Space Heating Equipment

### *D1. Is there any heating of the enclosed area at this address?*

| | | Total Gas | SST |
|---|---|---|---|
| D1. Is there any heating of the enclosed area at this address? | Yes | 89.60% | 90.2% |
| | No | 8.0% | 8.3% |
| | Don't know | 2.3% | 1.5% |

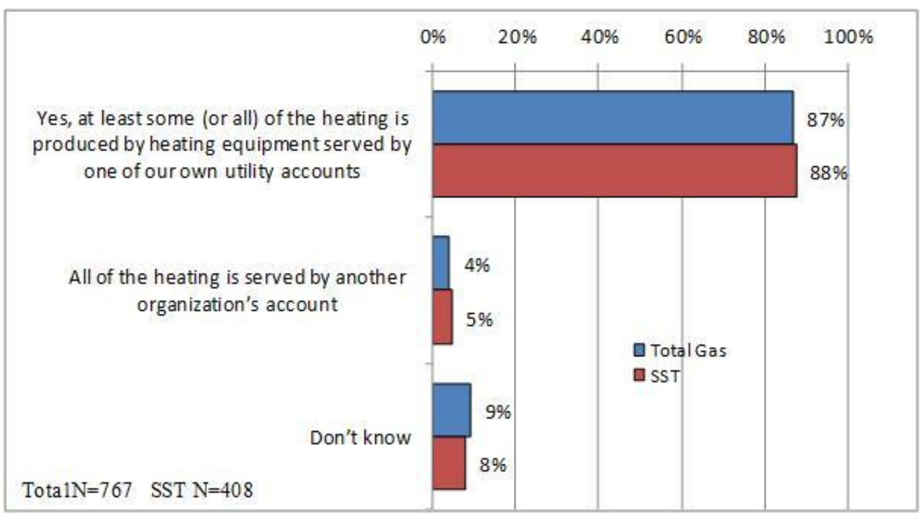
Ninety percent of the enclosed areas in both types of organizations are heated.

### *D2. Excluding parking floors, structures or garages, what percentage of the enclosed floor area at this address is heated?*

| | | Total Gas | SST |
|---|---|---|---|
| D2. Excluding parking floors, structures or garages, what percentage of the enclosed floor area at this address is heated? (Percentage) | Mean | 90.2% | 89.1% |
| | Don't know | 5.0% | 4.3% |

Similar to D1, 90% of the floor area is heated by the organization's utility account

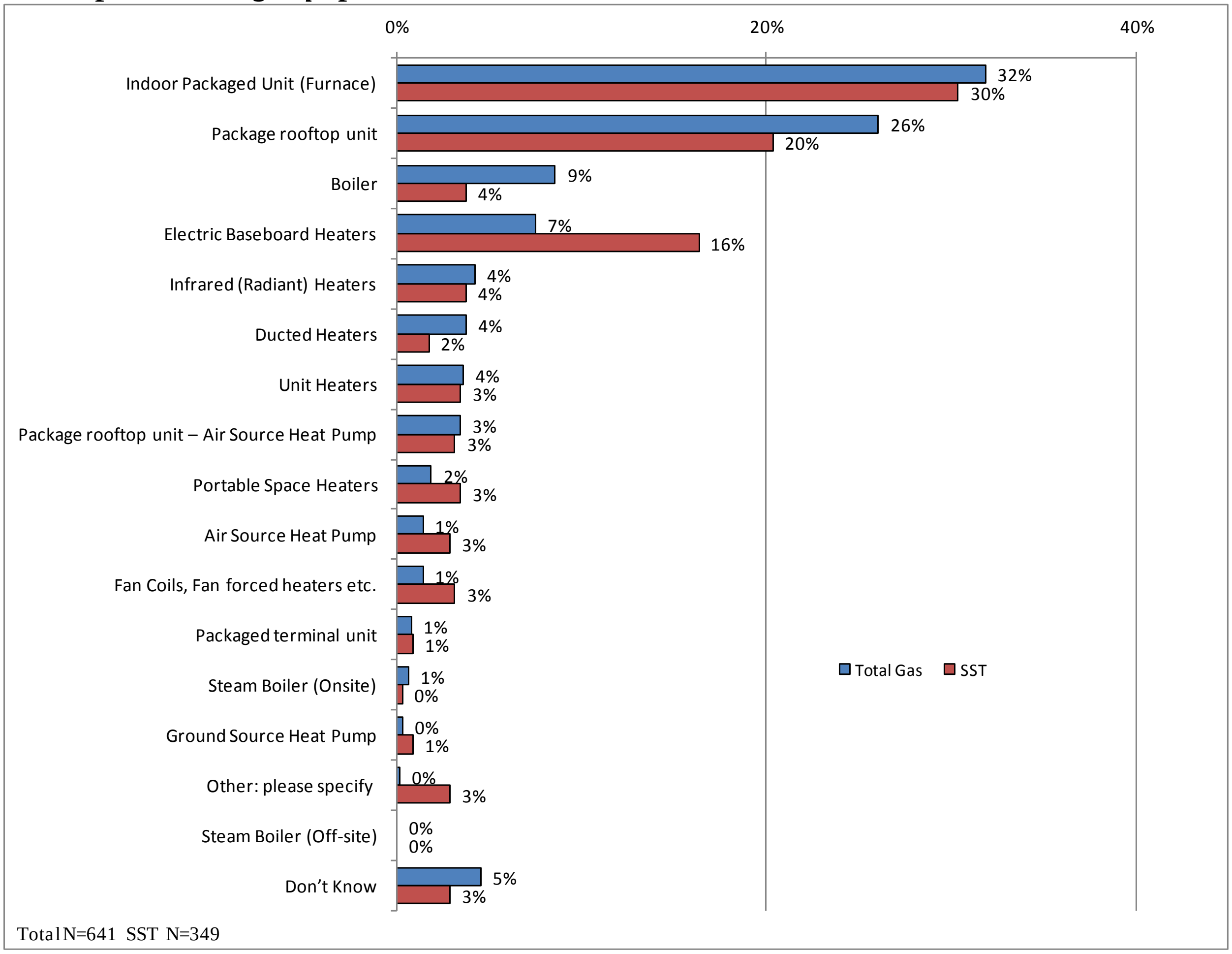
### *D3. Is any of the space heating at this address produced by heating equipment served by one of your utility accounts or is it all produced by a heating system – possibly a central one – served by another organization's account?*




Only 4-5% indicated that their building has space heating served by another organizations accounts.

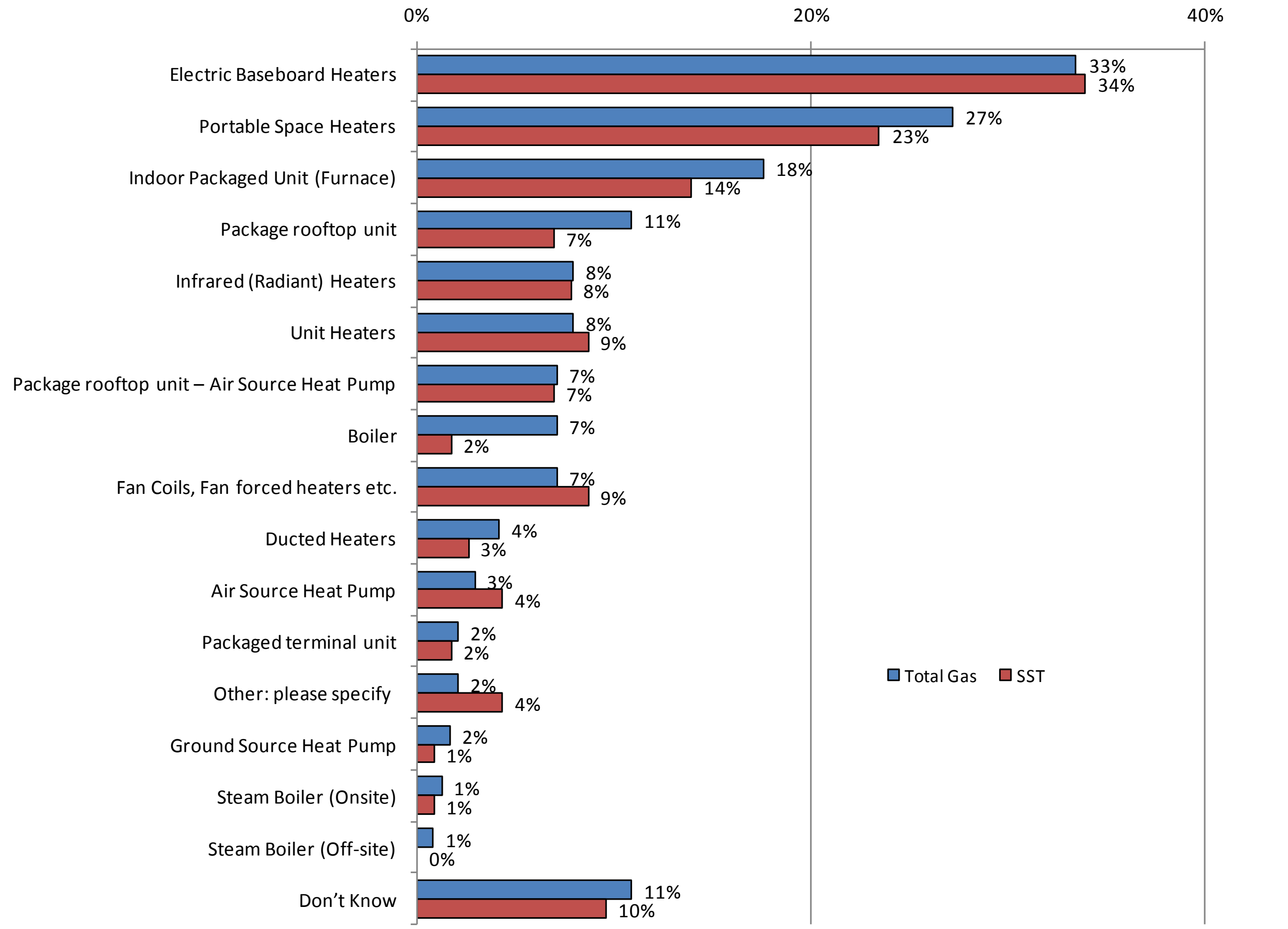
## *D4. Please indicate the Main Space Heating Equipment and Fuel type served by this organization's utility accounts (select one only) and any Other Space Heating Equipment and Fuel type served by your utility accounts.*

***Main Space Heating Equipment***




Indoor packaged units are the most popular followed closely by packaged rooftop units. *Shared service territory* respondents also indicated baseboard heaters are more frequently installed in their premises.

***Other Space Heating Equipment***




Total N=239 SST N=115

Baseboard heaters and portable space heaters augment the main heat source for both *total* and *shared service territory* organization, however indoor and rooftop packaged units do contribute.

*Fuel Type Served By Your Utility Accounts*

| | | Total Gas | SST |
|---|---|---|---|
| Package rooftop unit (Fuel) | Gas | 79.5% | 80.3% |
| | Electric | 20.5% | 19.7% |
| Indoor Packaged Unit (Furnace) (Fuel) | Gas | 91.3% | 84.8% |
| | Electric | 8.7% | 15.2% |
| Boiler (Fuel) | Gas | 85.7% | 77.8% |
| | Electric | 12.7% | 18.5% |
| | Oil | .8% | 3.7% |
| | Biomass | .8% | .0% |
| Packaged terminal unit (Fuel) | Gas | 52.6% | 40.0% |
| | Electric | 47.4% | 60.0% |
| Portable Space Heaters (Fuel) | Gas | 4.1% | .0% |
| | Electric | 95.9% | 100.0% |

Natural gas is the dominant fuel for al interior heating except for portable space heaters.

## *D5. Does the main space heating equipment or system recover waste heat?*

| | | Total Gas | SST |
|---|---|---|---|
| D5. Does the main space heating equipment or system recover waste heat? | Yes | 5.2% | 4.8% |
| | No | 68.0% | 75.6% |
| | Don't know | 26.8% | 19.6% |

Of those who have, more than 90% did not have heating equipment or systems that recover waste heat.

## *D6. Has the main space heating equipment been upgraded over the past 5 years?*

| | | Total Gas | SST |
|---|---|---|---|
| D6. Has the main space heating equipment been upgraded over the past 5 years? | Yes | 26.1% | 22.3% |
| | No | 65.1% | 71.7% |
| | Don't know | 8.8% | 6.0% |

Of those who have, more than 90% did not have heating equipment or systems that recover waste heat.

## *E. Space Cooling*

***E1. Is there any space cooling at this address? This may include space cooling produced by a central system, but also ceiling fans, portable fans and portable air conditioners.***

| | | Total Gas | SST |
|---|---|---|---|
| E1. Is there any space cooling at this address? This may include space cooling produced by a central system, but also ceiling fans, portable fans and portable air conditioners? | Yes | 75.0% | 74.8% |
| | No | 23.4% | 23.9% |
| | Don't know | 1.6% | 1.3% |

3/4 of both *total* and *shared service territory* offices have space cooling.

***E2. What percentage of the enclosed floor area for the organization at this addressed is cooled?***

| | | Total Gas | SST |
|---|---|---|---|
| E2. What percentage of the enclosed floor area for the organization at this address is cooled? (Percentage) | Mean | 70.9% | 77.0% |
| | Don't know | 6.4% | 6.9% |

*Shared service territory* organizations have cooling for 10% more of their premises than the *total* sample.

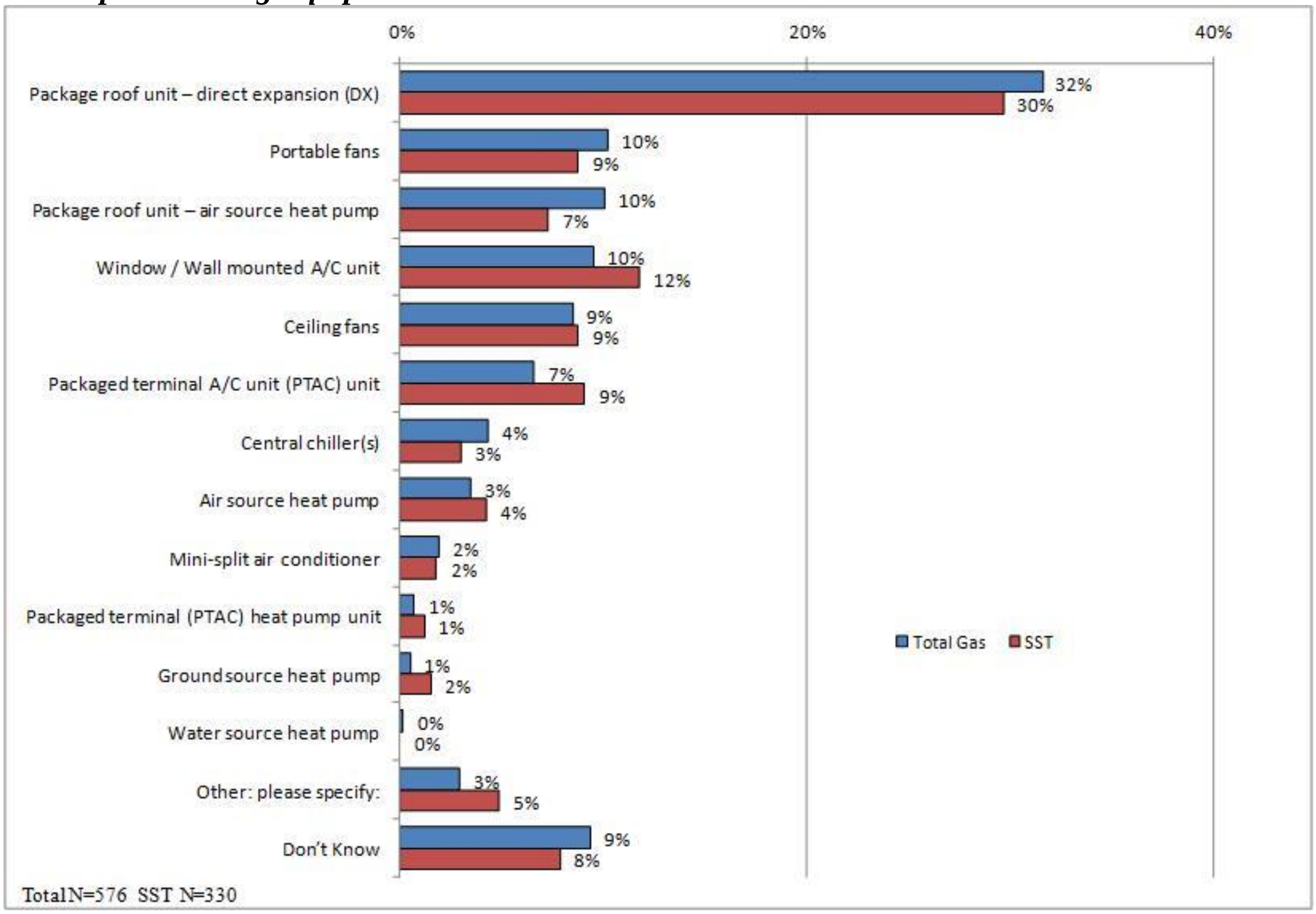
***E3. Is any of the space cooling at this address produced by cooling equipment served by this organization's electric account? Or is it all produced by a cooling system – possibly a central system – served by another account?***

| | | Total Gas | SST |
|---|---|---|---|
| E3. Is any of the space cooling at this address produced by cooling equipment served by this organization's electric account? Or is it all produced by a cooling system – possibility a central system – served by another account? | Yes, at least some (or all) of the cooling is | 81.7% | 87.7% |
| | No, all of the air conditioning is served by another | 9.5% | 7.1% |
| | Don't know | 8.9% | 5.1% |

Over 80% of all space cooling is produced by equipment serviced by the organization's electricity account.

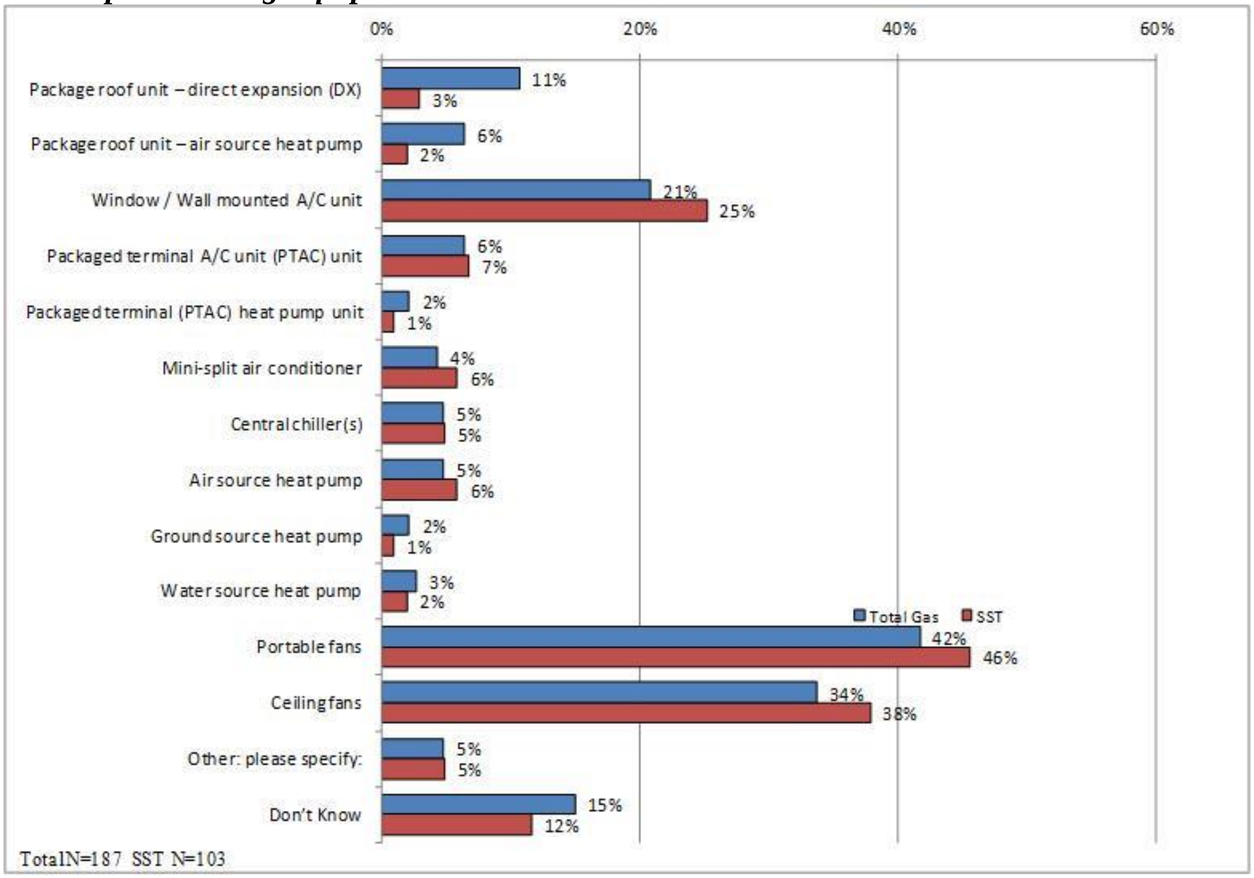
***E4. Please indicate the Main Space Cooling Equipment – served by this electrical account – used to cool space at this address.***

***Main Space Cooling Equipment***




The two samples have similar space cooling equipment installed as their main and secondary cooling methods. Package roof units are the most frequent primary cooling method.

***Other Space Cooling Equipment***




Secondary methods are mostly portable or ceiling fans.

### *E5. Has the main space cooling equipment been upgraded over the past 5 years?*

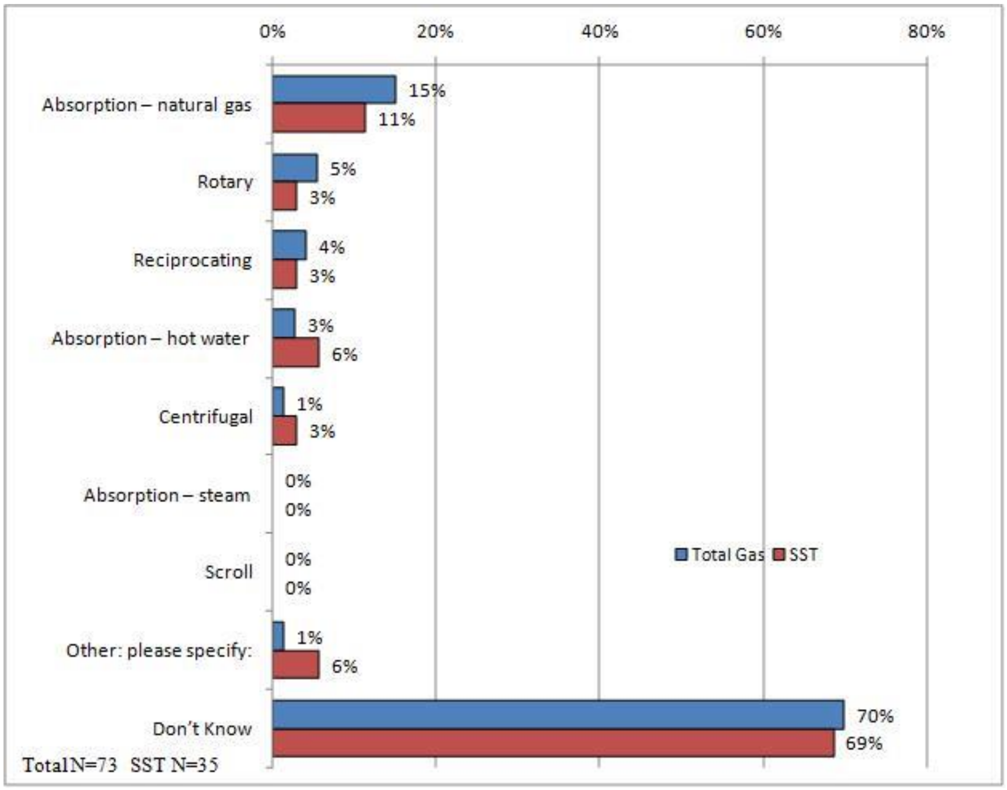
| | | Total Gas | SST |
|---|---|---|---|
| E5. Has the main space cooling equipment been upgraded over the past 5 years? | Yes | 29.5% | 28.4% |
| | No | 61.4% | 65.0% |
| | Don't know | 9.1% | 6.6% |

About 30% of space cooling equipment has been upgraded by both *total* and *shared service territory* organizations in the last year.

### *E6. Looking back at your response in Question E4, did you select "central chiller(s)" as the main space cooling equipment?*

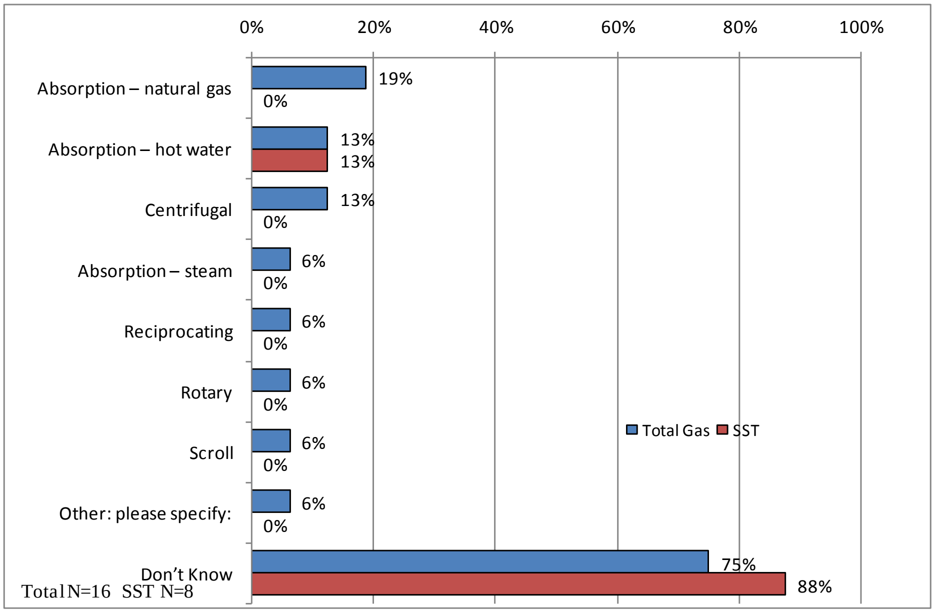
| | | Total Gas | SST |
|---|---|---|---|
| E6. Looking back at your response in QUESTION E4, did you select "central chiller(s)" as the main space cooling equipment? | Yes | 7.0% | 5.6% |
| | No | 83.2% | 87.7% |
| | Don't know | 9.9% | 6.8% |

## *E7. Please indicate the Main Type of Chiller System used at this address.*



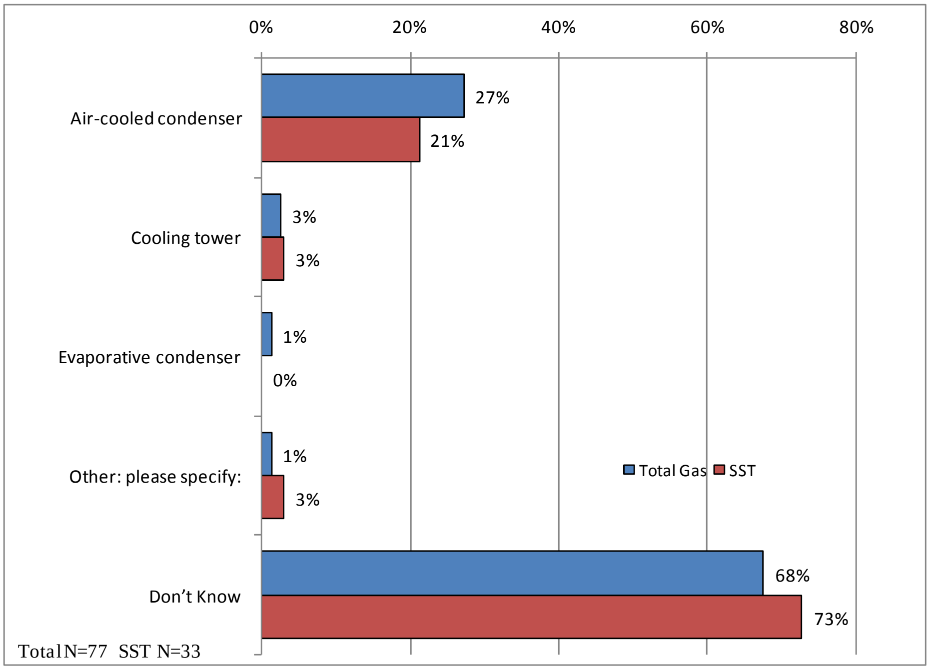

Under 7% of both *total* and *shared service territory* organizations identified a central chiller system as their main cooling method.

### *Other Type of Chiller Systems*



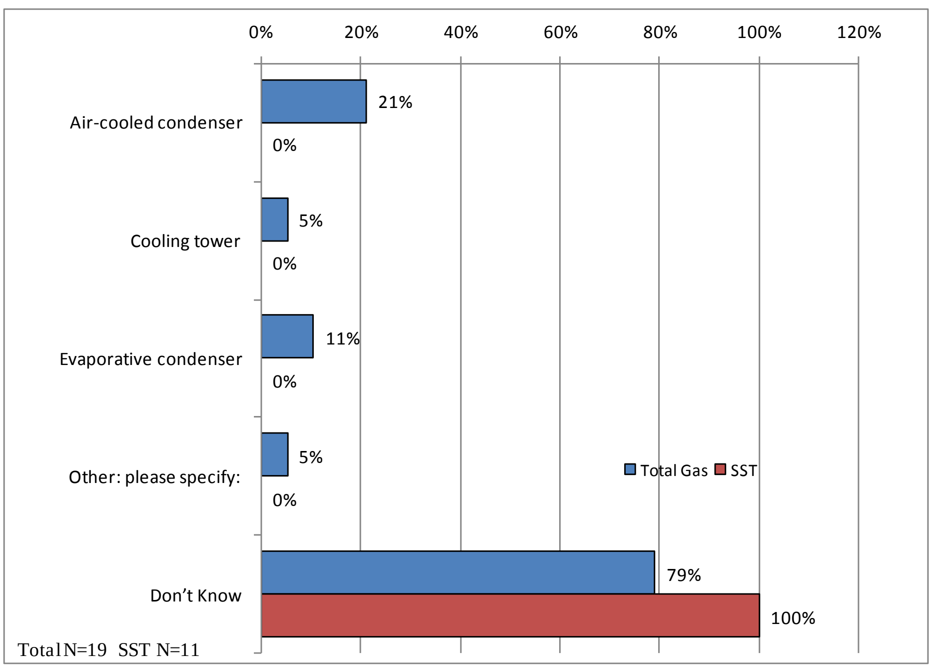

Although most were unaware of the method, natural gas was mentioned most frequently by respondents who did answer.

## *E8. Please indicate the Main Heat Rejection System used at this address.*




Most respondents were unaware of the Main Heat Rejection System but air cooled condenser was mentioned most frequently by those who were aware.

### *Other Heat Rejection Systems*



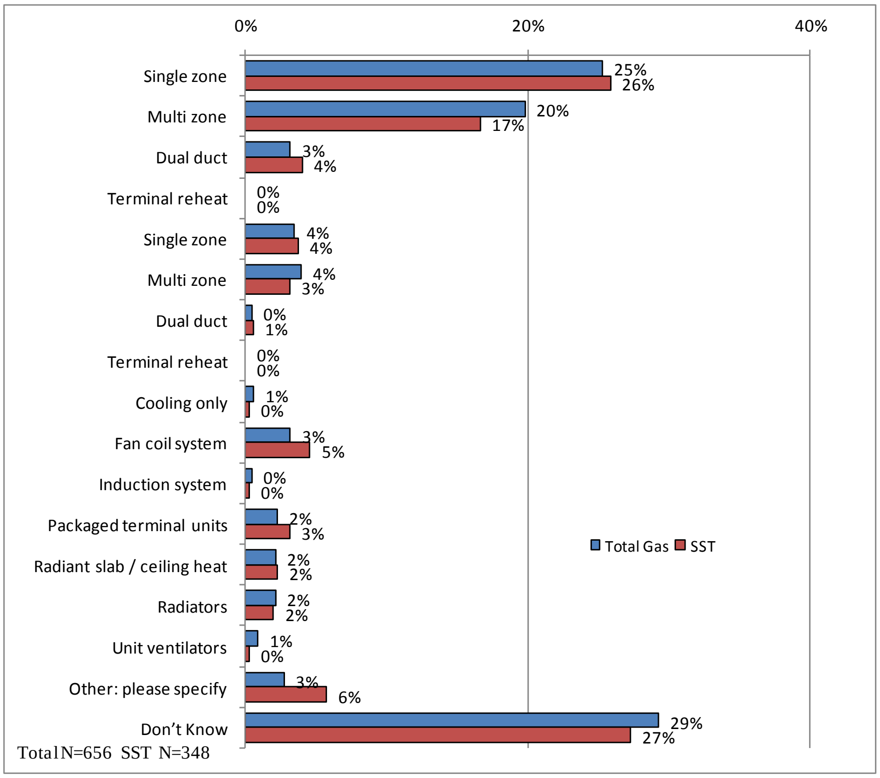
## *F. Space Cooling*

***F1. First, is any of the heating or cooling at this address produced by equipment served by one of your own utility accounts? Or is all of the heating and cooling served by another organization?***

| | | Total Gas | SST |
|---|---|---|---|
| F1. First, is any of the heating or cooling at this address produced by equipment served by one of your own utility accounts? Or is all of the heating and cooling served by another organization? | Yes, at least some (or all) of the heating or cooling | 79.5% | 80.6% |
| | All of the heating or cooling is served by another | 5.6% | 6.1% |
| | Don't know | 14.9% | 13.3% |

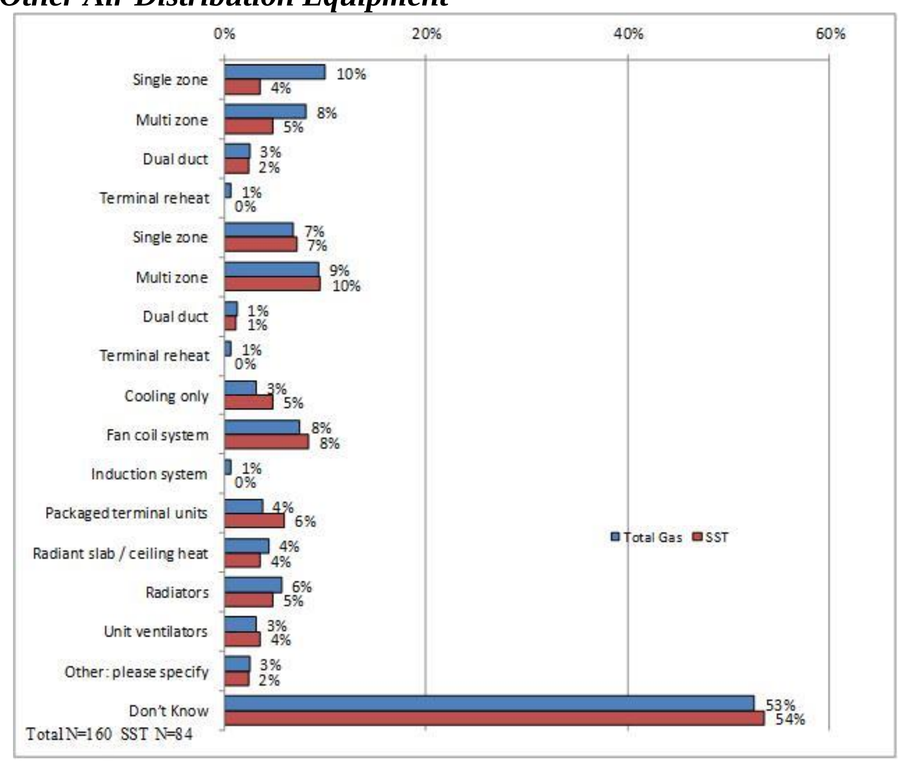
Almost all of the companies in both samples produce heating or cooling from their own equipment.

***F2. Please indicate the Main Air Distribution Equipment served by this organization's electric account.***



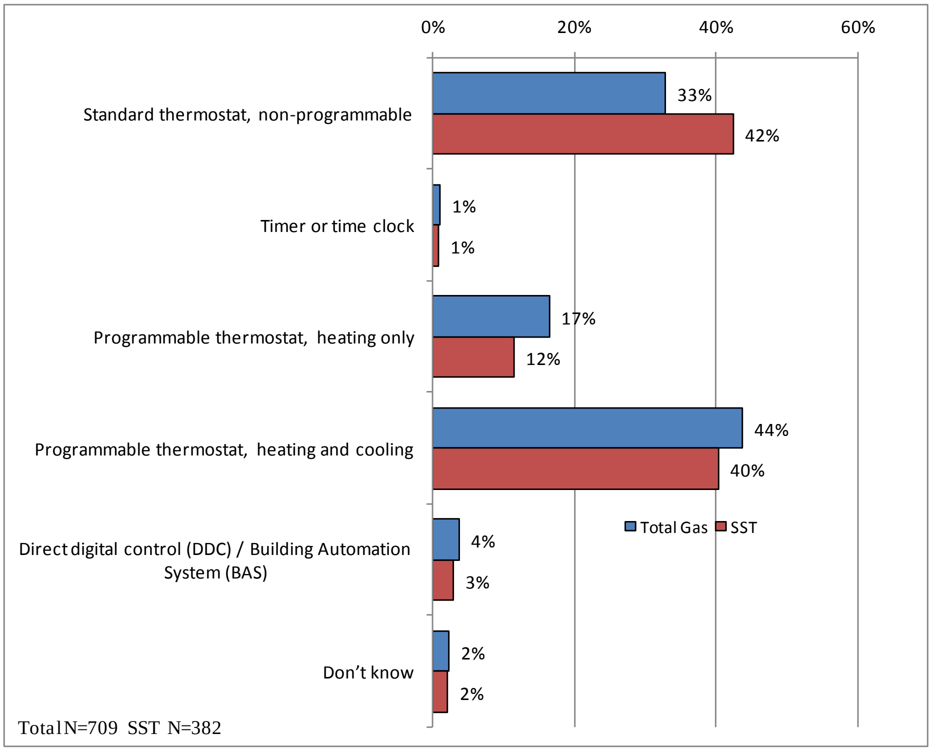

Most respondents were unaware of the Main Heat Rejection System but air cooled condenser was mentioned most frequently by those who were aware.

***Other Air Distribution Equipment***



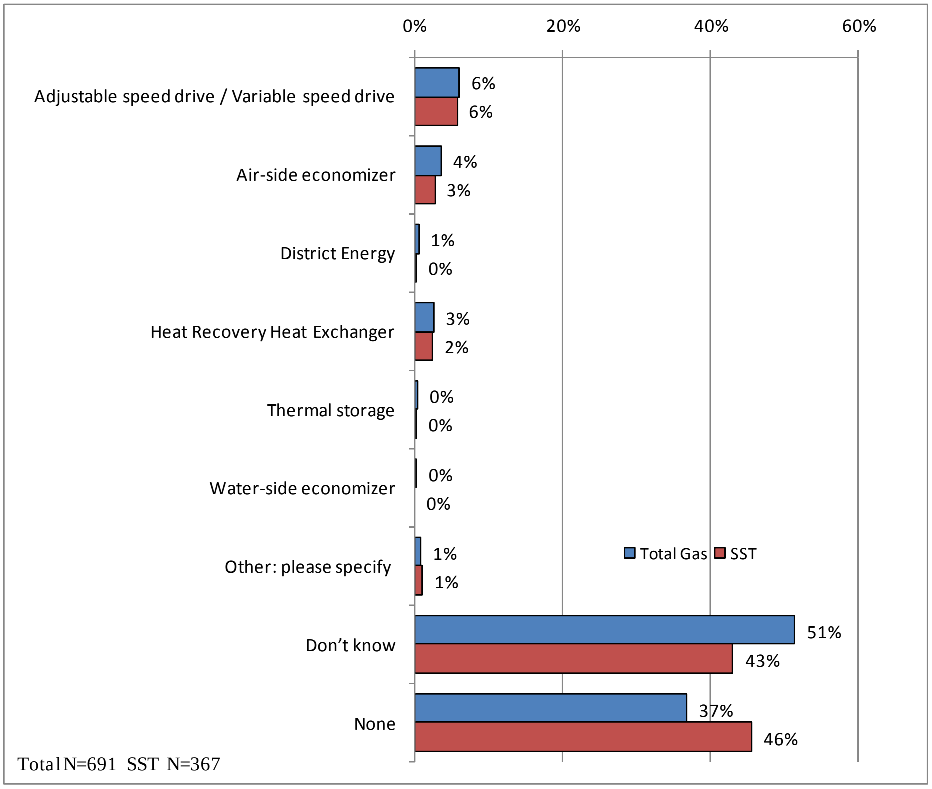

Although the air distributing methods are similar between the two samples, *total* organizations are more likely to have single and multi zone and *shared service territory* to utilize packaged terminal units.

## *F3. What is the main type of system used to control temperature?*




Programmable and standard non-programmable thermostats are used equally and most frequently by both *total* and *shared service territory* samples.

## *F4. Which, if any, of the following energy efficient technologies does your main HVAC system use?*




There is very low awareness among both *total* and *shared service territory* respondents about energy efficient technologies.

## *F5. Has the main HVAC system been upgraded in the past 5 years?*

| | | Total Gas | SST |
|---|---|---|---|
| F5. Has the main HVAC system been upgraded in the past 5 years? | Yes | 19.4% | 16.0% |
| | No | 66.6% | 71.5% |
| | Don't know | 13.9% | 12.5% |

Approximately 1 in 5 main HVAC systems of both *total* and *shared service territory* samples have been upgraded in the last 5 years.

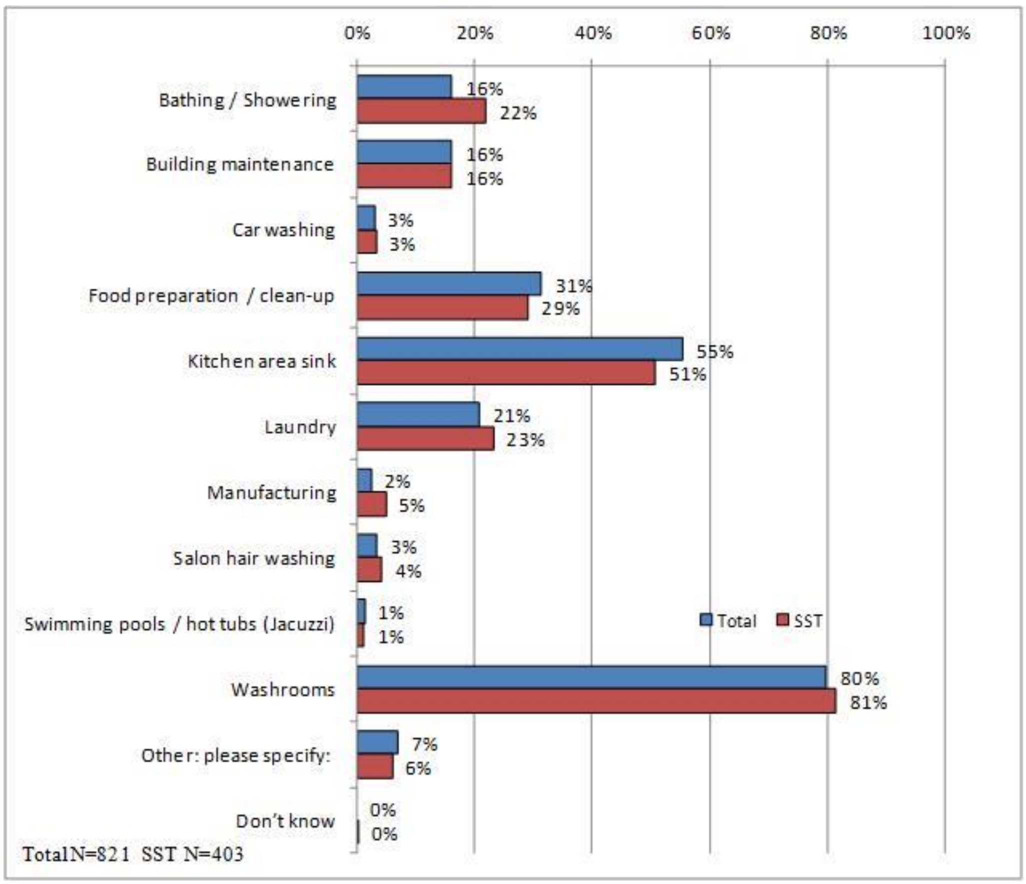
## G. Water Heating Equipment

### G1. Is hot water used by the organization at this address?

| | | Total Gas | SST |
|---|---|---|---|
| G1. Is hot water used by the organization at this address? | Yes | 93.8% | 87.1% |
| | No | 4.8% | 11.3% |
| | Don't know | 1.4% | 1.6% |

19 out of the 20 organizations in both samples have on-site hot water.

### G2. What are the main uses for hot water at this address?




Kitchens, food preparation and laundry are the main uses for hot water for both *total* and *shared service territory* organizations

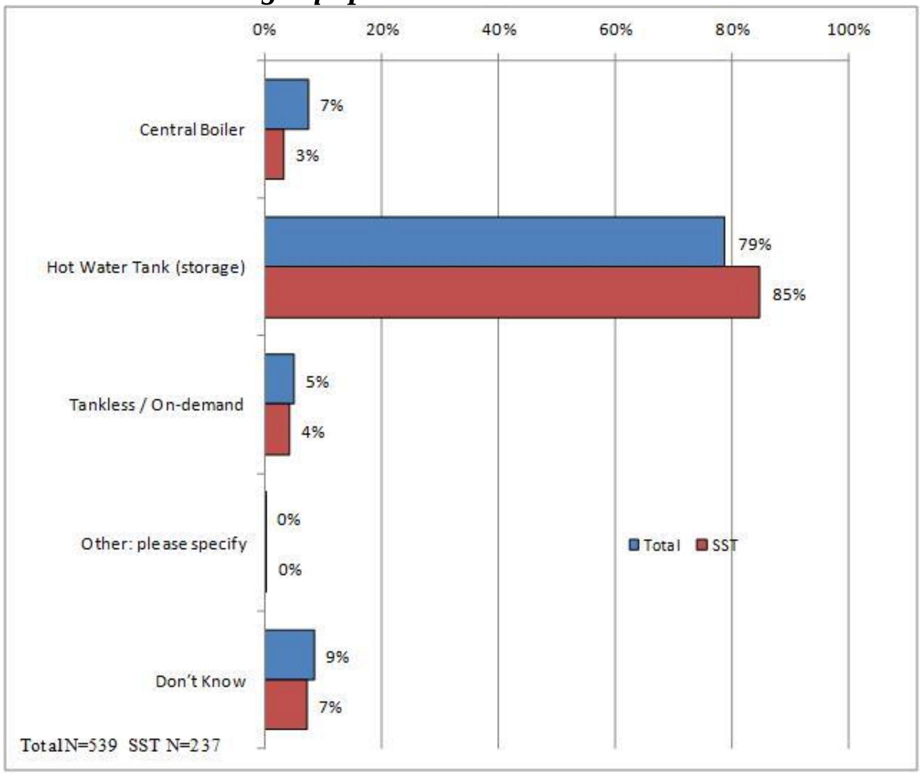
***G3. Is the hot water used at this address produced by heating equipment served by one of your own utility accounts, or is it produced by a heating system – possibly a central one – served by another organization's account?***

| | | Total Gas | SST |
|---|---|---|---|
| G3. Is the hot water used at this address produced by heating equipment served by one of your own utility accounts, or is it produced by a heating system – possibly a central one – served by another organization's account? | Yes, the hot water is produced by heating equipment served by one of our own utility accounts | 87.3% | 90.8% |
| | No, the hot water is served by another organization's account | 6.0% | 4.7% |
| | Don't know | 6.6% | 4.5% |

Almost all hot water (87%) is produced by equipment service by their own utility account.

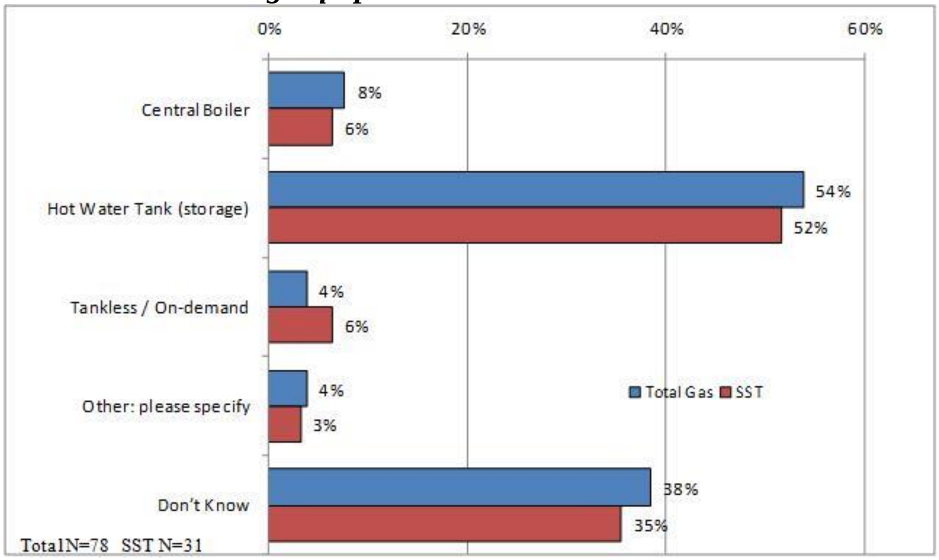
## *G4. Please indicate the Main Water Heating Equipment and Fuel type served by this organization's utility accounts.*

***Main Water Heating Equipment***

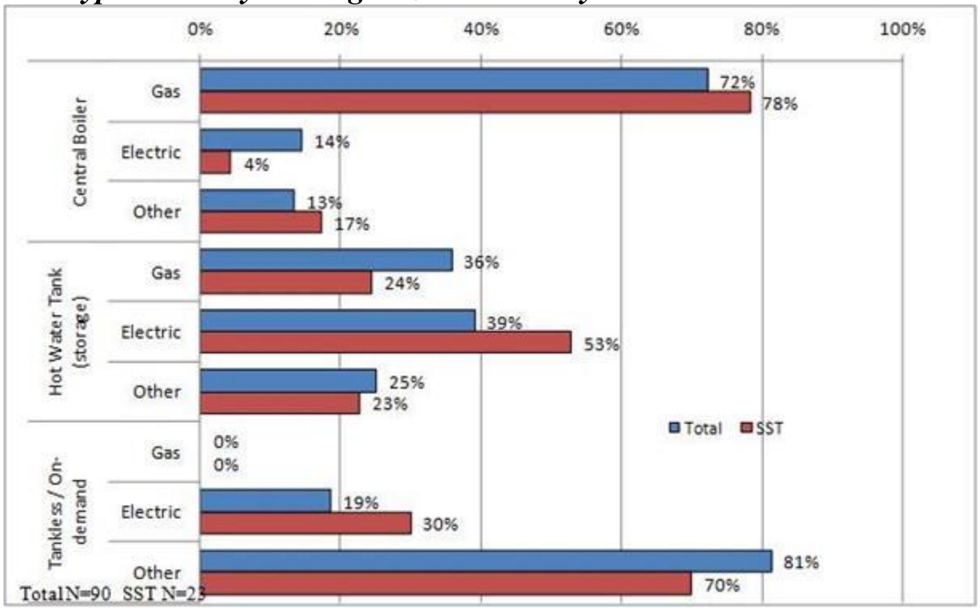



Hot water tanks are the overwhelming equipment choice which is heated by gas in both types of organizations.

***Other Water Heating Equipment***



***Fuel type served by this organization's utility accounts.***




Gas is more likely used by *shared service territory* organizations for their central boiler than *total* sample organizations, and electricity for their hot water tank.

| | | Total Gas | SST |
|---|---|---|---|
| Central Boiler (No. of Units) | Mean | 2 | 1 |
| Hot Water Tank (storage) (No. of Units) | Mean | 2 | 2 |
| Tankless / On-demand (No. of Units) | Mean | 1 | 1 |
| Other: please specify (No. of Units) | Mean | 1 | 1 |

The *total* sample indicted there are two central boilers in the premises but *shared service territory* respondents indicated 1 central boiler.

## *G5. Does the main water heating equipment or system use reserved waste heat?*

| | | Total Gas | SST |
|---|---|---|---|
| G5. Does the main water heating equipment or system use reserved waste heat? | Yes | 3.5% | 2.9% |
| | No | 69.4% | 76.6% |
| | Don't know | 27.1% | 20.5% |

Less than 5% of both samples' premises use reserved waste heat for heating water.

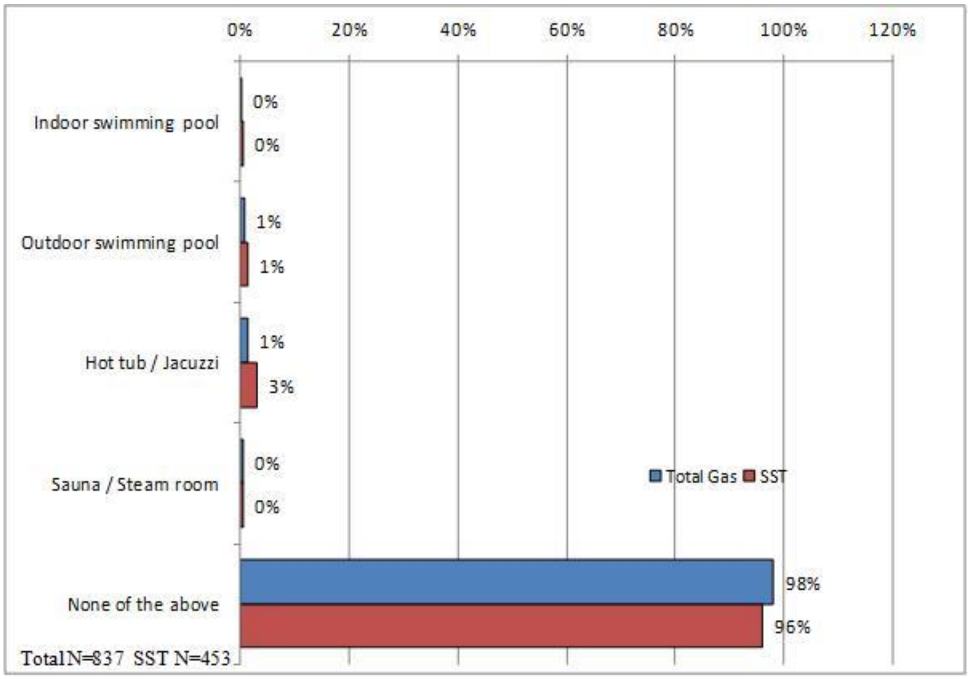
## *G6. Has the main water heating equipment been upgraded in the past 5 years?*

| | | Total Gas | SST |
|---|---|---|---|
| G6. Has the main water heating equipment been upgraded in the past 5 years? | Yes | 31.4% | 24.7% |
| | No | 59.8% | 68.9% |
| | Don't know | 8.8% | 6.4% |

Almost 1/3 of the *total* sample's water heating systems have been upgraded in the last 5 years compared to ¼ of the *shared service territory* systems.

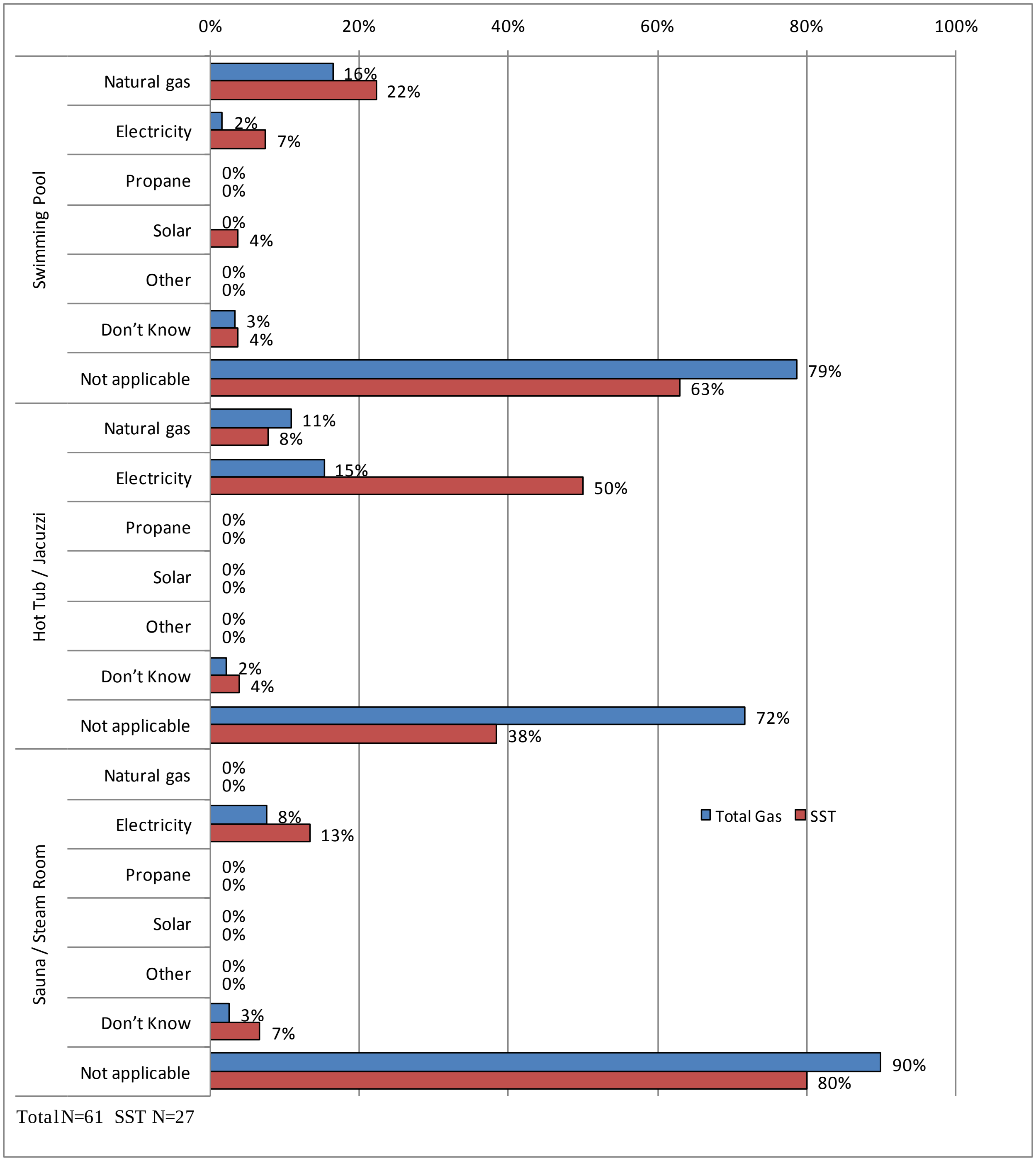
## H. Swimming Pools, Hot Tubs, Jacuzzis and Steam Rooms

***H1. Please indicate which of the following amenities are covered by your FortisBC accounts.***




Very few amenities are covered by a FortisBC account. .

## *H2. Please indicate the fuels used to heat these amenities.*




*Where these facilities are present:*

Natural gas is used for heating swimming pools especially by *shared service territory* customers. Electricity is used more frequently by *shared service territory* customers for both hot tubs and sauna/steam rooms.

### *H3. Is solar used to supplement the heating of the swimming pool?*

| | | Total Gas | SST |
|---|---|---|---|
| H3. Is solar used to supplement the heating of the swimming pool? | Yes | 4.3% | 10.6% |
| | No | 54.3% | 61.7% |
| | Not applicable | 41.5% | 27.7% |

Solar heating is not frequently installed. *Shared service territory* customers are more likely to have this option.

### *H4. Please indicate whether or not there are heaters or pumps used for swimming pools and hot tubs at this building.*

| | | Total Gas | SST |
|---|---|---|---|
| Heaters for swimming pools or hot tubs | Yes | 23.1% | 57.7% |
| | No | 23.1% | 15.4% |
| | Don't Know | 1.9% | .0% |
| | Not Applicable | 51.9% | 26.9% |
| Pumps for swimming pools or hot tubs | Yes | 18.0% | 47.8% |
| | No | 24.0% | 17.4% |
| | Don't Know | 2.0% | .0% |
| | Not Applicable | 56.0% | 34.8% |
| Pumps for swimming pools or hot tubs with variable frequency drives | Yes | 6.4% | 11.1% |
| | No | 27.7% | 33.3% |
| | Don't Know | 6.4% | 11.1% |
| | Not Applicable | 59.6% | 44.4% |

Heaters and pumps are used more frequently by *shared service territory* users for all uses cited.

***Number of Units***

| | | Total Gas | SST |
|---|---|---|---|
| Heaters for swimming pools or hot tubs (Number of Units) | Mean | 1 | 2 |
| Pumps for swimming pools or hot tubs (Number of Units) | Mean | 2 | 2 |
| Pumps for swimming pools or hot tubs with variable frequency drives (Number of Units) | Mean | 1 | 1 |

If used, *shared service territory* customers have two heaters compared to one for the *total* customer group.

Both have two pumps for swimming pools or hot tubs with variable frequency drives.

# I. Cooking Equipment

## I1. Is there any cooking equipment used by the organization at this address?

| | | Total Gas | SST |
|---|---|---|---|
| I1. Is there any cooking equipment used by the organization at this address? | Yes | 47.0% | 47.5% |
| | No | 51.8% | 51.6% |
| | Don't Know | 1.2% | .9% |

Almost 1/2 of all respondents have cooking facilities on site.

***I2. For each type of Natural Gas or Propane cooking equipment in the table below, please indicate whether this organization has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Range (Cooktop and oven) | Yes | 38.4% | 42.0% |
| | No | 57.9% | 56.7% |
| | Don't Know | 3.7% | 1.3% |
| Dual Fuel Range (Gas Cooktop/Electric oven) | Yes | 11.3% | 4.9% |
| | No | 85.3% | 93.4% |
| | Don't Know | 3.4% | 1.6% |
| Open burners/cook tops | Yes | 26.0% | 16.5% |
| | No | 70.5% | 82.7% |
| | Don't Know | 3.5% | .8% |
| Ovens | Yes | 31.5% | 26.7% |
| | No | 65.4% | 71.9% |
| | Don't Know | 3.0% | 1.5% |
| Grills/Griddles | Yes | 23.8% | 18.8% |
| | No | 73.0% | 79.7% |
| | Don't Know | 3.2% | 1.6% |
| Deep-fat fryers | Yes | 27.4% | 14.8% |
| | No | 70.1% | 84.4% |
| | Don't Know | 2.4% | .8% |
| Broilers/char broilers | Yes | 10.0% | 5.8% |
| | No | 87.4% | 93.3% |
| | Don't Know | 2.7% | .8% |
| Food warmers/soup pots | Yes | 16.4% | 10.4% |
| | No | 79.9% | 88.8% |
| | Don't Know | 3.7% | .8% |
| Steamers | Yes | 11.0% | 9.2% |
| | No | 86.2% | 90.8% |
| | Don't Know | 2.8% | .0% |

Although approximately 50% of both *total* and *shared service territory* respondents have cooking facilities, the *total* sample has more of most types of cooking equipment.

***I2. For each type of Natural Gas or Propane cooking equipment in the table below, please indicate whether this organization has at least one. (Number of units)***

| | | Total Gas | SST |
|---|---|---|---|
| Range (Cooktop and oven) (Number of Units) | Mean | 2 | 1.7 |
| Dual Fuel Range (Gas Cooktop/Electric oven) (Number of Units) | Mean | 2 | 2 |
| Open burners/cook tops (Number of Units) | Mean | 3 | 2 |
| Ovens (Number of Units) | Mean | 2 | 2 |
| Grills/Griddles (Number of Units) | Mean | 1 | 1 |
| Deep-fat fryers (Number of Units) | Mean | 2 | 2 |
| Broilers/char broilers (Number of Units) | Mean | 1 | 1 |
| Food warmers/soup pots (Number of Units) | Mean | 2 | 2 |
| Steamers (Number of Units) | Mean | 1 | 2 |

Both *total* and *shared service territory* respondents report having similar numbers of each utensil.

***I3. For each of the Electric cooking equipment in the table below, please indicate whether this organization has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Range (Cooktop and oven) | Yes | 48.8% | 60.1% |
| | No | 49.1% | 38.7% |
| | Don't Know | 2.2% | 1.2% |
| Cook top | Yes | 16.1% | 13.3% |
| | No | 81.5% | 85.8% |
| | Don't Know | 2.4% | .8% |
| Ovens | Yes | 26.2% | 25.6% |
| | No | 71.9% | 73.6% |
| | Don't Know | 1.9% | .8% |
| Grills/Griddles | Yes | 18.1% | 16.1% |
| | No | 79.4% | 83.1% |
| | Don't Know | 2.5% | .8% |
| Deep-fat fryers | Yes | 10.5% | 5.4% |
| | No | 87.4% | 93.8% |
| | Don't Know | 2.1% | .9% |
| Broilers / char broilers | Yes | 6.1% | 4.6% |
| | No | 91.7% | 94.5% |
| | Don't Know | 2.2% | .9% |
| Food warmers / soup pots | Yes | 34.1% | 23.3% |
| | No | 63.2% | 75.8% |
| | Don't Know | 2.7% | .8% |
| | | Total Gas | SST |
| Steamers | Yes | 12.7% | 9.0% |
| | No | 84.0% | 90.1% |
| | Don't Know | 3.4% | .9% |
| Microwave ovens | Yes | 88.6% | 87.8% |
| | No | 9.1% | 10.1% |
| | Don't Know | 2.0% | 2.1% |
| Ice makers | Yes | 34.6% | 32.5% |
| | No | 63.0% | 65.8% |
| | Don't Know | 2.3% | 1.7% |
| Kitchen exhaust fans (single speed) | Yes | 43.2% | 37.6% |
| | No | 53.9% | 58.6% |
| | Don't Know | 2.9% | 3.8% |
| Kitchen exhaust fans (variable speed) | Yes | 29.7% | 30.6% |
| | No | 66.4% | 66.9% |
| | Don't Know | 3.9% | 2.4% |
| Demand control ventilation system | Yes | 10.7% | 5.3% |
| | No | 83.7% | 89.5% |
| | Don't Know | 5.6% | 5.3% |
| Other: (please specify) | Yes | 13.5% | 17.9% |
| | No | 83.0% | 80.0% |
| | Don't Know | 3.5% | 2.1% |

Again *total* and *shared service territory* samples indicated similar range of electric cooking utensils, the exceptions being:

- Greater use of electricity by *shared service territory* respondents for ranges.
- *Total* respondents for deep fat fryers and food warmers.

***I3. For each of the Electric cooking equipment in the table below, please indicate whether this organization has at least one. (Number of Units)***

| | | Total Gas | SST |
|---|---|---|---|
| Range (Cooktop and oven) (Number of Units) | Mean | 3 | 3 |
| Cook top (Number of Units) | Mean | 2 | 2 |
| Ovens (Number of Units) | Mean | 2 | 2 |
| Grills/Griddles (Number of Units) | Mean | 1 | 1 |
| Deep-fat fryers (Number of Units) | Mean | 1 | 1 |
| Broilers / char broilers (Number of Units) | Mean | 1 | 2 |
| Food warmers / soup pots (Number of Units) | Mean | 2 | 2 |
| Steamers (Number of Units) | Mean | 1 | 2 |
| Microwave ovens (Number of Units) | Mean | 2 | 2 |
| Ice makers (Number of Units) | Mean | 1 | 1 |
| Kitchen exhaust fans (single speed) (Number of Units) | Mean | 2 | 2 |
| Kitchen exhaust fans (variable speed) (Number of Units) | Mean | 2 | 1 |
| Demand control ventilation system (Number of Units) | Mean | 1 | 1 |
| Other: (please specify) (Number of Units) | Mean | 1 | 2 |

The presence of the various electric utensils is similar for both *total* and *shared service territory* organizations.

## *I4. Does your organization prepare and serve meals?*

| | | Total Gas | SST |
|---|---|---|---|
| I4. Does your organization prepare and serve meals? | Yes | 43.7% | 33.2% |
| | No | 55.6% | 64.3% |
| | Don't Know | .7% | 2.6% |

*Total* responding organizations are more likely to prepare and serve meals than their *shared service territory* counterparts.

## *J. Building Automation Systems*

### *J1. Is there a building automation system (BAS) at this address for controlling building equipment or systems?*

| | | Total Gas | SST |
|---|---|---|---|
| J1. Is there a building automation system (BAS) at this address for controlling building equipment or systems? | Yes | 8.4% | 6.1% |
| | No | 74.5% | 80.9% |
| | Don't Know | 17.1% | 13.0% |

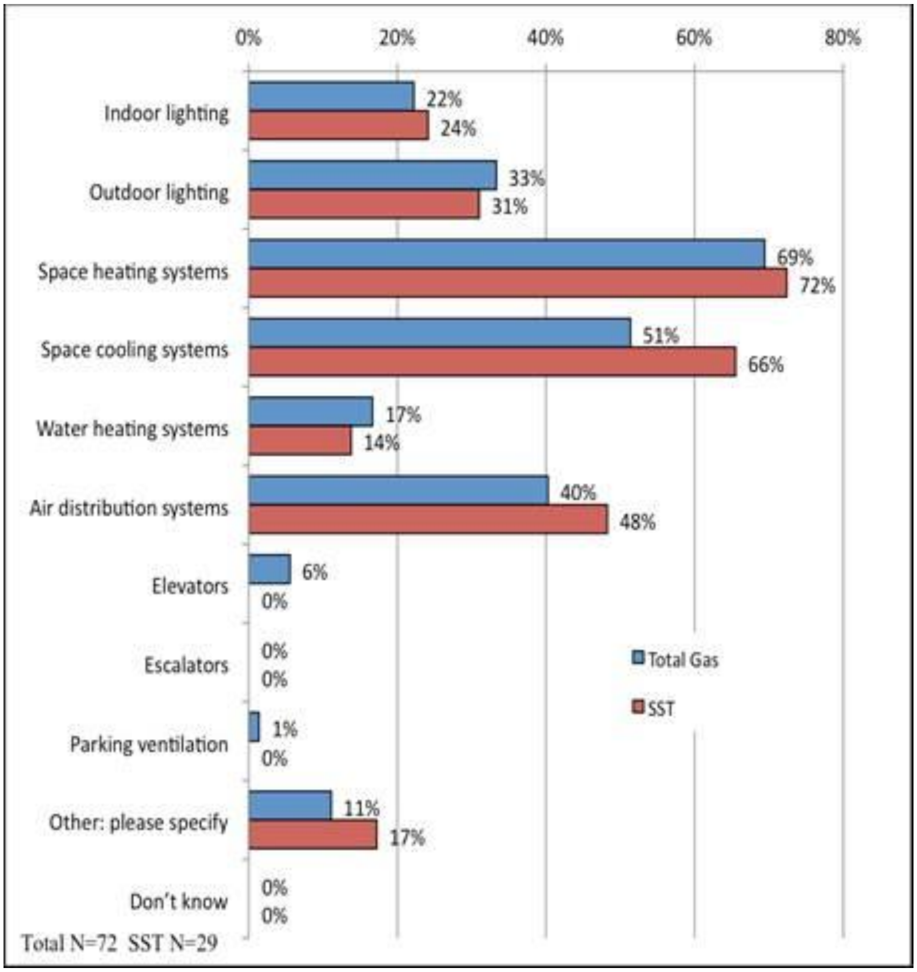
Less than 1/10 of both types of organizations reported having a BAS system.

### *J2. As the BAS installed as a retrofit (after the building was constructed)?*

| | | Total Gas | SST |
|---|---|---|---|
| J2. Was the BAS installed as a retrofit (after the building was constructed)? | Yes | 36.1% | 38.5% |
| | No | 36.1% | 44.2% |
| | Don't Know | 27.7% | 17.3% |

Of the respondents who knew, almost ½ were installed as a retrofit.

## *J3. Which equipment and systems are controlled or scheduled by the BAS?*




Space heating systems are the most frequently controlled by a BAS.

*Shared service territory* organizations use their BAS on more systems especially space cooling.

## *K. Refrigeration and Freezer Equipment*

***K1. Is there any refrigeration or freezer equipment used by the organization at this address?***

| | | Total Gas | SST |
|---|---|---|---|
| K1. Is there any refrigeration or freezer equipment used by the organization at this address? | Yes | 72.3% | 67.5% |
| | No | 27.3% | 32.1% |
| | Don't Know | 30.0% | .4% |

Almost the same proportion of organizations in the *total* and *shared service territory* segment (approximately 70%) have refrigeration equipment on site.

***K2. For each type of refrigeration equipment in the table below, please indicate whether or not the organization at this address has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units | Yes | 48.8% | 46.8% |
| | No | 50.0% | 51.4% |
| | Don't Know | 1.2% | 1.8% |
| Closed units (horizontal or vertical) | Yes | 57.3% | 59.2% |
| | No | 32.6% | 33.1% |
| | Don't Know | 10.1% | 7.7% |
| Open units (horizontal or vertical) | Yes | 19.7% | 19.1% |
| | No | 78.8% | 78.7% |
| | Don't Know | 1.5% | 2.1% |

Both types of organizations are using the same equipment types, sizes, and numbers on site.

***Number of Units:***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units (Number of Units) | Mean | 3 | 3 |
| Closed units (horizontal or vertical) (Number of Units) | Mean | 2 | 2 |
| Open units (horizontal or vertical) (Number of Units) | Mean | 1 | 2 |

***Typical size:***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units (Typical Size) | Mean | 1155 | 1054 |
| Closed units (horizontal or vertical) (Typical Size) | Mean | 18 | 15 |
| Open units (horizontal or vertical) (Typical Size) | Mean | 2262 | 1445 |

## *K3. Type of lighting used in the refrigeration equipment.*

| | | Total Gas | SST |
|---|---|---|---|
| LED (light emitting diodes) strips or bars | Yes | 21.5% | 20.2% |
| | No | 67.7% | 68.5% |
| | Don't Know | 10.8% | 11.2% |
| Linear Fluorescent (long Fluorescent tubes) | Yes | 46.8% | 50.0% |
| | No | 44.2% | 40.7% |
| | Don't Know | 9.1% | 9.3% |
| Other: please specify: | Yes | 27.4% | 23.5% |
| | No | 59.7% | 64.7% |
| | Don't Know | 12.9% | 11.8% |

Both samples use the same types of lighting with linear fluorescent being the more frequently cited option.

***% of all Lighting Fixtures in the Commercial Refrigeration Equipment***

| | | Total Gas | SST |
|---|---|---|---|
| LED (light emitting diodes) strips or bars (% of all Lighting Fixtures in the Commercial Refrigeration Equipment) | Mean | 55 | 61 |
| Linear Fluorescent (long Fluorescent tubes) (% of all Lighting Fixtures in the Commercial Refrigeration Equipment) | Mean | 78 | 83 |
| Other: please specify: (% of all Lighting Fixtures in the Commercial Refrigeration Equipment) | Mean | 81 | 79 |

***K4. For each type of commercial freezer equipment in the table below, please indicate whether or not the organization at this address has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units | Yes | 33.9% | 34.1% |
| | No | 62.9% | 60.2% |
| | Don't Know | 3.2% | 5.7% |
| Closed units (horizontal or vertical) | Yes | 38.0% | 39.4% |
| | No | 54.9% | 51.9% |
| | Don't Know | 7.0% | 8.7% |
| Open units (horizontal or vertical) | Yes | 3.6% | 5.1% |
| | No | 90.9% | 87.3% |
| | Don't Know | 5.5% | 7.6% |

The same proportion of both *total* and *shared service territory* organizations have the various commercial freezer types, numbers of units and sizes.

***Number of units***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units (Number of Units) | Mean | 1 | 1 |
| Closed units (horizontal or vertical) (Number of Units) | Mean | 3 | 2 |
| Open units (horizontal or vertical) (Number of Units) | Mean | 2 | 2 |

***Typical Size***

| | | Total Gas | SST |
|---|---|---|---|
| Walk-in units (Typical Size) | Mean | 683 | 713 |
| Closed units (horizontal or vertical) (Typical Size) | Mean | 25 | 21 |
| Open units (horizontal or vertical) (Typical Size) | Mean | - | 6 |

***K5. Thinking about the commercial freezer equipment you indicated having in the previous question, please indicate the type of lighting used in it.***

| | | Total Gas | SST |
|---|---|---|---|
| LED (light emitting diodes) strips or bars | Yes | 8.1% | 8.0% |
| | No | 79.0% | 75.9% |
| | Don't Know | 12.9% | 16.1% |
| Linear Fluorescent (long fluorescent tubes) | Yes | 22.2% | 24.2% |
| | No | 65.1% | 59.3% |
| | Don't Know | 12.7% | 16.5% |
| Other: please specify | Yes | 21.7% | 18.6% |
| | No | 63.3% | 62.8% |
| | Don't Know | 15.0% | 18.6% |

Linear fluorescent tubes are installed three times more frequently than LED strips by both *total* and *shared service territory* organizations.

***% of all lighting fixtures in the freezer equipment***

| | | Total Gas | SST |
|---|---|---|---|
| LED (light emitting diodes) strips or bars (% of all lighting fixtures in the freezer equipment) | Mean | 87.5% | 75.0% |
| Linear Fluorescent (long fluorescent tubes) (% of all lighting fixtures in the freezer equipment) | Mean | 93.0% | 92.9% |
| Other: please specify (% of all lighting fixtures in the freezer equipment) | Mean | 84.5% | 87.6% |

When either LED or fluorescent tubes are installed in commercial freezer units they are essentially used on their own.

***K6. For each type of light refrigeration and freezer equipment in the table below, please indicate whether or not the organization at this address has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Compact bar fridges | Yes | 67.1% | 62.8% |
| | No | 32.3% | 36.4% |
| | Don't Know | .6% | .8% |
| Household fridges | Yes | 76.7% | 76.2% |
| | No | 21.6% | 22.3% |
| | Don't Know | 1.7% | 1.5% |
| Household chest/upright freezers | Yes | 43.2% | 42.9% |
| | No | 54.7% | 55.2% |
| | Don't Know | 2.2% | 2.0% |
| Refrigerated beverage dispensers | Yes | 30.7% | 28.1% |
| | No | 66.9% | 69.7% |
| | Don't Know | 2.4% | 2.2% |
| Refrigerated ice cream snack dispensers | Yes | 6.0% | 8.7% |
| | No | 92.2% | 89.6% |
| | Don't Know | 1.7% | 1.7% |
| Soft ice cream machines | Yes | 3.5% | 3.0% |
| | No | 93.8% | 94.6% |
| | Don't Know | 2.7% | 2.4% |

The two organization types, *total* and *shared service territory*, have very similar light refrigeration and freezer equipment, household and bar fridges being the most popular.

***Number of Units***

| | | Total Gas | SST |
|---|---|---|---|
| Compact bar fridges (Number of Units) | Mean | 3 | 3 |
| Household fridges (Number of Units) | Mean | 3 | 3 |
| Household chest/upright freezers (Number of Units) | Mean | 2 | 2 |
| Refrigerated beverage dispensers (Number of Units) | Mean | 2 | 2 |
| Refrigerated ice cream snack dispensers (Number of Units) | Mean | 1 | 1 |
| Soft ice cream machines (Number of Units) | Mean | 2 | 2 |

The identical number of units are on site in both *total* and *shared service territory* facilities.

## L. Outdoor Lighting

***L1. Is there any outdoor lighting at this address that is served by this electrical account?***

| | | Total Gas | SST |
|---|---|---|---|
| L1. Is there outdoor lighting at this address that is served by this electrical account? | Yes | 76.1% | 74.8% |
| | No | 23.3% | 24.3% |
| | Don't Know | .7% | .9% |

3/4 of both *total* and *shared service territory* locations have outdoor lighting.

***L2. Please estimate the total number of outdoor light fixtures, including wall mounted units, at this address.***

| | | Total Gas | SST |
|---|---|---|---|
| L2. Total # of outdoor lighting fixtures | Mean | 8 | 7 |

Both have the same number of outdoor fixtures.

***L3. Please indicate whether or not the organization at this address has at least one fixture using the bulb type indicated.***

| | | Total Gas | SST |
|---|---|---|---|
| Incandescent (conventional) light bulbs | Yes | 43.5% | 47.0% |
| | No | 47.8% | 45.3% |
| | Don't Know | 8.7% | 7.6% |
| CFL (compact fluorescent lighting) bulbs | Yes | 44.8% | 49.3% |
| | No | 45.5% | 42.9% |
| | Don't Know | 9.8% | 7.8% |
| LED (light emitting diodes) bulbs | Yes | 31.6% | 34.6% |
| | No | 58.1% | 57.1% |
| | Don't Know | 10.3% | 8.3% |
| LED complete / hardwired fixtures | Yes | 13.0% | 14.6% |
| | No | 74.8% | 75.4% |
| | Don't Know | 12.2% | 9.9% |
| Linear fluorescent (long fluorescent tubes) | Yes | 41.2% | 36.6% |
| | No | 49.3% | 55.2% |
| | Don't Know | 9.6% | 8.2% |
| Halogen bulbs and tubes | Yes | 26.0% | 27.1% |
| | No | 61.8% | 63.0% |
| | Don't Know | 12.2% | 9.9% |
| High pressure sodium | Yes | 27.9% | 26.1% |
| | No | 60.5% | 63.8% |
| | Don't Know | 11.6% | 10.1% |
| Mercury vapour | Yes | 3.7% | 5.7% |
| | No | 81.7% | 81.8% |
| | Don't Know | 14.7% | 12.6% |
| Metal halide | Yes | 21.1% | 18.9% |
| | No | 67.5% | 70.9% |
| | Don't Know | 11.4% | 10.3% |

Both *total* and *shared service territory* organizations have installed similar types of bulbs at their facility.

***L3. Please indicate whether or not the organization at this address has at least one fixture using the bulb type indicated. (% of Outdoor fixtures)***

| | | Total Gas | SST |
|---|---|---|---|
| Incandescent (conventional) light bulbs (% of Outdoor Fixtures) | Mean | 62.6% | 60.2% |
| CFL (compact fluorescent lighting) bulbs (% of Outdoor Fixtures) | Mean | 62.3% | 62.8% |
| LED (light emitting diodes) bulbs (% of Outdoor Fixtures) | Mean | 58.3% | 56.8% |
| LED complete / hardwired fixtures (% of Outdoor Fixtures) | Mean | 58.3% | 57.5% |
| Linear fluorescent (long fluorescent tubes) (% of Outdoor Fixtures) | Mean | 66.7% | 61.5% |
| Halogen bulbs and tubes (% of Outdoor Fixtures) | Mean | 58.6% | 58.4% |
| High pressure sodium (% of Outdoor Fixtures) | Mean | 53.9% | 55.0% |
| Mercury vapour (% of Outdoor Fixtures) | Mean | 36.5% | 56.5% |
| Metal halide (% of Outdoor Fixtures) | Mean | 59.3% | 60.5% |

Both *total* and *shared service territory* organizations have installed similar numbers of bulbs at their facility.

The only exception is that *shared service territory* organizations indicate more mercury vapour bulbs are used in outdoor fixtures.

***L4. If the organization at this address has linear fluorescent lights outdoors, please indicate the specific types and the percentage breakdown.***

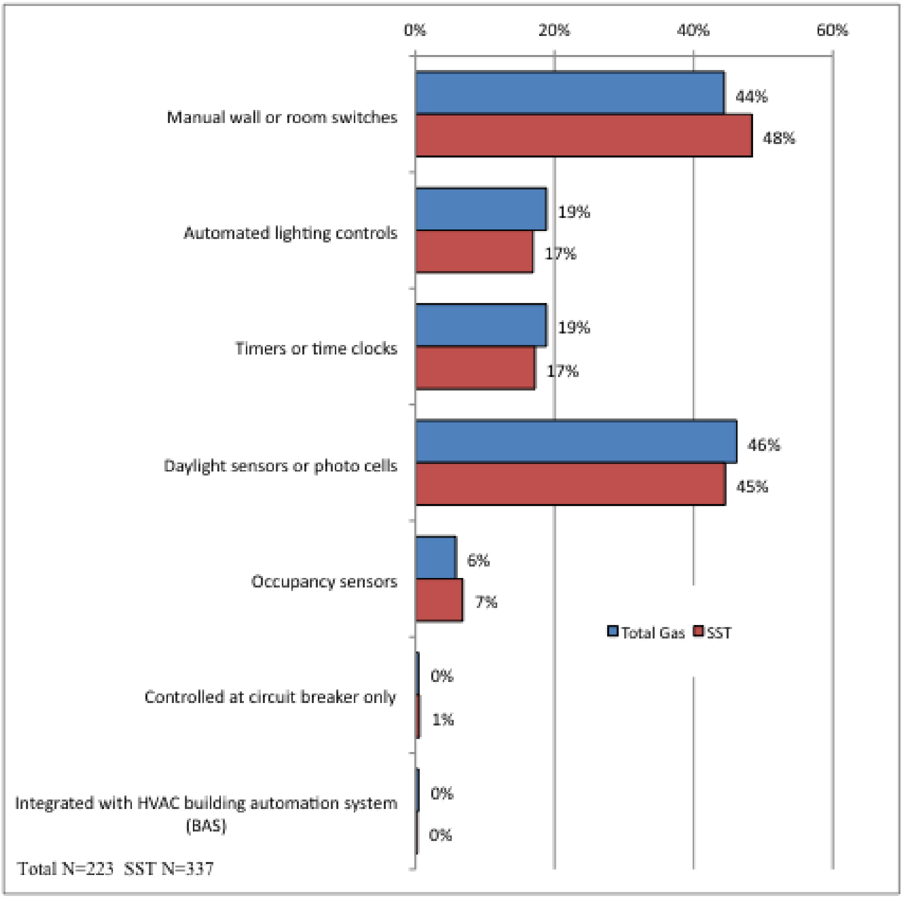
| | | Total Gas | SST |
|---|---|---|---|
| T5 linear fluorescent (5/8" diameter) | Yes | 11.1% | 8.5% |
| | No | 56.9% | 55.3% |
| | Don't Know | 31.9% | 36.2% |
| T8 linear fluorescent (1" diameter) | Yes | 29.5% | 26.2% |
| | No | 39.7% | 41.7% |
| | Don't Know | 30.8% | 32.0% |
| T12 linear fluorescent (1-1/2" diameter) | Yes | 20.8% | 18.8% |
| | No | 48.1% | 47.5% |
| | Don't Know | 31.2% | 33.7% |

The use of linear fluorescent bulbs by both *total* and *shared service territory* organizations is essentially identical.

***% of Outdoor Linear Fluorescent Lighting***

| | | Total Gas | SST |
|---|---|---|---|
| T5 linear fluorescent (5/8" diameter) | Mean | 89.3% | 89.3% |
| T8 linear fluorescent (1" diameter) | Mean | 94.6% | 91.4% |
| T12 linear fluorescent (1-1/2" diameter) | Mean | 96.1% | 92.3% |

## *L5. Please indicate all outdoor lighting controls used by the organization at this address.*



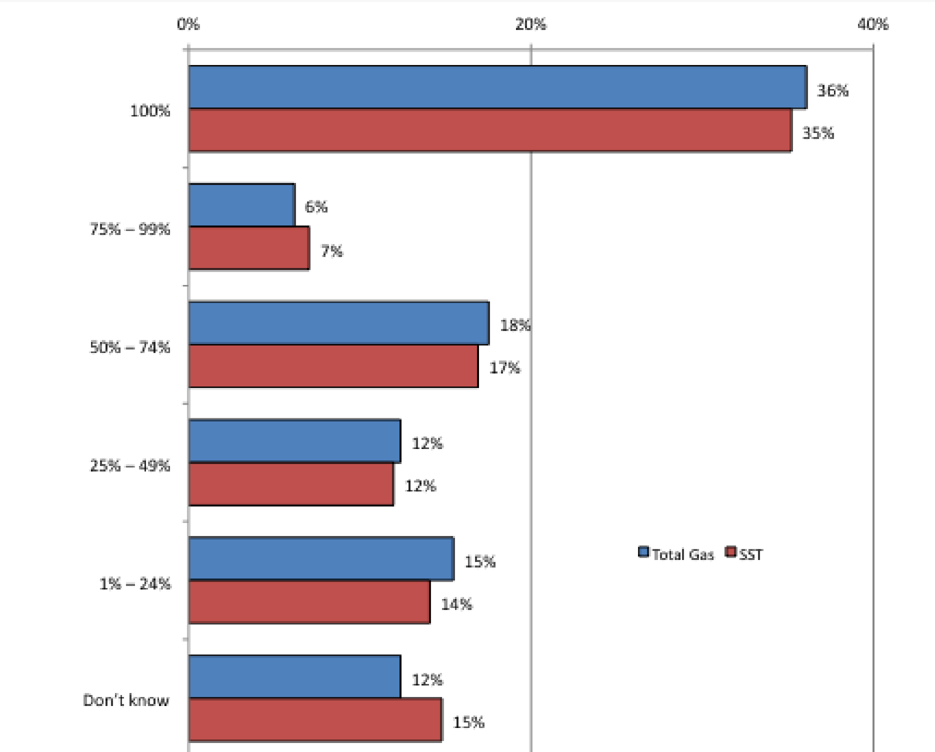

There is little variance between *total* and *shared service territory* organization lighting controls.

## *L6. Have any of the outdoor lighting fixtures been upgraded in the past 5 years?*

| | | Total Gas | SST |
|---|---|---|---|
| L6. Have any of the outdoor lighting fixtures been upgraded in the past 5 years? | Yes | 35.0% | 32.3% |
| | No | 55.8% | 59.5% |
| | Don't know | 9.3% | 8.2% |

Approximately 1/3 of all outdoor lighting fixtures have been upgraded in the last 5 years by both *total* and *shared service territory* organizations.

***L7. What percentage of the outdoor lighting fixtures have been upgraded during this time?***




Total N=97 SST N=142

All of the outdoor lighting fixtures have been upgraded by over 1/3 of both organization types.

## M. Indoor Lighting

### M1. What percentage of your organization's indoor floor space is illuminated?

| | | Total Gas | SST |
|---|---|---|---|
| M1. What percentage of your organization's indoor floor space is illuminated? (Percentage) | Mean | 97.9% | 97.0% |

All of both *total* and *shared service territory* organizations indoor area is illuminated.

### M2. On average, what percentage of the indoor lights are on during:

| | | Total Gas | SST |
|---|---|---|---|
| Occupied hours | Mean | 80.4% | 78.4% |
| Non-occupied hours | Mean | 8.6% | 9.0% |

Both *total* and *shared service territory* organizations have their lights on 80% of the time during the time their premises are occupied and 9% of the time when there is no occupancy.

***M3. Please indicate whether or not the organization at this address has at least one:***

| | | Total Gas | SST |
|---|---|---|---|
| Incandescent (conventional) light bulbs | Yes | 50.0% | 56.3% |
| | No | 45.1% | 39.4% |
| | Don't Know | 4.9% | 4.3% |
| CFL (compact fluorescent lighting) bulbs | Yes | 52.8% | 53.7% |
| | No | 42.1% | 40.4% |
| | Don't Know | 5.1% | 5.9% |
| LED (light emitting diodes) bulbs | Yes | 30.7% | 31.3% |
| | No | 63.4% | 63.0% |
| | Don't Know | 5.9% | 5.7% |
| LED complete / hardwired fixtures | Yes | 11.0% | 12.6% |
| | No | 83.8% | 82.4% |
| | Don't Know | 5.1% | 5.0% |
| Linear fluorescent (long fluorescent tubes) | Yes | 93.9% | 90.3% |
| | No | 3.1% | 6.3% |
| | Don't Know | 3.1% | 3.4% |
| Halogen bulbs and tubes | Yes | 33.6% | 32.6% |
| | No | 60.5% | 62.0% |
| | Don't Know | 5.9% | 5.4% |
| High pressure sodium | Yes | 2.8% | 4.0% |
| | No | 88.7% | 88.6% |
| | Don't Know | 8.5% | 7.4% |
| Mercury vapour | Yes | 4.1% | 3.9% |
| | No | 87.6% | 88.3% |
| | Don't Know | 8.3% | 7.8% |
| Metal halide | Yes | 16.0% | 14.4% |
| | No | 75.3% | 78.1% |
| | Don't Know | 8.7% | 7.4% |

Again, the percentage of usage of the various types of light bubs is similar between the *total* and *shared service territory* organizations.

***M3. Please indicate whether or not the organization at this address has at least one:***

| | | Total Gas | SST |
|---|---|---|---|
| Incandescent (conventional) light bulbs (% of floor space) | Mean | 23.6% | 31.4% |
| CFL (compact fluorescent lighting) bulbs (% of floor space) | Mean | 29.3% | 31.4% |
| LED (light emitting diodes) bulbs (% of floor space) | Mean | 31.0% | 34.1% |
| LED complete / hardwired fixtures (% of floor space) | Mean | 25.6% | 29.8% |
| Linear fluorescent (long fluorescent tubes) (% of floor space) | Mean | 73.7% | 71.4% |
| Halogen bulbs and tubes (% of floor space) | Mean | 27.2% | 28.9% |
| High pressure sodium (% of floor space) | Mean | 30.8% | 45.4% |
| Mercury vapour (% of floor space) | Mean | 68.0% | 77.1% |
| Metal halide (% of floor space) | Mean | 58.0% | 58.6% |

Of those using high pressure sodium bulbs, the *shared service territory* respondents indicated a larger % of the floor space was illuminated by this method.

## *M4. Please indicate the specific types and the percentage breakdown:*

| | | Total Gas | SST |
|---|---|---|---|
| T5 linear fluorescent (5/8" diameter) | Yes | 33.9% | 36.0% |
| | No | 38.0% | 37.7% |
| | Don't Know | 28.1% | 26.4% |
| T8 linear fluorescent (1" diameter) | Yes | 60.4% | 59.5% |
| | No | 18.3% | 19.7% |
| | Don't Know | 21.3% | 20.8% |
| T12 linear fluorescent (1-1/2" diameter) | Yes | 32.9% | 32.6% |
| | No | 41.3% | 41.7% |
| | Don't Know | 25.7% | 25.7% |
| M4. If the organization at this address has linear fluorescent lights indoor; please indicate the specific types and the percentage breakdown. | If none used indoor | 100.0% | 100.0% |

***% of indoor linear fluorescent lighting***

| | | Total Gas | SST |
|---|---|---|---|
| T5 linear fluorescent (5/8" diameter) (% of indoor linear fluorescent lighting) | Mean | 70.5% | 75.1% |
| T8 linear fluorescent (1" diameter) (% of indoor linear fluorescent lighting) | Mean | 82.0% | 82.6% |
| T12 linear fluorescent (1-1/2" diameter) (% of indoor linear fluorescent lighting) | Mean | 72.7% | 68.7% |

The usage of and coverage by the various types of linear fluorescent lighting is essentially identical for the *total* and *shared service territory* organizations.

## M5. *Please indicate whether or not the organization at this address uses it.*

| | | Total Gas | SST |
|---|---|---|---|
| Manual wall or room switches | Yes | 98.1% | 97.3% |
| | No | .4% | .5% |
| | Don't Know | 1.5% | 2.1% |
| Automated lighting controls | Yes | 10.7% | 11.8% |
| | No | 85.5% | 83.7% |
| | Don't Know | 3.8% | 4.5% |
| Timers or time clocks | Yes | 4.8% | 6.0% |
| | No | 90.3% | 89.3% |
| | Don't Know | 4.8% | 4.8% |
| Daylight sensors or photo cells | Yes | 6.5% | 8.9% |
| | No | 88.7% | 86.4% |
| | Don't Know | 4.8% | 4.7% |
| Occupancy sensors | Yes | 13.3% | 13.4% |
| | No | 82.8% | 82.6% |
| | Don't Know | 3.9% | 4.1% |
| Controlled at circuit breaker only | Yes | 8.1% | 10.1% |
| | No | 86.3% | 84.5% |
| | Don't Know | 5.6% | 5.4% |
| Integrated with HVAC building automation system (BAS) | Yes | .0% | .0% |
| | No | 94.2% | 94.4% |
| | Don't Know | 5.8% | 5.6% |

Controlling the interior illumination is almost 100% by manual wall or room switches in both *total* and *shared service territory* organisations' premises.

***% of Illuminated Floor Space Controlled***

| | | Total Gas | SST |
|---|---|---|---|
| Manual wall or room switches (% of illuminated floor space controlled) | Mean | 96.0% | 96.1% |
| Automated lighting controls (% of illuminated floor space controlled) | Mean | 26.1% | 26.7% |
| Timers or time clocks (% of illuminated floor space controlled) | Mean | 25.0% | 19.4% |
| Daylight sensors or photo cells (% of illuminated floor space controlled) | Mean | 7.4% | 7.8% |
| Occupancy sensors (% of illuminated floor space controlled) | Mean | 22.6% | 18.9% |
| Controlled at circuit breaker only (% of illuminated floor space controlled) | Mean | 55.8% | 54.5% |
| Integrated with HVAC building automation system (BAS) (% of illuminated floor space controlled) | Mean | 0% | 0% |

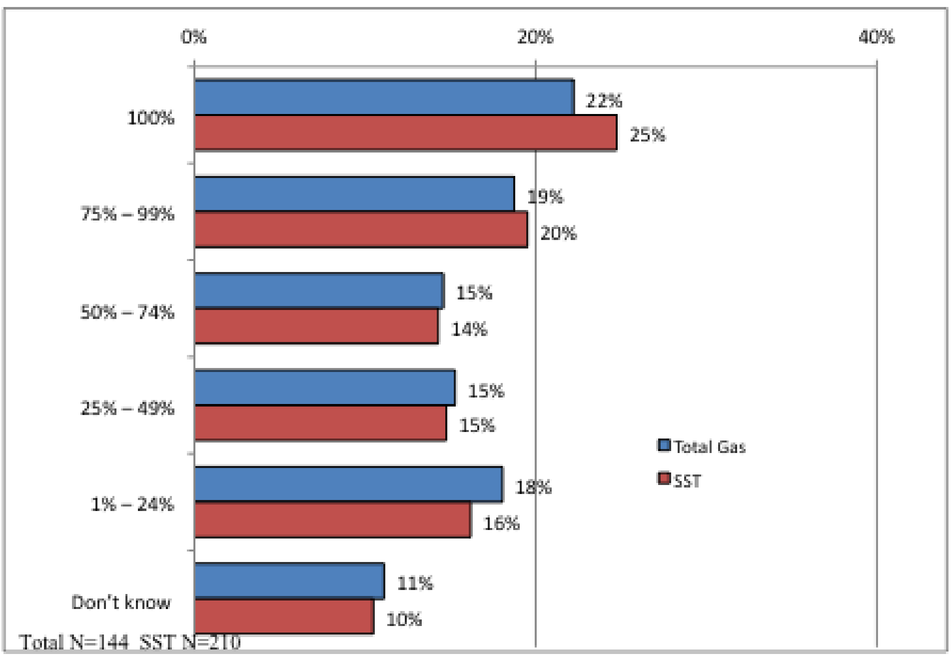
The area controlled by each method is essentially similar between the two organization types.

### *M6. Have any of the indoor lighting fixtures been upgraded in the past 5 years?*

| | | Total Gas | SST |
|---|---|---|---|
| M6. Have any of the indoor lighting fixtures been upgraded in the past 5 years? | Total | 290 | 431 |
| | | 885 | 475 |
| | | 595 | 44 |
| | | 290 | 431 |
| | Yes | 41.7% | 42.0% |
| | No | 50.0% | 50.8% |
| | Don't Know | 8.3% | 7.2% |

2/5 of all indoor lighting fixtures have been upgraded in the past five years by the *total* and *shared service territory* organizations.

### *M7. What percentage of the indoor lighting fixtures have been upgraded during this time?*




When fixtures have been upgraded, almost 1/4 of all light fixtures have received upgrading treatment by both *total* and *shared service territory* organizations.

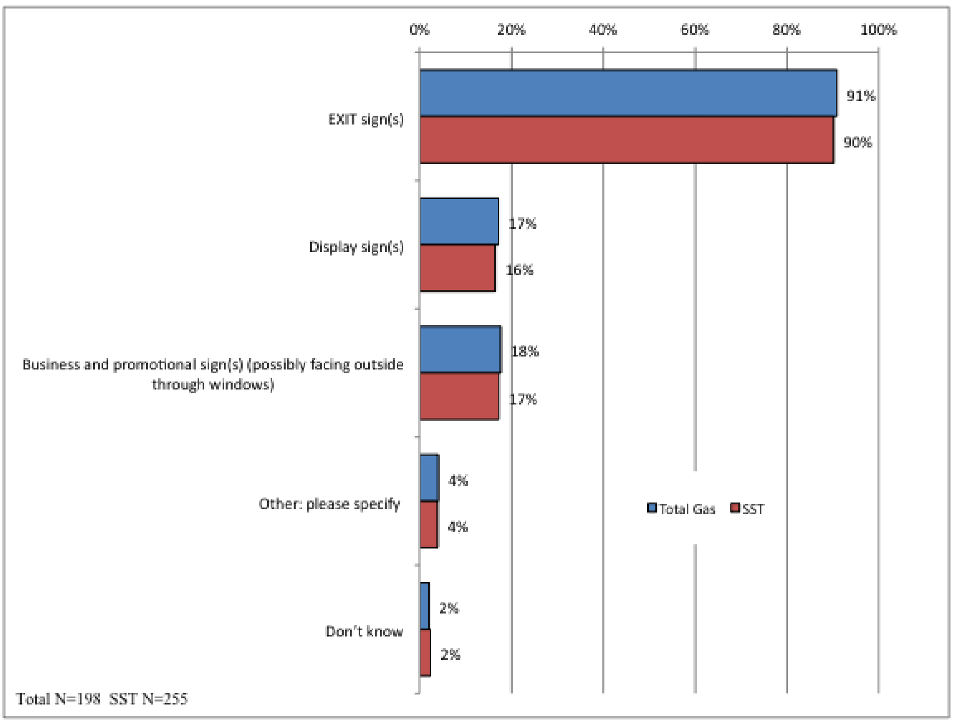
## N. Lit Indoor and Outdoor Signage

### *N1. What percentage of your organization's indoor floor space is illuminated?*

| | | Total Gas | SST |
|---|---|---|---|
| N1. Is there any lit indoor signage, including lit EXIT signs, at the address served by this electrical account? | Yes | 63.0% | 53.2% |
| | No | 36.0% | 45.7% |
| | Don't Know | 1.0% | 1.1% |

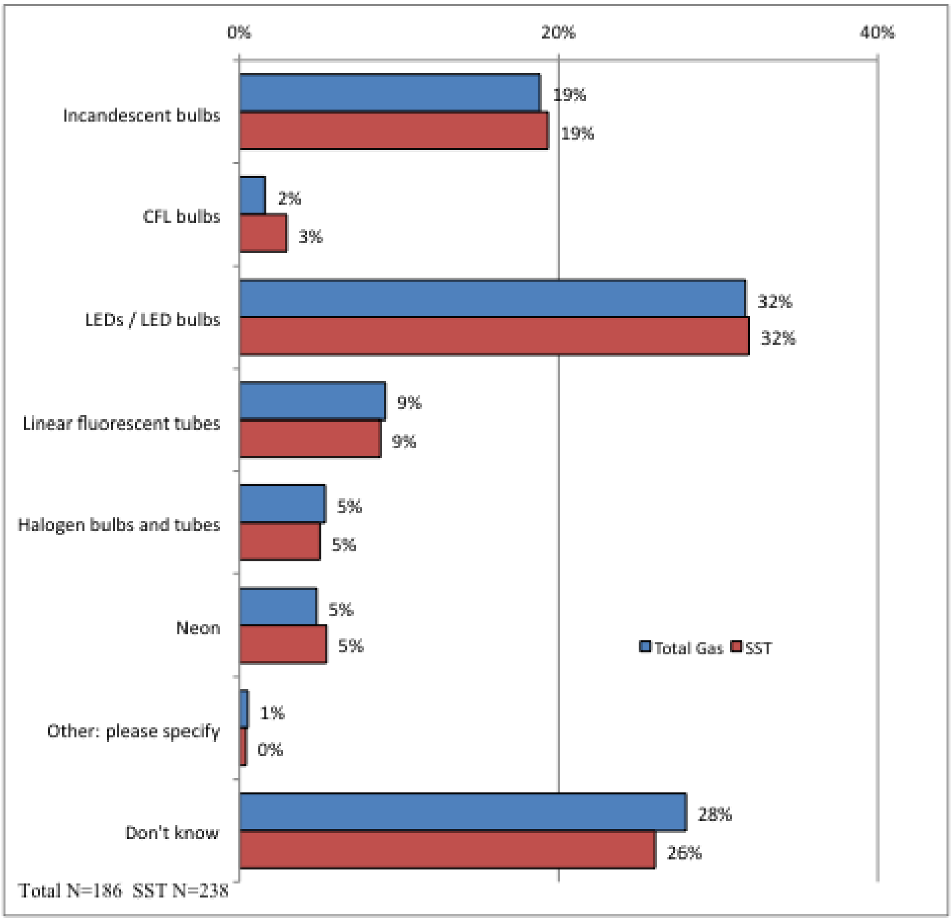
More *total* organizations have indoor signage than their *shared service territory* counterparts.

### *N2. What type of indoor signage is it?*




Indoor signage is dominated by EXIT signs for both *total* and *shared service territory*.

## *N3. What type of lighting is used in most of these indoor signs?*



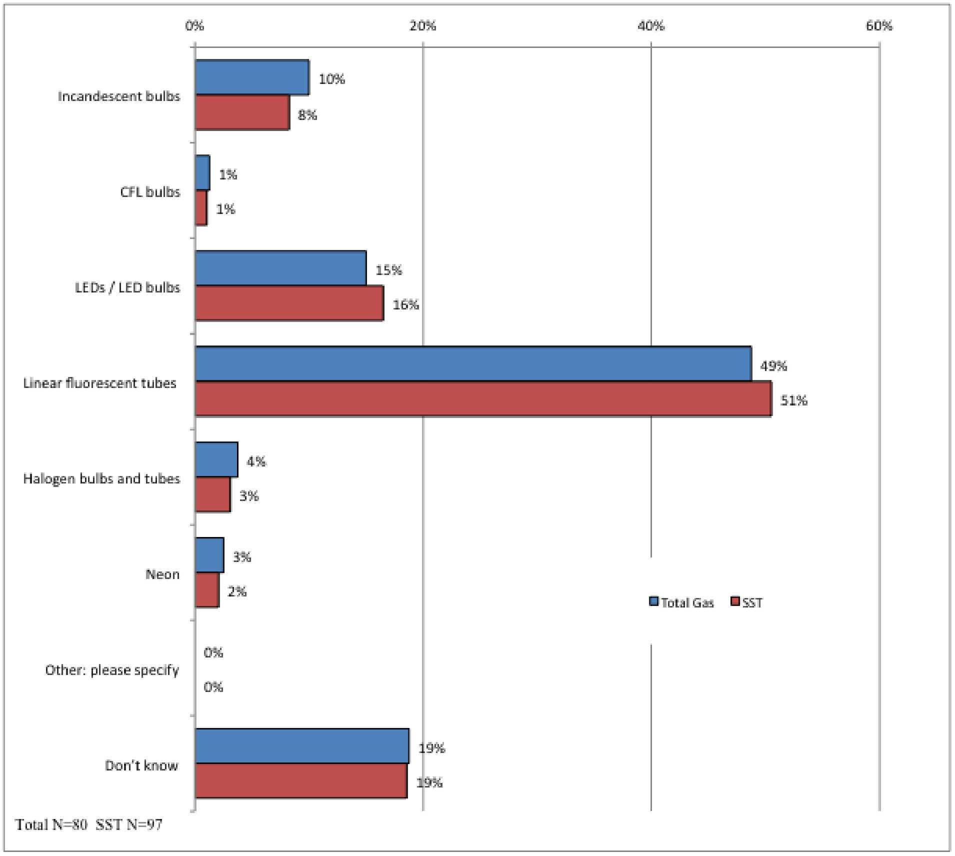

LED bulbs are the most frequently used for indoor signage, followed by incandescent bulbs.

## *N4. Is there any lit outdoor signage at this address that is served by this electrical account?*

| | | Total Gas | SST |
|---|---|---|---|
| N4. Is there any lit outdoor signage at this address that is served by this electrical account? | Yes, there is lit outdoor signage | 38.5% | 35.0% |
| | No | 60.5% | 63.8% |
| | Don't know | 1.0% | 1.2% |

Over 1/3 of both *total* and *shared service territory* organizations have outdoor signage powered through their electrical account.

## *N5. What type of lighting is used in these outdoor signs?*




Outdoor lighting is illuminated using linear fluorescent bulbs by 50% of both *total* and *shared service territory* organizations.

## O. Computers and Office Equipment

***O1. Is there any electric office equipment – such as computers, photocopiers and printers – used by the organization at this address?***

| | | Total Gas | SST |
|---|---|---|---|
| O1. Is there any electric office equipment – such as computers, photocopiers and printers – used by the organization at this address? | Yes, there is electric office equipment | 87.5% | 79.5% |
| | No | 12.2% | 20.1% |
| | Don't know | .3% | .4% |

Almost 90% of *total* responding organizations have electric office equipment compared to 80% of *shared service territory* premises.

***For each type of office equipment in the table below, please indicate whether or not the organization at this address has at least one.***

| | | Total Gas | SST |
|---|---|---|---|
| Desktop computer | Yes | 89.9% | 88.6% |
| | No | 10.1% | 10.8% |
| | Don't know | .0% | .6% |
| Laptop computer | Yes | 70.2% | 69.5% |
| | No | 27.9% | 28.4% |
| | Don't know | 1.9% | 2.1% |
| Tablets | Yes | 34.5% | 32.6% |
| | No | 62.0% | 63.9% |
| | Don't know | 3.5% | 3.5% |
| All-in-one computers (CPU is built into the monitor) | Yes | 20.8% | 19.4% |
| | No | 74.8% | 76.1% |
| | Don't know | 4.4% | 4.5% |
| Flat screen computer monitors | Yes | 82.7% | 81.1% |
| | No | 16.9% | 17.8% |
| | Don't know | .4% | 1.0% |
| Photocopiers (multi-function or single function) | Yes | 82.3% | 79.4% |
| | No | 17.3% | 19.7% |
| | Don't know | .4% | 1.0% |
| Laser printer | Yes | 73.5% | 70.3% |
| | No | 26.5% | 29.0% |
| | Don't know | .0% | .7% |
| Inkjet printer | Yes | 61.9% | 58.6% |
| | No | 36.0% | 38.8% |
| | Don't know | 2.1% | 2.7% |
| Scanner | Yes | 49.7% | 50.0% |
| | No | 49.2% | 48.0% |
| | Don't know | 1.1% | 2.0% |
| Fax machine | Yes | 68.3% | 65.2% |
| | No | 30.2% | 32.6% |
| | Don't know | 1.5% | 2.2% |

***O1. For each type of office equipment in the table below, please indicate whether or not the organization at this address has at least one. (Number of Units)***

| | | Total Gas | SST |
|---|---|---|---|
| Desktop computer (Number of Units) | Mean | 6 | 5 |
| Laptop computer (Number of Units) | Mean | 3 | 3 |
| Tablets (Number of Units) | Mean | 4 | 3 |
| All-in-one computers (CPU is built into the monitor) (Number of Units) | Mean | 2 | 2 |
| Flat screen computer monitors (Number of Units) | Mean | 6 | 6 |
| Photocopiers (multi-function or single function) (Number of Units) | Mean | 1 | 1 |
| Laser printer (Number of Units) | Mean | 2 | 2 |
| Inkjet printer (Number of Units) | Mean | 1 | 1 |
| Scanner (Number of Units) | Mean | 1 | 2 |
| Fax machine (Number of Units) | Mean | 1 | 1 |

Both *total* and *shared service territory* organizations have the same pattern of electric office equipment and the same number of each.

***O2. Are there any computer racks housing central servers, electronic data storage or networking equipment served by your electrical account at this address?***

| | | Total Gas | SST |
|---|---|---|---|
| O2. Are there any computer racks housing central servers, electronic data storage or networking equipment served by your electrical account at this address? | Yes | 32.4% | 29.1% |
| | No | 62.5% | 65.6% |
| | Don't know | 5.1% | 5.3% |

Approximately 30% of both *total* and *shared service territory* premises have computer racks.

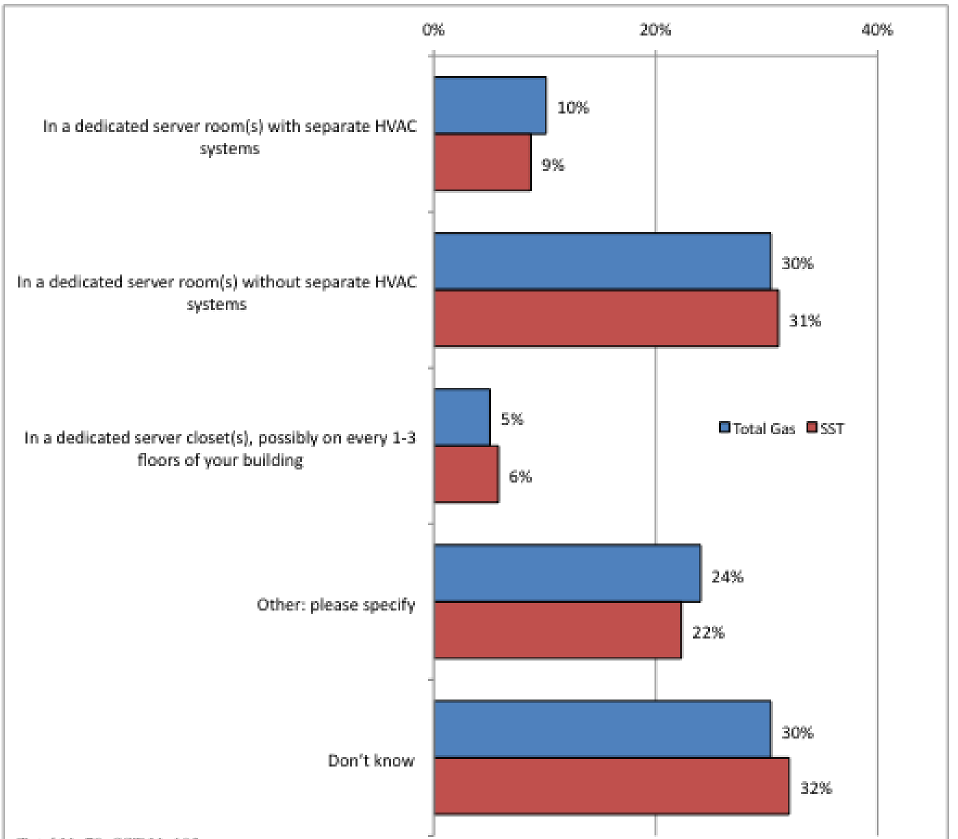
***O3. How many computer racks are there at this address? How many central servers are there? (Computer racks)***

| | | Total Gas | SST |
|---|---|---|---|
| O3. How many computer racks are there at this address? How many central servers are there? (computer racks) | Mean | 1 | 1 |
| Don't know | % | 100.0% | 100.0% |

| | | Total Gas | SST |
|---|---|---|---|
| O3. How many computer racks are there at this address? How many central servers are there? (central servers) | Mean | 1 | 1 |
| Don't know | % | 100.0% | 100.0% |

Both organizational types have the same numbers of computer racks and central servers.

## *O4. Where are the computer racks located?*




Total N=79 SST N=103

Both organizational types are located in similar locations in the facility.

## *P. Other Office and Commercial Equipment*

### *P1. Please indicate whether or not the organization at this address has at least one*

| | | Total Gas | SST |
|---|---|---|---|
| Televisions | Yes | 55.9% | 50.4% |
| | No | 43.3% | 48.3% |
| | Don't know | .8% | 1.3% |
| Audio systems | Yes | 56.7% | 52.8% |
| | No | 42.1% | 45.5% |
| | Don't know | 1.3% | 1.7% |
| Broadcast systems | Yes | 13.0% | 12.3% |
| | No | 85.5% | 86.0% |
| | Don't know | 1.5% | 1.7% |
| Clothes washers (include commercial units) | Yes | 34.4% | 32.9% |
| | No | 64.7% | 65.6% |
| | Don't know | .9% | 1.5% |
| Clothes dryers (include commercial units) | Yes | 32.9% | 31.0% |
| | No | 66.2% | 67.5% |
| | Don't know | .9% | 1.5% |
| Cathode ray tube (CRT) computer monitors | Yes | 1.6% | 2.8% |
| | No | 92.7% | 92.7% |
| | Don't know | 5.7% | 4.5% |
| Dishwashers (include commercial units) | Yes | 41.5% | 38.5% |
| | No | 57.6% | 60.3% |
| | Don't know | .9% | 1.2% |
| Battery chargers – large (golf carts, forklifts etc.) | Yes | 19.9% | 21.9% |
| | No | 78.2% | 75.9% |
| | Don't know | 1.9% | 2.2% |
| Battery chargers – small (cell phones, tablets, drills, etc.) | Yes | 43.8% | 42.8% |
| | No | 54.3% | 55.4% |
| | Don't know | 1.8% | 1.8% |
| Automatic teller machines (ATMs) | Yes | 10.2% | 7.5% |
| | No | 88.8% | 91.1% |
| | Don't know | 1.0% | 1.4% |
| Electronic cash registers | Yes | 29.8% | 27.7% |
| | No | 68.8% | 70.8% |
| | Don't know | 1.4% | 1.5% |
| Unrefrigerated snack dispensers | Yes | 4.7% | 4.5% |
| | No | 93.8% | 93.8% |
| | Don't know | 1.6% | 1.7% |
| Electronic medical devices | Yes | 12.8% | 9.9% |
| | No | 85.6% | 88.4% |
| | Don't know | 1.5% | 1.7% |
| Other electronic devices not unaccounted for in this list | Yes | 17.5% | 19.0% |
| | No | 78.3% | 76.8% |
| | Don't know | 4.2% | 4.2% |

Both *total* and *shared service territory* organizations provide their employees with similar more personal amenities, however slightly higher incidence of such equipment is seen from the *total* sample.

***P1. Please estimate the number of the equipment type (Number of Units).***

| | | Total Gas | SST |
|---|---|---|---|
| Televisions (Number of Units) | Mean | 5 | 5 |
| Audio systems (Number of Units) | Mean | 2 | 2 |
| Broadcast systems (Number of Units) | Mean | 1 | 1 |
| Clothes washers (include commercial units) (Number of Units) | Mean | 2 | 2 |
| Clothes dryers (include commercial units) (Number of Units) | Mean | 1 | 2 |
| Cathode ray tube (CRT) computer monitors (Number of Units) | Mean | 3 | 2 |
| Dishwashers (include commercial units) (Number of Units) | Mean | 1 | 1 |
| Battery chargers – large (golf carts, forklifts etc.) (Number of Units) | Mean | 2 | 2 |
| Battery chargers – small (cell phones, tablets, drills, etc.) (Number of Units) | Mean | 5 | 4 |
| Automatic teller machines (ATMs) (Number of Units) | Mean | 4 | 4 |
| Electronic cash registers (Number of Units) | Mean | 3 | 2 |
| Unrefrigerated snack dispensers (Number of Units) | Mean | 1 | 1 |
| Electronic medical devices (Number of Units) | Mean | 5 | 5 |
| Other electronic devices not unaccounted for in this list (Number of Units) | Mean | 3 | 3 |

There are the same number of more personal equipment units in both *total* and *shared service territory* organizations, except the *shared service territory* segment has more cathode ray tube monitors.

## Q. Elevators and Escalators

### *Q1. Please indicate whether or not there are elevators at this address served by this electrical account.*

| | | Total Gas | SST |
|---|---|---|---|
| Hydraulic Elevators (served by this account) | Yes | 5.2% | 3.7% |
| | No | 94.0% | 95.5% |
| | Don't know | .8% | .8% |
| Traction Elevators (served by this account) | Yes | 1.6% | 1.3% |
| | No | 97.6% | 97.9% |
| | Don't know | .8% | .8% |
| Escalators (served by this account) | Yes | .0% | .0% |
| | No | 99.2% | 99.2% |
| | Don't know | .8% | .8% |

Very few numbers of each type of organization have elevators or escalators

***Please indicate the number in use.***

| | | Total Gas | SST |
|---|---|---|---|
| Hydraulic Elevators (served by this account) (Number of Units) | Mean | 1 | 1 |
| Traction Elevators (served by this account) (Number of Units) | Mean | 1 | 1 |
| Escalators (served by this account) (Number of Units) | Mean | - | - |

Those who do have elevators or escalators, only have one.

## *R. Motor Driven Electrical Processes*

### *R1. Are there any electrical motors used for process activities at this address?*

| | | Total Gas | SST |
|---|---|---|---|
| R1. Are there any electrical motors used for process activities at this address? | Yes | 31.7% | 33.3% |
| | No | 61.6% | 61.1% |
| | Don't know | 6.7% | 5.5% |

Electrical motors are used by 1/3 of both types of organizations for their processing.

### *R2. Please indicate whether or not the organization at this address has at least one electrical motor.*

| | | Total Gas | SST |
|---|---|---|---|
| Compressors | Yes | 68.0% | 68.4% |
| | No | 15.0% | 18.7% |
| | Don't know | 17.0% | 12.9% |
| Fans | Yes | 47.8% | 51.1% |
| | No | 35.6% | 36.0% |
| | Don't know | 16.7% | 12.9% |
| Materials conveyance | Yes | 9.7% | 12.6% |
| | No | 75.8% | 76.8% |
| | Don't know | 14.5% | 10.5% |
| Process equipment | Yes | 31.0% | 34.3% |
| | No | 54.9% | 55.6% |
| | Don't know | 14.1% | 10.2% |
| Pumps | Yes | 35.5% | 45.7% |
| | No | 51.3% | 44.9% |
| | Don't know | 13.2% | 9.4% |
| Refrigeration | Yes | 33.3% | 34.2% |
| | No | 48.7% | 52.1% |
| | Don't know | 17.9% | 13.7% |

The *shared service territory* organizations are more likely to use electric motors for materials conveyance and to power pumps.

***Total number of motors used for this purpose***

| | | Total Gas | SST |
|---|---|---|---|
| Compressors (Total Number of Motors used for this purpose) | Mean | 2 | 2 |
| Fans (Total Number of Motors used for this purpose) | Mean | 5 | 5 |
| Materials conveyance (Total Number of Motors used for this purpose) | Mean | 1 | 1 |
| Process equipment (Total Number of Motors used for this purpose) | Mean | 5 | 4 |
| Pumps (Total Number of Motors used for this purpose) | Mean | 3 | 2 |
| Refrigeration (Total Number of Motors used for this purpose) | Mean | 4 | 4 |

The number of motors used for each of these purposes is essentially similar for each organization type.

***Total horsepower of motors used for this purpose***

| | | Total Gas | SST |
|---|---|---|---|
| Compressors (Total Number of Motors used for this purpose) | Mean | 2.2 | 1.9 |
| Fans (Total Horsepower of Motors used for this purpose) | Mean | 16.8 | 11.5 |
| Materials conveyance (Total Horsepower of Motors used for this purpose) | Mean | 5.4 | 4.5 |
| Process equipment (Total Horsepower of Motors used for this purpose) | Mean | 32.9 | 24.7 |
| Pumps (Total Horsepower of Motors used for this purpose) | Mean | 2815.0 | 1284.4 |
| Refrigeration (Total Horsepower of Motors used for this purpose) | Mean | 8.9 | 5.4 |

*Total* organizations have higher horsepower needs for all their equipment, especially pumps, fans, and process equipment.

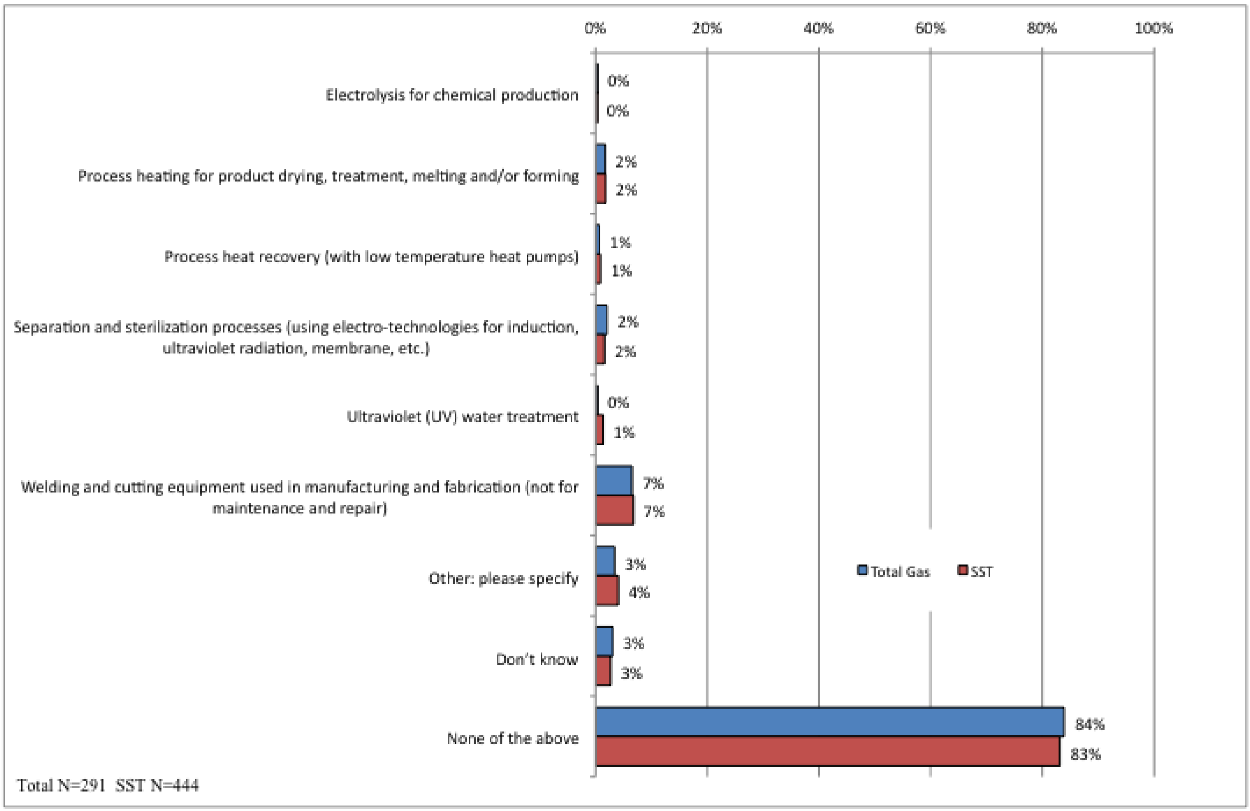
## *R3. Does the organization at this address have any regeneration equipment whereby motors generate electricity when they are braking or decelerating?*

| | | Total Gas | SST |
|---|---|---|---|
| R3. Does the organization at this address have any regeneration equipment whereby motors generate electricity when they are braking or decelerating? | Yes | 3.2% | 3.0% |
| | No | 89.5% | 89.6% |
| | Don’t know | 7.3% | 7.5% |

Regeneration equipment is installed in 3% of both *total* and *shared service territory* organizations.

## *S. Other Electrical Processes*

### *S1. Does the organization at this address use electricity for any of the following non-motor driven electrical processes?*




Electricity is not used frequently for many of these processes by either *total* or *shared service territory* organizations; welding having the highest application.

## T. Electric Vehicles

### *T1. Does the organization at this address own any pure electric vehicles that can be plugged in for charging?*

| | | Total Gas | SST |
|---|---|---|---|
| Electric cars | Yes | .0% | .0% |
| | No | 98.4% | 98.7% |
| | Don't know | 1.6% | 1.3% |
| Electric forklifts | Yes | 3.9% | 3.8% |
| | No | 94.9% | 95.2% |
| | Don't know | 1.2% | 1.0% |
| Other (Please specify): | Yes | .5% | 2.0% |
| | No | 98.2% | 96.6% |
| | Don't know | 1.4% | 1.4% |

Neither organization type; *total* or *shared service territory* has electric cars and few have electric forklifts or other vehicles.

***Total number of vehicles:***

| | | Total Gas | SST |
|---|---|---|---|
| Electric cars (Total Number of Vehicles) | Mean | - | - |
| Electric forklifts (Total Number of Vehicles) | Mean | 1 | 1 |
| Other (Please specify): (Total Number of Vehicles) | Mean | 1 | 4 |

### *T2. Does this building have parking with electrical outlets in most or all the stalls?*

| | | Total Gas | SST |
|---|---|---|---|
| T2. Does this building have parking with electrical outlets in most or all the stalls? | Yes | 5.8% | 4.3% |
| | No | 94.2% | 94.6% |
| | Don't know | .0% | 1.1% |

Plug-ins are not provided for employee vehicles by the majority of both organization types.

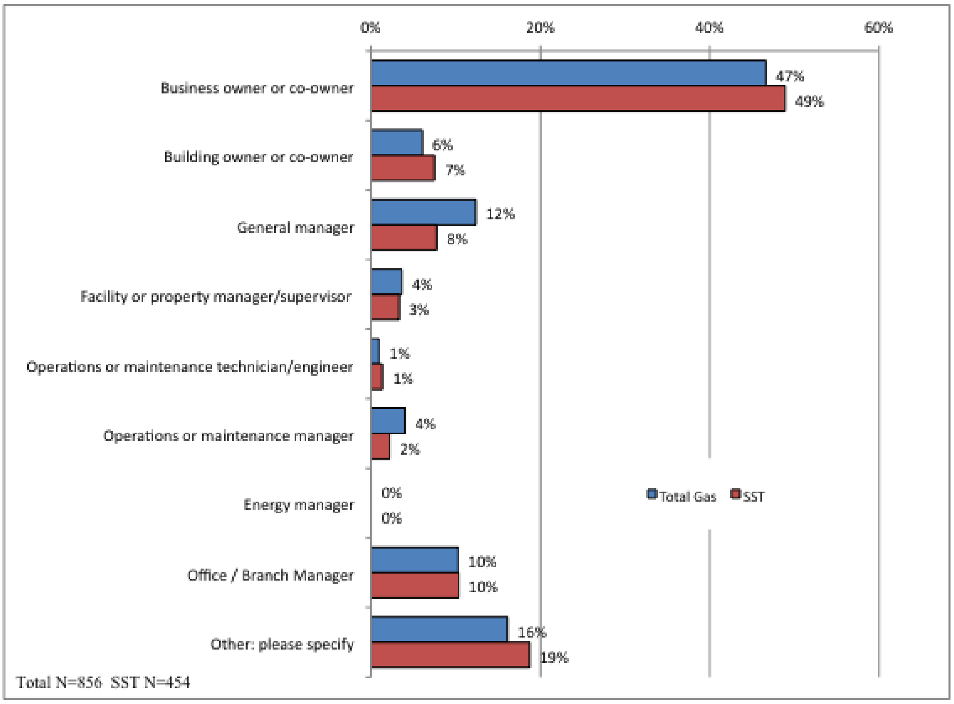
***T3. During the winter, how many hours per day are the electrical outlets in parking stalls turned on?***

| | | Total Gas | SST |
|---|---|---|---|
| T3. During the winter, how many hours per day are the electrical outlets in parking stalls turned on? | Mean | 1 | 1 |
| | Don't know | 100.0% | 100.0% |

The electrical outlets for parking stalls are not turned on very long, averaging 1 hour per day.

# U. About You

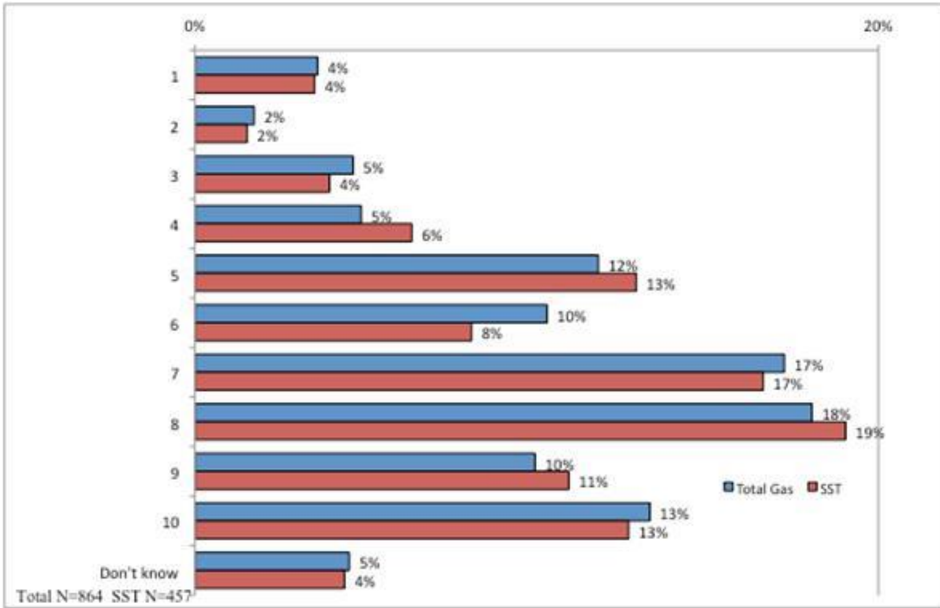
***U1. Which of the following best describes your position or title within the organization?***




The respondent in both organizational types had similar positions, although a few more general managers did respond from the *total* segment.

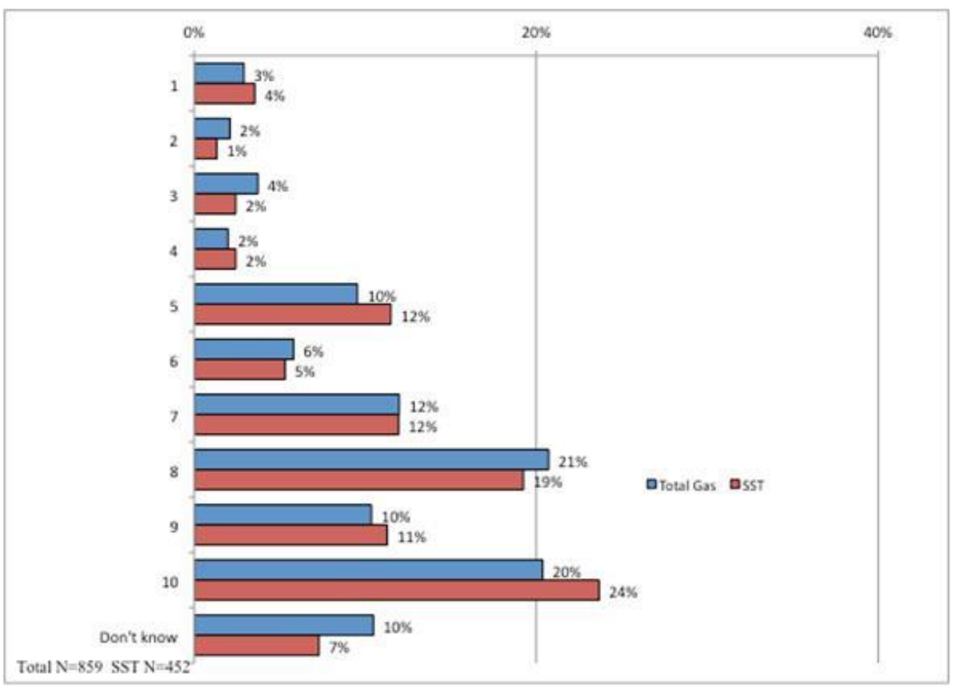
# *V. Attitudes Towards Energy Efficiency and Conservation*

***V1. How proactive are the owners in their maintenance and upkeep of the building?***



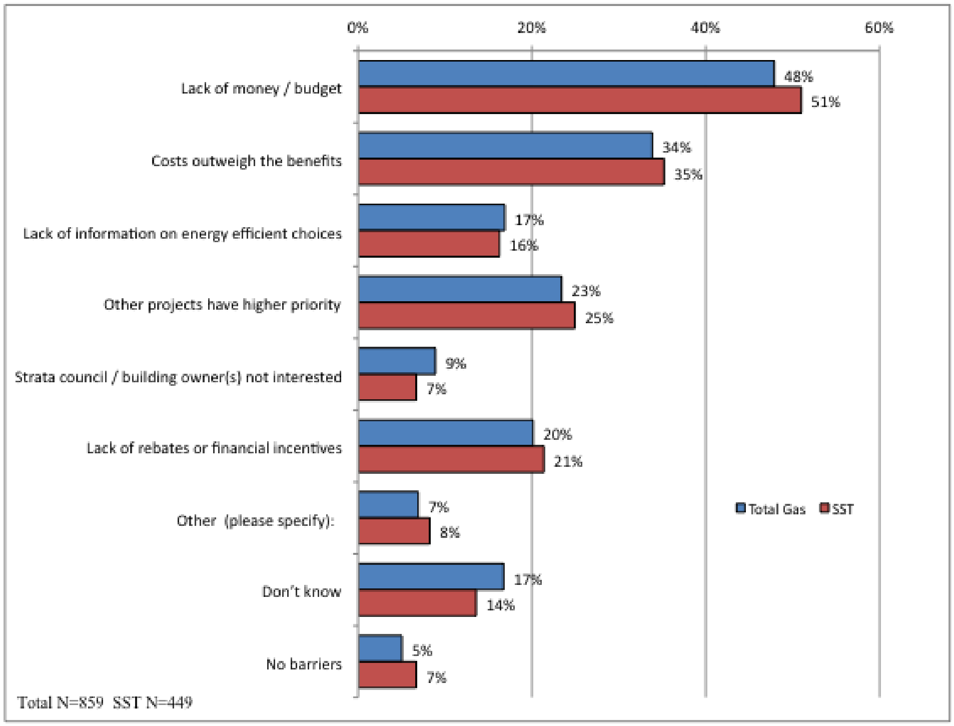

The median rating for ownership's attention to building upkeep was identical at 6.8 out of 10.

***V2. How important is energy efficiency to the owners of this building when making upgrades or improvements to this building?***




Both *total* and *shared service territory* respondents rated the importance of energy efficiency to the company owners at 7.6/10.

### *V3. What are the main barriers to making energy efficient upgrades to this building?*




There is general agreement between the *total* and *shared service territory* respondents that budget and lack of payment are the main two barriers to making energy efficient upgrades.

# British Columbia Conservation Potential Review

**Prepared for:**

**FortisBC Energy Inc.**

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## DISCLAIMER

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# EXECUTIVE SUMMARY

FortisBC Energy Inc. (FortisBC Gas) and the other BC Utilities engaged Navigant Consulting, Inc. (Navigant or the team) to prepare a conservation potential review (CPR) for electricity and natural gas across all of British Columbia over a 20-year forecast horizon from 2016 to 2035. The CPR's objective is to assess the energy efficiency potential in the residential, commercial, and industrial sectors by analyzing energy efficiency and peak-load-reduction measures, defining operational and maintenance activities to keep existing devices or equipment in good working order, and improving end-user behaviors to reduce energy consumption. These analysis efforts provide input data to Navigant's Demand Side Management Simulator (DSMSim™) model, which calculates technical and economic savings potential across FortisBC Gas's service territory. FortisBC Gas may use these results as input to their own DSM planning and long term conservation goals, energy efficiency program design, integrated resource planning (IRP), and load forecasting models.

The first stage of this CPR is to estimate technical and economic conservation potential, which is presented in this report. Further analyses, which will be presented in ensuing reports as part of the CPR's Additional Scope Services, include estimation of the province-wide technical and economic potential for electricity and natural gas, achievable market potential for gas savings and potential from fuel switching.

## Approach

This section provides an overview of the methods Navigant employed for conducting the 2016 CPR for British Columbia.

### *Base Year and Reference Case Forecast*

Navigant developed the Base Year (2014) Calibration (base year) based on an assessment of energy consumption in each utility's service territory, by customer sector and segment, end-use, fuel, and types of equipment used. The objective of the base year is to establish a profile of energy consumption by utility, which is consistent with the total energy consumption (gas and electricity) reported by each utility. The team used the base year as the foundation to develop the Reference Case Forecast of energy demand through 2035.

The Reference Case Forecast estimates the expected level of energy demand over the CPR period from 2016-2035 absent incremental demand-side management (DSM) activities and absent rate impacts on consumption. The significance of the Reference Case in the context of this CPR study is that it acts as the point of comparison (i.e., the reference) for the calculation of the technical and economic potential scenarios.

The Reference Case Forecast uses the base year calibration as the foundation for analysis. Navigant used two key inputs to construct the Reference Case forecast for each customer sector: building stock growth rates, and end-use intensity (EUI) trends. Applying building stock growth rates to the base year stocks of each customer segment results in a forecast of stocks through 2035. Similarly, applying the EUI trends to the base year EUIs results in a forecast of EUIs through 2035. The final step of this process involves multiplying the stock forecast with the corresponding EUI forecast in order to obtain a consumption forecast.

To construct the Reference Case Forecast, Navigant developed growth projections of residential building stock, commercial floor area, and industrial energy consumption. The team then modeled the potential for energy efficiency based on the resulting stock projections of each sector, while accounting for the changing mix of newly constructed versus existing building stock. The team applied EUI trends to the Base Year EUIs for each customer segment, and used these trends to represent natural change (i.e., naturally occurring increases or reductions in consumption not attributable to DSM programs) in end-use consumption over time.

Navigant compared the forecasts developed as part of the Reference Case for the residential, commercial, and industrial sectors with the long-term load forecast developed by each utility. The team performed this comparison to ensure that the Reference Case forecast is consistent with each utility's current expectations for load growth over the 2015 to 2035 period.

### *Measure Characterization*

Navigant fully characterized over 200 measures across the BC Utility's residential, commercial, and industrial sectors, covering electric and natural gas fuel types. The team prioritized measures with high impact, data availability, and likelihood to be cost-effective as criteria for inclusion into DSMSim™.

The team reviewed current BC program offerings, previous CPR and other Canadian programs, and potential model measure lists from other jurisdictions to identify which energy efficient measures to include in the study. The team supplemented the measure list using the Pennsylvania, Illinois, Mid-Atlantic, and Massachusetts technical resource manuals (TRMs), and partnered with CLEAResult to inform the list of industrial measures. Navigant worked with the BC Utilities to finalize the measure list and ensure it contained technologies viable for future BC program planning activities. Appendix A.2 provides the references to the final measure list and assumptions.

### *Estimation of Potential*

Navigant employed its proprietary DSMSim™ potential model to estimate the technical and economic savings potential for gas energy in FortisBC Gas's service territory.[1] DSMSim™ is a bottom-up technology diffusion and stock-tracking model implemented using a System Dynamics[2] framework. The DSMSim™ model explicitly accounts for different types of efficient measures such as retrofit (RET), replace-on-burnout (ROB), and new construction (NEW) and the impacts these measures have on savings potential. The model then reports the technical and economic potential savings in aggregate by service territory, sector, customer segment, end-use category, and highest-impact measures.

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or "burned out") and is in need of being replaced. Technically feasible measures are commercially available measures that are compatible with and may replace the existing baseline technology. Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening, in this case the TRC test. Similar to technical potential, economic potential does not represent an achievable level of savings potential because it does not account for market adoption and acceptance, desired customer payback period, etc. The estimation of achievable market potential will be completed as part of this CPR's Additional Scope Services.

Savings reported in this study are "gross", rather than "net," meaning they do not include the effects of natural change (as described in Section 2.3.2). The technical potential results section concludes with a comparison of aggregate potential before consideration of natural change and after including natural change. Providing gross potential is advantageous because it permits a reviewer to more easily calculate net potential when new information about net-to-gross ratios or changing end-use intensities become available.

## Findings

Figure ES-1 compares the total technical and economic gas energy savings potential in FortisBC Gas's service territories, and Table D-1 of Appendix D provides the associated data. Technical gas savings potential begins at approximately 46,000 TJ/year in 2016 and increases by 26% to 58,000 TJ/year by 2035. Economic gas savings potential grows by 53% from a 2016 value of 29,000 TJ/year to a 2035 value of 44,000 TJ/year. On average across the study period, 71% of technical potential is cost-effective, as reflected by the economic potential.

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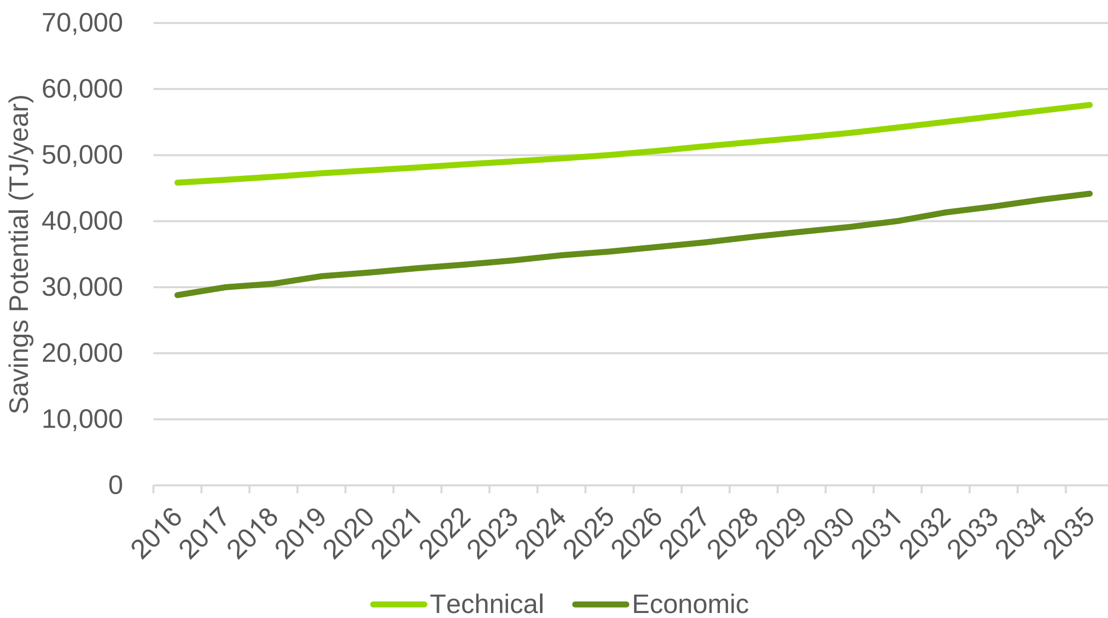
[1] The study also identified the impacts on electric consumption caused by gas measures with either dual-fuel savings or cross-fuel interactive effects. Since the electric impacts are negligible, they are included in Appendix A.1, but not within the body of the report.

[2] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

The residential and commercial sectors' contributions to the growth of technical potential are nearly equal, whereas technical potential from the industrial sector declines slightly over the forecast period. The commercial sector drives the majority of the growth in economic potential.

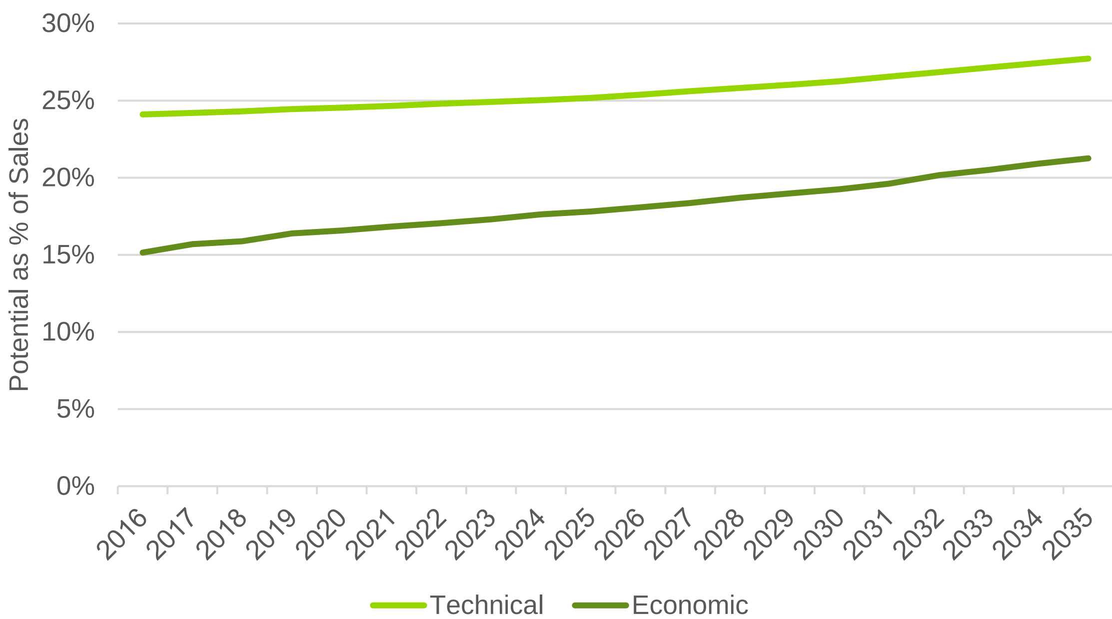
**Figure ES-1. Total Gas Energy Savings Potential (TJ/year)**




*Source: Navigant*

Figure ES-2 provides the technical and economic gas savings potential as a percentage of total gas consumption within the FortisBC Gas's service territories, and Table D-2 of Appendix D provides the associated data. The technical savings potential grows faster than the gas consumption forecast, such that the technical potential as a percentage of total gas consumption increases from 24% in 2016 to 28% by 2035. Economic savings potential increases from 15% in 2016 to 21%.

**Figure ES-2. Total Gas Energy Savings Potential as a Percent of Total Consumption (%)**




*Source: Navigant*

# 1. INTRODUCTION

## 1.1 Conservation Potential Review Background and Goals

The BC Utilities—defined in this report as BC Hydro, FortisBC Inc. (FortisBC Electric), FortisBC Energy Inc. (FortisBC Gas), and Pacific Northern Gas Ltd.—engaged Navigant Consulting, Inc. (Navigant or the team) to prepare a conservation potential review (CPR) for electricity and natural gas across all of British Columbia over a 20-year forecast horizon from 2016 to 2035. The CPR's objective is to assess the energy efficiency potential in the residential, commercial, and industrial sectors by analyzing energy efficiency and peak-load-reduction measures, defining operational and maintenance activities to keep existing devices or equipment in good working order, and improving end-user behaviors to reduce energy consumption. These analysis efforts provide input data to Navigant's Demand Side Management Simulator (DSMSim™) model, which calculates technical and economic savings potential across the BC Utilities' service territories. The BC Utilities may use these results as input to their own DSM planning and long-term conservation goals, energy efficiency program design, integrated resource planning (IRP), and load forecasting models.

## 1.2 Organization of Report

This report is organized as follows:

Section 2 describes the methodologies and approaches Navigant used for estimating energy efficiency and demand reduction potential, including discussion of base year calibration, Reference Case forecast, the frozen end-use intensity case, and measure characterization.

Section 3 offers the technical potential savings forecast for FortisBC Gas, including the methods for estimating technical potential and the modeling results by customer segment and end-use.

Section 4 offers the economic potential savings forecast for FortisBC Gas, including the methods for estimating economic potential and the modeling results by customer segment and end-use.

Accompanying Appendices provide detailed model results and additional context around modeling assumptions.

## 1.3 Caveats and Limitations

There are several caveats and limitations associated with the results of this study, as detailed below.

### *1.3.1 Forecasting Limitations*

Navigant obtained future energy sales forecasts from each BC Utility. Each of these forecasts contain assumptions, methodologies, and exclusions which could differ by utility. Navigant has leveraged the assumptions underlying these forecasts, as much as possible, as inputs into the development of the Reference Case stock and energy demand projections. Where sufficient and detailed information could not be extracted, as a result of the granularity of the information available or customer data protection requirements, Navigant developed independent projections of stock for each utility. The team developed these independent projections based on secondary data resources and in collaboration with the utilities. These secondary resources and any underlying assumptions are referenced throughout this report.

### 1.3.2 Program Design

The results of this study provide a big picture view of the unmet savings potential in each of the BC Utilities’ service territories. However, this study is not considered to be a detailed program design tool, as it does not consider incentive, marketing, advertising and budget levels, nor customers’ willingness to adopt efficient measures. As such, the magnitude of the results should not be interpreted as the savings potential that could be realistically achieved by utility-sponsored energy conservation programs.

### 1.3.3 Measure Characterization

Efficiency potential studies may employ a variety of primary data collection techniques (e.g., customer surveys, on-site equipment saturation studies, and telephone interviews), which can enhance the accuracy of the results, though not without associated cost and time requirements. The scope of this study did not include primary data collection, but rather relied on data from the BC Utilities, other regional efficiency programs, Natural Resources Canada (NRCan), and technical reference manuals (TRMs) from Pennsylvania, Illinois, Mid-Atlantic, and Massachusetts to inform inputs to DSMSim™.

Furthermore, the team considers the measure list used in this study to appropriately focus on those technologies likely to have the highest impact on savings potential over the potential study horizon. However, there is always the possibility that emerging technologies may arise that could increase savings opportunities over the forecast horizon, and broader societal changes may impact levels of energy use in ways not anticipated in the study.

### 1.3.4 Measure Interactions

This study models energy efficiency measures independently .[3] As a result, the total aggregated energy efficiency potential estimates may be different from the actual potential available if a customer installs multiple measures in their home or business. Multiple measure installations at a single site generate two types of interactions: within-end-use interactions, and cross-end-use interactions. An example of a within-end-use interaction is when a customer implements an operational program to review and maintain steam traps, but also installs a more efficient boiler. To the extent that the steam trap program reduces heating requirements at the boiler, the savings from the efficient boiler would be reduced. An example of a cross-end-use interaction would be when a homeowner replaces a number of heat producing incandescent light bulbs with efficient LEDs. This impacts the cooling and heating load of the space—however slightly—by increasing the amount of heat required from the HVAC system, and decreasing the amount of cooling required.

[3] A small number of measures accounted for interactions among multiple efficient measures. For measures whose characterization was based on building energy model simulations evaluating bundled measures, interactive effects among those measures were included in the savings estimates (e.g., ENERGY STAR New Homes, Net-Zero New Homes, etc.).

Navigant employed the following methods to account for interactive effects:

- Where measures clearly compete for the same application (e.g., CFL and LED), the team created competition groups to eliminate the potential for double counting savings
- For measures with significant interactions (e.g., industrial process and boilers), the team adjusted applicability percentages to reflect varying degrees of interaction
- Wherever cross-end-use interactions were appreciable (e.g., lighting and HVAC), the team characterized those interactions for both same-fuel (e.g., lighting and electric heating) and cross-fuel (e.g., lighting and gas heating) applications

B.1 provides further discussion on the challenges involved with accurately determining interactive effects.

### *1.3.5 Measure-Level Results*

This report includes a high-level account of savings potential results across the FortisBC Gas's service territories and focuses largely on aggregated forms of savings potential. However, Appendix A.1 provides results at the finest level of granularity, which is at the measure-level within each customer segment. The measure-level data is mapped to the various regions, customer segments and end-use categories to permit a reviewer to easily create custom aggregations

### *1.3.6 Gross Savings Study*

Navigant and BC Utilities agreed to show savings from this study at the gross level, whereby natural change and free ridership, as it relates to program implementation, are not included in the savings estimates but rather are estimated separately. Providing gross potential is advantageous because it permits a reviewer to more easily calculate net potential when new information about changing end-use intensities or net-to-gross ratios become available. However, the team calculated natural change at end-use level, which is available in Appendix A.1. Additionally, each results section concludes with a comparison of aggregate potential before consideration of natural change and after including natural change.

# 2. APPROACH TO ESTIMATING ENERGY AND DEMAND SAVINGS

This section describes the methodologies Navigant employed for estimating energy and demand savings across the BC Utility's service territories including base year calibration, reference case forecast, the frozen end-use intensity case, and measure characterization.

## 2.1 Base Year Calibration

Navigant developed a Base Year Calibration (base year) based on an assessment of energy consumption in each utility's service territory, by customer sector and segment, end-use, fuel, and types of equipment used. The objective of the base year is to define a detailed profile of energy consumption by utility which matches the total energy consumption (gas and electricity) reported by each utility. The team used the base year as the foundation to develop the Reference Case Forecast of energy consumption through 2035. Section 2.2 discusses the development of the Reference Case.

Navigant developed the Base Year analysis for the province as a whole relying on data provided by the BC Utilities. This report presents data that is specific to FortisBC Gas. The resources provided by FortisBC Gas included the following data sources:

- Historical gas consumption;
- Residential accounts data;
- Residential and Commercial End-Use Surveys;
- Program evaluation reports, conditional demand analyses (CDA); and
- The 2010 and 2006 CPR reports.

Where utility- or FortisBC-specific information was not available, Navigant utilized data from publicly available sources such as BC Statistics (BC Stats), Statistics Canada (StatsCan), and Natural Resources Canada (NRCan) and the Office of Energy Efficiency (OEE) in addition to internal Navigant data sources. Navigant's review of these sources supported the data provided by FortisBC Gas and to ensure consistency among all data used in the study. In order to develop the final estimates of energy consumption, Navigant compared and calibrated preliminary estimates with actual sales data obtained from FortisBC Gas.

Navigant focused the calibration analysis on volumetric energy (e.g., MWh or GJ) consumed in each region by customer segment, end-use, and equipment type in order to develop the base year energy profile for each utility. Navigant chose not to perform calibration based on peak demand (e.g., MW or GJ/hr.) for several reasons. First, each utility reports sales and self-generation amounts at the level of aggregation required for this analysis (e.g., by residential, commercial, and industrial segments) exclusively by volumetric energy. Second, utilities rarely aggregate and report peak demand data (other than for billing purposes) at the level of aggregation required. Third, each utility had readily available (and granular) volumetric energy data.

### *2.1.1 Segmentation of Customer Sectors*

Navigant disaggregated FortisBC Gas's base year gas consumption by region in the province, sector, and customer segment. Navigant worked with the BC utilities to determine an appropriate level of segmentation for each sector and an acceptable geographic representation resulting in four regions consistent with regional definitions used by FortisBC Gas.
Table 2-1 indicates the relationship between the four utilities' service territories and the regions considered in the CPR.

**Table 2-1: Mapping of Utility Service Territories to CPR Regions**

| | Vancouver Island | Lower Mainland | Southern Interior | Northern BC |
|---|---|---|---|---|
| BC Hydro (Electric) | ✓ | ✓ | ✓ | ✓ |
| FortisBC (Electric) | | | ✓ | |
| FortisBC Energy (Gas) | ✓ | ✓ | ✓ | ✓ |
| PNG (Gas) | | | | ✓ |

*Source: Navigant*

The first major task to develop the base year gas calibration involved the disaggregation of the three main sectors—the residential, commercial, and industrial sectors—into specific customer segments. Each sector was segmented according to several factors including the availability and level of detail of the data provided by each utility, supporting information from secondary resources, level of consumption within segments, and consistency with previous CPRs.

The segmentation also reflects Navigant's modeling approach for representing efficiency measures within the DSMSim™ model. DSMSim™ models energy efficiency measures at the segment level, and tracks building and equipment stocks for each segment within each region and utility. Differences in fuel choices (i.e., space and water heating market shares), types of equipment used (i.e., use of a furnace or boiler for space heating), and equipment and system efficiency levels are all represented within the model for each segment, region, and utility, as required.

This modeling approach represents all measures separately within each customer segment, and does not require the duplication of segments using different space heating sources or different industrial processes. For example, the model represents space conditioning measures separately by heating type (e.g., characterizing thermal envelope measures for homes with electric or gas heat), eliminating the need to define a customer segment with electric heat versus a segment with gas heat.

Table 2-2 shows the segmentation used for the residential, commercial, and industrial sectors, with additional detail provided for each sector in the following sections. Although the streetlights/traffic signals segment is included in the commercial sector in Table 2-2, it has been analyzed and referenced separately throughout this report.

**Table 2-2: Customer Segments by Sector**

| Residential | Commercial | Industrial |
|---|---|---|
| Single Family Detached | Accommodation | Agriculture |
| Single Family Attached/Row | Colleges/Universities | Cement |
| Apartments =< 4 stories | Food Service | Chemical |
| Apartments > 4 stories | Hospital | Food & Beverage |
| Other Residential | Logistics/Warehouses | Greenhouses |
| | Long Term Care | Mining - Coal |
| | Office | Mining - Metal |
| | Other Commercial | LNG Facilities |
| | Retail - Food | Oil and Gas |
| | Retail - Non Food | Manufacturing |
| | Schools | Pulp & Paper - Kraft |
| | Streetlights/Traffic Signals* | Pulp & Paper - TMP |
| | | Wood Products |
| | | Other Industrial |
| | | Transportation |

**Although the streetlights/traffic signals segment is included in the Commercial sector, it is only applicable to the electric utilities.*
*Source: Navigant*

#### *2.1.1.1 FortisBC Gas Sales*

FortisBC Gas supplies natural gas to residential, commercial and industrial customers across the four CPR regions. For internal purposes, FortisBC Gas distinguishes the location of its customers based on seven regions - different to the four CPR regions. As a result, to aggregate the FortisBC Gas sales data according to the four CPR regions, Navigant and FortisBC Gas developed a mapping to allocate sales and customer account data based on the seven FortisBC Gas regions and the four CPR regions.

The seven regions used by FortisBC Gas include Columbia, Fort Nelson, Inland, Lower Mainland, Revelstoke, Vancouver Island, and Whistler. Table 2-3 shows the mapping used to allocate sales to each of the CPR regions.

**Table 2-3: Mapping of FortisBC Gas to CPR Regions**

| Code | Region | Vancouver Island | Lower Mainland | Southern Interior | Northern BC |
|---|---|---|---|---|---|
| **COL** | Columbia | | | ✓ | |
| **FTN** | Fort Nelson | | | | ✓ |
| **INL** | Inland | | | ✓ | ✓ |
| **LML** | Lower Mainland | | ✓ | | |
| **RSK** | Revelstoke | | | ✓ | |
| **VI** | Vancouver Island | ✓ | | | |
| **WH** | Whistler | | ✓ | | |

*Source: Navigant analysis of FortisBC Gas data*

A second step was also required in order to allocate FortisBC Gas sales and customers appropriately across customer sectors. This step deals specifically with apartment buildings. In this CPR, apartment buildings have been included in the residential sector. However, for billing purposes, FortisBC Gas includes apartment buildings in the commercial sector.  As a result, a fraction of the commercial sector sales –attributed to apartment buildings- has been re-allocated to the residential sector. The fraction of sales attributed to apartment buildings was calculated as part of the analysis of Base Year sales, and is based on the stock of apartment units and the corresponding EUIs. Overall, relative to the initial allocation of sales the resulting residential sales are higher and the commercial sales are lower.

#### *2.1.1.2 Residential Sector*

Navigant divided residential customers into five segments based on the type of dwelling they occupied, as shown in Table 2-4.

**Table 2-4: Description of Residential Segments**

| Segment | Description |
|---|---|
| **Single Family Detached/Duplexes** | Detached and duplex residential dwellings |
| **Single Family Attached/Row** | Attached, row and/or townhouses |
| **Apartments < 4 stories** | Apartment units located in low-rise apartment buildings made up of four stories or fewer |
| **Apartments >= 4 stories** | Apartment units located in high-rise apartment buildings made up of more than four stories |
| **Other Residential** | Manufactured, mobiles or other types of residential dwellings |

*Source: Navigant*

This segmentation is largely consistent with the dwelling types employed in the FortisBC Gas 2010 CPR, with the following three exceptions:

- **Space heating system** - The 2010 CPR duplicated each residential dwelling type in order to model archetypes for different types of heating (e.g., electrically heated homes vs. gas heated homes). Based on Navigant's modelling approach, it is not necessary to duplicate residential segments to analyze dwelling types using different heating fuels.
- **Dwelling vintage** - The 2010 CPR divided the residential sector according to dwelling vintage (e.g., pre-1976 homes, and post-1976 homes). While Navigant recognizes that this approach is meant to reflect differences in gas consumption as a result of different types of equipment found in older and newer homes, Navigant's segmentation does not require this differentiation. These differences in gas consumption and the types of equipment used by different vintage homes can be, and are, captured in Navigant's *DSMSim* model.
- **Apartments -** The 2010 CPR included apartment buildings in the commercial sector, and divided them as large and medium apartment buildings to reflect differences in energy consumption that may appear in low and high rise buildings. For the base year and reference case analysis, this

CPR includes apartment buildings in the residential sector. This CPR also divides apartments based on buildings with less than or equal to 4 stories, and buildings with more than 4 stories. [4]

Navigant developed the breakdown of the residential sector into dwelling types based on FortisBC Gas billing data and supported by BC Hydro apartment unit counts. The team also used the same data sources to divide the total stock of each dwelling type by service region, provided in Table 2-5. While apartment buildings are reported in the residential sector for purposes of the base year analysis and the reference case forecast, they are moved to the commercial sector in the technical and economic potential results. Gas savings from apartment buildings are reported in the commercial sector because FortisBC Gas's conservation programs for apartment buildings are categorized as commercial programs.

**Table 2-5: Base Year Housing Stocks (Residential units) – FortisBC Gas**

| Housing Type | Lower Mainland | Southern Interior | Vancouver Island | Northern BC | Total |
|---|---|---|---|---|---|
| Single Family Detached/Duplexes | 475,475 | 170,298 | 89,448 | 45,448 | 780,669 |
| Single Family Attached/Row | 53,890 | 10,417 | 7,109 | 2,550 | 73,965 |
| Apartments < 4 stories | 216,678 | 52,875 | 59,179 | 10,195 | 338,927 |
| Apartments >= 4 stories | 158,724 | 6,853 | 17,195 | 1,007 | 183,779 |
| Other Residential | 10,348 | 8,940 | 2,198 | 2,405 | 23,891 |
| Total | 915,115 | 249,384 | 175,129 | 61,604 | 1,401,231 |
| ***Apartments Excluded*** | | | | | |
| Apartments Total | 375,402 | 59,729 | 76,374 | 11,202 | 522,707 |
| Non-Apartments Total | 539,713 | 189,655 | 98,755 | 50,402 | 878,525 |

*The number of apartment units represents individual apartment suites and not single-meter apartment buildings which FortisBC Gas considers and bills as a single account.*
*Source: Navigant analysis based on data provided by FortisBC Gas and BC Hydro*

#### *2.1.1.3 Commercial Sector*

Navigant divided the BC commercial sector into twelve (12) segments. The last segment listed below, streetlights and traffic signals, is only applicable to electric utilities.

[4] This CPR analyzes apartments units in the residential sector based on several factors. First, apartment buildings are generally characterized through Residential End Use Surveys (REUS) in parallel with non-apartment residential dwellings (e.g., detached and attached) – as is the case for BC Hydro's REUS studies but not FortisBC Gas. Second, end-use equipment – other than centralized systems for space heating, cooling and water heating – can be characterized in a consistent manner across apartments and non-apartment residential dwellings.

**Table 2-6: Description of Commercial Segments**

| Segment | Description |
|---|---|
| **Accommodation** | Short-term lodging including related services such as restaurants and recreational facilities |
| **Colleges/Universities** | Post-secondary education facilities such as colleges, universities and related training centers |
| **Food Service** | Establishments engaged in preparation of meals, snacks and beverages for immediate consumption including restaurants, taverns, and bars. |
| **Hospital** | Diagnostic and medical treatment services such as hospitals and clinics |
| **Logistics/Warehouses** | Warehousing/storage facilities for general merchandise, refrigerated goods, and other wholesale distribution |
| **Long Term Care** | Residential care, nursing, or other types of long term care |
| **Office** | Administration, clerical services, consulting, professional, or bureaucratic work but not including retail sales. |
| **Other Commercial** | Establishments, not categorized under any other sector, including but not limited to recreational, entertainment and other miscellaneous activities |
| **Retail - Food** | Engaged in retailing general or specialized food and beverage products |
| **Retail - Non Food** | Engaged in retailing services and distribution of merchandise but not including food and beverage products |
| **Schools** | Primary and secondary schools (K to 12) |
| **Streetlights/Traffic Signals** | Roadway lighting and traffic signal loads |

*Source: Navigant*

Navigant selected the commercial segments with the goal that the building types within those segments be reasonably similar in terms of gas and electricity use, operating and mechanical systems, and annual operating hours. This approach allowed for consistency in building characteristics within each segment as required by the measure characterization and modeling processes.

The selection of these commercial segments is similar to those for previous CPRs with the exception that Navigant does not distinguish commercial segments based on the size of facilities (e.g., large vs. medium facilities) as was done in the 2010 CPR. The analysis of gas consumption in the commercial sector is *scaled* based on the stock of commercial floor space in FortisBC Gas's territory. Using this approach, gas consumption is expressed in terms of GJ per square meter (GJ/$m^2$) of floor space. This approach assumes that the GJ/$m^2$ intensity within a commercial segment is constant, and independent of building size.[5] Another distinction, relative to the 2010 CPR, is that for the base year and reference case analysis, apartments units are included the residential sector. However, to report technical and economic savings potential results, apartments are moved to the commercial sector for consistency with the way FortisBC Gas delivers programs.

[5] While this CPR's modelling approach is different to the 2010 CPR, each modelling approaches has its own strengths and weaknesses. For example, the archetype-based approach provides increased visibility into the energy usage patterns of large vs. medium buildings. At the same time, the archetype based approach also introduces the risk of skewing energy consumption within a segment should the archetype analysis be based on a commercial building not representative of a segment-wide average. This potential shortcoming is addressed by Navigant's approach since developing a GJ/m2 intensity attempts to reflect segment-wide consumption patterns.

To determine the base year floor space stock for each commercial segment, Navigant applied the end-use intensities (EUIs) of each segment to the gas sales data provided by FortisBC Gas. Appendix B.3 describes in greater detail the methodology used to estimate the commercial EUIs. Table 2-7 summarizes the resulting floor space estimates developed for each commercial segment.

**Table 2-7: Base Year Commercial Floor Area (million $m^2$) – FortisBC Gas**

| Segment | Lower Mainland | Southern Interior | Vancouver Island | Northern BC | Total |
|---|---|---|---|---|---|
| Accommodation | 2.55 | 1.56 | 0.33 | 0.25 | 4.69 |
| Colleges/Universities | 4.10 | 0.39 | 0.74 | 0.07 | 5.30 |
| Food Service | 2.17 | 0.54 | 0.15 | 0.08 | 2.93 |
| Hospital | 1.56 | 0.64 | 0.05 | 0.10 | 2.35 |
| Logistics/Warehouses | 10.56 | 3.30 | 0.29 | 0.48 | 14.64 |
| Long Term Care | 2.05 | 0.87 | 0.36 | 0.04 | 3.33 |
| Office | 22.06 | 7.08 | 3.84 | 1.24 | 34.22 |
| Other Commercial[6] | - | - | - | - | - |
| Retail - Food | 2.10 | 0.99 | 0.27 | 0.11 | 3.47 |
| Retail - Non Food | 7.34 | 3.08 | 0.65 | 0.48 | 11.55 |
| Schools | 5.81 | 2.03 | 0.53 | 0.35 | 8.71 |
| **Total** | **60.31** | **20.49** | **7.19** | **3.19** | **91.18** |

*Source: Navigant analysis of FortisBC Gas Sales and EUIs*

[6] The Other Commercial segment was distributed across all other commercial segments proportionally. As a result, the Other Commercial segment does not include any floor area. FortisBC Gas directed Navigant to perform this distribution because of the wide variety of commercial building types reflected in the Other Commercial segment.

#### 2.1.1.4 Industrial Sector

Navigant divided the BC industrial sector into 15 segments as shown in Table 2-8.

**Table 2-8: Description of Industrial Segments**

| Segment | Description |
|---|---|
| **Agriculture** | Engaged in growing crops, raising animals, harvesting timber, fish and other animals, including farms, irrigation, ranches, or hatcheries. |
| **Cement** | Cement manufacturers and related operations including asphalt and concrete |
| **Chemical** | Industrial facilities that produce industrial and consumer chemicals including paints, synthetic materials, pesticides, and pharmaceuticals |
| **Food & Beverage** | Food and beverage industrial facilities including breweries, tobacco, meat/dairy and animal food manufacturers |
| **Greenhouses** | Engaged in growing nursery stock and flowers, including greenhouses, and nurseries. |
| **Mining - Coal** | Thermal and metallurgical coal mines |
| **Mining - Metal** | Copper, gold and other metal mines |
| **LNG Facilities** | Natural gas liquids processing facilities |
| **Oil and Gas** | Industries that explore, operate or develop oil and gas resources including the production of petroleum, mining and extraction of shale oil and oil sands. |
| **Manufacturing** | Industrial facilities that engage in light and heavy manufacturing processes including fabricated metal, metal manufacturing, machinery, and textiles. |
| **Pulp & Paper - Kraft** | Pulp and Paper industrial facilities dedicated specifically to the chemical kraft process |
| **Pulp & Paper - TMP** | Pulp and Paper industrial facilities dedicated to the thermo-mechanical pulp (TMP) process |
| **Wood Products** | Industrial facilities that manufacture wood products including lumber, plywood, veneer, boards, panel boards and pellets. |
| **Other Industrial** | Other industrial facilities and related production operations not categorized under any other industrial segment, including construction, contracting services, waste management and municipal water. |
| **Transportation** | Facilities providing transportation of passengers/cargo/resources and support activities related to common modes of transportation including air, rail, water, road, and pipeline. |

*Source: Navigant*

Navigant selected these industrial segments to group industries with similar manufacturing processes, operations, outputs, and patterns of electricity and gas use. Some sectors such as and Pulp & Paper, which contribute significantly to FortisBC Gas energy sales, were further sub-divided into Pulp & Paper - Kraft and Pulp & Paper -TMP. This subdivision allowed differences in processes or patterns of energy use for each segment to be characterized more accurately than if they were combined into one segment. While this approach attempts to better characterize and analyze energy consumption in certain industrial segments, the proposed segmentation is not intended to accurately represent energy consumption at individual industrial facilities. The team also notes that, in general, the industrial sector exhibits much greater diversity regarding energy usage compared to the commercial or residential sectors.

### 2.1.2 End-Use Definitions

The next step in the base year calibration analysis involved the establishment of specific end-uses for each customer sector. This CPR defines end-uses as a specific activity or customer need that requires energy, such as space heating or domestic water heating, without specifying the particular type of equipment used to satisfy that need. There are two industrial end-uses, however, that do not align to this definition and represent specific types of industrial equipment; Boilers and Pumps. These two end-uses were defined as specific industrial equipment to better reflect the nature of energy consumption and to enable the model to capture and analyze savings potential arising from these sources.

Table 2-9 presents the list of end-uses by sector used in the CPR, with end-use definitions provided in Appendix B.1. These end-use categories have significant impact on the base year calibration since Navigant calculated the energy consumption for a given baseline measure based on the gas intensity of the end-use to which that measure is assigned. These end-uses also allow Navigant's model to incorporate changes in electric and gas end-use intensity over time.

**Table 2-9: End-Uses by Sector**

| Residential | Commercial | Industrial |
|---|---|---|
| Appliances | Cooking | Boilers |
| Electronics | HVAC Fans/Pumps | Compressed Air |
| Hot Water | Hot Water | Fans & Blowers |
| Lighting | Lighting | Industrial Process |
| Other | Office Equipment | Lighting |
| Space Cooling | Other | Material Transport |
| Space Heating | Refrigeration | Process Compressors |
| Ventilation | Space Cooling | Process Heating |
| Whole Facility | Space Heating | Product Drying |
| | Whole Facility | Pumps |
| | | Refrigeration |
| | | Space Heating |
| | | Whole Facility |

*Source: Navigant*

### 2.1.3 Fuel Share and Equipment Data

Navigant developed fuel share and equipment data for each end-use based on the segmentations defined in the previous sections. The team followed two approaches, depending on sector, as described below:

- **Residential and Commercial Sectors**

  Navigant developed estimates of the distribution of fuel shares for each end-use and the types of equipment that contribute to energy consumption within each end-use based on available data from prior FortisBC Gas end-use surveys. Navigant analyzed FortisBC Gas's *2012 Residential End-Use Survey* (2012 REUS) and *2015 Commercial End-Use Survey* (2015 CEUS). Navigant's review of these resources was supported by data from BC Hydro's *2014 Residential End-Use Survey* (2014 REUS) and *2015 Commercial End-Use Survey* (2015 CEUS). The team also relied on program evaluation reports, conditional demand analysis (CDA) studies, and monitoring surveys provided by both utilities[7]. Appendix B.2 and Appendix B.3 summarize the fuel shares and equipment shares used for the residential and commercial sectors, respectively.

- **Industrial Sector**

  Navigant subcontracted CLEAResult, who has considerable expertise in the industrial sector in BC, to develop an estimate of the distribution of energy consumption by each end-use for each industrial customer segment. CLEAResult determined these estimates based on a detailed database of industrial equipment such as pumps, fans, blowers, motors, compressed air equipment, etc. This database contains information on equipment types, key equipment characteristics including system efficiency and/or equipment efficiency levels, and equipment market shares. CLEAResult developed this database based on *Power Smart* industrial reviews, industrial energy assessments, equipment inventories, and ongoing audit and market assessment work with BC Hydro and FortisBC.

Appendix B.2 and Appendix B.3 provide the information developed for each sector and the resulting estimates of energy intensity.

### 2.1.4 Calibration Process

This section describes the calibration process Navigant used for the residential, commercial, and industrial sectors.

#### 2.1.4.1 Residential and Commercial Sectors

For the residential and commercial sectors, Navigant developed a base year calibration model to analyze gas consumption at an equipment level, at an end-use level, and at a segment level. The team developed this calibration model to accurately calibrate the estimated gas consumption of each sector to the Fortis Gas sales.

The calibration process began at an equipment level for each of the energy-intensive end-uses—the primary end-uses—and at an end-use level for the less energy-intensive end-uses—the secondary end-uses. Navigant determined the primary end-uses as those that make up more than 15% of gas consumption and for which the availability of equipment data enabled a detailed analysis of equipment data. The calibration model for primary end-uses involved a complete bottom-up buildup of detailed equipment information including various efficiency levels, unit energy consumption (UEC) for each efficiency level, equipment market shares, and fuel types for different equipment. The team extracted these inputs primarily from FortisBC Gas and BC Hydro's REUS and CEUS studies. For the secondary end-uses, calibration focused primarily on analyzing and establishing end-use intensities based on previous CPR studies, CDA reports, and other secondary resources. This process ensured that the segment-level EUIs approximated the sales targets with reasonable precision.

The calibration model used these inputs to aggregate gas consumption by end-uses and by customer segment, and compared the results to the FortisBC Gas sales at the lowest level of disaggregation available. The calibration of the base year was an iterative process to estimate energy consumption from

[7] We note that the BC Utilities provided some data sources on a confidential basis and thus they are not publically available.

the lowest level of granularity (i.e., equipment types) to the sector level. Each calibrated iteration required refining of key variables and inputs such as the market share of equipment types, UECs by equipment, and fuel shares.

Table 2-10 shows an example of the calibration process followed for single family detached/duplexes in the Southern Interior region. The process used to calibrate the estimate of energy use builds on an estimate of the percentage of homes with a particular end-use and fuel type, using a particular type of equipment and efficiency within an end-use. The fuel shares (column B), equipment shares (column E), and an estimated level of energy use for each equipment type (column F) are multiplied to obtain an estimated UEC (column G). In the example below, column G sums the total consumption across all water heating equipment. The team summed the resulting EUCs across end-uses to obtain the segment-level intensity (GJ per year), and then calibrated to match the actual target intensity stemming from FortisBC Gas sales data. Navigant repeated this same process across all residential and commercial segments in each region.

**Table 2-10: Example of Calibration Process (Single Family Detached/Duplexes – Southern Interior)**

| A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|
| End Use | Fuel Share (%) | Equipment | Efficiency | Equipment Share (%) | Annual Energy Use (GJ) | End-Use Weighted Avg. Use (GJ) | Total Uncalibrated Consumption (GJ) | Total Calibrated Consumption (GJ) |
| Space Heating | 85% | … | … | … | … | … | 51.7 | 57.7 |
| Water Heating | 72% | Gas Water Heater Conventnl | n/a | 83% | 17.7 | 12.2 | 12.2 | 13.6 |
| | | Gas Water Heater Condensing | n/a | 13% | 13.7 | | | |
| | | Gas DHW Tankless | n/a | 4% | 10.9 | | | |
| Cooling | 0% | … | … | … | … | … | 0.0 | 0.0 |
| Appliances | 100% | … | | | | | 1.3 | 1.4 |
| Lighting | 0% | … | … | … | … | … | 0.0 | 0.0 |
| Electronics | 0% | … | … | … | … | … | 0.0 | 0.0 |
| Other | 0% | … | … | … | … | … | 2.5 | 2.8 |
| Ventilation | 0% | … | … | … | … | … | 0.0 | 0.0 |
| **Estimated Consumption (GJ per year)** | | | | | | | 67.7 | **75.6** |
| **Target Consumption (GJ per year)** | | - calculated based on Fortis Gas 2014 sales data | | | | | 75.6 | **75.6** |
| | Uncalibrated vs. Target | | | | | | **90%** | **100%** |

*Appliances are assigned a fuel share of 100%. This implies that all gas appliances have a fuel share of 100% gas. Similarly, electric utilities have an appliances fuel share of 100%. The actual penetration of individual gas appliances (e.g., x% of homes have a gas clothes dryer) is represented by the equipment shares column.*
*Source: Navigant*

Navigant developed the calibration process to operate across all of the dimensions of the model as listed below (e.g., energy types, sectors, regions, etc.). The following sections present the key estimates of energy use by end-use, sector, and region. Most inputs to the calibration process, including efficiency levels and shares, equipment types, equipment shares, fuel shares, and EUIs by end-use, segment, and region, are presented in Appendix B.2 for the residential sector and Appendix B.3 for the commercial sector.

**Table 2-11: Base Year Calibration Dimensions (Residential and Commercial Sectors)**

| Element | No. of Dimensions | Dimensions | |
|---|---|---|---|
| **Energy Types** | 2 | **Electricity** | **Natural Gas** |
| **Sectors** | 2 | Residential, Commercial | |
| **Regions** | 4 | Lower Mainland<br>Southern Interior<br>Vancouver Island<br>Northern BC | |
| **Utilities** | 4 | BC Hydro<br>FortisBC Inc. | FortisBC Energy Inc.<br>Pacific Northern Gas |
| **Segments** | 17 | Residential (5), Commercial (12) | |
| **End-Uses** | 17 | Residential (8), Commercial (9) | |
| **Equipment Types** | <5 | Varies by end-use—generally less than five | |
| **Efficiency Levels** | >2 | Generally two for each equipment type | |

*Source: Navigant*

### *2.1.4.2 Industrial Sector*

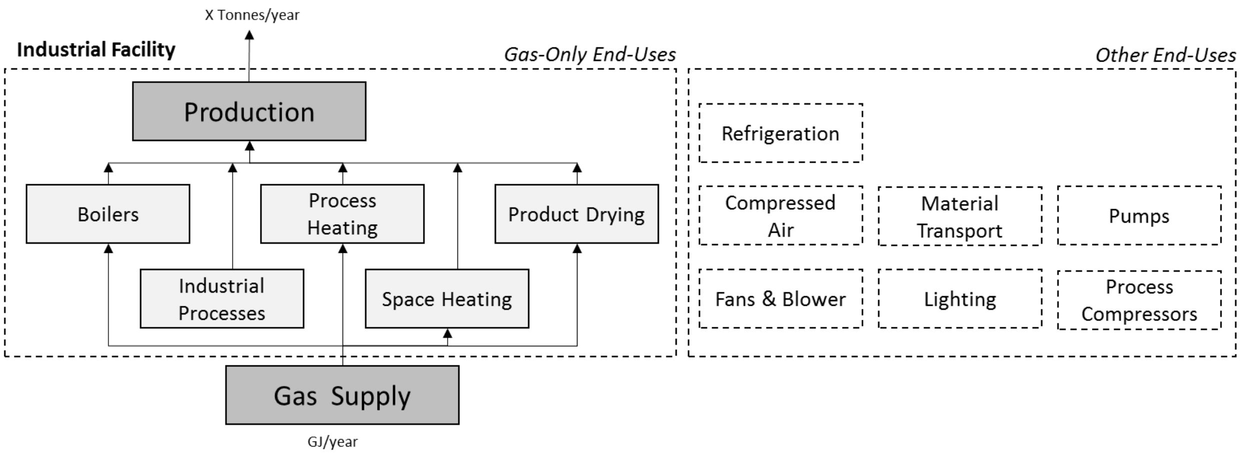
CLEAResult developed estimates of the distribution of energy consumption by end-use for each industrial segment. To calculate the energy consumption by end-use, CLEAResult utilized detailed data on industrial facilities for each of the industrial segments from numerous resources including:

- *BC Hydro* Industrial Electricity Analysis Reviews of industrial customers
- Prior industrial energy assessments performed for BC Hydro and FortisBC
- Detailed energy audits of large industrial facilities in BC
- Inventories of industrial equipment
- CLEAResult professional experience and literature review

Over many years of data collection, CLEAResult has used these resources to build a detailed database of industrial equipment such as pumps, fans, blowers, motors, compressed air equipment, etc. For each equipment type, CLEAResult determined key equipment characteristics including overall system efficiency and/or equipment efficiency levels and equipment market shares, and developed industrial models for BC Hydro and FortisBC. CLEAResult has used these models on a continuous basis to assist BC Hydro and FortisBC with market assessments and DSM program business-case developments. For this CPR, Navigant and CLEAResult aligned the industrial models with up-to-date billing account information broken down into the various industrial segments, and developed end-use allocation factors to estimate the proportion of energy use attributed to each end-use.

CLEAResult's industrial models are broken down into separate sub-models for the major industrial energy end-use categories. Figure 2-1 shows a schematic example of one of these industrial models. As illustrated, a subset of all industrial end-uses are served by natural gas.

**Figure 2-1: Schematic of Industrial Model**




*Source: Navigant schematic of CLEAResult model*

The production occurring in each particular segment drives the models for the major energy use industrial segments. A given amount of production requires a certain amount of electricity or natural gas consumption, and this energy can be broken down into each of the end-uses based on the installed equipment.

This detailed modeling approach is not appropriate for certain diverse segments such as food and beverage, manufacturing, and "other" industrial. These three segments involve such a large variety of processes and equipment types that it is not practical to setup an energy model for them. For these industrial segments, the team used end-use information from over 200 facility audits—sponsored by BC Hydro and FortisBC, and including industry groups such as the *BC Food Processors Association* and *Canadian Manufacturers & Exporters*—to estimate the end-use breakdown of each segment. For each of these audits, CLEAResult developed a breakdown of equipment and energy end-use, which Navigant used to develop the end-use breakdown of the food and beverage, manufacturing, and "other" industrial segments.

Table 2-12 shows the resulting end-use consumption percentages developed by CLEAResult, as a distribution of gas consumption by end-use for each industrial segment.

**Table 2-12: Industrial End-use Allocation Factors (%)**

| Segment | Boilers | Compressed Air | Fans & Blowers | Industrial Process | Lighting | Material Transport | Process Compressors | Process Heating | Product Drying | Space Heating | Pumps | Refrigeration | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture | 50% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 50% | 0% | 0% | **100%** |
| Cement | 4% | 0% | 0% | 0% | 0% | 0% | 0% | 90% | 4% | 2% | 0% | 0% | **100%** |
| Chemical | 48% | 0% | 0% | 0% | 0% | 0% | 0% | 43% | 0% | 9% | 0% | 0% | **100%** |
| Coal Mining | 8% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 89% | 2% | 0% | 0% | **100%** |
| Food & Beverage | 73% | 0% | 0% | 0% | 0% | 0% | 0% | 20% | 0% | 7% | 0% | 0% | **100%** |
| Greenhouses | 75% | 0% | 0% | 0% | 0% | 0% | 0% | 22% | 0% | 3% | 0% | 0% | **100%** |
| LNG Facilities | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | **0%** |
| Manufacturing | 5% | 0% | 0% | 0% | 0% | 0% | 0% | 43% | 21% | 31% | 0% | 0% | **100%** |
| Metal Mining | 8% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 89% | 2% | 0% | 0% | **100%** |
| Oil and Gas | 5% | 0% | 0% | 75% | 0% | 0% | 0% | 10% | 0% | 10% | 0% | 0% | **100%** |
| Pulp & Paper - Kraft | 48% | 0% | 0% | 0% | 0% | 0% | 0% | 38% | 12% | 2% | 0% | 0% | **100%** |
| Pulp & Paper - TMP | 49% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 49% | 2% | 0% | 0% | **100%** |
| Transportation | 40% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 60% | 0% | 0% | **100%** |
| Wood Products | 11% | 0% | 0% | 0% | 0% | 0% | 0% | 5% | 81% | 4% | 0% | 0% | **100%** |
| Other Industrial | 30% | 0% | 0% | 0% | 0% | 0% | 0% | 7% | 13% | 50% | 0% | 0% | **100%** |

*Source: CLEAResult*

The next step of the industrial sector analysis was to determine the total gas consumption by each segment. Navigant worked with FortisBC Gas to determine the total sales in each industrial segment during the base year. Table 2-13 shows the total gas consumption of each industrial segment region in the base year (2014).

**Table 2-13: Base Year Industrial Gas Consumption by Segment (TJ) – FortisBC Gas**

| Segment | All Regions |
|---|---:|
| Agriculture | 1,601 |
| Cement | 908 |
| Chemical | 1,284 |
| Coal Mining | 2,517 |
| Food & Beverage | 4,000 |
| Greenhouses | 5,473 |
| LNG Facilities | - |
| Manufacturing | 5,710 |
| Metal Mining | 10 |
| Oil and Gas | 8,761 |
| Pulp & Paper - Kraft | 14,585 |
| Pulp & Paper - TMP | 3,450 |
| Transportation | 921 |
| Wood Products | 7,567 |
| Other Industrial | 789 |
| **Totals** | **57,577** |

*Source: Navigant analysis of FortisBC Gas data*

The final step of this analysis was the application of the end-use consumption percentages to the gas consumption corresponding to each industrial segment. Table 2-14 shows the resulting distribution of gas consumption by end-use and by industrial segment.

**Table 2-14: Base Year Industrial Gas Consumption by End-use (TJ) – FortisBC Gas**

| Segment | Boilers | Compressed Air | Fans & Blowers | Industrial Process | Lighting | Material Transport | Process Compressors | Process Heating | Product Drying | Space Heating | Pumps | Refrigeration | Total |
|---|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|---:|
| Agriculture | 800 | - | - | - | - | - | - | - | - | 800 | - | - | **1,601** |
| Cement | 36 | - | - | - | - | - | - | 817 | 36 | 18 | - | - | **908** |
| Chemical | 611 | - | - | - | - | - | - | 557 | - | 116 | - | - | **1,284** |
| Coal Mining | 200 | - | - | - | - | - | - | 11 | 2,250 | 56 | - | - | **2,517** |
| Food & Beverage | 2,929 | - | - | - | - | - | - | 794 | - | 278 | - | - | **4,000** |
| Greenhouses | 4,105 | - | - | - | - | - | - | 1,204 | - | 164 | - | - | **5,473** |
| LNG Facilities | - | - | - | - | - | - | - | - | - | - | - | - | **-** |
| Manufacturing | 267 | - | - | - | - | - | - | 2,471 | 1,209 | 1,762 | - | - | **5,710** |
| Metal Mining | 1 | - | - | - | - | - | - | 0 | 9 | 0 | - | - | **10** |
| Oil and Gas | 438 | - | - | 6,571 | - | - | - | 876 | - | 876 | - | - | **8,761** |
| Pulp & Paper - Kraft | 7,001 | - | - | - | - | - | - | 5,542 | 1,750 | 292 | - | - | **14,585** |
| Pulp & Paper - TMP | 1,690 | - | - | - | - | - | - | - | 1,690 | 69 | - | - | **3,450** |
| Transportation | 368 | - | - | - | - | - | - | - | - | 552 | - | - | **921** |
| Wood Products | 799 | - | - | - | - | - | - | 363 | 6,097 | 308 | - | - | **7,567** |
| Other Industrial | 234 | - | - | - | - | - | - | 58 | 104 | 393 | - | - | **789** |
| **Totals -** | **19,480** | **-** | **-** | **6,571** | **-** | **-** | **-** | **12,694** | **13,147** | **5,686** | **-** | **-** | **57,577** |

*Source: Navigant analysis of FortisBC Gas sales data and CLEAResult data*

### 2.1.5 FortisBC Gas Base Year Consumption

Each of the BC utilities provided Navigant with information on actual sales and customer numbers for the base year (2014). Table 2-15 shows FortisBC Gas's total gas consumption by customer sector in 2014 (the "actual consumption").

Note that for the base year and reference case analysis, Navigant included apartment units in the residential sector. However, to report technical and economic savings potential in Section 3 and 4, apartments are included in the commercial sector. For reference, the second half of Table 2-15 shows the breakdown of the residential segment excluding apartment units.

**Table 2-15: Actual Consumption in 2014 (TJ) – FortisBC Gas**

| Segment | Lower Mainland | Southern Interior | Vancouver Island | Northern BC | Total |
|---|---|---|---|---|---|
| Residential | 65,227 | 16,103 | 6,789 | 4,949 | **93,069** |
| Commercial | 25,595 | 9,859 | 2,969 | 2,211 | **40,634** |
| Industrial | 22,019 | 12,281 | 8,587 | 14,690 | **57,577** |
| **Total** | **112,841** | **38,243** | **18,346** | **21,850** | **191,280** |
| | | | | | |
| ***Apartments Excluded*** | | | | | |
| Residential (excl. Apts.) | 49,192 | 13,917 | 5,539 | 4,469 | **73,117** |
| Apartments | 16,035 | 2,186 | 1,251 | 480 | **19,952** |
| Commercial | 25,595 | 9,859 | 2,969 | 2,211 | **40,634** |
| Industrial | 22,019 | 12,281 | 8,587 | 14,690 | **57,577** |
| **Total** | **112,841** | **38,243** | **18,346** | **21,850** | **191,280** |

*Source: Navigant analysis of FortisBC Gas data*

### 2.1.6 Comparison between Base Year and Actual Consumption

Navigant used the calibration process—described in previous sections—along with the actual consumption targets to develop calibrated estimates of gas consumption (the "base year consumption").

Table 2-16 shows the result of the base year calibration by sector and region. This table compares the actual consumption targets (based on FortisBC Gas sales) with the base year consumption (determined through the calibration process). As illustrated by the last column, the base year consumption values developed for the CPR study matches the 2014 actual consumption of each sector and region.

**Table 2-16: 2014 Actual Consumption vs. Base Year Consumption (TJ) – FortisBC Gas**

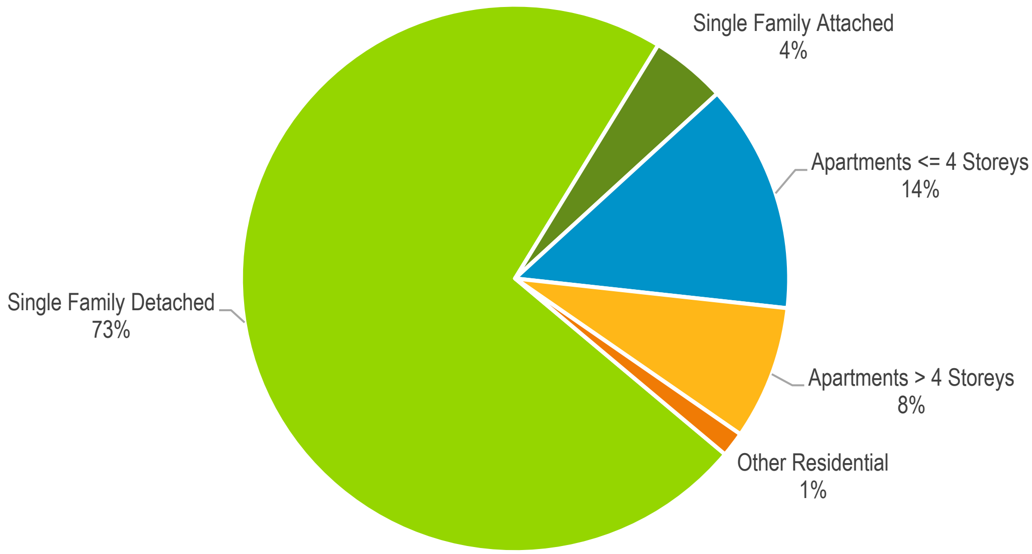
| Region | Sect or | Actual Consumption (TJ) | Base Year (TJ) | Difference (%) |
|---|---|---|---|---|
| Lower Mainland | Residential | 65,227 | 65,227 | 0.0% |
| | Commercial | 25,595 | 25,595 | 0.0% |
| | Industrial | 22,019 | 22,019 | 0.0% |
| Southern Interior | Residential | 16,103 | 16,103 | 0.0% |
| | Commercial | 9,859 | 9,859 | 0.0% |
| | Industrial | 12,281 | 12,281 | 0.0% |
| Vancouver Island | Residential | 6,789 | 6,789 | 0.0% |
| | Commercial | 2,969 | 2,969 | 0.0% |
| | Industrial | 8,587 | 8,587 | 0.0% |
| Northern BC | Residential | 4,949 | 4,949 | 0.0% |
| | Commercial | 2,211 | 2,211 | 0.0% |
| | Industrial | 14,690 | 14,690 | 0.0% |
| **Total** | **Residential** *(includes apartments)* | **93,069** | **93,069** | **0.0%** |
| | **Commercial** | **40,634** | **40,634** | **0.0%** |
| | **Industrial** | **57,577** | **57,577** | **0.0%** |

*Source: Navigant analysis*

As part of the development of the base year, Navigant determined the gas consumption for each segment within the residential, commercial, and industrial sectors. The distribution of gas consumption by segment and end-use for each sector is shown by Figure 2-2 through Figure 2-7, and the tabulated results are shown by Table 2-17 (residential) and Table 2-18 (commercial). The industrial results were shown by Table 2-14 in Section 2.1.4.2.

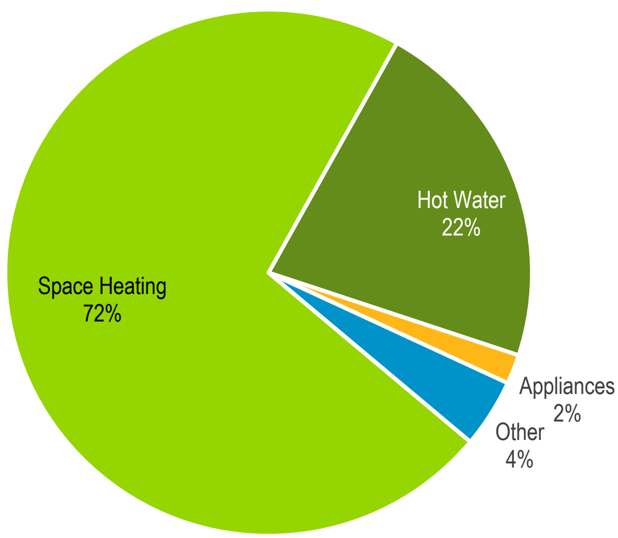
Additional information relating to each segment can be found in Appendix B.2 (for the residential sector), Appendix B.3 (for the commercial sector), and Appendix B.4 (for the industrial sector).

**Figure 2-2: Base Year Residential Consumption by Segment (%)**



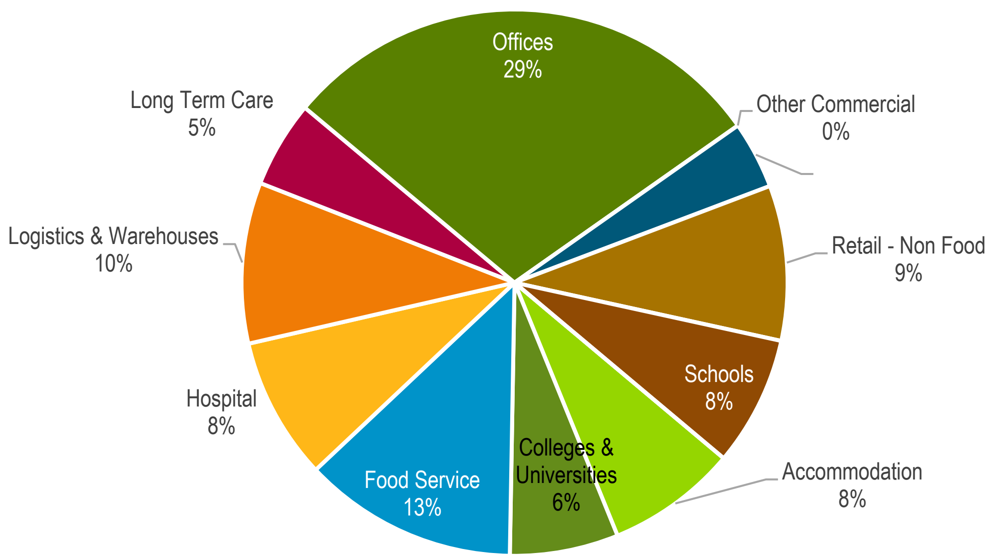

*Source: Navigant analysis*

**Figure 2-3: Base Year Residential Consumption by End-Use (%)**



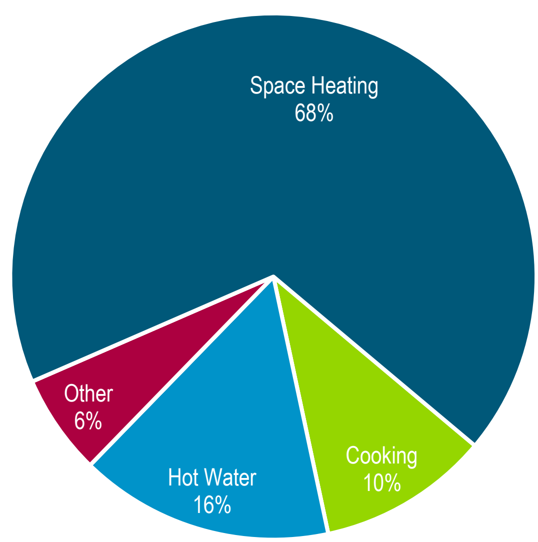

*Source: Navigant analysis*

**Figure 2-4: Base Year Commercial by Segment Consumption (%)**



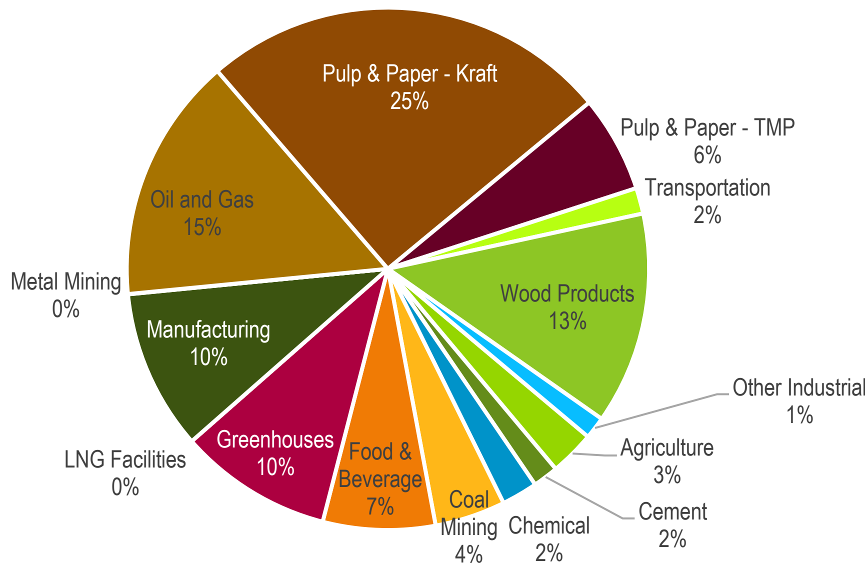

*Source: Navigant analysis*

**Figure 2-5: Base Year Commercial by Segment End-Use (%)**



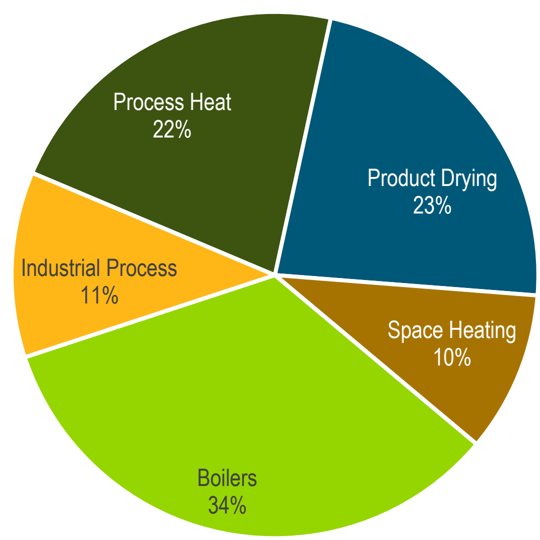

*Source: Navigant analysis*

**Figure 2-6: Base Year Industrial Consumption by Segment (%)**




*Source: Navigant analysis*

**Figure 2-7: Base Year Industrial Consumption by End-Use (%)**




*Source: Navigant analysis*

**Table 2-17: Base Year Residential Consumption by Segment and End-use (TJ) – FortisBC Gas**

| Segment | Space Heating | Hot Water | Space Cooling | Appliances | Lighting | Electronics | Other | Ventilation | Total |
|---|---|---|---|---|---|---|---|---|---|
| Single Family Detached/Duplexes | 53,132 | 11,235 | - | 1,103 | - | - | 2,129 | - | **67,598** |
| Single Family Attached/Row | 3,219 | 770 | - | 63 | - | - | 96 | - | **4,148** |
| Apartments <= 4 stories | 6,026 | 5,214 | - | 314 | - | - | 1,043 | - | **12,597** |
| Apartments > 4 stories | 3,596 | 2,944 | - | 188 | - | - | 628 | - | **7,355** |
| Other Residential | 1,036 | 287 | - | 21 | - | - | 27 | - | **1,370** |
| **Totals -** | **67,009** | **20,449** | **-** | **1,688** | **-** | **-** | **3,923** | **-** | **93,069** |

*Source: Navigant analysis*

**Table 2-18: Base Year Commercial Consumption by Segment and End-use (TJ) – FortisBC Gas**[8]

| Segment | Cooking | NVAC Fans/Pumps | Hot Water | Lighting | Office Equipment | Other | Refrigeration | Space Cooling | Space Hating | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Accommodation | 368 | - | 1,201 | - | - | 262 | - | - | 1,309 | **3,141** |
| Colleges/Universities | 198 | - | 367 | - | - | 346 | - | - | 1,715 | **2,625** |
| Food Service | 2,454 | - | 1,394 | - | - | 55 | - | - | 1,253 | **5,155** |
| Hospital | 153 | - | 644 | - | - | 548 | - | - | 2,083 | **3,428** |
| Logistics/Warehouses | 68 | - | 265 | - | - | 273 | - | - | 3,251 | **3,857** |
| Long Term Care | 186 | - | 517 | - | - | 217 | - | - | 1,170 | **2,091** |
| Office | 319 | - | 1,126 | - | - | 638 | - | - | 9,800 | **11,882** |
| Other Commercial | - | - | - | - | - | - | - | - | - | **-** |
| Retail - Food | 259 | - | 225 | - | - | 65 | - | - | 1,076 | **1,624** |
| Retail - Non Food | 150 | - | 269 | - | - | 75 | - | - | 3,204 | **3,698** |
| Schools | 131 | - | 340 | - | - | 41 | - | - | 2,628 | **3,140** |
| **Totals -** | **4,285** | **-** | **6,348** | **-** | **-** | **2,518** | **-** | **-** | **27,489** | **40,640** |

*Source: Navigant analysis*

[8] Gas sales initially attributed to the *Other Commercial* segment were distributed across all other commercial segments proportionally.

## 2.2 Reference Case Forecast

This section presents the Reference Case for the CPR study period from 2015 to 2035. The Reference Case estimates the expected level of gas consumption over the CPR period, absent incremental demand-side management (DSM) activities or load impacts from conservation rates. Gas consumption levels in the Reference Case are also based on codes and standards previously included in regulation and reflected in each utility's load forecast.[9] The Reference Case is significant in the context of this CPR study because it acts as the point of comparison (i.e., the reference) for the calculation of the technical and economic potential scenarios.

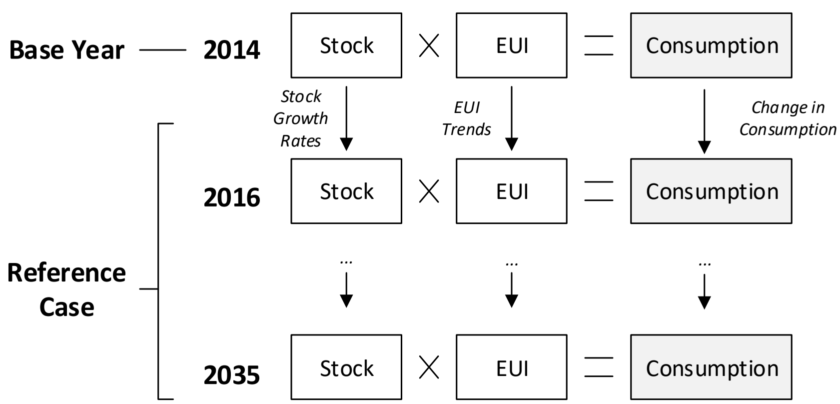
The Reference Case Forecast uses the base year calibration—presented in the previous section—as the foundation for analysis.

Navigant constructed the Reference Case forecast using two different approaches based on sector.

- **Residential and commercial sectors:** For the residential and commercial sectors, Navigant used two key inputs: stock growth rates and EUI trends. Navigant developed stock growth projections of residential accounts and commercial floor area. The team then modeled the potential for energy efficiency based on the resulting stock projections of each customer segment. The team applied EUI trends to the base year EUIs for each customer segment, and used these trends to represent natural change in end-use consumption over time.

  Figure 2-8 illustrates the process used to develop the Reference Case for the residential and commercial sectors. This figure illustrates that applying stock growth rates to the base year stocks of each customer segment results in a forecast of stocks through 2035. Similarly, applying the EUI trends to the base year EUIs results in a forecast of EUIs through 2035. The final step of this process involves multiplying the stock forecast with the corresponding EUI forecast in order to obtain a load forecast.

**Figure 2-8: Schematic of Reference Case Development**




*Source: Navigant*

[9] Each utility's load forecast reflects specific effectiveness dates and performance thresholds for codes and standards previously enshrined in regulation. By extension, recently announced performance targets or codes and standards that are not yet enshrined in regulation –such as the target for net zero new construction included in the BC Climate Leadership Plan– are excluded from the analysis.

- **Industrial sector:** The Reference Case for the Industrial sector assumed frozen EUIs over the Reference Case forecast (e.g., frozen EUIs assume that EUIs do not change and are static over time). A more detailed discussion supporting this assumption is presented in Section 2.2.3.3. Based on the frozen-EUI approach, the Industrial Reference Case was established solely by developing energy demand growth assumptions for each industrial segment.

Navigant compared the forecasts developed for the Reference Case for the residential, commercial, and industrial sectors with the long-term load forecast developed by each utility. This comparison ensured that the Reference Case forecast is consistent with each utility's current expectations for load growth over the 2015 to 2035 period.

### *2.2.1 Approach*

This section introduces the overall process for developing the residential and commercial Reference Case. As noted earlier, the Reference Case approach for the industrial sector differed from the residential and commercial sectors.

Navigant's Reference Case started with the base year estimate of stocks and gas consumption for 2014. Two key inputs were the basis for projected change in gas consumption through the CPR study period:

- Stock growth rates
- Gas EUI trends

To develop the Reference Case for each sector, Navigant first developed the stock growth rates based on the CPR segmentation for each sector and region. The second step established appropriate EUI trends that the team applied to each segment and region. Finally, the team applied these two inputs to the base year estimates of stock and EUIs, and projected the results through 2035 to construct the Reference Case.

Navigant developed the growth rates for stock and the EUI trends based primarily on information provided by FortisBC Gas. Secondary sources supported any gaps in these data.

The following two sections provide detailed descriptions of the approach followed to establish stock growth rates and gas EUI trends for each sector.[10] As noted in previous sections, for the base year and reference case analysis apartment units have been included in the residential sector. As such, the following sections will present stock growth rates and EUI trends for apartment units within the residential sector.

[10] For the industrial sector, the stock growth rate section (Section 2.2.2.3) presents the demand forecast established for each industrial customer segment, and the EUI trends section (Section 2.2.3.3) describes the reasoning for a frozen EUI approach.

### 2.2.2 Stock Growth Rates

This section describes the approach followed to develop stock growth rates for the residential, commercial and industrial sectors.[11]

#### 2.2.2.1 Residential Sector

To develop the residential Reference Case, Navigant first developed and applied growth rates for each residential segment and region over the CPR study period. Navigant established the stock growth rates from household forecasts derived from FortisBC's 2014 Long Term Resource Planning (LTRP) Demand Forecast (as updated)[12]. Based on the residential stock forecasts, average annual growth rates were established for each five-year period in the forecast (e.g., 2015 to 2020, 2021 to 2025, etc.). The team applied these five-year growth rates over the same periods through the end of the CPR study period for each residential segment. A detailed description of the approach used to develop the residential household projections is included in Appendix B.2.

[11] In relation to the natural turnover of commercial floor stock, Navigant's model assumes a stock demolition rate of 0.5% per year for commercial and residential segments and 0% for industrial segments. These demolition rates apply to the existing stock in each year of the analysis. A demolition rate of 0.5% is a conservative assumption used to avoid over-estimation of growth in building stock by recognizing that some new construction is replacing demolished stock and does not add to the total count of building stock. Industrial demolition rates are 0% because industrial facilities are less homogenous than commercial and residential buildings, and the closure of a single plant can represent a significant percentage of a given industrial segment. Given the lack of information about planned closures of industrial facilities, the 0% industrial demolition rate is a more reasonable assumption than representing industrial demolition as a continuous decay of building stock, as is modelled for commercial and residential buildings.

[12] The customer and demand forecast presented in FortisBC Gas's 2014 LTRP was developed from the 2011 year-end actual customer count. A subsequent update was prepared with the only change being the use of the more recent 2012 year-end actual customer count. This update is the most recent long term forecast available and thus has been used in the preparation of the 2016 CPR.

Table 2-19 shows the growth rates employed in the CPR study.

**Table 2-19: Annual Growth Rates by Residential Segment and Region (%) – FortisBC Gas**

| Region | Segment | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2014-2020 | 2021-2025 | 2026-2030 | 2031-2035 |
| **Lower Mainland** | Single Family Detached/Duplexes | 0.4% | 0.2% | 0.3% | 0.3% |
| | Single Family Attached/Row | 0.8% | 0.5% | 0.5% | 0.5% |
| | Apartments =< 4 stories | 0.6% | 0.4% | 0.4% | 0.5% |
| | Apartments > 4 stories | 0.6% | 0.4% | 0.4% | 0.5% |
| | Other Residential | 0.5% | 0.3% | 0.4% | 0.4% |
| **Southern Interior** | Single Family Detached/Duplexes | 0.9% | 0.6% | 0.6% | 0.7% |
| | Single Family Attached/Row | 1.3% | 1.1% | 0.9% | 0.7% |
| | Apartments =< 4 stories | 0.7% | 0.6% | 0.5% | 0.5% |
| | Apartments > 4 stories | 0.7% | 0.6% | 0.5% | 0.5% |
| | Other Residential | 1.6% | 0.9% | 0.9% | 0.8% |
| **Vancouver Island** | Single Family Detached/Duplexes | 0.5% | 0.4% | 0.4% | 0.5% |
| | Single Family Attached/Row | 0.9% | 0.6% | 0.6% | 0.5% |
| | Apartments =< 4 stories | 0.4% | 0.2% | 0.3% | 0.3% |
| | Apartments > 4 stories | 0.4% | 0.2% | 0.3% | 0.3% |
| | Other Residential | 1.0% | 0.5% | 0.6% | 0.8% |
| **Northern Region** | Single Family Detached/Duplexes | 0.5% | 0.3% | 0.3% | 0.4% |
| | Single Family Attached/Row | 0.7% | 0.5% | 0.5% | 0.5% |
| | Apartments =< 4 stories | 0.4% | 0.3% | 0.3% | 0.3% |
| | Apartments > 4 stories | 0.4% | 0.3% | 0.3% | 0.3% |
| | Other Residential | 1.2% | 0.8% | 1.1% | 0.8% |

*Source: Navigant analysis of FortisBC Gas's 2014 LTRP*

Table 2-20 presents the Reference Case forecast of households by segment and region over time. The team initially based the number of residential dwellings presented in Table 2-20 on the base year residential stock determined for 2014, but adjusted these numbers by applying the growth rates presented above in Table 2-19.

**Table 2-20: Number of Residential Dwellings by Segment by Region – FortisBC Gas**

| Region | Segment | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2014 | 2020 | 2025 | 2030 | 2035 |
| Lower Mainland | Single Family Detached/Duplexes | 475,475 | 486,379 | 492,271 | 499,539 | 507,855 |
| | Single Family Attached/Row | 53,890 | 56,388 | 57,682 | 59,107 | 60,645 |
| | Apartments <= 4 stories | 216,678 | 224,205 | 228,772 | 233,693 | 239,023 |
| | Apartments > 4 stories | 158,724 | 164,237 | 167,583 | 171,188 | 175,092 |
| | Other Residential | 10,348 | 10,653 | 10,806 | 10,998 | 11,203 |
| Southern Interior | Single Family Detached/Duplexes | 170,298 | 179,429 | 185,320 | 191,223 | 198,147 |
| | Single Family Attached/Row | 10,417 | 11,282 | 11,916 | 12,474 | 12,933 |
| | Apartments <= 4 stories | 52,875 | 54,993 | 56,591 | 58,010 | 59,346 |
| | Apartments > 4 stories | 6,853 | 7,128 | 7,335 | 7,519 | 7,692 |
| | Other Residential | 8,940 | 9,849 | 10,318 | 10,791 | 11,225 |
| Vancouver Island | Single Family Detached/Duplexes | 89,448 | 92,186 | 93,847 | 95,823 | 98,015 |
| | Single Family Attached/Row | 7,109 | 7,483 | 7,700 | 7,916 | 8,118 |
| | Apartments <= 4 stories | 59,179 | 60,627 | 61,388 | 62,210 | 63,136 |
| | Apartments > 4 stories | 17,195 | 17,616 | 17,837 | 18,076 | 18,345 |
| | Other Residential | 2,198 | 2,336 | 2,395 | 2,473 | 2,577 |
| Northern Region | Single Family Detached/Duplexes | 45,448 | 46,703 | 47,400 | 48,200 | 49,120 |
| | Single Family Attached/Row | 2,550 | 2,652 | 2,713 | 2,779 | 2,853 |
| | Apartments <= 4 stories | 10,195 | 10,436 | 10,584 | 10,724 | 10,896 |
| | Apartments > 4 stories | 1,007 | 1,031 | 1,045 | 1,059 | 1,076 |
| | Other Residential | 2,405 | 2,582 | 2,689 | 2,842 | 2,957 |
| Segment Totals | Single Family Detached/Duplexes | 780,669 | 804,697 | 818,838 | 834,784 | 853,136 |
| | Single Family Attached/Row | 73,965 | 77,804 | 80,011 | 82,276 | 84,549 |
| | Apartments <= 4 stories | 338,927 | 350,261 | 357,334 | 364,637 | 372,401 |
| | Apartments > 4 stories | 183,779 | 190,012 | 193,800 | 197,841 | 202,205 |
| | Other Residential | 23,891 | 25,419 | 26,208 | 27,104 | 27,961 |
| **Total** | | **1,401,231** | **1,448,194** | **1,476,192** | **1,506,641** | **1,540,253** |

*Source: Navigant analysis of Base Year residential stock and FortisBC Gas's 2014 LTRP*

#### *2.2.2.2 Commercial Sector*

To develop the commercial Reference Case, the team first selected floor area as the most appropriate driver for gas consumption in the commercial sector. This section describes the development and application of floor space growth rates for each commercial segment and region over the CPR study period. To develop projections of commercial floor area growth by segment, the team relied on three key resources:

- StatsCan's Labour Force Statistics for British Columbia (*BC Labour Force Statistics*)[13]
- NRCan-Office of Energy Efficiency (OEE) Comprehensive Energy Consumption Database
- FortisBC Gas's 2014 LTRP

The primary resource employed to develop stock growth rates was the BC Labour Force Statistics, which tracks labour force levels for 11 commercial segments and 36 commercial sub-segments across seven economic regions in British Columbia. BC Stats uses these statistics for employment forecasting, which represent the most granular publicly available resource reporting commercial sector trends since 2000. The team relied on these data because both employment levels and floor space can serve as the basis for predicting energy demand.[14]

Navigant calculated the statistical relationship between labour force levels and commercial floor space to determine the appropriateness of using labour as a proxy for floor space. The OEE database tracks commercial floor space in BC disaggregated across 10 commercial segments. Since the OEE reports data at a provincial level and not disaggregated across regions, the team summed employment levels across all regions. The team analyzed floor space and labour force levels for the period between 2000 and 2012 for each OEE commercial segment. Table 2-21 below shows the correlation coefficient corresponding to each segment. Most segments show a strong positive correlation with coefficient values ranging between 0.80 and 0.97.

[13] *CANSIM Labor Force Survey Estimates (LFS) (March 2001 to December 2015)* – Table 282-026

[14] For example, vacant floor space can misrepresent the actual stock of floor space in use. As a result, projections of floor space, which account for vacant floor space, can skew energy demand upwards. In Ontario, the Independent Electricity System Operator (IESO) employs a forecasting approach based on employment levels. The IESO utilizes employment figures as an indicator to forecast electricity demand in the near term (i.e., 18-Month Outlook forecasts) and in the long term (i.e., Long Term Energy Plan). The IESO employs non-manufacturing employment levels to forecast demand in the commercial sector, and manufacturing employment for the industrial sector.

**Table 2-21: Correlation Coefficient (Floor Space vs. Labor Force) – Commercial Sector**

| OEE Commercial Segment | Correlation Coefficient (2000 – 2012) |
|---|---|
| Wholesale Trade | 0.80 |
| Retail Trade | 0.90 |
| Transportation and Warehousing | (0.27) |
| Information and Cultural Industries | (0.62) |
| Offices | 0.80 |
| Educational Services | 0.87 |
| Health Care and Social Assistance | 0.95 |
| Arts, Entertainment and Recreation | 0.83 |
| Accommodation and Food Services | 0.89 |
| Other Services | 0.13 |

*Source: Navigant analysis of OEE and StatsCan data*

Three of the commercial OEE segments - Transportation and Warehousing, Information and Cultural Industries, and Other Services - are exceptions with a negative correlation or close to no correlation at all. Two of the commercial segments in this CPR - Logistics and Warehousing and Other Commercial - use employment levels derived from these three OEE segments to establish stock growth rates. To avoid the use of poorly correlated variables, the team adjusted the growth rates for these two segments to follow the growth in commercial gas consumption in each region, determined from Fortis Gas's 2014 LTRP.

Navigant mapped the employment levels of the BC Labour Force Statistics to each of the CPR commercial segments and regions in the Reference Case. The team then analyzed employment growth rates over the 15-year period from 2000 to 2014 to use as a proxy to establish commercial floor space growth rates.

Finally, Navigant analyzed the FortisBC Gas 2014 LTRP to ensure that the stock growth rates applied in the Reference Case aligned with the overall trends in commercial demand projected by FortisBC Gas. The team applied the growth rates derived from the BC Labour Force Statistics to the first five years of the CPR forecast through 2020. For each subsequent five-year period in the forecast, the team applied an adjustment multiplier to the stock growth rates in each region of BC to align with the 2014 LTRP.

For example, the 2014 LTRP projects commercial consumption in the Lower Mainland to grow slightly from 2015 through 2035, with very little incremental demand over time. The team adjusted the Reference Case growth rates established for the Lower Mainland every five-year period to align with these trends in consumption.

Table 2-22 presents the growth rates employed in the CPR study for each segment and across time. The Lower Mainland has the most modest stock growth rates – aligned with the gas sales projections of the load forecast. In general, commercial floor space growth expectations are higher in the Southern Interior, Northern BC, and particularly in Vancouver Island where more aggressive sales projections are forecasted. At a segment level, expectations of commercial floor space growth in the long term care, hospitals, and food service segments are to be at levels significantly higher than the regional average. The following paragraphs provide additional information related to these three segments:

- **Colleges/Universities:** Historical post-secondary enrollment data from StatsCan shows an average annual growth rate of 3.3% across the province.[15] Enrolment in 2000/2001 was reported at 183,000, growing to approximately 278,000 by 2013/2014. BC Labour Force Statistics show that employment growth rates are highest in the Lower Mainland, and slower paced in the Southern Interior, Vancouver Island, and Northern BC.
- **Long Term Care:** BC is experiencing the fastest growth rate of senior citizens across Canada.[16] In absolute numbers, much of this expected growth is in the Lower Mainland and Vancouver Island where retirement homes clusters are most predominant. However, in relative terms, growth rates in the Southern Interior and Northern BC will be higher.[17] BC's Ministry of Health forecasts that demand for long-term care facilities will more than double by 2036 as a result projected growth in the senior population over the next 20 years.[18] Based on BC Labour Force Statistics, employment in nursing and residential care facilities more than doubled in the Southern Interior from 3,700 in 2000 to 9,200 in 2014, at an average annual growth rate of 4.8%.
- **Hospitals:** The Ministry of Health has identified the province's aging hospital infrastructure and current hospital capacity as critical challenges to meet projected provincial demand over the next two decades.[19] Following hospital closures across the province between 2002 and 2004, employment in healthcare has grown from 69,000 in 2005 to 91,700 in 2014, at an annual growth rate of 3.2%.[20] The Ministry of Health forecasts significant increases in demand in all health services through 2036. Projections show hospital floor space growing at rates much higher than each regional average, with highest growth rates in Vancouver Island and Northern BC.

Table 2-23 shows the estimated stock of commercial floor space over time. The base year commercial stock determined for 2014 is the initial basis for the stock of commercial floor space presented in Table 2-23, then the team adjusted future years by applying the growth rates identified in Table 2-22.

Note that as described in Section 2.1.1.3, gas consumption from the Other Commercial segment was distributed across all other commercial segments in proportion to their consumption. Since the base year gas consumption for the Other Commercial segment is zero, growth rates are also zero.

[15] Statistic Canada. Table 477-0019. Post-secondary enrollments from 2000/2001 to 2013/2014.
[16] British Columbia. Ministry of Health. (2014). Setting priorities for the B.C. health system. Retrieved from http://www.health.gov.bc.ca/library/publications/year/2014/Setting-priorities-BC-Health-Feb14.pdf
[17] Office of the Senior's Advocate. May 2015. *"Senior's Housing in BC"*. Available: https://www.seniorsadvocatebc.ca/wp-content/uploads/sites/4/2015/05/Seniors-Housing-in-B.C.-Affordable-Appropriate-Available.pdf
[18] Marowitz, Ross. June 2015. The Canadian Press. *"Canada's Next Boom Industry? Retirement Homes, Developer Says"*. Available: http://www.huffingtonpost.ca/2015/06/17/quebec-developer-forecast_n_7603704.html
[19] Ministry of Health (2014)
[20] Cohen, March. July 2012. BC Health Coalition. *"Caring for BC's Aging Population".* Available: https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2012/07/CCPABC-Caring-BC-Aging-Pop.pdf

**Table 2-22: Annual Growth Rates by Commercial Segment and Region (%) – FortisBC Gas**

| Region | Segment | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2014-2020 | 2021-2025 | 2026-2030 | 2031-2035 |
| **Lower Mainland** | Accommodation | 1.4% | 1.2% | 1.0% | 0.8% |
| | Colleges/Universities | 1.8% | 1.5% | 1.3% | 1.1% |
| | Food Service | 1.2% | 1.0% | 0.9% | 0.7% |
| | Hospital | 1.5% | 1.3% | 1.1% | 0.9% |
| | Logistics/Warehouses | 1.6% | 1.4% | 1.2% | 1.0% |
| | Long Term Care | 1.5% | 1.3% | 1.1% | 0.9% |
| | Office | 1.6% | 1.3% | 1.2% | 0.9% |
| | Other Commercial | - | - | - | - |
| | Retail - Food | 1.0% | 0.8% | 0.7% | 0.6% |
| | Retail - Non Food | 1.0% | 0.8% | 0.7% | 0.6% |
| | Schools | 1.1% | 0.9% | 0.8% | 0.6% |
| **Southern Interior** | Accommodation | 2.2% | 1.9% | 1.8% | 1.6% |
| | Colleges/Universities | 1.8% | 1.5% | 1.4% | 1.3% |
| | Food Service | 1.6% | 1.4% | 1.3% | 1.2% |
| | Hospital | 2.5% | 2.2% | 2.0% | 1.9% |
| | Logistics/Warehouses | 1.7% | 1.5% | 1.4% | 1.3% |
| | Long Term Care | 4.3% | 3.6% | 3.4% | 3.1% |
| | Office | 1.8% | 1.5% | 1.4% | 1.3% |
| | Other Commercial | - | - | - | - |
| | Retail - Food | 1.3% | 1.1% | 1.0% | 0.9% |
| | Retail - Non Food | 0.6% | 0.5% | 0.5% | 0.5% |
| | Schools | 0.8% | 0.7% | 0.6% | 0.6% |
| **Vancouver Island** | Accommodation | 0.3% | 0.3% | 0.3% | 0.3% |
| | Colleges/Universities | 3.1% | 3.7% | 3.4% | 3.0% |
| | Food Service | 0.1% | 0.2% | 0.2% | 0.1% |
| | Hospital | 4.7% | 5.6% | 5.2% | 4.5% |
| | Logistics/Warehouses | 1.2% | 1.4% | 1.3% | 1.1% |
| | Long Term Care | 4.9% | 5.9% | 5.4% | 4.7% |
| | Office | 1.7% | 2.1% | 1.9% | 1.7% |
| | Other Commercial | - | - | - | - |
| | Retail - Food | 0.2% | 0.2% | 0.2% | 0.2% |
| | Retail - Non Food | 1.8% | 2.1% | 2.0% | 1.7% |
| | Schools | 3.0% | 3.6% | 3.3% | 2.9% |
| **Northern BC** | Accommodation | 1.6% | 1.9% | 1.7% | 1.5% |
| | Colleges/Universities | 2.6% | 3.2% | 2.9% | 2.6% |
| | Food Service | 0.6% | 0.7% | 0.6% | 0.6% |
| | Hospital | 3.9% | 4.7% | 4.3% | 3.8% |
| | Logistics/Warehouses | 0.5% | 0.6% | 0.6% | 0.5% |
| | Long Term Care | 5.1% | 6.1% | 5.6% | 4.9% |
| | Office | 1.1% | 1.3% | 1.2% | 1.0% |
| | Other Commercial | - | - | - | - |
| | Retail - Food | 0.9% | 1.1% | 1.0% | 0.9% |
| | Retail - Non Food | 0.7% | 0.8% | 0.8% | 0.7% |
| | Schools | 1.3% | 1.6% | 1.4% | 1.2% |

*Source: Navigant analysis of StatsCan Labour Market Statistics (CANSIM Table 282-026)*

**Table 2-23: Commercial Floor Space by Segment by Region (million m²) – FortisBC Gas**

| Region | Segment | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2014 | 2020 | 2025 | 2030 | 2035 |
| **Lower Mainland** | Accommodation | 2.55 | 2.78 | 2.94 | 3.10 | 3.23 |
| | Colleges/Universities | 4.10 | 4.55 | 4.90 | 5.24 | 5.52 |
| | Food Service | 2.17 | 2.34 | 2.46 | 2.57 | 2.66 |
| | Hospital | 1.56 | 1.71 | 1.82 | 1.93 | 2.02 |
| | Logistics/Warehouses | 10.56 | 11.61 | 12.43 | 13.20 | 13.84 |
| | Long Term Care | 2.05 | 2.24 | 2.39 | 2.52 | 2.64 |
| | Office | 22.06 | 24.21 | 25.88 | 27.45 | 28.77 |
| | Other Commercial | - | - | - | - | - |
| | Retail - Food | 2.10 | 2.24 | 2.33 | 2.41 | 2.48 |
| | Retail - Non Food | 7.34 | 7.83 | 8.16 | 8.47 | 8.72 |
| | Schools | 5.81 | 6.21 | 6.50 | 6.76 | 6.98 |
| **Southern Interior** | Accommodation | 1.56 | 1.77 | 1.95 | 2.13 | 2.31 |
| | Colleges/Universities | 0.39 | 0.43 | 0.47 | 0.50 | 0.54 |
| | Food Service | 0.54 | 0.59 | 0.63 | 0.67 | 0.71 |
| | Hospital | 0.64 | 0.74 | 0.82 | 0.91 | 1.00 |
| | Logistics/Warehouses | 3.30 | 3.67 | 3.95 | 4.23 | 4.50 |
| | Long Term Care | 0.87 | 1.10 | 1.31 | 1.55 | 1.81 |
| | Office | 7.08 | 7.88 | 8.49 | 9.10 | 9.70 |
| | Other Commercial | - | - | - | - | - |
| | Retail - Food | 0.99 | 1.08 | 1.14 | 1.20 | 1.25 |
| | Retail - Non Food | 3.08 | 3.24 | 3.33 | 3.41 | 3.49 |
| | Schools | 2.03 | 2.15 | 2.22 | 2.30 | 2.36 |
| **Vancouver Island** | Accommodation | 0.33 | 0.34 | 0.35 | 0.35 | 0.36 |
| | Colleges/Universities | 0.74 | 0.89 | 1.06 | 1.26 | 1.46 |
| | Food Service | 0.15 | 0.15 | 0.15 | 0.15 | 0.16 |
| | Hospital | 0.05 | 0.07 | 0.09 | 0.11 | 0.14 |
| | Logistics/Warehouses | 0.29 | 0.32 | 0.34 | 0.36 | 0.39 |
| | Long Term Care | 0.36 | 0.47 | 0.62 | 0.81 | 1.02 |
| | Office | 3.84 | 4.30 | 4.77 | 5.24 | 5.69 |
| | Other Commercial | - | - | - | - | - |
| | Retail - Food | 0.27 | 0.28 | 0.29 | 0.29 | 0.29 |
| | Retail - Non Food | 0.65 | 0.73 | 0.81 | 0.89 | 0.97 |
| | Schools | 0.53 | 0.63 | 0.75 | 0.89 | 1.03 |
| **Northern BC** | Accommodation | 0.25 | 0.28 | 0.31 | 0.33 | 0.36 |
| | Colleges/Universities | 0.07 | 0.08 | 0.10 | 0.11 | 0.13 |
| | Food Service | 0.08 | 0.08 | 0.08 | 0.08 | 0.09 |
| | Hospital | 0.10 | 0.12 | 0.15 | 0.18 | 0.22 |
| | Logistics/Warehouses | 0.48 | 0.50 | 0.52 | 0.53 | 0.55 |
| | Long Term Care | 0.04 | 0.06 | 0.08 | 0.10 | 0.13 |
| | Office | 1.24 | 1.33 | 1.42 | 1.51 | 1.59 |
| | Other Commercial | - | - | - | - | - |
| | Retail - Food | 0.11 | 0.11 | 0.12 | 0.13 | 0.13 |
| | Retail - Non Food | 0.48 | 0.51 | 0.53 | 0.55 | 0.57 |
| | Schools | 0.35 | 0.38 | 0.41 | 0.44 | 0.46 |
| **Segment Totals** | Accommodation | 4.69 | 5.17 | 5.54 | 5.91 | 6.25 |
| | Colleges/Universities | 5.30 | 5.95 | 6.53 | 7.11 | 7.64 |
| | Food Service | 2.93 | 3.16 | 3.32 | 3.48 | 3.62 |
| | Hospital | 2.35 | 2.64 | 2.89 | 3.14 | 3.38 |

| Region | Segment | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2014 | 2020 | 2025 | 2030 | 2035 |
| | Logistics/Warehouses | 14.64 | 16.11 | 17.24 | 18.33 | 19.28 |
| | Long Term Care | 3.33 | 3.86 | 4.40 | 4.98 | 5.59 |
| | Office | 34.22 | 37.73 | 40.56 | 43.30 | 45.74 |
| | Other Commercial | - | - | - | - | - |
| | Retail - Food | 3.47 | 3.71 | 3.87 | 4.03 | 4.16 |
| | Retail - Non Food | 11.55 | 12.31 | 12.83 | 13.32 | 13.75 |
| | Schools | 8.71 | 9.37 | 9.88 | 10.38 | 10.83 |
| **Totals** | **Schools** | **91.18** | **100.01** | **107.06** | **113.97** | **120.24** |

*Source: Navigant analysis of StatsCan Labour Market Statistics and FortisBC Gas's 2014 LTRP*

#### *2.2.2.3 Industrial Sector*

To develop the industrial Reference Case, the team developed and applied growth rates of gas demand for each industrial segment and region over the CPR study period. The team derived the demand growth rates from the FortisBC Gas 2014 LTRP.

FortisBC Gas's 2014 LTRP reports industrial sector gas sales as a whole and not broken down into individual industrial segments. To disaggregate the sector-wide forecast into industrial segments, Navigant and FortisBC worked together to develop gas sales projections which aligned with the sector-level forecast established for each region. Appendix B.4 describes the approach used to develop the industrial forecast in more detail.

Using this industrial load forecast, the team calculated average annual growth rates for each segment for each five-year period (e.g., 2015 to 2020, 2021 to 2025). The team applied these five-year growth rates to the same periods through the end of the CPR study period. For industrial segments with no presence in any particular region, the team specified a demand growth rate of zero (0.0%).

Table 2-24 presents the demand growth rates employed in the CPR study. Broadly speaking, the demand growth rates for the industrial sector show a gradual decline in gas sales over time across most segments and across each region. The growth rates presented in Table 2-24 lead to the estimated industrial consumption shown in Table 2-25. The base year consumption is the initial basis for the industrial demand in Table 2-25, which is then adjusted in future years by applying the growth rates identified in Table 2-24.

### Table 2-24: Annual Growth Rates by Industrial Segment and Region (%) – FortisBC Gas

| Region | Segment | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2015-2020 | 2021-2025 | 2026-2030 | 2031-2035 |
| Lower Mainland | Agriculture | -0.4% | -0.5% | 0.3% | 0.6% |
| | Cement | -1.2% | -1.8% | -0.1% | -0.1% |
| | Chemical | -2.4% | -1.4% | -0.5% | -0.2% |
| | Mining - Coal | -1.9% | -2.0% | -1.1% | -0.9% |
| | Food & Beverage | -1.8% | -2.0% | -1.1% | -0.9% |
| | Greenhouses | -1.0% | -1.1% | -0.2% | 0.0% |
| | LNG Facilities | 0.0% | 0.0% | 0.0% | 0.0% |
| | Manufacturing | 0.6% | 0.0% | 1.0% | 1.2% |
| | Mining - Metal | -1.9% | -2.0% | -1.1% | -0.9% |
| | Oil and Gas | -1.9% | -2.0% | -1.1% | -0.9% |
| | Pulp & Paper - Kraft | 0.0% | 0.0% | 0.0% | 0.0% |
| | Pulp & Paper - TMP | -1.9% | -2.0% | -1.1% | -0.9% |
| | Transportation | -1.3% | -1.2% | -1.2% | -1.0% |
| | Wood Products | -0.7% | -0.9% | -0.1% | 0.2% |
| | Other Industrial | 2.4% | 2.4% | -0.7% | -1.7% |
| Southern Interior | Agriculture | -0.6% | -0.8% | -0.8% | -0.8% |
| | Cement | -1.0% | -0.1% | 0.7% | 0.5% |
| | Chemical | 0.9% | 0.7% | 0.7% | 0.7% |
| | Mining - Coal | -0.5% | 0.2% | -0.3% | -0.3% |
| | Food & Beverage | 1.9% | 1.7% | 1.7% | 1.7% |
| | Greenhouses | 1.8% | 1.6% | 1.6% | 1.6% |
| | LNG Facilities | 0.0% | 0.0% | 0.0% | 0.0% |
| | Manufacturing | -0.3% | -0.4% | -0.3% | -0.3% |
| | Mining - Metal | 0.3% | 0.7% | -4.1% | 4.0% |
| | Oil and Gas | -0.1% | -0.3% | -0.3% | -0.3% |
| | Pulp & Paper - Kraft | -0.1% | -0.3% | -0.3% | -0.3% |
| | Pulp & Paper - TMP | -0.1% | -0.3% | -0.3% | -0.3% |
| | Transportation | 1.0% | 0.8% | 0.7% | 0.7% |
| | Wood Products | -0.3% | -1.0% | -0.6% | -0.6% |
| | Other Industrial | -2.1% | 3.9% | 1.8% | 1.1% |
| Vancouver Island | Agriculture | 1.1% | 0.9% | 1.5% | 1.5% |
| | Cement | 0.3% | -0.4% | 1.0% | 0.9% |
| | Chemical | -1.0% | 0.1% | 0.7% | 0.7% |
| | Mining - Coal | 0.0% | 0.0% | 0.0% | 0.0% |
| | Food & Beverage | -0.4% | -0.5% | 0.0% | 0.1% |
| | Greenhouses | 0.5% | 0.3% | 0.9% | 0.9% |
| | LNG Facilities | 0.0% | 0.0% | 0.0% | 0.0% |
| | Manufacturing | 2.1% | 1.5% | 2.1% | 2.1% |
| | Mining - Metal | -0.4% | -0.6% | 0.0% | 0.0% |
| | Oil and Gas | 0.0% | 0.0% | 0.0% | 0.0% |
| | Pulp & Paper - Kraft | 0.0% | 0.0% | 0.0% | 0.0% |
| | Pulp & Paper - TMP | -0.4% | -0.6% | 0.0% | 0.0% |
| | Transportation | 0.2% | 0.3% | 0.0% | 0.0% |
| | Wood Products | 0.8% | 0.5% | 1.1% | 1.1% |
| | Other Industrial | 3.9% | 3.9% | 0.4% | -0.8% |
| Northern BC | Agriculture | 1.1% | 1.0% | 1.0% | 1.1% |
| | Cement | 0.3% | -0.3% | 0.6% | 0.4% |
| | Chemical | -0.9% | 0.1% | 0.2% | 0.3% |
| | Mining - Coal | -0.4% | -0.5% | -0.5% | -0.4% |
| | Food & Beverage | -0.4% | -0.5% | -0.4% | -0.4% |
| | Greenhouses | 0.5% | 0.4% | 0.4% | 0.5% |
| | LNG Facilities | 0.0% | 0.0% | 0.0% | 0.0% |
| | Manufacturing | 2.1% | 1.5% | 1.7% | 1.7% |
| | Mining - Metal | -0.4% | -0.5% | -0.5% | -0.4% |
| | Oil and Gas | -0.4% | -0.5% | -0.5% | -0.4% |
| | Pulp & Paper - Kraft | -0.4% | -0.5% | -0.5% | -0.4% |
| | Pulp & Paper - TMP | -0.4% | -0.5% | -0.5% | -0.4% |
| | Transportation | 0.2% | 0.3% | -0.5% | -0.5% |
| | Wood Products | 0.8% | 0.6% | 0.6% | 0.7% |
| | Other Industrial | 3.9% | 3.9% | 0.0% | -1.3% |

*Source: Navigant analysis of FortisBC Gas 2014 LTRP*

**Table 2-25: Industrial Consumption by Segment by Region (TJ) – FortisBC Gas**

| Region | Segment | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2014 | 2020 | 2025 | 2030 | 2035 |
| All Regions | Agriculture | 1,601 | 1,616 | 1,627 | 1,644 | 1,664 |
| | Cement | 908 | 874 | 837 | 837 | 831 |
| | Chemical | 1,284 | 1,196 | 1,188 | 1,188 | 1,191 |
| | Mining - Coal | 2,517 | 2,443 | 2,458 | 2,417 | 2,378 |
| | Food & Beverage | 4,000 | 3,807 | 3,658 | 3,538 | 3,435 |
| | Greenhouses | 5,473 | 5,384 | 5,309 | 5,260 | 5,219 |
| | LNG Facilities | - | - | - | - | - |
| | Manufacturing | 5,710 | 6,037 | 6,215 | 6,443 | 6,687 |
| | Mining - Metal | 10 | 10 | 9 | 9 | 9 |
| | Oil and Gas | 8,761 | 8,512 | 8,310 | 8,139 | 7,981 |
| | Pulp & Paper - Kraft | 14,585 | 14,318 | 13,991 | 13,702 | 13,427 |
| | Pulp & Paper - TMP | 3,450 | 3,414 | 3,384 | 3,361 | 3,341 |
| | Transportation | 921 | 897 | 885 | 844 | 805 |
| | Wood Products | 7,567 | 7,606 | 7,481 | 7,443 | 7,421 |
| | Other Industrial | 789 | 921 | 1,092 | 1,078 | 1,006 |
| **Total** | | **57,577** | **57,036** | **56,444** | **55,903** | **55,393** |

*Source: Navigant analysis of FortisBC Gas 2014 LTRP*

### 2.2.3 EUI Trends

This section discusses the EUI trends across the residential, commercial, and industrial sectors.

#### 2.2.3.1 Residential Sector

To develop EUI trends for the Residential sector Reference Case, Navigant reviewed several resources including the FortisBC Gas 2012 REUS study, the accompanying Residential CDA study, BC Hydro's 2014 REUS, and the NRCan-OEE database. The main resource used to estimate the change in EUIs over time was BC Hydro's 2014 REUS study. BC Hydro's REUS was preferred over FortisBC Gas's REUS because it provided more granularity across individual residential segments. BC Hydro's REUS also provides survey results for gas equipment penetration for various years including 2002, 2003, 2005, 2007, and 2014. The team used the REUS data for each of these years to calculate an average annual rate of change for each EUI. A limitation of this approach is that the REUS data reflects the impact of provincial and federal DSM programs while the objective of this analysis is to trend natural change in EUIs in the absence of DSM impacts.

In certain cases, extrapolating recent trends 20 years into the future is uncertain and can result in implausibly high changes in the EUI over the forecast horizon. Recognizing this, Navigant endeavored to temper short-term trends by assuming a reduction in EUI trends further into the future. To determine these reductions in EUI trends over time, the team analyzed the FortisBC Gas 2014 LTRP. The analysis of the load forecast ensured that the Reference Case residential consumption—determined based on the growing residential stock and the EUI trends—aligned with the forecast of residential consumption reported in FortisBC Gas's load forecast. Navigant made these adjustments to the EUI trends across every five-year period of the CPR analysis horizon.

Based on this analysis, the team applied the EUI trends from the REUS analysis to the first five years of the CPR period, and systematically decreased the magnitude of EUI trends over the subsequent five-year periods. Specifically, the EUI trends decrease by a factor of 20% every five-year period. This 20% reduction enables the Reference Case residential consumption to match the load forecast consumption.[21] These EUI trends implicitly reflect natural changes in residential end-use consumption caused by naturally occurring improvements in end-use equipment efficiency, fuel share changes, saturation levels of energy efficient equipment, existing building retrofit activities, and stock turnover.

Table 2-26 shows the EUI trends determined for each residential segment and end-use over time, and Table 2-27 provides the resulting EUIs for each five-year period in the Lower Mainland. Navigant based the EUIs presented in Table 2-27 on the base year EUIs (for 2014) and adjusted them with the EUI trends identified in Table 2-26. The Reference Case EUIs for the Southern Interior, Vancouver Island and Northern BC are presented in Appendix B.2.

Please note that minor year-to-year changes in EUIs may not be explicitly reflected in the tables due to rounding.

As Table 2-26 indicates, gas consumption by most end-uses is expected to decrease over the CPR period. Current trends show that gas consumption from space heating and water heating are expected to decline over time, while consumption from appliances will increase. In general, the magnitude of the expected annual change in EUIs is greater in the near term and will decrease over time.

- **Space heating** – The use of natural gas for space heating has continued a small downward trend over the past decade—primarily in single detached homes and apartment units—resulting in a decrease in the gas space heating EUI. This trend is driven primarily by the lower penetration of gas space heating in new homes.
- **Water Heating** – Electricity consumption from water heating increases across most segments because of increased penetration of electric water heaters. The trend is most prevalent in single detached and attached homes. As a result, gas consumption for water heating has seen a steady decline across these segments. Survey results also show that apartment buildings are increasingly opting for centralized systems, rather than in-suite water heating units. Although, gas penetration of in-suite units has decreased, overall gas consumption is projected to increase due to centralized systems.
- **Appliances** – Gas consumption for appliances is forecast to increase over time, and at higher rates than space heating and water heating. Although gas clothes dryers are becoming less common, the increased adoption of gas-fired stoves and ranges has offset the impact of dryers and is expected to continue increasing gas consumption for appliances.

As noted for some of these end-uses, changing fuel shares for individual residential segments cause change in gas consumption over time.

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[21] For example, if the EUI trend determined from the 2014 REUS was a 1.0% decrease in EUI per year, the team applied 1.0% per year from 2015 through 2020, 0.8% per year from 2021 through 2025, 0.64% per year from 2026 through 2030, and 0.51% per year from 2031 through 2035.

**Table 2-26: Residential Gas Intensity Trends (%) – Five-Year Trends**

| Residential Segment | End-Use | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2015-2020 | 2020-2025 | 2025-2030 | 2030-2035 |
| **Single Family Detached** | Space Heating | -1.8% | -1.4% | -1.1% | -0.9% |
| | Water Heating | -0.9% | -0.7% | -0.6% | -0.4% |
| | Cooling | - | - | - | - |
| | Appliances | 1.3% | 1.1% | 0.9% | 0.7% |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | -1.3% | -1.0% | -0.8% | -0.7% |
| | Ventilation | - | - | - | - |
| **Single Family Attached/Row** | Space Heating | -1.5% | -1.2% | -1.0% | -0.8% |
| | Water Heating | -0.7% | -0.6% | -0.5% | -0.4% |
| | Cooling | - | - | - | - |
| | Appliances | 1.3% | 1.0% | 0.8% | 0.7% |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | -1.1% | -0.9% | -0.7% | -0.6% |
| | Ventilation | - | - | - | - |
| **Apartments =< 4 stories** | Space Heating | -2.0% | -1.6% | -1.3% | -1.0% |
| | Water Heating | 0.4% | 0.3% | 0.3% | 0.2% |
| | Cooling | - | - | - | - |
| | Appliances | 1.7% | 1.4% | 1.1% | 0.9% |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | -0.8% | -0.6% | -0.5% | -0.4% |
| | Ventilation | - | - | - | - |
| **Apartments > 4 stories** | Space Heating | -2.0% | -1.6% | -1.3% | -1.0% |
| | Water Heating | 0.4% | 0.3% | 0.3% | 0.2% |
| | Cooling | - | - | - | - |
| | Appliances | 1.7% | 1.4% | 1.1% | 0.9% |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | -0.8% | -0.6% | -0.5% | -0.4% |
| | Ventilation | - | - | - | - |
| **Other Residential** | Space Heating | -1.7% | -1.4% | -1.1% | -0.9% |
| | Water Heating | -1.2% | -1.0% | -0.8% | -0.6% |
| | Cooling | - | - | - | - |
| | Appliances | 1.0% | 0.8% | 0.6% | 0.5% |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | -1.5% | -1.2% | -0.9% | -0.8% |
| | Ventilation | - | - | - | - |

*Source: Navigant analysis of BC Hydro's 2014 REUS*

**Table 2-27: Residential Gas Intensity (GJ/household) – Lower Mainland**

| Residential Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Single Family Detached** | Space Heating | 77 | 69 | 64 | 61 | 58 |
| | Hot Water | 15 | 14 | 14 | 13 | 13 |
| | Cooling/Refrigeration | - | - | - | - | - |
| | Appliances | 1 | 1 | 2 | 2 | 2 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 2 | 2 | 2 | 2 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 95 | 87 | 82 | 78 | 75 |
| **Single Family Attached/Row** | Space Heating | 47 | 43 | 40 | 38 | 37 |
| | Hot Water | 10 | 10 | 10 | 9 | 9 |
| | Cooling/Refrigeration | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 59 | 55 | 52 | 50 | 48 |
| **Apartments =< 4 stories** | Space Heating | 21 | 19 | 17 | 16 | 15 |
| | Hot Water | 17 | 18 | 18 | 18 | 19 |
| | Cooling/Refrigeration | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 43 | 41 | 40 | 39 | 38 |
| **Apartments > 4 stories** | Space Heating | 21 | 19 | 17 | 16 | 15 |
| | Hot Water | 17 | 17 | 18 | 18 | 18 |
| | Cooling/Refrigeration | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 4 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 43 | 41 | 39 | 39 | 38 |
| **Other Residential** | Space Heating | 45 | 40 | 38 | 36 | 34 |
| | Hot Water | 13 | 12 | 12 | 11 | 11 |
| | Cooling/Refrigeration | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 60 | 55 | 51 | 49 | 47 |

*Source: Navigant analysis of BC Hydro's 2014 REUS*

#### 2.2.3.2 Commercial Sector

The next step in building the commercial sector Reference Case involved the development and application of EUI trends over the CPR study period. Navigant reviewed several resources including FortisBC Gas's 2015 CEUS, the NRCan-OEE database for British Columbia, and BC Hydro's 2014 CEUS to develop these trends. The main resource for EUI trends in the commercial sector was BC Hydro's 2014 CEUS. The team preferred BC Hydro's 2014 CEUS to FortisBC's 2015 CEUS because it provides detailed survey results for each commercial segment in each region.

BC Hydro's 2014 CEUS surveyed commercial customers in relation to upgrades made to end-use equipment in the past 5 years.[22] Based on the incidence of equipment upgrades made to specific end-uses (e.g., space cooling vs. space heating), Navigant estimated the potential reduction in energy consumption from higher efficiency equipment. This approach is described in more detail in Appendix 0. A limitation of this approach is that the CEUS data reflects the impact of provincial and federal commercial DSM programs, while the objective of this analysis is to trend natural change in EUIs in the absence of DSM impacts. The impact of this limitation on the study is that the EUI trends established for these commercial end-uses may be overstated, which may affect the overall results of this study. Additionally, this EUI trending approach inherently reflects both new and existing buildings because the CEUS customer pool included both new and existing buildings.

This analysis resulted in EUI trends for all the end-uses for which equipment upgrade information was reported in 2014 CEUS. [23] This included the following end-uses:

- Lighting
- Water heating
- Space cooling
- HVAC fans/pumps
- Space heating

Two of these end-uses—water heating and space heating—are applicable to gas consumption. The 2014 CEUS did not report the necessary information to develop EUI trends for the *cooking* and *other* gas end-uses, so the team assumed they would remain flat.

Similar to the residential sector, Navigant analyzed FortisBC Gas's 2014 LTRP to establish changes in the magnitude of commercial EUI trends every five years over the entire CPR analysis period. This ensured that the Reference Case commercial consumption—determined based on the commercial floor space stock and the EUI trends—aligned with the forecast of commercial consumption reported in the 2014 LTRP.

Based on this analysis, the commercial EUI trends determined from the CEUS analysis are applied to the first five years of the analysis, decreasing slightly over the subsequent five-year periods. Specifically, the EUI trends decrease by a factor of 30% every five-year period. This 30% reduction in EUI trends enables the Reference Case commercial consumption to match the load forecast consumption.

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[22] For example, the incidence of water heating equipment upgrades within the past 5 years was 23% across the entire commercial sector. However, the incidence of water heating upgrades varied across commercial segments (e.g., 38% in Colleges & Universities, 12% in Offices).

[23] The 2014 CEUS did not report equipment upgrade information for the cooking, refrigeration, and office equipment end-uses.

Table 2-28 shows the EUI trends for each commercial segment and end-use, and Table 2-29 shows the resulting EUIs over five-year intervals for the Lower Mainland. The EUIs presented in Table 2-29 were initially derived from the base year EUIs (for 2014) and have been adjusted by applying the EUI trends identified in Table 2-28. The Reference Case EUIs for the Southern Interior, Vancouver Island and Northern BC are presented in Appendix B.3.

As seen in Table 2-28, gas consumption for water heating and space heating is expected to decrease over the CPR period.

These changes in EUIs over time implicitly reflect natural changes in gas end-use consumption caused by naturally occurring improvements in end-use equipment efficiency and saturation levels, fuel switching, and retrofit activities. For example, energy efficient improvements driven by initiatives like ENERGY STAR and the Leadership in Energy and Environmental Design (LEED) certification are expected to influence EUI trends. Although the impact of these two energy performance initiatives remains limited thus far, the initiatives are likely to increase adoption of commercial envelope measures and higher efficiency space heating, lighting and cooking equipment.

**Table 2-28: Commercial Gas Intensity Trends (%) – Five-Year Trends**

| Commercial Segment | End-Use | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2015-2020 | 2020-2025 | 2025-2030 | 2030-2035 |
| Accommodation | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.8% | -0.6% | -0.4% | -0.3% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.7% | -1.2% | -0.8% | -0.6% |
| Colleges/ Universities | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -1.1% | -0.8% | -0.5% | -0.4% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.9% | -1.3% | -0.9% | -0.6% |
| Food Service | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -1.1% | -0.8% | -0.5% | -0.4% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -2.0% | -1.4% | -1.0% | -0.7% |
| Hospital | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.7% | -0.5% | -0.3% | -0.2% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.8% | -1.2% | -0.9% | -0.6% |
| Logistics/ Warehouses | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.7% | -0.5% | -0.4% | -0.3% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.3% | -0.9% | -0.7% | -0.5% |
| Long Term Care | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -1.0% | -0.7% | -0.5% | -0.3% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.8% | -1.3% | -0.9% | -0.6% |
| Office | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |

| Commercial Segment | End-Use | CPR Period | | | |
|---|---|---|---|---|---|
| | | 2015-2020 | 2020-2025 | 2025-2030 | 2030-2035 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.4% | -0.3% | -0.2% | -0.1% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.8% | -1.2% | -0.9% | -0.6% |
| **Other Commercial** | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.4% | -0.3% | -0.2% | -0.1% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.8% | -1.2% | -0.9% | -0.6% |
| **Retail - Food** | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.9% | -0.6% | -0.4% | -0.3% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -2.2% | -1.5% | -1.1% | -0.7% |
| **Retail – Non Food** | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.9% | -0.6% | -0.4% | -0.3% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -2.2% | -1.5% | -1.1% | -0.7% |
| **Schools** | Cooking | 0.0% | 0.0% | 0.0% | 0.0% |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | -0.6% | -0.4% | -0.3% | -0.2% |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 0.0% | 0.0% | 0.0% | 0.0% |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | -1.8% | -1.2% | -0.9% | -0.6% |

*Source: Navigant analysis of BC Hydro 2014 CEUS*

**Table 2-29: Commercial Gas Intensity (MJ/m2) – Lower Mainland**

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Accommodation | Cooking | 80 | 80 | 80 | 80 | 80 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 258 | 246 | 239 | 234 | 230 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 56 | 56 | 56 | 56 | 56 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 252 | 228 | 215 | 206 | 200 |
| | **Total** | 646 | 609 | 589 | 576 | 567 |
| Colleges/ Universities | Cooking | 37 | 37 | 37 | 37 | 37 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 69 | 65 | 62 | 61 | 60 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 310 | 276 | 259 | 247 | 239 |
| | **Total** | 481 | 444 | 424 | 410 | 401 |
| Food Service | Cooking | 839 | 839 | 839 | 839 | 839 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 476 | 446 | 430 | 418 | 411 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 425 | 376 | 351 | 334 | 323 |
| | **Total** | 1,759 | 1,680 | 1,638 | 1,610 | 1,591 |
| Hospitals | Cooking | 65 | 65 | 65 | 65 | 65 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 274 | 263 | 257 | 253 | 250 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 233 | 233 | 233 | 233 | 233 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 758 | 682 | 641 | 614 | 596 |
| | **Total** | 1,330 | 1,243 | 1,197 | 1,165 | 1,144 |
| Logistics/ Warehouses | Cooking | 5 | 5 | 5 | 5 | 5 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 18 | 17 | 17 | 17 | 16 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 201 | 185 | 177 | 171 | 167 |
| | **Total** | 242 | 226 | 217 | 211 | 207 |
| Long Term Care | Cooking | 56 | 56 | 56 | 56 | 56 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 156 | 147 | 142 | 138 | 136 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 337 | 301 | 282 | 270 | 262 |
| | **Total** | 613 | 569 | 545 | 530 | 519 |
| **Office** | Cooking | 9 | 9 | 9 | 9 | 9 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 33 | 32 | 32 | 31 | 31 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 263 | 237 | 223 | 213 | 207 |
| | **Total** | 324 | 297 | 282 | 273 | 266 |
| **Other Commercial** | Cooking | 15 | 15 | 15 | 15 | 15 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 26 | 26 | 25 | 25 | 25 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 13 | 13 | 13 | 13 | 13 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 276 | 248 | 233 | 223 | 217 |
| | **Total** | 330 | 301 | 286 | 276 | 269 |
| **Retail - Food** | Cooking | 75 | 75 | 75 | 75 | 75 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 65 | 61 | 60 | 58 | 57 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 311 | 273 | 253 | 240 | 231 |
| | **Total** | 469 | 428 | 406 | 391 | 381 |
| **Retail – Non Food** | Cooking | 13 | 13 | 13 | 13 | 13 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 23 | 22 | 21 | 21 | 21 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 6 | 6 | 6 | 6 | 6 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 256 | 225 | 208 | 197 | 190 |
| | **Total** | 299 | 266 | 249 | 237 | 230 |
| **Schools** | Cooking | 15 | 15 | 15 | 15 | 15 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 39 | 38 | 37 | 36 | 36 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 5 | 5 | 5 | 5 | 5 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 277 | 249 | 234 | 224 | 218 |
| | **Total** | 336 | 307 | 291 | 280 | 273 |

*Source: Navigant analysis of FortisBC Gas's 2014 LTRP, and BC Hydro 2014 CEUS*

#### 2.2.3.3 Industrial Sector

Discussions between Navigant and CLEAResult concluded "natural" change in industrial energy efficiency would be minimal over the study horizon. This assumption is consistent with past CPRs, which forecasted very small changes in industrial EUIs over a 20-year forecast horizon (typically only a few percent over 20 years)[24]. Given the expected small magnitude of natural change in industrial EUIs, inherent EUI forecasting uncertainty, and limited historical data availability for industrial EUIs, this study assumes that EUIs in the industrial sector will remain constant in the absence of conservation programs.

The study represents industrial production levels as an index that begins at 1.0 in 2014 and grows or declines in accordance with expected trends in production. These production levels are analogous to building stocks and are multiplied by EUIs to determine consumption in a given year.

The outline below details key considerations for the industrial consumption forecast.

- **Resource-extraction industries** are much more sensitive to primary cost drivers (timber prices, labor costs), suggesting their consumption is not strongly dependent on electricity and gas prices. The prime reason for upgrading equipment is for increasing production, market expansion, or new product lines, rather than to increase energy efficiency.
- **Non-resource-extraction industries** are unlikely to experience significant changes in EUIs. Many of these customers—particularly food & beverage and manufacturing customers—operate smaller facilities and the tendency is not to invest capital upgrading older facilities but rather in expanding or building new plants.
- The **pulp & paper and wood products** consumption has been declining steadily over the past decade, as is evident by mill shutdowns. By and large, these industrial segments are projected to continue declining through 2020, particularly in other regions where much of the industry is concentrated. Capital constraints in this segment limit the opportunities for energy efficiency. These industries—in addition to the chemical and cement sector—consist mainly of older plants where customers have shown reluctance to upgrade to more efficient equipment due to uncertain market conditions.

### 2.2.4 Reference Case Forecast and Comparison with Utility Forecast

This section provides the final Reference Case forecast and compares the sector-level results of the Reference Case forecast with FortisBC Gas's load forecast.

#### 2.2.4.1 Reference Case Forecast

Table 2-30 summarizes the results of the Reference Case for each sector and customer segment. Navigant computed these results by applying the stock growth rates and the EUI trends established in previous sections for each customer segment to the base year results.

[24] The base year analysis did not characterize industrial consumption on a per-unit basis, as was done for the residential sector (i.e., kWh or GJ *per* household) and commercial sector (i.e., kWh or GJ *per* m2). Industrial EUIs are expressed directly in electric or gas units of consumption (i.e., kWh or GJ).

**Table 2-30: Reference Case Forecast by Segment (TJ)**

| Sector | Segment | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Residential | Single Family Detached | 67,598 | 63,730 | 61,177 | 59,574 | 58,711 |
| | Single Family Attached/Row | 4,148 | 4,212 | 4,249 | 4,318 | 4,406 |
| | Apartments =< 4 stories | 12,597 | 12,774 | 12,911 | 13,108 | 13,352 |
| | Apartments > 4 stories | 7,355 | 7,502 | 7,606 | 7,747 | 7,915 |
| | Other Residential | 1,370 | 1,366 | 1,353 | 1,358 | 1,369 |
| | **Total** | **93,069** | **89,584** | **87,296** | **86,105** | **85,752** |
| Commercial | Accommodation | 3,141 | 3,261 | 3,381 | 3,523 | 3,667 |
| | Colleges/Universities | 2,625 | 2,715 | 2,847 | 3,004 | 3,161 |
| | Food Service | 5,155 | 5,313 | 5,451 | 5,610 | 5,761 |
| | Hospital | 3,428 | 3,600 | 3,808 | 4,055 | 4,312 |
| | Logistics/Warehouses | 3,857 | 3,950 | 4,054 | 4,186 | 4,317 |
| | Long Term Care | 2,091 | 2,257 | 2,466 | 2,718 | 2,995 |
| | Office | 11,882 | 11,986 | 12,241 | 12,614 | 13,006 |
| | Other Commercial | - | - | - | - | - |
| | Retail – Food | 1,624 | 1,582 | 1,567 | 1,571 | 1,584 |
| | Retail - Non Food | 3,698 | 3,502 | 3,411 | 3,378 | 3,375 |
| | Schools | 3,140 | 3,081 | 3,083 | 3,122 | 3,176 |
| | Street Lights | - | - | - | - | - |
| | **Total** | **40,640** | **41,248** | **42,308** | **43,781** | **45,351** |
| Industrial | Agriculture | 1,601 | 1,616 | 1,627 | 1,644 | 1,664 |
| | Cement | 908 | 874 | 837 | 837 | 831 |
| | Chemical | 1,284 | 1,196 | 1,188 | 1,188 | 1,191 |
| | Mining – Coal | 2,517 | 2,443 | 2,458 | 2,417 | 2,378 |
| | Food & Beverage | 4,000 | 3,807 | 3,658 | 3,538 | 3,435 |
| | Greenhouses | 5,473 | 5,384 | 5,309 | 5,260 | 5,219 |
| | LNG Facilities | - | - | - | - | - |
| | Manufacturing | 5,710 | 6,037 | 6,215 | 6,443 | 6,687 |
| | Mining – Metal | 10 | 10 | 9 | 9 | 9 |
| | Oil and Gas | 8,761 | 8,512 | 8,310 | 8,139 | 7,981 |
| | Pulp & Paper - Kraft | 14,585 | 14,318 | 13,991 | 13,702 | 13,427 |
| | Pulp & Paper - TMP | 3,450 | 3,414 | 3,384 | 3,361 | 3,341 |
| | Transportation | 921 | 897 | 885 | 844 | 805 |
| | Wood Products | 7,567 | 7,606 | 7,481 | 7,443 | 7,421 |
| | Other Industrial | 789 | 921 | 1,092 | 1,078 | 1,006 |
| | **Total** | **57,577** | **57,036** | **56,444** | **55,903** | **55,393** |
| **Total** | | **191,286** | **187,867** | **186,048** | **185,789** | **186,497** |

*Source: Navigant analysis*

#### 2.2.4.2 Comparison between Reference Case and Utility Forecast

In this section, Navigant compares the Reference Case forecast with FortisBC Gas's 2014 LTRP. Since most of the demand growth assumptions underlying the load forecast were used as inputs to develop the stock growth rates in the Reference Case, the two forecasts are largely consistent.

Table 2-31 compares the projected gas sales in 2035 between the Reference Case and the Load Forecast.

**Table 2-31: Reference Case Forecast**

| Class/Sector | Average Annual Growth Rate (%) | | 2035 Sales (TJ) | | Difference (%) |
|---|---|---|---|---|---|
| | Reference Forecast | FortisBC Gas Forecast | Reference Forecast | FortisBC Gas Forecast | |
| Residential | -0.4% | -0.4% | 85,752 | 85,752 | 0.0% |
| Commercial | 0.5% | 0.5% | 45,351 | 45,351 | 0.0% |
| Industrial | -0.2% | -0.2% | 55,393 | 55,393 | 0.0% |
| **Total** | **-0.1%** | **-0.1%** | **186,497** | **186,497** | **0.0%** |

*Source: Navigant analysis*

## 2.3 Frozen End-use Intensity Case and Natural Change

Navigant's model uses the building stock projections from the Reference Case forecast to calculate technical and economic potential, but does not use the reference case's time-changing end-use intensities. Rather, it freezes the end-use intensities from the Reference Case forecast at 2016 levels and holds them fixed over time. This section describes the reasons for this approach and the method by which the team links the frozen EUI case back to the reference case using "natural change."

### *2.3.1 Frozen EUI Case*

The Reference Case includes many embedded assumptions derived from observed trends in the market and forward-looking expectations. The Reference Case allows end-use intensities to change over time as a function of:

- Changing mix of efficient versus inefficient equipment
- Changing use of building space (e.g., open plan office spaces)
- Changing mix of commercial activities (e.g., decrease in manufacturing and increase in service industries)
- New trends in consumption (e.g., increase in use of home electronics)
- Fuel switching (e.g., switching from electric appliances to gas appliances, or vice versa)

Modelling these considerations at the *measure* level would require a detailed adoption forecast for every measure in each customer segment. Typically, potential studies forecast measure-level adoption when looking at achievable market potential in the context of utility-sponsored energy efficiency programs. The achievable market potential hinges on expected levels of incentives, program budgets, and marketing/advertising levels, and there is adequate industry experience to provide substance to these forecasts. Conversely, it is notoriously difficult to estimate retrospectively what would have happened with measure adoption in the absence of energy efficiency programs (typically estimated through "net-to-gross" ratio studies), and it is even more difficult and uncertain to *forecast* such "natural" behavior at the measure level. Since program design is outside the scope of this study, and considering the inherent uncertainty in forecasting natural adoption at the measure level, Navigant did not pursue and create detailed measure adoption forecasts for technical and economic potential. Rather, the study uses a "frozen EUI" approach to estimate technical and economic potential combined with an estimation of aggregate end-use intensity trends to calculate the natural change expected at the end-use level.

Navigant calculated technical and economic potential assuming that EUIs are frozen at 2016 levels, ensuring consistency between modelled energy sales and measure characterization. For example, measure characterization assumes a fixed mix of efficient and inefficient measures over time—absent any energy efficiency programs—implying that end-use intensities do not change over time when calculating technical and economic potential. However, building stock changes (e.g., growth in the residential customer count or commercial floor space) can increase overall energy sales and assumed total equipment counts, which would impact the estimates for technical and economic potential.

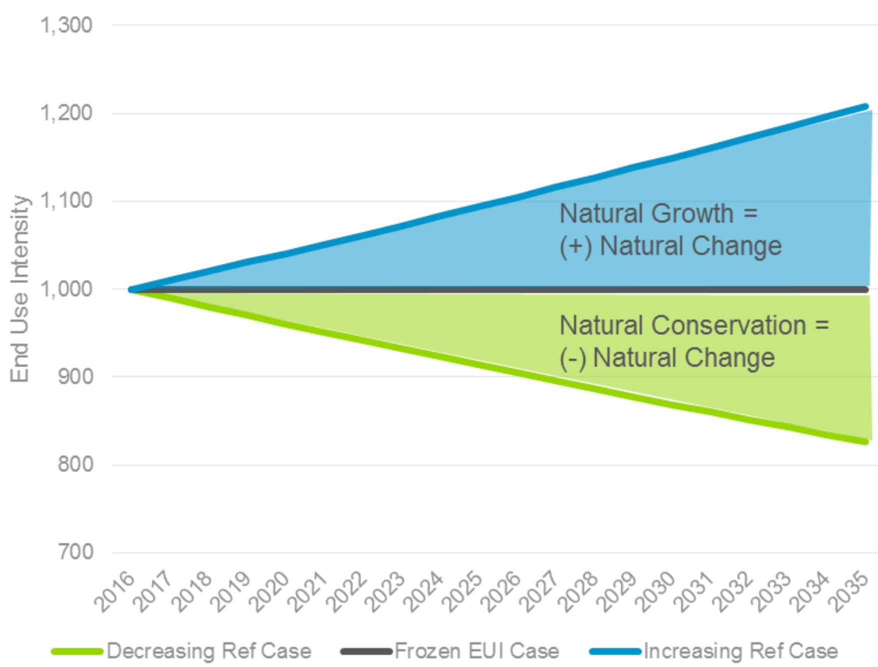
If end-use intensities are changing in the Reference Case, Navigant calculates what this study refers to as the "natural change"—defined in section 2.3.2—of EUIs over time. The team then applies this natural change to the technical and economic potential results using the frozen EUI to estimate the shift in potential savings.

### *2.3.2 Natural Change*

Navigant's definition of "natural change" stems from two related concepts: natural conservation and natural growth. Natural *conservation* is a well-established concept in demand side management programs, and typically refers to actions taken by utility customers—in absence of utility-sponsored programs—to improve energy efficiency and reduce consumption. These actions are occurring naturally, with no influence from utilities or program administrators. Natural *growth* refers to actions taken by utility customers to *increase consumption* without the involvement of utility-guided programs. An example of natural growth is home electronics, where customers may be increasing their electric consumption (e.g., through addition of more televisions, computers, etc.) and causing an increase in the electronics end-use intensity.

This study captures the effects of natural conservation as well as natural growth within the end-use intensities, and defines these effects as "natural change." When natural change is positive for an end-use category, it reflects growth. When natural change is negative, it reflects conservation. Figure 2-9 illustrates this concept of natural change as it relates to the Reference Case end-use intensities as compared with the frozen EUI case.

**Figure 2-9. Natural Change in Context of End-use Intensity**




*Source: Navigant*

Navigant calculated natural change by subtracting the energy consumption in the frozen EUI case from the energy consumption in the Reference Case (see Table 2-32). Positive natural change results indicate a quantity of consumption missing from the frozen EUI case, whereas negative natural change indicates an overestimate of consumption in the frozen EUI case. Since Navigant estimates technical and economic potential based on the frozen EUI case, any missing consumption (i.e., positive natural change) is not included in the technical and economic results. Conversely, the model overestimates technical and economic potential when natural change is negative. Natural change helps provide a bound for the technical and economic potential forecasts, as it reflects one component of the uncertainty in energy savings from end-uses with expected changes to intensities over time.

**Table 2-32. Illustrative Calculation of Natural Change**

| Year | Building Stock (homes) | Reference Case EUI (GJ/year-home) | Frozen Case EUI (GJ/year-home) | Reference Case Consumption (GJ/year) | Frozen EUI Case Consumption (GJ/year) | Natural Change (GJ/year) |
|---|---|---|---|---|---|---|
| | A | B | C | D = A x B | E = A x C | F = D - E |
| 2016 | 1,000 | 70 | 70 | 70,000 | 70,000 | 0 |
| 2020 | 1,082 | 69 | 70 | 74,808 | 75,770 | -962 |
| 2025 | 1,195 | 68 | 70 | 81,351 | 83,656 | -2,305 |
| 2030 | 1,319 | 67 | 70 | 88,412 | 92,364 | -3,952 |
| 2035 | 1,457 | 66 | 70 | 96,162 | 101,977 | -5,815 |

*Source: Navigant*

Calculating technical and economic potential that includes natural change at the measure level would require measure-level adoption forecasts. As mentioned in section 2.3.1, Navigant's calculation of technical and economic potential does not involve forecasting adoption at the measure level. However, the team does estimate upper and lower bounds on the technical and economic potential inclusive of natural change at the end-use level.[25]

Navigant refined the frozen EUI technical potential by estimating savings potential percentages for natural change. The team calculated the technical potential as a percentage of consumption within a given end-use category, and applied that percentage to the natural change occurring within that end-use. For example, if the model concludes that technical potential for gas appliances is 30% of the total consumption from gas appliances, Navigant can apply that 30% to the natural change occurring within the appliance end-use to find a midway estimate between the technical potential and the upper or lower bound.

Table 2-33 builds off the example in Table 2-32 by estimating adjusted technical potential for the frozen EUI case by applying the example of 30% savings to the natural change estimates.

[25] Adding consumption from natural change directly to savings potential—instead of adding the expected savings from the natural change—typically exaggerates the upper or lower bound results.

**Table 2-33. Illustrative Calculation of Bounds on Technical Potential (GJ/year)**

| Year | Frozen EUI Case Consumption | Natural Change | Tech Potent @ 30% Savings | Tech Potent + Nat Change | Tech Potent + 30% Nat Change |
|---|---|---|---|---|---|
| | A | B | C = A x 30% | D = B + C | E = B x 30% + C |
| 2016 | 70,000 | 0 | 24,500 | 24,500 | 24,500 |
| 2020 | 75,770 | -962 | 26,520 | 25,558 | 26,231 |
| 2025 | 83,656 | -2,305 | 29,280 | 26,975 | 28,588 |
| 2030 | 92,364 | -3,952 | 32,327 | 28,375 | 31,142 |
| 2035 | 101,977 | -5,815 | 35,692 | 29,877 | 33,948 |

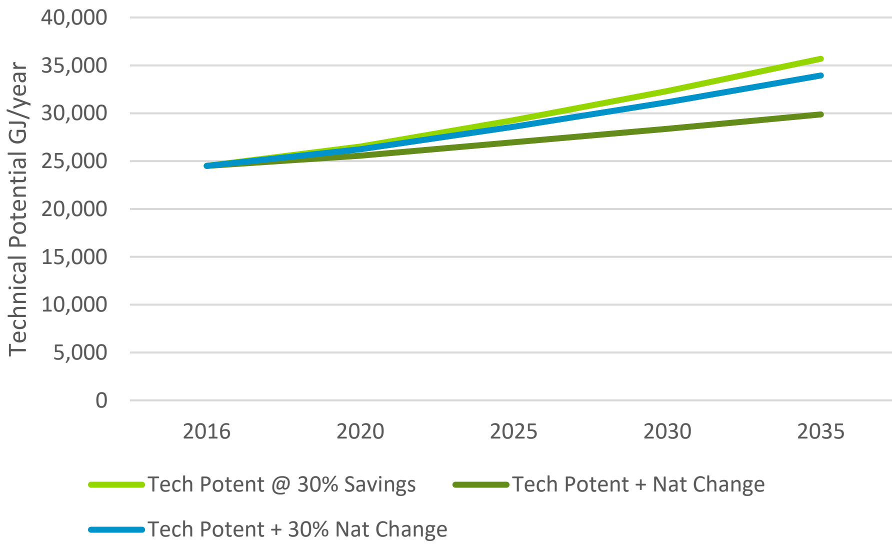
*Source: Navigant*

Where:

- **Frozen EUI Case Consumption** – the consumption forecast from the frozen EUI case
- **Natural Change** – the natural change between the frozen EUI case and the Reference Case
- **Tech Potent @ 30% Savings** – the technical potential assuming that efficient measures, in aggregate, lead to 30% savings as a percentage of the frozen EUI case's consumption
- **Tech Potent + Nat Change** – the sum of technical potential and natural change. Because natural change is negative, it reduces the total technical potential and indicates an extreme lower bound. This lower bound is overly conservative because it reduces the technical potential by the total natural change, rather than reducing potential by the overestimation of savings from natural change.
- **Tech Potent + 30% Nat Change** – the sum of technical potential and 30% of the natural change. Instead of reducing the technical potential by the total natural change, we reduce the potential by an estimate of the savings from natural change. The savings from natural change is a rough estimate based on the same 30% savings as a percentage of consumption used to estimate the technical potential. In reality, the percentage savings from natural change could be different from the 30% aggregate technical savings for the end-use.

Figure 2-10 plots the illustrative results from Table 2-33.

**Figure 2-10. Illustrative Example of Technical Potential and Bounds Derived from Natural Change**




*Source: Navigant*

At the end-use level, the technical potential plus the adjusted natural change (i.e., "Tech Potential + 30% Nat Change") will always fall between the technical potential and the bound created by adding natural change directly to the potential. At the sector level, however, this may not always be the case due to the aggregation of various end-use categories that may have positive or negative natural change. The natural change and estimated savings from natural change can be positive or negative and will cancel each other out, which leads to aggregate natural change and aggregate savings from natural change that can be in different proportions than was calculated at the end-use level. After aggregation, the technical potential plus the adjusted natural change may or may not fall between the technical potential and the bound.[26]

## 2.4 Measure Characterization

Navigant fully characterized over 200 measures across the BC Utilities' residential, commercial, and industrial sectors, covering electric and natural gas fuel types. The team prioritized measures with high impact, data availability, and most likely to be cost-effective as thresholds for inclusion into DSMSim™.

### *2.4.1 Measure List*

Navigant developed a comprehensive measure list of energy efficiency measures likely to contribute to economic potential. The team reviewed current BC program offerings, previous CPR and other Canadian programs, and potential model measure lists from other jurisdictions to identify EE measures with the highest expected economic impact. The team supplemented the measure list using the Pennsylvania, Illinois, Mid-Atlantic, and Massachusetts technical resource manuals (TRMs), and partnered with CLEAResult to inform the list of industrial measures. Navigant worked with the BC Utilities to finalize the

[26] The effects of natural change by end-use category and customer segment are available in Appendix A.1.

measure list and ensure it contained technologies viable for future BC program planning activities. Appendix A.2 provides the final measure list and assumptions.

Working sessions with the BC Utilities revealed topics of note regarding the following measures:

- **Multi-Unit Residential Building (MURB) measures –** Navigant characterized both in-suite and common area measures for MURBs. In-suite measures are similar to other residential measures such as LED light bulbs, power strips, and televisions. Common area measures include space heating and hot water heating measures such as make-up air units, HVAC controls, central boilers, and roof deck insulation
- **Showerheads for MURBs –** The model currently uses material and labor costs for showerheads assuming the customer installs the measure themselves. However, BC Utilities offer a direct install program for showerheads in the MURB customer segment and may purchase showerheads at a wholesale price. Since the measure is already cost-effective without the direct install cost adjustments, this issue does not impact the technical and economic potential results. This issue would impact any further analysis of achievable potential, but that is outside of the scope of this study.

### *2.4.2 Measure Characterization Key Parameters*

The measure characterization effort consisted of defining nearly 50 individual parameters for each of the 200 measures included in this study. This section defines the top 10 key parameters and how they impact technical and economic potential savings estimates.

1. **Measure Definition**: The team used the following variables to qualitatively define each characterized measure:
    - ***Replacement Type****:* Replacing the baseline technology with the efficient technology can occur in three variations:
        1. Retrofit (RET): where the model considers the baseline to be the existing equipment, and uses the energy and demand savings between the existing equipment and the efficient technology during technical potential calculations. RET also applies the full installed cost of the efficient equipment during the economic screening.
        2. Replace On Burnout (ROB): where the model considers the baseline to be the code-compliant technology option, and uses the energy and demand savings between the current code option and the efficient technology during technical potential calculations. ROB also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.
        3. New Construction (NEW): where the model considers the baseline to be the least cost, code-compliant option, and uses the energy and demand savings between this specific current code option and the efficient technology during technical potential calculations. NEW also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.
    - ***Baseline Definition***: Describes the baseline technology (e.g., the existing equipment).
    - ***EE Definition***: Describes the efficient technology set to replace the baseline technology.
    - ***Unit Basis***: The normalizing unit for energy, demand, cost, and density estimates.

2. **Regional, Sector, and End-use Mapping:** The team mapped each measure to the appropriate end-uses, customer segments, sectors, and climate regions across the BC Utility's service territory. Section 2.1 describes the breakdown of customer segments with each sector in greater detail. Navigant characterized weather dependent measures into four regions: Lower Mainland, Southern Interior, Vancouver Island, and Northern BC to account for changes in climate that impact energy savings.
3. **Annual Energy Consumption:** The annual energy consumption in kilowatt-hours (kWh) or mega joules (MJ) for each of the base and energy-efficient technologies
4. **Coincident Electric Demand**: The peak coincident demand in kilowatts (kW) for each of the base and energy-efficient technologies
5. **Fuel Type Applicability Multipliers**: Assigns the percentage of electric fuel type to measures with electric fuel type such as water heaters and space heating equipment
6. **Measure Lifetime:** The lifetime in years for the base and energy-efficient technologies. The Base and EE lifetime only differ in instances where the two cases represent inherently different technologies, such as light-emitting diodes (LEDs) or compact fluorescent lamp (CFL) bulbs compared to a baseline incandescent bulb.
7. **Incremental Costs:** The incremental cost between the assumed baseline and efficient technology, using the following variables:
    - ***Base Costs***: The cost of the base equipment, including both material and labor costs
    - ***EE Costs:*** The cost of the energy-efficient equipment
8. **Technology Densities**: This study defines "density" as the penetration or saturation of the baseline and efficient technologies across the BC Utility's territory. For residential measures, these saturations are on a per home basis, for commercial they are per 1,000 square meters of building space, and for industrial they are based on energy consumption.[27]
    - ***Base Initial Saturation***: The saturation of the baseline equipment in a territory for a given customer segment
    - ***EE Initial Saturation:*** The saturation of the efficient equipment in a territory for a given customer segment
    - ***Total Maximum Density***: The total number of both the baseline and efficient units in a territory for a given technology
9. **Technology Applicability:** The percentage of the base technology that can be reasonably and practically replaced with the specified efficient technology. For instance, occupancy sensors are only practical for certain interior lighting fixtures (an applicability less than 1.0), while all existing incandescent exit signs can be replaced with efficient LED signs (an applicability of 1.0).
10. **Competition Group**: The team combined efficient measures competing for the same baseline technology density into a single competition group to avoid the double-counting of savings. (Section 3.1.3 provides further explanation on competition groups.)

### *2.4.3 Measure Characterization Approaches and Sources*

This section provides approaches and sources for the main measure characterization variables. The BC Utilities and Technical Advisory Committee reviewed Navigant's measure assumptions for each sector

[27] Navigant sourced density estimates from the residential end-use survey (REUS), commercial end-use survey (CEUS), BC Utility program data, and other related secondary resources.

and provided inputs to refine measure assumptions. Navigant also worked with CLEAResult to further customize industrial measures.

#### *2.4.3.1 Energy and Demand Savings*

Navigant took three general bottom-up approaches to analyzing residential and commercial measure energy and demand savings:

1. **TRM Standard Algorithms:** Navigant used TRM standard algorithms for unit energy savings and demand savings calculations for the majority of measures. FortisBC Gas provided coincidence factors for the residential sector.
2. **Program Evaluation Data:** Where available, Navigant used measure specific program evaluation data from the BC Utilities to inform energy savings.
3. **Engineering Analysis:** Navigant used appropriate engineering algorithms to calculate energy savings for any measures not included in BC Utility programs or available TRMs.

#### *2.4.3.2 Incremental Costs*

Navigant relied primarily on BC Utility provided program data and TRM data for incremental cost data. Navigant conducted secondary research and used other publicly available cost data sources such as the Database for Energy Efficient Resources (DEER), ENERGY STAR®, RSMeans, and the Michigan Energy Measures Database (MEMD) for all other cost data.[28]

#### *2.4.3.3 Building Stock and Densities*

The residential end-use survey (REUS) and commercial end-use survey (CEUS) provided building stock data for the BC Utility's service territory, enabling Navigant to characterize residential and commercial measures. The measure characterization workbooks include full documentation of assumptions applied to each measure. Navigant also used the REUS and CEUS reports to develop measure densities by customer segment. For measures not included in REUS and CEUS, Navigant reviewed other data sources such as NRCan for estimates.

#### *2.4.3.4 Industrial Measures*

The industrial sector measure characterization deploys a top-down approach, which differs from the residential and commercial sectors. Navigant characterized industrial measures as a percentage reduction of the customer segment and/or end-use consumption. CLEAResult evaluated past and recent project data from the BC Utilities to estimate the energy savings and incremental cost for all industrial measures.

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[28] For example, measure costs for new construction whole-building measures were gathered from a variety of sources. For residential measures, Navigant received data from the BC Utilities, and performed secondary research for measures where data was not provided. For Commercial whole-building new construction measures, Navigant leveraged RSMeans new construction cost data for Vancouver, BC and supplemented those costs with data from LEED and green building reports that reported incremental costs associated with higher energy savings. Navigant determined energy savings and costs for the discrete new construction measures in their entirety without analyzing what bundles of other CPR measures would make up a new construction measure.

### 2.4.4 Codes and Standards Adjustments

Natural Resources Canada publishes all energy efficiency regulations. Amendment 14[29] states that the intent of the amendment is to “align with energy efficiency standards in force or soon to be in force in the U.S.” The U.S. Department of Energy (DOE) Technical Support Documents (TSD)[30] contains information on energy and cost impact of each appliance standard. Engineering analysis is available in Chapter 5 of the TSD; energy use analysis is available in Chapter 7, and cost impact is available in Chapter 8.

As these codes and standards take effect, the energy savings from existing measures impacted by these codes and standards diminishes. Navigant accounts for the impact of codes and standards by baseline energy and cost multipliers—sourced from the DOE’s analysis—which reduce the baseline equipment consumption starting from the year a particular code or standard takes effect.[31] The baseline cost of an efficient measure impacted by codes and standards will often increase upon implementation of the code. Technical and economic savings potential presented in the model results includes savings potential from codes and standards, and measure-level results show their contribution to overall potential. Savings potential results do not consider fuel switching.[32]

The City of Vancouver By-Law (VBBL) varies from the National Building Code for insulation measures and water heating equipment. Navigant did not estimate the impact of the VBBL as the model segmentation does not drill down to city level granularity. City specific stock and sales data are not available to estimate the impact of the VBBL. Navigant expects the impact of VBBL to be small compared to the EE potential of the entire province. The majority of energy efficient savings from Part 9 buildings come from existing buildings in the near future. The VBBL does not require a specific upgrade level if the retrofit project is less than $5,000, which represents most residential measures in the model. Part 3 Buildings from VBBL references the National Building Code and ASHRAE 90.1 standards. The model assumes the National Building Code as the baseline for Part 3 buildings, therefore, the discrepancy in impact is minimal for commercial buildings.

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[29] Natural Resources Canada Amendment 14 to the Energy Efficiency Regulations. Access at: http://www.nrcan.gc.ca/energy/regulations-codes-standards/18437

[30] Appliance standards rulemaking notices and Technical Support Documents can be found at: http://energy.gov/eere/buildings/current-rulemakings-and-notices

[31] Navigant uses a similar method of applying multipliers for changes in measure economics over time if sufficient data exists for extrapolating such changes, e.g. reducing measure costs over time for Commercial High Efficiency Gas-Fired Condensing Rooftop Units (RTU).

[32] For example, if a natural gas heated new home is upgraded from the code-mandated performance level to an R-2000 home, the savings potential analysis assumes that this home remains natural gas heated.

# 3. TECHNICAL POTENTIAL FORECAST

This section describes Navigant's approach to calculating technical potential and presents the results for FortisBC Gas's service territory.

## 3.1 Approach to Estimating Technical Potential

This study defines technical potential as the total energy savings available assuming that all installed measures can *immediately* be replaced with the "efficient" measure/technology—wherever technically feasible—regardless of the cost, market acceptance, or whether a measure has failed and must be replaced.

Navigant used its DSMSim model to estimate the technical potential for demand side resources in the regions considered for this study. Navigant's modelling approach considers an energy-efficient measure to be any change made to a building, piece of equipment, process, or behaviour that could save energy. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure. Measures like condensing water heaters are best characterized as some fixed amount of savings per water heater; savings for measures like commercial automated building controls are typically characterized as a percentage of customer segment consumption; and measures like industrial ventilation heat recovery are characterized as a percentage of end-use consumption. The model can appropriately handle savings characterizations for all three methods.

The calculation of technical potential in this study differs depending on the assumed measure replacement type. Technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home) and total building stock in each service territory. The study accounts for three replacement types, where potential from retrofit and replace-on-burnout measures are calculated differently from potential for new measures. The formulae used to calculate technical potential by replacement type are shown below.

### 3.1.1 New Construction Measures

The cost of implementing new construction (NEW) measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock.[33] New building stock is added to keep up with forecast growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year, and this study uses a demolition rate of 0.5% per year for residential and commercial stock and 0% for industrial stock. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the incremental annual addition to technical potential, which is then added to totals from previous years to calculate the total potential in any given year. The equations used to calculate technical potential for new construction measures are provided below.

**Equation 1. Annual Incremental NEW Technical Potential (AITP)**

$AITP_{YEAR}$ = New $Buildings_{YEAR}$ (e.g., buildings/year[34]) X Measure Density (e.g., widgets/building) X $Savings_{YEAR}$ (e.g., GJ/widget) X Technical Suitability (dimensionless)

**Equation 2. Total NEW Technical Potential (TTP)**

$$TTP = \sum_{YEAR=2016}^{YEAR=2035} AITP_{YEAR}$$

### 3.1.2 Retrofit and Replace-on-Burnout Measures

Retrofit (RET) measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. Retrofit measures can also be efficient processes that are not currently in place and that are not required for operational purposes. Retrofit measures incur the full cost of implementation less a deferred replacement credit, rather than incurring a cost incremental to some other baseline technology or process because the customer could choose not to replace the measure and would therefore incur no costs.[35] In contrast, replace-on-burnout (ROB) measures, sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or they are existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing replace-on-burnout measures is always incremental to the cost of a baseline (and less efficient) measure.

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[33] In some cases, customer-segment-level and end-use-level consumption are used as proxies for building stock. These consumption figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.

[34] Units for new building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters of building space, number of residential homes, customer-segment consumption, etc.)

[35] This study's approach subtracts a deferred replacement credit from the full cost of implementation whenever the average remaining useful life of currently installed measures can be reasonably approximated. This methodology leads to a similar outcome as subtracting a salvage value from the full incremental cost. For more discussion of deferred replacement credits, see "Retrofit Economics 201: Correcting Commons Errors in Demand-Side Management Cost-Benefit Analysis" by Rachel Brailove, John Plunkett, and Jonathan Wallach.

Retrofit and replace-on-burnout measures have a different meaning for technical potential compared with new construction measures. In any given year, we use the entire building stock for the calculation of technical potential.[36] This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation. For retrofit and replace-on-burnout measures, annual potential is equal to total potential, thus offering an *instantaneous* view of technical potential. The equation used to calculate technical potential for retrofit and replace-on-burnout measures is provided below.

**Equation 3. Annual/Total RET/ROB Technical Savings Potential**

$$\text{Total Potential} = \text{Existing Building Stock}_{YEAR} \text{ (e.g., buildings}^{37}\text{) X Measure Density (e.g., widgets/building) X Savings}_{YEAR} \text{ (e.g., GJ/widget}^{38}\text{) X Technical Suitability (dimensionless)}$$

### *3.1.3 Competition Groups*

Navigant's modelling approach recognizes that some efficient technologies will compete against each other in the calculation of potential. The study defines "competition" as an efficient measure competing for the same installation as another efficient measure. For instance, a consumer has the choice to install a condensing or a near-condensing water heater, but not both. These efficient technologies compete for the same installation.

General characteristics of competing technologies used to define competition groups in this study include the following:

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption
- The total (baseline plus efficient) measure densities of competing efficient technologies are the same
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)
- Competing technologies share the same replacement type (RET, ROB, or NEW)

To address the overlapping nature of measures within a competition group, Navigant's analysis only selects one measure per competition group to include in the *summation* of technical potential across measures (e.g., at the end-use, customer segment, sector, service territory, or total level). The measure with the largest energy savings potential in a given competition group is used for calculating total technical potential of that competition group. This approach ensures that the aggregated technical potential does not double-count savings. However, the model still calculates the technical potential for

[36] In some cases, customer-segment-level and end-use-level consumption/sales are used as proxies for building stock. These consumption/sales figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.
[37] Units for building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters of building space, number of residential homes, customer-segment consumption/sales, etc.).
[38] To determine energy savings, Navigant consistently applies one measure-specific baseline across the entire measure life of each respective measure.

each individual measure outside of the summations.

## 3.2 Technical Potential Results

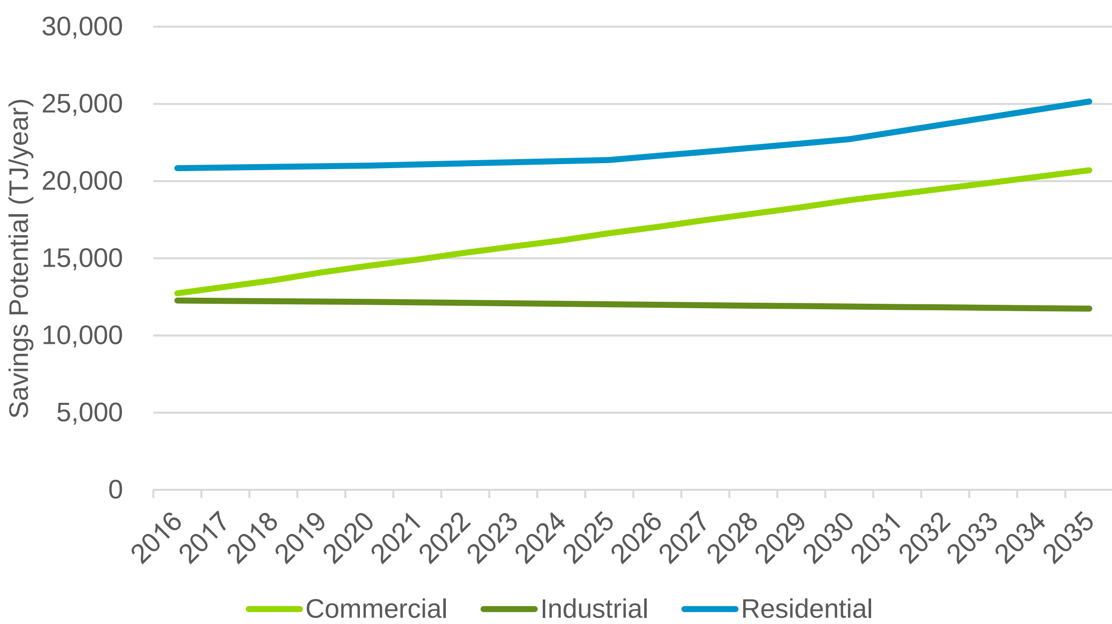
This section provides the technical savings potential calculated by the model at varying levels of aggregation. Results are shown by sector, customer segment, end-use category, and highest-impact measures. The section concludes with a review of natural change and its impacts on technical potential.

### *3.2.1 Results by Sector*

Figure 3-1 shows the total gas energy technical savings potential split by sector, and Table D-3 in Appendix D provides the associated data. As noted in previous sections, although apartments were included in the residential sector for the Base Year and Reference Case analyses, technical and economic savings potential from apartments are reported with the commercial sector to align with FortisBC Gas's categorization for conservation programs.

The increased rate of growth in residential technical potential beginning around 2025 is due to improvements in whole-building energy efficiency practices for single-family detached homes. The upward trend in the commercial sector stems largely from high-impact whole-building new construction measures as well. Of the largest contributing industrial customer segments, reductions in potential from greenhouses and food and beverage outpace the increase in potential from manufacturing, leading to a slight decrease in industrial potential over the forecast period.

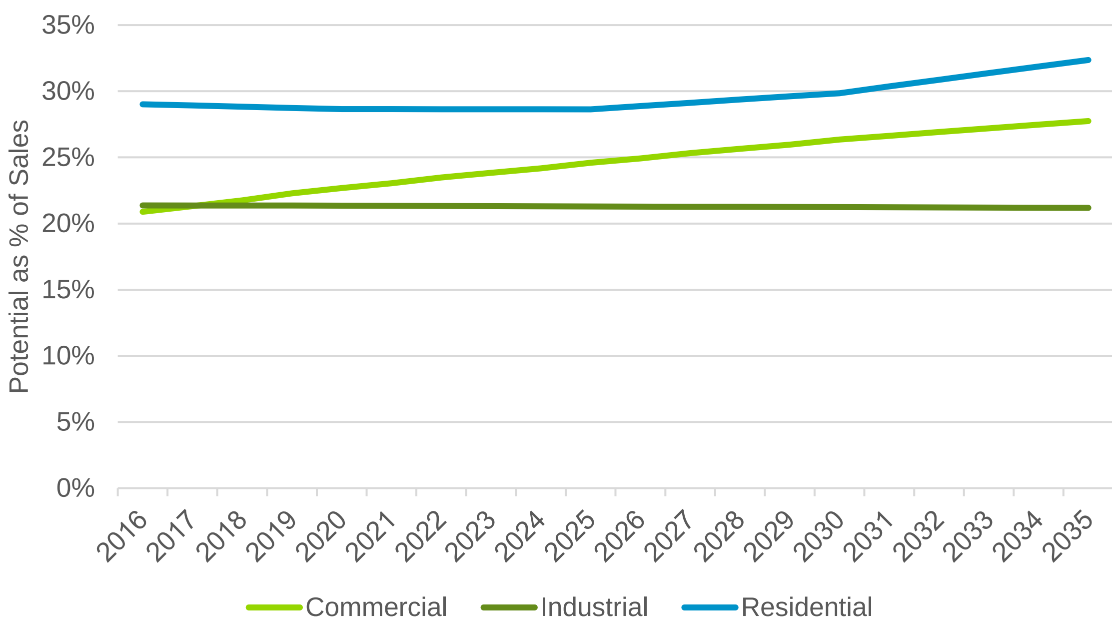
**Figure 3-1. Gas Energy Technical Savings Potential by Sector (TJ/year)**




*Source: Navigant*

Figure 3-2 shows the gas energy technical savings potential as a percentage of each sector's total forecasted consumption. Table D-4 in Appendix D provides the associated data. The percentages reflect a weighted average savings among measures applicable to existing building stock and new building stock constructed during the study period. As such, upward-sloping sectors indicate that savings opportunities—on a percentage of consumption basis—are larger in new construction than existing construction. Although growth in total residential consumption declines over time, the high impact new construction measures—several of which were not available until later years—help the residential percentages recover an upward trend by 2026. The commercial sector benefits from new construction measures with significant savings. New construction opportunities in the industrial sector are limited because many of the customer segments show no growth in the consumption forecasts. As such, the vast majority of savings from the industrial sector come from existing facilities rather than facilities constructed during the forecast period.

**Figure 3-2. Gas Energy Technical Savings Potential by Sector as a Percent of Sector Consumption (%)**

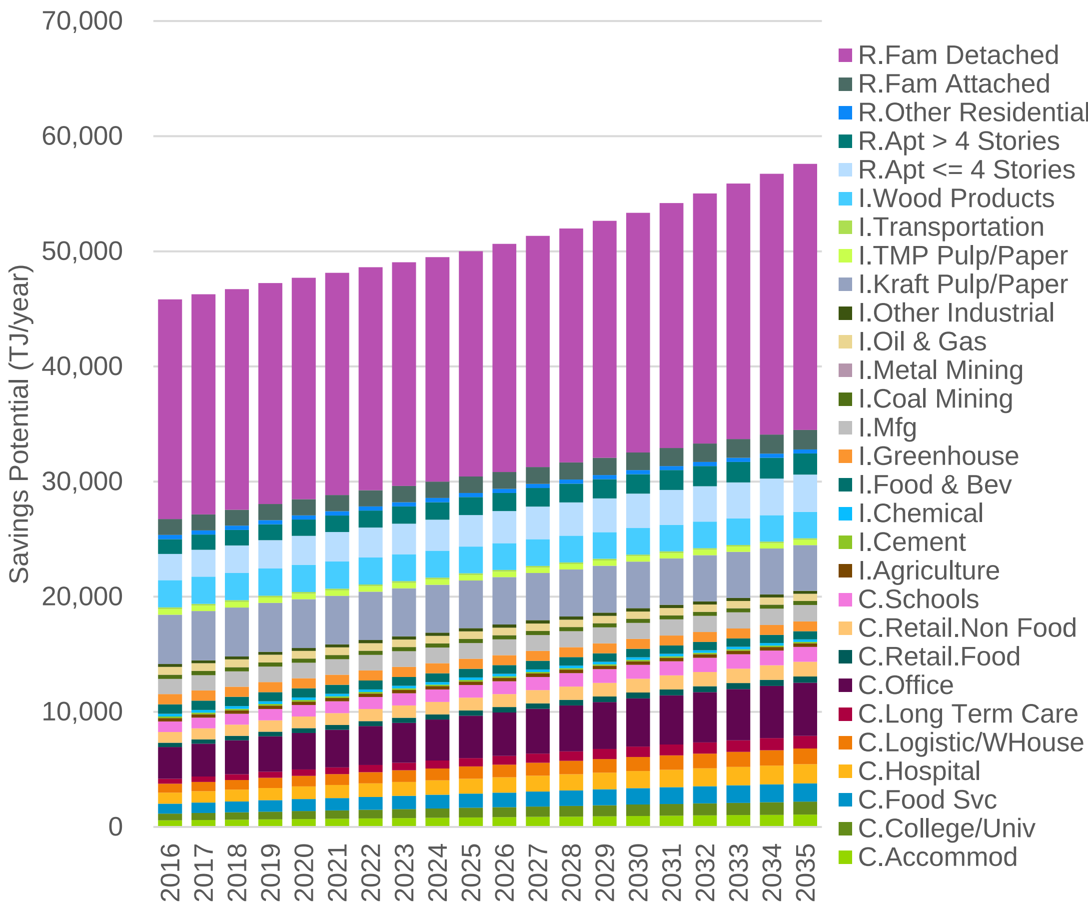



*Source: Navigant*

### *3.2.2 Results by Customer Segment*

Figure 3-3 shows the gas energy technical savings potential across all customer segments, and Table D-5 in Appendix D provides the associated data.[39] This figure highlights the large savings potential of the residential detached single-family home customer segment relative to other customer segments. The growth in potential for the detached single-family home segment is the largest contributor to the increase in savings potential in the last ten years of the study. This coincides with the improvements to efficient home construction practices that reach maturity toward the end of the forecast. The savings opportunities from new construction buildings (45% above code) boost potential for most commercial segments. [40]

**Figure 3-3. Gas Energy Technical Savings Potential by Customer Segment (TJ/year)**




*Source: Navigant*

[39] The LNG segment does not appear in this figure because FortisBC Gas does not supply natural gas to LNG facilities. Gas sales to LNG facilities are zero across the Reference Case forecast, hence, the savings potential is also zero.

[40] Note that whole-building, new construction measures do not necessarily align with provincial energy *step* codes. For example, while the new construction 30% and 45% better than code measures were selected to broadly align with step codes, savings attributed to these measures are calculated based on overall energy consumption, and not based on a particular building code requirement stated in the step codes.

Figure 3-4, Figure 3-5, and Figure 3-6 break out the gas energy technical savings potential for each sector by customer segment. For the residential sector, detached single-family homes represents the largest savings potential of any customer segment by far, accounting for 91% of the total savings potential. Offices and apartments provide approximately half of the savings in the commercial sector. In general, the distribution of savings among customer segments aligns well with the distribution of gas consumption among segments. In the industrial sector, kraft pulp and paper accounts for the largest share of energy savings at 35%. Wood products and manufacturing also provide significant savings among industrial segments.

**Figure 3-4. Residential Gas Energy Technical Potential Customer Segment Breakdown in 2025**

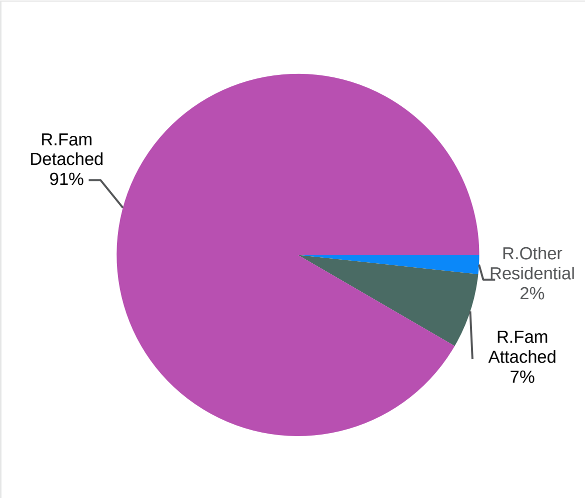



**Figure 3-5. Commercial Gas Energy Technical Potential Customer Segment Breakdown in 2025**

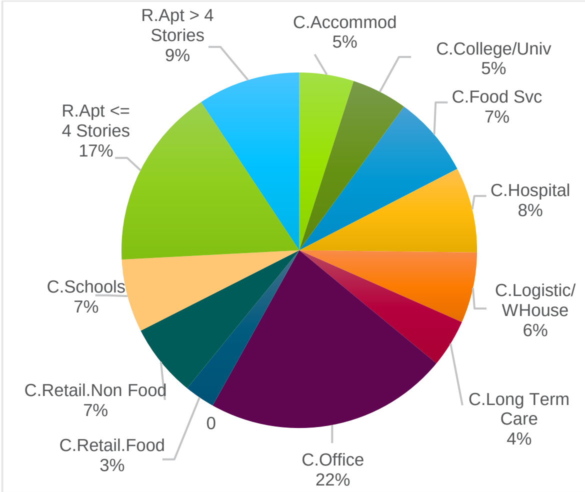
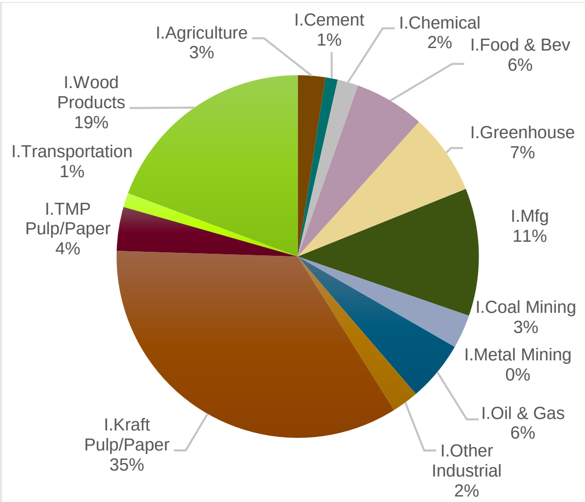



**Figure 3-6. Industrial Gas Energy Technical Potential Customer Segment Breakdown in 2025**

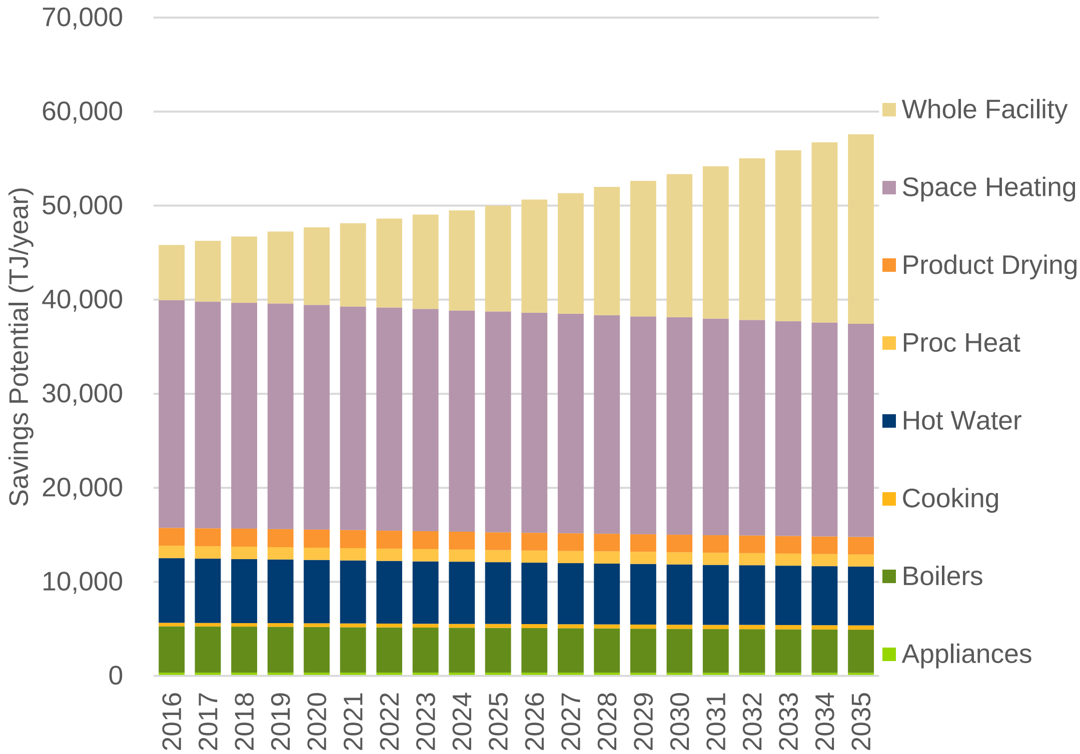



*Source: Navigant*

### *3.2.3 Results by End-use*

Figure 3-7 shows the gas energy technical savings potential across end-uses. The data used to generate the figure are in Table D-6 in Appendix D. The dominant end-uses are space heating and whole facility. The bulk of savings potential in the space heating end-use come from smart thermostats. The whole facility end-use primarily consists of savings from comprehensive whole-facility new construction practices and energy management programs. As such, these whole-facility savings implicitly include savings from multiple end-uses.

**Figure 3-7. Gas Energy Technical Savings Potential by End-Use across sectors (TJ/year)**




*Source: Navigant*

Figure 3-8, Figure 3-9, and Figure 3-10 break out the gas energy technical savings potential for each sector. The space heating and hot water end-uses dominate the residential sector, together accounting for 87% of the total savings potential. In the residential sector, smart thermostats and efficient fireplaces are the two largest space heating measures, while condensing and non-condensing gas tankless water heaters contribute significantly to the hot water end-use's savings.[41] In the commercial sector, the space heating and whole facility end-uses account for roughly 89% of the total technical savings potential. Savings in commercial space heating come largely from wall insulation, HVAC control upgrades, and condensing make-up air units. Boilers measures, which are included in the hot water and space heating end-uses account for roughly 13% of the technical potential. The whole-facility end-use's savings are driven by new building construction practices that are at least 45% above code. While the appliances end-use is not inherent to the commercial sector, the inclusion of apartment buildings in the commercial sector means that savings from appliances are also reported in the commercial sector. In the industrial sector, the boiler end-use plays the largest role, consisting of high savings measures like process boiler load control and heat recovery systems.

[41] Note that efficient fireplaces and envelope upgrade measures are classified as space heating measures.

**Figure 3-8. Residential Gas Energy Technical Potential End-Use Breakdown in 2025**

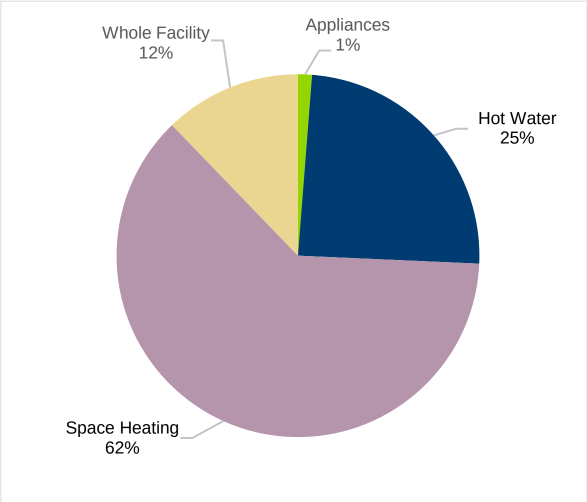



**Figure 3-9. Commercial Gas Energy Technical Potential End-Use Breakdown in 2025**

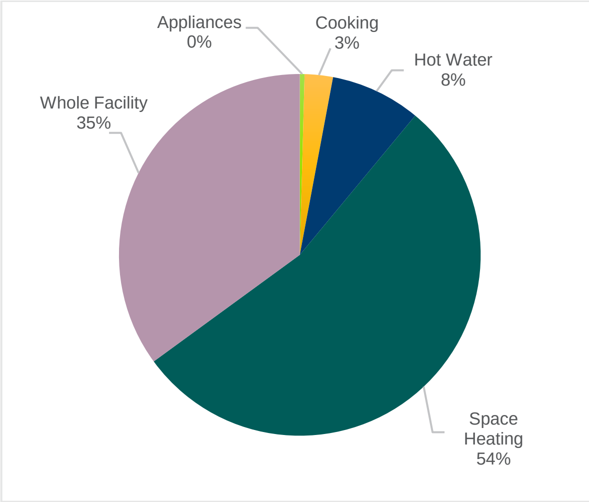
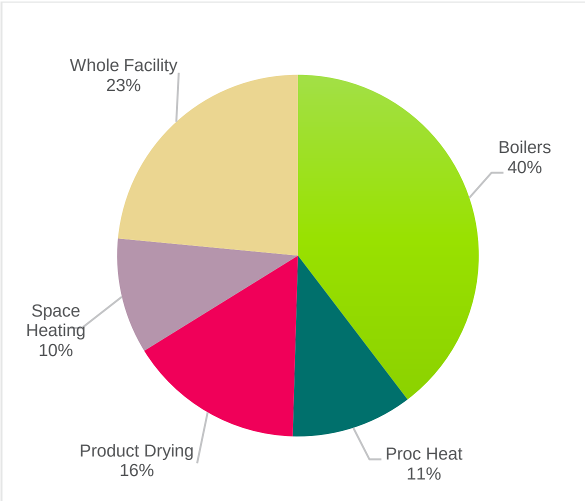



**Figure 3-10. Industrial Gas Energy Technical Potential End-Use Breakdown in 2025[42]**




*Source: Navigant*

### *3.2.4 Results by Measure*

The measure-level savings potential shown in Figure 3-11 is prior to adjustments made to competition groups. Some of the measures shown here are not included in the customer segment, end-use, sector and portfolio totals because they are not the measures with the greatest savings potential for their respective competition group.

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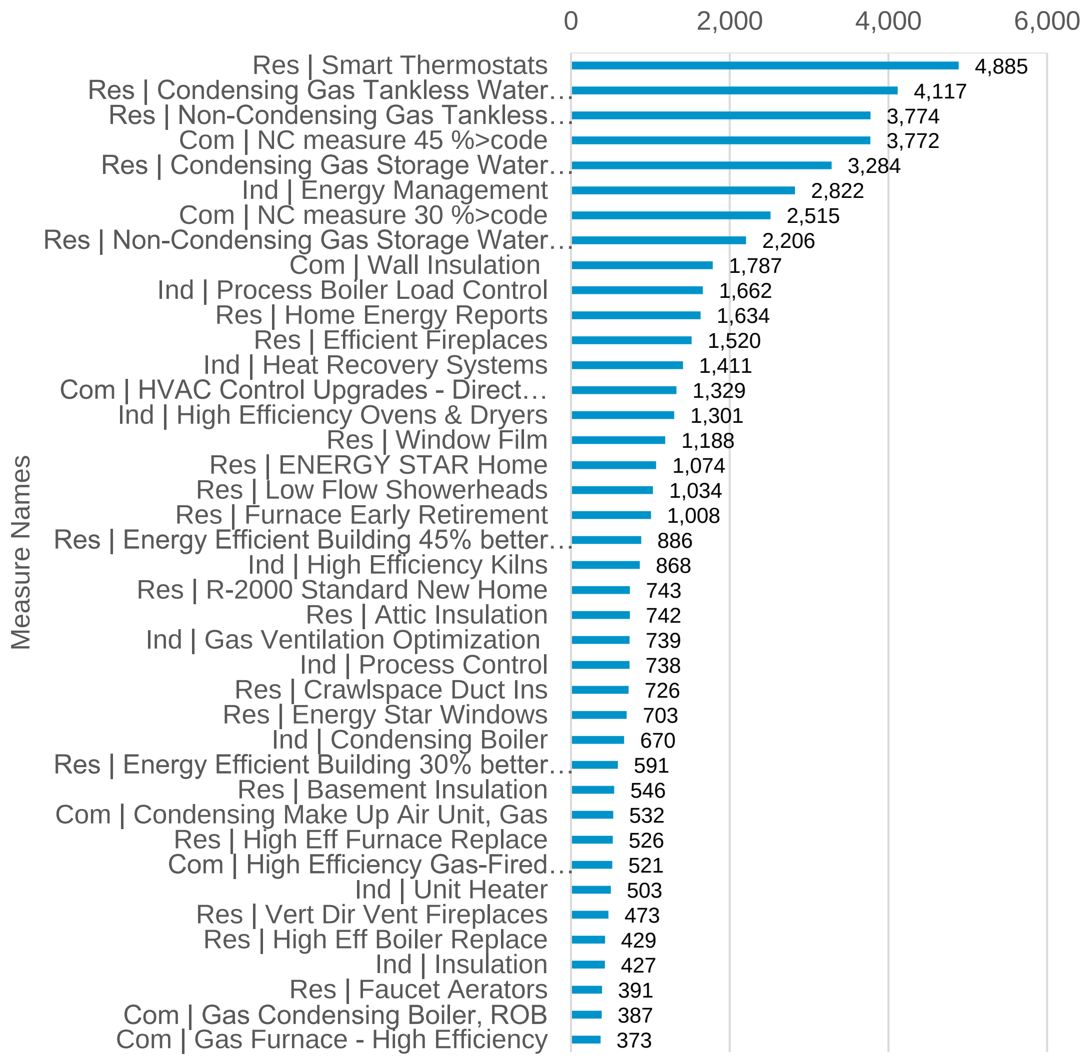
[42] Note that no natural gas energy savings measures are assigned to the *industrial process* end use. As a result, no energy savings potential is reported for this end use.

The figure presents the top forty measures ranked by their gas energy technical savings potential in 2025. Wherever a group of measures were similar in nature, Navigant consolidated their potential into a representative measure name to produce a more succinct view at the measure level. For example, the energy management potential in the figure represents the technical savings potential for industrial energy management and commercial energy management, which encompass energy savings opportunities unique to each sector.

When code-change measures become applicable, they “steal” savings potential from other related measures that may display significant savings in absence of the code. In this way, the sum of the total savings potential between the code and the related energy-efficient measure is the same before and after a code takes effect. This ensures there is no double counting of savings from codes and the energy efficient measures impacted by the code.

The top ten measures come from the space heating, whole-facility, and hot water end-uses. However, non-condensing gas tankless water heaters, new construction building practices at least 30% better than code, and condensing storage water heaters are in competition with other higher impact measures, so their savings do not contribute to aggregate potential results. Smart thermostats and energy management are two of the top ten measures that provide savings in multiple sectors. Thermostats contribute to residential and commercial savings.

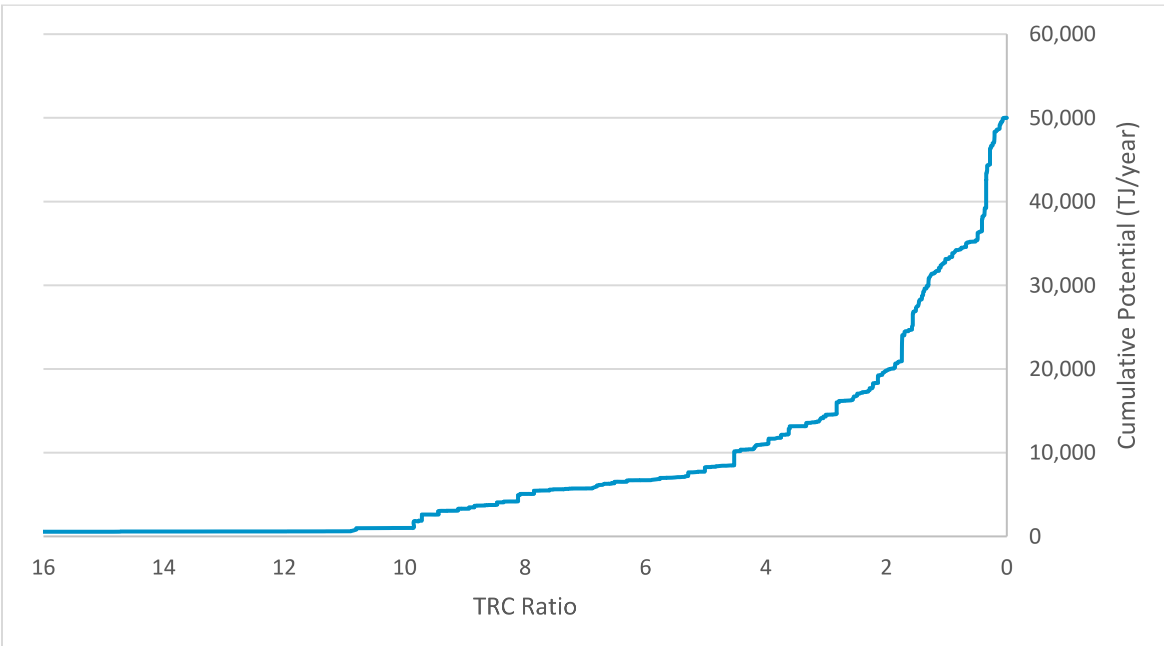
**Figure 3-11. Top 40 Measures for Gas Energy Technical Savings Potential in 2025 (TJ/year)**




*Source: Navigant*

Figure 3-12 provides a supply curve of technical savings potential versus the TRC ratio for all measures considered in the study. Navigant truncated this curve only to show TRC ratios below 16, although the full curve would extend well beyond this ratio. Much of the potential with TRC ratios larger than 16 come from new codes and standards measures, which the team modelled as having zero costs and infinite TRC ratios. There is a distinct “elbow” in the supply curve at a TRC ratio of about 4.0, indicating the majority of savings coming from measures with TRC ratios less than 4.0. For TRC ratios below 4.0, cumulative potential increases to about 33,000 TJ/year at a ratio of 1.0. Measures with TRC ratios less than 1.0 are non-cost-effective and do not appear in the economic potential.

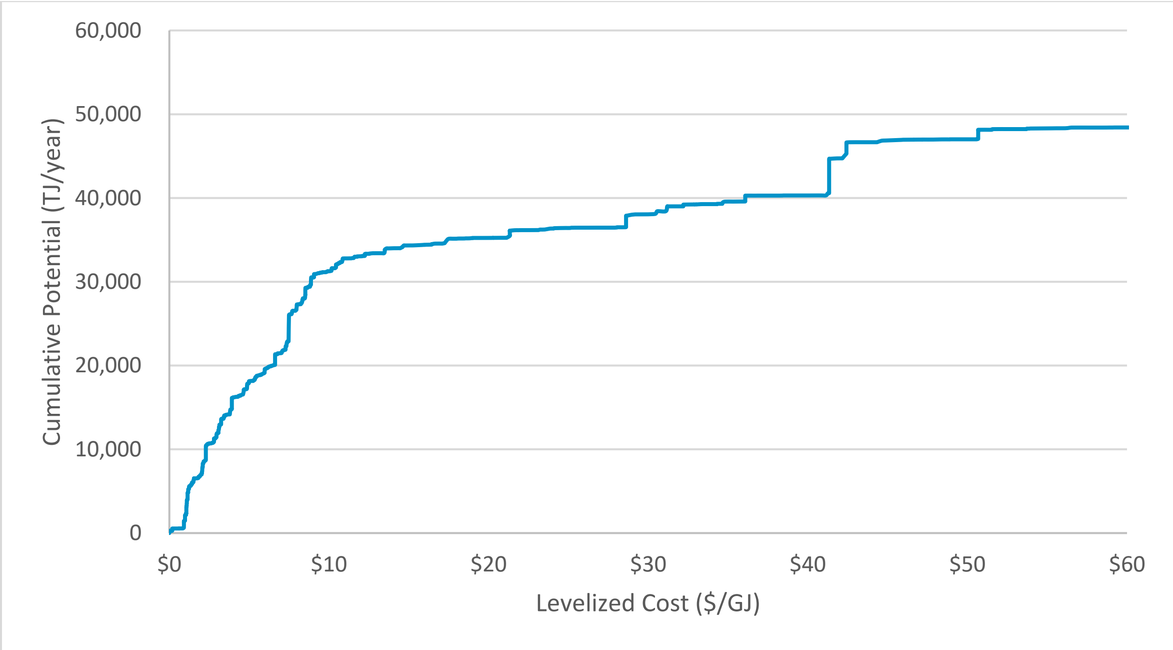
**Figure 3-12. Supply Curve of Gas Energy Technical Potential (TJ/year) vs. TRC Ratio (ratio) in 2025**




*Source: Navigant*

Figure 3-13 provides a supply curve of savings potential versus levelized cost of savings in $/GJ for all measures considered in the study. Navigant truncated this curve to show only those measures with a levelized cost less than $60/GJ, though the full curve would extend beyond this to measures with costlier savings. The savings potential having a cost of $0/GJ is due to code-change measures, which Navigant modelled as having zero costs. Total cumulative savings potential increase steadily to just over 48,000 TJ/year at a cost of $60/GJ, beyond which costlier modes of savings add minimal cumulative potential.

**Figure 3-13. Supply Curve of Gas Energy Technical Potential (TJ/year) vs. Levelized Cost of Savings ($/GJ) in 2025**



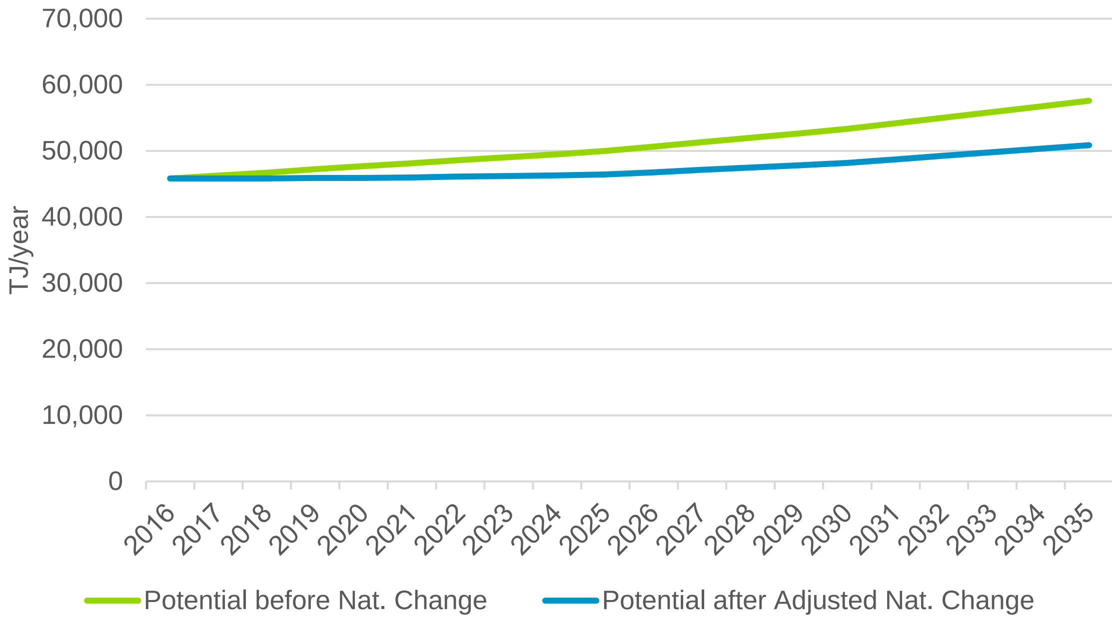

*Source: Navigant*

### *3.2.5 Adjustments for Natural Change*

As discussed in section 2.3.2, Navigant estimated natural change to account for differences in end-use consumption in the Reference Case compared to the frozen EUI case. Natural change accounts for changes in consumption that are naturally occurring and are not the result of utility-sponsored programs or incentives. Adding natural change to the frozen EUI case required adjusting the technical potential forecasts accordingly.

Figure 3-14 shows the total technical potential across all sectors before and after adjusting for natural change. The total natural change across all sectors is negative in all years, indicating an overall natural tendency toward increased energy conservation rather than growth. The adjusted natural change is computed by accounting for the percentage of the gross natural change that could reasonably be attributed to energy savings for each end-use. On average across the study period, the technical potential after adjusted natural change is roughly 7% lower than the potential prior to natural change.

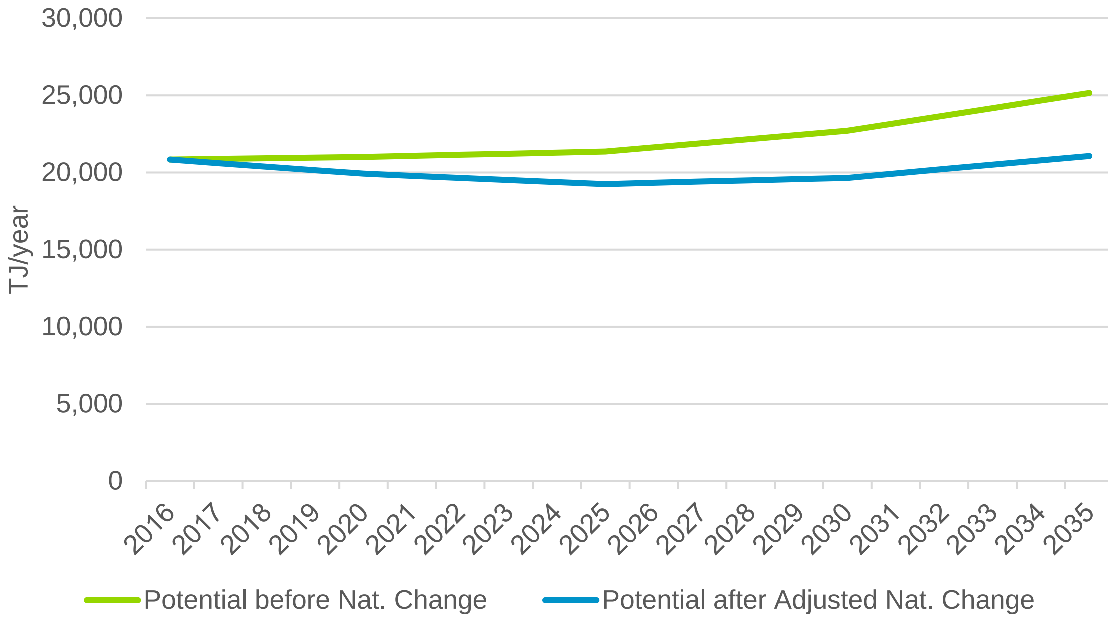
**Figure 3-14. Gas Energy Technical Savings Potential with Natural Change – All Sectors (TJ/year)**




*Source: Navigant*

Figure 3-15 shows the effect of adjustments for natural change in the residential sector. Space heating and hot water end-uses account for significant natural conservation. In contrast, appliances account for a minor amount of natural growth. When aggregated to the sector level, natural conservation has a much larger effect than natural growth. On average across the study period, the residential technical potential after adjusted natural change is roughly 10% lower than the potential prior to natural change.

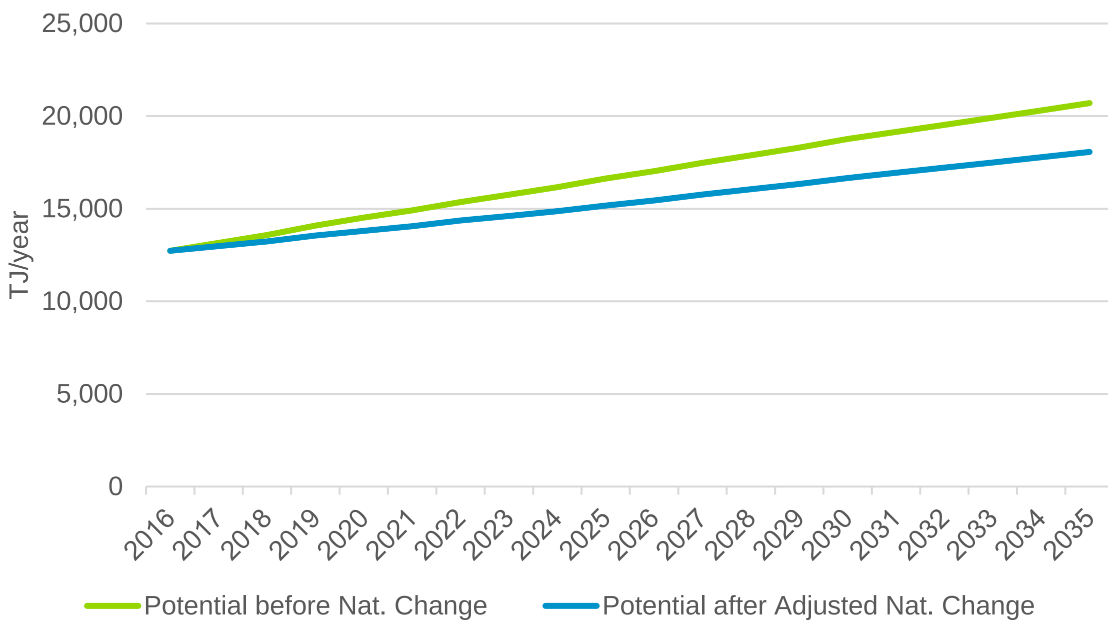
**Figure 3-15. Residential Gas Energy Technical Savings Potential with Natural Change (TJ/year)**




*Source: Navigant*

The effect of adjustments for natural change on the commercial sector's technical potential is slightly less than for the residential sector, as seen in Figure 3-16. Space heating and hot water are the commercial end-uses contributing to natural change, and both exhibit natural conservation. On average across the study period, the commercial technical potential after adjusted natural change is roughly 9% lower than the potential prior to natural change.

**Figure 3-16. Commercial Gas Energy Technical Savings Potential with Natural Change (TJ/year)**




*Source: Navigant*

For the industrial sector, there was no forecasted natural change, so adjustments to the technical potential results presented in previous sections were not necessary.

# 4. ECONOMIC POTENTIAL FORECAST

This section describes the economic savings potential, which is potential that meets a prescribed level of cost effectiveness, available in the BC Utilities' service territories. The section begins by explaining Navigant's approach to calculating economic potential. It then presents the results for economic potential.

## 4.1 Approach to Estimating Economic Potential

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening (in this case the Total Resource Cost (TRC) test, per the BC Utilities' guidance). The TRC ratio for each measure is calculated each year and compared against the measure-level TRC ratio screening threshold of 1.0. A measure with a TRC ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's TRC meets or exceeds the threshold, it is included in the economic potential.

The TRC test is a cost-benefit metric that measures the net benefits of energy efficiency measures from combined stakeholder viewpoint of the utility (or program administrator) and the customers. The model calculates the TRC benefit-cost ratio using the following equation:

**Equation 4. Benefit-Cost Ratio for Total Resource Cost Test**

$$TRC = \frac{PV(Avoided\ Costs + O\&M\ Savings)}{PV(Technology\ Cost + Admin\ Costs)}$$

Where:

- *PV( )* is the present value calculation that discounts cost streams over time;
- *Avoided Costs* are the monetary benefits resulting from gas and electric savings (e.g., avoided costs of infrastructure investments, as well as avoided commodity costs due to gas and/or electric energy conserved by efficient measures);
- *O&M Savings* are the non-energy benefits such as operation and maintenance cost savings;
- *Technology Cost* is the incremental equipment cost to the customer;
- *Admin Costs* are the administrative costs incurred by the utility or program administrator.

Navigant calculated TRC ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's life. Appendix A.3 presents the avoided costs, discount rates, and other key data inputs used in the TRC calculation, and Appendix A.2 provides measure-specific inputs. As agreed upon with the BC Utilities, effects of free ridership are not present in the results from this study, so no net-to-gross (NTG) factor was applied. Providing gross savings results will allow the BC Utilities to easily apply updated NTG assumptions in the future, as well as allow for variations in NTG assumptions by reviewers.

Although the TRC equation includes administrative costs, the study does not consider these costs during the economic screening process because an individual measure's cost effectiveness "on the margin" is the primary focus. Additionally, Navigant excluded administrative costs from this analysis because those costs are largely driven by program design, which is outside of the scope of this evaluation.

Similar to technical potential, only one "economic" measure (meaning that its TRC ratio meets the 1.0 threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end-use category, customer segment, sector, service territory or total level). If a competition group is composed of more than one measure that passes the TRC test, then the economic measure that provides the greatest gas savings potential is included in the summation of economic potential. This approach ensures that double counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated and reported outside of the summation.

## 4.2 Economic Potential Results

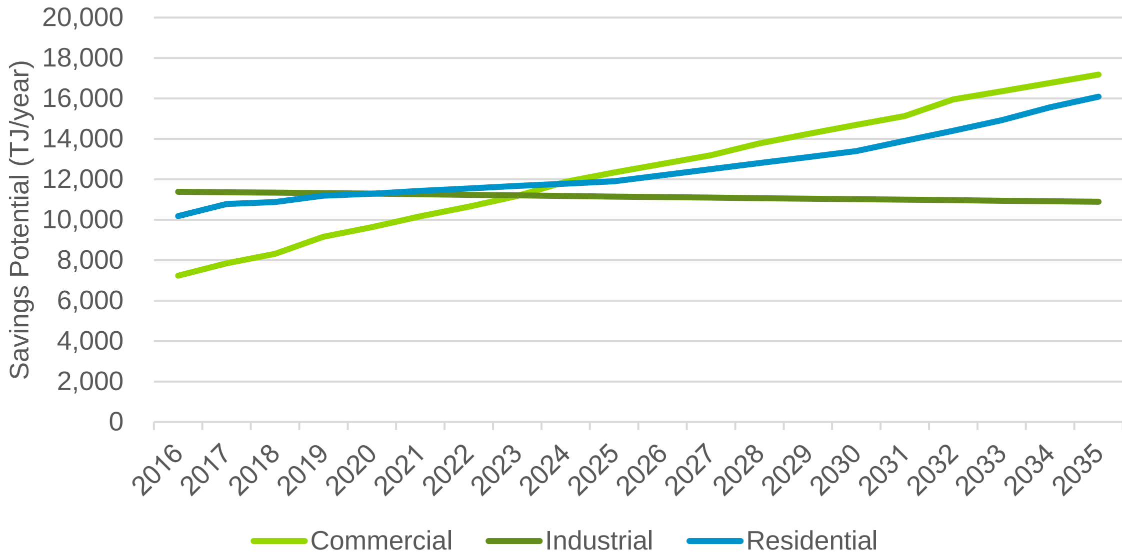
This section provides the results pertaining to economic savings potential at different forms of aggregation. Results are shown by sector, customer segment, end-use category and highest-impact measures.

### *4.2.1 Results by Sector*

Figure 4-1 shows economic gas savings potential across all sectors. The data used to generate the figure are in Table D-7 in Appendix D. In contrast to technical potential, the residential economic potential shows a steady growth through 2035. The commercial economic potential grows nearly twice as fast as the technical potential. The industrial sector's economic potential exhibits similar decay trends as the technical potential. On average across the study period, 57% of residential, 74% of commercial and 93% of industrial technical potential pass the economic screening process.[43]

[43] The BC Utilities Commission (BCUC) allows for the use of a modified-TRC test (mTRC) for evaluating cost-effectiveness of energy efficiency measures. The mTRC test is based on higher avoided energy costs, and produces different results in comparison with the standard TRC test. The use of the mTRC test for economic potential is not in the scope of this portion of the BC CPR.

**Figure 4-1. Gas Energy Economic Savings Potential by Sector (TJ/year)**



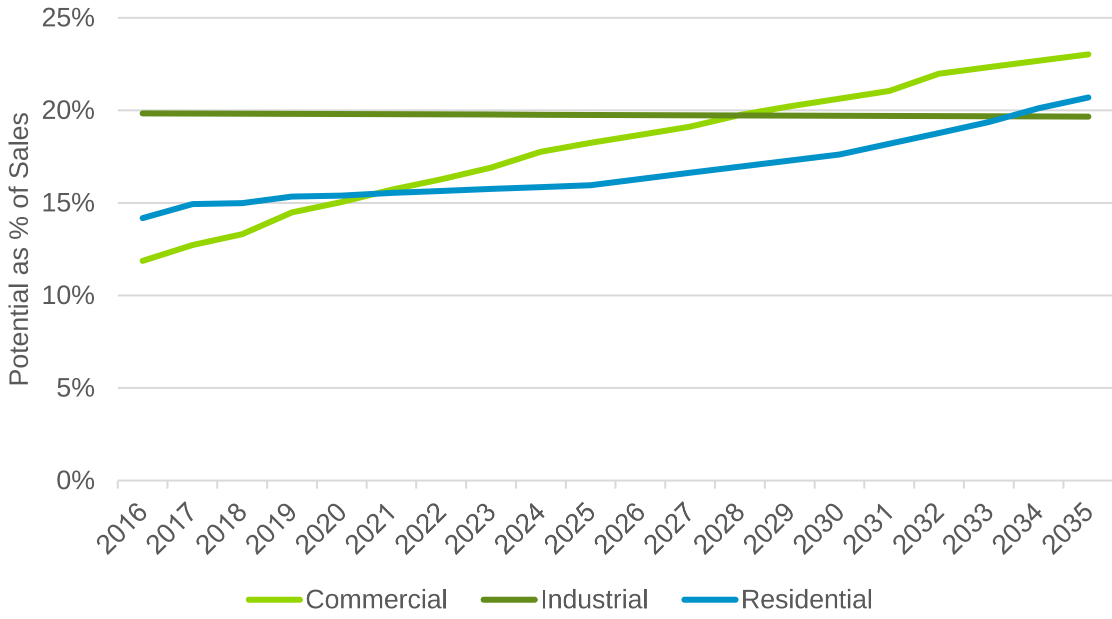

*Source: Navigant*

The bumps in select years of the residential and commercial economic potential occur whenever one or more measures cross the cost-effectiveness threshold in one or more customer segments. The slope of energy savings over time reflect changes in gas sales and the roll-out of high-efficiency, new construction measures. These measures having TRC ratios slightly less than 1.0 at the beginning of the study period become economically feasible as ***avoided gas costs—which escalate at a faster rate than equipment, operation and maintenance costs***—increase throughout the study the period. For example, smart thermostats become cost-effective in 2017 for the residential sector. The bumps in commercial economic potential prior to 2026 result from HVAC control upgrades using direct digital data control becoming cost-effective in various customer segments and years. When vertical direct-vent fireplaces become economically feasible in 2031, it induces the final visible jump in commercial potential.

Technical and economic energy potential are similar in the industrial sector because the measures included in the study are selected on the premise that they are currently or could become reasonably attractive to industrial customers and have some likelihood of adoption given a wide range of market environments. Considering many industrial customers purchase gas in bulk at rates lower than other customers, market experience has shown industrial customers require measures to be more economic than residential and commercial customers do. Thus, the measures deemed reasonably attractive to industrial customers tend to fair very well in a TRC ratio using the utility's avoided costs, which are often higher than industrial gas retail rates.

Figure 4-2 shows the economic gas savings potential as a percentage of gas consumption, with associated data presented in Table D-8 in Appendix D. Though it had the lowest technical potential as a percentage of consumption, the industrial sector had the highest percentages for economic potential. For the residential sector, the introduction of new whole-home new construction measures allowed the sector to increase economic savings despite the limited growth in residential consumption. Similarly, whole-building new construction practices in the commercial sector enable the increase in savings potential as a percent of commercial-sector consumption over time.

**Figure 4-2. Gas Energy Economic Savings Potential by Sector as a Percent of Sector Consumption (%)**

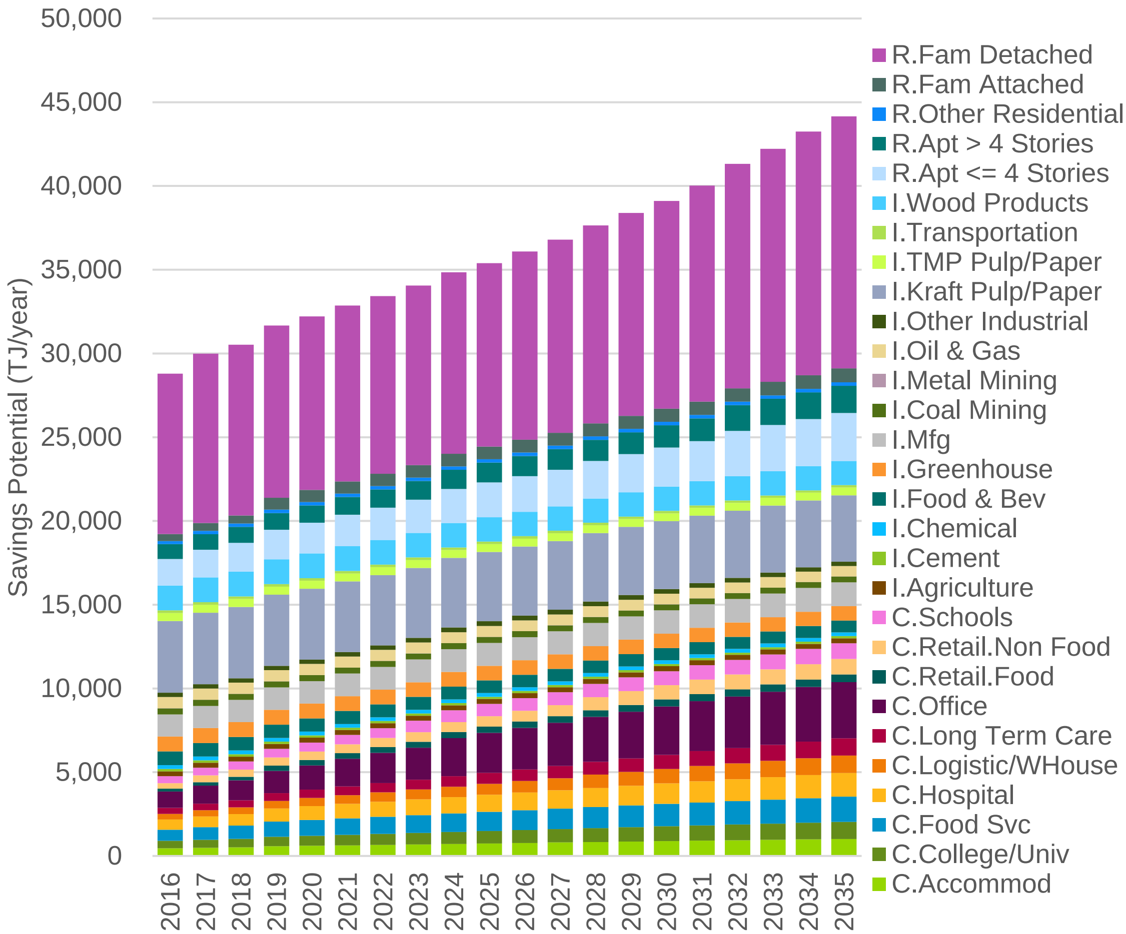



*Source: Navigant*

### 4.2.2 Results by Customer Segment

Figure 4-3 depicts the economic energy savings potential for all customer segments, and Table D-9 in Appendix D provides the corresponding data values. Depending on the customer segment, between 49% and 57% of the technical energy potential pass the economic screening threshold within the residential sector. The greatest reduction from technical potential to economic potential appeared in single-family attached homes, while the smallest reduction occurs in single-family detached homes. For the commercial customer segments, the reduction in economic potential relative to technical potential ranges from 59% to 92%. Non-food retail establishments see the greatest loss from non-economic potential, while long term care facilities are the most resilient. In the industrial sector, high-efficiency kilns do not pass the economic screen.

**Figure 4-3. Gas Energy Economic Savings Potential by Customer Segment (TJ/year)**




*Source: Navigant*

In general, the mix of economic energy savings from various customer segments within a given sector is similar between economic and technical potential. Detached single-family homes is the segment with the highest fraction of savings potential that are economic, and they provide the largest share of economic savings potential within the residential sector. Similarly, the mix of economic potential from the commercial segments do not change appreciably relative to the technical potential. The wood products segment falls from 19% of the industrial technical potential mix to 13% of the economic potential. Figure 4-4, Figure 4-5 and Figure 4-6 provide a breakdown of economic energy potential by customer segment and sector.

**Figure 4-4. Residential Gas Energy Economic Potential Customer Segment Breakdown in 2025**

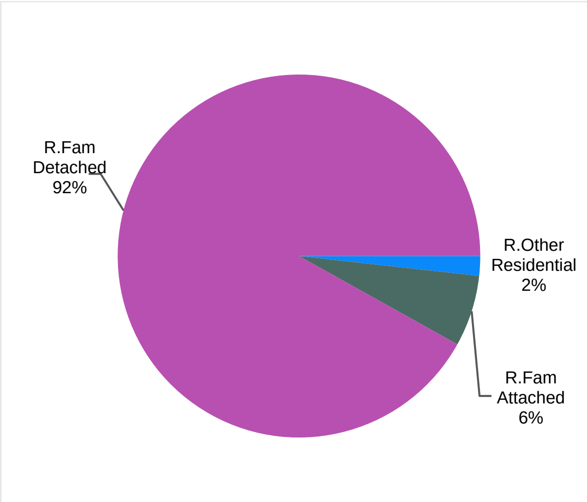



**Figure 4-5. Commercial Gas Energy Economic Potential Customer Segment Breakdown in 2025**

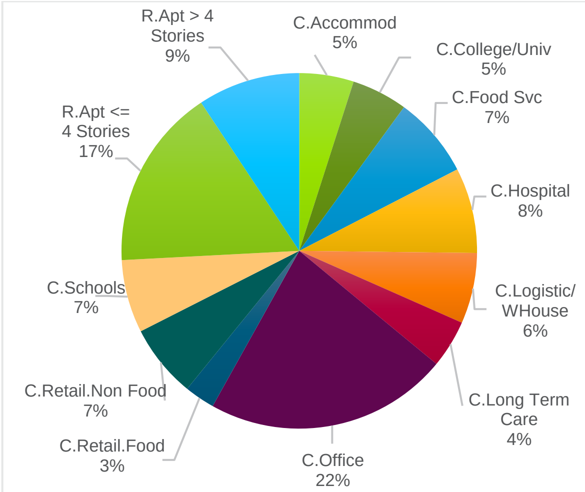
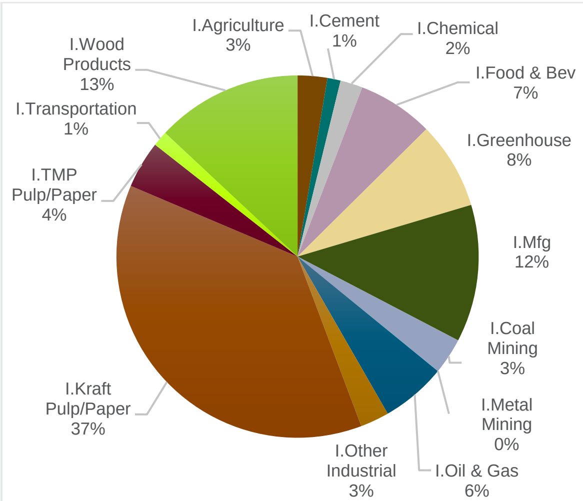



**Figure 4-6. Industrial Gas Energy Economic Potential Customer Segment Breakdown in 2025**

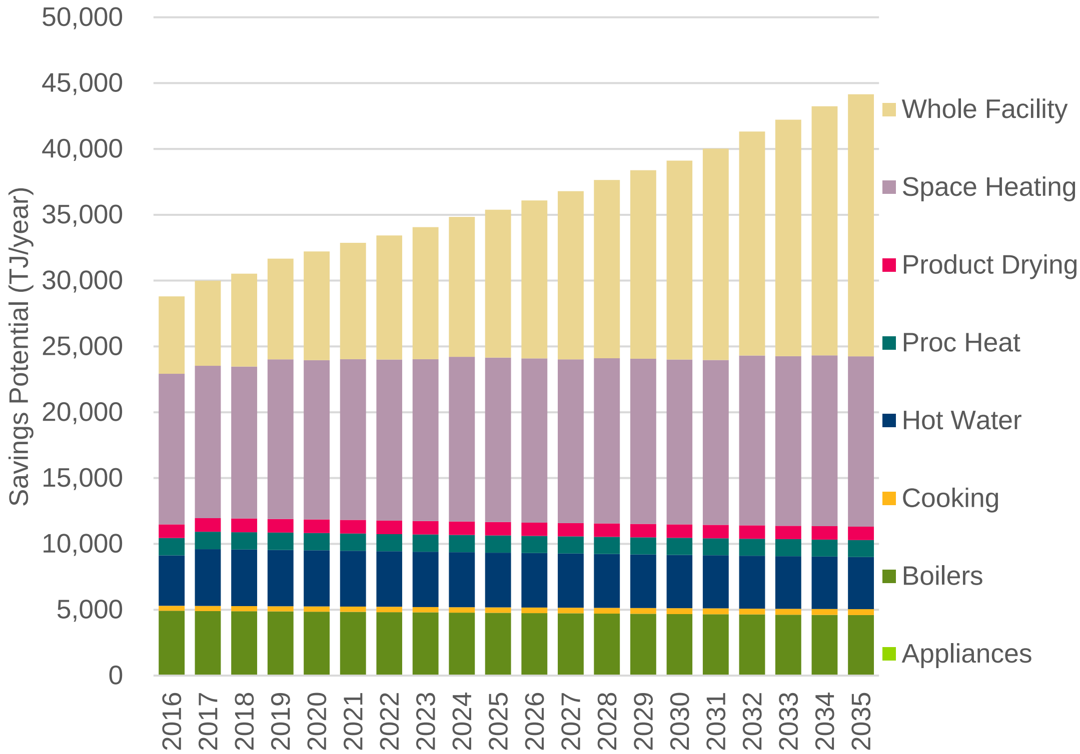



*Source: Navigant*

### *4.2.3 Results by End-use*

Depending on the end-use category, between 0% and 100% of the technical energy potential is cost-effective. The least economic end-uses across all customer sectors are appliances (0% of technical potential), space heating (53% of technical potential), and product drying (54% of technical potential). Boilers, cooking, and process heat are end-use categories that have economic potential of 100% of technical potential. Figure 4-7, shows the economic gas potential by end-use, with associated data in Table D-10 in Appendix D.

**Figure 4-7. Gas Energy Economic Savings Potential by End-Use (TJ/year)**




*Source: Navigant*

Figure 4-8, Figure 4-9 and Figure 4-10 provide the breakdown of economic energy potential by end-use categories within each sector. In the residential sector, space heating decreases from 62% to 52%, while whole facility increases from 12% to 22%. Similarly, in the commercial sector, space heating decreases from 54% to 41% of the total, while whole facility increases from 35% to 47%. Product drying declines by 7 percentage points in the makeup of industrial potential.

**Figure 4-8. Residential Gas Energy Economic Potential End-Use Breakdown in 2025**

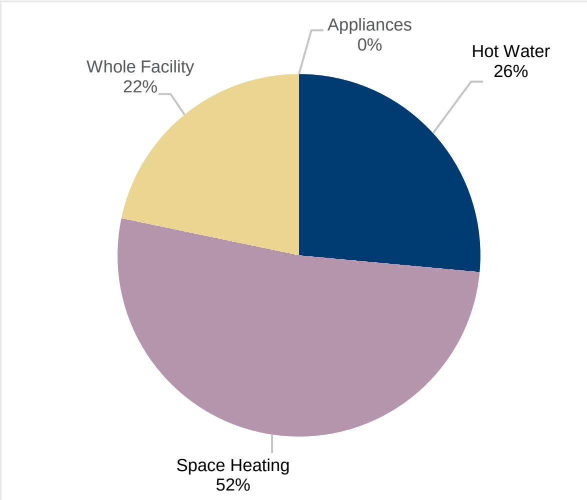



**Figure 4-9. Commercial Gas Energy Economic Potential End-Use Breakdown in 2025**

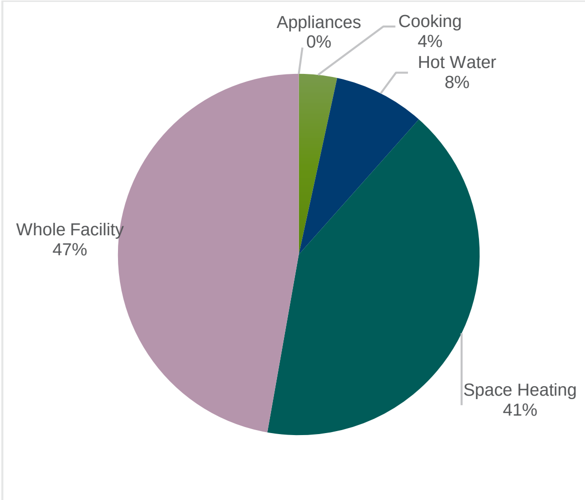
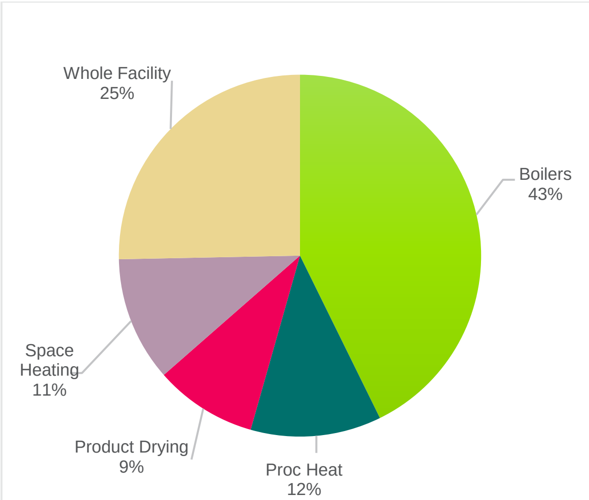



**Figure 4-10. Industrial Gas Energy Economic Potential End-Use Breakdown in 2025**

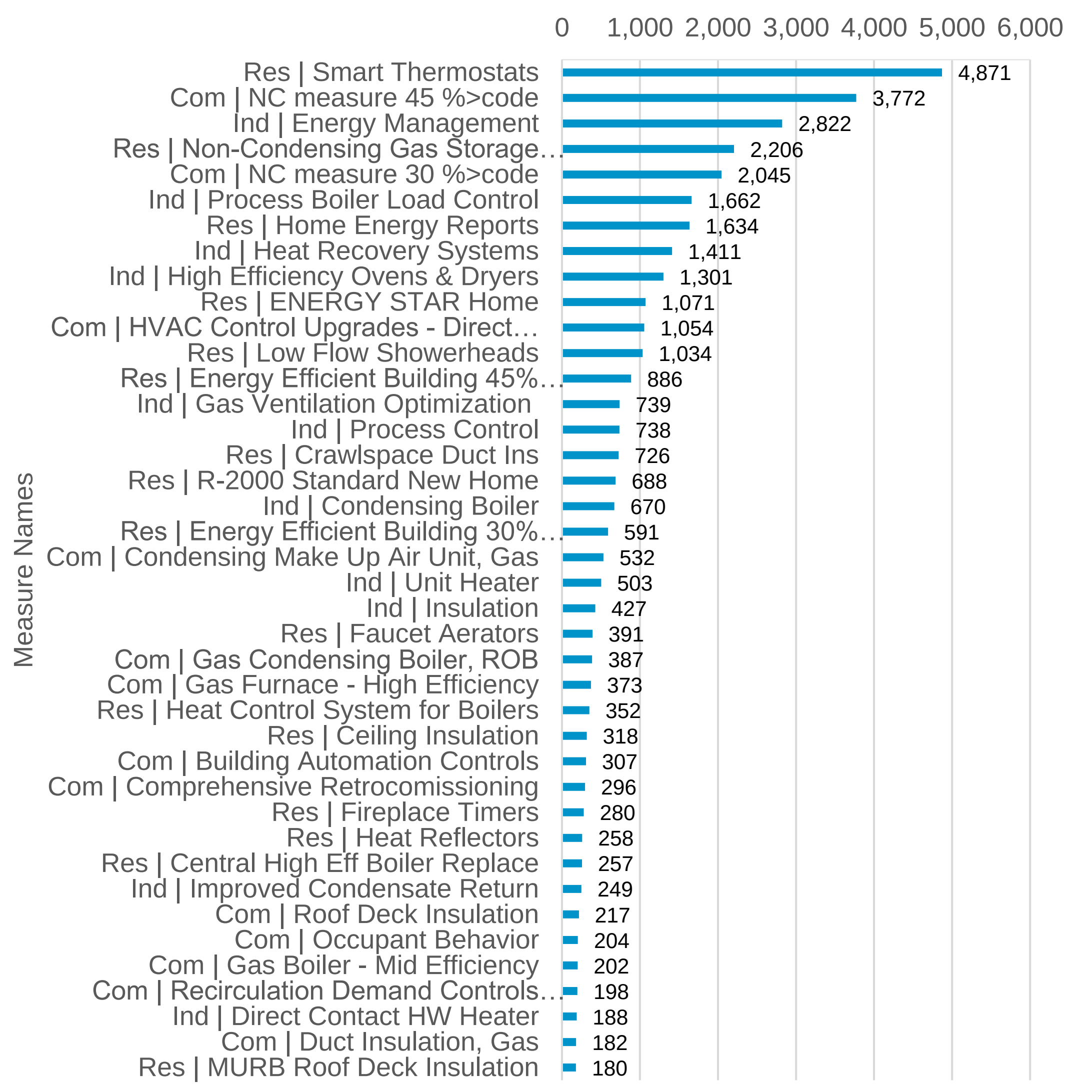



*Source: Navigant*

### *4.2.4 Results by Measure*

The measure-level economic energy savings potential shown in Figure 4-11 is prior to adjustments made to competition groups as detailed in Section 3.2.4. The figure highlights the economic potential from the top 40 highest-impact measures. When compared with the top 10 technical potential measures, three residential measures (condensing and non-condensing tankless water heaters and condensing storage water heaters), and one commercial measure (wall insulation) are not economic and fall out of the top 40. Measures pertaining to the industrial sector, such as energy management and process boiler load control, move up the rankings due to their economic potential remaining similar to their respective technical potential.

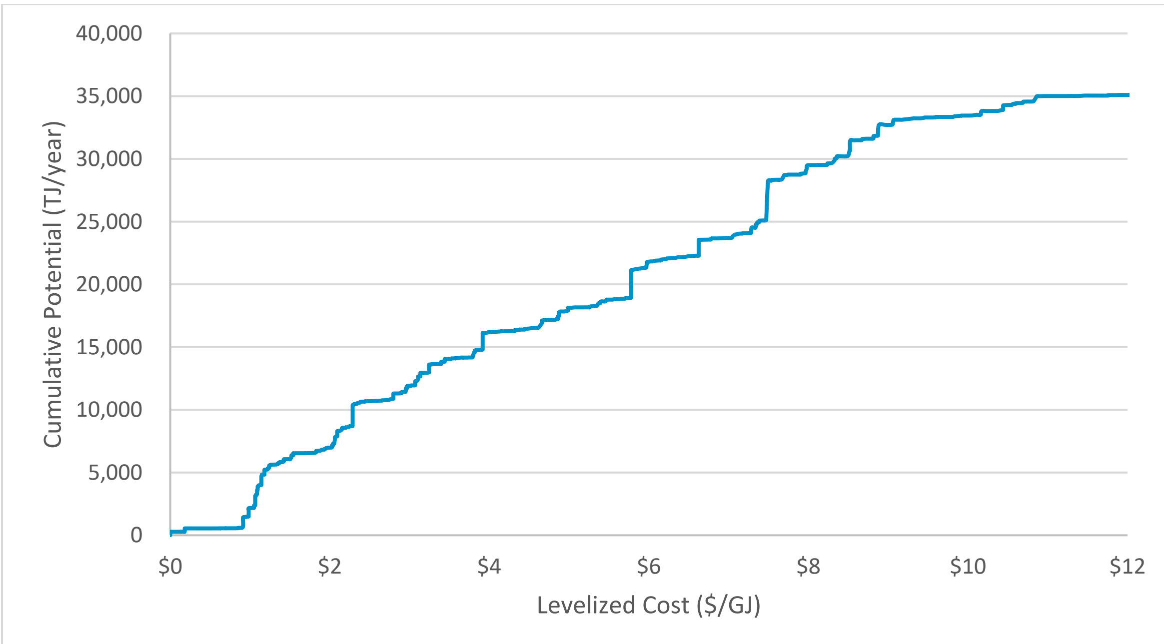
**Figure 4-11. Top 40 Measures for Economic Potential in 2025 (TJ/year)**




*Source: Navigant*

Figure 4-12 provides a supply curve of savings potential versus levelized cost of savings in $/GJ for all measures considered in the study. This curve shows only those measures with a levelized cost less than $12/GJ. While the full curve extends beyond the $12/GJ point to measures with costlier savings, savings from these measures is negligible since the curve flattens out. The savings potential seen at a cost of $0/GJ is due to code-change measures, which have zero costs in the model.

**Figure 4-12. Supply Curve of Gas Economic Potential (TJ/year) vs. Levelized Cost of Savings ($/GJ) in 2025**




*Source: Navigant*

# APPENDIX A. ADDITIONAL MODEL RESULTS AND INPUT ASSUMPTIONS

## A.1 Detailed Model Results

See attachment, “FortisGas_Appendix_A1_2017-01-23.xlsx,” for granular results from the model.

## A.2 Measure List and Characterization Assumptions

See attachment, “FortisGas_Appendix_A2_2017-01-23.xlsx,” for granular measure input to the model.

## A.3 Other Key Input Assumptions

See attachment, “FortisGas_Appendix_A3_2017-01-23.xlsx,” for key assumptions about building stocks, end-use intensities, avoided costs, discount rates, etc. used by the model.

# APPENDIX B. APPROACH TO BASELINE CALIBRATION

## B.1 End-Use Definitions

**Table B-1. Description of End-Uses[44],**

| Segment | End-Use | Definition |
|---|---|---|
| **Residential** | Appliances | Large/small appliances including ovens, refrigerators, freezers, clothes washers, etc. |
| | Electronics | Televisions, computers and related peripherals, and other electronic systems |
| | Water Heating | Heating of water for domestic hot water use |
| | Lighting | Interior, exterior and holiday/seasonal lighting |
| | Other | Miscellaneous loads |
| | Space Cooling | All space cooling, including both central AC and room or portable AC |
| | Space Heating | All space heating, including both primary heating and supplementary heating |
| | Ventilation | Ventilation requirements for space heating/cooling including furnace fans |
| | Whole Facility | The whole facility end-use reflects the total customer load. The residential whole facility end-use is used to characterize new construction and behavioral measures that impact overall energy consumption. In the residential sector this includes as home energy reports, and new construction home/building measures such as ENERGY STAR and Net Zero homes. |
| **Commercial** | Cooking | Food preparation equipment including ranges, broilers, ovens, and griddles |
| | HVAC Fans/Pumps | HVAC auxiliaries including fans, pumps, and cooling towers |
| | Hot Water | Hot water boilers, tank heaters, and others |
| | Lighting | Interior, exterior and holiday/seasonal lighting for main building areas and secondary areas |
| | Office Equipment | Computers, monitors, servers, printers, copiers and related peripherals |
| | Other | Miscellaneous loads including elevators, gym equipment, and other plug loads |
| | Refrigeration | Refrigeration equipment including fridges, coolers, and display cases |
| | Space Cooling | All space cooling equipment, including chillers, and DX cooling. |
| | Space Heating | All space heating equipment, including boilers, furnaces, unit heaters, and baseboard units |
| | Whole Facility | The whole facility end-use reflects the total customer load. The commercial whole facility end-use is used to characterize new construction and behavioral measures that impact overall energy consumption. In the commercial sector this includes building automation controls, new construction measures, occupant behavior, and retro-commissioning. |
| **Industrial** | Boilers | Boilers for industrial applications |
| | Compressed Air | Air compressors and related equipment |
| | Fans & Blowers | Fans and blowers for ventilation, combustion and pneumatic conveyance |
| | Industrial Process | Industrial processes for various applications including mechanical, electrical, and chemical processes |
| | Lighting | Interior, exterior, and seasonal lighting loads |
| | Material Transport | Feedstock and product movement by conveyance or stackers |
| | Process Compressors | Process compressors |
| | Process Heating | Process heating including heat treatment and industrial ovens |
| | Product Drying | Industrial drying equipment and systems |
| | Space Heating | All non-process space heating equipment (e.g., comfort heating) |
| | Pumps | Process pump systems |
| | Refrigeration | Industrial refrigeration |

[44] While not all end-uses are applicable to FortisBC Gas, this table shows definitions for all electric and gas end-uses.

| | |
|---|---|
| Whole Facility | The whole facility end-use reflects the total customer load. The industrial whole facility end-use is used to characterize new construction and behavioral measures that impact overall energy consumption. In the industrial sector this includes energy management, and new plant measures. |

*Source: Navigant*

## B.2 Residential Sector – Additional Detail

In order to characterize the residential sector energy usage, Navigant developed a bottom-up analysis based on the mix of fuel shares and the types of equipment used for each end-use. Navigant developed these estimates based on a review of FortisBC Gas's 2012 REUS study and BC Hydro's 2014 REUS. Both of these end-use surveys provides detailed residential household data, and detailed information in relation to each of the end-uses, existing equipment, main and secondary fuel systems, and saturation levels for common energy efficiency measures. Using the data provided by the residential survey, Navigant developed specific fuel share and equipment estimates for each residential segment. The following sections summarized the approach for developing the following:

- **Residential Stock** for each residential segment
- **Fuel shares** and **equipment shares** for each residential segment in each region
- **End-use intensities (EUIs)** for each residential segment in each region

### Fuel Shares and Equipment Shares

Using the data provided by the FortisBC 2012 REUS study, Navigant developed specific fuel share and equipment estimates for each residential segment in each region. The translation of data from the 2012 REUS study to Navigant's analysis was relatively straightforward given the granularity of the REUS data. For example, the residential survey reports most information aggregated based on four types of dwellings (Single Detached, Single Attached, Apartments, and Other), which are largely consistent with the residential segments employed for this CPR.

- Table B-2 shows the mix of fuel shares for each residential segment by region[45]
- Table B-3 shows the types of equipment used for the **Space Heating**, and **Water Heating** end-uses by residential segment and region
- Table B-4 shows the types of **Appliance** equipment by residential segment and region

[45] This table shows the gas share of appliances at 100% and the electric share at 0%. This does not mean that all appliances use gas and that no appliances use electricity, but rather reflect the fact that - from the perspective of a gas utility (FortisBC Gas and PNG) - all gas appliances are fueled by gas. For the electric utilities (BC Hydro and Fortis Electric), the opposite is true – all electric appliances are fueled by electricity such that the electric fuel share is 100%.

**Table B-2. FortisBC Gas Residential Fuel Shares (Percentage of FortisBC Customers Using Each Energy Type)**

| Building Type | End-use | Lower Mainland | | Vancouver Island | | Southern Interior | | Northern BC | |
|---|---|---|---|---|---|---|---|---|---|
| | | Gas | Electric | Gas | Electric | Gas | Electric | Gas | Electric |
| **Single Family Detached/Duplexes** | Space Heating | 89% | 9% | 64% | 32% | 85% | 11% | 86% | 9% |
| | Water Heating | 84% | 15% | 70% | 29% | 72% | 27% | 75% | 24% |
| **Single Family Attached** | Space Heating | 76% | 23% | 61% | 39% | 89% | 11% | 91% | 9% |
| | Water Heating | 69% | 30% | 66% | 34% | 85% | 15% | 79% | 21% |
| **Apartments <= 4 Storeys** | Space Heating | 30% | 69% | 18% | 80% | 35% | 62% | 29% | 71% |
| | Water Heating | 69% | 30% | 50% | 48% | 64% | 36% | 63% | 37% |
| **Apartments > 4 Storeys** | Space Heating | 30% | 69% | 18% | 80% | 35% | 62% | 29% | 71% |
| | Water Heating | 69% | 30% | 50% | 48% | 64% | 36% | 63% | 37% |
| **Other Residential** | Space Heating | 89% | 9% | 64% | 32% | 85% | 11% | 86% | 9% |
| | Water Heating | 89% | 3% | 82% | 10% | 79% | 13% | 81% | 11% |

*Source: Navigant analysis of 2012 REUS*

**Table B-3. Residential Equipment Shares (%)**

| End-use | Equipment Type | Fraction of Households Using Equipment Type (%) | | | | |
|---|---|---|---|---|---|---|
| | | Single Family Detached | Single Family Attached | Apartments <=4 Storeys | Apartments >4 Storeys | Other Residential |
| **Space Heating** | Gas Furnace 0.6 AFUE | 8% | 8% | 4% | 4% | 1% |
| | Gas Furnace 0.8 AFUE | 27% | 28% | 14% | 14% | 5% |
| | Gas Furnace 0.9 AFUE | 36% | 29% | 13% | 13% | 66% |
| | Gas Boiler 0.7 EF | 0% | 0% | 0% | 0% | 0% |
| | Gas Boiler 0.8 EF | 8% | 10% | 2% | 2% | 19% |
| | Gas Boiler 0.9 EF | 4% | 5% | 17% | 17% | 11% |
| | Gas Fireplace | 89% | 79% | 0% | 0% | 79% |
| **Water Heating** | Gas Water Heater Conventional | 93% | 91% | 5% | 5% | 85% |
| | Gas Water Heater Condensing | 0% | 0% | 0% | 0% | 0% |
| | Gas DHW Tankless | 5% | 5% | 0% | 0% | 5% |

*^Note - Equipment types using same energy type add to percentage of homes with end-use. Space heating system may add to >100% due to secondary systems (i.e. fireplaces).*
*Source: Navigant analysis of 2012 REUS and BC Hydro 2014 REUS*

**Table B-4. Appliances Equipment (%)**

| | | Percentage of Households with Appliance | | | | |
|---|---|---|---|---|---|---|
| **End-Use** | **Equipment Type** | **Single Family Detached** | **Single Family Attached** | **Apartments <=4 Storeys** | **Apartments > 4 Storeys** | **Other Res** |
| **Appliances** | C. Dryer Gas Low E | 7% | 7% | 4% | 4% | 7% |
| | C. Dryer Gas ENERGY STAR® | 4% | 4% | 7% | 7% | 4% |
| | Stove Gas | 16% | 12% | 6% | 6% | 11% |

*Source: Navigant analysis of BC Hydro 2014 REUS*

## End-Use Intensities (EUIs)

The next step of the residential calibration to FortisBC Gas's Reference Forecast process required the roll up of the fuel share and equipment share estimates in order to establish EUIs for each residential segment in each region. Based on this approach, Navigant developed bottom-up EUI estimates for Space Heating, Water Heating, and Appliances. The EUIs for the Other end-use was estimated based on the 2010 FortisBC Gas CPR.

Table B-5 shows an example of the calibration process followed for Single Family Detached/Duplexes in the Southern Interior. The process used to calibrate the estimate of energy use builds on an estimate of the percentage of homes with a particular end-use and fuel type, using a particular type of equipment and efficiency within an end-use. The fuel shares (column B), equipment shares (column E), and an estimated level of energy use for each equipment type (column F) are multiplied to obtain an estimated UEC (column G). In the example below, column G sums the total consumption across all water heating equipment. The team summed the resulting EUCs across end-uses to obtain the segment-level intensity (GJ per year), and then calibrated to match the actual target intensity stemming from FortisBC Gas sales data.

This same process is repeated across all residential and commercial segments in each region. Ultimately, EUIs that matched the segment-level sales targets in the base year were determined for each end-use and segment, and across all regions.

With the base year EUIs established, the Reference Case EUIs were determined based on the residential and commercial sector EUI trends. The approach for developing the EUI trends is described in the body of the report.

Table B-7, Table B-8, and Table B-9 show the residential EUIs used in the Reference Case for the Southern Interior, Vancouver Island, and Northern BC regions. The EUIs presented in these tables start with the base year EUIs shown in Table B-6 and adjusted based on the EUI trends. The Lower Mainland EUIs are included the main body of the report.

**Table B-5. Example of Calibration Process (Single Family Detached/Duplexes – Southern Interior)**

| *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* |
|---|---|---|---|---|---|---|---|---|
| ***End Use*** | ***Fuel Share (%)*** | ***Equipment*** | ***Efficiency*** | ***Equipment Share (%)*** | ***Annual Energy Use (GJ)*** | ***End-Use Weighted Avg. Use (GJ)*** | ***Total Uncalibrated Consumption (GJ)*** | ***Total Calibrated Consumption (GJ)*** |
| *Space Heating* | *85%* | *…* | *…* | *…* | *…* | *…* | *51.7* | *57.7* |
| *Water Heating* | *72%* | *Gas Water Heater Conventnl* | *n/a* | *83%* | *17.7* | *12.2* | *12.2* | *13.6* |
| | | *Gas Water Heater Condensing* | *n/a* | *13%* | *13.7* | | | |
| | | *Gas DHW Tankless* | *n/a* | *4%* | *10.9* | | | |
| *Cooling* | *0%* | *…* | *…* | *…* | *…* | *…* | *0.0* | *0.0* |
| *Appliances* | *100%* | *…* | | | | | *1.3* | *1.4* |
| *Lighting* | *0%* | *…* | *…* | *…* | *…* | *…* | *0.0* | *0.0* |
| *Electronics* | *0%* | *…* | *…* | *…* | *…* | *…* | *0.0* | *0.0* |
| *Other* | *0%* | *…* | *…* | *…* | *…* | *…* | *2.5* | *2.8* |
| *Ventilation* | *0%* | *…* | *…* | *…* | *…* | *…* | *0.0* | *0.0* |
| ***Estimated Consumption (GJ per year)*** | | | | | | | *67.7* | ***75.6*** |
| ***Target Consumption (GJ per year)*** | | | *- calculted based on Fortis Gas 2014 sales data* | | | | *75.6* | ***75.6*** |
| | *Uncalibrated vs. Target* | | | | | | ***90%*** | ***100%*** |

*Appliances are assigned a fuel share of 100%. This implies that all gas appliances have a fuel share of 100% gas. Similarly, electric utilities have an appliances fuel share of 100%. Penetration of gas appliances are represented by equipment shares.*
*Source: Navigant*

**Table B-6. Base Year Residential EUIs (GJ/household) by Segment and Region**

| Building Type | End-Use | Average Use per Household (GJ) | | | |
|---|---|---|---|---|---|
| | | Lower Mainland | Southern Interior | Vancouver Island | Northern BC |
| **Single Family Detached/Duplexes** | Space Heating | 77 | 58 | 38 | 76 |
| | Water Heating | 15 | 14 | 15 | 12 |
| | Cooling | - | - | - | - |
| | Appliances | 1 | 1 | 2 | 1 |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | 3 | 3 | 3 | 2 |
| | Ventilation | - | - | - | - |
| | **Total** | 95 | 76 | 58 | 91 |
| **Single Family Attached** | Space Heating | 47 | 39 | 23 | 49 |
| | Water Heating | 10 | 12 | 10 | 8 |
| | Cooling | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - |
| | **Total** | 59 | 52 | 36 | 59 |
| **Apartments <= 4 Storeys** | Space Heating | 21 | 18 | 5 | 23 |
| | Water Heating | 17 | 15 | 8 | 16 |
| | Cooling | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | 3 | 3 | 2 | 3 |
| | Ventilation | - | - | - | - |
| | **Total** | 43 | 37 | 16 | 43 |
| **Apartments > 4 Storeys** | Space Heating | 21 | 18 | 5 | 23 |
| | Water Heating | 17 | 15 | 8 | 15 |
| | Cooling | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | 4 | 3 | 2 | 4 |
| | Ventilation | - | - | - | - |
| | **Total** | 43 | 37 | 16 | 43 |
| **Other Residential** | Space Heating | 45 | 43 | 25 | 56 |
| | Water Heating | 13 | 11 | 11 | 11 |
| | Cooling | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - |
| | Electronics | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - |
| | **Total** | 60 | 56 | 38 | 69 |

*Source: Navigant analysis of Base Year EUIs, BC Hydro's 2014 REUS, FortisBC Gas Residential Load* Forecast

**Table B-7. Residential Gas Intensity (GJ/household) – Southern Interior**

| Residential Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Single Family Detached/Duplexes** | Space Heating | 58 | 52 | 48 | 46 | 44 |
| | Water Heating | 14 | 13 | 12 | 12 | 12 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 2 | 2 | 2 | 2 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 2 | 2 | 2 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 76 | 69 | 65 | 62 | 60 |
| **Single Family Attached/Row** | Space Heating | 39 | 36 | 33 | 32 | 31 |
| | Water Heating | 12 | 11 | 11 | 10 | 10 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 52 | 48 | 46 | 44 | 43 |
| **Apartments =< 4 stories** | Space Heating | 18 | 16 | 14 | 14 | 13 |
| | Water Heating | 15 | 15 | 16 | 16 | 16 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 37 | 35 | 34 | 33 | 33 |
| **Apartments > 4 stories** | Space Heating | 18 | 16 | 15 | 14 | 13 |
| | Water Heating | 15 | 15 | 15 | 15 | 16 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 37 | 35 | 34 | 33 | 33 |
| **Other Residential** | Space Heating | 43 | 38 | 36 | 34 | 32 |
| | Water Heating | 11 | 10 | 10 | 10 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 56 | 51 | 48 | 45 | 43 |

*Source: Navigant analysis of Base Year EUIs, BC Hydro's 2014 REUS, FortisBC Gas Residential Load* Forecast

**Table B-8. Residential Gas Intensity (GJ/household) – Vancouver Island**

| Residential Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Single Family Detached/Duplexes | Space Heating | 38 | 34 | 32 | 30 | 29 |
| | Water Heating | 15 | 14 | 14 | 14 | 13 |
| | Cooling | - | - | - | - | - |
| | Appliances | 2 | 2 | 2 | 2 | 2 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 58 | 53 | 51 | 48 | 47 |
| Single Family Attached/Row | Space Heating | 23 | 21 | 20 | 19 | 18 |
| | Water Heating | 10 | 10 | 10 | 9 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 36 | 34 | 32 | 31 | 30 |
| Apartments =< 4 stories | Space Heating | 5 | 4 | 4 | 4 | 4 |
| | Water Heating | 8 | 9 | 9 | 9 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 2 | 2 | 2 | 2 | 2 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 16 | 16 | 16 | 16 | 16 |
| Apartments < 4 stories | Space Heating | 5 | 5 | 4 | 4 | 4 |
| | Water Heating | 8 | 8 | 9 | 9 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 2 | 2 | 2 | 2 | 2 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 16 | 16 | 16 | 16 | 15 |
| Other Residential | Space Heating | 25 | 22 | 21 | 20 | 19 |
| | Water Heating | 11 | 11 | 10 | 10 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 38 | 35 | 33 | 31 | 30 |

*Source: Navigant analysis of Base Year EUIs, BC Hydro's 2014 REUS, FortisBC Gas Residential Load Forecast*

**Table B-9. Residential Gas Intensity (GJ/household) – Northern BC**

| Residential Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Single Family Detached/Duplexes** | Space Heating | 76 | 68 | 64 | 60 | 57 |
| | Water Heating | 12 | 11 | 11 | 11 | 10 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 2 | 2 | 2 | 2 | 2 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 91 | 83 | 78 | 74 | 71 |
| **Single Family Attached/Row** | Space Heating | 49 | 44 | 42 | 40 | 38 |
| | Water Heating | 8 | 8 | 8 | 8 | 7 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 59 | 54 | 51 | 49 | 47 |
| **Apartments =< 4 stories** | Space Heating | 23 | 20 | 19 | 18 | 17 |
| | Water Heating | 16 | 16 | 16 | 17 | 17 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 3 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 43 | 41 | 39 | 38 | 38 |
| **Apartments > 4 stories** | Space Heating | 23 | 20 | 19 | 18 | 17 |
| | Water Heating | 15 | 16 | 16 | 16 | 16 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 4 | 3 | 3 | 3 | 3 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 43 | 41 | 39 | 38 | 38 |
| **Other Residential** | Space Heating | 56 | 51 | 47 | 45 | 43 |
| | Water Heating | 11 | 10 | 9 | 9 | 9 |
| | Cooling | - | - | - | - | - |
| | Appliances | 1 | 1 | 1 | 1 | 1 |
| | Lighting | - | - | - | - | - |
| | Electronics | - | - | - | - | - |
| | Other | 1 | 1 | 1 | 1 | 1 |
| | Ventilation | - | - | - | - | - |
| | **Total** | 69 | 62 | 58 | 55 | 53 |

*Source: Navigant analysis of Base Year EUIs, BC Hydro's 2014 REUS, FortisBC Gas Residential Load* Forecast

## B.3 Commercial Sector – Additional Detail

To characterize the Commercial sector, Navigant first developed a bottom-up analysis based on the mix of fuel shares and the types of equipment used for each end-use. Navigant developed these estimates based primarily on a review of BC Hydro's 2014 CEUS. BC Hydro's CEUS was preferred over the FortisBC 2015 CEUS given the increased granularity provided by the BC Hydro data. BC Hydro's 2015 CEUS study provides detailed information for several commercial segments across the CPR regions, including commercial building characteristics, main and secondary fuel systems, fuel shares and common commercial equipment, and saturation levels for common energy efficiency measures.

The following sections summarized the approach for developing the following:

- **Fuel Shares** and **Equipment Shares** for each commercial segment
- **End-use intensities (EUIs)** for each commercial segment
- **Commercial Floor Space Stock** for each commercial segment

### Fuel Shares and Equipment Shares

Fuel share estimates were developed for end-uses that generally show a split across gas and electricity supply: Cooking, Hot Water, and Space Heating. All other end-uses were treated as electric-only end-uses, with the exception of the Other end-use.

Using the data provided by BC Hydro's 2014 CEUS, Navigant developed fuel share and equipment estimates for each commercial segment. The 2014 CEUS results are disaggregated across each region and are reported for each commercial segment.

Table B-10 and Table B-11Table B-11 shows the space heating equipment shares. The team used these space heating equipment shares to develop space heating EUIs, while EUIs for other end-uses were determined based on the 2010 CPR and did not require equipment shares.

Table B-11 summarize the results of this analysis. These tables show the estimated fuel shares and equipment shares for each commercial segment and climate region.

**Table B-10. Commercial Fuel Shares (Percentage of Segment Using Each Energy Type)**

| Building Type | End-use | Lower Mainland | | Vancouver Island | | Southern Interior | | Northern BC | |
|---|---|---|---|---|---|---|---|---|---|
| | | Gas | Electric | Gas | Electric | Gas | Electric | Gas | Electric |
| Accommodation | Cooking | 76% | 24% | 75% | 25% | 74% | 26% | 58% | 42% |
| | Hot Water | 71% | 29% | 69% | 31% | 78% | 22% | 55% | 36% |
| | Space Heating | 51% | 44% | 43% | 57% | 67% | 33% | 55% | 36% |
| Colleges/ Universities | Cooking | 52% | 48% | 52% | 48% | 52% | 48% | 52% | 48% |
| | Hot Water | 63% | 32% | 32% | 63% | 63% | 32% | 63% | 32% |
| | Space Heating | 53% | 42% | 48% | 48% | 53% | 42% | 63% | 32% |
| Food Service | Cooking | 79% | 21% | 79% | 21% | 79% | 21% | 79% | 21% |
| | Hot Water | 57% | 43% | 32% | 68% | 44% | 56% | 60% | 40% |
| | Space Heating | 63% | 37% | 19% | 81% | 47% | 41% | 75% | 25% |
| Hospitals | Cooking | 52% | 48% | 52% | 48% | 52% | 48% | 52% | 48% |
| | Hot Water | 93% | 7% | 93% | 7% | 93% | 7% | 93% | 7% |
| | Space Heating | 93% | 7% | 93% | 7% | 93% | 7% | 93% | 7% |
| Logistics/ Warehouses | Cooking | 0% | 100% | 0% | 100% | 0% | 100% | 0% | 100% |
| | Hot Water | 30% | 69% | 18% | 59% | 8% | 67% | 43% | 48% |
| | Space Heating | 60% | 30% | 10% | 76% | 42% | 33% | 64% | 36% |
| Long Term Care | Cooking | 52% | 48% | 52% | 48% | 52% | 48% | 52% | 48% |
| | Hot Water | 88% | 12% | 46% | 46% | 50% | 38% | 67% | 28% |
| | Space Heating | 56% | 44% | 50% | 50% | 50% | 50% | 54% | 46% |
| Offices | Cooking | 13% | 87% | 9% | 91% | 6% | 94% | 4% | 96% |
| | Hot Water | 32% | 68% | 18% | 82% | 37% | 63% | 41% | 59% |
| | Space Heating | 54% | 44% | 24% | 75% | 59% | 39% | 53% | 43% |
| Other | Cooking | 18% | 82% | 22% | 78% | 22% | 78% | 20% | 80% |
| | Hot Water | 42% | 54% | 19% | 77% | 44% | 48% | 46% | 45% |
| | Space Heating | 60% | 37% | 31% | 59% | 52% | 41% | 62% | 32% |
| Retail - Food | Cooking | 26% | 74% | 26% | 74% | 26% | 74% | 26% | 74% |
| | Hot Water | 63% | 37% | 18% | 74% | 33% | 56% | 60% | 40% |
| | Space Heating | 67% | 27% | 24% | 72% | 63% | 25% | 50% | 50% |
| Retail - Non Food | Cooking | 14% | 86% | 11% | 89% | 9% | 91% | 9% | 91% |
| | Hot Water | 34% | 58% | 16% | 81% | 36% | 64% | 36% | 64% |
| | Space Heating | 64% | 34% | 32% | 65% | 55% | 41% | 71% | 29% |
| Schools | Cooking | 20% | 80% | 18% | 82% | 17% | 83% | 17% | 83% |
| | Hot Water | 71% | 19% | 40% | 60% | 67% | 17% | 78% | 22% |
| | Space Heating | 75% | 25% | 54% | 46% | 80% | 20% | 90% | 10% |

*Source: Navigant analysis of BC Hydro 2014 CEUS*

Table B-11 shows the space heating equipment shares. The team used these space heating equipment shares to develop space heating EUIs, while EUIs for other end-uses were determined based on the 2010 CPR and did not require equipment shares.

**Table B-11. Commercial Equipment Shares (%)**

| End-use | Equipment Type | Percentage of Equip in End-use within Fuel Type^ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Accommodation | Colleges/ Universities | Food Service | Hospital | Logistics/ Warehouses | Long Term Care | Office | Other Commercial | Retail - Food | Retail - Non Food | Schools |
| **Space Heating** | Gas Boiler Low E | 35% | 40% | 6% | 73% | 4% | 34% | 8% | 10% | 1% | 1% | 40% |
| | Gas Boiler High E | 9% | 0% | 2% | 19% | 1% | 10% | 2% | 4% | 0% | 0% | 11% |
| | Gas Rooftop or Other Forced Air (Low E) | 45% | 60% | 64% | 6% | 60% | 44% | 64% | 53% | 72% | 65% | 35% |
| | Gas Rooftop or Other Forced Air (High E) | 11% | 0% | 18% | 2% | 11% | 12% | 17% | 21% | 20% | 25% | 9% |
| | Gas Unit Heater (Conventional.) | 0% | 0% | 8% | 0% | 20% | 0% | 7% | 8% | 5% | 6% | 5% |
| | Gas Unit Heater (Condensing) | 0% | 0% | 2% | 0% | 4% | 0% | 2% | 3% | 1% | 2% | 1% |

*Source: Navigant analysis of BC Hydro 2014 CEUS*

### End-Use Intensities (EUIs)

The next step of the commercial calibration process required the roll up of the fuel share and equipment share estimates in order to establish EUIs for each commercial segment in each region. Based on this approach, Navigant developed bottom-up EUI estimates for the Space Heating end-use. For other end-uses including Water Heating, Cooking, and Other, EUI estimates were developed based on a review of the 2010 CPR, and adjusted to the base year (2014) according to the EUI trends established for the Reference Case for FortisBC Gas.

Table B-12 presents the EUIs established for each end-use, and commercial segment. With the EUIs established for the base year, the Reference Case EUIs were determined based on the commercial EUI trends. The approach for developing the commercial EUI trends is described in the body of the report.

### Table B-12: Base Year Commercial EUIs (MJ/m2) by Segment and Region

| Segment | End-Use | Lower Mainland | Southern Interior | Vancouver Island | Northern BC |
|---|---|---|---|---|---|
| Accommodation | Cooking | 80 | 76 | 82 | 71 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 258 | 253 | 261 | 246 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 56 | 56 | 56 | 56 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 252 | 305 | 250 | 436 |
| | **Total** | 646 | 690 | 649 | 809 |
| Colleges/ Universities | Cooking | 37 | 37 | 37 | 37 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 69 | 69 | 69 | 69 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 310 | 372 | 329 | 811 |
| | **Total** | 481 | 543 | 501 | 982 |
| Food Service | Cooking | 839 | 839 | 839 | 839 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 476 | 476 | 476 | 476 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 425 | 368 | 311 | 1,173 |
| | **Total** | 1,759 | 1,702 | 1,645 | 2,506 |
| Hospitals | Cooking | 65 | 65 | 65 | 65 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 274 | 274 | 274 | 274 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 233 | 233 | 233 | 233 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 758 | 1,037 | 725 | 2,062 |
| | **Total** | 1,330 | 1,609 | 1,297 | 2,635 |
| Logistics/ Warehouses | Cooking | 5 | 5 | 5 | 5 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 18 | 18 | 18 | 18 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 201 | 253 | 207 | 483 |
| | **Total** | 242 | 295 | 248 | 525 |
| Long Term Care | Cooking | 56 | 56 | 56 | 56 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 156 | 156 | 156 | 156 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |

| Segment | End-Use | Lower Mainland | Southern Interior | Vancouver Island | Northern BC |
|---|---|---|---|---|---|
| | Other | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 337 | 374 | 334 | 778 |
| | **Total** | 613 | 651 | 610 | 1,054 |
| **Offices** | Cooking | 9 | 9 | 9 | 9 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 33 | 33 | 33 | 32 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 263 | 330 | 275 | 485 |
| | **Total** | 324 | 390 | 336 | 545 |
| **Other Commercial** | Cooking | 15 | 14 | 12 | 14 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 26 | 27 | 28 | 27 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 13 | 14 | 16 | 14 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 276 | 347 | 297 | 452 |
| | **Total** | 330 | 402 | 353 | 507 |
| **Retail – Food** | Cooking | 75 | 75 | 75 | 75 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 65 | 65 | 65 | 65 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 311 | 278 | 290 | 639 |
| | **Total** | 469 | 436 | 448 | 797 |
| **Retail – Non Food** | Cooking | 13 | 13 | 15 | 13 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 23 | 23 | 23 | 23 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 6 | 7 | 7 | 7 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 256 | 315 | 272 | 367 |
| | **Total** | 299 | 357 | 317 | 410 |
| **Schools** | Cooking | 15 | 15 | 14 | 14 |
| | HVAC Fans/Pumps | - | - | - | - |
| | Hot Water | 39 | 39 | 39 | 39 |
| | Lighting | - | - | - | - |
| | Office Equipment | - | - | - | - |
| | Other | 5 | 5 | 5 | 5 |
| | Refrigeration | - | - | - | - |
| | Space Cooling | - | - | - | - |
| | Space Heating | 277 | 323 | 286 | 623 |
| | **Total** | 336 | 381 | 344 | 680 |

*Source: Navigant analysis*

**Description of EUI Trending Approach**

BC Hydro's 2014 CEUS surveyed commercial customers across each commercial segment in relation to upgrades made to end-use equipment in the past 5 years. The annual incidence of end-use equipment upgrades is then used to estimate the reduction in energy consumption from the adoption of higher efficiency equipment. Table B-13 summarizes an example of the incidence of water heating equipment upgrades.

**Table B-13: Incidence of Water Heating Commercial Equipment Upgrades (2014 CEUS)**

| Segment | Equipment Upgrades | |
|---|---|---|
| | Past 5 years (%) | Estimate per year (%) |
| Accommodation | 25.0% | 5.0% |
| Colleges & Universities | 33.0% | 6.6% |
| Food Service | 32.5% | 6.5% |
| Hospital | 20.0% | 4.0% |
| Logistics & Warehouses | 22.0% | 4.4% |
| Long Term Care | 29.0% | 5.8% |
| Offices | 12.0% | 2.4% |
| Other | 12.0% | 2.4% |
| Retail - Food | 27.0% | 5.4% |
| Retail - Non Food | 27.0% | 5.4% |
| Schools | 19.0% | 3.8% |

*Source: Navigant analysis of BC Hydro 2014 CEUS*

Although the 2014 CEUS did not survey the type of equipment or the efficiency of the upgrades, Navigant estimated the potential reduction in consumption by analyzing the inputs used to characterize conservation measures corresponding to each end-use. For example, the team estimated the average improvement in water heating measure efficiency at approximately 17% such that the efficient consumption is 83% of the base consumption. Navigant determined this improvement from characterization of water heating measures. The difference between the efficient and base consumption of the water heating measures listed below is, on average, 17%:

- Natural Gas On-Demand Water Heaters
- Natural Gas Storage Water Heaters
- Low-Flow Showerheads
- Faucet Aerators
- Natural Gas Hot Water Supply Boilers
- Recirculation Demand Controls for Hot Water

Navigant followed this process across all commercial segments for end-uses for which equipment upgrade information is reported in the 2014 CEUS. This includes the following end-uses:

- Lighting;

- Water Heating;
- Space Cooling;
- HVAC Fans/Pump; and
- Space Heating

Two of these end-uses – water heating and space heating – are applicable to gas consumption. For the remaining gas end-uses – cooking and other – survey information needed to develop EUI trends was not reported and are assumed to remain flat. Table B-14 summarizes the results for each end-use.

**Table B-14: Commercial Measure Efficiency – Base vs. EE**

| End-Use | Improvement in End-Use Efficiency (%) | EE as % of Base consumption (%) |
|---|---|---|
| Water Heating | 17% | 83% |
| Space Heating | 42% | 58% |

*Source: Navigant analysis of measure characterization*

Based on this approach, if the Water Heating EUI for the Accommodation segment is estimated at approx. 250 MJ/m2 in 2014, the EUI is estimated to decrease by 0.8% in 2015, down to 248 MJ/m2. This calculation is included below:

$$EUI_{2015} = EUI_{2014} * (EE\ equipment_{\%} * EE\ consumption_{kWh} + Base\ equipment_{\%} * Base\ consumption_{kWh})$$

$$248\frac{MJ}{m2} = 250\frac{MJ}{m2} * (5\% * 83\% + 95\% * 100\%)$$

A limitation of this approach is that the estimated decrease in EUI inherently reflects the impact of DSM programs. Navigant has not attempted to extract the impact of DSM participation from the EUI trends.

Table 2-28 in the main body of this report, shows the EUI trends determined for each end-use and commercial segment.

Table B-15,
Table B-16, and Table B-17, show the commercial EUIs used in the Reference Case for the Southern Interior, Vancouver Island, and Northern BC regions. The Lower Mainland EUIs are included in the main body. The EUIs presented in these tables were initially based on the Base Year EUIs shown in

Table B-12 and then were adjusted based on the EUI trends. The Lower Mainland EUIs are included the main body of the report.

### Table B-15: Commercial Gas Intensity (MJ/m2) – Southern Interior

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Accommodation** | Cooking | 76 | 76 | 76 | 76 | 76 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 253 | 241 | 234 | 229 | 226 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 56 | 56 | 56 | 56 | 56 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 305 | 276 | 260 | 249 | 242 |
| | **Total** | 690 | 648 | 626 | 611 | 600 |
| **Colleges/ Universities** | Cooking | 37 | 37 | 37 | 37 | 37 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 69 | 65 | 62 | 61 | 60 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 372 | 332 | 310 | 296 | 287 |
| | **Total** | 543 | 499 | 475 | 460 | 449 |
| **Food Service** | Cooking | 839 | 839 | 839 | 839 | 839 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 476 | 446 | 430 | 418 | 411 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 368 | 326 | 304 | 289 | 279 |
| | **Total** | 1,702 | 1,629 | 1,591 | 1,565 | 1,547 |
| **Hospitals** | Cooking | 65 | 65 | 65 | 65 | 65 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 274 | 263 | 257 | 253 | 250 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 233 | 233 | 233 | 233 | 233 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 1,037 | 933 | 877 | 840 | 815 |
| | **Total** | 1,609 | 1,494 | 1,432 | 1,391 | 1,363 |
| **Logistics/ Warehouses** | Cooking | 5 | 5 | 5 | 5 | 5 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 18 | 17 | 17 | 17 | 16 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 253 | 234 | 223 | 216 | 211 |
| | **Total** | 295 | 274 | 263 | 256 | 250 |

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Long Term Care** | Cooking | 56 | 56 | 56 | 56 | 56 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 156 | 147 | 142 | 138 | 136 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 374 | 335 | 314 | 300 | 291 |
| | **Total** | 651 | 603 | 577 | 560 | 548 |
| **Office** | Cooking | 9 | 9 | 9 | 9 | 9 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 33 | 32 | 31 | 31 | 31 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 330 | 296 | 279 | 267 | 259 |
| | **Total** | 390 | 356 | 338 | 326 | 318 |
| **Other Commercial** | Cooking | 14 | 14 | 14 | 14 | 14 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 27 | 26 | 26 | 26 | 25 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 14 | 14 | 14 | 14 | 14 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 347 | 312 | 294 | 281 | 273 |
| | **Total** | 402 | 366 | 347 | 335 | 326 |
| **Retail - Food** | Cooking | 75 | 75 | 75 | 75 | 75 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 65 | 61 | 60 | 58 | 57 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 278 | 244 | 226 | 214 | 206 |
| | **Total** | 436 | 398 | 378 | 365 | 357 |
| **Retail – Non Food** | Cooking | 13 | 13 | 13 | 13 | 13 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 23 | 22 | 21 | 21 | 21 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 7 | 7 | 7 | 7 | 7 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 315 | 276 | 256 | 242 | 233 |
| | **Total** | 357 | 318 | 297 | 283 | 274 |
| **Schools** | Cooking | 15 | 15 | 15 | 15 | 15 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 39 | 38 | 37 | 36 | 36 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 5 | 5 | 5 | 5 | 5 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 323 | 290 | 273 | 262 | 254 |
| | **Total** | 381 | 347 | 329 | 317 | 309 |

*Source: Navigant analysis of 2014 CEUS, FortisBC Gas 2016 Load Forecast*

**Table B-16: Commercial Gas Intensity (MJ/m2) – Vancouver Island**

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Accommodation | Cooking | 82 | 82 | 82 | 82 | 82 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 261 | 248 | 241 | 236 | 233 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 56 | 56 | 56 | 56 | 56 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 250 | 226 | 213 | 204 | 199 |
| | **Total** | 649 | 612 | 592 | 579 | 570 |
| Colleges/ Universities | Cooking | 37 | 37 | 37 | 37 | 37 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 69 | 65 | 62 | 61 | 60 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 329 | 294 | 275 | 263 | 254 |
| | **Total** | 501 | 461 | 440 | 426 | 416 |
| Food Service | Cooking | 839 | 839 | 839 | 839 | 839 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 476 | 446 | 430 | 418 | 411 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 311 | 276 | 257 | 245 | 236 |
| | **Total** | 1,645 | 1,579 | 1,544 | 1,520 | 1,504 |
| Hospitals | Cooking | 65 | 65 | 65 | 65 | 65 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 274 | 263 | 257 | 253 | 250 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 233 | 233 | 233 | 233 | 233 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 725 | 652 | 613 | 587 | 570 |
| | **Total** | 1,297 | 1,213 | 1,168 | 1,138 | 1,118 |
| Logistics/ Warehouses | Cooking | 5 | 5 | 5 | 5 | 5 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 18 | 17 | 17 | 17 | 16 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 207 | 191 | 182 | 176 | 172 |
| | **Total** | 248 | 231 | 222 | 216 | 212 |

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Long Term Care** | Cooking | 56 | 56 | 56 | 56 | 56 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 156 | 147 | 142 | 138 | 136 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 334 | 299 | 280 | 268 | 259 |
| | **Total** | 610 | 567 | 543 | 527 | 517 |
| **Office** | Cooking | 9 | 9 | 9 | 9 | 9 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 33 | 32 | 32 | 32 | 31 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 275 | 247 | 232 | 223 | 216 |
| | **Total** | 336 | 307 | 292 | 282 | 275 |
| **Other Commercial** | Cooking | 12 | 12 | 12 | 12 | 12 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 28 | 28 | 27 | 27 | 27 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 16 | 16 | 16 | 16 | 16 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 297 | 267 | 251 | 241 | 234 |
| | **Total** | 353 | 323 | 306 | 296 | 288 |
| **Retail - Food** | Cooking | 75 | 75 | 75 | 75 | 75 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 65 | 61 | 60 | 58 | 57 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 290 | 254 | 235 | 223 | 215 |
| | **Total** | 448 | 409 | 388 | 375 | 366 |
| **Retail – Non Food** | Cooking | 15 | 15 | 15 | 15 | 15 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 23 | 22 | 21 | 21 | 20 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 7 | 7 | 7 | 7 | 7 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 272 | 238 | 221 | 209 | 202 |
| | **Total** | 317 | 282 | 264 | 252 | 244 |
| **Schools** | Cooking | 14 | 14 | 14 | 14 | 14 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 39 | 38 | 37 | 36 | 36 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 5 | 5 | 5 | 5 | 5 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 286 | 257 | 242 | 231 | 225 |
| | **Total** | 344 | 314 | 297 | 287 | 279 |

*Source: Navigant analysis of 2014 CEUS, FortisBC Gas 2016 Load Forecast*

## Table B-17: Commercial Gas Intensity (MJ/m2) – Northern BC

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Accommodation | Cooking | 71 | 71 | 71 | 71 | 71 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 246 | 234 | 227 | 222 | 219 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 56 | 56 | 56 | 56 | 56 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 436 | 395 | 372 | 357 | 347 |
| | **Total** | 809 | 755 | 726 | 707 | 693 |
| Colleges/ Universities | Cooking | 37 | 37 | 37 | 37 | 37 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 69 | 65 | 62 | 61 | 60 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 811 | 724 | 677 | 647 | 626 |
| | **Total** | 982 | 891 | 842 | 810 | 788 |
| Food Service | Cooking | 839 | 839 | 839 | 839 | 839 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 476 | 446 | 430 | 418 | 411 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 1,173 | 1,039 | 968 | 922 | 891 |
| | **Total** | 2,506 | 2,342 | 2,255 | 2,197 | 2,158 |
| Hospitals | Cooking | 65 | 65 | 65 | 65 | 65 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 274 | 263 | 257 | 253 | 250 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 233 | 233 | 233 | 233 | 233 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 2,062 | 1,855 | 1,744 | 1,671 | 1,621 |
| | **Total** | 2,635 | 2,417 | 2,300 | 2,222 | 2,170 |
| Logistics/ Warehouses | Cooking | 5 | 5 | 5 | 5 | 5 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 18 | 17 | 17 | 17 | 16 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 483 | 446 | 425 | 412 | 402 |
| | **Total** | 525 | 486 | 466 | 452 | 442 |
| Long Term Care | Cooking | 56 | 56 | 56 | 56 | 56 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 156 | 147 | 142 | 138 | 136 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 65 | 65 | 65 | 65 | 65 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 778 | 696 | 652 | 624 | 604 |
| | **Total** | 1,054 | 964 | 915 | 883 | 862 |

| Commercial Segment | End-Use | CPR Period | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2020 | 2025 | 2030 | 2035 |
| **Office** | Cooking | 9 | 9 | 9 | 9 | 9 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 32 | 32 | 31 | 31 | 31 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 485 | 436 | 410 | 393 | 381 |
| | **Total** | 545 | 496 | 469 | 452 | 440 |
| **Other Commercial** | Cooking | 14 | 14 | 14 | 14 | 14 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 27 | 26 | 26 | 26 | 25 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 14 | 14 | 14 | 14 | 14 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 452 | 407 | 382 | 366 | 355 |
| | **Total** | 507 | 461 | 436 | 420 | 409 |
| **Retail - Food** | Cooking | 75 | 75 | 75 | 75 | 75 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 65 | 61 | 60 | 58 | 57 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 19 | 19 | 19 | 19 | 19 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 639 | 560 | 519 | 492 | 474 |
| | **Total** | 797 | 715 | 672 | 644 | 625 |
| **Retail – Non Food** | Cooking | 13 | 13 | 13 | 13 | 13 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 23 | 22 | 21 | 21 | 21 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 7 | 7 | 7 | 7 | 7 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 367 | 322 | 298 | 282 | 272 |
| | **Total** | 410 | 363 | 339 | 323 | 312 |
| **Schools** | Cooking | 14 | 14 | 14 | 14 | 14 |
| | HVAC Fans/Pumps | - | - | - | - | - |
| | Hot Water | 39 | 38 | 37 | 36 | 36 |
| | Lighting | - | - | - | - | - |
| | Office Equipment | - | - | - | - | - |
| | Other | 5 | 5 | 5 | 5 | 5 |
| | Refrigeration | - | - | - | - | - |
| | Space Cooling | - | - | - | - | - |
| | Space Heating | 623 | 560 | 527 | 505 | 490 |
| | **Total** | 680 | 616 | 582 | 559 | 544 |

*Source: Navigant analysis of 2014 CEUS, FortisBC Gas 2016 Load Forecast*

## B.4 FortisBC Gas Industrial Sector – Additional Detail

This section describes the approach used to develop the Reference Case for the industrial sector.

FortisBC Gas's load forecast reports industrial sector gas sales as a whole and not broken down into individual industrial segments. To disaggregate the sector-wide forecast into industrial segments, Navigant and FortisBC worked together to develop gas sales projections which aligned with the sector-level forecast established for each region.

As a starting point, Navigant applied the electricity demand growth rates established for BC Hydro's Reference Case. FortisBC Gas reviewed those assumptions and directed Navigant to make adjustment to certain industrial segments which did not align with FortisBC Gas projections. These adjusted growth rates were used to estimate a forecast of gas consumption for each segment through 2035. A key aspect of this analysis is that this estimated forecast - determined based on adjusted growth rates – needed to reconcile with FortisBC Gas's sector-level forecast FortisBC Gas.

The steps to develop the Reference Case forecast are outlined below:

- Apply the adjusted growth rates to the base year (2014) consumption and sum the projected sales across each region to obtain a sector-level sales forecast (the "estimated" consumption forecast).
- Compare the estimated consumption across every 5-year period (e.g., 2020, 2025, 2030, and 2035) against the forecast 2035 consumption, and determine the difference (e.g., a surplus or a deficit)
- If the estimated consumption is greater than (or less than) the forecast consumption in each milestone year, reallocate the surplus or deficit across each segment according to each segment's contribution (%) to the regional total (e.g., if Pulp & Paper TMP accounts for 20% of industrial consumption then reallocate 20% of the surplus/deficit to the TMP segment) – this is the "re-adjusted" consumption
- Using the re-adjusted consumption determined in each milestone year, re-calculate the 5-year growth rates of each segment. These re-adjusted growth rates will ensure that the estimated consumption reconciles with the forecast consumption.
- These re-adjusted growth rates are used to develop the industrial sector Reference Case.

# APPENDIX C. FORTISBC GAS - INTERACTIVE EFFECTS OF EFFICIENCY STACKING

The results shown throughout the body of this report assume that measures are implemented in isolation from other efficient measures and do not include adjustments for interactive effects of efficiency stacking (with some exceptions).[46] Interactive effects from efficiency stacking are different from cross-end-use interactive effects (e.g., efficient lighting impacts heating/cooling loads), which are present regardless of stacking assumptions and are included in the reported savings estimates. This appendix describes the challenges related to accurately determining the impacts of efficiency stacking, and why Navigant has modelled savings as though measures are implemented independently from others. Although the examples in this appendix focus on gas measures, the concepts are dually applicable to electric measures.

## C.1 Background on Efficiency Stacking

When two or more measures that impact the same end-use energy consumption are installed in the same building, the total savings that can be achieved are less than the sum of the savings from those measures independently. For example, in isolation, the installation of a high efficiency boiler might save 11% of gas consumption relative to a baseline (lower efficiency) boiler, while ceiling insulation might save 71% of gas consumption relative to a baseline insulation level. However, if both the boiler and the insulation are installed in the same facility, the savings from the high efficiency boiler decrease due to the reduced need for space heating caused by better insulation.

To generalize this concept Navigant refers to measures that actually convert energy as *engines* (boilers, light bulbs, motors, etc.). We refer to measures that impact the amount of energy that engines must convert as *drivers* (insulation, thermostats, lighting controls, etc.). Anytime an engine and driver are implemented in the same building, the expectation is that savings from the engine measure will decrease.[47]

Figure C-1 provides an illustration of three different efficiency stacking approaches. The modelled approach assumes no overlap in measure implementation and no efficiency stacking, which leads to an upper bound on savings potential. The opposite of the modelled approach is to assume all measures are stacked wherever possible, which provides a lower bound on savings. Lastly, there is the real-world approach where some measures are implemented in isolation and others are stacked. Unfortunately, the data is simply not available to accurately estimate the savings from the real-world approach.

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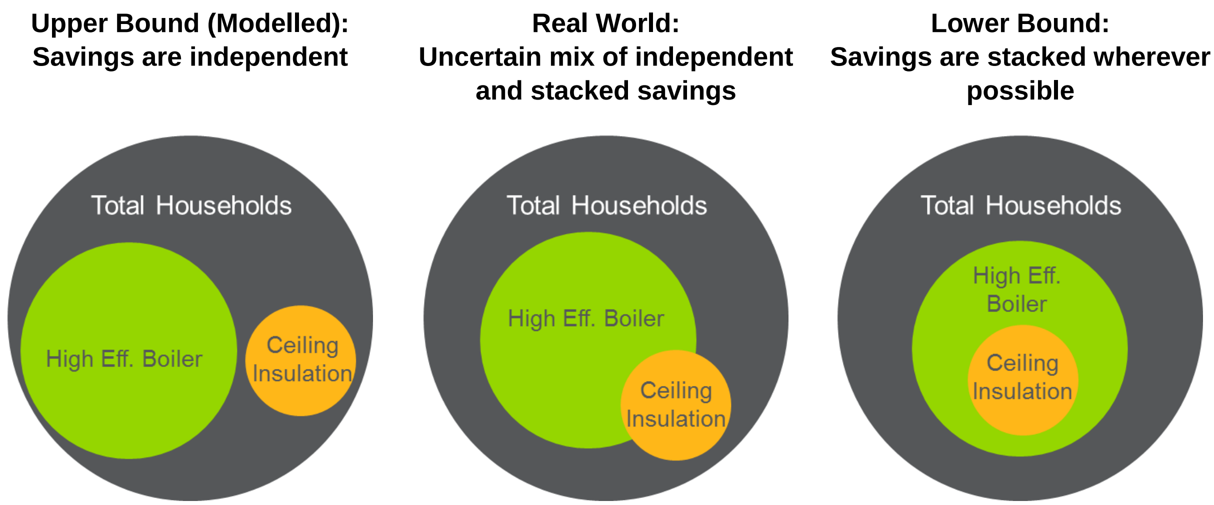
[46] Wherever savings were derived from building energy model simulations evaluating bundled measures, interactive effects of efficiency stacking are included in the savings estimates (e.g., ENERGY STAR New Homes, Net-Zero New Homes, etc.).

[47] In practice it does not matter whether one assumes the engine's savings decrease or the driver's savings decrease, as the final savings result is the same. In this discussion, the team has chosen to always reduce the savings from the engine measures, while holding the savings from the driver measures fixed.

**Figure C-1. Venn Diagrams for Various Efficiency Stacking Situations**




Area of colored circle represents the number of households with a given savings opportunity. Overlapping circles indicate a household has implemented both measures.

## C.2 Illustrative Calculation of Savings after Efficiency Stacking

For a very simplistic scenario looking at only two measures, it is possible to determine the stacked savings from the lower bound approach, which assumes efficient measures are stacked wherever possible. To find the high efficiency boiler's savings relative to the baseline after stacking, one must perform several steps:

1. Find the complement of the insulation's savings percentage:

   Insulation Savings Complement = 100% - Insulation Savings
   Insulation Savings Complement = 100% - 71% = 29%

2. Reduce the boiler's unstacked savings by the complement of the insulation's savings:

   Stacked Boiler Savings = Unstacked Boiler Savings x Insulation Savings Complement
   Stacked Boiler Savings =11% x 29% = 3.2%

3. Find the greatest percentage of homes where boiler and insulation stacking is possible:

   % of Homes with Stacking = Homes with Insulation / Homes with Boilers x 100%
   % of Homes with Stacking = 145,300 / 720,200 x 100% = 20.2%

4. Calculate the boiler's weighted average savings across all homes with boilers:

   Weighted Boiler Savings = Stacked Boiler Savings x % of Homes with Stacking +
   Unstacked Boiler Savings x (100% - % of Homes with Stacking)
   Weighted Boiler Savings = 3.2% x 20.2% + 11% x (100% - 20.2%) = 9.4%

Table C-1 provides an example of the technical potential from the boiler and insulation before and after stacking. As expected, the combined savings from the measures treated independently exceeds the combined savings after stacking.

**Table C-1. Comparison of Savings Before and After Stacking**

| | High Efficiency Boiler | Ceiling Insulation | Combined Technical Potential |
|---|---|---|---|
| Applicable Households (households) | 720,200 | 145,300 | |
| Savings treated independently (no stacking) | | | |
| Savings Relative to Baseline (%) | 11% | 71% | |
| Total Technical Potential in Region (TJ/year) | 2,540 | 1,860 | 4,400 |
| Savings treated interactively (stacking) | | | |
| Savings Relative to Baseline (%) | 9.4% | 71% | |
| Total Technical Potential in Region (TJ/year) | 2,176 | 1,860 | 4,036 |

## C.3 Impetus for Treating Measure Savings Independently

Although it is possible to find the lower bound on savings with just one driver and one engine measure, the process quickly becomes intractable when multiple drivers and engines can be installed in the same facility. Table C-2 lists all of the engine and driver measures included in this study that could have interactive effects within the gas residential space heating end-use (which is just one of many end-uses across multiple sectors where stacking could occur).

**Table C-2. Measures with Opportunity for Stacking in Residential Gas Space Heating End-use**

| Engine Measures | Driver Measures |
|---|---|
| Boiler Tune Up | Air Infiltration |
| Central High Eff Boiler Replace | Attic Duct Insulation |
| Combination System | Attic Insulation |
| Direct Vent Heaters | Basement Insulation |
| Efficient Fireplaces | Ceiling Insulation |
| Furnace Early Retirement | Crawlspace Duct Insulation |
| High Eff Boiler Replace | Energy Star Windows |
| High Eff Furnace Replace | Fireplace Timers |
| Vertical Direct Vent Fireplaces | Heat Reflectors |
| | Smart Thermostats |
| | Wall Insulation |
| | Window Film |

Determining the appropriate stacking and correctly weighting the savings percentages from each of the engine measures requires:

- Case-by-case expert judgment about the combinations of driver and engine measures that might realistically be found in the same building, given historic and future construction practices;
- The conditional probability that a building has an inefficient driver “A” and an inefficient engine “B” for all drivers and engines relevant to a given end-use;
- In-depth knowledge of program design and how managers are considering pursuing participants and bundling measure offerings.

Answering the bullets above is beyond the scope of this study.

Lastly, at low levels of customer participation, it’s clear that assuming savings are independent is the best representation of what actual measure stacking would be. When customer participation is high, the “real-world” scenario is the best representation of actual measure stacking. Thus, under the plausible ranges of customer participation, the modelled (upper bound) scenario is likely to be a better representation of actual measure stacking than the lower bound scenario.

As such, this report does not attempt to quantify the impact from efficiency stacking within the modelled service territories.

# APPENDIX D. SUPPORTING DATA FOR CHARTS

**Table D-1. Total Gas Energy Savings Potential (TJ/year)**

| | Technical | Economic |
|---|---|---|
| 2016 | 45,828 | 28,797 |
| 2017 | 46,269 | 29,990 |
| 2018 | 46,717 | 30,522 |
| 2019 | 47,244 | 31,666 |
| 2020 | 47,699 | 32,214 |
| 2021 | 48,128 | 32,865 |
| 2022 | 48,619 | 33,430 |
| 2023 | 49,054 | 34,057 |
| 2024 | 49,496 | 34,844 |
| 2025 | 50,005 | 35,389 |
| 2026 | 50,645 | 36,087 |
| 2027 | 51,335 | 36,792 |
| 2028 | 51,985 | 37,645 |
| 2029 | 52,642 | 38,390 |
| 2030 | 53,348 | 39,111 |
| 2031 | 54,186 | 40,025 |
| 2032 | 55,030 | 41,321 |
| 2033 | 55,879 | 42,221 |
| 2034 | 56,732 | 43,248 |
| 2035 | 57,591 | 44,158 |

*Source: Navigant*

**Table D-2. Total Gas Energy Savings Potential as Percent of Total Consumption (%)**

| | Technical | Economic |
|---|---|---|
| 2016 | 24.1% | 15.1% |
| 2017 | 24.2% | 15.7% |
| 2018 | 24.3% | 15.9% |
| 2019 | 24.4% | 16.4% |
| 2020 | 24.5% | 16.6% |
| 2021 | 24.7% | 16.8% |
| 2022 | 24.8% | 17.1% |
| 2023 | 24.9% | 17.3% |
| 2024 | 25.0% | 17.6% |
| 2025 | 25.2% | 17.8% |
| 2026 | 25.4% | 18.1% |
| 2027 | 25.6% | 18.4% |
| 2028 | 25.8% | 18.7% |
| 2029 | 26.0% | 19.0% |
| 2030 | 26.3% | 19.2% |
| 2031 | 26.6% | 19.6% |
| 2032 | 26.8% | 20.2% |
| 2033 | 27.1% | 20.5% |
| 2034 | 27.4% | 20.9% |
| 2035 | 27.7% | 21.3% |

*Source: Navigant*

**Table D-3. Gas Energy Technical Savings Potential by Sector (TJ/year)**

| | Commercial | Industrial | Residential |
|---|---|---|---|
| 2016 | 12,730 | 12,262 | 20,836 |
| 2017 | 13,152 | 12,240 | 20,877 |
| 2018 | 13,579 | 12,219 | 20,918 |
| 2019 | 14,085 | 12,198 | 20,960 |
| 2020 | 14,518 | 12,179 | 21,003 |
| 2021 | 14,909 | 12,145 | 21,074 |
| 2022 | 15,362 | 12,111 | 21,145 |
| 2023 | 15,759 | 12,079 | 21,217 |
| 2024 | 16,160 | 12,047 | 21,289 |
| 2025 | 16,628 | 12,016 | 21,361 |
| 2026 | 17,028 | 11,987 | 21,630 |
| 2027 | 17,477 | 11,958 | 21,899 |
| 2028 | 17,886 | 11,930 | 22,169 |
| 2029 | 18,300 | 11,903 | 22,438 |
| 2030 | 18,764 | 11,876 | 22,708 |
| 2031 | 19,143 | 11,847 | 23,196 |
| 2032 | 19,527 | 11,818 | 23,685 |
| 2033 | 19,915 | 11,790 | 24,174 |
| 2034 | 20,307 | 11,763 | 24,663 |
| 2035 | 20,703 | 11,736 | 25,152 |

*Source: Navigant*

**Table D-4. Gas Energy Technical Savings Potential by Sector as a Percent of Sector Consumption (%)**

| | All | Commercial | Industrial | Residential |
|---|---|---|---|---|
| 2016 | 24.1% | 20.9% | 21.4% | 29.0% |
| 2017 | 24.2% | 21.3% | 21.4% | 28.9% |
| 2018 | 24.3% | 21.7% | 21.4% | 28.8% |
| 2019 | 24.4% | 22.3% | 21.4% | 28.7% |
| 2020 | 24.5% | 22.7% | 21.4% | 28.6% |
| 2021 | 24.7% | 23.0% | 21.3% | 28.6% |
| 2022 | 24.8% | 23.5% | 21.3% | 28.6% |
| 2023 | 24.9% | 23.8% | 21.3% | 28.6% |
| 2024 | 25.0% | 24.2% | 21.3% | 28.6% |
| 2025 | 25.2% | 24.6% | 21.3% | 28.6% |
| 2026 | 25.4% | 24.9% | 21.3% | 28.9% |
| 2027 | 25.6% | 25.3% | 21.3% | 29.1% |
| 2028 | 25.8% | 25.6% | 21.3% | 29.4% |
| 2029 | 26.0% | 26.0% | 21.3% | 29.6% |
| 2030 | 26.3% | 26.3% | 21.2% | 29.9% |
| 2031 | 26.6% | 26.6% | 21.2% | 30.4% |
| 2032 | 26.8% | 26.9% | 21.2% | 30.9% |
| 2033 | 27.1% | 27.2% | 21.2% | 31.4% |
| 2034 | 27.4% | 27.5% | 21.2% | 31.9% |
| 2035 | 27.7% | 27.7% | 21.2% | 32.4% |

*Source: Navigant*

## Table D-5. Gas Energy Technical Potential by Customer Segment (TJ/year)[48]

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.Accommod | 575 | 602 | 630 | 660 | 688 | 714 | 742 | 768 | 795 | 823 | 849 | 876 | 902 | 929 | 957 | 981 | 1,005 | 1,030 | 1,054 | 1,080 |
| C.College/Univ | 588 | 615 | 642 | 672 | 700 | 727 | 757 | 785 | 813 | 844 | 872 | 901 | 929 | 958 | 989 | 1,015 | 1,041 | 1,067 | 1,094 | 1,121 |
| C.Food Svc | 862 | 903 | 945 | 991 | 1,033 | 1,071 | 1,112 | 1,150 | 1,188 | 1,230 | 1,266 | 1,306 | 1,342 | 1,380 | 1,420 | 1,452 | 1,485 | 1,518 | 1,551 | 1,584 |
| C.Hospital | 956 | 991 | 1,027 | 1,066 | 1,103 | 1,139 | 1,177 | 1,214 | 1,252 | 1,292 | 1,329 | 1,368 | 1,406 | 1,446 | 1,487 | 1,523 | 1,560 | 1,597 | 1,636 | 1,675 |
| C.Logistic/WHouse | 772 | 803 | 835 | 878 | 910 | 938 | 975 | 1,003 | 1,031 | 1,069 | 1,098 | 1,133 | 1,162 | 1,192 | 1,228 | 1,254 | 1,280 | 1,306 | 1,333 | 1,360 |
| C.Long Term Care | 438 | 466 | 496 | 528 | 559 | 589 | 622 | 654 | 688 | 724 | 757 | 793 | 828 | 865 | 904 | 939 | 975 | 1,012 | 1,051 | 1,090 |
| C.Office | 2,750 | 2,847 | 2,946 | 3,071 | 3,171 | 3,263 | 3,376 | 3,469 | 3,563 | 3,679 | 3,773 | 3,882 | 3,978 | 4,074 | 4,187 | 4,271 | 4,357 | 4,444 | 4,531 | 4,619 |
| C.Other Commercial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C.Retail.Food | 376 | 385 | 393 | 406 | 415 | 422 | 433 | 440 | 448 | 459 | 467 | 477 | 485 | 493 | 503 | 510 | 517 | 524 | 531 | 539 |
| C.Retail.Non Food | 930 | 948 | 965 | 995 | 1,012 | 1,028 | 1,053 | 1,068 | 1,083 | 1,109 | 1,125 | 1,149 | 1,166 | 1,183 | 1,207 | 1,221 | 1,236 | 1,251 | 1,266 | 1,281 |
| C.Schools | 922 | 939 | 957 | 986 | 1,004 | 1,020 | 1,046 | 1,062 | 1,078 | 1,104 | 1,122 | 1,147 | 1,165 | 1,183 | 1,209 | 1,225 | 1,241 | 1,258 | 1,274 | 1,291 |
| C.Streetlights/Signals | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I.Agriculture | 292 | 292 | 292 | 293 | 293 | 294 | 294 | 294 | 295 | 295 | 295 | 296 | 296 | 297 | 298 | 298 | 299 | 299 | 300 | 301 |
| I.Cement | 140 | 139 | 139 | 138 | 137 | 136 | 134 | 133 | 132 | 131 | 131 | 131 | 131 | 131 | 131 | 131 | 131 | 130 | 130 | 130 |
| I.Chemical | 235 | 233 | 230 | 227 | 224 | 224 | 224 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 |
| I.Food & Bev | 814 | 807 | 800 | 793 | 787 | 780 | 773 | 767 | 761 | 755 | 749 | 744 | 739 | 733 | 728 | 724 | 719 | 715 | 710 | 706 |
| I.Greenhouse | 893 | 890 | 888 | 885 | 883 | 880 | 878 | 875 | 873 | 870 | 869 | 867 | 865 | 864 | 862 | 860 | 859 | 858 | 856 | 855 |
| I.LNG Facility | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I.Mfg | 1,317 | 1,324 | 1,331 | 1,338 | 1,345 | 1,349 | 1,353 | 1,358 | 1,362 | 1,366 | 1,372 | 1,378 | 1,383 | 1,389 | 1,395 | 1,401 | 1,407 | 1,413 | 1,420 | 1,426 |
| I.Coal Mining | 366 | 364 | 363 | 361 | 359 | 359 | 360 | 360 | 360 | 360 | 359 | 358 | 357 | 356 | 354 | 353 | 352 | 351 | 350 | 349 |
| I.Metal Mining | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| I.Oil & Gas | 676 | 673 | 669 | 666 | 663 | 660 | 657 | 653 | 650 | 647 | 645 | 642 | 639 | 637 | 634 | 631 | 629 | 627 | 624 | 622 |
| I.Other Industrial | 250 | 252 | 255 | 258 | 262 | 266 | 271 | 276 | 281 | 287 | 285 | 284 | 283 | 282 | 281 | 276 | 271 | 266 | 262 | 257 |
| I.Kraft Pulp/Paper | 4,285 | 4,272 | 4,259 | 4,245 | 4,232 | 4,213 | 4,194 | 4,174 | 4,155 | 4,136 | 4,119 | 4,101 | 4,084 | 4,067 | 4,050 | 4,034 | 4,018 | 4,001 | 3,985 | 3,969 |
| I.TMP Pulp/Paper | 477 | 477 | 476 | 475 | 474 | 473 | 472 | 472 | 471 | 470 | 469 | 469 | 468 | 467 | 467 | 466 | 466 | 465 | 464 | 464 |
| I.Transportation | 157 | 157 | 156 | 155 | 155 | 154 | 154 | 153 | 153 | 152 | 151 | 150 | 148 | 147 | 145 | 144 | 143 | 141 | 140 | 139 |
| I.Wood Products | 2,358 | 2,360 | 2,361 | 2,362 | 2,363 | 2,355 | 2,346 | 2,338 | 2,330 | 2,321 | 2,318 | 2,315 | 2,312 | 2,309 | 2,306 | 2,304 | 2,302 | 2,300 | 2,298 | 2,296 |
| R.Apt <= 4 Stories | 2,284 | 2,341 | 2,398 | 2,454 | 2,511 | 2,558 | 2,606 | 2,653 | 2,700 | 2,747 | 2,795 | 2,842 | 2,890 | 2,937 | 2,985 | 3,034 | 3,083 | 3,132 | 3,180 | 3,229 |
| R.Apt > 4 Stories | 1,278 | 1,311 | 1,345 | 1,378 | 1,412 | 1,439 | 1,466 | 1,494 | 1,521 | 1,548 | 1,576 | 1,605 | 1,633 | 1,661 | 1,689 | 1,718 | 1,747 | 1,776 | 1,805 | 1,835 |
| R.Other Residential | 372 | 372 | 371 | 370 | 369 | 368 | 366 | 365 | 364 | 363 | 362 | 361 | 360 | 359 | 358 | 357 | 356 | 355 | 354 | 353 |
| R.Fam Attached | 1,377 | 1,381 | 1,386 | 1,391 | 1,396 | 1,402 | 1,409 | 1,415 | 1,421 | 1,428 | 1,448 | 1,468 | 1,488 | 1,509 | 1,529 | 1,563 | 1,597 | 1,630 | 1,664 | 1,698 |
| R.Fam Detached | 19,087 | 19,124 | 19,162 | 19,200 | 19,238 | 19,304 | 19,370 | 19,437 | 19,503 | 19,570 | 19,820 | 20,070 | 20,321 | 20,571 | 20,822 | 21,277 | 21,733 | 22,189 | 22,645 | 23,101 |

[48] While apartment buildings are prefaced with a "R" (for residential), their savings are grouped into and reported under the commercial sector. Apartments are labelled with an "R" because they are included in the residential sector for purposes of the base year and reference case analysis.

*Source: Navigant*

**Table D-6. Gas Energy Technical Potential by End-use (TJ/year)[49]**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appliances | 343 | 343 | 342 | 341 | 340 | 339 | 338 | 337 | 336 | 335 | 334 | 333 | 332 | 331 | 330 | 329 | 328 | 327 | 327 | 326 |
| Boilers | 4,920 | 4,904 | 4,888 | 4,872 | 4,857 | 4,837 | 4,818 | 4,800 | 4,781 | 4,763 | 4,745 | 4,727 | 4,710 | 4,693 | 4,676 | 4,659 | 4,642 | 4,625 | 4,609 | 4,592 |
| Cooking | 379 | 384 | 388 | 393 | 398 | 402 | 407 | 411 | 415 | 420 | 424 | 428 | 432 | 437 | 441 | 444 | 448 | 452 | 455 | 459 |
| Hot Water | 6,869 | 6,835 | 6,801 | 6,767 | 6,733 | 6,699 | 6,666 | 6,632 | 6,599 | 6,566 | 6,533 | 6,501 | 6,468 | 6,436 | 6,404 | 6,372 | 6,340 | 6,308 | 6,277 | 6,245 |
| Proc Heat | 1,323 | 1,321 | 1,319 | 1,318 | 1,316 | 1,313 | 1,310 | 1,307 | 1,304 | 1,301 | 1,299 | 1,298 | 1,297 | 1,295 | 1,294 | 1,293 | 1,292 | 1,290 | 1,289 | 1,288 |
| Product Drying | 1,915 | 1,915 | 1,916 | 1,916 | 1,916 | 1,910 | 1,905 | 1,899 | 1,893 | 1,888 | 1,885 | 1,883 | 1,880 | 1,877 | 1,875 | 1,873 | 1,871 | 1,869 | 1,867 | 1,865 |
| Space Heating | 24,202 | 24,105 | 24,009 | 23,987 | 23,887 | 23,783 | 23,736 | 23,629 | 23,521 | 23,476 | 23,384 | 23,337 | 23,246 | 23,156 | 23,110 | 23,019 | 22,929 | 22,839 | 22,750 | 22,662 |
| Whole Facility | 5,876 | 6,463 | 7,054 | 7,651 | 8,253 | 8,844 | 9,440 | 10,040 | 10,646 | 11,256 | 12,040 | 12,828 | 13,620 | 14,417 | 15,218 | 16,197 | 17,181 | 18,167 | 19,158 | 20,153 |

*Source: Navigant*

[49] The industrial process end use is not shown in this table because no natural gas measures are assigned to it. As a result, savings are not reported for the industrial process end use.

**Table D-7. Gas Energy Economic Savings Potential by Sector (TJ/year)**

| | Commercial | Industrial | Residential |
|---|---|---|---|
| 2016 | 7,233 | 11,382 | 10,181 |
| 2017 | 7,849 | 11,360 | 10,781 |
| 2018 | 8,311 | 11,338 | 10,872 |
| 2019 | 9,158 | 11,317 | 11,192 |
| 2020 | 9,631 | 11,296 | 11,287 |
| 2021 | 10,168 | 11,265 | 11,432 |
| 2022 | 10,648 | 11,235 | 11,547 |
| 2023 | 11,180 | 11,205 | 11,672 |
| 2024 | 11,881 | 11,176 | 11,787 |
| 2025 | 12,335 | 11,148 | 11,907 |
| 2026 | 12,763 | 11,120 | 12,204 |
| 2027 | 13,196 | 11,094 | 12,502 |
| 2028 | 13,775 | 11,068 | 12,801 |
| 2029 | 14,247 | 11,043 | 13,100 |
| 2030 | 14,693 | 11,019 | 13,398 |
| 2031 | 15,131 | 10,992 | 13,901 |
| 2032 | 15,950 | 10,966 | 14,405 |
| 2033 | 16,355 | 10,941 | 14,925 |
| 2034 | 16,765 | 10,916 | 15,568 |
| 2035 | 17,180 | 10,891 | 16,087 |

*Source: Navigant*

**Table D-8. Gas Energy Economic Savings Potential by Sector as a Percent of Sector Consumption (%)**

| | All | Commercial | Industrial | Residential |
|---|---|---|---|---|
| 2016 | 15.1% | 11.9% | 19.8% | 14.2% |
| 2017 | 15.7% | 12.7% | 19.8% | 14.9% |
| 2018 | 15.9% | 13.3% | 19.8% | 15.0% |
| 2019 | 16.4% | 14.5% | 19.8% | 15.3% |
| 2020 | 16.6% | 15.0% | 19.8% | 15.4% |
| 2021 | 16.8% | 15.7% | 19.8% | 15.5% |
| 2022 | 17.1% | 16.3% | 19.8% | 15.6% |
| 2023 | 17.3% | 16.9% | 19.8% | 15.8% |
| 2024 | 17.6% | 17.8% | 19.8% | 15.9% |
| 2025 | 17.8% | 18.2% | 19.7% | 16.0% |
| 2026 | 18.1% | 18.7% | 19.7% | 16.3% |
| 2027 | 18.4% | 19.1% | 19.7% | 16.6% |
| 2028 | 18.7% | 19.8% | 19.7% | 17.0% |
| 2029 | 19.0% | 20.2% | 19.7% | 17.3% |
| 2030 | 19.2% | 20.6% | 19.7% | 17.6% |
| 2031 | 19.6% | 21.1% | 19.7% | 18.2% |
| 2032 | 20.2% | 22.0% | 19.7% | 18.8% |
| 2033 | 20.5% | 22.3% | 19.7% | 19.4% |
| 2034 | 20.9% | 22.7% | 19.7% | 20.1% |
| 2035 | 21.3% | 23.0% | 19.7% | 20.7% |

*Source: Navigant*

**Table D-9. Gas Energy Economic Savings Potential by Customer Segment (TJ/year)[50]**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C.Accommod | 456 | 484 | 513 | 579 | 609 | 635 | 662 | 689 | 716 | 744 | 777 | 808 | 835 | 862 | 890 | 914 | 939 | 964 | 989 | 1,015 |
| C.College/Univ | 455 | 483 | 511 | 569 | 598 | 626 | 654 | 683 | 713 | 743 | 771 | 800 | 829 | 858 | 888 | 914 | 941 | 967 | 995 | 1,023 |
| C.Food Svc | 657 | 751 | 794 | 901 | 944 | 983 | 1,022 | 1,067 | 1,106 | 1,146 | 1,183 | 1,220 | 1,257 | 1,295 | 1,333 | 1,366 | 1,400 | 1,433 | 1,467 | 1,500 |
| C.Hospital | 606 | 643 | 680 | 788 | 827 | 864 | 903 | 942 | 981 | 1,023 | 1,061 | 1,101 | 1,141 | 1,182 | 1,224 | 1,262 | 1,300 | 1,339 | 1,378 | 1,419 |
| C.Logistic/WHouse | 334 | 368 | 403 | 449 | 490 | 522 | 554 | 587 | 620 | 653 | 684 | 716 | 794 | 826 | 857 | 923 | 951 | 979 | 1,007 | 1,035 |
| C.Long Term Care | 362 | 391 | 421 | 463 | 495 | 526 | 558 | 591 | 625 | 660 | 694 | 729 | 765 | 803 | 846 | 881 | 917 | 955 | 993 | 1,033 |
| C.Office | 975 | 1,083 | 1,197 | 1,329 | 1,441 | 1,647 | 1,801 | 1,907 | 2,275 | 2,383 | 2,482 | 2,583 | 2,685 | 2,788 | 2,892 | 2,983 | 3,075 | 3,168 | 3,262 | 3,356 |
| C.Other Commercial | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C.Retail.Food | 177 | 201 | 211 | 318 | 327 | 336 | 345 | 354 | 362 | 371 | 379 | 388 | 396 | 405 | 413 | 421 | 428 | 436 | 443 | 451 |
| C.Retail.Non Food | 327 | 404 | 426 | 486 | 507 | 527 | 547 | 567 | 588 | 618 | 637 | 656 | 778 | 831 | 850 | 866 | 883 | 900 | 916 | 933 |
| C.Schools | 412 | 466 | 487 | 511 | 532 | 562 | 582 | 694 | 715 | 735 | 755 | 775 | 795 | 818 | 839 | 857 | 875 | 893 | 912 | 931 |
| C.Streetlights/Signals | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I.Agriculture | 292 | 292 | 292 | 293 | 293 | 294 | 294 | 294 | 295 | 295 | 295 | 296 | 296 | 297 | 298 | 298 | 299 | 299 | 300 | 301 |
| I.Cement | 140 | 139 | 139 | 138 | 137 | 136 | 134 | 133 | 132 | 131 | 131 | 131 | 131 | 131 | 131 | 131 | 131 | 130 | 130 | 130 |
| I.Chemical | 235 | 233 | 230 | 227 | 224 | 224 | 224 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 | 223 |
| I.Food & Bev | 814 | 807 | 800 | 793 | 787 | 780 | 773 | 767 | 761 | 755 | 749 | 744 | 739 | 733 | 728 | 724 | 719 | 715 | 710 | 706 |
| I.Greenhouse | 893 | 890 | 888 | 885 | 883 | 880 | 878 | 875 | 873 | 870 | 869 | 867 | 865 | 864 | 862 | 860 | 859 | 858 | 856 | 855 |
| I.LNG Facility | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I.Mfg | 1,317 | 1,324 | 1,331 | 1,338 | 1,345 | 1,349 | 1,353 | 1,358 | 1,362 | 1,366 | 1,372 | 1,378 | 1,383 | 1,389 | 1,395 | 1,401 | 1,407 | 1,413 | 1,420 | 1,426 |
| I.Coal Mining | 366 | 364 | 363 | 361 | 359 | 359 | 360 | 360 | 360 | 360 | 359 | 358 | 357 | 356 | 354 | 353 | 352 | 351 | 350 | 349 |
| I.Metal Mining | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| I.Oil & Gas | 676 | 673 | 669 | 666 | 663 | 660 | 657 | 653 | 650 | 647 | 645 | 642 | 639 | 637 | 634 | 631 | 629 | 627 | 624 | 622 |
| I.Other Industrial | 250 | 252 | 255 | 258 | 262 | 266 | 271 | 276 | 281 | 287 | 285 | 284 | 283 | 282 | 281 | 276 | 271 | 266 | 262 | 257 |
| I.Kraft Pulp/Paper | 4,285 | 4,272 | 4,259 | 4,245 | 4,232 | 4,213 | 4,194 | 4,174 | 4,155 | 4,136 | 4,119 | 4,101 | 4,084 | 4,067 | 4,050 | 4,034 | 4,018 | 4,001 | 3,985 | 3,969 |
| I.TMP Pulp/Paper | 477 | 477 | 476 | 475 | 474 | 473 | 472 | 472 | 471 | 470 | 469 | 469 | 468 | 467 | 467 | 466 | 466 | 465 | 464 | 464 |
| I.Transportation | 157 | 157 | 156 | 155 | 155 | 154 | 154 | 153 | 153 | 152 | 151 | 150 | 148 | 147 | 145 | 144 | 143 | 141 | 140 | 139 |
| I.Wood Products | 1,479 | 1,479 | 1,480 | 1,480 | 1,481 | 1,475 | 1,470 | 1,464 | 1,459 | 1,453 | 1,451 | 1,451 | 1,450 | 1,450 | 1,449 | 1,450 | 1,450 | 1,450 | 1,450 | 1,450 |
| R.Apt <= 4 Stories | 1,585 | 1,651 | 1,711 | 1,771 | 1,831 | 1,882 | 1,932 | 1,982 | 2,033 | 2,083 | 2,134 | 2,185 | 2,235 | 2,286 | 2,337 | 2,389 | 2,707 | 2,757 | 2,808 | 2,859 |
| R.Apt > 4 Stories | 888 | 924 | 959 | 994 | 1,029 | 1,059 | 1,088 | 1,117 | 1,146 | 1,175 | 1,205 | 1,235 | 1,265 | 1,295 | 1,325 | 1,356 | 1,535 | 1,565 | 1,595 | 1,625 |

[50] While apartment buildings are prefaced with a "R" (for residential), their savings are grouped into and reported under the commercial sector. Apartments are labelled with an "R" because they are included in the residential sector for purposes of the base year and reference case analysis.

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R.Other Residential | 183 | 204 | 204 | 204 | 205 | 205 | 204 | 204 | 204 | 208 | 208 | 207 | 207 | 207 | 206 | 206 | 206 | 206 | 205 | 208 |
| R.Fam Attached | 422 | 460 | 470 | 706 | 718 | 723 | 729 | 745 | 750 | 755 | 761 | 766 | 773 | 779 | 786 | 792 | 799 | 805 | 812 | 831 |
| R.Fam Detached | 9,576 | 10,117 | 10,199 | 10,281 | 10,364 | 10,505 | 10,614 | 10,724 | 10,834 | 10,943 | 11,236 | 11,529 | 11,821 | 12,114 | 12,406 | 12,903 | 13,400 | 13,915 | 14,551 | 15,047 |

*Source: Navigant*

**Table D-10. Gas Energy Economic Savings Potential by End-Use (TJ/year)[51]**

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Appliances | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Boilers | 4,920 | 4,904 | 4,888 | 4,872 | 4,857 | 4,837 | 4,818 | 4,800 | 4,781 | 4,763 | 4,745 | 4,727 | 4,710 | 4,693 | 4,676 | 4,659 | 4,642 | 4,625 | 4,609 | 4,592 |
| Cooking | 379 | 384 | 388 | 393 | 398 | 402 | 407 | 411 | 415 | 420 | 424 | 428 | 432 | 437 | 441 | 444 | 448 | 452 | 455 | 459 |
| Hot Water | 3,828 | 4,317 | 4,300 | 4,278 | 4,257 | 4,235 | 4,214 | 4,199 | 4,178 | 4,157 | 4,136 | 4,115 | 4,095 | 4,074 | 4,054 | 4,034 | 4,013 | 3,993 | 3,973 | 3,954 |
| Proc Heat | 1,323 | 1,321 | 1,319 | 1,318 | 1,316 | 1,313 | 1,310 | 1,307 | 1,304 | 1,301 | 1,299 | 1,298 | 1,297 | 1,295 | 1,294 | 1,293 | 1,292 | 1,290 | 1,289 | 1,288 |
| Product Drying | 1,036 | 1,035 | 1,035 | 1,034 | 1,034 | 1,031 | 1,028 | 1,025 | 1,023 | 1,020 | 1,018 | 1,018 | 1,018 | 1,018 | 1,018 | 1,019 | 1,019 | 1,019 | 1,020 | 1,020 |
| Space Heating | 11,440 | 11,572 | 11,543 | 12,121 | 12,102 | 12,209 | 12,224 | 12,290 | 12,516 | 12,496 | 12,465 | 12,436 | 12,549 | 12,549 | 12,520 | 12,519 | 12,897 | 12,874 | 12,974 | 12,939 |
| Whole Facility | 5,871 | 6,457 | 7,049 | 7,650 | 8,251 | 8,838 | 9,430 | 10,026 | 10,627 | 11,233 | 11,999 | 12,769 | 13,544 | 14,324 | 15,108 | 16,058 | 17,010 | 17,967 | 18,927 | 19,905 |

*Source: Navigant*

[51] The industrial process end use is not shown in this table because no natural gas measures are assigned to it. As a result, savings are not reported for the industrial process end use.

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# British Columbia Conservation Potential Review

## Section 5. Market Potential

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## DISCLAIMER

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# 5. MARKET POTENTIAL FORECAST

This section contains details of the market potential analysis that Navigant conducted for FortisBC Gas's service territory, including the following:

- Section 5.1 describes the approach to estimating market potential, including discussion of the model calibration steps and the strategy selected for simulating incentives in the analysis.
- Section 5.2 provides overall gas market potential estimates, as well as savings by sector, customer segment, end use, and certain measures.
- Section 5.3 follows with details of the associated budgets and cost effectiveness results under the TRC test across all sectors, which is consistent with the methodology Navigant used for the economic potential presented in Section 4.
- Section 5.4 provides the economic, market potential, and cost effectiveness results under the modified-TRC (mTRC) test across all sectors.
- Section 5.5 provides the economic, market potential, and cost effectiveness results under the Hybrid mTRC/TRC case (described below).

## 5.1 Approach to Estimating Market Potential

Market potential is a subset of economic potential that considers the likely rate of DSM acquisition, given factors like the rate of equipment turnover (a function of a measure's lifetime), simulated incentive levels, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption. The adoption of DSM measures can be broken down into calculation of the "equilibrium" market share and calculation of the dynamic approach to equilibrium market share, as discussed in more detail below.

Market potential differs from program potential in that market potential does not specifically take into account the various delivery mechanisms that can be used by program managers to tailor their approach depending on the specific measure or market. Rather, market potential represents a high-level assessment of savings that could be achieved over time, factoring in broader assumptions about customer acceptance and adoption rates that are not dependent on a particular program design. Additional effort is typically undertaken by program designers, using the directional guidance from a market potential study, to develop detailed plans for delivering conservation programs.

This report presents market potential results from three distinct approaches to screening measures for cost effectiveness. The objective for assessing these three approaches was to consider various possible cost effectiveness environments over the future of this long-range analysis by incorporating the different cost effectiveness approaches present at the time of the analysis. The regulatory environment for FortisBC Gas at the time of this analysis allowed the utility to spend up to 33% of its entire DSM portfolio on measures or programs that require an mTRC to be cost effective.[1] To date, FortisBC Gas's experience is that, typically, most programs in the residential sector require the mTRC. Since FortisBC Gas uses a

[1] The formulation of the mTRC benefit-cost test is the same as the TRC test, with the exception that the avoided costs stem from a zero emission energy supply alternative (ZEEA) cost and a 15% non-energy benefits adder increases benefits.

combination of TRC and mTRC benefit-cost tests to screen measures and programs within their portfolio, Navigant estimated market potential using the following benefit-cost tests to screen cost effective measures:

1. **TRC only:** This case uses the TRC test across all sectors and presents results consistent with the screening method used in the previous CPR report focusing on technical and economic potential.
2. **mTRC only:** This case uses the mTRC test across all sectors.
3. **Hybrid mTRC/TRC:** This case uses the mTRC test for the residential sector and the TRC test for the commercial and industrial (C&I) sectors, which is most analogous to FortisBC Gas's actual DSM program environment.[2]

Table 5-1 below summarizes the key methodology considerations and decision points informing the analysis in this report, with more detail provided in the report sections noted in the right-hand column of the table. Navigant and FortisBC Gas agreed upon this methodology through discussions about which approach best serves the needs of the utility for understanding market savings potential. Since this study's scope for market potential estimates are not intended to be program-specific and are most reasonable when results are considered in aggregate, the methodology presented here focuses primarily on portfolio-level or sector-level approaches. However, FortisBC Gas selected five high impact measures for measure-level calibration, which is discussed in Section 5.1.6.

[2] Model limitations prevented the team from implementing a strict 33% cap on spending directed towards measures requiring the mTRC screen. However, the cap was approximated by only allowing residential measures to screen the mTRC test for cost-effectiveness.

**Table 5-1. Market Potential Methodology Overview**

| Methodology Parameters | Approach | Report Section |
|---|---|---|
| **Benefit-cost test screen** | Use the TRC as the primary screen for technical, economic, and market potential, with economic and market potential also calculated using the mTRC and a hybrid of mTRC/TRC tests. | 5.1 |
| **Diffusion parameters** | Adjust diffusion parameters within ranges recommended by industry standard data sources to produce savings that are reasonably aligned with FortisBC DSM sector-level historical achievements. Customize the diffusion parameters for the five high impact measures selected in advance by FortisBC Gas in order to align with historic savings at the measure level. | 5.1.1, 5.1.2, and 5.1.6 |
| **Budget constraints** | Do not apply budget constraints. | 5.1.4 |
| **Incentive strategy** | Set incentives as a percent of the incremental cost for all measures pertaining to each sector, such that the simulated percentages of total spending from incentives versus non-incentive costs aligns with historic values across the sector. | 5.1.5 and 5.1.7 |
| **Treatment of admin and fixed costs** | Exclude portfolio-level fixed costs; use a sector-level $/GJ cost derived from historic non-incentive program spending, which includes fixed and variable administrative costs. | 5.3.1 and 5.3.2 |
| **Net-to-Gross (NTG)** | Focus on gross savings within the report, and include discussion on impacts of NTG factors at the sector level for high-level estimates of net savings (consistent with the approach used for technical and economic potential) | 5.2.6 |
| **Re-participation** | Assume 100% of measures re-participate as an efficient measure at the end of their measure life | N/A |
| **Codes and standards** | Use the same assumptions about codes and standards as in technical and economic potential | 5.2.5 |

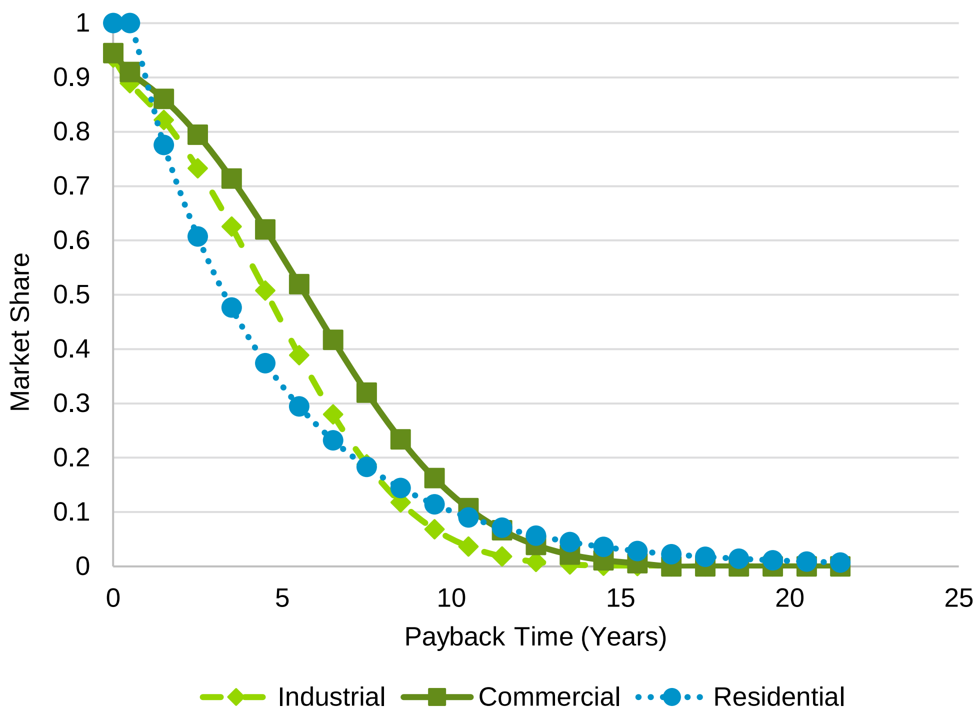
### *5.1.1 Calculation of "Equilibrium" Market Share*

The equilibrium market share can be thought of as the percentage of individuals choosing to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). For DSM measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency often comes at a premium in initial cost. This study calculates an equilibrium market share as a function of the payback time of the efficient technology relative to the inefficient technology. In effect, measures with more favorable customer payback times will have higher equilibrium market share, which reflects consumers' economically rational decision making. While such approaches certainly have limitations, they are nonetheless directionally reasonable and simple enough to permit estimation of market share for the hundreds of technologies appearing in most potential studies.

To inform this CPR, Navigant used equilibrium "payback acceptance" curves that Navigant developed using primary research in the US Midwest in 2012.[3] To develop these curves, Navigant relied on surveys of 400 residential, 400 commercial, and 150 industrial customers. These surveys presented decision makers with numerous "choices" between technologies with low up-front costs, but high annual energy costs, and measures with higher up-front costs but lower annual energy costs. Navigant conducted statistical analysis to develop the set of curves shown in Figure 5-1, which Navigant used in this CPR. Though FortisBC-specific data were not available to estimate these curves, Navigant considers that the nature of the customer decision-making process is such that the data developed using North American customers represents the best industry-wide data available at the time of this study.

As the curves show, the proportion of customers who will accept different payback periods for an energy efficiency investment is different for residential, commercial and industrial customers.[4] The model uses this information to simulate how customers in each sector will accept measures with differing payback periods.

**Figure 5-1. Payback Acceptance Curves**




*Source: Navigant*

Since the payback time of a technology can change over time, as technology costs and/or energy costs change over time, the "equilibrium" market share can also change over time. The equilibrium market

[3] A detailed discussion of the methodology and findings of this research are contained in "Demand Side Resource Potential Study," prepared for Kansas City Power and Light, August 2013.
[4] These payback curves represent customer payback acceptance in aggregate across each sector. In practice, customer behavior can vary across sub-sectors. However, there is minimal industry-wide data available on customer payback acceptance at the sub-sector level.

share is therefore recalculated for every year of the forecast to ensure the dynamics of technology adoption take this effect into consideration. As such, “equilibrium” market share is a bit of an oversimplification and a misnomer, as it can itself change over time and is therefore never truly in equilibrium, but it is used nonetheless to facilitate understanding of the approach.

### *5.1.2 Calculation of the Approach to Equilibrium Market Share*

Two approaches are used for calculating the approach to equilibrium market share, one for technologies being modeled as retrofit (RET) measures, and one for technologies simulated as replace-on-burnout (ROB) or new construction (NEW measures).[5] A high-level overview of each approach is provided below.

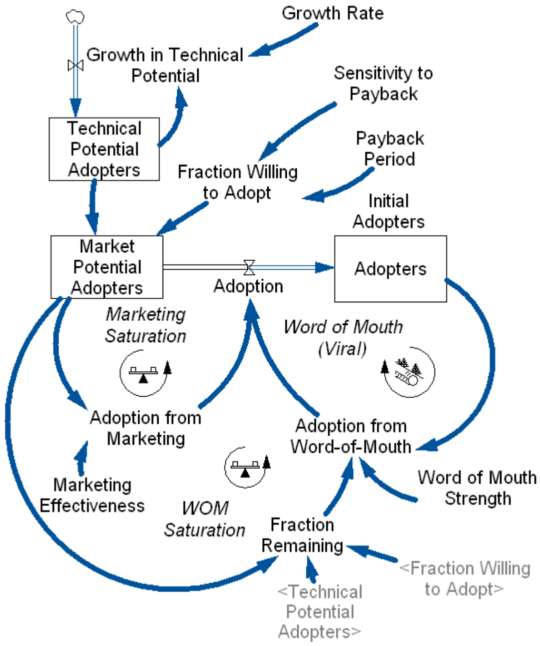
#### *5.1.2.1 Retrofit Technology Adoption Approach*

RET technologies employ an enhanced version of the classic Bass diffusion model[6,7] to simulate the S-shaped approach to equilibrium that is observed again and again for technology adoption. Figure 5-2 provides a stock/flow diagram illustrating the causal influences underlying the Bass model. In this diagram, market potential adopters “flow” to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, or “word-of-mouth.” Navigant estimated the “fraction willing to adopt” using the payback acceptance curves illustrated in Figure 5-1.

Navigant estimated the marketing effectiveness and word-of-mouth parameters for this diffusion model by drawing upon case studies where these parameters were estimated for dozens of technologies.[8] Recognition of the positive, or self-reinforcing, feedback generated by the “word-of-mouth” mechanism is evidenced by increasing discussion of the concepts such as social marketing as well as the term “viral,” which has been popularized and strengthened most recently by social networking sites such as Twitter, Facebook and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass diffusion model of product adoption since its inception in 1969.

[5] Each of these approaches can be better understood by visiting Navigant’s technology diffusion simulator, available at: http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation.
[6] Bass, Frank (1969). "A new product growth model for consumer durables". Management Science 15 (5): p215–227.
[7] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000. p. 332.
[8] See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12 for estimation of the Bass diffusion parameters for dozens of technologies.

**Figure 5-2. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits**



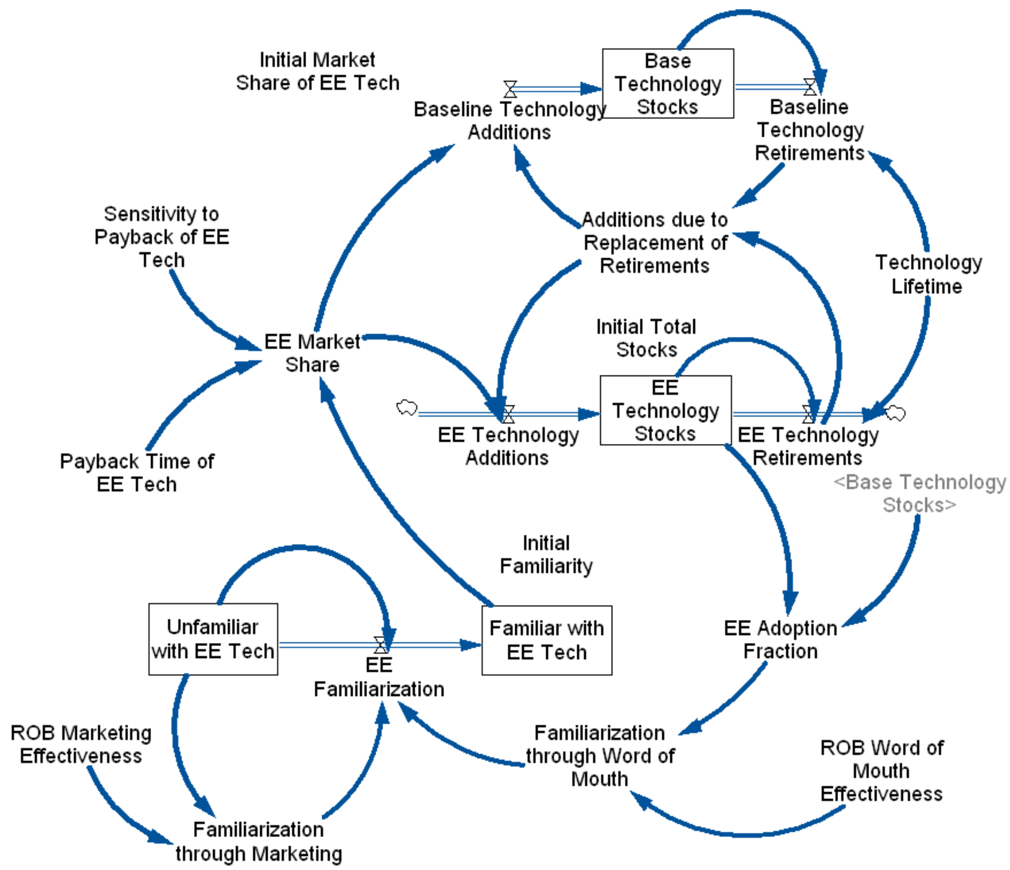

*Source: Navigant*

The model illustrated above generates the commonly seen S-shaped growth of product adoption and is a simplified representation of that employed in DSMSim$^{TM}$.

### *5.1.2.2 Replace-on-Burnout Technology Adoption Approach*

The dynamics of adoption for ROB technologies are somewhat more complex than for NEW/RET technologies since it requires simulating the turnover of mostly long-lived technology stocks. The DSMSim$^{TM}$ model tracks the stock of all technologies, both base and efficient, and explicitly calculates technology retirements and additions consistent with the lifetime of the technologies. Such an approach ensures that technology “churn” is considered in the estimation of market potential, since only a fraction of the total stock of technologies are replaced each year, which affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the Bass approach described above, is overlaid on the stock tracking model to capture the dynamics associated with the diffusion of technology familiarity. Figure 5-3 graphically illustrates a simplified version of the model employed in DSMSim$^{TM}$.

**Figure 5-3. Stock/Flow Diagram of Diffusion Model for ROB Measures**




*Source: Navigant*

### *5.1.3 Behavioral Measures*

Behavior measures typically impose little to no direct costs to the participant[9] and their rate of adoption is highly dependent on the marketing and incentive efforts taken by program administrators. Given these unique characteristics of behavior measures, the payback acceptance curves and technology diffusion models have limited applicability to these types of measures. As such, this study models the adoption of behavior measures in terms of an equilibrium saturation level relative to economic potential and a given amount of time to reach that equilibrium state.

[9] Participants may incur indirect costs through implementation of adjustments to typical operations in response to energy information feedback (e.g., through upgrading a water heater). However, estimating these indirect costs requires additional data on the actions taken by the participant outside of the program and is beyond the scope of this analysis.

This study includes four measures that are distinctly behavioral:

- Commercial Comprehensive Retrocommissioning[10]
- Commercial Occupant Behavior[11]
- Industrial Energy Management[12]
- Residential Home Energy Reports[13]

For each of these measures, the team used multiple sources of information to define the equilibrium saturation level and the duration of time required to reach that level. Figure 5-4 illustrates the saturation trajectory as a percentage of economic potential for each of the behavior measures. Although the adoption of behavior measures is not linked to customers' payback acceptance time, the market potential for behavior measures is still dependent on cost effectiveness by means of the economic potential. As such, the realized market savings from these measures can vary between the TRC and mTRC cases if economic potential varies.

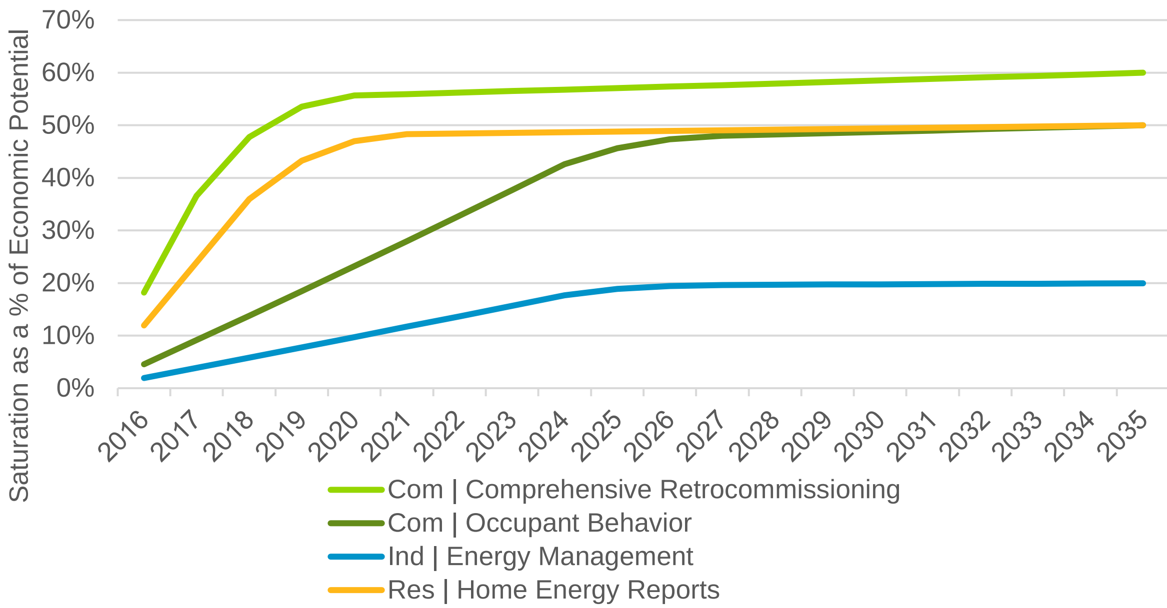
[10] Commercial comprehensive retrocommisioning is similar to FortisBC Gas's Continuous Energy Optimization offering, so the annual ramp rate was trended with historic savings from that measure. Differing from the other behavioral measures, the characterization of retrocommisioning includes some upfront costs to the participant (e.g., paying for a portion of staff training). Since it is uncertain whether comparable training would be available absent program offerings and enrollment efforts, the study treats this measure as a behavior measure that is dependent on on-going support from program administrators.

[11] The team chose the adoption trajectory for the commercial occupant behavior measure after reviewing research conducted for the California Public Utilities Commission on similar measures and after reviewing the trends in historic savings from similar measures within FortisBC Gas's Energy Specialist program.

[12] Navigant designed the rollout of industrial energy management to mimic historical participation levels within BC Hydro's more mature program focusing on industrial energy management. This trajectory implies participation of about nine customers/sites per year, which aligns well with the number of annual customers that participated in BC Hydro's programs, given the different size of each utility's customer base.

[13] The team developed the saturation curves for residential home energy report using information attained through interviews with OPower staff and their experience with typical offerings of these reports. These energy reports encompass many of Fortis Gas's current activities focused on residential behavior.

**Figure 5-4. Behavior Measure Market Saturation as a Percentage of Economic Potential (%)**




*Source: Navigant*

### *5.1.4 Budget Strategy*

FortisBC Gas elected to view market potential without imposing any budget constraints on the simulated results. The implication of this decision is that market potential is only constrained by stock turnover and customer willingness to adopt efficient measures. Without future budget constraints, the utility spending falls out naturally from the input assumptions for per-unit-of-savings incentive and administrative costs and a given year's level of market savings, without tying spending to a given budget level. In this case, the per-unit-of-savings incentive and administrative spending levels are fixed at the same levels (in real dollars) over the study horizon. Therefore, changes in spending (in real dollars) only reflect a changing mix and magnitude of savings among measures.

### *5.1.5 Incentive Strategy*

Per FortisBC Gas's guidance, this study calculates measure-level incentives based on a specified percentage of incremental measure costs. For example, if the specified incentive percentage was 50% and a measure's incremental cost was $100, then the calculated incentive for that measure would be $50. The incentive percentage differs by sector and is applied uniformly to all measures within a given sector.[14] Section 5.1.7 discusses how the model calibration process informed the specified incentive percentage in more detail.

[14] Navigant applied incentive percentages at the sector level, as opposed to the measure level, per the focus of this study's scope on sector-level market potential, rather than program-level potential. Actual program design would define incentive levels for each measure.

### 5.1.6 High Impact Measures

FortisBC Gas selected five measures that merit a more granular measure-level analysis, with the intent that Navigant would perform measure-level calibration customized to each measure's historic savings trajectories. These five high impact measures include:

1. Residential Condensing Storage Water Heater
2. Residential Condensing Tankless Water Heater
3. Residential Efficient Fireplaces
4. Residential Furnace Early Retirement
5. Residential High Efficiency Boiler Replacement

Section 5.1.7 discusses how Navigant customized the calibration of these measures in more detail.

### 5.1.7 Model Calibration

Any model simulating *future* product adoption faces challenges with "calibration," as there is no future world against which one can compare simulated results to actual results. Engineering models, on the other hand, can often be calibrated to a higher degree of accuracy since simulated performance can be compared directly with performance of actual hardware. Unfortunately, DSM potential models do not have this luxury, and therefore must rely on other techniques to provide both the developer and the recipient of model results with a level of comfort that simulated results are reasonable. For this CPR, Navigant took a number of steps to ensure that forecast model results were reasonable, including:

- Identifying the subset of CPR measures that were included in historic program offerings in order to have a basis for comparison with historic program achievements.
- Ensuring similar trends and magnitudes between average historic sector-level savings between 2013-2015 and simulated sector-level savings from the measure subset in 2016.[15]
- For the five high-impact measures, ensuring similar trends and magnitudes between historic measure-level savings and 2016 simulated savings. Additionally, the team calibrated long-term trends to align reasonably with FortisBC Gas's projections for these measures.
- Seeking general alignment between 2015 historic sector-level incentives as a percentage of total sector-level spending and simulated 2016 values.[16]

Before making comparisons of model results to historic achievements, it was first necessary to identify the CPR measures that were included in historic program offerings. The simulated savings from this subset of CPR measures became the basis for comparing modelled savings to historic savings during the calibration process. It is important to note that although the team reached good alignment in trends between historic and simulated results for this subset of measures, this study's results for *total* market potential significantly exceed the historically achieved program savings. This is because the study includes many additional measures that have historically not been included in programs, and those extra

[15] The team compared simulated savings to 2013-2015 historic averages, rather than a single historic year, because historic savings varied appreciably from one near to the next within each sector.
[16] The team compared the percentage of simulated spending derived from incentives to the 2015 historic percentages because 2015 was deemed to be most representative of expectations about future spending allocations between incentives and non-incentives.

measures contribute significant savings to the total market potential results.

When comparing residential results to historic program achievements, Navigant used results from the mTRC case because they are most analogous to FortisBC Gas's program environment (as described in Section 5.1). When comparing commercial and industrial results to historic program achievements, Navigant used results from the TRC case.

To obtain close agreement with FortisBC Gas's historic savings across a wide variety of metrics, Navigant adjusted incentive levels, technology diffusion coefficients and payback acceptance curves. Calibration required an iterative process of modifying the aforementioned parameters until all goals of calibration were reasonably satisfied. For example, the marketing effectiveness parameters are the key lever for calibrating the magnitude of 2016 savings for each sector, whereas the word-of-mouth parameter strongly influences how rapidly adoption and savings ramp up over time. Navigant varied these diffusion parameters within the commonly observed ranges until simulated savings were trending reasonably compared with historic savings at the sector level.[17]

For the five high impact measures, the team made several custom adjustments to align simulated savings with the historic trends. First, the team automatically included these measures in the market potential (for the mTRC and Hybrid cases, but not the TRC case) regardless of their sub-sector cost effectiveness.[18] The team made this provision to ensure that these measures, which are currently offered through FortisBC Gas's programs, would also appear in the market potential.[19] Second, Navigant customized the marketing effectiveness and payback acceptance curves for these measures to achieve similar magnitudes and trends between modelled savings and historic savings.

Lastly, the team adjusted sector-level incentive levels to be different percentages of incremental costs until the percentage of 2016 total spending attributable to incentives was similar to 2015 historic values. The calibrated incentive levels produce a weighted average incentive percentage of 56% for the simulated portfolio. This calibrated value coincides well with the initial target of having modelled incentives cover roughly 50% of incremental costs across the portfolio.

To summarize, the calibration process ensures that forecast potential is grounded against real-world results considering the many factors that determine likely adoption of DSM measures, including both economic and non-economic factors.

---

[17] This study uses a value of 0.255 for the word-of-mouth strength, which is the 25th percentile of values observed by Mahajan 2000. The marketing effectiveness parameter varied between 0.010 and 0.053, depending on the sector. These values span from roughly the 25th percentile to 75th percentile of observed marketing effectiveness, per Mahajan 2000.

[18] While these measures are cost effective overall, some measures are not cost effective for certain sub-sectors and regions within the analysis. Since actual programs focus on overall cost effectiveness across the sector, rather than within sub-sectors, Navigant forced the five high impact measures to pass across all sub-sectors to better reflect actual program implementation.

[19] Each of the five high impact measures are currently offered through FortisBC Gas's residential programs. Because programs look at the collective cost effectiveness of a group of measures (e.g., several water heater technologies), it is possible that a technology within the group may not be cost-effective. However, the group as a whole can be cost-effective, and therefore any technology within the group can be offered through programs.

## 5.2 Market Potential Results

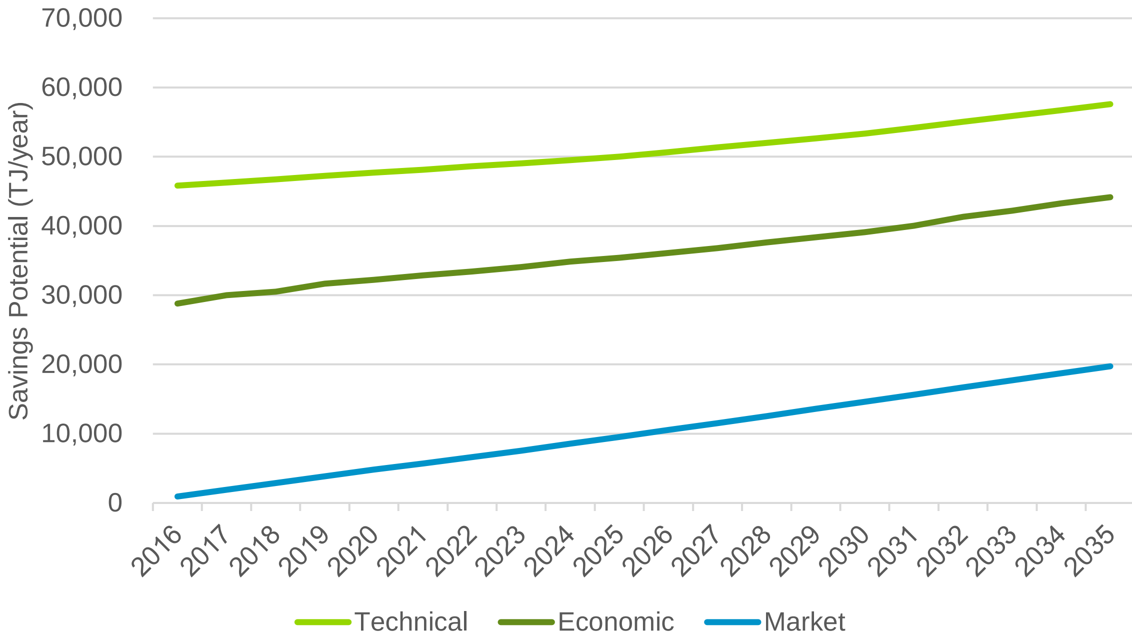
This section provides the market potential results calculated by the model at varying levels of aggregation, using the TRC benefit-cost test as a screen (as consistent with the representation of economic potential in Section 4). Results are shown by sector, customer segment, end-use category, and by highest-impact measures. The section concludes with a review of natural change and its impacts on market potential.

### *5.2.1 Comparison of Savings by Potential Type*

Values shown below for market potential are termed “cumulative market” potential, in that they represent the accumulation of each year’s annual incremental market potential (e.g., an annual incremental market potential of 0.8% per year for ten years would result in a cumulative market potential of 8.0% of forecast consumption). Economic potential, as defined in this study, can be thought of as a bucket of potential from which programs can draw over time. Market potential represents the draining of that bucket, the rate of which is governed by a number of factors, including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative market potential ultimately reaches the economic potential, it would signify that all economic potential in the “bucket”’ had been drawn down, or harvested.

As shown in Figure 5-5 and Table B-1 in Appendix B, the market potential, which accounts for the rate of DSM acquisition, increases steadily throughout the CPR period, reaching 19,736 TJ/year in 2035. By 2035, market potential reaches nearly 46% of the economic potential. Incremental annual market potential added year-over-year to the cumulative potential averages 987 TJ/year over the study horizon.[20]

**Figure 5-5. Total Cumulative Gas Savings Potential (TJ/year)**

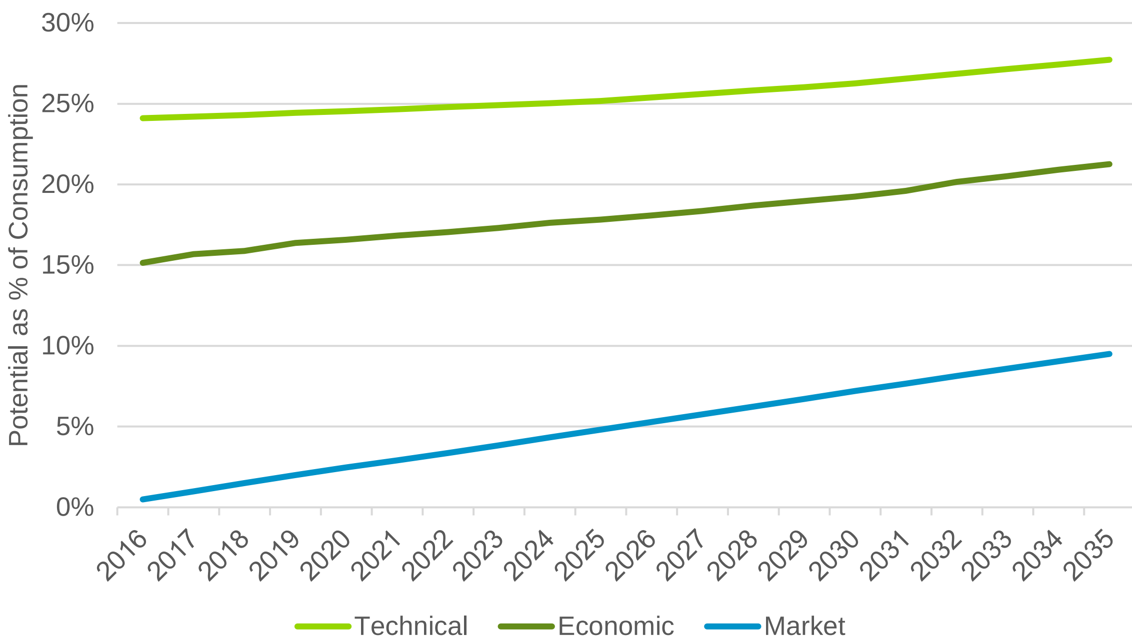



*Source: Navigant*

[20] The time horizon for the CPR is 2016-2035 (20 years).

Under the TRC screen, market potential grows from 0.5% in 2016 to 9.5% of forecast gas consumption by 2035, as shown in Figure 5-6 and in Appendix B. The annual incremental market potential is approximately 0.5% per year on average over the CPR time horizon.

**Figure 5-6. Total Cumulative Gas Savings Potential as a Percentage of Consumption (%)**

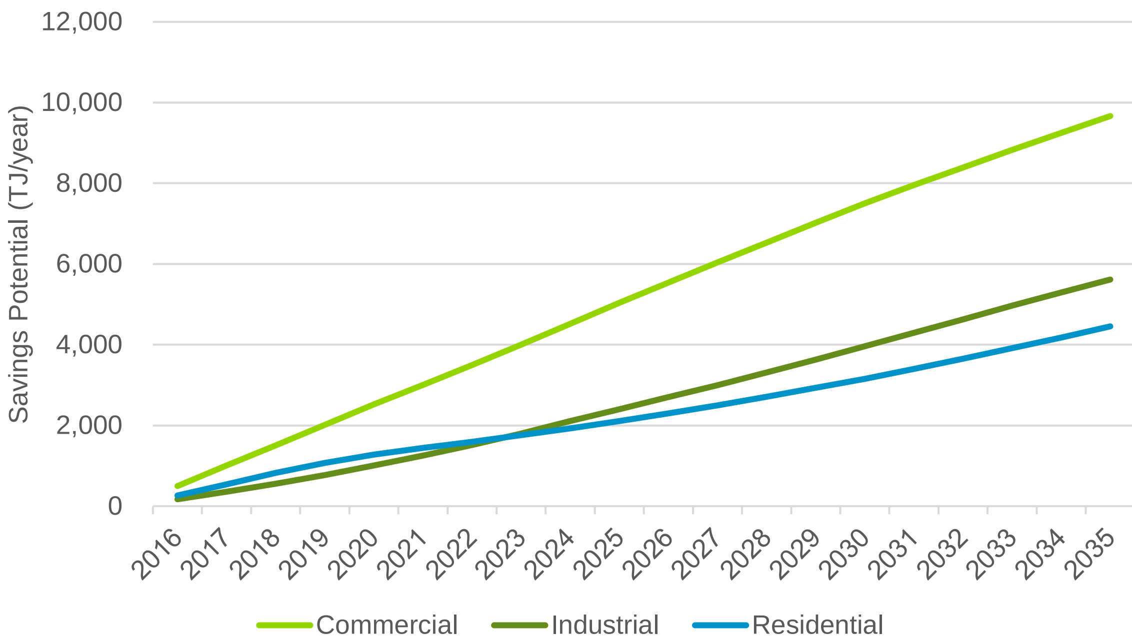



*Source: Navigant*

### *5.2.2 Results by Sector*

Figure 5-7 and in Appendix B show the magnitude of gas market potential by sector. Navigant found the greatest potential exists in the commercial sector in terms of TJ/year and as a percentage of consumption. The commercial and industrial sectors captured just over 50% of economic potential by 2035, while the residential sector captured 28% of the economic potential.

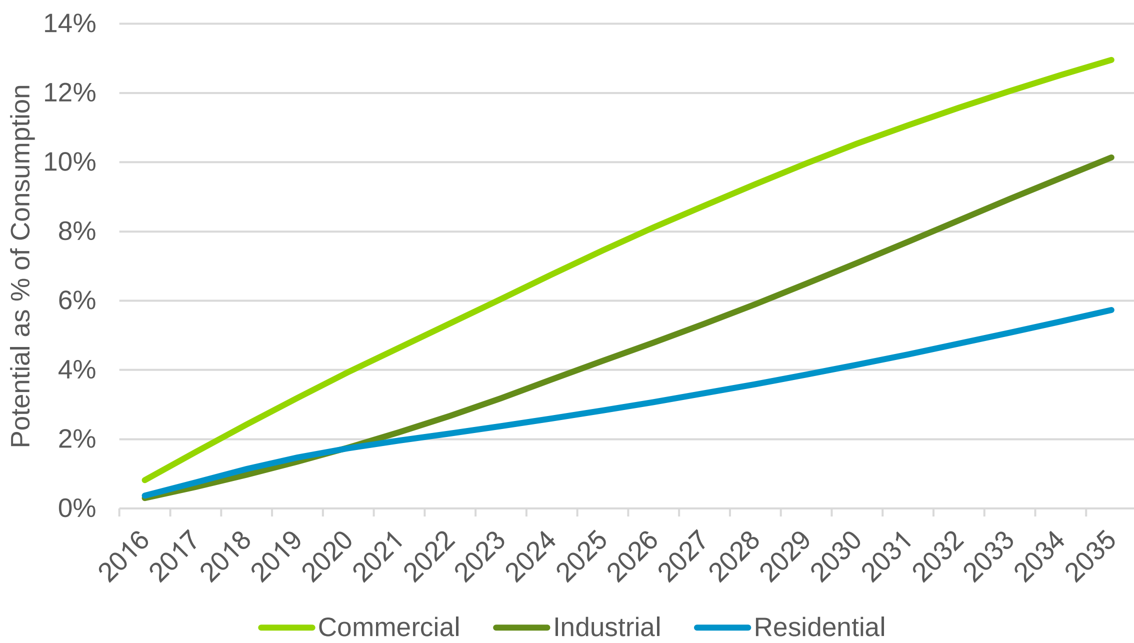
**Figure 5-7. Cumulative Gas Savings Market Potential by Sector (TJ/year)**




*Source: Navigant*

When viewed as a percentage of consumption, similar sector-level trends in the market potential are evident, as shown in Figure 5-8 and Table B-4. The commercial sector's market potential reaches 13% of commercial consumption by 2035, and the industrial sector achieves slightly over 10%. The residential sector increases to nearly 6% of consumption by the final study year, and this lower percentage reflects the lower cost-effectiveness and longer payback times of the residential sector on the whole.

**Figure 5-8. Cumulative Gas Savings Market Potential as a Percentage of Consumption by Sector (%)**

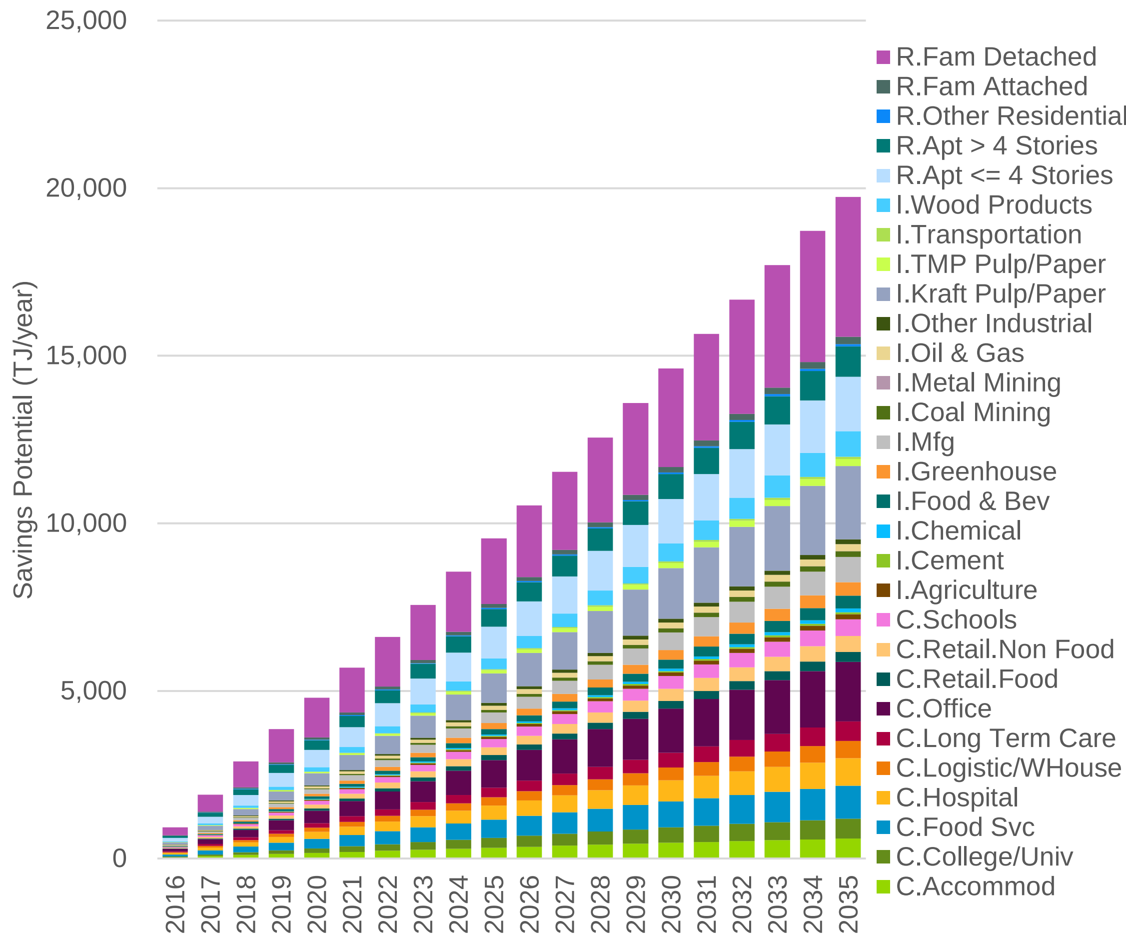



*Source: Navigant*

### 5.2.3 Results by Customer Segment

Figure 5-9 shows the gas energy market savings potential across all customer segments, and Table B-5 in Appendix B provides the associated data.[21] This figure highlights the large savings potential of the residential detached single-family home customer segment relative to other customer segments. Other segments with significant savings potential are kraft pulp and paper, apartments less than 4 stories, and offices. The segments with high savings are also segments with high consumption.

**Figure 5-9. Cumulative Gas Savings Market Potential by Customer Segment (TJ/year)**




*Source: Navigant*

[21] The LNG segment does not appear in this figure because FortisBC Gas does not supply natural gas to LNG facilities. Gas sales to LNG facilities are zero across the Reference Case forecast; hence, the savings potential is also zero.

Figure 5-10, Figure 5-11, and Figure 5-12 break out the gas energy market savings potential for each sector by customer segment. For the residential sector, detached single-family homes represents the largest savings potential of any customer segment by far, accounting for 93% of the total savings potential. Offices and apartments provide nearly half of the savings in the commercial sector. In general, the distribution of savings among customer segments aligns well with the distribution of gas consumption among segments. In the industrial sector, kraft pulp and paper accounts for the largest share of energy savings at 37%. Wood products and manufacturing also provide significant savings among industrial segments.

**Figure 5-10. Residential Gas Savings Market Potential Customer Segment Breakdown in 2025**

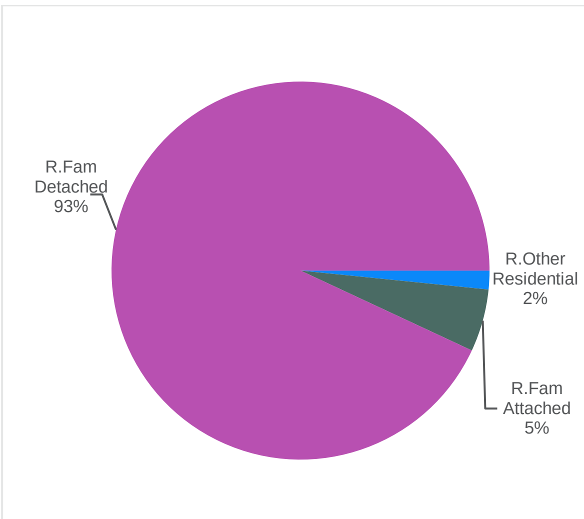



**Figure 5-11. Commercial Gas Savings Market Potential Customer Segment Breakdown in 2025**

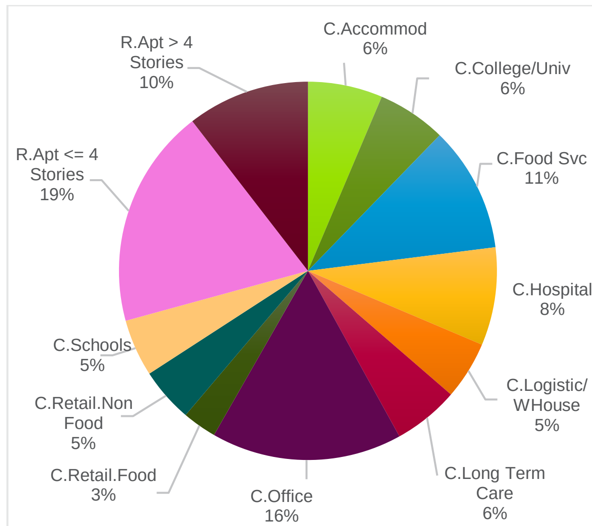
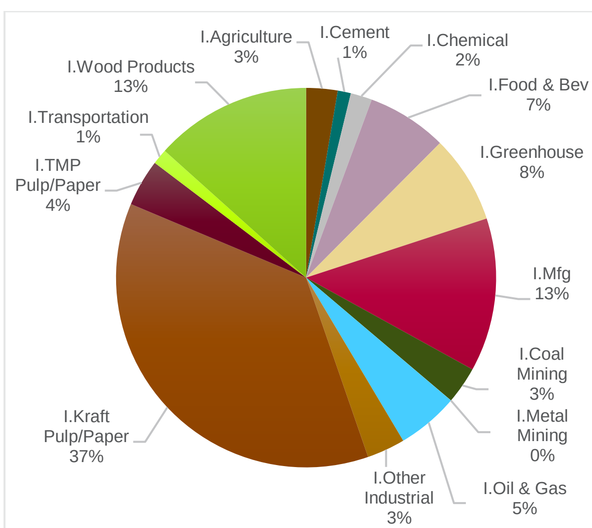



**Figure 5-12. Industrial Gas Savings Market Potential Customer Segment Breakdown in 2025**

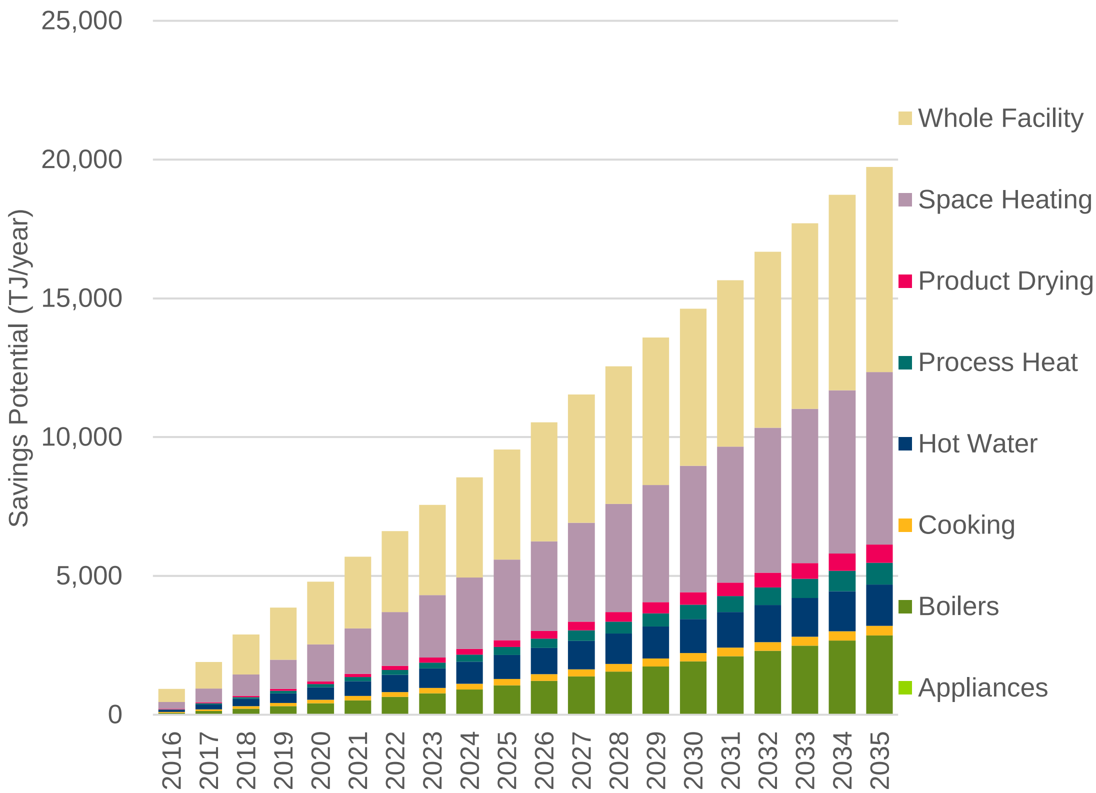



*Source: Navigant*

### 5.2.4 Results by End-use

Figure 5-13 shows the gas energy market savings potential across end-uses.[22] The data used to generate the figure are in Table B-6 in Appendix B. The dominant end-uses are space heating and whole facility. The bulk of savings potential in the space heating end-use comes from smart thermostats. The whole facility end-use primarily consists of savings from comprehensive whole-facility new construction practices, home energy reports, and energy management programs. As such, these whole-facility savings implicitly include savings from multiple end-uses.

**Figure 5-13. Cumulative Gas Savings Market Potential by End-Use (TJ/year)**




*Source: Navigant*

Figure 5-14, Figure 5-15, and Figure 5-16 break out the gas energy market savings potential for each sector. The whole facility end-use dominates the residential sector, accounting for 50% of the total savings potential. This is largely driven by home energy reports, which have by far the most market potential of all residential measures, and ENERGY STAR Homes, which is the third highest residential potential saver. In the commercial sector, the space heating and whole facility end-uses account for roughly 86% of the total market savings potential. Savings in commercial space heating come largely from HVAC control upgrades, condensing make-up air units and high efficiency furnaces. The whole-facility end-use's savings are driven by new building construction practices that are at least 45% above

[22] This study evaluated several gas appliances (convection ovens, gas ranges, and clothes washers and dryers) and found all to be non-cost-effective. As such, the appliances end use shows no market potential. For a list of measures associated with each end use, please refer to Appendix A.2 of the technical and economic potential report.

code. In the industrial sector, the boiler end-use plays the largest role, consisting of high savings measures like process boiler load control and heat recovery systems.

**Figure 5-14. Residential Gas Savings Market Potential End-Use Breakdown in 2025**

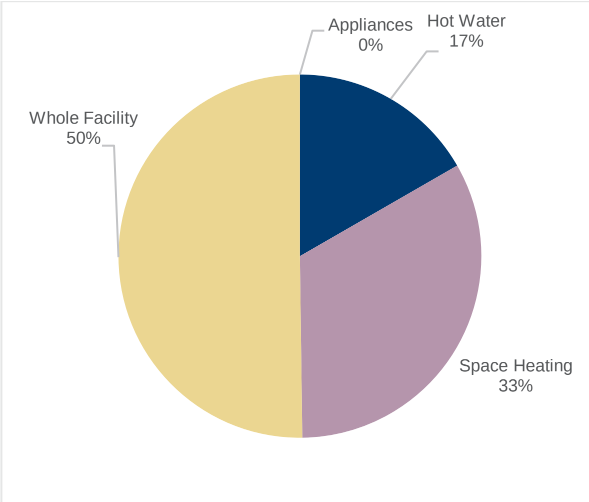



**Figure 5-15. Commercial Gas Savings Market Potential End-Use Breakdown in 2025**

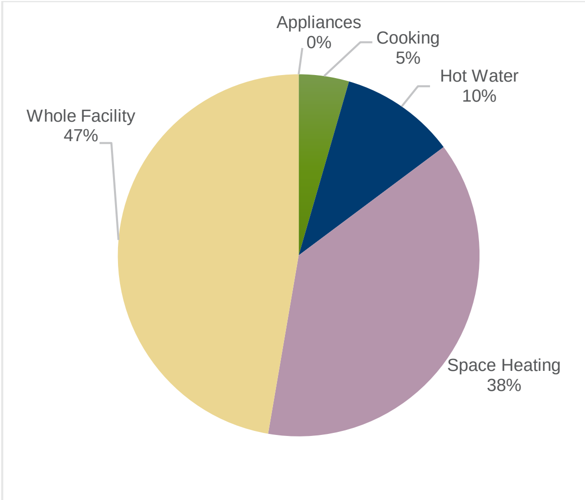
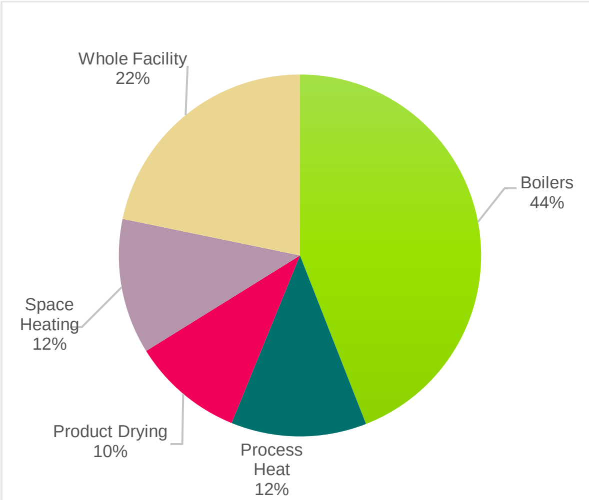



**Figure 5-16. Industrial Gas Savings Market Potential End-Use Breakdown in 2025**




*Source: Navigant*

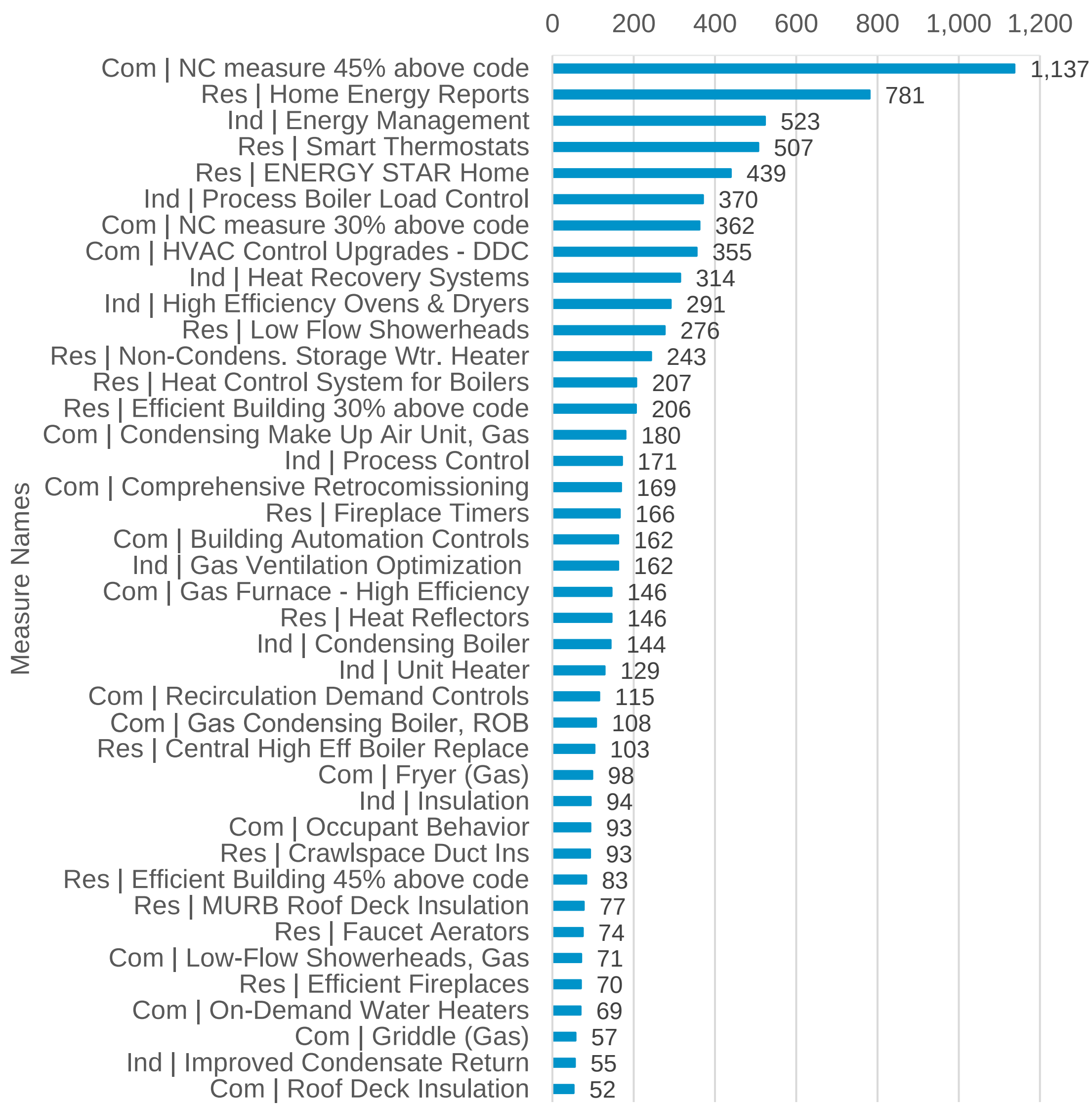
### *5.2.5 Results by Measure*

Figure 5-17 and Table B-7 present the top 40 measures ranked by their gas energy market savings potential in 2025. Wherever a group of measures were similar in nature, Navigant consolidated their potential into a representative measure name to produce a more succinct view at the measure level. Unlike similar figures for economic and technical potential, these rankings already account for competition among measures providing the same service. Thus, one can add the potential shown without encountering issues of double counting.

When code-change measures become applicable, they “steal” savings potential from other related measures that may display significant savings in absence of the code. In this way, the sum of the total savings potential between the code and the related energy-efficient measure is the same before and after a code takes effect. This ensures there is no double counting of savings from codes and the energy efficient measures impacted by the code.

The top ten measures come from the whole-facility, space heating, boiler, and industrial process heating end-uses. Notably, five of the top ten measures are associated with the whole facility end-use. New construction practices 45% better than code ranks as the highest impact market potential measure. Smart thermostats, which has the highest economic savings potential, ranks fourth in terms of market potential. Home energy reports move from the 7th position in economic potential to the 2nd position in market potential.

**Figure 5-17. Top 40 Measures for Gas Energy Market Savings Potential in 2025 (TJ/year)**



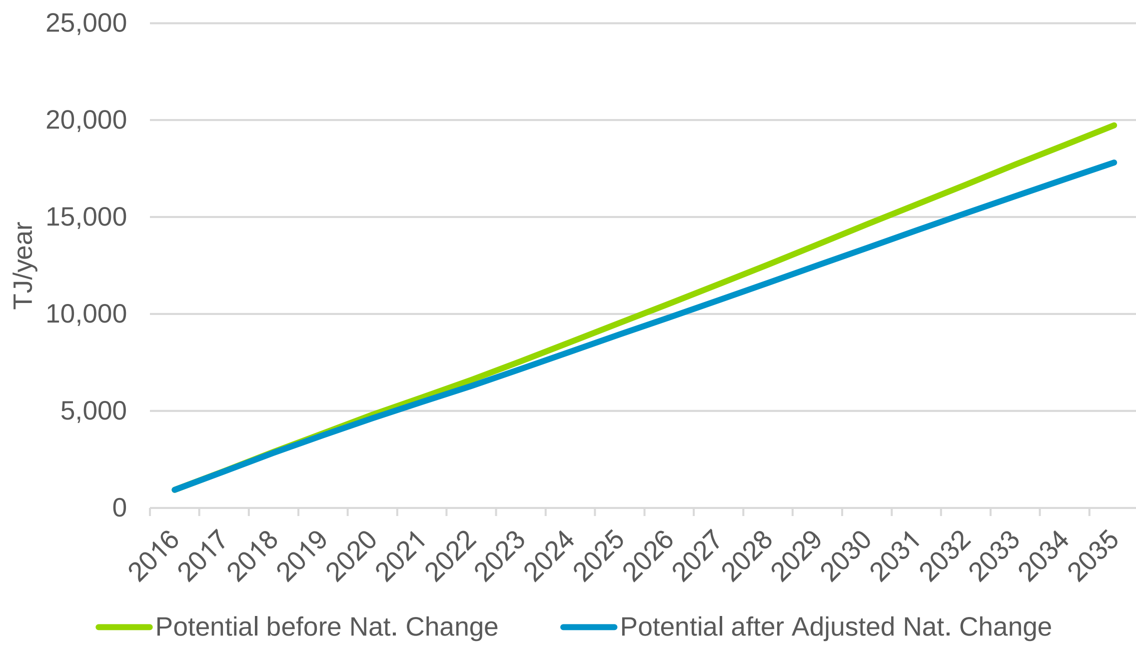

*Source: Navigant*

### *5.2.6 Adjustments for Natural Change*

As discussed in Section 2.3.2, Navigant estimated natural change to account for differences in end-use consumption in the Reference Case compared to the frozen EUI case. Natural change accounts for changes in consumption that are naturally occurring and are not the result of utility-sponsored programs or incentives. Adding natural change to the frozen EUI case required adjusting the market potential forecasts accordingly.

Figure 5-18 and Table B-8 in Appendix B show the total market potential across all sectors before and after adjusting for natural change. The total natural change across all sectors is negative in all years, indicating an overall natural tendency toward increased energy conservation rather than growth. The adjusted natural change is computed by accounting for the percentage of the gross natural change that could reasonably be attributed to energy savings for each end-use. Market potential after adjustment for natural change is on average about 10% lower than potential before natural change by 2034.

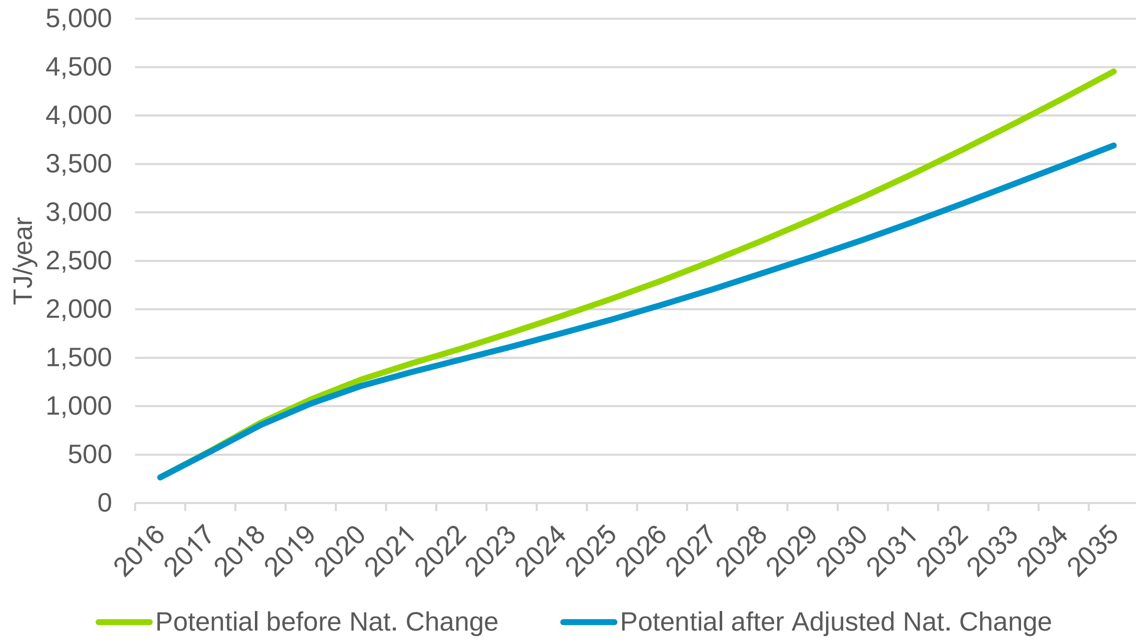
**Figure 5-18. Gas Energy Market Savings Potential with Natural Change – All Sectors (TJ/year)**




*Source: Navigant*

Figure 5-19 and Table B-9 show the effect of adjustments for natural change in the residential sector. Space heating and hot water end-uses account for significant natural conservation. In contrast, appliances account for a minor amount of natural growth. When aggregated to the sector level, natural conservation has a much larger effect than natural growth. On average across the study period, the residential technical potential after adjusted natural change is roughly 12% lower than the potential prior to natural change.

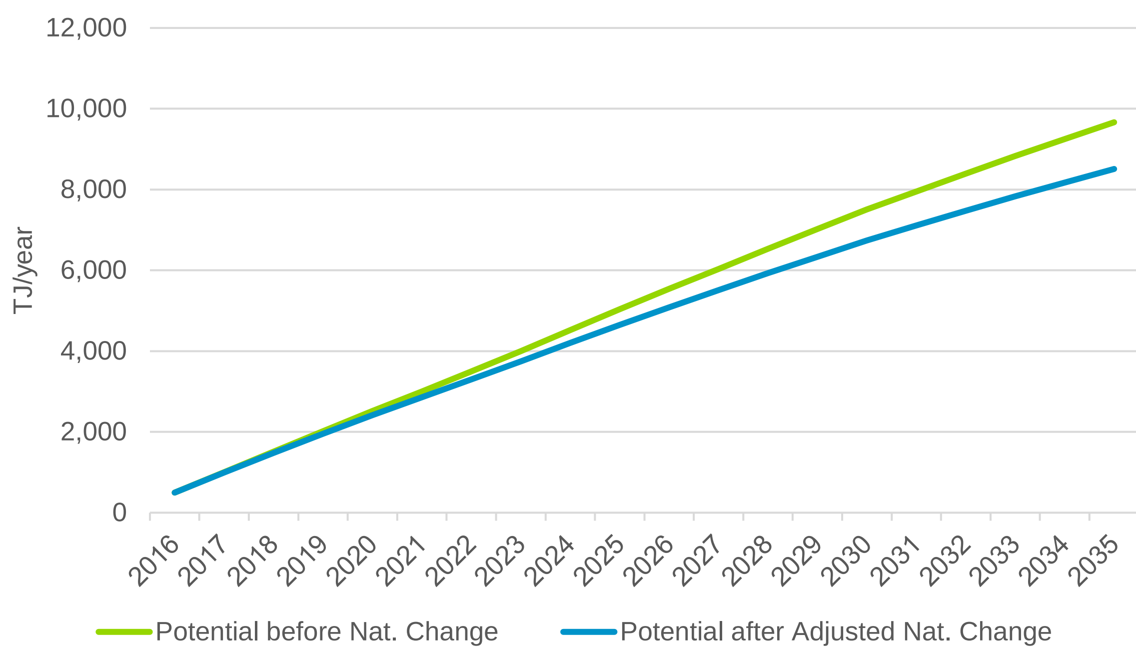
**Figure 5-19. Residential Gas Energy Market Savings Potential with Natural Change (TJ/year)**




*Source: Navigant*

The effect of adjustments for natural change on the commercial sector's market potential is slightly less than for the residential sector, as seen in Figure 5-20 and Table B-10. Space heating and hot water are the commercial end-uses contributing to natural change, and both exhibit natural conservation. On average across the study period, the commercial technical potential adjusted for natural change is roughly 9% lower than the potential prior to natural change.

**Figure 5-20. Commercial Gas Energy Market Savings Potential with Natural Change (TJ/year)**




*Source: Navigant*

For the industrial sector, there is no forecasted natural change, so adjustments to the market potential results presented in previous sections are not necessary.

## 5.3 Market Potential Budget Estimates

The following section describes the approach that Navigant used to develop the budget estimates for the market potential savings presented in this report, as well as the results of the market potential budget and cost effectiveness assessments when using the TRC test as an economic measure screen.

### *5.3.1 Approach to Budget Estimation*

Navigant developed estimates of the portfolio-level DSM spending that FortisBC Gas would need to support the market potential savings forecast over the study period. Navigant calculated these estimates in the DSMSim™ model using incentive levels calibrated to align simulated 2016 incentive values with historic sector-level incentives as a percentage of total sector-level spending (as described in Section 5.1.7). The incentive budgets reflect the amount of spending that would result from the level of adoption for each measure that makes up the market potential estimates. Incentive budgets grow over time due to changes in the mix of DSM measures and cost inflation. The sector and total administration budgets result from the amount of savings potential in a given year multiplied by the historical per-unit-of-savings administrative expenditures ($/GJ) reported by FortisBC Gas, which the study escalates over time at the assumed inflation rate.[23]

### *5.3.2 Total Market Potential Budget*

Table 5-2 presents the estimated spending levels for incentives, administrative costs (non-incentives), and the total portfolio. As can be seen from the table, the total simulated funding for market potential is roughly $21 million in 2016, and more than doubles to almost $54 million by 2035 as the portfolio mix changes and low-hanging fruit is harvested.

**Table 5-2. Budgets by Sector – TRC Case (Million $)**

| Sector | Spending Type | 2016 | 2020 | 2025 | 2030 | 2035 | 2016-2035 Total* |
|---|---|---|---|---|---|---|---|
| Commercial | Incentives | $9.52 | $14.21 | $18.58 | $21.55 | $23.05 | $351.38 |
| | Non-Incentives | $1.51 | $1.62 | $1.85 | $1.90 | $1.81 | $34.83 |
| | Total | $11.03 | $15.83 | $20.43 | $23.45 | $24.86 | $386.22 |
| Industrial | Incentives | $2.33 | $3.94 | $6.53 | $8.93 | $9.75 | $131.07 |
| | Non-Incentives | $1.14 | $1.67 | $2.35 | $2.87 | $3.08 | $46.02 |
| | Total | $3.47 | $5.61 | $8.89 | $11.81 | $12.83 | $177.09 |
| Residential | Incentives | $2.73 | $4.28 | $5.39 | $7.83 | $10.82 | $123.04 |
| | Non-Incentives | $3.55 | $2.99 | $2.85 | $4.04 | $5.36 | $72.87 |
| | Total | $6.27 | $7.27 | $8.24 | $11.87 | $16.18 | $195.92 |
| Portfolio | Incentives | $14.58 | $22.43 | $30.50 | $38.31 | $43.62 | $605.50 |
| | Non-Incentives | $6.19 | $6.27 | $7.06 | $8.81 | $10.25 | $153.73 |
| | Total | $20.77 | $28.71 | $37.56 | $47.13 | $53.87 | $759.23 |

*The 2016-2035 Total column represents the sum of all forecasted years (2016-2035), not just those shown in the table.
*Source: Navigant*

The costs borne by the utility to acquire market savings—on a dollar-per-savings basis—increase 2 to 3 percent per year, on average and in real terms, for each sector. This contrasts with recent program experience, where per-unit-of-savings utility costs have shown declining trends. There are several factors creating this difference:

- Actual program implementation may be dynamically allocating incentive spending to measures providing lower cost savings than the incentive strategy employed in this analysis (refer to Section 5.1.5). Though the modeling approach captures customers' tendency to favor the adoption of economically attractive measures over less economically attractive measures, it does not preferentially incentivize the most economic measures.

[23] The study includes administrative costs directly tied to programs and measures providing energy savings. Outreach and enabling costs and portfolio-level administrative costs (i.e., not tied to a program) were not included in this study. This study's portfolio total administrative costs are a summation of sector-level administrative costs, so this analysis is likely to underrepresent total administrative budgets at the portfolio level. However, this underrepresentation may be partially offset by not accounting for efficiencies gained through program experience, which would reduce per-unit-of-savings administrative costs over time.

- Actual programs may not be experiencing significant saturation yet in the uptake of certain low cost measures. This study's upward trend in the percentage of spending directed to incentives indicates that low-cost savings are harvested early in the study horizon and the remaining savings opportunities become increasingly costlier.
- This study did not attempt to estimate the reduction in per-unit-of-savings administrative costs that could be realized as experience in program administration leads to greater efficiency in administrative spending.
- Compliancy to codes and efficiency standards enacted during the study horizon reduces the savings potential and cost-effectiveness of impacted measures, resulting in higher costs to the utility to capture those measures' savings potential.

### 5.3.3 TRC Cost Effectiveness

Table 5-3 shows the benefit-cost test ratios by sector and for the portfolio for each benefit-cost test. The benefit-cost test ratios are greater than 1.0 for all benefit-cost test types at the sector and portfolio level across all analysis years, with an exception for the RIM test, which very rarely has a benefit-cost test greater than 1.0 for DSM measures.

**Table 5-3. Benefit-Cost Test Ratios for the Portfolio and by Sector**

| Sector | Year | Total Resource Cost Test | Utility Cost Test | Participant Cost Test | Rate Impact Measure Test |
|---|---|---|---|---|---|
| Commercial | 2016 | 1.86 | 2.78 | 2.63 | 0.75 |
| | 2020 | 1.83 | 2.71 | 2.38 | 0.80 |
| | 2025 | 1.82 | 2.69 | 2.21 | 0.84 |
| | 2030 | 1.78 | 2.63 | 2.05 | 0.88 |
| | 2035 | 1.76 | 2.60 | 1.92 | 0.92 |
| | 2016-2035 | 1.84 | 2.71 | 2.27 | 0.83 |
| Industrial | 2016 | 2.07 | 2.23 | 3.50 | 0.75 |
| | 2020 | 2.47 | 2.67 | 3.60 | 0.85 |
| | 2025 | 2.81 | 3.05 | 3.60 | 0.95 |
| | 2030 | 2.99 | 3.25 | 3.48 | 1.02 |
| | 2035 | 3.22 | 3.50 | 3.47 | 1.10 |
| | 2016-2035 | 2.75 | 2.98 | 3.54 | 0.94 |
| Residential | 2016 | 1.16 | 1.59 | 3.14 | 0.51 |
| | 2020 | 1.70 | 2.43 | 3.45 | 0.61 |
| | 2025 | 1.93 | 2.75 | 3.41 | 0.67 |
| | 2030 | 1.98 | 2.78 | 3.28 | 0.70 |
| | 2035 | 2.02 | 2.81 | 3.16 | 0.74 |
| | 2016-2035 | 1.79 | 2.51 | 3.38 | 0.65 |
| Portfolio | 2016 | 1.68 | 2.33 | 2.84 | 0.69 |
| | 2020 | 1.89 | 2.63 | 2.77 | 0.75 |
| | 2025 | 2.03 | 2.79 | 2.68 | 0.82 |
| | 2030 | 2.07 | 2.82 | 2.59 | 0.86 |
| | 2035 | 2.12 | 2.88 | 2.53 | 0.90 |
| | 2016-2035 | 1.99 | 2.72 | 2.72 | 0.80 |

*Source: Navigant*

Table 5-4 presents the net benefits by sector and for the portfolio under each benefit-cost test. As with the benefit-cost test ratios, net benefits are positive in all cases, with the exception of the RIM test. The analysis estimates that the total net present value for the portfolio over the 2016-2035 analysis timeframe is more than $450 million from the TRC perspective.

**Table 5-4. Cost Test Net Benefits for the Portfolio and by Sector (Million $)**

| Sector | Year | Total Resource Cost Test | Utility Cost Test | Participant Cost Test | Rate Impact Measure Test |
|---|---|---|---|---|---|
| Commercial | 2016 | $14.16 | $19.58 | $24.35 | -$10.19 |
| | 2020 | $19.47 | $27.13 | $30.87 | -$10.97 |
| | 2025 | $24.78 | $34.46 | $35.74 | -$10.27 |
| | 2030 | $26.94 | $38.16 | $35.94 | -$8.37 |
| | 2035 | $27.92 | $39.81 | $33.75 | -$5.40 |
| | 2016-2035* | $218.08 | $302.17 | $319.53 | -$96.98 |
| Industrial | 2016 | $4.00 | $4.27 | $6.52 | -$2.52 |
| | 2020 | $8.89 | $9.35 | $11.43 | -$2.54 |
| | 2025 | $17.45 | $18.19 | $18.91 | -$1.46 |
| | 2030 | $25.53 | $26.56 | $24.69 | $0.84 |
| | 2035 | $31.01 | $32.13 | $26.79 | $4.22 |
| | 2016-2035* | $143.16 | $149.48 | $156.42 | -$13.26 |
| Residential | 2016 | $1.39 | $3.72 | $10.82 | -$9.43 |
| | 2020 | $7.25 | $10.40 | $18.81 | -$11.27 |
| | 2025 | $10.96 | $14.44 | $23.02 | -$11.18 |
| | 2030 | $16.32 | $21.09 | $31.98 | -$13.80 |
| | 2035 | $22.94 | $29.27 | $42.01 | -$15.94 |
| | 2016-2035* | $96.08 | $130.83 | $220.95 | -$116.74 |
| Portfolio | 2016 | $19.55 | $27.57 | $41.69 | -$22.14 |
| | 2020 | $35.61 | $46.88 | $61.11 | -$24.77 |
| | 2025 | $53.18 | $67.09 | $77.68 | -$22.92 |
| | 2030 | $68.78 | $85.80 | $92.61 | -$21.34 |
| | 2035 | $81.87 | $101.22 | $102.56 | -$17.12 |
| | 2016-2035* | $457.31 | $582.48 | $696.90 | -$226.97 |

**Total net benefits for 2016-2035 represent the total present values in 2016 dollars. Other yearly values represent non-discounted single-year net benefits.*
*Source: Navigant*

## 5.4 mTRC Results

This section describes the approach taken for estimating DSM potential using the mTRC benefit-cost test as a screen, rather than the TRC benefit-cost test. Given that the economic potential results will differ under the mTRC test from the results presented in Section 4, this section provides the results for both economic and market potential using the mTRC, as well as the sector and portfolio cost effectiveness.

### *5.4.1 Approach to Estimating mTRC Results*

The primary change between the TRC benefit-cost test and mTRC benefit-cost test is the application of different values for avoided costs, with the mTRC avoided costs roughly six times higher than the TRC avoided costs.[24] The use of higher avoided costs increases the benefits calculated for each measure and results in more measures screening as cost-effective. Based on input from FortisBC Gas, Navigant also included the five high impact measures in the mTRC market potential, regardless of cost-effectiveness,[25] to capture additional market dynamics with these measures (as described in Section 5.1.7). All other calculations are the same between the TRC and mTRC tests.

### *5.4.2 mTRC Economic Potential Results*

Figure 5-21 shows the cumulative gas economic potential by sector in TJ/year. The data used to generate the figure are in Table B-11 in Appendix B. The use of the mTRC screen instead of the TRC screen increases the proportion of technical savings potential that are economic. Economic potential increases from 71% of technical potential based on the TRC screen, to 94% based on the mTRC screen.

mTRC economic potential for the commercial and residential sectors increases significantly over the study period to 25% and 67%, respectively. This increase in economic potential over time is a result of whole-facility, high-impact measures such as new construction practices 45% more efficient than code and ENERGY STAR homes. Industrial sector economic potential stays roughly the same as the TRC case (see Section 4.2), decreasing by 4% over the study period, primarily because industrial gas consumption is not forecast to increase over time.

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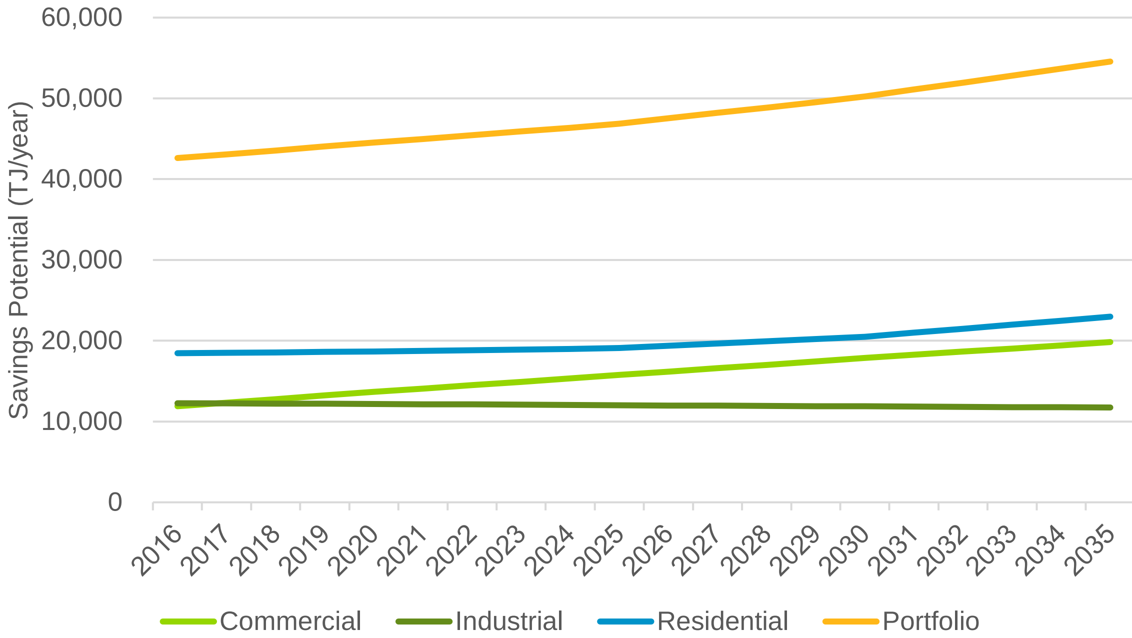
[24] The formulation of the mTRC benefit-cost test is the same as the TRC test, with the exception that the avoided costs stem from a zero emission energy supply alternative (ZEEA) cost and benefits are increased by a 15% non-energy benefits adder.

[25] As stated in Section 5.1.7, while these measures are cost effective overall, some measures are not cost effective for certain sub-sectors and regions within the analysis. Since actual programs focus on overall cost effectiveness across the sector, rather than within sub-sectors, Navigant forced the five high impact measures to pass across all sub-sectors to better reflect actual program implementation.

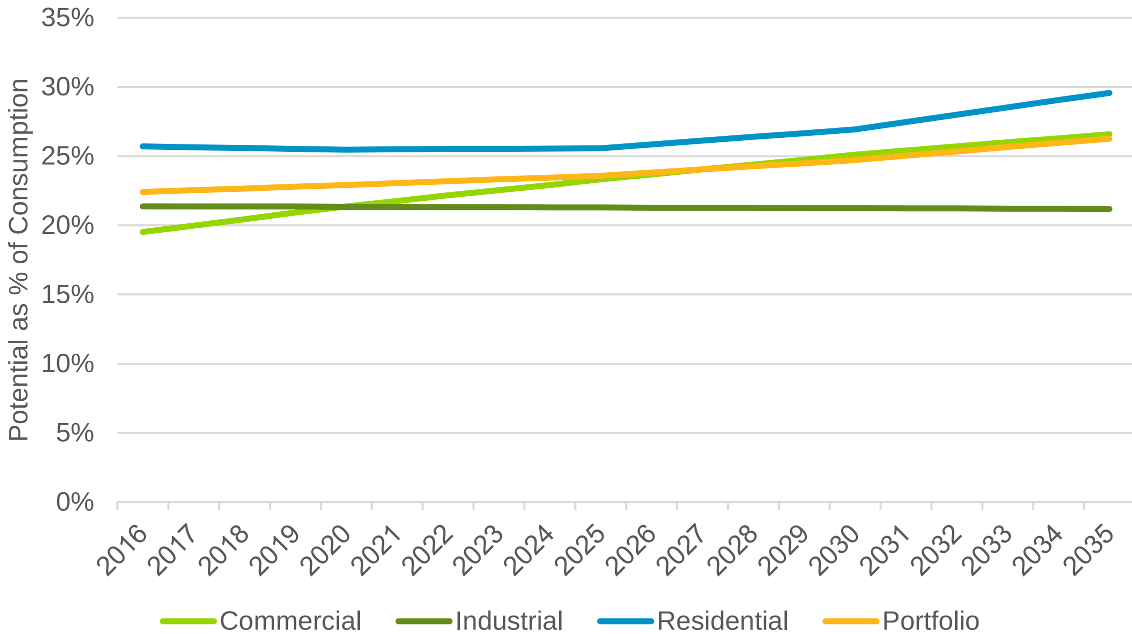
**Figure 5-21. mTRC Cumulative Gas Savings Economic Potential by Sector (TJ/year)**




*Source: Navigant*

Figure 5-22 shows the cumulative gas economic potential as a percent of sector consumption. The data used to generate the figure are in Table B-12 in Appendix B. Whole-facility, new construction measures in the residential and commercial sectors enable the increase in savings potential as a percent of sector consumption over time. Industrial savings as a percent of consumption do not increase because limited growth in the sector result in limited opportunities for high-impact measures. While the overall shape of the mTRC economic savings curves are similar to the TRC economic curves, the use of the mTRC screen increases the percentage of technical savings that are economic. Economic savings as a percent of consumption in 2016 increase from 15.1% (based on the TRC screen) to 22.4% (based on the mTRC screen). The 2035 economic savings increase from 21.3% to 26.3%.

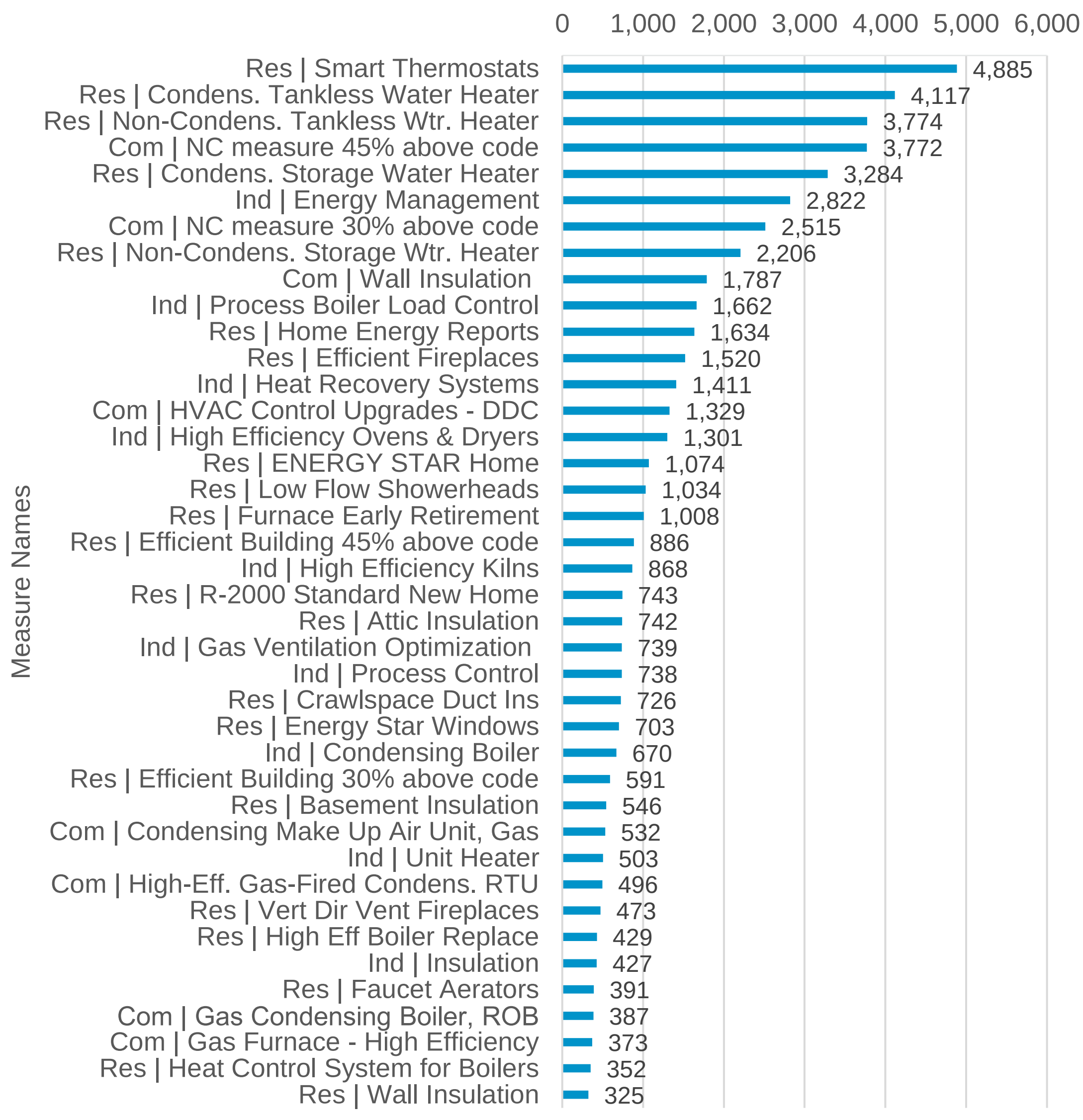
**Figure 5-22. mTRC Cumulative Gas Savings Economic Potential as Percent of Sector Consumption (%)**




*Source: Navigant*

Figure 5-23 and Table B-13 list the top 40 gas saving measures with the highest economic potential prior to adjustments made to competition groups. There are no changes in ranking or savings potential in results when compared with the top 10 technical potential measures. The four measures (residential condensing and non-condensing tankless water heaters, residential condensing storage water heaters, and commercial wall insulation) that were not economic using the TRC screen are economic using the mTRC screen.

**Figure 5-23. mTRC Top 40 Measures for Gas Energy Economic Savings Potential in 2025 (TJ/year)**

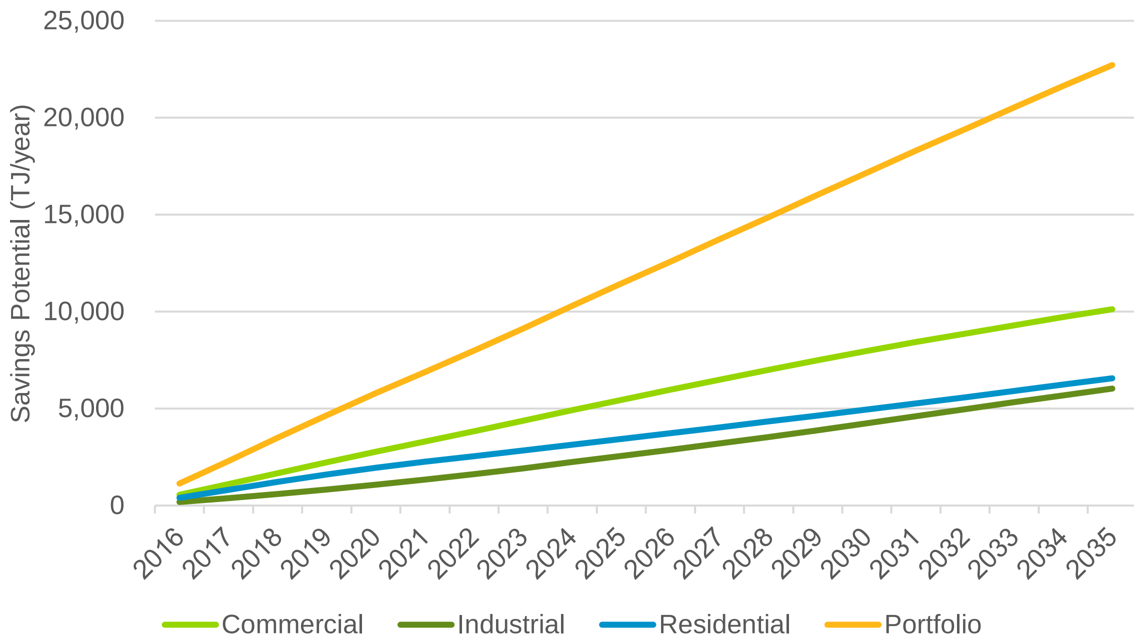



*Source: Navigant*

### 5.4.3 mTRC Market Potential Results

The following figures show the market potential results for the mTRC case. Figure 5-24 and Table B-14 show the cumulative gas market potential by sector in TJ/year. The commercial sector contributes approximately 46% of the cumulative gas savings market potential over the study period, down from approximately 50% using a TRC screen. The residential and industrial sectors contribute 30% and 24%, respectively. Relative to the TRC market potential savings, the residential sector's market potential increased 45%, while the commercial and industrial sectors only increased 5% and 7%, respectively.

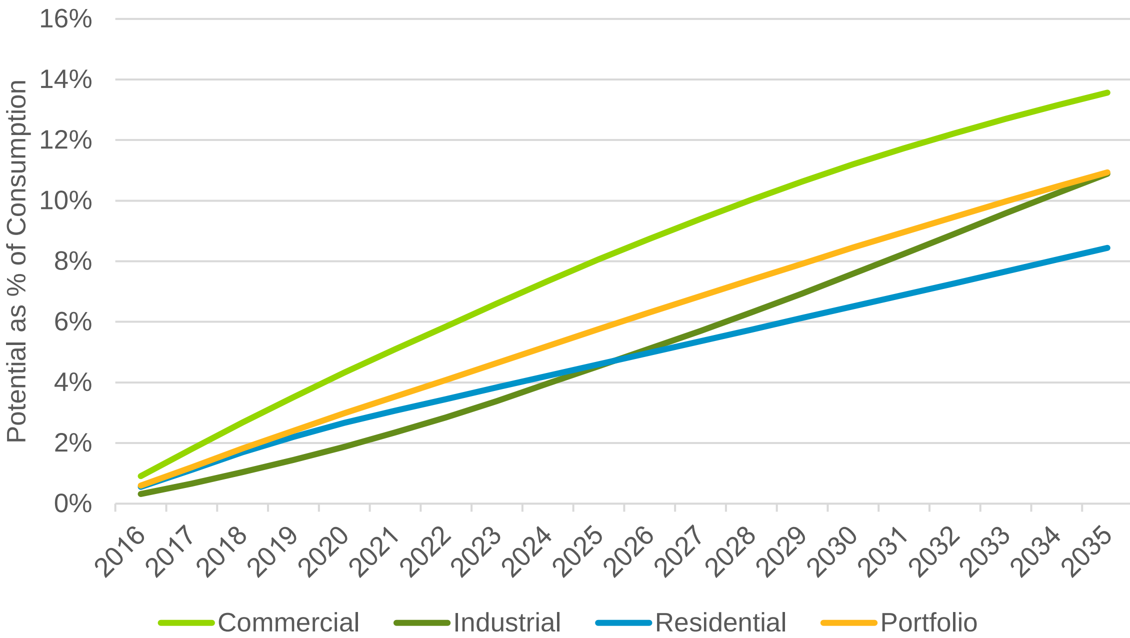
**Figure 5-24. mTRC Cumulative Gas Savings Market Potential by Sector (TJ/year)**




*Source: Navigant*

Figure 5-25 and Table B-15 show the cumulative gas market potential as a percent of sector consumption, with portfolio savings increasing from just under 0.6% to 10.9% of gas consumption over the timeframe of the analysis. Compared to the TRC market potential savings, the 2035 savings increased from 9.5% using the TRC screen to 10.9% using the mTRC screen. The residential sector saw the largest increase as a percent of consumption, rising from 5.8% using the TRC screen to 8.4% using the mTRC screen.

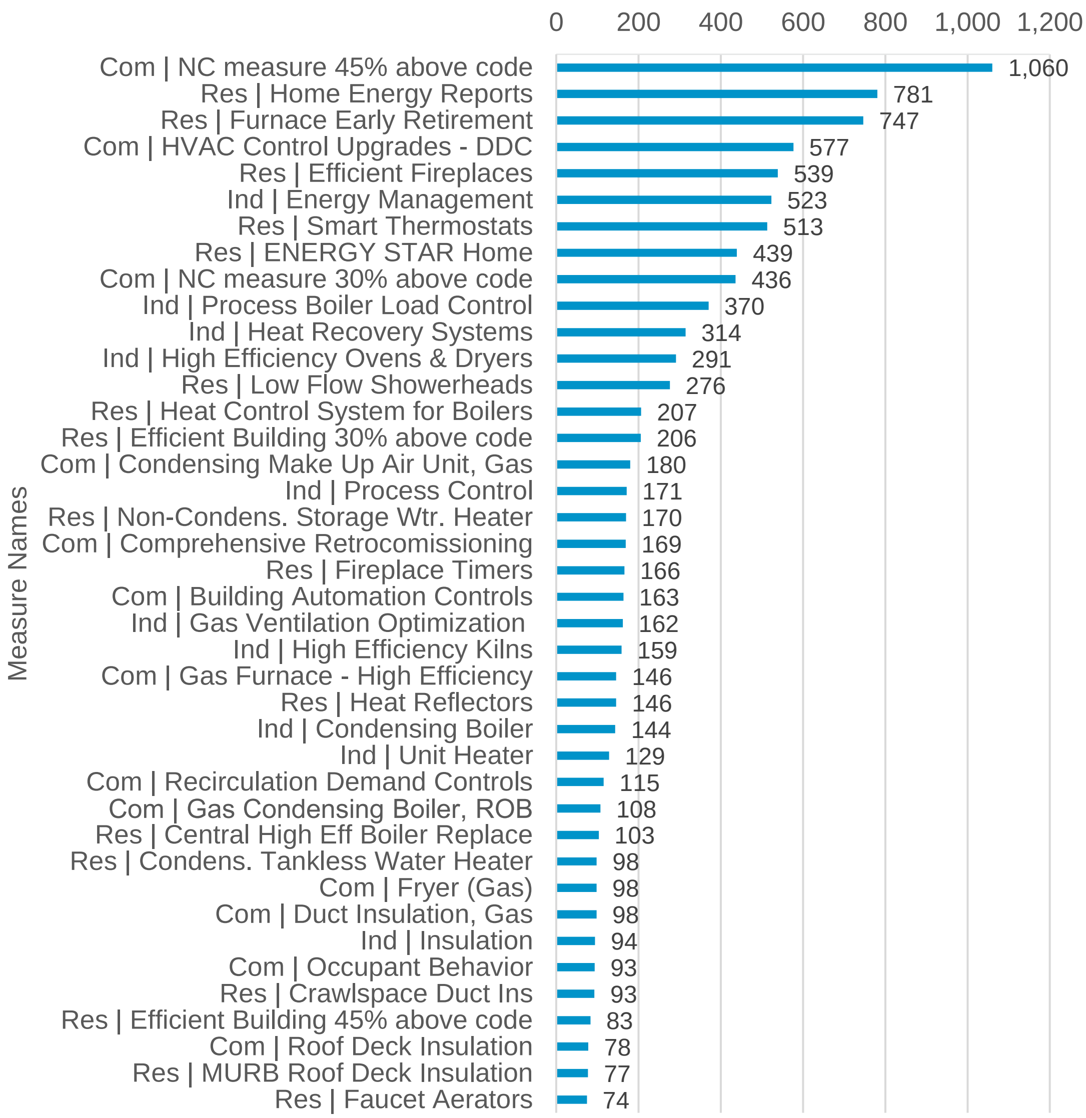
**Figure 5-25. mTRC Cumulative Gas Savings Market Potential as Percent of Sector Consumption (%)**




*Source: Navigant*

Figure 5-26 and Table B-16 list the top 40 gas saving measures with the highest market potential. Compared with the TRC market potential results, new construction practices 45% better than code and home energy reports remain as the top two measures. Residential furnace early replacement which is uneconomic using the TRC screen becomes economic and ranks third. Similarly, residential efficient fireplaces increase significantly in market savings using the mTRC and move into the top five measures.

**Figure 5-26. mTRC Top 40 Measures for Gas Energy Market Savings Potential in 2025 (TJ/year)**




*Source: Navigant*

### *5.4.4 mTRC Cost Effectiveness*

The following tables present cost effectiveness results for the mTRC case, including the portfolio and sector-level budget estimates and benefit-cost test ratios. Table 5-5 shows the mTRC case's total portfolio budget is $1,388 million over the 2016-2035 timeframe, as compared to $760 million under the TRC case over the same timeframe. Although market potential savings increase by 15% using the mTRC screen instead of the TRC screen, the portfolio budget increased by approximately 85%. This is because the least costly savings are captured using the TRC screen (i.e., the "low hanging fruit"), whereas the measures captured using the mTRC screen are significantly more costly on a $/GJ basis.

The vast majority of the increased budget is from an increase in residential incentive costs. Residential incentives more than triple in magnitude, while commercial and industrial incentives increase by 14% and 34%, respectively.

**Table 5-5. Budgets by Sector – mTRC Case (Million $/year)**

| Sector | Spending Type | 2016 | 2020 | 2025 | 2030 | 2035 | 2016-2035 Total* |
|---|---|---|---|---|---|---|---|
| Commercial | Incentives | $13.77 | $18.32 | $21.65 | $23.21 | $23.16 | $402.89 |
| | Non-Incentives | $1.68 | $1.76 | $1.93 | $1.93 | $1.78 | $36.33 |
| | Total | $15.44 | $20.08 | $23.58 | $25.14 | $24.94 | $439.22 |
| Industrial | Incentives | $3.45 | $5.70 | $9.21 | $12.67 | $14.32 | $187.59 |
| | Non-Incentives | $1.21 | $1.78 | $2.52 | $3.10 | $3.36 | $49.48 |
| | Total | $4.66 | $7.47 | $11.73 | $15.76 | $17.67 | $237.06 |
| Residential | Incentives | $26.45 | $32.93 | $33.64 | $31.43 | $30.01 | $606.37 |
| | Non-Incentives | $5.32 | $5.01 | $4.71 | $5.43 | $6.43 | $105.38 |
| | Total | $31.78 | $37.94 | $38.35 | $36.86 | $36.44 | $711.75 |
| Portfolio | Incentives | $43.67 | $56.94 | $64.50 | $67.31 | $67.49 | $1,196.85 |
| | Non-Incentives | $8.21 | $8.55 | $9.17 | $10.45 | $11.57 | $191.19 |
| | Total | $51.88 | $65.49 | $73.67 | $77.77 | $79.05 | $1,388.04 |

*The 2016-2035 Total column represents the sum of all forecasted years (2016-2035), not just those shown in the table.
*Source: Navigant*

Given that the change in avoided costs for the mTRC does not apply to the UCT, PCT, or RIM benefit-cost tests, these test ratios are only presented in Section 5.3.

Table 5-6 shows the mTRC benefit-cost test ratios by sector and for the portfolio. Compared with the TRC benefit-cost test ratio, the 2016-2035 portfolio benefit-cost ratio increases from 1.99 to 4.67. The mTRC benefit-cost ratios for the residential, commercial, and industrial sector also have increases of similar magnitude. The increase in benefit-cost ratios is a result of the higher avoided costs used for mTRC test.

**Table 5-6. mTRC Benefit-Cost Test Ratios for the Portfolio and by Sector**

| Sector | Year | Benefit-Cost Ratio |
|---|---|---|
| Commercial | 2016 | 6.86 |
| | 2020 | 6.54 |
| | 2025 | 6.32 |
| | 2030 | 5.98 |
| | 2035 | 5.65 |
| | 2016-2035 | 6.41 |
| Industrial | 2016 | 7.88 |
| | 2020 | 8.50 |
| | 2025 | 8.86 |
| | 2030 | 8.59 |
| | 2035 | 8.33 |
| | 2016-2035 | 8.55 |
| Residential | 2016 | 2.07 |
| | 2020 | 2.44 |
| | 2025 | 2.74 |
| | 2030 | 3.42 |
| | 2035 | 4.00 |
| | 2016-2035 | 2.66 |
| Portfolio | 2016 | 3.98 |
| | 2020 | 4.35 |
| | 2025 | 4.86 |
| | 2030 | 5.32 |
| | 2035 | 5.47 |
| | 2016-2035 | 4.67 |

*Source: Navigant*

Table 5-7 presents the mTRC net benefits by sector and for the portfolio. The net benefits increase from $460 million using the TRC screen to approximately $3,310 million using the mTRC screen. The residential, commercial, and industrial sectors increase in net benefits almost proportionally to the overall portfolio.

**Table 5-7. mTRC Net Benefits for the Portfolio and by Sector (Million $/year)**

| Sector | Year | Net Benefits |
|---|---|---|
| Commercial | 2016 | $137.22 |
| | 2020 | $165.37 |
| | 2025 | $184.18 |
| | 2030 | $183.98 |
| | 2035 | $171.44 |
| | 2016-2035 | $1,683.70 |
| Industrial | 2016 | $34.95 |
| | 2020 | $61.06 |
| | 2025 | $100.57 |
| | 2030 | $130.88 |
| | 2035 | $141.95 |
| | 2016-2035 | $832.10 |
| Residential | 2016 | $48.88 |
| | 2020 | $74.72 |
| | 2025 | $82.88 |
| | 2030 | $103.21 |
| | 2035 | $126.07 |
| | 2016-2035 | $801.37 |
| Portfolio | 2016 | $221.05 |
| | 2020 | $301.15 |
| | 2025 | $367.63 |
| | 2030 | $418.07 |
| | 2035 | $439.47 |
| | 2016-2035 | $3,317.18 |

*Total net benefits for 2016-2035 represent prevent values. Other yearly values represent non-discounted single year net benefits.
*Source: Navigant*

## 5.5 Hybrid mTRC/TRC Results

The "Hybrid" case uses results from the mTRC test for the residential sector and results from the TRC test for the commercial and industrial (C&I) sectors, which is most analogous to FortisBC Gas's actual DSM program environment. Because sector-level results are identical to the mTRC case's residential results and the TRC case's C&I results, the reader can refer to Sections 5.2 and 5.4 for sector-level results. This section focuses exclusively on portfolio-level results, which are a weighted combination of TRC and mTRC results.

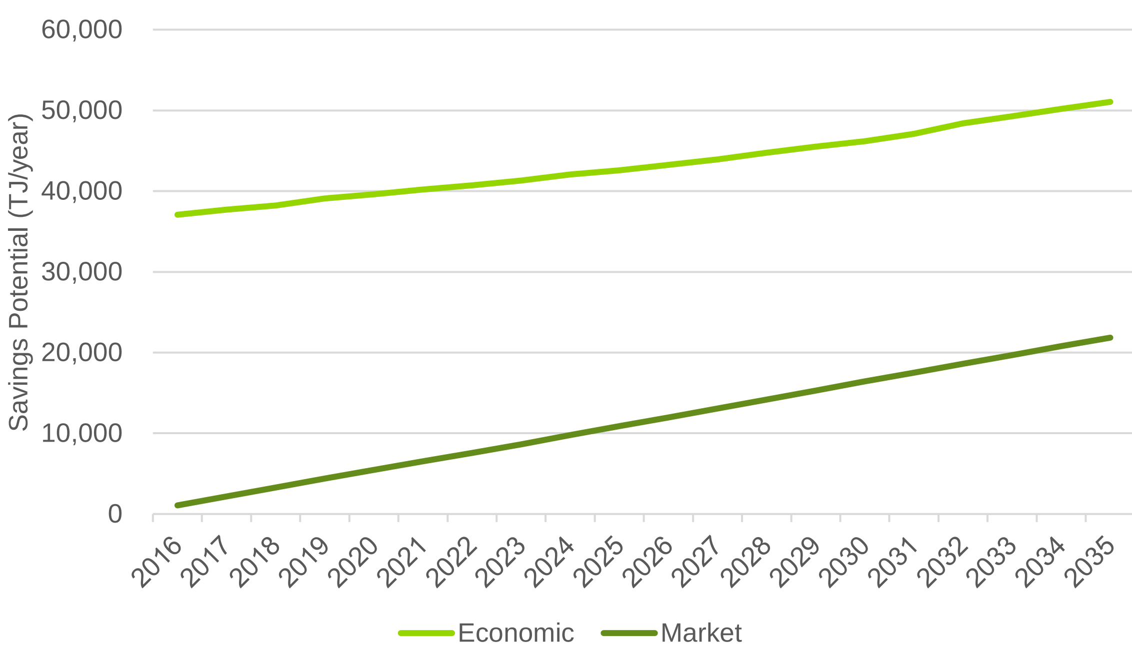
### *5.5.1 Approach to Estimating Hybrid mTRC/TRC Results*

FortisBC Gas uses both the mTRC and TRC tests as cost effectiveness screens for measures within their existing DSM portfolio. As noted in Section 5.1, FortisBC Gas's regulatory environment at the time of this analysis allowed the utility to spend up to 33% of its entire DSM portfolio on measures or programs that require the mTRC to be cost effective. To date, FortisBC Gas's experience is that typically most programs in the residential sector require the mTRC. Since FortisBC Gas uses a combination of TRC and mTRC benefit-costs tests to screen measures and programs within their portfolio, Navigant estimated "Hybrid" market potential using the mTRC test for the residential sector and the TRC test for the C&I sectors to most closely simulate FortisBC Gas's actual DSM portfolio.

### *5.5.2 Hybrid mTRC/TRC Economic and Market Potential Results*

Since the results from the Hybrid case are a weighted combination of the TRC and mTRC results, all results in this section will fall somewhere between the bounds set by those two cases. Figure 5-27 and Table B-17 in Appendix B show the economic and market gas savings potential for the Hybrid case. On average across the study period, the Hybrid case's economic potential is 20% larger than the TRC case and 9% smaller than the mTRC case, while the market potential is 12% larger than the TRC case and 5% smaller than the mTRC case. The Hybrid results more closely resemble the mTRC case because over two-thirds of the increase in market potential between the TRC and mTRC cases occurred in the residential sector, and those residential increases are captured in the Hybrid results.

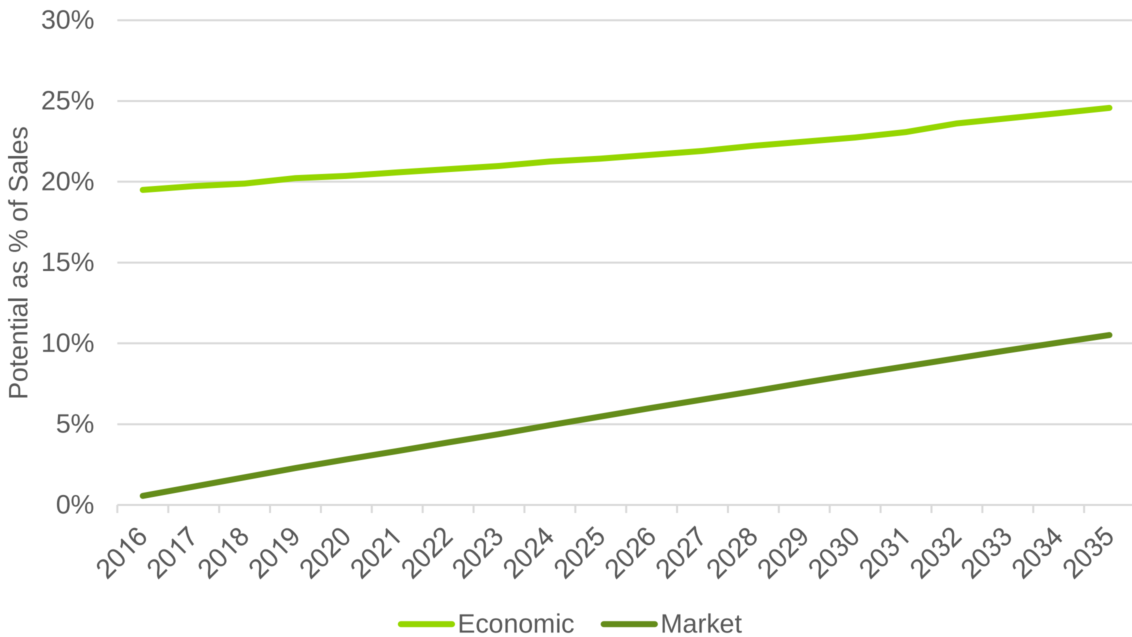
**Figure 5-27. Hybrid Cumulative Gas Savings Economic and Market Potential by Sector (TJ/year)**




*Source: Navigant*

Figure 5-28 and Table B-18 present the Hybrid case's economic and market potential as a percentage of total gas consumption. Market potential reaches just over 10% of total gas consumption by 2035, and it captures 43% of the economic potential.

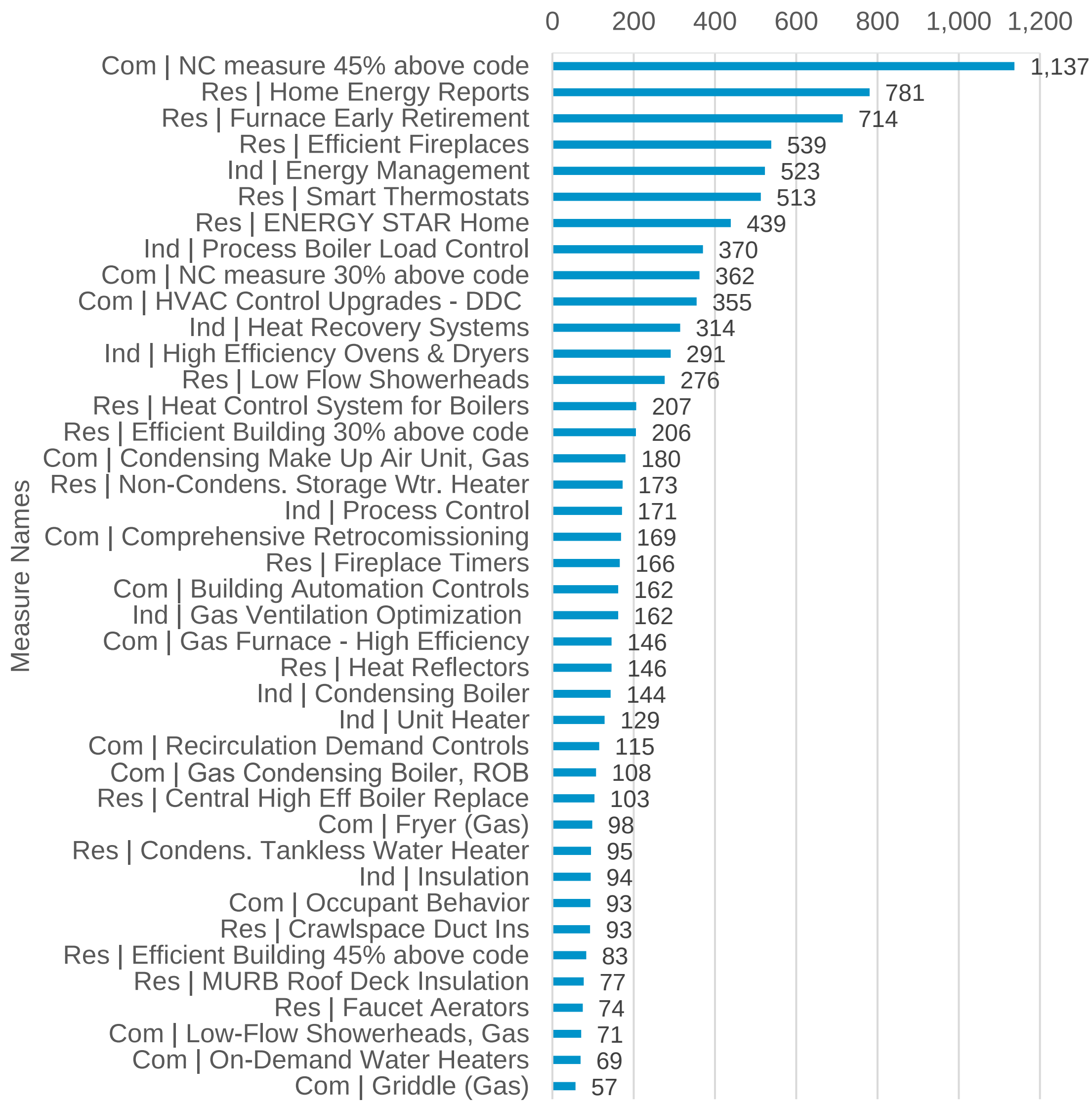
**Figure 5-28. Hybrid Cumulative Gas Savings Economic and Market Potential as Percentage of Consumption (%)**




*Source: Navigant*

Figure 5-29 and Table B-19 list the top 40 gas saving measures with the highest market potential for the Hybrid case. This table looks very similar to the TRC case except that residential measures have moved up the ranks. In particular, furnace early retirements and efficient fireplaces appear in the top ten, whereas they do not in the TRC case.

**Figure 5-29. Hybrid Top 40 Measures for Gas Energy Market Savings Potential in 2025 (TJ/year)**




*Source: Navigant*

### *5.5.3 Hybrid mTRC/TRC Cost Effectiveness*

The following tables present cost-effectiveness results for the hybrid mTRC/TRC case. Table 5-8 shows that total spending for the Hybrid case begins at just over $46M/year and increases to $74M/year by 2035. The total 20-year spending in the Hybrid case is 71% larger than the TRC case and 8% smaller than the mTRC case. The costs borne by the utility to acquire market savings—on a dollar-per-savings basis—increase 0 to 3 percent per year, on average and in real terms, across the various sectors. This contrasts with recent program experience, where per-unit-of-savings utility costs have shown declining trends (see Section 5.3.2 for a discussion on this difference in cost trends).

**Table 5-8. Budget for Portfolio – Hybrid Case (Million $/year)**

| Sector | Spending Type | 2016 | 2020 | 2025 | 2030 | 2035 | 2016-2035 Total* |
|---|---|---|---|---|---|---|---|
| Portfolio | Incentives | $38.30 | $51.08 | $58.75 | $61.91 | $62.81 | $1,114.66 |
| | Non-Incentives | $7.97 | $8.29 | $8.92 | $10.21 | $11.33 | $186.88 |
| | Total | $46.27 | $59.37 | $67.67 | $72.12 | $74.13 | $1,301.53 |

**The 2016-2035 Total column represents the sum of all forecasted years (2016-2035), not just those shown.*
*Source: Navigant*

The benefit-cost ratios and net benefits from the Hybrid case, which are presented in Table 5-9, are more similar to the TRC case than the mTRC case. Since the residential sector has lower benefit-cost ratios compared to the other sectors in both the TRC and mTRC cases, using the slightly higher residential results from the mTRC case does not significantly lift the benefit-cost ratios of the Hybrid portfolio. However, the additional net benefits that the residential mTRC case adds to the Hybrid portfolio is approximately $705 million in present value over the study period (expressed in 2016 dollars).

**Table 5-9. Hybrid Portfolio Benefit-Cost Test Ratios and Net Benefits (Million $/year)**

| Sector | Year | Benefit-Cost Ratio | Net Benefits |
|---|---|---|---|
| Portfolio | 2016 | 2.02 | $67.04 |
| | 2020 | 2.26 | $103.08 |
| | 2025 | 2.43 | $125.10 |
| | 2030 | 2.73 | $155.67 |
| | 2035 | 3.00 | $185.00 |
| | 2016-2035* | 2.41 | $1,162.60 |

**Total net benefits for 2016-2035 represent present values in 2016 dollars. Other yearly values represent non-discounted, single-year net benefits.*
*Source: Navigant*

# APPENDIX A. ADDITIONAL MODEL RESULTS

## A.1 Detailed Model Results

For granular Base Case results from the model, see attachments

- “FortisGas_Appendix_A1_2017-02-10.xlsx”
- “FortisGas_Appendix_A1_mTRC_2017-02-10.xlsx”

# APPENDIX B. SUPPORTING DATA FOR CHARTS

**Table B-1. Total Cumulative Gas Savings Potential (TJ/year)**

| | Technical | Economic | Market |
|---|---|---|---|
| 2016 | 45,828 | 28,797 | 934 |
| 2017 | 46,269 | 29,990 | 1,900 |
| 2018 | 46,717 | 30,522 | 2,895 |
| 2019 | 47,244 | 31,666 | 3,858 |
| 2020 | 47,699 | 32,214 | 4,799 |
| 2021 | 48,128 | 32,865 | 5,695 |
| 2022 | 48,619 | 33,430 | 6,611 |
| 2023 | 49,054 | 34,057 | 7,563 |
| 2024 | 49,496 | 34,844 | 8,556 |
| 2025 | 50,005 | 35,389 | 9,551 |
| 2026 | 50,645 | 36,087 | 10,537 |
| 2027 | 51,335 | 36,792 | 11,537 |
| 2028 | 51,985 | 37,645 | 12,554 |
| 2029 | 52,642 | 38,390 | 13,585 |
| 2030 | 53,348 | 39,111 | 14,625 |
| 2031 | 54,186 | 40,025 | 15,648 |
| 2032 | 55,030 | 41,321 | 16,678 |
| 2033 | 55,879 | 42,221 | 17,705 |
| 2034 | 56,732 | 43,248 | 18,726 |
| 2035 | 57,591 | 44,158 | 19,736 |

*Source: Navigant*

**Table B-2. Total Cumulative Gas Savings Potential as a Percentage of Consumption (%)**

| | Technical | Economic | Market |
|---|---|---|---|
| 2016 | 24.1% | 15.1% | 0.5% |
| 2017 | 24.2% | 15.7% | 1.0% |
| 2018 | 24.3% | 15.9% | 1.5% |
| 2019 | 24.4% | 16.4% | 2.0% |
| 2020 | 24.5% | 16.6% | 2.5% |
| 2021 | 24.7% | 16.8% | 2.9% |
| 2022 | 24.8% | 17.1% | 3.4% |
| 2023 | 24.9% | 17.3% | 3.8% |
| 2024 | 25.0% | 17.6% | 4.3% |
| 2025 | 25.2% | 17.8% | 4.8% |
| 2026 | 25.4% | 18.1% | 5.3% |
| 2027 | 25.6% | 18.4% | 5.8% |
| 2028 | 25.8% | 18.7% | 6.2% |
| 2029 | 26.0% | 19.0% | 6.7% |
| 2030 | 26.3% | 19.2% | 7.2% |
| 2031 | 26.6% | 19.6% | 7.7% |
| 2032 | 26.8% | 20.2% | 8.1% |
| 2033 | 27.1% | 20.5% | 8.6% |
| 2034 | 27.4% | 20.9% | 9.1% |
| 2035 | 27.7% | 21.3% | 9.5% |

*Source: Navigant*

**Table B-3. Cumulative Gas Savings Market Potential by Sector (TJ/year)**

| | Commercial | Industrial | Residential |
|---|---|---|---|
| 2016 | 498 | 172 | 265 |
| 2017 | 1,004 | 357 | 539 |
| 2018 | 1,511 | 557 | 828 |
| 2019 | 2,017 | 772 | 1,069 |
| 2020 | 2,519 | 1,005 | 1,276 |
| 2021 | 3,003 | 1,253 | 1,440 |
| 2022 | 3,496 | 1,519 | 1,596 |
| 2023 | 4,001 | 1,803 | 1,760 |
| 2024 | 4,520 | 2,106 | 1,930 |
| 2025 | 5,040 | 2,403 | 2,108 |
| 2026 | 5,541 | 2,699 | 2,297 |
| 2027 | 6,038 | 3,000 | 2,499 |
| 2028 | 6,533 | 3,311 | 2,710 |
| 2029 | 7,022 | 3,633 | 2,930 |
| 2030 | 7,505 | 3,962 | 3,159 |
| 2031 | 7,952 | 4,296 | 3,400 |
| 2032 | 8,394 | 4,632 | 3,652 |
| 2033 | 8,827 | 4,966 | 3,912 |
| 2034 | 9,251 | 5,295 | 4,180 |
| 2035 | 9,666 | 5,615 | 4,455 |

*Source: Navigant*

**Table B-4. Cumulative Gas Savings Market Potential as a Percentage of Consumption by Sector (%)**

| | Commercial | Industrial | Residential |
|---|---|---|---|
| 2016 | 0.8% | 0.3% | 0.4% |
| 2017 | 1.6% | 0.6% | 0.7% |
| 2018 | 2.4% | 1.0% | 1.1% |
| 2019 | 3.2% | 1.4% | 1.5% |
| 2020 | 3.9% | 1.8% | 1.7% |
| 2021 | 4.6% | 2.2% | 2.0% |
| 2022 | 5.3% | 2.7% | 2.2% |
| 2023 | 6.0% | 3.2% | 2.4% |
| 2024 | 6.8% | 3.7% | 2.6% |
| 2025 | 7.5% | 4.3% | 2.8% |
| 2026 | 8.1% | 4.8% | 3.1% |
| 2027 | 8.7% | 5.3% | 3.3% |
| 2028 | 9.4% | 5.9% | 3.6% |
| 2029 | 10.0% | 6.5% | 3.9% |
| 2030 | 10.5% | 7.1% | 4.2% |
| 2031 | 11.1% | 7.7% | 4.4% |
| 2032 | 11.6% | 8.3% | 4.8% |
| 2033 | 12.1% | 8.9% | 5.1% |
| 2034 | 12.5% | 9.5% | 5.4% |
| 2035 | 13.0% | 10.1% | 5.7% |

*Source: Navigant*

**Table B-5. Cumulative Gas Savings Market Potential by Customer Segment (TJ/year)**

| | 2016 | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|
| C.Accommod | 36 | 168 | 322 | 468 | 592 |
| C.College/Univ | 25 | 135 | 296 | 457 | 599 |
| C.Food Svc | 58 | 284 | 541 | 776 | 978 |
| C.Hospital | 44 | 212 | 422 | 631 | 822 |
| C.Logistic/WHouse | 22 | 118 | 250 | 386 | 518 |
| C.Long Term Care | 29 | 140 | 283 | 435 | 582 |
| C.Office | 71 | 370 | 823 | 1,323 | 1,776 |
| C.Other Commercial | 0 | 0 | 0 | 0 | 0 |
| C.Retail.Food | 11 | 66 | 147 | 228 | 298 |
| C.Retail.Non Food | 23 | 118 | 234 | 358 | 478 |
| C.Schools | 22 | 114 | 247 | 379 | 494 |
| C.Streetlights/Signals | 0 | 0 | 0 | 0 | 0 |
| I.Agriculture | 5 | 27 | 64 | 106 | 151 |
| I.Cement | 2 | 12 | 27 | 44 | 63 |
| I.Chemical | 3 | 19 | 44 | 73 | 108 |
| I.Food & Bev | 12 | 69 | 164 | 269 | 380 |
| I.Greenhouse | 13 | 77 | 181 | 289 | 407 |
| I.LNG Facility | 0 | 0 | 0 | 0 | 0 |
| I.Mfg | 23 | 135 | 314 | 525 | 753 |
| I.Coal Mining | 6 | 32 | 76 | 121 | 169 |
| I.Metal Mining | 0 | 0 | 0 | 0 | 1 |
| I.Oil & Gas | 11 | 59 | 126 | 171 | 216 |
| I.Other Industrial | 5 | 31 | 78 | 113 | 138 |
| I.Kraft Pulp/Paper | 59 | 355 | 880 | 1,512 | 2,185 |
| I.TMP Pulp/Paper | 7 | 41 | 96 | 152 | 213 |
| I.Transportation | 2 | 13 | 32 | 51 | 70 |
| I.Wood Products | 23 | 135 | 321 | 534 | 765 |
| R.Apt <= 4 Stories | 100 | 509 | 946 | 1,324 | 1,620 |
| R.Apt > 4 Stories | 56 | 286 | 528 | 740 | 909 |
| R.Other Residential | 4 | 21 | 34 | 49 | 67 |
| R.Fam Attached | 14 | 71 | 113 | 161 | 216 |
| R.Fam Detached | 246 | 1,184 | 1,962 | 2,949 | 4,172 |

*Source: Navigant*

**Table B-6. Cumulative Gas Savings Market Potential by End-Use (TJ/year)**

| | 2016 | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|
| Appliances | 0 | 0 | 0 | 0 | 0 |
| Boilers | 66 | 410 | 1,059 | 1,924 | 2,853 |
| Cooking | 30 | 133 | 226 | 295 | 347 |
| Hot Water | 82 | 445 | 871 | 1,222 | 1,490 |
| Process Heat | 19 | 117 | 291 | 527 | 787 |
| Product Drying | 15 | 94 | 240 | 441 | 658 |
| Space Heating | 248 | 1,340 | 2,899 | 4,560 | 6,208 |
| Whole Facility | 474 | 2,261 | 3,965 | 5,656 | 7,392 |

*Source: Navigant*

**Table B-7. Top 40 Measures for Gas Energy Market Savings Potential in 2025 (TJ/year)**

| Rank | Measure | Market Potential |
|---|---|---|
| 1 | Com \| NC measure 45 %>code | 1,137 |
| 2 | Res \| Home Energy Reports | 781 |
| 3 | Ind \| Energy Management | 523 |
| 4 | Res \| Smart Thermostats | 507 |
| 5 | Res \| ENERGY STAR Home | 439 |
| 6 | Ind \| Process Boiler Load Control | 370 |
| 7 | Com \| NC measure 30 %>code | 362 |
| 8 | Com \| HVAC Control Upgrades - Direct Digital Data Control | 355 |
| 9 | Ind \| Heat Recovery Systems | 314 |
| 10 | Ind \| High Efficiency Ovens & Dryers | 291 |
| 11 | Res \| Low Flow Showerheads | 276 |
| 12 | Res \| Non-Condensing Gas Storage Water Heater | 243 |
| 13 | Res \| Heat Control System for Boilers | 207 |
| 14 | Res \| Energy Efficient Building 30% better than code | 206 |
| 15 | Com \| Condensing Make Up Air Unit, Gas | 180 |
| 16 | Ind \| Process Control | 171 |
| 17 | Com \| Comprehensive Retrocomissioning | 169 |
| 18 | Res \| Fireplace Timers | 166 |
| 19 | Com \| Building Automation Controls | 162 |
| 20 | Ind \| Gas Ventilation Optimization | 162 |
| 21 | Com \| Gas Furnace - High Efficiency | 146 |
| 22 | Res \| Heat Reflectors | 146 |
| 23 | Ind \| Condensing Boiler | 144 |
| 24 | Ind \| Unit Heater | 129 |
| 25 | Com \| Recirculation Demand Controls for CDHW, Gas | 115 |
| 26 | Com \| Gas Condensing Boiler, ROB | 108 |
| 27 | Res \| Central High Eff Boiler Replace | 103 |
| 28 | Com \| Fryer (Gas) | 98 |
| 29 | Ind \| Insulation | 94 |
| 30 | Com \| Occupant Behavior | 93 |
| 31 | Res \| Crawlspace Duct Ins | 93 |
| 32 | Res \| Energy Efficient Building 45% better than code | 83 |
| 33 | Res \| MURB Roof Deck Insulation | 77 |
| 34 | Res \| Faucet Aerators | 74 |
| 35 | Com \| Low-Flow Showerheads, Gas | 71 |
| 36 | Res \| Efficient Fireplaces | 70 |
| 37 | Com \| Natural Gas On-Demand Water Heaters, ROB | 69 |
| 38 | Com \| Griddle (Gas) | 57 |
| 39 | Ind \| Improved Condensate Return | 55 |
| 40 | Com \| Roof Deck Insulation | 52 |

*Source: Navigant*

**Table B-8. Gas Energy Market Savings Potential with Natural Change – All Sectors (TJ/year)**

| | Potential before Nat. Change | Potential after Adjusted Nat. Change |
|---|---|---|
| 2016 | 934 | 934 |
| 2017 | 1,900 | 1,882 |
| 2018 | 2,895 | 2,842 |
| 2019 | 3,858 | 3,754 |
| 2020 | 4,799 | 4,629 |
| 2021 | 5,695 | 5,460 |
| 2022 | 6,611 | 6,300 |
| 2023 | 7,563 | 7,167 |
| 2024 | 8,556 | 8,061 |
| 2025 | 9,551 | 8,946 |
| 2026 | 10,537 | 9,828 |
| 2027 | 11,537 | 10,716 |
| 2028 | 12,554 | 11,611 |
| 2029 | 13,585 | 12,512 |
| 2030 | 14,625 | 13,412 |
| 2031 | 15,648 | 14,306 |
| 2032 | 16,678 | 15,201 |
| 2033 | 17,705 | 16,087 |
| 2034 | 18,726 | 16,960 |
| 2035 | 19,736 | 17,816 |

*Source: Navigant*

**Table B-9. Residential Gas Energy Market Savings Potential with Natural Change (TJ/year)**

| | Potential before Nat. Change | Potential after Adjusted Nat. Change |
|---|---|---|
| 2016 | 265 | 265 |
| 2017 | 539 | 532 |
| 2018 | 828 | 806 |
| 2019 | 1,069 | 1,027 |
| 2020 | 1,276 | 1,209 |
| 2021 | 1,440 | 1,350 |
| 2022 | 1,596 | 1,481 |
| 2023 | 1,760 | 1,616 |
| 2024 | 1,930 | 1,753 |
| 2025 | 2,108 | 1,894 |
| 2026 | 2,297 | 2,046 |
| 2027 | 2,499 | 2,207 |
| 2028 | 2,710 | 2,372 |
| 2029 | 2,930 | 2,542 |
| 2030 | 3,159 | 2,715 |
| 2031 | 3,400 | 2,901 |
| 2032 | 3,652 | 3,094 |
| 2033 | 3,912 | 3,290 |
| 2034 | 4,180 | 3,489 |
| 2035 | 4,455 | 3,691 |

*Source: Navigant*

**Table B-10. Commercial Gas Energy Market Savings Potential with Natural Change (TJ/year)**

| | Potential before Nat. Change | Potential after Adjusted Nat. Change |
|---|---|---|
| 2016 | 498 | 498 |
| 2017 | 1,004 | 994 |
| 2018 | 1,511 | 1,479 |
| 2019 | 2,017 | 1,954 |
| 2020 | 2,519 | 2,415 |
| 2021 | 3,003 | 2,857 |
| 2022 | 3,496 | 3,300 |
| 2023 | 4,001 | 3,748 |
| 2024 | 4,520 | 4,202 |
| 2025 | 5,040 | 4,648 |
| 2026 | 5,541 | 5,083 |
| 2027 | 6,038 | 5,509 |
| 2028 | 6,533 | 5,928 |
| 2029 | 7,022 | 6,337 |
| 2030 | 7,505 | 6,735 |
| 2031 | 7,952 | 7,109 |
| 2032 | 8,394 | 7,476 |
| 2033 | 8,827 | 7,831 |
| 2034 | 9,251 | 8,175 |
| 2035 | 9,666 | 8,510 |

*Source: Navigant*

**Table B-11. mTRC Cumulative Gas Savings Economic Potential by Sector (TJ/year)**

| | Commercial | Industrial | Residential | Portfolio |
|---|---|---|---|---|
| 2016 | 11,896 | 12,262 | 18,459 | 42,618 |
| 2017 | 12,325 | 12,240 | 18,512 | 43,077 |
| 2018 | 12,761 | 12,219 | 18,564 | 43,544 |
| 2019 | 13,235 | 12,198 | 18,617 | 44,051 |
| 2020 | 13,679 | 12,179 | 18,671 | 44,529 |
| 2021 | 14,081 | 12,145 | 18,753 | 44,979 |
| 2022 | 14,506 | 12,111 | 18,835 | 45,453 |
| 2023 | 14,916 | 12,079 | 18,918 | 45,913 |
| 2024 | 15,320 | 12,047 | 19,001 | 46,368 |
| 2025 | 15,774 | 12,016 | 19,084 | 46,873 |
| 2026 | 16,178 | 11,987 | 19,364 | 47,528 |
| 2027 | 16,598 | 11,958 | 19,644 | 48,200 |
| 2028 | 17,011 | 11,930 | 19,924 | 48,866 |
| 2029 | 17,429 | 11,903 | 20,205 | 49,537 |
| 2030 | 17,878 | 11,876 | 20,485 | 50,239 |
| 2031 | 18,262 | 11,847 | 20,984 | 51,093 |
| 2032 | 18,650 | 11,818 | 21,483 | 51,951 |
| 2033 | 19,042 | 11,790 | 21,982 | 52,815 |
| 2034 | 19,438 | 11,763 | 22,482 | 53,683 |
| 2035 | 19,838 | 11,736 | 22,982 | 54,556 |

*Source: Navigant*

**Table B-12. mTRC Cumulative Gas Savings Economic Potential as Percent of Sector Consumption (%)**

| | Commercial | Industrial | Residential | Portfolio |
|---|---|---|---|---|
| 2016 | 19.5% | 21.4% | 25.7% | 22.4% |
| 2017 | 20.0% | 21.4% | 25.6% | 22.5% |
| 2018 | 20.4% | 21.4% | 25.6% | 22.7% |
| 2019 | 20.9% | 21.4% | 25.5% | 22.8% |
| 2020 | 21.4% | 21.4% | 25.5% | 22.9% |
| 2021 | 21.8% | 21.3% | 25.5% | 23.0% |
| 2022 | 22.2% | 21.3% | 25.5% | 23.2% |
| 2023 | 22.6% | 21.3% | 25.5% | 23.3% |
| 2024 | 22.9% | 21.3% | 25.6% | 23.4% |
| 2025 | 23.3% | 21.3% | 25.6% | 23.6% |
| 2026 | 23.7% | 21.3% | 25.9% | 23.8% |
| 2027 | 24.0% | 21.3% | 26.1% | 24.0% |
| 2028 | 24.4% | 21.3% | 26.4% | 24.3% |
| 2029 | 24.7% | 21.3% | 26.7% | 24.5% |
| 2030 | 25.1% | 21.2% | 26.9% | 24.7% |
| 2031 | 25.4% | 21.2% | 27.5% | 25.0% |
| 2032 | 25.7% | 21.2% | 28.0% | 25.3% |
| 2033 | 26.0% | 21.2% | 28.5% | 25.7% |
| 2034 | 26.3% | 21.2% | 29.0% | 26.0% |
| 2035 | 26.6% | 21.2% | 29.6% | 26.3% |

*Source: Navigant*

**Table B-13. mTRC Top 40 Measures for Gas Energy Economic Savings Potential in 2025 (TJ/year)**

| Rank | Measure | Economic Potential |
|---|---|---|
| 1 | Res \| Smart Thermostats | 4,885 |
| 2 | Res \| Condensing Gas Tankless Water Heater | 4,117 |
| 3 | Res \| Non-Condensing Gas Tankless Water Heater | 3,774 |
| 4 | Com \| NC measure 45 %>code | 3,772 |
| 5 | Res \| Condensing Gas Storage Water Heater | 3,284 |
| 6 | Ind \| Energy Management | 2,822 |
| 7 | Com \| NC measure 30 %>code | 2,515 |
| 8 | Res \| Non-Condensing Gas Storage Water Heater | 2,206 |
| 9 | Com \| Wall Insulation | 1,787 |
| 10 | Ind \| Process Boiler Load Control | 1,662 |
| 11 | Res \| Home Energy Reports | 1,634 |
| 12 | Res \| Efficient Fireplaces | 1,520 |
| 13 | Ind \| Heat Recovery Systems | 1,411 |
| 14 | Com \| HVAC Control Upgrades - Direct  Digital Data Control | 1,329 |
| 15 | Ind \| High Efficiency Ovens & Dryers | 1,301 |
| 16 | Res \| ENERGY STAR Home | 1,074 |
| 17 | Res \| Low Flow Showerheads | 1,034 |
| 18 | Res \| Furnace Early Retirement | 1,008 |
| 19 | Res \| Energy Efficient Building 45% better than code | 886 |
| 20 | Ind \| High Efficiency Kilns | 868 |
| 21 | Res \| R-2000 Standard New Home | 743 |
| 22 | Res \| Attic Insulation | 742 |
| 23 | Ind \| Gas Ventilation Optimization | 739 |
| 24 | Ind \| Process Control | 738 |
| 25 | Res \| Crawlspace Duct Ins | 726 |
| 26 | Res \| Energy Star Windows | 703 |
| 27 | Ind \| Condensing Boiler | 670 |
| 28 | Res \| Energy Efficient Building 30% better than code | 591 |
| 29 | Res \| Basement Insulation | 546 |
| 30 | Com \| Condensing Make Up Air Unit, Gas | 532 |
| 31 | Ind \| Unit Heater | 503 |
| 32 | Com \| High Efficiency Gas-Fired Condensing Rooftop Unit (RTU) | 496 |
| 33 | Res \| Vert Dir Vent Fireplaces | 473 |
| 34 | Res \| High Eff Boiler Replace | 429 |
| 35 | Ind \| Insulation | 427 |
| 36 | Res \| Faucet Aerators | 391 |
| 37 | Com \| Gas Condensing Boiler, ROB | 387 |
| 38 | Com \| Gas Furnace - High Efficiency | 373 |
| 39 | Res \| Heat Control System for Boilers | 352 |
| 40 | Res \| Wall Insulation | 325 |

*Source: Navigant*

**Table B-14. mTRC Cumulative Gas Savings Market Potential (TJ/year)**

| | Commercial | Industrial | Residential | Portfolio |
|---|---|---|---|---|
| 2016 | 554 | 183 | 397 | 1,134 |
| 2017 | 1,113 | 380 | 803 | 2,296 |
| 2018 | 1,673 | 593 | 1,229 | 3,494 |
| 2019 | 2,223 | 822 | 1,609 | 4,654 |
| 2020 | 2,769 | 1,070 | 1,955 | 5,794 |
| 2021 | 3,294 | 1,335 | 2,257 | 6,886 |
| 2022 | 3,827 | 1,618 | 2,549 | 7,994 |
| 2023 | 4,367 | 1,921 | 2,843 | 9,131 |
| 2024 | 4,911 | 2,244 | 3,137 | 10,292 |
| 2025 | 5,453 | 2,562 | 3,432 | 11,446 |
| 2026 | 5,974 | 2,880 | 3,729 | 12,583 |
| 2027 | 6,488 | 3,205 | 4,032 | 13,726 |
| 2028 | 6,995 | 3,539 | 4,337 | 14,871 |
| 2029 | 7,492 | 3,886 | 4,644 | 16,021 |
| 2030 | 7,980 | 4,240 | 4,951 | 17,171 |
| 2031 | 8,431 | 4,601 | 5,264 | 18,296 |
| 2032 | 8,870 | 4,964 | 5,583 | 19,418 |
| 2033 | 9,298 | 5,326 | 5,906 | 20,531 |
| 2034 | 9,716 | 5,684 | 6,233 | 21,632 |
| 2035 | 10,123 | 6,032 | 6,562 | 22,718 |

*Source: Navigant*

**Table B-15. mTRC Cumulative Gas Savings Market Potential as Percent of Sector Consumption (%)**

| | Commercial | Industrial | Residential | Portfolio |
|---|---|---|---|---|
| 2016 | 0.9% | 0.3% | 0.6% | 0.6% |
| 2017 | 1.8% | 0.7% | 1.1% | 1.2% |
| 2018 | 2.7% | 1.0% | 1.7% | 1.8% |
| 2019 | 3.5% | 1.4% | 2.2% | 2.4% |
| 2020 | 4.3% | 1.9% | 2.7% | 3.0% |
| 2021 | 5.1% | 2.3% | 3.1% | 3.5% |
| 2022 | 5.9% | 2.8% | 3.5% | 4.1% |
| 2023 | 6.6% | 3.4% | 3.8% | 4.6% |
| 2024 | 7.3% | 4.0% | 4.2% | 5.2% |
| 2025 | 8.1% | 4.5% | 4.6% | 5.8% |
| 2026 | 8.7% | 5.1% | 5.0% | 6.3% |
| 2027 | 9.4% | 5.7% | 5.4% | 6.8% |
| 2028 | 10.0% | 6.3% | 5.7% | 7.4% |
| 2029 | 10.6% | 6.9% | 6.1% | 7.9% |
| 2030 | 11.2% | 7.6% | 6.5% | 8.5% |
| 2031 | 11.7% | 8.2% | 6.9% | 9.0% |
| 2032 | 12.2% | 8.9% | 7.3% | 9.5% |
| 2033 | 12.7% | 9.6% | 7.7% | 10.0% |
| 2034 | 13.1% | 10.2% | 8.1% | 10.5% |
| 2035 | 13.6% | 10.9% | 8.4% | 10.9% |

*Source: Navigant*

**Table B-16. mTRC Top 40 Measures for Gas Market Savings Potential in 2025 (TJ/year)**

| Rank | Measure | Market Potential |
|---|---|---|
| 1 | Com \| NC measure 45 %>code | 1,060 |
| 2 | Res \| Home Energy Reports | 781 |
| 3 | Res \| Furnace Early Retirement | 747 |
| 4 | Com \| HVAC Control Upgrades - Direct Digital Data Control | 577 |
| 5 | Res \| Efficient Fireplaces | 539 |
| 6 | Ind \| Energy Management | 523 |
| 7 | Res \| Smart Thermostats | 513 |
| 8 | Res \| ENERGY STAR Home | 439 |
| 9 | Com \| NC measure 30 %>code | 436 |
| 10 | Ind \| Process Boiler Load Control | 370 |
| 11 | Ind \| Heat Recovery Systems | 314 |
| 12 | Ind \| High Efficiency Ovens & Dryers | 291 |
| 13 | Res \| Low Flow Showerheads | 276 |
| 14 | Res \| Heat Control System for Boilers | 207 |
| 15 | Res \| Energy Efficient Building 30% better than code | 206 |
| 16 | Com \| Condensing Make Up Air Unit, Gas | 180 |
| 17 | Ind \| Process Control | 171 |
| 18 | Res \| Non-Condensing Gas Storage Water Heater | 170 |
| 19 | Com \| Comprehensive Retrocomissioning | 169 |
| 20 | Res \| Fireplace Timers | 166 |
| 21 | Com \| Building Automation Controls | 163 |
| 22 | Ind \| Gas Ventilation Optimization | 162 |
| 23 | Ind \| High Efficiency Kilns | 159 |
| 24 | Com \| Gas Furnace - High Efficiency | 146 |
| 25 | Res \| Heat Reflectors | 146 |
| 26 | Ind \| Condensing Boiler | 144 |
| 27 | Ind \| Unit Heater | 129 |
| 28 | Com \| Recirculation Demand Controls for CDHW, Gas | 115 |
| 29 | Com \| Gas Condensing Boiler, ROB | 108 |
| 30 | Res \| Central High Eff Boiler Replace | 103 |
| 31 | Res \| Condensing Gas Tankless Water Heater | 98 |
| 32 | Com \| Fryer (Gas) | 98 |
| 33 | Com \| Duct Insulation, Gas | 98 |
| 34 | Ind \| Insulation | 94 |
| 35 | Com \| Occupant Behavior | 93 |
| 36 | Res \| Crawlspace Duct Ins | 93 |
| 37 | Res \| Energy Efficient Building 45% better than code | 83 |
| 38 | Com \| Roof Deck Insulation | 78 |
| 39 | Res \| MURB Roof Deck Insulation | 77 |
| 40 | Res \| Faucet Aerators | 74 |

*Source: Navigant*

**Table B-17. Hybrid Cumulative Gas Savings Economic and Market Potential by Sector (TJ/year)**

| | Economic | Market |
|---|---|---|
| 2016 | 37,075 | 1,067 |
| 2017 | 37,721 | 2,164 |
| 2018 | 38,213 | 3,296 |
| 2019 | 39,092 | 4,398 |
| 2020 | 39,598 | 5,479 |
| 2021 | 40,186 | 6,513 |
| 2022 | 40,718 | 7,564 |
| 2023 | 41,303 | 8,647 |
| 2024 | 42,057 | 9,763 |
| 2025 | 42,567 | 10,875 |
| 2026 | 43,246 | 11,969 |
| 2027 | 43,933 | 13,070 |
| 2028 | 44,768 | 14,181 |
| 2029 | 45,495 | 15,299 |
| 2030 | 46,198 | 16,418 |
| 2031 | 47,108 | 17,512 |
| 2032 | 48,399 | 18,609 |
| 2033 | 49,278 | 19,699 |
| 2034 | 50,162 | 20,779 |
| 2035 | 51,052 | 21,843 |

*Source: Navigant*

**Table B-18. Hybrid Cumulative Gas Savings Economic and Market Potential as Percent of Sector Consumption (%)**

| | Economic | Market |
|---|---|---|
| 2016 | 19.5% | 0.6% |
| 2017 | 19.7% | 1.1% |
| 2018 | 19.9% | 1.7% |
| 2019 | 20.2% | 2.3% |
| 2020 | 20.4% | 2.8% |
| 2021 | 20.6% | 3.3% |
| 2022 | 20.8% | 3.9% |
| 2023 | 21.0% | 4.4% |
| 2024 | 21.3% | 4.9% |
| 2025 | 21.4% | 5.5% |
| 2026 | 21.7% | 6.0% |
| 2027 | 21.9% | 6.5% |
| 2028 | 22.2% | 7.0% |
| 2029 | 22.5% | 7.6% |
| 2030 | 22.7% | 8.1% |
| 2031 | 23.1% | 8.6% |
| 2032 | 23.6% | 9.1% |
| 2033 | 23.9% | 9.6% |
| 2034 | 24.3% | 10.0% |
| 2035 | 24.6% | 10.5% |

*Source: Navigant*

**Table B-19. Hybrid Top 40 Measures for Gas Energy Market Savings Potential in 2025 (TJ/year)**

| Rank | Measure | Market Potential |
|---|---|---|
| 1 | Com \| NC measure 45 %>code | 1,137 |
| 2 | Res \| Home Energy Reports | 781 |
| 3 | Res \| Furnace Early Retirement | 714 |
| 4 | Res \| Efficient Fireplaces | 539 |
| 5 | Ind \| Energy Management | 523 |
| 6 | Res \| Smart Thermostats | 513 |
| 7 | Res \| ENERGY STAR Home | 439 |
| 8 | Ind \| Process Boiler Load Control | 370 |
| 9 | Com \| NC measure 30 %>code | 362 |
| 10 | Com \| HVAC Control Upgrades - Direct Digital Data Control | 355 |
| 11 | Ind \| Heat Recovery Systems | 314 |
| 12 | Ind \| High Efficiency Ovens & Dryers | 291 |
| 13 | Res \| Low Flow Showerheads | 276 |
| 14 | Res \| Heat Control System for Boilers | 207 |
| 15 | Res \| Energy Efficient Building 30% better than code | 206 |
| 16 | Com \| Condensing Make Up Air Unit, Gas | 180 |
| 17 | Res \| Non-Condensing Gas Storage Water Heater | 173 |
| 18 | Ind \| Process Control | 171 |
| 19 | Com \| Comprehensive Retrocomissioning | 169 |
| 20 | Res \| Fireplace Timers | 166 |
| 21 | Com \| Building Automation Controls | 162 |
| 22 | Ind \| Gas Ventilation Optimization | 162 |
| 23 | Com \| Gas Furnace - High Efficiency | 146 |
| 24 | Res \| Heat Reflectors | 146 |
| 25 | Ind \| Condensing Boiler | 144 |
| 26 | Ind \| Unit Heater | 129 |
| 27 | Com \| Recirculation Demand Controls for CDHW, Gas | 115 |
| 28 | Com \| Gas Condensing Boiler, ROB | 108 |
| 29 | Res \| Central High Eff Boiler Replace | 103 |
| 30 | Com \| Fryer (Gas) | 98 |
| 31 | Res \| Condensing Gas Tankless Water Heater | 95 |
| 32 | Ind \| Insulation | 94 |
| 33 | Com \| Occupant Behavior | 93 |
| 34 | Res \| Crawlspace Duct Ins | 93 |
| 35 | Res \| Energy Efficient Building 45% better than code | 83 |
| 36 | Res \| MURB Roof Deck Insulation | 77 |
| 37 | Res \| Faucet Aerators | 74 |
| 38 | Com \| Low-Flow Showerheads, Gas | 71 |
| 39 | Com \| Natural Gas On-Demand Water Heaters, ROB | 69 |
| 40 | Com \| Griddle (Gas) | 57 |

*Source: Navigant*