**Diane Roy**
Vice President, Regulatory Affairs

**Gas Regulatory Affairs Correspondence**
Email: gas.regulatory.affairs@fortisbc.com

**Electric Regulatory Affairs Correspondence**
Email: electricity.regulatory.affairs@fortisbc.com

**FortisBC**
16705 Fraser Highway
Surrey, B.C. V4N 0E8
Tel: (604)576-7349
Cell: (604) 908-2790
Fax: (604) 576-7074
www.fortisbc.com

August 23, 2022

Commercial Energy Consumers Association of British Columbia
c/o Owen Bird Law Corporation
P.O. Box 49130
Three Bentall Centre
2900 – 595 Burrard Street
Vancouver, BC
V7X 1J5

Attention: Mr. Christopher P. Weafer

Dear Mr. Weafer:

**Re: FortisBC Inc. (FBC)**

**Application for Acceptance of Demand-Side Management (DSM) Expenditures Plan for the period covering from 2023 to 2027 (Application)**

**Response to the Commercial Energy Consumers Association of British Columbia (CEC) Information Request (IR) No. 1**

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On June 6, 2022, FBC filed the Application referenced above. In accordance with the regulatory timetable established in British Columbia Utilities Commission Order G-182-22 for the review of the Application, FBC respectfully submits the attached response to CEC IR No. 1.

For convenience and efficiency, FBC has occasionally provided an internet address for referenced reports instead of attaching lengthy documents to its IR responses. FBC intends for the referenced documents to form part of its IR responses and the evidentiary record in this proceeding.

If further information is required, please contact the undersigned.

Sincerely,

**FORTISBC INC.**

***Original signed:***

Diane Roy

Attachments

cc (email only): Commission Secretary
Registered Parties

**1. Reference: Exhibit B-1, page 1**

**Table 1-1: 2023-2027 DSM Plan Expenditures and Savings**

| Plan | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|
| **Expenditures ($000s)** | | | | | | |
| 2023-2027 DSM Plan | $14,455 | $15,436 | $16,572 | $17,412 | $18,707 | **$82,583** |
| **Energy savings (GWh)** | | | | | | |
| 2023-2027 DSM Plan | 26.4 | 27.4 | 28.6 | 29.7 | 31.3 | **143.4** |

> The DSM Plan provides details on each of FBC's program areas and individual DSM programs, including cost-effectiveness test results. The information presented in the DSM Plan involved a collaborative working effort between FBC DSM program personnel and the Posterity Group, an energy efficiency consulting firm that is also assisting FortisBC Energy Inc. (FEI) with its DSM expenditures planning. More details on the approach undertaken to develop the DSM Plan can be found in section 1 of the DSM Plan (Appendix A).

1.1 Please provide Table 1-1 dating back to 2017.

**Response:**

Please refer to Attachment 1.1, which provides the response to this information request as well as additional information to respond to other information requests in the set. The following information for each past, current, and proposed FBC DSM program since 2017 has been provided:

- Status of the program (active, inactive, or proposed)
- Total expenditures
- Incentive expenditures
- Non-incentive expenditures
- Energy savings
- Demand savings
- Total Resource Cost (TRC) test result

Note that expenditures from 2019-2022 are in actual dollars and expenditures forecast from the 2023-2027 DSM Plan are in real dollars (inflation adjusted). Also note that the Net Present Value (NPV) of Electricity Savings, NPV of Demand Savings and Levelized Cost of Energy (LCOE) were only forecast in the 2023-2027 DSM Plan and not recorded to date, thus, are not shown in Attachment 1.1.

1.2 Please provide the relevant credentials for the Posterity Group, or identify where they may be located in the application.

**Response:**

Posterity Group provides energy and low carbon-related support to utilities, governments, and regulatory bodies. Core work includes conservation potential analysis, resource planning, market characterization, program design services, technical support, DSM planning, policy impact analysis, and third-party evaluation. Posterity Group has worked with utilities across North America, including FortisBC, Enbridge Gas, Pacific Northern Gas, Southern California Gas, and Ontario's Independent Electricity System Operator, among others, to support DSM operations by characterizing markets and savings potential for energy efficient technologies.

Posterity Group staff led analysis for both the 2006 Terasen Gas CPR and 2010 FEI CPR. Other major assignments have included developing end-use models to support the 2017 and 2022 FEI Long Term Gas Resource Plan and development of the 2021 FEI Conservation Potential Review. Their CVs are included as Attachment 1.2.

Posterity Group has offices in Ottawa, Toronto, and Vancouver.

1.3 Has FBC used external consulting firms in the past to assist with DSM planning?

1.3.1 If yes, please indicate if FBC has used the same company or different companies, and, if different, which ones were used.

1.3.2 If no, why did FBC determine that it would be appropriate to seek external assistance now?

**Response:**

While FBC routinely retains third-party external support to assist with DSM planning (including evaluation and program development), FBC has not used a consulting firm in the past to assist with the direct preparation of the DSM Plan.

FBC sought external assistance with the preparation of the DSM Plan for three key reasons:

- To seek expert advice from professionals having DSM planning experience in other jurisdictions;

- To reduce workload on current FBC C&EM staff; and
- To be consistent with how FEI conducts DSM planning, reflecting that FortisBC has an integrated gas and electric C&EM department.

1.3.3 Please provide the number of internal staff that would be considered as DSM program personnel.

**Response:**

Most FortisBC C&EM staff have both gas and electric DSM responsibilities. FortisBC currently has 12 full-time equivalent staff working on FBC DSM programs.

1.3.4 Please provide the total cost of the external consultant to FBC and identify if those costs are included as part of the DSM expenditure plan, and, if so, where they are included.

**Response:**

The total cost of the external consultant is estimated to be approximately $100 thousand; these costs are included within the 2021 and 2022 years of the 2019-2022 DSM Expenditure Plan under Portfolio Expenditures. This estimate includes the work conducted to assist with development of the DSM Plan and also information requests support.

**2. Reference: Exhibit B-1, page 6**

> On August 24, 2021, FBC filed its 2021 LTERP, which included its LT DSM Plan, and is currently under review by the BCUC. The 2021 LTERP and LT DSM Plan included Conservation Potential Review (CPR) results for the FBC service territory (FBC CPR)[7]. The LT DSM Plan included an assessment of the appropriate level of cost-effective DSM resource acquisition to match FBC's resource needs over the LTERP's 20-year planning horizon.
>
> The Base DSM scenario FBC selected for its LT DSM Plan contemplated total DSM expenditures between 2023 and 2027 of $63 million[8] and total DSM savings of 139.8 GWh[9]. The LT DSM Plan was premised on a ramp up in DSM spending and savings, beginning in 2021, that would offset an average of 32 percent of FBC's forecast load growth annually over the LTERP's planning horizon. In response to emerging customer activities, the DSM Plan that is the subject of this Application builds on the target savings contemplated in the LT DSM Plan. Table 3-2 below, shows that the proposed budget for the DSM Plan is $19 million more, in total, than the pro-forma budget contemplated in the LT DSM Plan (inflation adjusted) and is expected to achieve an additional 3.6 GWh of electricity savings for this period.

**Table 3-2: 2023-2027 DSM Plan Compared with the LT DSM Plan[10]**

| Plan | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|
| **Expenditures ($000s)** | | | | | | |
| 2023-2027 DSM Plan | $14,455 | $15,436 | $16,572 | $17,412 | $18,707 | **$82,583** |
| LT DSM Plan | $11,249 | $11,907 | $13,139 | $12,951 | $14,014 | **$63,260** |
| *Difference* | *$3,206* | *$3,529* | *$3,433* | *$4,461* | *$4,693* | ***$19,323*** |
| **Energy savings (GWh)** | | | | | | |
| 2023-2027 DSM Plan | 26.4 | 27.4 | 28.6 | 29.7 | 31.3 | **143.4** |
| LT DSM Plan | 27 | 27.3 | 29.3 | 28.6 | 27.6 | **139.8** |
| *Difference* | *-0.6* | *0.1* | *-0.7* | 1.1 | *3.7* | ***3.6*** |

2.1 Please confirm that the Commission has not yet made a determination with respect to FBC's Long Term Electric Resource Plan and has not yet approved the LT DSM Plan.

**Response:**

Confirmed. FBC's 2021 Long Term Electric Resource Plan, which includes FBC's LT DSM Plan, is currently under review with the BCUC.

2.2 Please explain why FBC's forecast increase in Energy Savings relative to the LT DSM Plan is primarily concentrated in 2027 while the proposed spending is fairly consistently higher than the LT DSM Plan.

**Response:**

Please refer to the responses to BCOAPO IR1 2.9 and BCUC IR1 3.1.

2.3 Please explain whether or not the GWh Savings is an Annual Savings Expected for the Expenditure.

**Response:**

The "Energy savings (GWh)" reported in the referenced table is the annual incremental energy savings forecast for the Expenditure.

2.4 Please provide the average useful life over which the DSM benefits would be achieved.

**Response:**

The overall portfolio average Effective Useful Life (EUL) is estimated to be 12.9 years.

2.5 Please confirm that the following analysis (below) of the above Table 3-2 data is correct and please explain the substantial cost increase for achieving DSM savings with quantitative analysis of the FBC cost structure for delivering DSM savings.

**Response:**

Confirmed that the analysis of Table 3-2 data provided in CEC's IR1 2.7 is correct.

An explanation of how FBC views the differing forecasting approaches of the LT DSM Plan and 2023-2027 Plan, as well as an explanation of the variances in cost and savings, is included in BCUC IR1 3.1.

2.6 Please explain what FBC is doing to improve the cost-effectiveness of DSM measures with quantitative analysis of progress if any.

**Response:**

FBC monitors cost effectiveness throughout the year by reviewing expenditures and savings across the portfolio. Regular reviews of measure library assumptions are also scheduled to ensure inputs are being adequately assessed when factored into program values and cost tests.

FBC receives feedback through formal program evaluation, customer feedback, and internal review to find opportunities to reduce program costs and improve program savings.

Cost effectiveness is a key focus of program design and is sought out whenever feasible.

2.7 Please provide the total customer benefit for participating customers arising from the DSM expenditures, as a present value of savings, associated with the expenditure for each year in the 2023-2027 DSM plan.

| FBC DSM PLAN EXPE+A1:F26NDITURES AND SAVINGS 2023-2027 DSM Plan | | | | | |
|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 |
| 2023-2027 DSM Plan | | | | | |
| Expenditures in $ | $ 14,455 | $ 15,436 | $ 16,572 | $ 17,412 | $ 18,707 |
| Savings in GWh | 26.4 | 27.4 | 28.6 | 29.7 | 31.3 |
| Cost per MWh | 547.5 | 563.4 | 579.4 | 586.3 | 597.7 |
| % Increase of $/MWh | | 2.89% | 2.85% | 1.18% | 1.95% |
| % Increase of $/MWh Change from LT DSM | 31.4% | 29.2% | 29.2% | 29.5% | 17.7% |

| FBC DSM PLAN EXPENDITURES AND SAVINGS LT DSM Plan | | | | | |
|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 |
| 2023-2027 DSM Plan Expenditures in $ | $ 11,249 | $ 11,907 | $ 13,139 | $ 12,951 | $ 14,014 |
| Savings in GWh | 27 | 27.3 | 29.3 | 28.6 | 27.6 |
| Cost per MWh | 416.6 | 436.2 | 448.4 | 452.8 | 507.8 |
| % Increase | | 4.69% | 2.81% | 0.98% | 12.13% |

**Response:**

FBC interprets total customer benefits as the sum of the incentives and the net present value of customer electricity savings. Using this definition, the total customer benefit for each year of the 2023-2027 DSM Plan is presented in the table below.

| | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|
| Total Customer Benefit for Participating Customers (in millions of $) | $49.1 | $51.9 | $54.9 | $58.2 | $62.8 | **$276.8** |

**3. Reference: Exhibit B-1, page 7 and pages 20-21**

The benefits of the TRC test are FBC's "avoided costs", calculated as the DSM measures' present value over the effective measure life of energy savings and demand savings, represented by the long run marginal cost (LRMC) and deferred capital expenditure (DCE) values. In response to BCUC IR1 38.1 in the 2021 LTERP, FBC indicated that the LRMC of acquiring electricity from BC "clean or renewable" resources is as follows:

- $90 per MWh (for measures that save energy and capacity)
- $63 per MWh (for measures that only save energy)
- $145 per kW-y (for measures that only save capacity)

In the DSM Plan, FBC continues to use the $90/MWh as the LRMC for most measures except demand response and air conditioning measures that use an LRMC of $145/kW-y. In the same response to BCUC IR1 38.1 in the 2021 LTERP, FBC proposes to use a DCE value of $51.22 per kW-yr[12] as its avoided costs for the purposes of DSM benefits calculations. The DSM Plan achieves a TRC Benefit/Cost ratio of 1.2 on a portfolio basis using the above LRMC and DCE factor.

[11] The TRC test is the ratio of the benefits of a DSM measure divided by the DSM measure's cost, including the utility's program costs. The TRC is further described in Section 5.1.2.
[12] Order G-19-17 (FBC's 2017 DSM Expenditure Application)

### 5.1.2 Total Resource Cost (TRC) Test

The governing TRC test is often expressed as a ratio of the benefits of a DSM measure divided by the measure's cost, including the utility's program costs. The benefits are the "avoided costs", calculated as the present value over the effective measure life of:

i. the measure's energy savings, valued at the LRMC; and

ii. the measure's demand savings, valued at the DCE.

The measures' energy and demand savings are grossed-up by the avoided transmission and distribution energy losses ("line losses") of 8 percent before the benefits are calculated. In its DSM Plan, FBC uses the follow values for cost effectiveness testing under the DSM Regulation, proposed in the 2021 LTERP and LT DSM Plan:

- A LRMC of $90 per MWh ($2020);
- A DCE value of $51.22 per kW-yr ($2020); and
- A 7.9 percent discount rate.

For a DSM measure(s) with only capacity savings and no energy savings (such as the demand response program), FBC used the capacity-only LRMC of $145 per kW-yr ($2020), rather than the blended energy and capacity LRMC of $90 per MWh. Otherwise, the TRC calculation remains the same.

3.1 Please explain how the Deferred Capital expenditure value of $51.22 was derived.

**Response:**

FBC uses a Deferred Capital Expenditure (DCE) value of $51.22 per kW-Year for DSM purposes to estimate the avoided transmission and distribution (T&D) costs (i.e., benefits from avoided infrastructure), resulting from the implementation of DSM programs. The 2021 DCE value has been calculated using the methodology created by EES Consulting and filed with the 2017 DSM Application[1] which considered the present value of planned future T&D upgrades divided by the growth in the coincident system peak. The EES Consulting report is included as Attachment 3.1 to this response.

3.2 Please detail in what ways the DCE value of $51.22 is being used and differentiate that from when the $145/kW-y is used, and please explain why.

**Response:**

Please refer to the response to CEC IR1 3.1 for a description of the DCE value of $51.22 and how it is used.

The $145 per kW-Year value is the Capacity Only component of the Long Run Marginal Cost (LRMC). To calculate the LRMC for DSM purposes, the gross load forecast (before any DSM savings) is used as the load requirement for which an optimal portfolio of supply-side resources is required to meet. Clean energy requirements are applied as constraints within the optimization routine such that the characteristics of the portfolio represent the avoided costs of serving the gross load using only regulation defined 'clean resources' from BC. The Blended Energy and Capacity LRMC of $90 per MWh for DSM is inclusive of both energy and generation capacity. The utility's LRMC calculated using the Average Incremental Cost (AIC) approach is appropriate for programs that are designed primarily to conserve energy and are offered broadly across the utility's service area. For targeted demand response programs, the capacity-only value per kW of the LRMC would be more appropriate to use. The LRMC for DSM purposes can be split into energy and capacity components, included in the table below, using the approach outlined in section 5.2.3 of the EES Consulting report, included as an attachment to the response to CEC IR1 3.1.

| Component of LRMC | Unit Costs |
|---|---|
| Blended Energy and Capacity | $90 per MWh |
| Energy Only | $63 per MWh |
| Capacity Only | $145 per kW-Year |

[1] FBC 2017 DSM Application. Appendix C: Deferred Capital Expenditure Study (EES Consulting). Exhibit B-1.

3.3 How was the 7.9% discount rate derived?

**Response:**

The 7.9 percent pre-tax nominal discount rate represents FBC's Weighted Average Cost of Capital (WACC) based on values filed in July 2020 as part FBC's Annual Review for 2020 and 2021 Rates and calculations.

**4. Reference: Exhibit B-1, page 11**

| Status | 2021 Annual Report | 2023-2027 DSM Plan |
|---|---|---|
| **Demand Response** | | |
| Approved Programs | Demand Response | Residential Demand Response |
| | Codes and Standards | Commercial and Industrial Demand Response |
| New Program | None | Considered transitioned from approved Pilot to regular Programming for Residential, Commercial, and Industrial sectors |

4.1 Please provide further details of Demand Response that is considered transition from approved Pilot to regular Programming for Residential, Commercial and Industrial sectors. Which programs were specifically transitioned from approved pilots?

**Response:**

In the 2019-2022 DSM Plan, FBC included expenditures for demand response which supported a Kelowna Demand Response Pilot for commercial and industrial customers, and a Kelowna Residential Peak Saver Pilot. In the 2023-2027 DSM Plan, FBC is proposing a new Demand Response Program Area that will include a permanent residential demand response program beginning in 2023 and a permanent commercial demand response program beginning in 2025.

For further discussion regarding FBC's demand response pilots, permanent programs, and transitions, please refer to the response to BCUC IR1 8.1.

**5. Reference: Exhibit B-1-1, page 15**

**Table 4-2: 2023-2027 DSM Plan Proposed Expenditures (inflation adjusted)**

| Program Area (Sector) | 2019-22 Plan | Expenditures ($000's) | | | | | | Energy Savings (GWh) | | | | | | TRC 2023-2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Approved 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | Ratio |
| Residential | $2,795 | $2,946 | $3,258 | $3,566 | $4,015 | $4,548 | $18,334 | 5.7 | 6.2 | 6.9 | 7.6 | 8.6 | 35.0 | 1.4 |
| Commercial | $3,047 | $3,129 | $3,416 | $3,643 | $3,850 | $4,912 | $18,050 | 10.8 | 11.1 | 11.5 | 11.8 | 12.2 | 57.4 | 1.4 |
| Industrial | $1,815 | $2,119 | $2,130 | $2,187 | $2,196 | $2,206 | $10,837 | 8.4 | 8.4 | 8.6 | 8.6 | 8.6 | 42.5 | 2.1 |
| Low Income | $930 | $1,743 | $1,730 | $1,790 | $1,844 | $1,934 | $9,043 | 1.6 | 1.6 | 1.7 | 1.8 | 1.9 | 8.5 | 1.1 |
| *Program sub-total* | *$8,587* | *$9,938* | *$10,543* | *$11,186* | *$11,905* | *$12,700* | *$56,264* | *26.5* | *27.3* | *28.7* | *29.8* | *31.3* | *143.4* | *1.5* |
| Conservation Education and Outreach | $666 | $897 | $978 | $1,002 | $1,028 | $1,163 | $5,067 | | | | | | | |
| Enabling Activities* | $1,044 | $1,550 | $1,600 | $1,960 | $1,846 | $2,046 | $9,001 | | | | | | | |
| Innovative Technologies* | | $485 | $685 | $255 | $318 | $276 | $2,019 | | | | | | | |
| Demand Response | $133 | $773 | $803 | $1,316 | $1,443 | $1,626 | $5,962 | | | | | | | 1.0 |
| Portfolio | $956 | $813 | $836 | $853 | $872 | $896 | $4,270 | | | | | | | |
| **Total** | **$11,400** | **$14,455** | **$15,436** | **$16,572** | **$17,412** | **$18,707** | **$82,583** | **27.4** | **27.4** | **28.6** | **29.7** | **31.3** | **143.4** | **1.3** |
| **LT DSM Plan** | **$10,600** | **$11,249** | **$11,907** | **$13,139** | **$12,951** | **$14,014** | **$63,259** | **27** | **27.3** | **29.3** | **28.6** | **27.6** | **139.8** | |

* Innovative Technologies 2022 budget was included within the Supporting Initiatives Program Area of the approved 2019-22 DSM Plan. Supporting Initatives is now named to Enabling Activities, to align with FEI

5.1 The inserted revised table is not very legible in the Application Errata document. Please provide a clearer table if possible.

**Response:**

Please refer to the following table:

| Program Area (Sector) | 2019-22 Plan | Expenditures ($000's) | | | | | | Energy Savings (GWh) | | | | | | TRC 2023-2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Approved 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | Ratio |
| Residential | $2,795 | $2,946 | $3,258 | $3,566 | $4,015 | $4,548 | $18,334 | 5.7 | 6.2 | 6.9 | 7.6 | 8.6 | 35.0 | 1.4 |
| Commercial | $3,047 | $3,129 | $3,416 | $3,643 | $3,850 | $4,012 | $18,050 | 10.8 | 11.1 | 11.5 | 11.8 | 12.2 | 57.4 | 1.4 |
| Industrial | $1,815 | $2,119 | $2,130 | $2,187 | $2,196 | $2,206 | $10,837 | 8.4 | 8.4 | 8.6 | 8.6 | 8.6 | 42.5 | 2.1 |
| Low Income | $930 | $1,743 | $1,730 | $1,790 | $1,844 | $1,934 | $9,043 | 1.6 | 1.6 | 1.7 | 1.8 | 1.9 | 8.5 | 1.1 |
| *Program sub-total* | *$8,587* | *$9,938* | *$10,543* | *$11,186* | *$11,905* | *$12,700* | *$56,264* | *26.5* | *27.3* | *28.7* | *29.8* | *31.3* | *143.4* | *1.5* |
| Conservation Education and Outreach | $666 | $897 | $978 | $1,002 | $1,028 | $1,163 | $5,067 | | | | | | | |
| Enabling Activities* | $1,044 | $1,550 | $1,600 | $1,960 | $1,846 | $2,046 | $9,001 | | | | | | | |
| Innovative Technologies* | | $485 | $685 | $255 | $318 | $276 | $2,019 | | | | | | | |
| Demand Response | $133 | $773 | $803 | $1,316 | $1,443 | $1,626 | $5,962 | | | | | | | 1.0 |
| Portfolio | $956 | $813 | $836 | $853 | $872 | $896 | $4,270 | | | | | | | |
| **Total** | **$11,400** | **$14,455** | **$15,436** | **$16,572** | **$17,412** | **$18,707** | **$82,583** | **27.4** | **27.4** | **28.6** | **29.7** | **31.3** | **143.4** | **1.3** |
| **LT DSM Plan** | **$10,600** | **$11,249** | **$11,907** | **$13,139** | **$12,951** | **$14,014** | **$63,259** | **27** | **27.3** | **29.3** | **28.6** | **27.6** | **139.8** | |

* Innovative Technologies 2022 budget was included within the Supporting Initiatives Program Area of the approved 2019-22 DSM Plan. Supporting Initatives is now named to Enabling Activities, to align with FEI

**6. Reference: Exhibit B-1, page 23 and Appendix D Cover page**

## 6. EVALUATION, MEASUREMENT AND VERIFICATION

Evaluation, Measurement and Verification (EM&V) are important aspects of managing a DSM portfolio. FBC follows the EM&V framework that FEI created with stakeholder review which is attached as Appendix E.

The Company employs Measurement and Verification (M&V) protocols on individual DSM projects, using IPMV[23] best practices, to ensure energy savings estimates are sound. Furthermore, the Company conducts Monitoring and Evaluation (M&E) activities on all programs, with comprehensive impact, process and/or market reviews[24] at appropriate times in program life cycles. The evaluation results inform program design, and summaries of M&E reports are shared with stakeholders and the BCUC through FBC's DSM Annual Reports.

### 6.1 *MONITORING AND EVALUATION*

Section 8.1 of the DSM Plan (Appendix A) details the M&E expenditures FBC proposes to make to ensure an adequate M&E review is in place for the DSM Plan period.

FBC's portfolio expenditures include costs for EM&V activities. The total proposed expenditure for EM&V activities to be conducted over the 2023 – 2027 DSM Plan period is approximately $1.6 million, or four percent of the DSM expenditure portfolio.

[23] International Performance Measurement and Verification Protocol® (IPMVP) http://evo-world.org/en/

6.1 The EM&V framework appears to have been last revised in 2018. Has the EM&V framework been approved by the Commission either directly or indirectly?

6.1.1 If yes, please identify when this was approved, and if no, please explain why not.

**Response:**

The EM&V Framework was originally created in consultation with internal and external stakeholders, including the EEC Advisory Group. The Framework was submitted in FBC's Application for acceptance of its 2018 DSM Expenditures which was accepted by the BCUC in its Decision and Order G-113-18 dated June 14, 2018.[2] Minor revisions were made to address changes in industry best practice and reflect FBC's experience administering the Framework since it was originally introduced. Those revisions were submitted to the BCUC in FBC's Application for acceptance of its 2019-2022 DSM Expenditures which was accepted by the BCUC in its Decision and Order G-47-19, dated March 4, 2019.[3]

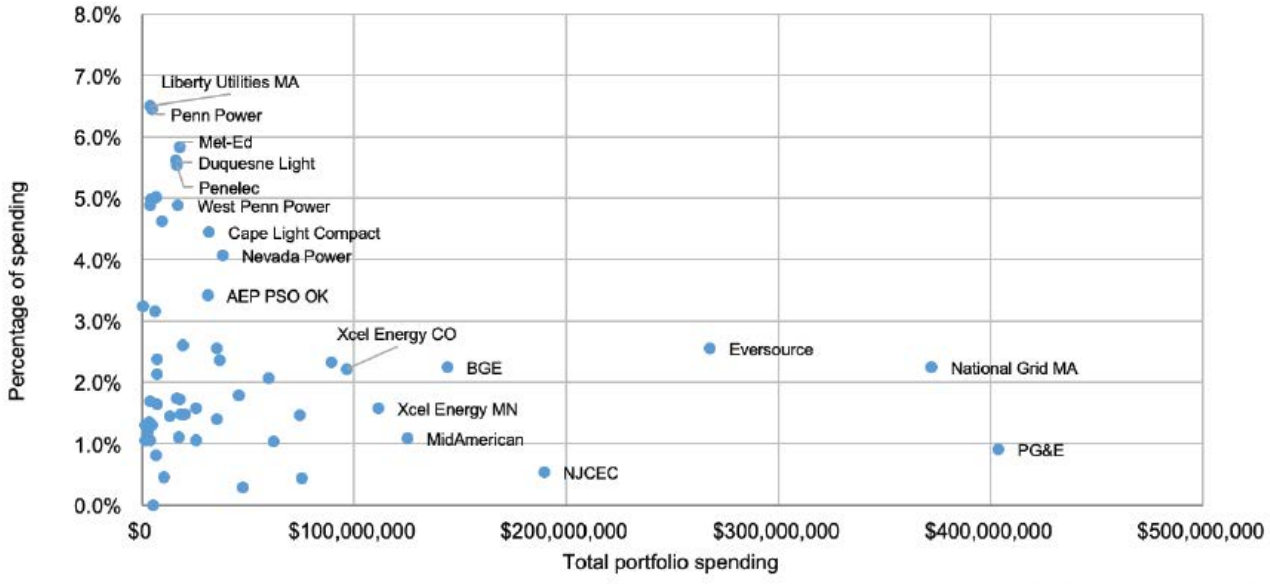
[2] BCUC Decision and Order G-113-18, page 5.
[3] BCUC Decision and Order G-47-19, page 24.

6.2 Please explain how FBC determined that $1.6 million was an appropriate expenditure.

**Response:**

FBC's EM&V budget was developed from the bottom up to reflect the activities required to support the measurement and valuation of its DSM program. FBC's proposed EM&V budget is $1.6 million (representing approximately 2.1 percent of the overall DSM expenditures), which falls in line with industry standards as discussed below.

FBC reviewed a study that included a review of EM&V practices and expenditures in DSM programs prepared by E Source.[4] The study showed that the industry standard for EM&V expenditures was between 2 to 5 percent of total expenditures. The figure below presents a plot from the study of utilities' total annual expenditures and percent of budget allocated to EM&V activities.




**Notes:** n = 56. Data represents actual spending values for administrators that reported evaluation spending in at least two of the three years between 2015 and 2017.

Please note that the second paragraph of Section 6.1 (page 23 of Application) stated that the proposed EM&V expenditures budget of $1.6 million represents four percent of the DSM expenditure portfolio. This was in error and the $1.6 million represents two percent of the DSM expenditure portfolio.

[4] E Source , 2019. Retrieved from: https://www.esource.com/429191abpd/dsm-budget-trends-through-2020.

6.3 Please explain whether or not 4% of the expenditure portfolio is a typical proportion for EM&V spending historically, and if no, please elaborate on a typical proportion or why this value may vary from year to year.

**Response:**

As described in FBC's response to CEC IR 1.6.2, the stated four percent of the DSM expenditure portfolio was in error and the proposed $1.6 million EM&V budget represents two percent of the DSM expenditure portfolio.

FBC will continue to conduct and complete evaluations at appropriate times within the program lifecycle, given resources and program growth. FBC's proposed EM&V expenditures for 2023-2027 have increased both in expenditure dollars and percentage of the total portfolio expenditure compared to prior years to accommodate the increase in evaluation activities as more DSM programs mature within the period of the funding request. In previous years, FBC's EM&V expenditure has been between one to two percent of the total portfolio expenditure and this amount varies from year to year with respect to the actual evaluation activities completed.

6.4 Is the 4% also a typical percentage used in other corporations or a recommended protocol for EM&V spending?

**Response:**

Please refer to the response to CEC IR1 6.2.

**7. Reference: Exhibit B-1, pages 23-24**

### 6.2 NET-TO-GROSS RATIO: SPILL-OVER AND FREE RIDERS

Historically, FBC calculated the net-to-gross (NTG) ratio by adjusting the benefits downward for the presumed presence of free riders[25]. Additionally, FBC has included known spill-over[26] effects in the NTG ratio, which is a recognized approach used by other utilities including BC Hydro. Spill-over is the conceptual opposite of free riders, thus including both effects presents a more complete and balanced view of program impacts.

FBC will continue to evaluate and quantify free-rider and spill-over effects on a program-by-program basis. Where adequate estimates are developed or acquired based on the results of an evaluation, free-rider and spill-over effects will be accounted for in the NTG ratio, as appropriate.

Table 6-1 below lists the free-ridership and spill-over rates currently used by FBC. The figure "0%" indicates zero [free-ridership], and a "blank" space indicates that spill-over has not been determined in prior M&E studies.

[24] Types of evaluation activities include: Process evaluations, where surveys and interviews are used to assess customer satisfaction and program success; Impact evaluations, including NTG assessment, to measure the achieved energy savings attributable to the program; and Market reviews to gauge Market Transformation progress.
[25] Individuals who participate in an incentive program who would have undertaken the measure even in the absence of an incentive.
[26] Spillover effects involve non-participants who acquired an energy conservation measure (ECM), and who did not receive an incentive, but were influenced by the operation of the utility's DSM program.

**Table 6-1: FBC Program Free-Rider and Spill-Over Rates**

| Program Area | Free-rider | Spill-over | Source of Justification |
|---|---|---|---|
| **Residential** | | | |
| HRR – Home Improvement | 63% | 0% | Evergreen Economics, 2015 |
| HRR – Heat Pumps, Incentive | 36% | 4% | Evergreen Economics, 2020 |
| HRR – Heat Pumps, Loans | 25% | 4% | Evergreen Economics, 2020 |
| HRR – Heat Pump Water Heaters | 13% | 55% | Evergreen Economics, 2020 |
| HRR – Retail Lighting | 50% | 15% | Evergreen Economics, 2019 |
| HRR - Appliances | 39% | 17% | Evergreen Economics, 2019 |
| New Home Program | 26% | 0% | Mazzi Consulting, 2022 |
| **Low Income** | | | |
| Self Install Program | 0% | 0% | as per BC Hydro |
| Direct Install Program | 0% | 0% | as per BC Hydro |
| Prescriptive Program | 0% | 0% | (To be evaluated in the future) |
| Performance Program | 0% | 0% | (To be evaluated in the future) |
| **Commercial** | | | |
| Performance Program – Custom Efficiency | 69% | 0% | Evergreen Economics, 2018 |
| Performance Program – New Construction | 0% | 0% | (To be evaluated in the future) |
| Performance Program – Continuous Optimization | 0% | 0% | FortisBC Business Case, 2020 |
| Prescriptive Program - Lighting | 27% | 43% | Mazzi Consulting, 2019 |
| Prescriptive Program – Non-lighting | 30% | 12% | Sampson Research, 2012 |
| Rental Apartment Efficiency Program | 10% | 4% | Cohesium Research, 2022 |
| **Industrial** | | | |
| Performance Program – Custom Efficiency | 12% | 0% | Sampson Research, 2013 |
| Performance Program – Strategic Energy Management | 20% | 0% | FortisBC Business Case, 2018 |
| Prescriptive Program | 30% | 12% | Sampson Research, 2012 |
| **Demand Response** | | | |
| Residential Demand Response | 0% | 0% | (To be evaluated in the future) |
| Commercial and Industrial Demand Response | 0% | 0% | (To be evaluated in the future) |

7.1 Please discuss FBC's level of confidence with respect to its assessment of spill-over and free-rider rates, and please explain why.

**Response:**

FBC does not assess the statistical confidence level of spill-over and free-rider rates as part of its evaluation activities. FBC's free-rider and spill-over calculations are based on self-reported survey data which means individual survey questions used in the calculation of free-rider and spill-over. Due to the multiple survey questions involved, each with their own error margins, the resulting confidence interval around the final free-rider and spill-over values would be difficult to quantify.

7.2 Please provide the potential range of values (i.e. +/-) if FBC's confidence level is not high for the free-rider and spill-over rates cited.

**Response:**

Please refer to the response to CEC IR1 7.1.

**8. Reference: Exhibit B-1, page 25**

> **7.1.1 Funding Transfers**
>
> BCUC Decision and Order G-47-19 laid out the following inter-program funding transfer rules for the duration of FBC's 2019-22 DSM Plan:
>
> > The Panel approves transfers of up to twenty five percent of accepted DSM expenditures from one existing program area to another existing program area without prior approval of the BCUC on the condition that FBC adds information regarding such transfers so that all amounts transferred from one existing program area to another existing program area are transparently accounted for in the DSM annual reports. In cases where a proposed transfer into or out of an approved program area is greater than twenty five percent of that program area's accepted expenditures for the year in question, prior BCUC approval is required.[27]
>
> In the Decision, the BCUC Panel further noted that some discretion should be permitted to the utility in transferring funds, but within defined limits. FBC agrees that the funding transfer rules in place for its 2019-22 DSM Plan provide some flexibility to respond to changes in the execution of its DSM programs. However, FBC is proposing some small changes to the rules to overcome some of the challenges of working within the transfer rules. These proposed changes provide the necessary boundaries to ensure that the DSM portfolio still aligns with the approved portfolio deemed to be in the public interest.

8.1 The CEC understands that the Commission's Decision applied to the remainder of the 2019-2022 DSM Plan. Please provide the funding transfer rules that the Commission had in place before it made the Decision and Order G-47-19, if any.

**Response:**

The existing funding transfer rules have been in place since 2012 when the BCUC in its Decision and Order G-110-12 in FBC's 2012-2013 Revenue Requirements Application directed that FBC required a more formal policy regarding funding transfers.[5]

[5] Order G-110-12, page 140.

**9. Reference: Exhibit B-1, page 25 and 26**

FBC is proposing the following changes to the funding transfer rules:

- **Remove the requirement for approval of transferred funds into a program area:** FBC is proposing that only the transfer of funds greater than 25 percent **out of** a program area should be required. This change ensures that the limits on the amount any one program

[27] Order G-47-19, pp. 15-16

area can lose funding are still in place, but eliminates the limits on how much one program area can gain. FBC submits that the greater concern in executing the portfolio is ensuring that no program area is reduced significantly to the benefit of another program area. FBC would still report on transfers into and out of program areas in its annual reporting to the BCUC.

- **Remove the requirement of *prior* approval:** FBC will endeavor to file for approval as soon as it is aware that a transfer above 25 percent is required; however, often it is not known for certain that the 25 percent limit will be passed until it is about to occur or already occurring. Additionally, the exact amount of the transfer above 25 percent is difficult to forecast ahead of its occurrence, and time is also required to draft and submit an application to the BCUC.

In summary, FBC is requesting the following funding transfer rule be in place for its 2023-27 DSM Plan:

> *In cases where a proposed transfer out of an approved program area is greater than twenty five percent of that program area's accepted expenditures for the year in question, BCUC acceptance is required.*

9.1 Please provide examples of circumstances in which FBC would determine that it was necessary to transfer spending out of a Program area. Would FBC expect to provide any justification in its annual reporting, and if so, under what threshold or other conditions would it provide justification?

**Response:**

FBC will only transfer funds out of a program area if those funds are not needed in that program area due to lower than forecast activity **and** those funds could be appropriately used in another program area in that year. If a program area has lower expenditures than forecast due to timing, FBC would choose to carry those funds over into the next year to be used in the same program area.

FBC reports on all funding transfers and carryovers in its annual reporting regardless of the amount. FBC also provides explanation of the need for these transfers and carryovers. If the total portfolio variance allowance is approved as proposed in Section 7.1.3, FBC will also include an explanation of any variance in its DSM annual report for 2027.

9.2 Does the funding transfer apply only to the year in which it is requested/undertaken, or is the funding transfer a permanent transfer such that the total Program would be reduced for the balance of the term? Please explain.

**Response:**

The funding transfer is a permanent transfer, and therefore the total five-year approved expenditure amount for the program area would be increased/decreased as a result.

9.3 What options are available to the Commission to 'withhold' approval or provide penalties in the event that FBC has already made a transfer in excess of 25% that the Commission did not consider appropriate in retrospect?

**Response:**

If FBC were to make a transfer in excess of 25 percent which the BCUC determines not to be in the public interest, then the BCUC may not accept a portion of FBC's DSM expenditures for recovery in rates.

9.4 Would FBC be willing to commence filing for approval at a lower level, such as 20%, so that even if there is uncertainty, the transfer would not exceed 25% without the Commission's approval? Please explain why or why not.

**Response:**

Please refer to the responses to BCOAPO IR1 7.1 and 7.2 regarding the practical challenges of filing for approval of a transfer prior to the threshold being exceeded.

9.5 What protections are there available to ensure that FBC does not, over multiple years, transfer out a sizeable proportion of spending from a single program resulting in a substantially reduced program without Commission approval? Please explain.

**Response:**

Please refer to the responses to BCUC IR1 15.1 and 15.2. Under the proposed changes, the most that FBC could transfer out of a program area without BCUC approval is limited to twenty five percent. The 2023-2027 DSM Plan reflects FBC's best forecasts for program performance over the period and as such, it would be unlikely that a program would continuously be under budget by 25 percent or more in each year of the plan.

9.6 As programs often have a rate class association, how will FBC maintain rate class balance when transferring DSM expenditures between programs?

**Response:**

FBC does not specifically design and allocate expenditures for DSM programs to ensure rate class balance, though FBC has a DSM guiding principle (Section 1.6 of the Application) to "[offer] access to energy efficiency and conservation for all residential, commercial and industrial customers, including low-income customers."

As noted in the Application, FBC has created a DSM Plan that is consistent with the LT DSM Plan using a number of inputs: the Conservation and Energy Management guiding principles; review of historical and forecasting of future program activity levels; consultation with stakeholders; and calibration to the market potential results contained in FBC's CPR (included as Appendix D).

9.7 Can FBC, upon transferring DSM expenditures, report on any impacts which would change the cost-effectiveness of the FBC DSM?

**Response:**

FBC's annual DSM reports detail cost-effectiveness results based on actual expenditures (including any transfers) and savings for a given reporting year.

**10. Reference: Exhibit B-1, page 26 and page 27**

> **7.1.2 Funding Carryover**
>
> FBC is requesting to continue the funding carryover rules that were previously approved as part of its 2019-22 DSM Expenditure Plan with one proposed change. FBC is requesting to be permitted to carryover overspent (or negative amounts) into the following year. For clarity, FBC would be permitted to carryover unspent and **overspent** expenditures in a Program Area to the same Program Area in the following year. In effect, FBC is requesting that the BCUC accept the total expenditures per Program Area over the time period of the expenditure schedule.
>
> FBC considers that carrying over negative amounts is consistent with the spirit and intent of its existing funding carryover rules. The ability to carryover funding amounts from one year to the next within the DSM funding period was applied for and approved in order to provide FBC with additional flexibility to manage the portfolio expenditures as it strives to meet the overall expenditure targets set out in the DSM Plan. Although the existing carryover rules focused on carrying over unspent amounts in the early years of the Plan to future years, the primary purpose of the carryover funding transfer request was to help FBC achieve the four-year total expenditures. Carrying forward negative amounts to future years of the plan will similarly help FBC to manage timing of expenditures and decrease the likelihood of underspending of the 2023-2027 DSM Plan. While spending may be higher than planned in one year, it may be lower than planned in the following year. Therefore, FBC considers that the funding carryover rules should include the flexibility to manage both positive and negative carry over amounts.
>
> In summary, FBC is requesting the following funding carryover rule be in place for its 2023-27 DSM Plan:
>
> *FBC is permitted to carryover unspent and overspent expenditures in a Program Area to the same Program Area in the following year.*

10.1 Please explain how FBCs proposed Funding Carryover rules would relate to the transfer of funds. For instance, if FBC transferred $50,000 from Program A to Program C, would Program A carryover the underspending, and would Program C carryover the overspending? Please explain.

**Response:**

FBC will only transfer funds out of a program area where the funds are not needed due to lower activity than forecast in the DSM Plan and where those funds could be used in another program area in that same year. Therefore, FBC would not transfer funds into another program area only for those same funds to be carried over into the next year in that new program area.

**11. Reference: Exhibit B-1, page 27**

> **7.1.3 Total Portfolio Variance Allowance**
>
> FBC is seeking approval of an allowed variance above the approved DSM expenditure amount for the final year of the 2023-27 DSM Plan without prior approval from the BCUC. FBC is proposing that in the final year of the 2023-27 DSM Plan (i.e. 2027 DSM expenditures), actual DSM expenditures for 2027 may only exceed 2027 approved DSM expenditures (excluding any carryover amounts from prior years) by no more than five percent without prior approval from the BCUC. This means that in the final year of the Plan, FBC has additional flexibility to overspend 2027 approved expenditures by $935 thousand.
>
> It is difficult to accurately forecast to the level of precision where FBC will spend exactly 100 percent of its DSM portfolio and no more or less. Actual DSM Plan expenditures are determined by many factors outside FBC's control, including changes in market conditions and customer responses to programs. In FBC's view, a variance allowance of five percent provides the necessary flexibility in the final year to respond to any conditions outside of FBC control that might require additional spending above approved.
>
> For clarity, FBC is requesting the following variance allowance rule be in place for its 2023-27 DSM Plan:
>
> > *FBC is permitted to exceed total approved DSM Portfolio expenditures before any carryover amounts in the final year of the DSM Plan by no more than five percent without prior approval from the BCUC.*
>
> In summary, the funding transfer and carryover rules, and the variance allowance will all serve to provide FBC with the flexibility to manage its DSM portfolio most effectively.

11.1 Please explain how FBC selected 5% as opposed to any other % such as 2% or 3%.

**Response:**

Please refer to the response to BCUC IR1 16.1.

11.2 Please explain why FBC has asked for flexibility only with respect to its final plan year and not all years.

**Response:**

FBC has the flexibility provided by the funding transfer and carryover rules for the years 2023-2026 and does not also need variance allowances in those years as well.

11.3 Please explain why FBC has only asked for flexibility in regard to expenditures and not for instance increases to the savings anticipated or perhaps more valuable flexibility to enhance cost-effectiveness or even total cost-effective DSM delivered.

**Response:**

FBC has filed its 2023-2027 DSM Plan Application pursuant to section 44.2(3) of the UCA which provides that a utility may file with the Commission an "expenditure schedule" containing "a statement of the **expenditures** on demand-side measures the public utility has made or anticipates making during the period addressed by the schedule" [emphasis added]. Under section 44.2(2) of the UCA, DSM expenditures must be the subject of a schedule of DSM expenditures accepted by the BCUC before those expenditures are included in a utility's rates. Since FBC is requesting acceptance of DSM expenditures (and not specifically DSM savings or cost-effectiveness), FBC requires flexibility with respect to those expenditures accepted by the BCUC.

FBC also did not consider requesting flexibility to enhance cost-effectiveness as part of its 2023-2027 DSM Plan Application as cost-effectiveness is specifically defined under the Demand-Side Measures Regulation.

**12. Reference: Exhibit B-1, Appendix A, page 9**

Exhibit 3 – Portfolio Expenditures by Program Area

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Residential | 2,187 | 2,484 | 2,774 | 3,203 | 3,710 | 4,357 | 760 | 753 | 754 | 757 | 760 | 3,782 | 2,946 | 3,236 | 3,528 | 3,959 | 4,469 | 18,138 |
| Commercial | 2,141 | 2,399 | 2,606 | 2,788 | 2,922 | 12,856 | 988 | 988 | 988 | 988 | 988 | 4,940 | 3,129 | 3,387 | 3,594 | 3,776 | 3,910 | 17,796 |
| Industrial | 1,770 | 1,770 | 1,820 | 1,820 | 1,820 | 9,000 | 349 | 349 | 349 | 349 | 349 | 1,745 | 2,119 | 2,119 | 2,169 | 2,169 | 2,169 | 10,745 |
| Low Income | 1,209 | 1,267 | 1,315 | 1,355 | 1,431 | 6,577 | 534 | 451 | 453 | 457 | 458 | 2,355 | 1,743 | 1,718 | 1,769 | 1,812 | 1,889 | 8,932 |
| Conservation Education and Outreach | - | - | - | - | - | - | 897 | 954 | 958 | 962 | 1,064 | 4,835 | 897 | 954 | 958 | 962 | 1,064 | 4,835 |
| Enabling Activities | 739 | 774 | 908 | 1,017 | 1,159 | 4,595 | 811 | 807 | 1,008 | 777 | 813 | 4,216 | 1,550 | 1,580 | 1,916 | 1,794 | 1,972 | 8,811 |
| Innovative Technologies | 175 | 175 | - | - | - | 350 | 310 | 499 | 244 | 298 | 252 | 1,603 | 485 | 674 | 244 | 298 | 252 | 1,953 |
| Demand Response | 67 | 113 | 337 | 385 | 482 | 1,384 | 706 | 673 | 936 | 991 | 1,046 | 4,352 | 773 | 785 | 1,273 | 1,375 | 1,528 | 5,736 |
| Portfolio Activities | - | - | - | - | - | - | 813 | 813 | 813 | 813 | 813 | 4,063 | 813 | 813 | 813 | 813 | 813 | 4,063 |
| Total ($000s) | 8,288 | 8,981 | 9,759 | 10,567 | 1,524 | 49,118 | 6,167 | 6,286 | 6,503 | 6,391 | 6,543 | 31,890 | 14,455 | 15,268 | 16,262 | 16,958 | 18,066 | 81,008 |

12.1 Please explain how FBC determines the proportion of spending that is appropriately applied to Incentive vs Non-Incentive Expenditures.

**Response:**

Please refer to the response to BCSEA IR1 1.1.

12.2 Please provide the same table data as above for the LT DSM Plan and explain any significant differences between these sets of data.

**Response:**

Please refer to the response to BCOAPO IR1 4.1 for the LT DSM Plan tabular data. Note that as part of the LT DSM Plan planning exercise, non-incentive expenditures were assumed as a flat percentage of overall portfolio costs. Non-incentive expenditures were not forecast at the program level.

Please refer to the response to BCUC IR1 3.1 for an explanation of differences between the LT DSM Plan and 2023-2027 DSM Plan.

**13. Reference: Exhibit B-1, Appendix A, page 13**

> 3.1 Key Changes in New Plan
>
> Compared with the previous DSM Plan, the 2023 – 2027 DSM Plan has the following key updates in the Residential program area:
>
> - The Rental Apartment Efficiency Program (RAP) will not be a program under FBC's residential program area. The program has been consolidated under the commercial program area. RAP is administered in collaboration with FEI, the natural gas utility. In this DSM plan, the program will be included under FBC's commercial program area.
> - Air conditioners and air sealing added as new measures under the Home Renovation Rebate program.
> - Connected home bundle added as a new measure under the New Home program
> - LED bulbs removed from the Lighting (under Home Renovation Program). LED controls and fixtures remain.
> - Step 2 and Step 3 new home code measures are ramped down to align with the Step Code updates. Starting in 2025, there are no Step 2 and 3 measures – the focus instead shifts to the higher Step 4, and 5 measures.

13.1 Please elaborate on the 'Connected Home Bundle' and what the program offers.

**Response:**

Connected home technologies, also commonly known as smart home technologies, use hardware, software, sensors, and network connectivity to control their environment, allow for remote control over the internet or local networks, and/or provide varying levels of home automation.

Measures being considered in the connected home bundle are smart water heaters, smart HVAC zoning, smart plugs and power strips, smart lighting, and connected thermostats. Development for the measure bundle is planned to commence in 2023 with implementation in 2024.

13.2 Why were LED bulbs removed from Home Renovation? Were they newly included elsewhere or were they removed altogether? Please explain.

**Response:**

Please refer to the response to BCUC IR1 12.2.

**14. Reference: Exhibit B-1, Appendix A, page 14**

Exhibit 6 – Residential Program Area Expenditures by Program ($000s)

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Home Renovation | 1,792 | 2,006 | 2,294 | 2,619 | 2,988 | 11,699 | 148 | 139 | 139 | 139 | 139 | 704 | 1,940 | 2,145 | 2,433 | 2,758 | 3,127 | 12,403 |
| New Home | 395 | 477 | 480 | 583 | 722 | 2,658 | 40 | 40 | 40 | 40 | 40 | 200 | 435 | 517 | 520 | 623 | 762 | 2,858 |
| Labour | | | | | | | 536 | 536 | 536 | 536 | 536 | 2,678 | 536 | 536 | 536 | 536 | 536 | 2,678 |
| Non-Program Specific Expenses | | - | - | - | - | - | 36 | 38 | 39 | 42 | 45 | 200 | 36 | 38 | 39 | 42 | 45 | 200 |
| Total ($000s) | 2,187 | 2,484 | 2,774 | 3,203 | 3,710 | 14,357 | 760 | 753 | 754 | 757 | 760 | 3,782 | 2,946 | 3,236 | 3,528 | 3,959 | 4,469 | 18,138 |

Exhibit 7 - Residential Electricity Savings, Demand Savings, and Cost-Effectiveness by Program

| Program Area | Net Incremental Annual Electricity Savings (GWh) | | | | | | NPV of Electricity Savings ($000s) | NPV of Electricity Savings (GWh) | Annual Demand Savings (MW) | NPV of Demand Savings ($000s) | TRC | LCOE ($/kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | | | | | | |
| Home Renovation | 5.2 | 5.7 | 6.2 | 6.8 | 7.6 | 31.5 | $29,300 | 287 | 12.7 | $6,744 | 1.6 | $0.05 |
| New Home | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 3.5 | $4,400 | 41 | 1.8 | $1,034 | 1.0 | $0.08 |
| **Total** | **5.7** | **6.3** | **6.9** | **7.6** | **8.6** | **35.0** | **$33,700** | **328** | **14.5** | **$7,778** | **1.4** | **$0.05** |

14.1 For each table, please provide the same evidence for the 2017-2022 period, and identify any areas that have been rolled up or separated out. Are the Non-Incentive expenditures in constant dollars? If not, please explain why non-incentive expenditures are expected to remain flat.

**Response:**

Please refer to the response to CEC IR1 1.1. All expenditures in Exhibits 6 and 7 are in nominal dollars. The non-incentive expenditures are flat as FBC does not anticipate those expenditures to grow beyond inflation.

**15. Reference: Exhibit B-1, Appendix A, page 16 and page 17**

## 4.1 Key Changes in New Plan

Compared to the previous DSM Plan, the 2023 – 2027 DSM Plan has the following key updates in the Commercial program area:

- Rental Apartment Efficiency Program (RAP) has been consolidated under the Commercial program area. Previously the RAP expenses were included in the Residential program area.
- High efficiency air conditioners (four variations based on system sizes) have been added under the Prescriptive program.

Exhibit 8 – Commercial Program Area Expenditures by Program ($000s)

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Prescriptive | 1,081 | 1,224 | 1,346 | 1,455 | 1,558 | 6,541 | 50 | 50 | 50 | 50 | 50 | 250 | 1,131 | 1,274 | 1,396 | 1,505 | 1,608 | 6,791 |
| Performance | 1,050 | 1,166 | 1,250 | 1,323 | 1,355 | 6,143 | 120 | 120 | 120 | 120 | 120 | 600 | 1,170 | 1,286 | 1,370 | 1,443 | 1,475 | 6,743 |
| Rental Apartment | 10 | 10 | 10 | 10 | 10 | 50 | 35 | 35 | 35 | 35 | 35 | 175 | 45 | 45 | 45 | 45 | 45 | 225 |
| Labour | - | - | - | - | - | - | 683 | 683 | 683 | 683 | 683 | 3,415 | 683 | 683 | 683 | 683 | 683 | 3,415 |
| Non-Program Specific Expenses | | - | - | - | - | - | 100 | 100 | 100 | 100 | 100 | 500 | 100 | 100 | 100 | 100 | 100 | 500 |
| Total ($000s) | 2,141 | 2,399 | 2,606 | 2,788 | 2,922 | 12,734 | 988 | 988 | 988 | 988 | 988 | 4,940 | 3,129 | 3,387 | 3,594 | 3,776 | 3,910 | 17,796 |

Exhibit 9 - Commercial Electricity Savings, Demand Savings, and Cost-Effectiveness by Program

| Program Area | Net Incremental Annual Electricity Savings (GWh) | | | | | | NPV of Electricity Savings ($000s) | NPV of Electricity Savings (GWh) | Annual Demand Savings (MW) | NPV of Demand Savings ($000s) | TRC | LCOE ($/kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | | | | | | |
| Prescriptive | 5.9 | 6.1 | 6.3 | 6.5 | 6.7 | 31.5 | $29,800 | 293 | 7 | $4,444 | 1.7 | $0.03 |
| Performance | 4.7 | 4.9 | 5 | 5.1 | 5.3 | 25 | $23,700 | 233 | 1.5 | $779 | 1.1 | $0.04 |
| Rental Apartment | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.8 | $100 | 1 | 0.2 | $10 | 0.4 | $0.34 |
| **Total** | **10.8** | **11.2** | **11.5** | **11.8** | **12.2** | **57.3** | **$53,600** | **527** | **8.7** | **$5,233** | **1.4** | **$0.03** |

15.1 For each table, please provide the same evidence for the 2017-2022 period, and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

15.2 Does the "Rental Apartment" line item refer to the 'Rental Apartment Efficiency Program'?

**Response:**

Yes, the "Rental Apartment" line item refers to the Rental Apartment Efficiency Program.

15.3 Please provide the reason for consolidating the RAP under the Commercial program instead of under the Residential Program. Please provide the calculation for the Levelized Cost of Electricity for each line item.

**Response:**

Dividing the Rental Apartment Efficiency Program (RAP) between the Residential and Commercial Program Areas, results in challenges for forecasting, reporting, and allocating program expenditures between the program areas. Shifting the residential component of the RAP to the Commercial Program Area is an administrative change to help address these challenges.

The RAP is being reorganized under the Commercial Program Area, as the participant journey is more connected to the building as a whole rather than residential customers in the context of rental apartments. Also, this reorganization for FBC aligns with FEI's approach to RAP programming, development and management.[6]

The Levelized Cost of Electricity (LCOE) for each program is calculated using the following formula:

LCOE [$/kWh] = (Total Expenses including labour costs per program for 2023-2027) / (NPV of Electricity Savings in 2023-2027)

[6] FEI's 2023 DSM Plan Application proposes to consolidate RAP under the Commercial Program Area.

**16. Reference: Exhibit B-1, Appendix A, page 18 and page 20**

> The **Performance Program** provides incentives to encourage customers to identify, assess and implement measures that use energy for process-related activities. The program is administered jointly with FEI, providing customers with a one-stop program in the FBC service territory to evaluate and implement industrial energy efficiency projects. FBC Technical Advisors provide customer outreach and engagement for the Performance Program.
>
> The Performance Program offers co-funding for plant wide audits, feasibility studies, and implementation incentives. The Plant Wide Audit offer in the Performance Program provides incentives for customers to engage a qualified energy consultant to perform a high-level, whole facility audit to identify opportunities to use electricity and natural gas more efficiently within an industrial facility. The Feasibility Study offer in the Performance Program provides incentives to study a specific process or system within an industrial facility to use electricity and natural gas more efficiently. DSM incentives are available to encourage the implementation of cost-effective electric energy efficiency measures.
>
> The **Strategic Energy Management Program** is a comprehensive offering for large and medium industrial customers that provides them with energy modeling, energy efficiency coaching and strategic planning support to achieve both operational savings and to encourage larger capital upgrades. The program will be administered in collaboration with FEI. In 2020, FBC began a pilot project to extend FEI's SEM cohort offer to one wood products customer in the FBC service territory. This pilot is now being expanded into a full offer in this DSM Plan.

16.1 Please elaborate on the co-funding provided for plant-wide audits. How is this divided between FEI and FBC?

**Response:**

The FBC and FEI co-funding occurs in the Shared Service Territory (SST) and only if both electricity and natural gas efficiency measures are identified. For example, in the case of a plant-wide audit in the SST, FBC funds the electricity efficiency measures, while FEI funds the natural gas efficiency measures. If the plant-wide audit includes a similar amount of electricity and natural gas energy efficiency measures, FBC and FEI will each provide 50 percent of the total funding.

The cost-effectiveness benefits of FEI and FBC coordinating on plant wide audits are as follows:

- The average cost for a gas-only plant-wide audit is approximately $10,000. The average cost for an electric-only plant-wide audit is approximately $8,000. For a customer who is located in the SST and intends to identify both electricity and natural gas saving opportunities in one joint audit, the average cost of a joint plant-wide audit is approximately $12,500. Thus, a joint audit saves approximately $5,500 in study cost when compared to pursuing the studies separately.
- As Conservation and Energy Management department staff collectively work on both FEI natural gas efficiency programs and FBC electricity efficiency programs, this reduces the administration and labour costs of both portfolios. While difficult to quantify, this joint approach results in lower non-incentive expenditures and better cost-effectiveness.

16.2 Is the qualified energy consultant being engaged for the Performance Program internal to FEI or FBC? Or is this an external resource? Please explain.

**Response:**

The qualified energy consultants being engaged for the Performance Program are external to FEI and FBC. The consultants are from firms with Professional Engineers on staff who are subject-matter experts on energy efficiency, mechanical engineering, and/or electrical engineering.

16.3 Please provide further details of the Strategic Energy Management Pilot program, and identify any lessons learned that FBC intends to integrate into the new program. What results suggested that it would be appropriate to make the program permanent?

**Response:**

FBC's Strategic Energy Management (SEM) pilot program is designed for medium and large industrial customers and provides them with energy modeling, energy efficiency coaching and strategic planning support. SEM allows customers to identify energy saving opportunities by way of a third-party conducted site scan and access support to achieve operational savings. It also encourages customers to participate in larger capital upgrades through the Industrial Custom Program. In addition, the SEM Pilot program assists in fostering a culture of energy efficiency within the organization and enabling facility personnel to sustain the reduced energy consumption levels that were achieved through the program once their participation comes to an end.

As part of the SEM Pilot program, the participants are eligible for three types of incentives:

- incentives attributable to verified energy savings that are paid at the end of each year of participation;
- year one milestone incentive, rewarding the customer for completing their first year in the program; and
- top five measures milestone incentive, which is paid out for the completion of a participant's top five measures over the two-year participation period as identified by the customer and the energy consultant during the initial site scan.

One of FBC's key learnings in running the SEM Pilot program has been the effectiveness of a cohort model and the benefits of providing third-party energy coaching and support to the industrial customers. This model played an important role in fostering and sustaining a culture of energy efficiency at the customers' sites and developing a pipeline of new energy efficiency projects.

For results to date, please refer to the response to BCUC IR1 5.1.

FBC is proposing to transition the SEM pilot into a permanent program in the 2023-2027 DSM Plan. For factors FBC considered in deciding to transition the pilot into a permanent program, please refer to the response to BCUC IR1 5.2.

16.4 Please elaborate on the collaboration between FEI and FBC. For example, how is funding split between the companies, and how do the companies cooperate to maximize customer benefits?

**Response:**

For explanation of the funding split between FBC and FEI, please refer to the response to CEC IR1 16.1. For overall cooperation and coordination between the two utilities to maximize customer benefits, please refer to the response to CEC IR1 16.6.

16.5 Please provide a quantitative assessment of the cost-effectiveness benefits of FEI and FBC cooperating and coordinating on plant wide audits.

**Response:**

Please refer to the response to CEC IR1 16.1.

16.6 Please provide a summary of all the areas in which FBC and FEI are able to cooperate and coordinate their DSM activities for their customers.

**Response:**

In the Industrial Program Area, FBC and FEI collaborate in all DSM activities. From a non-incentive expenditure perspective, Conservation and Energy Management department staff collectively work on both FEI natural gas efficiency programs and FBC electricity efficiency programs. As a result of this cross-utility coordination, total administration, marketing and communications and labour costs are reduced for both FBC and FEI. Moreover, the customer journey for FBC and FEI customers located in the Shared Service Territory (SST) is streamlined and simplified.

In the Performance Program, FBC and FEI partner to co-fund energy studies, plant-wide audits and implementation incentives for projects that are located in the SST. For those projects, FBC incents electricity saving measures and FEI incents natural gas savings measures.

In the Strategic Energy Management Pilot program, FBC and FEI coordinate to offer a program that achieves both electricity and natural gas savings. As part of this program, participants benefit from a third-party energy assessment to identify electricity and natural gas energy savings opportunities and develop better corporate energy management practices. Through regular engagement, participants are also encouraged to implement energy savings opportunities identified in the assessment.

In the absence of coordination between FBC and FEI, an alternative approach would be to have both utilities run separate programs, each hiring separate third-party coaches for electricity and natural gas savings, respectively. That alternative could potentially result in higher administration expenditures, conflicting customer advice, and a less streamlined customer journey.

**17. Reference: Exhibit B-1, Appendix A, page 20**

Exhibit 10 - Industrial Program Area Expenditures by Program ($000s)

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Prescriptive | 785 | 785 | 785 | 785 | 785 | 3,925 | 12 | 12 | 12 | 12 | 12 | 60 | 797 | 797 | 797 | 797 | 797 | 3,985 |
| Performance | 785 | 785 | 785 | 785 | 785 | 3,925 | 25 | 25 | 25 | 25 | 25 | 125 | 810 | 810 | 810 | 810 | 810 | 4,050 |
| Strategic Energy Management | 200 | 200 | 250 | 250 | 250 | 1,150 | 35 | 35 | 35 | 35 | 35 | 175 | 235 | 235 | 285 | 285 | 285 | 1,325 |
| Labour | - | - | - | - | - | - | 277 | 277 | 277 | 277 | 277 | 1,385 | 278 | 278 | 278 | 278 | 278 | 1,385 |
| Non-Program Specific Expenses | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total ($000s) | 1,770 | 1,770 | 1,820 | 1,820 | 1,820 | 9,000 | 349 | 349 | 349 | 349 | 349 | 1,745 | 2,120 | 2,120 | 2,170 | 2,170 | 2,170 | 10,745 |

Exhibit 11 - Industrial Electricity Savings, Demand Savings, and Cost-Effectiveness by Program

| Program Area | Net Incremental Annual Electricity Savings (GWh) | | | | | | NPV of Electricity Savings ($000s) | NPV of Electricity Savings (GWh) | Annual Demand Savings (MW) | NPV of Demand Savings ($000s) | TRC | LCOE ($/kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | | | | | | |
| Prescriptive | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 27.7 | $23,900 | 238 | 5.2 | $2,514 | 2.6 | $0.02 |
| Performance | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 10 | $7,100 | 72 | 0.9 | $367 | 1.5 | $0.06 |
| Strategic Energy Management | 0.8 | 0.8 | 1.0 | 1.0 | 1.0 | 4.8 | $2,000 | 21 | 1.3 | $290 | 1.0 | $0.07 |
| **Total** | **8.3** | **8.3** | **8.5** | **8.5** | **8.5** | **42.5** | **$33,000** | **331** | **7.4** | **$3,171** | **2.1** | **$0.03** |

17.1 For each table, please provide the same evidence for the 2017-2022 period, and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**18. Reference: Exhibit B-1, Appendix A, page 21**

## 6 Low Income Program Area

This program area focuses on creating energy savings opportunities for low income customers - both through programs that low income customers can apply to and through programs that serve charities and housing providers, including Indigenous community housing providers, which in turn benefits FBC's low income customers.

This program area also contributes to meeting the "adequacy" component of the DSM Regulation Section 3, whereby a utilities' DSM portfolio is considered adequate when there is "a demand-side measure intended specifically to assist residents of low income households to reduce their energy consumption"[5].

In this DSM plan, the Low Income Program Area consists of four programs:

- Self Install Program
- Direct Install Program
- Prescriptive Program
- Performance Program

The **Self Install Program** is a program whereby low income participants receive an Energy Savings Kit (ESK) which includes energy saving measures along with an instruction booklet and directions to access online "how to" videos. All measures are easy to install which participants install themselves. The Self Install program is a partnership program with FEI.

The **Direct Install Program** is a program whereby low-income participants receive an in-home visit from a program contractor to assess their home's energy efficiency, install basic measures (e.g., LED lighting, high efficiency showerheads, etc.) and provide customized energy efficiency coaching. Additionally, some participants qualify to receive more robust measures such as fridges and insulation. Partners in the Direct Install Program include FEI and BC Hydro.

The **Prescriptive Rebate Program** provides rebates, implementation support, funding for energy studies, and training for housing providers. It also includes rebates for individual low-income customers and Indigenous communities' residential buildings. Prescriptive rebates provide a straightforward path for participants in energy efficiency programs. Prescriptive rebates are available for measures such as commercial lighting and kitchen equipment, and heat pump heating systems; and for Indigenous communities, additional measures for health and safety (e.g., mould or asbestos removal), ventilation, air sealing, insulation and appliance maintenance are included.

The **Performance Program** provides incentives to support charities, non-profit housing providers, co-ops, and Indigenous communities to construct high-performance homes and commercial buildings. For

18.1 Please describe the conditions that enable a customer to qualify for Low Income Programming.

**Response:**

Conditions that enable a customer to qualify for Low Income programs are defined in the B.C. Demand-Side Measures Regulation, the definition of "low-income household" and Section 3(1)(a).[7]

Other eligibility requirements, as detailed in terms and conditions, are program specific and vary but may include housing type and condition of existing equipment.

18.2 FBC states that the Self Install program is a partnership with FEI, while FBC partners with FEI and BC Hydro for the Direct Install Program. Why does FBC not partner with both entities for all programs?

**Response:**

There are instances where program offers do not align between utilities and there are limited opportunities for efficiencies to be gained from a partnership. Although formal partnerships may not be established for every program, FBC continues to collaborate with other utilities to ensure a coordinated approach, by combining skills and expertise, to improve the delivery of conservation and energy efficiency programs in the province.

[7] https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/10_326_2008.

**19. Reference: Exhibit B-1, Appendix A, page 23**

Exhibit 12 – Low Income Program Area Expenditures by Program ($000s)

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Self Install | 43 | 43 | 48 | 48 | 54 | 236 | 18 | 18 | 19 | 19 | 20 | 94 | 61 | 61 | 67 | 67 | 74 | 330 |
| Direct Install | 500 | 500 | 500 | 500 | 500 | 2,500 | 180 | 157 | 157 | 158 | 158 | 810 | 680 | 657 | 657 | 658 | 658 | 3,310 |
| Prescriptive | 516 | 574 | 617 | 656 | 727 | 3,091 | 78 | 22 | 23 | 26 | 26 | 175 | 594 | 596 | 640 | 682 | 753 | 3,266 |
| Performance | 150 | 150 | 150 | 150 | 150 | 750 | 15 | 11 | 11 | 11 | 11 | 59 | 165 | 161 | 161 | 161 | 161 | 809 |
| Labour | - | - | - | - | - | - | 233 | 233 | 233 | 233 | 233 | 1,167 | 233 | 233 | 233 | 233 | 233 | 1,167 |
| Non-Program Specific Expenses | | - | - | - | - | - | 10 | 10 | 10 | 10 | 10 | 10 | 50 | 10 | 10 | 10 | 10 | 10 |
| Total ($000s) | 1,209 | 1,267 | 1,315 | 1,355 | 1,431 | 6,577 | 534 | 451 | 453 | 457 | 458 | 2,355 | 1,743 | 1,718 | 1,769 | 1,812 | 1,889 | 8,932 |

Exhibit 13 - Low Income Electricity Savings, Demand Savings, and Cost-Effectiveness by Program

| Program Area | Net Incremental Annual Electricity Savings (GWh) | | | | | | NPV of Electricity Savings ($000s) | NPV of Electricity Savings (GWh) | Annual Demand Savings (MW) | NPV of Demand Savings ($000s) | TRC | LCOE ($/kWh) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | | | | | | |
| Self Install | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 1.7 | $1,000 | 10 | - | - | 3.2 | $0.04 |
| Direct Install | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 2.1 | $2,000 | 20 | - | - | 0.7 | $0.19 |
| Prescriptive | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 4 | $3,500 | 34 | 0.7 | $332 | 1.3 | $0.11 |
| Performance | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.7 | $800 | 7 | 0.2 | $112 | 1.6 | $0.13 |
| **Total** | **1.5** | **1.6** | **1.7** | **1.8** | **1.8** | **8.5** | **$7,300** | **71** | **0.9** | **$444** | **1.2** | **$0.13** |

19.1 For each table, please provide the evidence for the period 2017-2022, and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**20. Reference: Exhibit B-1, Appendix A, page 25 and 26**


20.1 Please elaborate on each of the key changes in the Conservation Education and Outreach.

**Response:**

Please refer to the response to BCSEA IR1 5.1.

**21. Reference: Exhibit B-1, Appendix A, page 27 and page 31**

Exhibit 14 – Conservation Education and Outreach Expenditures by Activity ($000s)

| Activity | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Residential Customer Engagement Tool | - | - | - | - | - | - | 282 | 326 | 328 | 330 | 431 | 1,697 | 282 | 326 | 328 | 330 | 431 | 1,697 |
| Residential Education Program | - | - | - | - | - | - | 105 | 107 | 107 | 107 | 107 | 533 | 105 | 107 | 107 | 107 | 107 | 533 |
| Commercial Education Program | - | - | - | - | - | - | 86 | 93 | 95 | 95 | 95 | 464 | 86 | 93 | 95 | 95 | 95 | 464 |
| School Education and Post-Secondary Program | - | - | - | - | - | - | 51 | 55 | 55 | 58 | 58 | 277 | 51 | 55 | 55 | 58 | 58 | 277 |
| Labour | - | - | - | - | - | - | 373 | 373 | 373 | 373 | 373 | 1,865 | 373 | 373 | 373 | 373 | 373 | 1,865 |
| **Total ($000s)** | - | - | - | - | - | - | $897 | $954 | $958 | $962 | $1,064 | $4,835 | $897 | $954 | $958 | $962 | $1,064 | $4,835 |

Exhibit 15 – Enabling Activities Expenditures by Activity ($000s)

| Activity | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Trade Ally Network | - | - | - | - | - | 133 | 166 | 184 | 147 | 152 | 152 | 801 | 166 | 184 | 147 | 152 | 152 | 801 |
| Codes & Standards | 176 | 251 | 365 | 474 | 616 | 1,882 | 247 | 254 | 268 | 255 | 287 | 1,311 | 422 | 505 | 633 | 729 | 903 | 3,192 |
| Reporting Tool & Customer Application Portal | - | - | - | - | - | - | 95 | 83 | 305 | 83 | 83 | 649 | 95 | 83 | 305 | 83 | 83 | 649 |
| Commercial Energy Specialist Program | 213 | 213 | 213 | 213 | 213 | 1,065 | 35 | 35 | 35 | 35 | 35 | 175 | 248 | 248 | 248 | 248 | 248 | 1,240 |
| Community Energy Specialist Program | 351 | 310 | 330 | 330 | 330 | 1,651 | 12 | 8 | 8 | 8 | 8 | 44 | 363 | 318 | 338 | 338 | 338 | 1,695 |
| Customer Research | - | - | - | - | - | - | 8 | 8 | 7 | 6 | 8 | 37 | 8 | 8 | 7 | 6 | 8 | 37 |
| Labour | - | - | - | - | - | - | 248 | 236 | 238 | 239 | 240 | 1,201 | 249 | 236 | 239 | 239 | 240 | 1,203 |
| Total ($000s) | 739 | 774 | 908 | 1,017 | 1,159 | 4,598 | 811 | 807 | 1,008 | 777 | 813 | 4,216 | 1,550 | 1,580 | $1,916 | $1,794 | $1,972 | $8,811 |

21.1 For each table, please provide the evidence for the period 2017-2022, and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**22. Reference: Exhibit B-1, Appendix A, page 29 and 30**

> The **Commercial Energy Specialist Program** is a joint initiative between FBC and FEI that co-funds Energy Specialist, Analyst or Thermal Energy Manager positions in large commercial organizations. FBC provides up to $40,000 per year in an annual contract with the remaining $40,000 provided by FEI. The priority is to identify and implement energy efficiency upgrades for their organizations and to participate in FBC and FEI's DSM programs. They are also responsible to identify and implement non-program specific opportunities to use electricity and natural gas more efficiently. FBC considers this an energy management program, and hence a specified demand-side measure, as defined in Section 1 the DSM Regulation and subject to Section 4[13].
>
> The **Community Energy Specialist Program** provides financial support to local municipal governments and regional districts, including Indigenous communities, and institutional customers to facilitate energy efficiency planning activities like the development of community energy plans, energy efficient design practices and organizational policies such as adopting advanced energy efficiency standards for the entities' own buildings. The planning must be targeted at reducing electricity usage and demand. FBC considers this an energy management program, and hence a specified demand-side measure, as defined in Section 1 the DSM Regulation and subject to Section 4[14].

22.1 How did FBC and FEI determine that a 50%/50% funding split was appropriate for funding energy professional positions in large commercial organizations? Is the customer expected to fund any of the annual cost? Please explain why or why not.

**Response:**

The funding split between FBC and FEI has been set at 50 percent between utilities due to shared responsibilities to manage both electricity and natural gas. Organizations who apply to participate in this program to receive both FBC and FEI funding have historically expressed a desire for the position to work equally on gas and electric DSM projects. Hence, the 50/50 funding split was deemed appropriate.

Customers are not required to fund any of the annual cost, but are encouraged to supplement the funding provided by FBC and FEI and frequently do provide additional salary above the funding maximum to keep the salary competitive with the overall market.

22.2 For how long is the energy professional expected to be employed? Please explain.

**Response:**

Contracts for positions funded within the Commercial and Community Energy Specialist Program can vary in length:

- Energy Analysts - Six months to one year
- Commercial Energy Specialists - Typically 1 year

- Community Energy Specialists - Typically 2 years
- Thermal Energy Managers - Typically 2 years

All positions are reviewed for funding renewal three quarters into the contract period.

22.3 Please provide the funding levels available for an individual Community Energy specialist.

**Response:**

FBC and FEI fund a percentage up to 100 percent of Community Energy Specialists' salary to a maximum of $100 thousand for the first year and $80 thousand for subsequent years. These positions are co-funded as applicable between FBC and FEI DSM budgets and the FEI External Relations department.

**23. Reference: Exhibit B-1, Appendix A, page 31**

Exhibit 15 – Enabling Activities Expenditures by Activity ($000s)

| Activity | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Trade Ally Network | - | - | - | - | - | 133 | 166 | 184 | 147 | 152 | 152 | 801 | 166 | 184 | 147 | 152 | 152 | 801 |
| Codes & Standards | 176 | 251 | 365 | 474 | 616 | 1,882 | 247 | 254 | 268 | 255 | 287 | 1,311 | 422 | 505 | 633 | 729 | 903 | 3,192 |
| Reporting Tool & Customer Application Portal | - | - | - | - | - | - | 95 | 83 | 305 | 83 | 83 | 649 | 95 | 83 | 305 | 83 | 83 | 649 |
| Commercial Energy Specialist Program | 213 | 213 | 213 | 213 | 213 | 1,065 | 35 | 35 | 35 | 35 | 35 | 175 | 248 | 248 | 248 | 248 | 248 | 1,240 |
| Community Energy Specialist Program | 351 | 310 | 330 | 330 | 330 | 1,651 | 12 | 8 | 8 | 8 | 8 | 44 | 363 | 318 | 338 | 338 | 338 | 1,695 |
| Customer Research | - | - | - | - | - | - | 8 | 8 | 7 | 6 | 8 | 37 | 8 | 8 | 7 | 6 | 8 | 37 |
| Labour | - | - | - | - | - | - | 248 | 236 | 238 | 239 | 240 | 1,201 | 249 | 236 | 239 | 239 | 240 | 1,203 |
| Total ($000s) | 739 | 774 | 908 | 1,017 | 1,159 | 4,598 | 811 | 807 | 1,008 | 777 | 813 | 4,216 | 1,550 | 1,580 | $1,916 | $1,794 | $1,972 | $8,811 |

23.1 Please provide the evidence for the period 2017-2022 and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**24. Reference: Exhibit B-1, Appendix A, page 32**

## 9 Innovative Technologies

Innovative Technologies funding supports the development of or increased use of technologies that can achieve significant energy use reductions. FBC supports feasibility studies, field studies, and pilots to validate customer acceptance and energy savings of innovative equipment and systems. Technologies that have potential are incorporated into DSM programs. Innovative technologies are a specified demand-side measure as defined in Section 1 of the DSM Regulation, which means that the program and the technologies are evaluated as part of the DSM portfolio[15].

As an example, in 2020, FBC funded a field study to assess the performance of cold climate heat pumps in partnership with Natural Resources Canada, BC Hydro, and EMLI. This study will be used to help increase adoption of heat pumps and improve energy savings assumptions for the technology.

For this DSM Plan, the major focus of the Innovative Technologies team and budget will be demand and capacity resources and a pilot project for deep retrofits.

Exhibit 16 shows the annual expenditures for the Innovative Technologies activities by expenditure type.

**Exhibit 16 - Annual Innovative Technologies DSM Expenditures by Expenditure Type ($000s)**

| Expenditure Type | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|
| Incentive Costs | 175 | 175 | - | - | - | 350 |
| Non-Incentive Costs | 225 | 410 | 150 | 200 | 150 | 1,135 |
| Labour | 85 | 89 | 94 | 98 | 102 | 468 |
| **Total ($000s)** | **485** | **674** | **244** | **298** | **252** | **1,953** |

24.1 Please provide the evidence for the period 2017-2022 and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

24.2 Please provide the rationale for removing incentive costs in 2025-2027.

**Response:**

The incentive costs are specific to the deep energy retrofit pilot, which will conclude incentive expenditures in 2024. Some minor non-incentive expenditures associated with pilot evaluation

are anticipated to extend into 2025. Please refer to the response to BCSEA IR1 4.2 for further discussion regarding the incentive costs associated with the deep energy retrofit pilot.

24.3 Please provide the impact on benefits anticipated for 2025 through 2027 and provide the benefits anticipated for 2023 & 2024.

**Response:**

Please note that energy and capacity savings are not claimed as part of the Innovative Technologies Program Area. The benefits anticipated by the Innovative Technologies Program Area come from further understanding of the technologies studied, including how the technology can be implemented, energy and capacity savings impacts, implementation costs, and customer perception.

The only Innovative Technology pilot FBC has forecast to transition to a permanent program within the DSM plan years is the commercial automated demand response pilot. The pilot is expected to run in 2023 and 2045, but the capacity benefits past 2025 for the permanent program are reflected in the forecast for the Demand Response Program Area.

24.4 Please elaborate on the Pilot project for deep retrofits and at which customer group this program is targeted.

**Response:**

Please refer to the response to BCUC IR1 14.1.

**25. Reference: Exhibit B-1, page 33 and 34**

The **Commercial and Industrial Demand Response** activities including conducting the next phase of the commercial DR program, focusing on automated DR in 2023 and 2024, and adding industrial customers to the program. If successful, FBC would make the program permanent and expand to additional customers. The budget supports the DR platform licensing, program administration, marketing, and program incentives.

Exhibit 17 shows the incentive, non-incentive, and total expenditures for the Demand Response budget by program. Exhibit 18 shows the forecasted electricity demand savings and cost effectiveness expected from the DR programs.

Exhibit 17 – Demand Response Program Area Expenditures by Program ($000s)

| Program Area | Incentive Expenditures ($000s) | | | | | | Non-Incentive Expenditures ($000s) | | | | | | Total Expenditures ($000s) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
| Residential Demand Response | 67 | 113 | 267 | 274 | 326 | 1,047 | 345 | 301 | 331 | 350 | 369 | 1,696 | 413 | 413 | 598 | 624 | 695 | 2,743 |
| Commercial and Industrial Demand Response | - | - | 70 | 110 | 157 | 337 | 31 | 26 | 243 | 262 | 281 | 843 | 31 | 26 | 312 | 372 | 438 | 1,179 |
| Labour | - | - | - | - | - | - | 330 | 346 | 363 | 378 | 395 | 1,812 | 330 | 346 | 363 | 378 | 395 | 1,812 |
| Non-Program Specific Expenses | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Total ($000s) | 67 | 113 | 337 | 384 | 483 | 1,384 | 706 | 673 | 937 | 990 | 1045 | 4,351 | 773 | 785 | 1,273 | 1,375 | 1,528 | 5,736 |

Exhibit 18 – Demand Response Demand Savings and Cost-Effectiveness by Program

| Program Area | Net Forecasted Annual Demand Savings (MW) | | | | | | NPV of Demand Savings ($000s) | TRC |
|---|---|---|---|---|---|---|---|---|
| | 2023 | 2024 | 2025 | 2026 | 2027 | Total | | |
| Residential Demand Response | 1.0 | 2.2 | 4.5 | 6.0 | 7.7 | 21.4 | $3,100 | 1.1 |
| Commercial and Industrial Demand Response | - | - | 1.9 | 3.0 | 4.3 | 9.2 | $1,300 | 0.8 |
| **Total** | **1.0** | **2.2** | **6.4** | **9.0** | **12.0** | **30.6** | **$4,400** | **1.0** |

25.1 Please elaborate on the commercial aspect of the demand response pilot project.

**Response:**

Please refer to the responses to BCUC IR1 8.5, 8.5.1, 8.5.2, and 8.5.3.

25.2 What criteria will be used to determine if the project can be considered 'successful'?

**Response:**

Please refer to the response to BCUC IR1 8.4.

25.3 Please provide the evidence for the period 2017-2022 and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**26. Reference: Exhibit B-1, appendix A, page 35**

Exhibit 19 - Annual Portfolio DSM Expenditures by Activity ($000s)

| Activity | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|
| Evaluation | 325 | 325 | 325 | 325 | 325 | 1,625 |
| Portfolio Level Activities* | 487 | 487 | 487 | 487 | 487 | 2,436 |
| **Total ($000s)** | **813** | **813** | **813** | **813** | **813** | **4,063** |

26.1 Please provide the evidence for the period 2017-2022 and identify any areas that have been rolled up or separated out.

**Response:**

Please refer to the response to CEC IR1 1.1.

**27. Reference: Exhibit B-1, Appendix B, page 13**

> **4.1 OVERVIEW**
>
> Commercial DSM programs encourage commercial customers, including institutions and government, to reduce overall consumption of electricity and associated energy costs. The Commercial programs produced aggregate electricity savings of 12.3 GWh, compared to 11.1 GWh in 2020, and achieved an overall TRC of 1.4 in 2021. Commercial program expenditures totalled $3.5 million, of which 79 percent was in the form of incentives.
>
> Table 4-1 summarizes Plan and actual expenditures for the Commercial programs, including incentive and non-incentive spending, and annual energy savings achieved.

**Table 4-1: 2021 Commercial Program Results Summary**

| Program | Savings (kWh) | | Plan ($000s) | Actual Expenditures ($000s) | | |
|---|---|---|---|---|---|---|
| | Plan | Actual | Total | Total | Incentive | Non-Incentive |
| Commercial Custom | 6,048,000 | 5,215,201 | $ 1,006 | $ 1,081 | $ 1,068 | $ 13 |
| Commercial Prescriptive | 9,242,514 | 7,106,720 | $ 1,177 | $ 1,767 | $ 1,701 | $ 66 |
| Labour and expenses | - | - | $ 869 | $ 649 | $ - | $ 649 |
| **Total** | **15,290,514** | **12,321,921** | **$ 3,052** | **$ 3,497** | **$ 2,769** | **$ 728** |
| **Plan including 2020 carryover of $225** | | | **$ 3,277** | | | |

27.1 Please explain why the commercial custom and commercial prescriptive programs had actual expenditures that approximated or exceeded the planned expenditures, but the Actual savings were below those planned.

**Response:**

In order to stimulate program demand during the COVID-19 pandemic, FBC introduced a limited-time COVID-19 recovery offer, which included higher incentives for prescriptive measures (Prescriptive Program), energy studies and capital upgrades (Custom Program). While this was successful in maintaining some program interest during a challenging time, capital project completions and measure implementation remained challenging for many FBC customers.

FBC's Commercial Custom Program is characterized by large, intermittent capital upgrade projects that generally occur less frequently and take longer to complete. The program also provides a portion of the incentive payments prior to completion due to the higher costs associated with these investments for customers. As a result, expenditures and energy savings realization can occur in different years, thus expenditures in 2021 may realize energy savings in the following year(s), i.e., in 2022 and 2023. Moreover, since a number of custom projects are subject to measurement and verification as per the Commercial Custom Program terms, those energy savings are realized upon completion of the measurement and verification process, which normally takes 12-24 months from start to finish.

A key lesson learned for FBC in this case was the importance of reacting swiftly to a global disruption (i.e., COVID-19 pandemic). Introducing FBC's COVID-19 recovery offer to stimulate commercial customers to follow through with their pre-pandemic energy efficiency plans under the Commercial Custom Program supported projects that otherwise may have been cancelled. This included working closely with customers on a project-by-project basis to provide support as needed to ensure capital upgrade projects were implemented, despite setbacks caused by the pandemic, including supply chain issues. In the Commercial Prescriptive Program, FBC's learning relates to its Point-of-Sale partner activities and the importance of expanding it further to allow more customers to directly access FBC incentives through participating vendors and contractors.

27.2 Please provide FBC's views as to why the savings were not achieved as expected despite the spending, and identify any lessons learned that could assist in improving savings performance.

**Response:**

Please refer to the response to CEC IR1 27.1.

27.3 Please provide the calculations for the actual savings versus calculations for estimates.

**Response:**

For the Commercial Custom program, the total forecast plan energy savings in the 2019-2022 DSM Plan were calculated based on a forecast participation rate and a $/kWh ratio for incentive. Both inputs were derived from program data from previous years.

For retrofit projects under the Commercial Custom Program, the actual savings for this program were based on the modeled savings per project that are calculated by third-party engineering consultants. The accuracy of these savings were generally within +/- 10% of estimate. Once the third-party energy study was completed, it was submitted to FBC for technical review. At this stage, cost-effective measures along with their corresponding savings (as quantified by the third-party consultant) were verified by FBC's technical reviewer. Some larger projects were selected for measurement and verification and FBC adjusted their actual measured savings achieved accordingly.

For each completed new construction project under the Commercial Custom Program, the actual savings were calculated from the BC Energy Step Code or National Energy Code of Canada for Buildings (NECB) modeled energy consumption of the proposed building less the baseline energy consumption for an equivalent code-compliant building. This calculation was then verified by a third-party consultant. Lastly, a FBC engineer further verified that the completed building was consistent with the provided energy model.

The actual savings for each retrofit and new construction project completed and verified in the year was then summed and reported as the total actual savings for the Commercial Custom Program.

For the Commercial Prescriptive Program, the total forecast plan energy savings were generally based on two variables: (1) a pre-determined energy saving value (also known as “deemed savings” value) that were either based on a Technical Reference Manual (TRM) or developed and/or verified by a third-party consultant in collaboration with FBC at the time of measure development; and (2) the forecast number of participants for each measure under this program in each year in the 2019-2022 DSM Plan. Some measures also had additional factors that were considered into the calculation of savings (ex. deemed operating hours by building type).

The calculation to determine actual energy savings reported for this program was the same as methodology used to forecast plan savings, except the actual total number of participants were used instead of the forecast number.

**28. Reference: Exhibit B-1, Appendix B, page 15**

**Table 5-1: 2021 Industrial Program Results Summary**

| Program | Savings (kWh) | | Plan ($000s) | Actual Expenditures ($000s) | | |
|---|---|---|---|---|---|---|
| | Plan | Actual | Total | Total | Incentive | Non-Incentive |
| Industrial Custom | 8,226,000 | 4,828,760 | $ 1,308 | $ 1,841 | $ 1,833 | $ 9 |
| Industrial Prescriptive | 1,887,556 | 3,871,692 | $ 311 | $ 487 | $ 466 | $ 21 |
| Labour and expenses | - | - | $ 195 | $ 324 | $ - | $ 324 |
| **Total** | **10,113,556** | **8,700,452** | **$ 1,813** | **$ 2,653** | **$ 2,299** | **$ 354** |
| **Plan including 2020 carryover of $274** | | | **$ 2,087** | | | |

28.1 The Industrial custom program had actual expenditures that approximated or exceeded the planned expenditures, but the Actual savings were substantially below those planned. Please provide FBC's views as to why the savings were not achieved as expected despite the spending and identify any lessons learned.

**Response:**

The Industrial custom program savings were lower than forecast, while expenditures were higher than forecast for the following reasons:

- FBC observed that the COVID-19 pandemic significantly disrupted the energy efficiency plans for many of FBC's industrial customers. In order to stimulate program demand, FBC introduced a limited-time COVID-19 recovery offer, which included higher incentives for studies and capital upgrades. While this was successful in maintaining program interest during a challenging time, capital project completions and measure implementation remained challenging for industrial customers. The net impact was fewer customers achieving similar savings at a higher level of expenditure.
- In 2021, FBC implemented a Strategic Energy Management (SEM) Pilot that, by design, had front-loaded expenditures, but will achieve savings in 2022 and 2023.
- FBC experienced higher than anticipated participation for measures that have lower savings, such as cannabis lighting, resulting in lower than anticipated energy savings in 2021.
- FBC's Industrial Custom program is characterized by large intermittent capital upgrade projects that generally occur less frequently and take longer to complete, so the realization of energy savings may shift to the following year(s).

A key lesson learned for FBC in this case was the importance of reacting swiftly to a global disruption (i.e., COVID-19 pandemic) and introducing FBC's COVID-19 recovery offer to motivate industrial customers to follow through with their pre-pandemic energy efficiency plans, as much

as possible. While FBC acknowledges this will result in higher expenditures for similar savings, supporting the projects (even at a higher cost) continues to be a cost-effective means to manage load.

28.2 The Industrial Prescriptive Program had substantially higher actual savings than those planned, with lower spending. Please provide FBC's view as to why this occurred, and whether there are any lessons learned that could be transferred to the commercial Prescriptive programs.

**Response:**

The higher than planned savings in the Industrial Prescriptive program in 2021 is attributable to the higher than expected number of pumps and variable speed drives (VSDs) upgrades FBC incented in that year. FBC incented 11 pumps and VSD projects totaling 1.4 GWh/yr in electricity savings in 2021 alone, which was significantly more than forecast in the 2019-2022 DSM Plan and incented in 2019 and 2020.

One of the key drivers of this success and a lesson learned for FBC was the importance of early and continuous engagement with FBC's larger customers (either commercial and industrial) and their contractors through the Trade Ally Network (TAN) to learn about their capital plans and identify energy efficiency opportunities early on in the project planning stage. While FBC does not expect that the Commercial Program Area has the same market potential for VSD and pump retrofits, FBC also learned the value of identifying emerging retrofits that are gaining traction in industry and look at expanding customer participation for those type of projects by leveraging past successes.

# Attachment 1.1

## REFER TO LIVE SPREADSHEET MODEL

Provided in electronic format only

(accessible by opening the Attachments Tab in Adobe)

# Attachment 1.2

# Chris Pulfer, P.Eng.

## Principal

### EXPERIENCE OVERVIEW

Chris brings a collaborative approach to his work, leveraging client knowledge and resources to ensure sound, actionable results. He has spent his career working to identify opportunities for energy efficiency, characterize barriers, and implement solutions.

Chris has contributed to the successful completion of several major jurisdictional energy conservation and demand management studies, including key roles in energy conservation potential reviews in six provinces and territories. Through these assignments Chris has provided technical analysis, conservation potential modelling, model development and project management focused primarily on the commercial and institutional sectors.

Chris has also led or contributed to more than a dozen smaller scale market and prefeasibility studies focused on energy market characterization for efficient equipment, technical assessment of energy impact, and conservation & program potential.

Chris holds a B.Eng. (Mechanical) and B.Sc. (Ecology), and is registered as a Professional Engineer in the Province of Ontario.

### PROJECT EXPERIENCE

*Energy Efficiency Technology and Market Research*

Prefeasibility Study: Integrated and Connected Homes: FortisBC (April 2021-July 2021). Building on our 2018 study for FortisBC, Posterity Group conducted an updated prefeasibility study to assess the opportunity for Connected Home systems that meet the BC's Innovative Technologies definition. FortisBC is interested in potential electricity and natural gas savings due to these technologies, with specific emphasis on potential benefits resulting from integrating various technologies. The scope of this assignment included both market and technology characterizations in the residential sector. Chris acted as Project Director for this assignment, with overall responsibility for project design, high level execution guidance and support, and quality control.

Multifamily and Single Family Natural Gas Deep Retrofits Prefeasibility Study: FortisBC (September 2020-December 2020). FortisBC explored natural gas driven deep retrofits as a conservation and energy management solution for single family and multifamily customers. The goal of this study was to determine if there is a Demand Side Management (DSM) business case for natural gas driven deep retrofits and to recommend potential pathways for uptake if a business case exists, and identify and recommend opportunities and structures for future rebate programs. This prefeasibility study is supporting decision-making for an internal steering group made up of technical and program staff. This group will work to secure funding, socialize program concepts with external stakeholders and interveners, and launch pilot programs over the next several months. Posterity Group leveraged our ongoing measure assessment and end use modelling work with FortisBC to assess potential energy and GHG savings and worked with Harbourgreene Consulting to develop program pathways to overcome the market barriers evident in BC. Chris acted as Project Director.

Prefeasibility Study and M&V Best Practices: Gas Heat Pumps and Dual-Fuel Heat Pumps: ConEdison via CEATI International Inc. (May 2020-December 2020). Posterity Group conducted a technical, economic

and market potential study for natural gas heat pumps (GHP) and dual-fuel heat pumps (Dual-Fuel HP) in Con Edison's and Orange and Rockland's residential, multi-family and commercial sectors for both retrofit and new construction applications. Technologies were compared to two reference cases: electric air source heat pumps, and most efficient in-kind replacement. Phase 2 of the project involves developing Measurement and Verification (M&V) best practices for natural gas heat pumps technologies. Chris acted as Technical Advisor.

Prefeasibility Study: Residential Water Heater Controls: FortisBC (April 2020-August 2020). Posterity Group conducted a prefeasibility study to assess the technical and market opportunities for smart residential water heater controllers. FortisBC was interested in finding out the technology's potential energy savings, demand response, and non-energy benefits. Posterity Group conducted literature reviews, jurisdictional scans, interviews with market actors to gather market and technical information. The information was then used to develop technical resource manuals, scenario analysis, and energy saving models. Chris acted as Project Director.

Fenestration Market Study Cost Benefit Support: Natural Resources Canada (NRCan) (April 2019-June 2019). Posterity Group gathered detailed costing information about fenestration products and calculated energy impacts in support of NRCan's Cost Benefit Analysis of potential Minimum Energy Performance Standards for these products. Posterity Group obtained precise costing through tear down analyses and discussions with manufacturers, and modelled the fenestration products in different climate zones across Canada using the Housing Technology Assessment Program (HTAP). Chris acted as project director and technical analyst, with responsibility for methodological oversight, quality control and guidance.

High-Efficiency Buildings: Case Studies: NRCan Office of Energy Research and Development (February 2019-July 2019). NRCan's Office of Energy Research and Development engaged Posterity Group to undertake literature review, interviews, and technical case-study development for the purpose of gathering information about high efficiency buildings in Canada and to better quantify the costs, energy usage, and ensuing greenhouse gas emissions of high efficiency buildings. This work combined two of Posterity Group's core competencies: The assessment of markets for energy efficient and low carbon technologies and services; and technical assessment of energy performance in the built environment. Our team developed an inventory of high performing Canadian buildings, undertook market research and interviews with leading builders and developers, assessed and developed building energy simulation models and Class D estimates of incremental costing for high performance buildings, and developed a series of case studies covering both technical and market-related aspects of high-performance building development. Chris acted as project director, with responsibility for methodological oversight, quality control and guidance.

Assessment and Development of Fireplace Program Savings Assumptions: FortisBC (July 2018-February 2019). Posterity Group worked with FortisBC to develop updated savings assumptions for their EnerChoice Fireplace program. Project scope included savings assumptions for fireplaces installed in residential detached housing and MURB buildings, with particular interest on isolating behavioral and technical components affecting energy use for upgrade fireplaces. PG staff conducted technical and market research, reviewed current and proposed changes to federal and provincial energy performance standards, and modelled upgrade performance using multiple HOT2000 archetypes. Chris acted as Project Director, with responsibility for overall study methodology and work product quality review.

Prefeasibility Study: Connected Home Technologies: FortisBC (February 2018-August 2018). Posterity Group conducted a prefeasibility study to assess the opportunity for Connected Home systems that meet the BC's Innovative Technologies definition. FortisBC is interested in potential electricity and natural gas savings due to these technologies, potential benefits resulting from provision of data back to the customer via home energy

reports, and the potential for demand response activities. The scope of this assignment included both market and technology characterizations in the residential sector. Chris acted as Project Director for this assignment, with overall responsibility for project design, high level execution guidance and support, and quality control.

ENERGY STAR Skylight Market and Options Analysis: NRCan (May 2018-July 2018). Following a broader assessment of the Canadian fenestration market, NRCan engaged Posterity Group to conduct a more detailed assessment of ENERGY STAR technical criteria options for the unit skylight market. Work included detailed energy savings and GHG modelling and analysis for alternate U-factor compliance options. Chris acted as Project Director, with responsibility for study design, guidance and quality control.

Prefeasibility Study: Residential Micro Combined Heat and Power Technologies: FortisBC (March 2018-November 2018). Posterity Group conducted a prefeasibility study to assess the opportunity for Micro CHP systems that meet the BC's Innovative Technologies definition. FortisBC is interested in potential electricity displacement and examining scenarios where natural gas savings may be achieved using these technologies. The scope of this assignment included both market and technology characterizations in the residential sectors. Chris acted as Project Director for this assignment, with overall responsibility for project design, high level execution guidance and support, and quality control.

Market Study and Participant Forecast for Fenestration and Insulation Measures: Independent Electricity System Operator (September 2017-October 2017). Posterity Group provided market characterization and program design support to for the development of building envelope measures. This work was led by the IESO for the Ontario Ministry of Energy and Climate Change Low-carbon Technology Rebate Program. Specific areas of work included: A review of current programs in other jurisdictions and programs previously run in the Ontario market; a market overview with major market actors (manufacturers, distributors and contractors) and market structure/value chain mapped specifically for the renovation market; and participant forecast for the period between November and March 31, and for the following 3 fiscal years, by measure. Chris managed this assignment and acted as lead consultant.

Solar Thermal Market Scan: Independent Electricity System Operator (November 2017-December 2017). Posterity Group helped IESO and the GreenON Fund to understand the current market for residential solar thermal technologies in Ontario for both air and water heating. Posterity Group provided: a description of the products currently available in the Ontario market for both solar thermal water heating, a characterization of the Ontario value chain, market actors and their relationships, including a market structure diagram; a description of market actor roles, a listing of active firms; a characterization of market failures and barriers, with a focus on barriers that may be addressed by a future program; a summary of similar programs that are currently active or that operated in the past. Chris acted as project director for this assignment with overall responsibility for project scoping and deliverables.

Analysis of Fenestration Products in Support of Canadian Market Transformation Activities: NRCan (July 2017-June 2018). NRCan engaged Posterity Group to analyze the residential low-rise fenestration market (windows, doors and skylights) in Canada as part of a broader strategy to decrease their impact on low-rise building energy use. This assignment included technical and market analysis of proposed changes to ENERGY STAR criteria and proposed incoming Minimum Energy Performance Standards.

Posterity staff examined the impact of these proposed standards on energy use and GHG emissions; and market actors including manufacturers, consumers, dealers and homebuilders. We also developed a stakeholder database, and critiqued proposed standards, and suggested modifications. Chris acted as Project Manager and Lead Analyst.

Development of Emerging Technologies Profiles: Energy Solutions Center (July 2017-November 2017). Posterity Group provided measures research and analysis, and ultimately produced prioritized lists of emerging natural gas technologies for ESC for their residential and commercial working groups. These prioritized lists are intended to help ESC member utilities identify opportunities and prioritize funding for further market research. Technology research for this project, which included manufacturers, market readiness of the technology, lifetime and warranty information, general costing information (where available) and how the technology is expected to save natural gas, is expected to be relevant for all members. Stage II of this project is expected to include detailed market research to determine the feasibility of these technologies for a prescriptive or deemed savings program. Chris acted as Project Director for this assignment, with overall responsibility for project design, high level execution guidance and support, and quality control.

Gas Heat Pump Prefeasibility Study: CEATI International (July 2016-June 2017). Recent R&D has positioned gas heat pumps (GHP) as a high efficiency alternative to conventional boiler or furnace equipment, providing justification for a pre-feasibility study of the technology in British Columbia's residential and commercial building sectors. Chris Pulfer led Posterity Group's work with CEATI and FortisBC to: identify commercially available technologies, assess technology risks and market barriers, estimate the achievable potential of relevant technologies, and provide scenario specific technical resource manuals.

Residential HVAC Zone Control Prefeasibility Study: CEATI International (February 2016-February 2017). While the market for forced-air gas furnaces has been largely transformed through minimum energy performance standards, technological advances and cost savings of residential HVAC zone controls represent a potential energy savings strategy. Chris Pulfer led Posterity Group's work with CEATI and FortisBC to: identify commercially available residential zone control technologies, assess technology risks and market barriers, estimate the achievable potential of relevant technologies, and provide scenario specific technical resource manuals.

Greenhouse Construction Industry Standard Practice Study: Enbridge Gas Inc. (formerly Union Gas) (August 2016-June 2017). Posterity Group helped Union Gas establish a defensible energy performance base case for greenhouse new construction and expansion projects in Union Gas' service territory by employing a study methodology that aligns with the California Public Utilities Commission's Industry Standard Practice Guide. The study findings allowed Union program staff, the Ontario Energy Board and their evaluation contractor to accurately assess impacts resulting from DSM program activities targeting the greenhouse subsector. Chris acted as Project Director for this assignment, with high-level study design and quality control responsibilities.

Indirect-Fired Domestic Hot Water Heater Technology Study: Enbridge Gas Inc. (formerly Union Gas) (February 2016-May 2017). Posterity Group assisted Union Gas to develop an in-depth market characterization and energy savings potential analysis for indirect-fired water heaters in commercial and residential applications within their service territory. Chris oversaw technical and savings potential analysis to allow Union to assess the potential for a prescriptive or quasi prescriptive DSM program. This included the development of DSM measures inputs and supporting substantiation documents, estimating conservation potential, and characterizing market barriers and intervention opportunities.

Conservation Fund Investment Strategies: Independent Electricity System Operator (January 2016-May 2016). Posterity Group was retained by the Independent Electricity System Operator (IESO) to study the potential impact of investing Conservation Fund resources in a variety of technologies in the building envelope and glazing sectors. Involving research on secondary materials as well as interviews with key market actors, each report synthesized how the various available technologies conserve energy, assessed the current market structure and existing penetration, and analyzed the likelihood of each technology making a significant impact in the near term. Chris acted as Project Director for this assignment.

RETScreen Expert Measure Costing: Natural Resources Canada (October 2015 – January 2016). As part of a team led by TdS Dixon, Posterity Group helped NRCan to review and quantify base and upgrade equipment and installation costs for a variety of energy efficiency measures. This project was undertaken to support the development of RETScreen Expert, specifically the development of a set of comprehensive facility archetypes for the Ontario market. Chris oversaw project efforts and undertook scoping and costing for several measures.

High Efficiency Natural Gas Laundry Dryers Pre-feasibility Study: FortisBC (June 2014-December 2014). As lead analyst and project manager, Chris developed methodologies to assess high efficiency laundry drying equipment as a potential DSM measure. He undertook interviews and secondary research, including interviewing researchers and performing patent searches to characterize emerging technologies, and is led modelling activities to estimate conservation potential within FortisBC's residential and commercial customer base.

Combination Units Pre-feasibility Study: FortisBC (December 2013-May 2014). As lead analyst and project manager, Chris developed methodologies to assess combination space and water heating equipment as a potential DSM measure, undertook interviews and secondary research to characterize the BC market and supply chain for combination units, and led modelling activities to estimate conservation potential within FortisBC's residential customer base. Chris' tasks included in-depth modelling of natural gas savings potential for numerous baseline and upgrade scenarios including end-of-life and early replacement, new construction and retrofit applications, and across various service regions.

Energy Saving Potential Using Occupancy Based Controls: CEATI International (December 2011-June 2012). As project manager, Chris developed methodologies for the estimation of energy consumption which may be affected by the increased uptake of occupancy-based controls within the service territory of several Canadian electric and natural gas utilities. He also developed base case profiles, upgrade scenarios and modelled the electricity and natural gas savings potential for occupancy-based controls in lighting and HVAC applications.

Characterization of the Solid-State Lighting Industry in Canada: Natural Resources Canada Office of Energy Efficiency (January 2012-August 2012). Chris led research and analysis for this study of the LED lighting market in Canada. Tasks included identifying market actors, designing and deploying data collection tools, performing interviews with senior management in a number of Canadian firms involved in the SSL industry and building projections of future sales and revenue and reporting results to both the client and industry stakeholders.

High Efficiency Commercial Washing Machine Potential Study: Union Gas (August 2010-August 2011). As project manager, Chris developed methodologies for the estimation of energy and water consumption by commercial clothes washers within the Union Gas service territory and developed base case profiles, upgrade scenarios and modelled of the electricity, water and natural gas savings potential of high efficiency commercial clothes washers.

### *Energy Efficiency Program Design, Administration and Support*

Assessment of Additional Energy Savings from DSM Measures: FortisBC (June 2021-September 2021). Calculating the impact of building level energy and emissions reductions can be subjective. At a project level, the value can be subject the baseline, early replacement considerations, calculation methodology, spillover attributions, and free ridership attributions. The subjectivity of these factors ultimately impacts the way the FortisBC can communicate the impact of their DSM program as part of their emissions reductions efforts and tracking for their 30 By 30 targets. To assist FortisBC, Posterity Group is investigating FortisBC's current DSM programs, the provincial CleanBC Funds, and other DSM jurisdictions for new methodologies and best practices on building level emissions reductions calculations. Chris is acting as Project Director.

Residential Prescriptive Program Research: Enbridge Gas Inc. (May 2021-November 2021). Posterity Group provided Enbridge with technical and market information to support the development of prescriptive and quasi-prescriptive insulation measures for inclusion in the Ontario Technical Resource Manual. Measures were developed based on an analysis of baseline and upgrade states included in over 2000 custom program applications and associated HOT2000 models, and independent cost analysis. Measures developed included various attic insulation, wall insulation, foundation insulation, floor header insulation and exposed floor insulation. Chris acted as Project Director.

Community Buildings Retrofit Program Support: Federation of Canadian Municipalities (FCM) (March 2021-May 2021). Posterity Group supported FCM ahead of the launch of their new Community Buildings Retrofit Support program by assessing training and support tools available to municipal practitioners and identifying and assessing potential partners to support program rollout. Special focus was placed on tools, training, and partners to support small and medium municipalities, including those that would integrate with current provincial or utility initiatives. Chris acted as Project Director.

Sustainable Affordable Housing Innovation Program Development: Federation of Canadian Municipalities (FCM) (October 2019-March 2020). As a sub consultant to Dunsky Energy Consulting, Posterity Group supported the development of this program to provide funding and capacity building to municipal and non-municipal organizations in support of energy-efficient affordable housing. The new program's goal was to catalyze action through both innovation and replication. The program was scheduled for implementation in Spring 2020. Posterity Group supported the research and design tasks to support the program definition report, including conducting literature review and data collection and developing modelling tools to assess potential program impact. Chris is acting as the Posterity Group Project Director.

District Energy System GHG Accounting and Reporting: Public Services and Procurement Canada (September 2019-March 2020). Stratos, in partnership with Posterity Group, is supporting Public Services and Procurement Canada to develop a greenhouse gas accounting and reporting guidance document for their Energy Services Acquisition Program (ESAP). One of ESAP's main objectives is to reduce the GHG intensity of the district energy system currently serving a portfolio of buildings in the national capital region. As GHG reductions are a key metric for ESAP to measure and report on, Stratos and Posterity Group are helping to design corporate- and project-level GHG accounting and reporting methodologies that align with existing federal policies on GHG accounting and reporting requirements. Chris is acting as Senior Technical Advisor.

Housing Technology and Assessment Platform (HTAP) Development and Training: Nova Scotia Department of Energy and Mines (March 2019-September 2019). The Nova Scotia Department of Energy and Mines is leveraging Posterity Group's knowledge of HTAP to develop tools and training to assess the energy and cost impacts of different bundles of energy measures for typical housing architypes in Nova Scotia, including energy efficiency measures, heating system fuel switching and solar PV installation.

Posterity Group developed a Nova Scotia-specific version of HTAP, developed a master data set of energy impact and costing data for several dozen measures, and developed and delivered a two-day training course for staff from the Department and other organizations. Chris acted as Project Director and delivering training sessions.

Development of GHG Inventory and Lifecycle Analysis Tools – Canadian Mortgage and Housing Corporation (Phase 1: November 2018-March 2019, Phase 2: June 2019-October 2019). CMHC reached out to Posterity Group to scope and develop two tools: an energy and GHG assessment and inventory tool that will allow CMHC to track and assess the energy and GHG impacts of National Housing Strategy – funded projects and a lifecycle assessment tool that will allow builders to evaluate the Net Present Value and lifecycle costs of energy efficiency in their affordable housing projects.

In Phase 1, completed by Posterity Group in Q1 2019, PG designed the two products and developed the scope of work. Phase 2 involved the software development, testing and deployment of the two tools. Chris acted as Project Director and Technical Advisor.

Commercial and Industrial Prescriptive Measure Development: FortisBC (October 2018-March 2019). Posterity Group worked with FortisBC to further develop and optimize energy saving measures under the Commercial and Industrial Product Rebate Program (PRP). This assignment built on Posterity Group's understanding of FortisBC's customer base to develop measure characterizations for proposed products and determine product-specific considerations that should be included in PRP. Tasks included interviewing market actors, reviewing program assumptions in other jurisdictions, conducting secondary research, and developing detailed program parameters and business case inputs for prescriptive demand side management rebates in both retrofit and new construction applications. Chris acted as Project Director and Technical Advisor.

FortisBC Ad-Hoc Measure Update: FortisBC (November 2018-May 2019). Posterity Group is pleased to provide our expertise to FortisBC to further provide expert consulting services to review and update measures on an ad-hoc and as required basis. The project team will help FortisBC to explore the merits of various measure ideas or questions, and where appropriate, undertake the research that may be required to appropriately substantiate a proposed changed to any given measure or incentive. The following have been examined: Air curtain operating hours; steam trap survey parameters, eligibility and incentive levels; appropriate heating load assumptions for insulation measures; Industrial unit heater applications; incoming codes and standards for air curtains, unit heaters and insulation; Infrared heater applications and operating assumptions for poultry barns. Chris acted as Project Director and Technical Advisor.

Development of Prescriptive Incentives – Commercial New Construction Non-Lighting; Industrial Gas Retrofit: FortisBC Energy and FortisBC Inc. (April 2017-November 2017). Posterity Group updated FortisBC Inc.'s (Fortis electric) commercial prescriptive non-lighting retrofit measures, and expanded the list to include new construction measures. Posterity Group also developed a list of prescriptive natural gas retrofit measures for FortisBC Energy's (Fortis gas) industrial customers. FortisBC wanted its measure lists to be comprehensive, contemporary, and applicable to a wide range of end-uses. The primary work plan tasks were to research and identify potential commercial and industrial measures for discussion with FortisBC, and to develop inputs and assumptions (i.e., energy and demand savings, cost, rebate level, TRC and PAC) for the measures FortisBC wanted to add to its commercial and industrial programs. Chris acted as Expert Advisor, supporting the development of several measures.

Development of Prescriptive New Construction & Retrofit Lighting Incentives: FortisBC Electric (February 2017-April 2017). Posterity Group helped FortisBC develop a prescriptive lighting offering that covered both retrofit and new construction projects. The project's primary tasks included a jurisdictional scan to evaluate the applicability prescriptive lighting programs and measures offered by other utilities, and the development of input assumptions and eligibility criteria for each measure. Posterity Group contacted local lighting distributors and mined existing FortisBC program data to create region-specific cost assumptions.

HPNC Program Refinements: Independent Electricity Service Operator (May 2015-June 2015, September 2016-October 2016, February 2017-September 2017). Over three successive contracts, Posterity Group developed tools to allocate saveONenergy High Performance New Construction (HPNC) Program incentives based on improvement over code; updated these tools to reflect changing Measurement & Verification requirements, and updated program tools to reflect changes to Ontario Building Code baselines. Chris acted as project manager and lead analyst.

Upstream Program Development Support: Enbridge Gas Distribution (June 2016-January 2017). Enbridge Gas relied on Posterity Group to provide strategic guidance on how and where employing an upstream

program approach may improve the effectiveness of its commercial program offerings. Posterity Group evaluated candidate measures regarding their suitability for an upstream program delivery approach in consultation with EGD staff; and characterized the Ontario market for two selected measures in order to determine market size, market structure, barriers to increased uptake, market actor support for an upstream delivery approach, and consistency with EGD's overarching DSM strategy. Chris developed the methodological approach for this assignment and provided modelling advice and strategic market characterization input.

Upstream Commercial Program Design: Independent Electricity System Operator (September 2015-February 2016). A working group of Local Distribution Companies in Ontario (Toronto Hydro, Hydro One, Horizon Utilities, and Entregrus) contracted Posterity Group through the IESO to undertake three upstream program designs for the commercial sector. As support for these designs, Chris led market characterization activities in three technology areas, compressed-air, unitary packaged air conditioning units (rooftop units), and variable frequency drives. The methodology for the detailed market characterization of each technology area, included a literature review, program administrator interviews, and market actor interviews to determine barriers that an upstream program approach could overcome. The market characterization informed the program design phase which undertook to establish the proper intervention point for the program in the supply chain, to establish technology eligibility and program economics.

Commercial Sector DSM Program Design: Yukon Energy / Yukon Electrical Company (January 2012-May 2012). Following a successful engagement as commercial sector lead for Yukon Energy and Yukon Electrical Company's Conservation Potential study, Chris was engaged to assist the design of demand side management programs for the Territory through analysis of study outputs.

Design of an Energy Efficiency Lending Program: Confidential Client (June 2012-September 2012). Chris contributed to the design of an energy efficiency lending program on behalf of a major Canadian financial Institution, quantifying energy savings and subsequent cost savings in a number of building sectors within the client's portfolio of commercial borrowers. The program provided more favorable lending terms to commercial clients who undertook energy retrofits based on their increased ability to service debt.

Commercial Sector DSM Program Design: SaskPower (July 2011-February 2012). Following a successful engagement as commercial sector lead for SaskPower's Conservation Potential study, Chris was engaged to assist the design of SaskPower's commercial sector demand side management programs. Chris led the market characterization portion of this project, designing data collection tools, interviewed various market actors and identified market trends and failures. He also assisted in program forecasting through analysis of Conservation Potential study outputs.

Energy Retrofit Incentive Program: Various Ontario Electricity Local Distribution Companies (September 2010-February 2011). Chris was a technical reviewer of incentive applications to the Energy Retrofit Incentive Program for lighting, air conditioning, agricultural and alternative energy equipment

High Performance New Construction Program: Enbridge Gas Distribution (September 2010-February 2011). Chris was a technical reviewer of incentive applications to the High Performance New Construction Program for lighting, air conditioning, agricultural and alternative energy equipment

*Strategic Planning for Energy Management*

Review of Building Energy Mapping Applications: Natural Resources Canada Buildings and Renewables, CanmetENERGY Ottawa (February 2021-April 2021). As a follow up to our 2020 examination, Posterity Group supported CanmetENERGY's Canadian Energy End-Use (CEE) Mapping project by completing a comprehensive

review of ten additional spatial building and energy models to identify priority features for consideration in the initial CEE map prototype and future iterations. Chris is acted as Project Director.

DSM Planning Support: Enbridge Gas Inc. (January 2021-January 2022). In 2019 and 2020, Posterity Group worked with EGI to develop a Navigator end-use energy model to support DSM planning. The model aligns closely to the Ontario Energy Board's 2019 Achievable Potential Study but includes adjustments that better reflect Enbridge's input and experience, and to correct for identified limitations. Model outputs are housed within Power BI to provide an interactive means to support future EGI planning efforts. In 2021, Posterity Group is working with EGI to update and enhance the end-use model dataset to support its next multi-year DSM plan submission. Priorities include: Developing evidence to position the APS in a context that more accurately reflects EGI's knowledge and experience; Making further adjustments to the APS dataset to address deficiencies and enable sensitivity analysis; and Interrogatory and Witness Support. Chris is acting as Expert Advisor.

Comparative Evaluation of Spatial Building Stock and Energy Models: Natural Resources Canada Buildings and Renewables, CanmetENERGY Ottawa (November 2019-January 2020). CanmetENERGY is undertaking the Canadian Energy End-Use (CEE) Mapping project to develop a prototype of a residential energy use and efficiency opportunities map in the 2019-2020 fiscal year. The long-term plan for the CEE mapping project is to create an online, open, and authoritative spatial mapping platform to support housing energy end-use characterization and enable non-building science professionals to identify efficiency opportunities. Posterity Group will complete a comprehensive review of ten spatial building and energy models to identify priority features for consideration in the initial CEE map prototype and future iterations. Chris is acting as Project Director and Advisor.

Analysis of Funding Programs to Support Market Transformation: Natural Resources Canada (NRCan) (June 2019-September 2019). Posterity Group was retained by NRCan to identify federal, provincial and territorial funding programs that could support initiatives to promote the uptake of high efficiency equipment. This project supports the implementation of the "*Paving the Road to 2030 and Beyond: Market transformation roadmap for energy efficient equipment in the building sector*" plan which has 44 high-priority initiatives to overcome barriers to market adoption for high efficiency residential windows, space heating equipment and water heating equipment. This assignment involved researching and describing available funding sources which could support priority initiatives and identifying gaps in funding related to the priority initiatives. Chris acted as Project Director.

High-Efficiency Buildings: Case Studies: NRCan Office of Energy Research and Development (February 2019-June 2019). NRCan's Office of Energy Research and Development engaged Posterity Group to undertake literature review, interviews, and technical case-study development for the purpose of gathering information about high efficiency buildings in Canada and to better quantify the costs, energy usage, and ensuing greenhouse gas emissions of high efficiency buildings. This work combined two of Posterity Group's core competencies: The assessment of markets for energy efficient and low carbon technologies and services; and technical assessment of energy performance in the built environment. Our team developed an inventory of high performing Canadian buildings, undertook market research and interviews with leading builders and developers, assessed and developed building energy simulation models and Class D estimates of incremental costing for high performance buildings, and developed a series of case studies covering both technical and market-related aspects of high-performance building development. Chris acted as project director, with responsibility for methodological oversight, quality control and guidance.

Natural Gas Demand Scenarios: FortisBC (July 2017-December 2017). Posterity Group provided demand scenario analysis to support FortisBC demand forecasting. This work involved analysis of six scenarios that build on the core end-use forecast completed in June 2017. The project results are helping FortisBC to assess the impact of various

policies, including the City of Vancouver zero emissions plan and the BC Step Code. As part of this work, Posterity Group added features to the processing software at the heart of the forecasting model, allowing users to dynamically select the municipalities that are expected to opt into new energy efficiency requirements. Chris acted as Project Director and commercial sector advisor, providing scope, methodology and technical advice and direction.

Long Term Resource Plan Model and Forecast: FortisBC (October 2016-June 2017). FortisBC turned to Posterity Group to develop a new end-use forecasting model to enhance their current end-use resource forecasting approach, and to generate a new 2017 forecast. The project entailed building an entirely new modelling platform that applies an innovative approach to generating transparent data input files and results in faster more reliable operation. The forecasting project work incorporated multiple data sources including as end-use surveys, customer energy use data, price and commodity forecasts. It also estimated and integrated expected impacts of various policy drivers, including anticipated federal, provincial and municipal codes and standards, various potential carbon pricing regimes; and the potential impacts of increased efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and/or district energy availability. Chris acted as Commercial Sector lead and Project Director for this assignment.

Study of Federal Programming Strategies to Achieve Energy Savings: Natural Resources Canada (December 2016-July 2017). NRCan's Assistant Deputy Ministers of the Office of Energy Efficiency (OEE) and Innovative Energy Technology Services (IETS) needed to explore an approach to planning and prioritizing national energy efficiency programming and research investments that leverages lessons learned from "Ecosystem" approach that the US Department of Energy's Buildings Technology Office (BTO) has deployed, which allows for greater coordination of activities, leveraging of respective outcomes, and more efficient use of resources. Posterity Group assisted NRCan to develop a comprehensive, data-driven approach to energy efficiency programming focused on the built environment and informed by the experience of the BTO. With our US partners, we conducted both primary and secondary research in order to provide NRCan with recommendations on how best to design, deliver, and coordinate federal energy efficiency programming and R&D investments that similar to the approach taken by the U.S. This study also equipped NRCan with the tools necessary to adapt its existing programs to maximize their positive impacts on the energy efficiency of the built environment. Chris acted as a Senior Advisor for the modelling and tracking of market indicators.

Energy & GHG Management and Planning Services: Various Ontario Municipalities & Communities (December 2012-Present). Chris has supported several medium and small municipalities and communities to manage energy more effectively. His projects have involved the acquisition and analysis of utility data; assessment of utility incentive applicability; development of energy/emissions inventories and management plans at both the corporate and community levels; facility and portfolio-level energy benchmarking; and technical support and analysis for energy management projects and procurement. Assignments have included substantial consultation with municipal staff and stakeholders. Recent clients include the City of Clarence-Rockland, Township of Addington Highlands, Town of Gananoque, Township of North Glengarry, the United Counties of Prescott and Russell, Town of Hawkesbury, the Aboriginal Community of Nibinamik, and the City of Stratford.

Development of Major Energy Retrofit Guidelines (II): Natural Resources Canada (May 2015-March 2016). Following a first successful engagement, Posterity Group, in partnership with Arborus Consulting and TdS Dixon, developed additional guidelines for the Office of Energy Efficiency's Buildings Division to support building sector initiatives, including the National Energy Code of Canada for Buildings and ENERGY STAR Portfolio Manager. The guidelines target decision makers in small to medium-sized commercial and institutional facilities and outline an approach to identifying and undertaking major retrofits. This assignment included three building – specific modules which present opportunities unique to hotels, supermarkets, and restaurants/food stores.

Development of Major Energy Retrofit Guidelines (I): Natural Resources Canada (February 2014-March 2015). Posterity Group, in partnership with Arborus Consulting and TdS Dixon, developed guidelines for the Office of Energy Efficiency's Buildings Division to support building sector initiatives, including the National Energy Code of Canada for Buildings and ENERGY STAR Portfolio Manager. The guidelines target decision makers in small to medium-sized commercial and institutional facilities and outline an approach to identifying and undertaking major retrofits. They include four building –specific companion modules which present opportunities unique to office buildings, K-12 schools, hospitals and non-food retail facilities.

Development of an Energy Management Best Practices Guide: Natural Resources Canada (January 2013-July 2013). Chris supported the development of an Energy Management Best Practices Guide and updated the Office of Energy Efficiency Building Division's Energy Management Action Plan. This project's major task was to develop a document that incorporated information from several sources into a clear, concise document suitable for an audience with varying levels of technical knowledge.

*Energy Efficiency and GHG Mitigation Potential Assessment*

Conservation Potential Study: Pacific Northern Gas (August 2021-November 2021). Posterity Group is developing a Conservation Potential Review study for Pacific Northern Gas. This analysis will build on resource planning and conservation potential work Posterity Group has recently completed in BC, including FortisBC's 2021 CPR. It will support adjustments to PNG's current portfolio of DSM programs and PNG's 2023 DSM Plan and Resource Plan filing. Chris is acting as Project Director and Commercial Advisor.

2022 Long Term Gas Resource Plan Demand Forecast and Resource Planning: FortisBC Energy Inc. (February 2020-July 2021). Following a successful engagement in 2017, FortisBC again engaged Posterity Group to generate a natural gas end-use forecast in support of their 2022 Long Term Gas Resource Plan filing. The analysis uses baseline end-use energy intensities for over 40 customer segments across 5 provincial regions developed by Posterity Group through the 2021 Conservation Potential Review. Forecasting analysis incorporates multiple data sources including customer end-use surveys, customer energy use data, and price and commodity forecasts. In addition to the reference case forecast, Posterity Group will conduct scenario analysis that estimates the impact on gas demand from a number of policy drivers including anticipated federal, provincial and municipal codes and standards, carbon pricing, efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and availability of district energy. Chris is acting as Project Director.

2021 Conservation Potential Review FortisBC Energy Inc (December 2019-Ongoing). FortisBC has entrusted its 2021 Conservation Potential Review Study (CPR) to Posterity Group. The CPR will support two of FortisBC's major regulatory filings in 2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group will estimate BC's technical, economic and market potential savings over a 20-year period for natural gas using its Navigator™ Energy and Emissions Simulations Suite, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group will complete FortisBC's 2022 LTGRP in parallel with the CPR. Chris is acting as Commercial Sector lead, with additional responsibility for overall methodology and project coordination.

Energy Management Best Practices for Cannabis Greenhouses and Warehouses: CEATI International Inc. (November 2019-May 2020). Posterity Group, in partnership with Cultivate Energy Optimization and D+R International, will assess and document best practices of energy management for cannabis production in both greenhouse and warehouse facilities. The study will develop a five-year forecast of energy use in three regions

(Ontario, British Columbia and the Pacific Northwest) for the sector and assess energy saving opportunities. The outcome of this work will form an important base of industry knowledge and bridge the gap to provide up to date and comprehensive information regarding energy use in cannabis facilities, from which future conservation activities might be developed. Chris is acting as Advisor.

Resource and DSM Planning: Enbridge Gas (July 2019-October 2019). Enbridge Gas requires Achievable Potential Study (APS) and Integrated Resources Planning (IRP) support as part of their ongoing planning and DSM activities. Posterity Group will provide support in these two related areas using their Navigator™ Energy and Emissions Simulation Suite, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. Posterity Group will help Enbridge understand outputs from their 2019 achievable potential study, identify limitations in the underlying dataset, and leverage outputs in support of their submission to the OEB for the next DSM framework. The scope of IRP support will include a defensible method and analysis tool to forecast consumption, demand, and carbon emissions within a defined control zone over a range of scenarios. Chris acted as Advisor.

Review of Natural Gas Achievable Potential Study Scenarios: Ontario Energy Board (April 2019-August 2019). Posterity Group supported the OEB by reviewing detailed natural gas savings potential outputs from Ontario's 2019 Achievable Potential Study, and providing interpretation and analysis based on our knowledge of the Ontario market. Analysis included reviewing base year disaggregation, reference forecast, technical potential, economic potential, and achievable potential workbooks. Chris acted as project manager with responsibility for review and advice on work products.

Market Characterization and Conservation Potential for Ontario's Drinking Water and Waste Water Treatment Plants: Independent Electricity System Operator (May 2018-December 2018).

Market Characterization and Conservation Potential for Ontario First Nation Communities' Drinking Water and Waste Water Treatment Plants: Independent Electricity System Operator (August 2018-January 2019).

Posterity Group conducted a study of the study of the potential for energy efficiency and cogeneration in drinking water treatment plans (DWTP) and wastewater treatment plants (WWTP), including a series of case studies on successful energy and GHG management activities in the sector. The study ultimately provided IESO and municipal stakeholders with recommendations for plant efficiency, increased integration of distributed energy resources, and estimates of Province-wide energy and GHG savings potential. This study was conducted concurrently with a project focused on similar equipment within Ontario Indigenous Communities. In this companion project, case study work also focused on training and capacity development. Chris acted as Project Director for both studies.

Low Carbon Heating Options for Ontario: Ontario Ministry of the Environment and Climate Change (November 2017-June 2018). Posterity Group helped the Ontario Ministry of the Environment and Climate Change to identify and study the GHG reduction impact potential of low carbon space, water and process heating technologies and fuels in Ontario's residential, commercial and industrial sectors. The project was completed under four main activities: Development of energy and GHG Inventory and accompanying business as usual forecast for Ontario's thermal end-uses by fuel, sector/subsector, and end use; Development of a long list of fuels and technologies with abatement potential, and an evaluation matrix to build a short list of the 10 preferred, most promising technologies and fuels for detailed analysis; Detailed analysis of the short list of fuels and technologies to understand their current market structure, barriers, and applicability; and, development of illustrative deployment scenarios to estimate the potential impacts of the shortlisted fuels. This project was completed with input from stakeholders in six additional ministries. Chris acted as Project Director, with lead responsibility for technology assessment.

Demand Response Potential Assessment: Hydro Ottawa (December 2011-March 2012, with ICF Marbek). Chris led this study to identify potential targets for demand response programming among Hydro Ottawa's customer base.

Chris developed a methodological framework to determine customers with high potential by examining yearly load profiles, installed generation capacity, typical opportunity size based on building type and overall energy consumption, and willingness to participate based on operational and management structure.

Electricity Conservation Potential Review: SaskPower (March 2010-May 2011). Chris led commercial/institutional sector analysis for this project. In this role, he was responsible for technical analysis, including quantitatively integrating workshop results as part of the broader analysis of achievable conservation potential. Chris also designed and led workshop discussions with a variety of stakeholders centered on realistically achievable levels of energy conservation within Saskatchewan's commercial sector.

Conservation Potential Review: Yukon Energy Corporation/ Yukon Electrical Company Ltd. / Yukon Government (March 2011-January 2012). As lead for commercial/institutional sector analysis, Chris was responsible for technical analysis including "business as usual" reference case scenarios, evaluating the financial and energy impact of various measures, and determining the potential for electricity conservation within the Territory's Commercial/ institutional sector. Chris also developed and led workshop discussions with a variety of stakeholders centered on determining realistically achievable levels of electricity conservation within the Territory.

Conservation Potential Review: FortisBC (May 2010-March 2011). Chris led commercial sector analysis for this project. In this role, he developed "business as usual" reference case scenarios and modeled the impact of energy efficiency measures in the FortisBC commercial sector; and led workshop discussions with a variety of stakeholders centered on realistically achievable levels of energy conservation within BC's commercial sector.

Conservation Potential Review and 20 Year Load Forecast: Ontario Power Authority (September 2009-April 2010). Chris led commercial/institutional sector analysis for this project. In this role, he developed "business as usual" reference case scenarios and modeled the impact of energy efficiency measures in Ontario's commercial/institutional sector. He also evaluated costs and benefits of dozens of specific energy management activities.

2009 New Brunswick Integrated Resource Plan: NB Power (April 2009-November 2009). Chris led commercial sector analysis for this project. In this role, he evaluated costs and benefits of specific energy efficient technologies in the commercial sector. He also assisted and advised NB Power staff to estimate savings potential and theoretical program cost and participation rates.

Natural Gas Energy Efficiency Potential: Union Gas and Enbridge Gas Distribution (May 2008-March 2009). Chris led commercial/institutional sector analysis for these two concurrent projects. In this role, he developed "business as usual" reference case scenarios and modeled the impact of natural gas efficiency measures within Union Gas & Enbridge's commercial, institutional and multi-unit residential market. He also evaluated costs and benefits of specific energy efficient technologies and analyzed the impact of GHG pricing on conservation activities.

Conservation and Demand Management Potential Newfoundland and Labrador: Newfoundland & Labrador Hydro and Newfoundland Power (May 2007-April 2008). Chris led commercial sector analysis for this project. In this role, he evaluated costs and benefits of specific energy efficient technologies in the commercial sector and modelled the impact of energy efficiency and operations & maintenance measures in Newfoundland and Labrador's commercial electricity sector.

Conservation Potential Review Update: BC Hydro (March 2007- November 2007). Chris's role in this project was to Model the impact of energy efficiency, operations & maintenance and fuel switching measures in British Columbia's commercial electricity sector.

*Transportation Energy Efficiency Technology and Market Research*

Environmental and Health Impacts of Small Gasoline Powered versus Electric Powered Mobile Outdoor Equipment in Canada: Environment and Climate Change Canada (February 2021-May 2021). As part of the transformation to a low-carbon economy, the Government of Canada has committed to reduce emissions from off-road engines, potentially including small spark-ignition engines. Posterity group was retained to identify the potential benefits of electrifying outdoor power equipment such as lawnmowers, leaf blowers, chainsaws, small generators, and more. The project has two major focusses: Establishing a clear understanding of the environmental and health benefits of electrification from a number of perspectives including: GHG and air pollutant emissions, noise, air quality, health impacts to the public and to the user; and comparing both the performance and price between similar gasoline powered and electric powered equipment. Chris acted as Expert Advisor.

Survey of Fuel-saving Measures in Heavy-Duty Vehicles: Transport Canada (December 2017-March 2018). Under the *Pan-Canadian Framework on Clean Growth and Climate Change*, Transport Canada has the responsibility to develop and implement new requirements for heavy-duty trucks to install fuel-saving devices. In support of this responsibility, Posterity Group developed a methodology to survey of the use of fuel-saving measures in Class 8 heavy duty vehicles across Canada, executed the field survey in seven locations across the country, and analyzed the resulting data. The outcomes of this work will act as a baseline from which to measure the effects of future fuel efficiency requirements. Chris acted as Project Director for this assignment, with lead responsibility for study design, field sampling quality assurance, and reporting/analysis quality control.

Study to Assess the Level of Usage of EnerGuide Label for Vehicles and the Accuracy of Label Values: Natural Resources Canada - Office of Energy Efficiency (December 2012-March 2013; October 2014-March 2015; January 2016-March 2016; September 2016-February 2017). NRCan and the vehicle industry developed a voluntary program in 1998 to affix a standardized EnerGuide fuel consumption label to all new light-duty vehicles for retail sale in Canada. Under four separate assignments, Posterity Group supported the evaluation of this program and gathered supplementary data important to NRCan's Office of Energy Efficiency. Major tasks included: Assembly of a statistically representative sample of new car dealerships across five regions in Canada; Conducting site visits at the sampled dealerships to determine the availability of plug-in hybrid electric (PHE) and battery electric (BE) vehicles available for test driving, and to assess the proportion of new vehicles with updated 2017 EnerGuide label information; and analyze and report on the resulting data, to summarize findings about the availability of PHE and BE vehicles and label accuracy/usage rates. In early studies, Chris acted Project Manager and Field Staff. In later studies, as Project Director. In all cases, he had lead responsibility for study design, field sampling quality assurance, and reporting/analysis quality control.

Vehicle Technology, Transportation Energy-use and Electric Vehicle Information Scan for ecoENERGY Efficiency for Vehicles: Natural Resources Canada (February 2016-May 2016). Posterity Group leveraged our in-depth understanding of the ecoENERGY Efficiency for Vehicles program and experience in conducting jurisdictional reviews, energy-focused market studies, and environmental scans to help NRCan evaluate the information it provides to the public in support of its transportation-sector market transformation activities. This assignment focused on ensuring that the ecoENERGY Efficiency for Vehicles program is offering Canadians up to date and relevant information regarding low-carbon vehicle technologies, including electric vehicles, alternative-fueled vehicles, and efficient internal-combustion engine vehicle technologies. Major tasks included a review of "vehicles and energy", electric vehicle, and manufacturer websites to identify issues, content and technologies in to enhance the information communicated by NRCan to Canadians. Chris acted as Project Manager and lead consultant.

## EDUCATION

B.Sc. (Biology, Concentration in Ecology), University of Ottawa – Ottawa, Ontario, Canada, 2006

B. Eng. (Mechanical), Carleton University – Ottawa, Ontario, Canada, 2003

## CERTIFICATIONS

Professional Engineer (Ontario)

## PROFESSIONAL AFFILIATIONS

Professional Engineers Ontario

Association of Energy Service Professionals

Association of Energy Engineers (Senior Member)

## EMPLOYMENT HISTORY

| | | |
|---|---|---|
| Posterity Group | Principal | 2012 - present |
| ICF Marbek | Consultant | 2011 - 2012 |
| Marbek Resource Consultants | Consultant | 2007 - 2011 |
| One Change/Project Porchlight | Field Representative | 2006 - 2007 |

# Talha Mirza, PMP

## Consultant

### EXPERIENCE OVERVIEW

Talha is a Certified Project Management Professional with over 12 years of experience developing, managing, and consulting on renewable energy and energy efficiency projects. As a consultant with Posterity Group, Talha helps governments, utilities, and private sector clients understand and resolve their energy and emissions issues. His expertise includes technical and commercial due-diligence, market intelligence, energy management, and low-carbon policy development.

Prior to joining Posterity Group, Talha led project development teams in designing and building solar energy projects worth over $15 million. He also advised utility companies, government agencies, property owners, and engineering firms on solar technologies and led his company's consulting and advisory practice.

Talha holds a Bachelor of Science degree in Electrical Engineering from Texas A&M University.

### SELECT PROJECT EXPERIENCE

#### *Consulting and Advisory Engagements*

2021 Conservation Potential Review: FortisBC Energy Inc. (January 2020 – May 2021). FortisBC has entrusted its 2021 Conservation Potential Review Study (CPR) to Posterity Group. The CPR will support two of FortisBC's major regulatory filings in 2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group will estimate BC's technical, economic and market potential savings over a 20-year period for natural gas using its Navigator Energy and Emissions Simulations Suite™, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group has proposed a transparent, well-documented approach to develop the CPR and will facilitate the engagement of internal and external stakeholders. Posterity Group will complete FortisBC's 2022 LTGRP in parallel with the CPR, which will ensure smooth handoffs and technical consistency across the projects. Talha is the Project Manager for the CPR and the Residential Program Analyst.

Prescriptive Lighting Measure Review: Ontario IESO (April 2020 – July 2020). Posterity Group conducted a study to update the IESO's prescriptive lighting technology list to reflect current regional incremental costs and cover technologies that accurately reflect Ontario's lighting market baseline. As part of the project, Posterity Group also updated the IESO's incentive setting strategy to ensure that incentives continue to be used cost-effectively to address the achievable potential in Ontario's non-residential lighting market. Talha was responsible for project management.

Smart Water Heater Controllers Prefeasibility Study: FortisBC (April 2020-July 2020). Posterity Group conducted a prefeasibility study to assess the technical and market opportunities for smart residential water heater controllers. FortisBC was interested in finding out the technology's potential energy savings, demand response, and non-energy benefits. Posterity Group conducted literature reviews,

jurisdictional scans, interviews with market actors to gather market and technical information. The information was then used to develop technical resource manuals, scenario analysis, and energy saving models. Talha was the Project Manager and the Lead Analyst in this project.

Prefeasibility Study and M&V Best Practices: Gas Heat Pumps and Dual-Fuel Heat Pumps: Con Edison via CEATI International Inc. (May 2020 – December 2020). Posterity Group is conducting a technical, economic and market potential study for natural gas heat pumps (GHP) and dual-fuel heat pumps (Dual-Fuel HP) in Con Edison's and Orange and Rockland's residential, multi-family and commercial sectors for both retrofit and new construction applications. Technologies will be compared to two reference cases: electric air source heat pumps, and most efficient in-kind replacement. Phase 2 of the project involves developing Measurement and Verification (M&V) best practices for natural gas heat pumps technologies. Talha is the Project Manager and is also providing support on research activities.

Sustainable Affordable Housing Innovation Program Development: Federation of Canadian Municipalities (October 2019-March 2020). The project involved developing a program that provides funding and capacity building to municipal and non-municipal organizations to support the construction of energy-efficient affordable housing. The new program's goal is to catalyze action through both innovation and replication. Talha supported the client, FCM, and the main consultant, Dunsky Energy Consulting, on the research and design tasks to support the program definition report and on developing a tool to model the program impacts.

Building Energy Benchmarking Program: City of Edmonton (April 2019-April 2020). Talha is the lead technical resource for the City of Edmonton's building energy reporting pilot program. Talha is responsible for developing technical resources for program participants, administering the program's Benchmarking Support Services, analyzing data submissions, and reporting on program outcomes.

Conservation and Demand Management (CDM) Plans (May 2019-June 2019). Talha supported several municipalities – Town of Oakville, Counties of Prescott-Russell, and Township of Addington Highlands – in updating their 5-year CDM plans. Talha identified the municipalities' current energy management practices, gaps, goals and objectives - and developed relevant action plans.

Food Services Challenge: IESO / Restaurants Canada (July 2018-April 2020). Talha led project management as well as the consulting responsibilities in this program which included stakeholders from Restaurants Canada, IESO, and NRCan; it involved energy audits and energy efficiency capability development, training, and M&V in restaurants, commercial kitchens, and other food service organizations in Ontario.

Evaluation of Industrial Optimization Program: FortisBC (September 2018-April 2019). Talha was the project manager and lead analyst on this project that evaluated the utility's Industrial Optimization Program by obtaining program feedback from participants, verifying program-enabled savings, free ridership, spillover, and analyzing program requirements.

Retrofit Program Technical Reviews: IESO (August 2019-January 2020). Posterity Group, in association with Nexant, is providing technical review services for custom applications to the IESO's retrofit program. Talha is the technical reviewer for the applications and is responsible for technical due diligence on energy savings calculations and methodology.

Connected Home Prefeasibility Studies: FortisBC (February 2018-August 2018 and February 2021 - Present). Talha led the project management as well as the advisory duties in this project which involved market, technology, and savings assessment of various Smart Home technologies and exploring pilot program options for the residential sector in BC.

Campus Sustainability Plan: La Cité College (April 2018-July 2018). Talha led the development of a campus sustainability plan for the La Cité Collégiale in Ottawa. The project involved baseline assessments and recommending organizational and capital initiatives that can support the institution achieve carbon neutrality by 2030.

Oakville Energy Policy (December 2018-March 2019). Talha supported the development of an energy policy for the Town of Oakville which included developing an outline, conducting gap analysis to identify further research areas, data analysis, stakeholder interviews, and a review of best practices from other municipalities.

Nibinamik First Nations Community Energy Plan: IESO (October 2017-April 2018). Talha was the project manager for the project and the energy specialist responsible for delivery of a community energy plan for the Nibinamik First Nation following site surveys, assessments, and stakeholder consultations.

Residential New Construction Program: IESO (October 2017-May 2018). For this project with Ontario's Independent Electricity System Operator (IESO), Talha led the market and measure assessment responsibilities that supported the program design and business case development phases.

Survey of Fuel-saving Measures in Heavy-Duty Vehicles: Transport Canada (December 2017-March 2018). Talha led the project management and delivery responsibilities for this project that involved Pan-Canadian study and survey of the use of aerodynamic fuel-saving measures in Class 8 heavy duty vehicles.

Needs Assessment for Provincial-Territorial Building Energy Labelling and Disclosure Programs: Natural Resources Canada (September 2017-February 2018). Talha supported the market assessment phases of this project with Natural Resources Canada which was aimed at collecting feedback and identifying tools used by provinces and territories in labelling and disclosure of building energy use.

Solar Thermal Market Scan: IESO (November 2017-December 2017). As the project manager, Talha was responsible for the successful delivery of this project which involved technology, market, and jurisdictional scan of solar thermal technologies in Ontario and performed the market study tasks.

### *Product Development*

GHG Inventory and Lifecycle Analysis Software Development: Canadian Mortgage and Housing Corporation (November 2018-Ongoing). Talha led the product design of two software tools on behalf of CMHC. The inventory tracking tool will be used to track the GHG impacts of project funded through National Housing Strategy, and the Lifecycle Analysis tool is a website that allows project developers to determine net present value and payback on their energy efficiency investments. Talha is responsible for project management as well as the lead developer of the tools.

### *Project Development*

Rooftop and Carpark PV Solar Systems: Qatar Foundation (June 2014-December 2016). As the project manager, Talha was responsible for the delivery of the full scope that involved design, procurement, and construction of photovoltaic solar rooftop systems and canopies at seven institutional locations. He led the contract negotiations with clients and vendors, project planning efforts, and managed all design, procurement, and construction.

Solar Carpark Shades: Qatar Science and Technology Park (February 2016-November 2016). Talha led the turnkey project for the design and construction of solar-integrated carpark shades at three locations in the technology park. He was also responsible for the quality assurance, quality control and day-to-day client relations.

Solar Test Facility: Qatar Foundation, Chevron (October 2009-May 2014). Talha coordinated and later managed the development of the Solar Test Facility, at Qatar Science and Technology Park with a public-private stakeholder group (Chevron, the US energy giant, and Qatar Foundation), technical consultants, and over 40 technology providers

## EDUCATION

Bachelor of Science in Electrical Engineering, Texas A&M University, 2009

## CERTIFICATIONS

Certified Project Management Professional (PMP)

## LANGUAGES

Urdu – Fluent

Arabic – Intermediate

## EMPLOYMENT HISTORY

| | | |
|---|---|---|
| Posterity Group | Consultant | 2017-Present |
| GreenGulf | Projects Manager | 2013-2017 |
| GreenGulf | Senior Associate | 2011-2012 |

# Paula Claudino, P.Eng., M.A.Sc.

## Senior Consultant

### EXPERIENCE OVERVIEW

Paula Claudino has over twelve years of experience working with industrial, utility and government clients in the areas of energy and GHG emission demand-side management (DSM), GHG emission verification, and energy and GHG emission auditing.

Paula was the Industrial Advisor for FortisBC's 2021 Conservation Potential Review and is currently the Project Manager and Industrial Advisor for Pacific Northern Gas' Conservation Potential Review. While working with previous employers, Paula completed the energy and GHG modelling and analysis for many major demand side management projects, including for the Ontario Energy Board, Union Gas, Enbridge Gas Distribution, Terasen Gas, New Brunswick Power, SaskPower, and the Government of Singapore.

### SELECT PROJECT EXPERIENCE

Conservation Potential Review: Pacific Northern Gas (August 2021-ongoing). Posterity Group is developing a Conservation Potential Review study for Pacific Northern Gas. This analysis will build on resource planning and conservation potential work Posterity Group has recently completed in BC, including FortisBC's 2021 CPR. It will support adjustments to PNG's current portfolio of DSM programs and PNG's 2023 DSM Plan and Resource Plan filing. Paula is acting as the Project Manager and Industrial Advisor.

FortisBC DSM Basics Workshop: FortisBC (Jun. 2021-Oct. 2021). Posterity Group is developing and facilitating a Demand Side Management (DSM) workshop for FortisBC to assist with employee on-boarding, strengthen the department's context of the programs, and amplify opportunities to work on energy savings initiatives with customers. Paula is acting as Advisor.

Residential Prescriptive Building Envelope Research: Enbridge Gas Distribution (April 2021-ongoing). Enbridge would like to develop and substantiate several new DSM insulation measures for the single-family residential sector. Posterity Group has been hired to provide technical and market information to support the development of prescriptive or quasi-prescriptive measures for inclusion in the Ontario Technical Resource Manual. Paula is acting as the Project Manager and Lead Analyst.

Load Forecasts for the Southwest Ontario Greenhouse Sector: IESO (February 2021-August 2021). Greenhouse energy demand continues to expand in the Windsor-Essex and Chatham-Kent regions. To support planning efforts in these regions, the IESO developed three load forecast scenarios (a low growth, reference case, and high growth scenario) for greenhouse non-coincident winter-peak load. Posterity Group was hired to review the information and assumptions used by the IESO and provide additional information to validate the IESO's forecast scenarios or identify possible areas for adjustment. The main activities included in this project were data collection, review and analysis, scenario development, modelling, and a comparison of the data and model results to the IESO's assumptions and models. Paula acted as the Project Manager and Lead Analyst.

2021 Conservation Potential Review: FortisBC Energy Inc. (January 2020-September 2021). FortisBC's 2021 Conservation Potential Review Study (CPR) will support two of FortisBC's major regulatory filings in

2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group estimated BC's technical, economic, and market potential savings over a 20-year period for natural gas using its Navigator Energy and Emissions Simulations Suite™, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group proposed a transparent, well-documented approach to develop the CPR and facilitated the engagement of internal and external stakeholders. Posterity Group completed the end-use modelling and scenario development for FortisBC's 2022 Long Term Gas Resource Plan (LTGRP) in parallel with the CPR, which will ensure technical consistency across the projects. Paula acted as the Industrial Sector Lead.

2022 Long Term Gas Resource Plan Demand Forecast and Resource Planning: FortisBC Energy Inc. (February 2020-July 2021). Following a successful engagement in 2017, FortisBC again engaged Posterity Group to generate a natural gas end-use forecast in support of their 2022 Long Term Gas Resource Plan (LTGRP) filing. The analysis uses baseline end-use energy intensities for over 40 customer segments across 5 provincial regions developed by Posterity Group through the 2021 Conservation Potential Review. Forecasting analysis incorporates multiple data sources including customer end-use surveys, customer energy use data, and price and commodity forecasts. In addition to the reference case forecast, Posterity Group conducted scenario analysis that estimates the impact on gas demand from a number of policy drivers including anticipated federal, provincial and municipal codes and standards, carbon pricing, efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and availability of district energy. Paula acted as Project Advisor.

Comparative Evaluation of Spatial Building Stock and Energy Models, Natural Resources Canada Buildings and Renewables: CanmetENERGY Ottawa (November 2019-January 2020, January 2021-April 2021). The Ottawa division of CanmetENERGY is undertaking the Canadian Energy End-Use (CEE) Mapping project to develop a prototype of a residential energy use and efficiency opportunities map in the 2019-2020 fiscal year. The long-term plan for the CEE mapping project is to create an online, open, and authoritative spatial mapping platform to support housing energy end-use characterization and enable non-building science professionals to identify efficiency opportunities. Posterity Group completed a comprehensive review of eighteen spatial building and energy models (ten in the first scan and eight in the second scan) to identify priority features for consideration in the initial CEE map prototype and future iterations. Paula acted as the Project Manager.

Heat Pump and Water Heater Rebate Review: FortisBC Energy Inc. (May 2021-June 2021). Posterity Group helped FortisBC evaluate and streamline its heat pump and heat pump water heater rebate programs for commercial and multi-unit residential customers within the FortisBC electric service territory. Posterity Group conducted: a review of existing programs to understand the current FortisBC program and how it compares to other North American programs; a review of equipment eligibility to standardize the "Qualified Product" list, determine potential equipment additions, and recommend heating capacity limits; and a review of measure details to recommend incremental costs, baseline changes, and measure lives for each relevant equipment category. Paula acted as the Project Manager.

Program Evaluation for the Industrial Optimization Program: FortisBC Energy Inc. (September 2018-May 2019). Posterity Group helped FortisBC evaluate its Industrial Optimization Program and provided recommendations on how to improve the Program moving forward by focusing on four evaluation objectives: (1) Obtaining Program feedback from participants and consultants; (2) Verifying Program enabled savings; (3) Comparing the Program M&V structure to similar programs in other jurisdictions;

and (4) Assessing free-ridership and participant spillover. FortisBC used the outcomes from this evaluation to report on program enabled impact savings and establish a Program net-to-gross ratio, while at the same time drawing insights from program feedback, M&V structure research and free-ridership and spillover findings to inform future program enhancements. Paula acted as Industry Technical Advisor.

Integrated Electricity and Natural Gas Conservation Achievable Potential Study: IESO and Ontario Energy Board (OEB) (2019, independent). Provided expert input on customer decision making and market barriers to energy efficiency in the mining sector in Ontario for the study's Delphi process.

Study of Low Carbon Heating Options for Ontario: Ministry of the Environment and Climate Change (2018, with Posterity Group). Study of heating technologies and fuels in the residential, commercial, and industrial sectors and high-level analysis of options for the decarbonisation of space, water, and process heating in Ontario. The study included the identification of low carbon technology and fuel options, an assessment of barriers to their implementation and an estimate of their potential to mitigate GHG emissions. Paula completed the research and analysis for several low carbon heating options, including renewable natural gas and solid and liquid biofuel options.

Technical Review Services: Ministry of Northern Development and Mines (September 2011 – February 2020, ICF International). The Northern Industrial Electricity Rate (NIER) program encourages large industries in Northern Ontario to improve their energy efficiency and sustainability through the development and implementation of an energy management plan. Paula was the technical due diligence manager for this program from 2011 to 2016. From 2017 to 2020 she continued to conduct annual site visits and provide technical reviews of quarterly reports submitted by program participants.

Pay for Performance Pilot Design and Modelling: IESO (2017 to 2019, with Posterity Group). Paula developed program rules and completed the cost effectiveness modelling and business case for the IESO Industrial Pay for Performance Pilot Program. During the pilot phase, participated in the screening process and developed measurement and verification plans for pilot participants.

Business, Non-Profit and Institutional (BNI) Energy Savings Program: Energy Efficiency Alberta. (2018, with ICF International). The BNI program offered prescriptive rebates on a range of energy efficiency technologies. Paula provided technical review and input on the various measures that were considered as part of the expanded offering of energy efficiency measures, specifically aimed at the industrial and oil and gas sectors in Alberta.

Long Term Resource Plan: FortisBC Energy Inc. (2017, with Posterity Group). Provided internal guidance on industrial energy end uses, efficiency measures and trends.

Market Characterization of Commercial and Residential Condensing Hot Water Heaters and Boilers: Enbridge Gas Distribution (2016, with Posterity Group). Performed research on both tankless and storage condensing hot water heaters and boilers in the Ontario market.

Measurement and Verification Plan: Confidential Client (2016, with Posterity Group)**.** Reviewed and edited a measurement and verification plan for an experimental commercial facility HVAC technology.

European Industrial Energy Efficiency Modelling: Directorate-General for Energy, of the European Commission (2016, with ICF International). Paula created a model for estimating energy efficiency potential across several industrial sub-sectors, fuel types, and policy scenarios in the European Union.

Natural Gas Conservation Potential Study: Ontario Energy Board (2016, with ICF International). The scope of this project covered residential, commercial, and institutional, and industrial natural gas use,

natural gas efficiency potential, and greenhouse gas emission reduction potential for Ontario. Paula acted as the Project Manager and Industrial Technical Lead.

Singapore Industry Energy Efficiency Potential Analysis: National Climate Change Secretariat (NCCS), Government of Singapore (2014-2015, with ICF International). This project involved modelling energy efficiency and greenhouse gas emission reduction potential in industry in Singapore under several energy efficiency scenarios. Paula acted as Technical Lead, performed on-site audits to collect data for modelling purposes, and conducted training for NCCS staff on the use of the energy model.

Building Retrofit Strategy and Validation Update: City of Vancouver (2013, with ICF International). Developed estimates of potential residential, commercial, and institutional energy use reductions that could result from various policy and program initiatives undertaken by the City of Vancouver, through the Greenest City Action Plan.

GHG Reduction Opportunities in Newfoundland Labrador Iron Ore Mining: Government of Newfoundland and Labrador (NL) (2012, with ICF International). Paula acted as Technical Lead for modelling a baseline and forecasts of GHG emissions in the NL iron ore mining sector under different scenarios and creating marginal abatement cost curves.

Bangladesh Industrial Energy Efficiency Opportunities Assessment: USAID, (2012, with ICF International). Paula performed energy audits of textile, frozen food, and steel re-rolling facilities in Bangladesh.

Upstream Oil and Gas Energy Efficiency Benchmarking: SaskPower, (2011, with ICF International). Paula scheduled and organized upstream oil and gas site audits, processed results, and developed report cards and benchmarking reports for each site.

Industrial Energy Management & Benchmarking: Canadian Manufacturers and Exporters (CME) Alberta, (2011, with ICF International). Paula conducted on-site surveys of industrial sites in Alberta and modelled energy savings potential scenarios using the results of the surveys.

Greenhouse Gas Emission Re-Verification: Alberta Environment (2011, with ICF International). Supported the re-verification of a greenhouse gas emission report, including the site audit, of a major coal mine in Alberta.

Upstream Oil and Gas Energy Efficiency Potential: Natural Resource Canada, (2009, with ICF International). Paula researched upstream oil and gas processes and energy efficiency measures and opportunities.

DSM Potential Study: Enbridge Gas Distribution (2009, with ICF International). Paula developed reference case scenarios and modelled the impact of industrial sector natural gas efficiency measures on Enbridge Gas Distribution's Ontario industrial market. She also evaluated costs and benefits of specific energy efficient technologies and drafted study reports.

DSM Potential Study: Union Gas (2009, with ICF International). Paula developed reference case scenarios and modelled the impact of natural gas efficiency measures on Union Gas' Ontario industrial market. She also evaluated costs and benefits of specific energy efficient technologies and drafted study reports.

**PUBLICATIONS AND PRESENTATIONS**

*Experimental and Modelling Study of a Geodesic Dome Solar Greenhouse System in Ottawa.* Carleton University, Department of Mechanical and Aerospace Engineering, Ottawa, 2015.

Seminar Program on Industrial Energy Management, hosted by the Brazilian National Industry Confederation, Sao Paulo, Brazil, March 2013.

*Successful Approach to Industry Program Baseline Market Characterization*. AESP Summer Conference, Toronto, Ontario, Canada, July 2012.

## EDUCATION

Master of Applied Science (Sustainable Energy Engineering and Policy), Carleton University, Ottawa, Ontario, Canada, 2016

Bachelor of Engineering and Management (Mechanical), McMaster University, Hamilton, Ontario, Canada, 2006

## CERTIFICATIONS AND TRAINING

International Energy Agency (IEA), "Energy Efficiency in Emerging Economies Training Week." 12-16 June 2017, Paris, France.

Professional Engineer in the Province of Ontario (P.Eng.)

Energy Integration of Industrial Processes, CanmetENERGY (2013)

Certified Energy Manager (CEM), Association of Energy Engineers (AEE) (2011-2015)

## EMPLOYMENT HISTORY

| | | |
|---|---|---|
| Posterity Group | Senior Consultant<br>Associate | 2019-Present<br>2016-2019 |
| ICF International (Previously ICF Marbek and Marbek Resource Consultants) | Senior Manager<br>Manager<br>Senior Associate<br>Consultant | 2016<br>2012-2016<br>2011-2012<br>2007-2011 |
| Labatt Breweries of Canada Ltd. (InBev) | Logistics Support Manager | 2006-2007 |
| InBev | Global Management Trainee | 2006 |
| Apotex Inc. | Summer Engineering Co-op | 2004, 2005 |
| Xerox Canada, Oakville Colour Toner Plant | Summer Engineering Co-op | 2003 |

# Alanna Komisar, M.Eng., BASc.

## Consultant

### Experience Overview

Alanna Komisar has broad experience in working energy efficiency scenario planning, physical and operational climate risks and resiliency, clean technology (cleantech) and innovation start-ups, and carbon utilization technologies. She has a Bachelor of Applied Science from the University of Toronto where she focused on Building Sciences and a Master of Engineering in mechanical and industrial engineering focused on tracking energy indicators to manage the health of smarter cities. Her previous experience includes implementing energy efficiency measures for municipalities, governments, and industrial sites at Enbridge Gas Distribution, implementing carbon utilization pilot projects and business development with CarbonCure Technologies, supporting Canada's growing CleanTech sector with MaRS Discovery District, and helping commercial and industrial buildings proactively protect themselves from physical risks created by climate change at FM Global.

### Energy Modelling, Program Evaluation, and Delivery

Additional Savings Review for FortisBC (2021): Alanna is leading a review of FEI's current practices to identify the potential for additional incremental savings and emissions reductions based on different calculations methodologies. This study includes a jurisdictional review of other similar best practices, investigating spillover, free ridership, and in-situ efficiency baselines.

Government & Industrial Project DSM Delivery – Enbridge (2018 – 2021): Alanna lead demand side management initiatives to reduce natural gas consumption for industrial sites and government bodies. The industrial sites included automotive, industrial bakeries, metal manufacturing, breweries, aerospace and similar operations. The government sites included municipalities, the province of Ontario, and federal bodies including the military. She created energy models and business cases to help clients elect energy efficient and low carbon solutions such as high efficiency boilers, district energy, geothermal energy, biomass, and CHP systems. She collaborated with stakeholder teams across Enbridge to streamline processes and find mutual goals in order to help government address net zero and climate emergency targets resulting in 30 million m3 of natural gas reduced over the past three years.

Energy efficiency improvements for windows and building envelops in heritage buildings (2012): As part of her undergraduate thesis at the University of Toronto, Alanna explored potential high efficiency window options to reduce thermal losses in residential and small commercial heritage buildings in cold climates like Canada. These solutions took heritage building standards and aesthetics into consideration. WINDOW and HOT2000 models were done in various territories across the country to consider local climate, available grants and rebates, energy pricing, and GHG intensities.

Energy Efficiency Audit and Emissions Reductions Pathway for Honest Ed's Retail Building (2012): Alanna lead a team to produce and model recommendations for Toronto's iconic retailer Honest Ed's. The

implemented results could reduce energy demand by 50% with a 7-year ROI. Awarded the Enwave Design Award in Sustainable Engineering for the cohort's best sustainability project.

**Climate Risk and Infrastructure Resiliency**

Industrial and Commercial Building Risk Assessment Delivery (2012 – 2013):
As part of an industrial and commercial building insurance company called FM Global, Alanna coached and worked with management at residential and commercial buildings valued between $15 - $200 million to create strategies that work with their existing operations and business model to improve infrastructure resilience and reduce client risks to mitigate potential financial payouts.

Flooding risk evaluation for Toronto Hydro Transformers (2018): Performed research on operational interdependencies, all hazard analysis, incident sequencing, hazard timelines, and create business cases for solutions to address ongoing and future damages for underground Toronto Hydro transformers to mitigate business disruptions.

Silver Linings Project – Using shared indigenous knowledge to address climate resiliency in Cambodian villages (2019): Alanna conducted literature review and interviews on climate change's distortional impact on indigenous women in rural Cambodia due to cultural norms and policies aggravating social mobility and time poverty challenges. She worked with a team to create policy recommendations to help support community knowledge exchanges, policy development, and future research that were presented at regional conferences in Southeast Asia.

**Project Management and Future Technology Adoption**

The Pan-Canadian Framework of Cleantech Data co-design session (2018): As part of MaRS Discovery District's cleantech practices, Alanna conducted research, wrote white papers, and facilitated conversations at a co-design session in partnership with NRCan to over 50 convene key public and private sector stakeholders for the construction of Pan-Canadian Cleantech Data Framework, a tool to measure the health and growth of Canada's cleantech sector.

ISO37120 Global Indicators for Energy Themed Ontologies for Smart Cities (2014): Alanna created an annotated structure for energy data indicators for the first global standard for comparable open-sourced city level data called ISO37120 created by the World Council of City Data (WCCD) to be used by government and private stakeholders.

Financing for Carbon Utilization Technologies (2018): Alanna create grant proposal to secure $1M in funding from Elemental Exxcelerator facilitating CarbonCure's entry into Asian markets and supported initiatives to secure funding from Bill Gate's Breakthrough Energy Venture Fund and XPRIZE.

Project Management and Pilot Project Demonstrations (2017-2018): Alanna coordinated with clients' engineering, sales, and marketing teams for the installation of CarbonCure's technology in 18 ready-mixed concrete plants, allowing plants to profitably reduce 18 000t of $CO_2$ emissions. She led training

programs for customer concrete producers to position CarbonCure's CO2 recycling technology to architectural and engineering firms, supporting a 25% increase in revenue from resale opportunities.

## Education

Master of Engineering (Mechanical & Industrial Engineering), University of Toronto - Toronto, ON, Canada, 2014

Bachelor of Engineering (Civil Engineering – Building Sciences), University of Toronto - Toronto, ON, Canada, 2012

## Certifications

Professional Engineers of Ontario – EIT

Association of Energy Engineers - EMIT

## Languages

French: Working Proficiency

German: Beginner

## Employment History

| | | |
|---|---|---|
| Posterity Group | Consultant | 2021 – present; |
| Enbridge Gas Distribution | Energy Solutions Advisor | 2018 – 2021 |
| CarbonCure Technologies Inc. | Director of Marketing<br>Director of Project Installs | 2017 – 2018 |
| MaRS Discovery District | CleanTech Venture Services Fellow | 2016 – 2017 |
| Bell Canada Enterprises | Product Manager<br>Graduate Leadership Program | 2014 - 2016 |
| FM Global | Loss Prevention Consultant | 2012 - 2013 |
| RDH Building Engineering | Building Science Engineering Student | 2011 |
| Universität Technische Kaiserslautern | Soils and Seismic Engineering Student | 2010 |

| | | |
|---|---|---|
| Own the Podium | Carded Long Track Speed Skater | 2004 - 2007 |

# CHRISTINE GUSTAFSON, P.ENG., C.E.M.

## ENERGY CONSERVATION STRATEGIST & CONSULTANT

### / BIO

Throughout my career I have worked effectively with teams and subject matter experts to deliver complex studies, develop and manage standards and policy, facilitate the development of strategic plans, manage stakeholder advisory committees, and prepare and support regulatory applications.

My experience is grounded technical and analytical experience, developing and implementing conservation programs, ensuring quality energy savings, conducting energy audits and designing energy efficient systems for commercial buildings.

I draw on these broad experiences and combine them with robust research techniques, risk identification and mitigation strategies and meaningful stakeholder engagement to find ways to make energy efficiency our number one resource of the future and reduce greenhouse gases.

christine@harbourgreene.ca | harbourgreene.ca | LinkedIn.com/in/christinegustafsonpeng | 604.655.9232

## / EDUCATION & CERTIFICATIONS

**Association of Energy Engineers**
Certified Energy Manager | 2021

**Royal Roads University**
Master of Business Administration | 2009

**Engineers and Geoscientists of British Columbia**
Registered Professional Engineer | 2007

**University of Victoria**
Bachelor of Mechanical Engineering | 2002

## / WORK EXPERIENCE

Harbourgreene Consulting Inc. | 2016 to present
**Owner and Principal Consultant**

Support government and utility clients with their energy management and greenhouse gas emission reduction portfolios through policy and program development and implementation, stakeholder engagement and regulatory filings.

Home Performance Stakeholder Council | 2016 to present
**Board Advisor**

Support the Home Performance Stakeholder Council Managing Director and Board through participation, review and input on industry engagement, advocacy, strategic and operational planning, policy development and special projects.

**Executive Team, Project Manager**

Incorporated, developed and managed a not-for-profit society working to advance home performance in BC. Responsible for strategy and work planning developed in collaboration with industry, fund raising, society management and operations, and the delivery of projects and initiatives.

ICF International | 2014 to 2015
**Senior Manager**

Led the development of the ICF Energy Efficiency business in British Columbia and contributed to broader ICF objectives through management of DSM strategy, planning, regulatory, and program design and implementation projects for utilities across North America.

BC Hydro | 2005 to 2013
**Business Strategy Advisor, Quality Assurance Manager, Conservation Potential Review Project Manager**

Provided strategic advice and management on DSM planning, policy, regulatory applications, communications and stakeholder engagement. Managed the Power Smart governance process and assured the quality of reported energy savings. Managed the completion of detailed estimates of long term conservation potential in BC.

Avalon Mechanical Consultants, Keen Engineering | 2002 to 2005
**Design Engineer**

Consulted as part of an integrated design process team on energy consumption and heating, ventilation, and air conditioning (HVAC) systems for commercial and public buildings. Conducted energy audits.

Canadian Airlines, Pacifica Papers, Keen Engineering, Canfor Northwood | 1999 to 2001
**Coop Student**

## / VOLUNTEER EXPERIENCE

**Efficiency Canada**
Regional Champions Co-Chair and BC Lead | 2019 - present

**BC Advanced Conservation and Efficiency Association**
Director | 2016 -2019

**Engineers and Geoscientists of British Columbia**
Career Awareness Volunteer | 2018 - present

**Elements Society**
Advisory Committee Member | 2016-2018

**Minerva Foundation for BC Women**
Learning to Lead and Combining Our Strength Session Facilitator | 2012

**Association of Professional Engineers and Geoscientists of British Columbia**
Climate Change Task Force Member| 2009-2010

**Building Owners and Managers Association of BC**
Environment and Energy Committee Member and Awards of Excellence Judge | 2009-2012

## / SELECT PROJECT EXPERIENCE

**Program Development, Implementation and Evaluation**

- Supporting BC Hydro's administration of the CleanBC Facilities Electrification Fund by tracking candidate electrification projects and information needs, gathering needed information and supporting the preparation of applications to government.
- Developing new programs and delivery pathways for Pacific Northern Gas' Smart Energy Solutions portfolio through design, analysis, and communications.
- Advised on the BC home retrofit market and identifying key market barriers and opportunities in the context of deep energy retrofit program concepts for FortisBC.
- Worked with the BC Hydro Community Energy Manager network to design and deliver a New Retrofit Experience with the aim of radically increasing the number of deep low-carbon retrofits in existing Part 9 homes in BC.
- Managed work planning and partner coordination for the Ministry of Energy and Mines CleanBC Better Homes program working with the BC Hydro and FortisBC Home Renovation Retrofit program.
- Established processes and systems that enable effective management by the BC Hydro Electric Vehicle Initiative Manager Sponsor and Steering Committee.
- Completed research, financial analysis, and program design for BC Hydro's Customer Emergency Fund pilot program. Helped secure executive support. Drafted the regulatory application and prepared responses for information requests.
- Designed key elements of SaskPower's commercial demand side management program including an online energy tips tool, in person building energy audits and a custom incentive application process.
- Provided technical oversight to the launch of Yukon's first demand side management programs including updating of project inputs and key performance indicators, developing the Technical Reference Manual, developing the program tracking database and evaluation, measurement and verification support.
- Managed the development and launch of Southern California Edison's online and live courses focused on Energy Star Portfolio Manager, Benchmarking, and Strategic Energy Management and Continuous Improvement.
- Co-designed and implemented BC Hydro's first workplace conservation awareness program that went on to become the model for the customer facing program.

## / SELECT PROJECT EXPERIENCE

**Stakeholder Engagement**

- Facilitating external stakeholder engagement of the Technical Advisory Committee for the FortisBC 2020 Conservation Potential Review and Long Term Gas Resource Plan.
- Lead the Home Performance Stakeholder Council through work with industry stakeholders focused on increasing the supply and demand for BC contractors that deliver quality, affordable whole home performance services to consumers.
- Facilitated the customer journey mapping of the CleanBC Better Homes/ Home Renovation Rebate program with the aims of improving program implementation and helping the program partners offer the best customer experience.
- Managed the development and work of stakeholders, First Nations, and project staff that form BC Hydro's Energy Conservation and Efficiency advisory committee in support of provincial goals.
- Led senior managers and support staff in the development and communication of a new Power Smart and Customer Care Strategic Plan.

**Policy Development and Regulatory Support**

- Supporting BC Hydro's Electrification Plan regulatory filing to the BC Utilities Commission by drafting materials, managing contributing authors and reviewers, identifying and developing key strategies and content, and preparing supporting materials.
- Engaged industry to assess the HVAC trades readiness for the City of Vancouver's plans to achieve 100% Renewable Energy usage by 2050. Advised the City on key demographics and qualifications of trades working on space conditioning and water heating systems in multi-unit residential and commercial office buildings. Developed recommendations based on known barriers and opportunities for both industry, to help ready themselves, and the City, to help support the transition to a low carbon future.
- Led the development of Pacific Northern Gas' successful 2020-2022 DSM Plan, approved by the BCUC, planning for the growth of four existing energy efficiency programs and the launch of two new programs and supporting initiatives.
- Supported the IESO and Ontario Energy Board 2018 Achievable Potential Study Project Team and Advisory Group as an Expert Panel member; presenting on study best practices and evaluating study methodology and outputs.
- Supported the development of PNG's 2017 Energy Conservation and Innovation Annual Report and 2018 Energy Conservation and Innovation Extension Application to the BCUC.
- Developed a reference guidance document, on behalf of the Ministry of Environment, for industrial companies in BC on their greenhouse gas reporting requirements. Peer reviewed the development of guidance documents covering greenhouse gas offset and verification.
- Led utility staff in Conservation Potential Study needs assessment, scoping, RFP development and evaluation.
- Managed project staff, consultants, stakeholders, and First Nations to complete detailed estimates of long-term conservation potential that are used as the foundation for demand side management planning in BC, Yukon and Newfoundland.
  - BC Hydro: Internal Project Manager, 2007/8
  - Yukon Energy: Consulting Client Liaison, 2014/15
  - Newfoundland Power & Newfoundland & Labrador Hydro: Consulting Project Manager, 2014/15
  - Fortis BC: Stakeholder Engagement Lead, 2019/2020
- Prepared BC Hydro demand side management regulatory applications and coordinated and prepared timely and accurate responses to demand side management information requests on these and other regulatory applications.
- Designed and managed BC Hydro's governance process responsible for the approval of business cases for energy conservation and efficiency programs and initiatives.
- Support utility staff and stakeholders in the use of Conservation Potential Study results in program and policy design and analysis.
- Worked with stakeholders and subject matter experts to develop, communicate and manage BC Hydro Power Smart standards and policy on complex, technical demand side management issues that assure the quality of reported energy savings.

# David F. Shipley

## Senior Consultant

### Experience Overview

David Shipley has over 25 years of experience as an energy engineer. His areas of expertise include: stock-and-flow models for energy efficient buildings and technologies, load forecasting, CDM potential estimates, building energy modelling, building commissioning, building energy systems, energy efficiency, renewable energy, energy and environmental systems modelling, and demand-side management. Mr. Shipley recently served on the expert panel for the 2019 Ontario Achievable Potential Study, as a recognized national expert on these studies.

In recent years, Mr. Shipley has coordinated the residential sector analysis for conservation potential studies for electric and gas utilities in six provinces, and has developed modeling tools used for analysis by the commercial and industrial teams in these studies. This has led to the development of Posterity Group's Navigator™ suite of energy and emissions simulation tools. He has also conducted market studies on building commissioning, HVAC and lighting technologies for commercial buildings, and efficient equipment for industry. Before joining Posterity Group, Mr. Shipley was a Senior Consultant in energy efficiency with ICF/Marbek, and Project Manager with the Energy Center of Wisconsin.

### Select Project Experience

#### *Conservation Potential and High Efficiency Buildings*

Conservation Potential Study: Pacific Northern Gas (August 2021-November 2021). Posterity Group is developing a Conservation Potential Review study for Pacific Northern Gas. This analysis will build on resource planning and conservation potential work Posterity Group has recently completed in BC, including FortisBC's 2021 CPR. It will support adjustments to PNG's current portfolio of DSM programs and PNG's 2023 DSM Plan and Resource Plan filing. Dave is acting as Technical Lead and Residential Advisor.

2021 Conservation Potential Review: FortisBC Energy Inc. (January 2020-September 2021). FortisBC's 2021 Conservation Potential Review Study (CPR) will support two of FortisBC's major regulatory filings in 2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group will estimate BC's technical, economic and market potential savings over a 20-year period for natural gas using its Navigator Energy and Emissions Simulations Suite™, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group has proposed a transparent, well-documented approach to develop the CPR and will facilitate the engagement of internal and external stakeholders. Posterity Group will complete end-use modelling and scenario development for FortisBC's 2022 Long Term Gas Resource Plan (LTGRP) in parallel with the CPR, which will ensure technical consistency across the projects. Dave is acting as Technical Director and Residential Sector Lead.

2022 Long Term Gas Resource Plan Demand Forecast and Resource Planning: FortisBC Energy Inc. (February 2020-July 2021). Following a successful engagement in 2017, FortisBC again engaged Posterity Group to generate a natural gas end-use forecast in support of their 2022 Long Term Gas Resource Plan

(LTGRP) filing. The analysis uses baseline end-use energy intensities for over 40 customer segments across 5 provincial regions developed by Posterity Group through the 2021 Conservation Potential Review. Forecasting analysis incorporates multiple data sources including customer end-use surveys, customer energy use data, and price and commodity forecasts. In addition to the reference case forecast, Posterity Group will conduct scenario analysis that estimates the impact on gas demand from a number of policy drivers including anticipated federal, provincial and municipal codes and standards, carbon pricing, efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and availability of district energy. Dave is acting as Technical Director.

Integrated Resource Planning and Achievable Potential Study Support: Enbridge (2019-Present). Technical lead on modeling and analysis to support Enbridge Gas in their planning and DSM activities. Building on the results of the provincial Achievable Potential Study (APS), used the Navigator™ Energy and Emissions Simulation Suite to construct a model of Enbridge's service territory to estimate DSM potential and peak demand impacts. The detailed model will permit the client-consultant team to better understand the outputs from the 2019 APS, identify limitations in the underlying dataset, and integrate additional data to estimate program potential and budgets. The Navigator™ Energy and Emissions Simulation Suite enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. It also has an 8760 peak analysis module, which we are using to develop full annual load shape profiles for the gas end uses relevant to Enbridge's service territory.

Greenhouse Energy Profile Study: Ontario IESO (2018-2019). Technical lead on modeling and analysis of economic and achievable potential for energy conservation in covered agricultural facilities in Ontario, including greenhouses and indoor agriculture. Developed the stock-and-flow model for three different scenarios of sector expansion, for technical, economic, and achievable energy savings potential, and for peak demand reduction. Provided full 8760-hour profiles of demand before and after the application of energy and demand reduction measures.

2019 Ontario Achievable Potential Study Technical Advisory Panel: IESO (2018-2019). Acted as an Expert Panel Member to the Independent Electricity System Operator (IESO) and the Ontario Energy Board (OEB) for the 2019 Ontario Achievable Potential Study (APS). Provided advice on the integrated electricity and natural gas APS, which will seek to identify and quantify energy savings, GHG emission reductions, and associated costs from demand side resources for 2019-2038. Helped the IESO and OEB ensure that the APS is conducted using industry best practices. Reviewed and provided guidance on all aspects of the APS including the methodology and workplan, base case and reference forecast, energy efficiency and conservation measures, technical and economic potential analysis, achievable potential analysis, and final report.

Conservation Potential Study: Ontario Energy Board (2015-2016). Technical lead on modeling and analysis of economic and achievable potential for energy conservation in Ontario, covering the service territories of both natural gas companies. Led the residential analysis and was principal model developer, including development of stock-and-flow models, economic screening models, and achievable adoption models.

Conservation and Demand Management Study: Newfoundland Power and Newfoundland Labrador Hydro (2014-2015). Technical lead on modeling and analysis of economic and achievable potential for conservation and demand management in Newfoundland and Labrador. Led the residential analysis and was principal model developer.

Tailored Achievable Potential Studies for Ontario LDCs: Hydro One Networks, NPEI, Powerstream, Horizon Utilities, Thunder Bay Hydro, Waterloo North Hydro, Entegrus, Canadian Niagara Power, Algoma

Power, Brantford Power, Milton Hydro, Oakville Hydro, Oshawa PUC, Haldimand County Power, Halton Hills Hydro, Burlington Hydro, Brant County Power (2014-2015). Developed tailored versions of the OPA achievable potential model (see the project immediately below), to provide detailed conservation potential estimates for the service territories of several Ontario LDCs.

Achievable Potential Study: Ontario Power Authority (2013). Led the analysis of conservation potential for all sectors, deriving much of the economic potential from outputs of OPA's End Use Forecaster model, but applying data from ICF Marbek's internal databases to estimate achievable potential. After a market characterization phase targeting the application of measures in Ontario, produced a fine-tuned estimate of achievable potential.

Conservation Potential Study for Yukon Government: YEC, and YECL (2011-2012). Led residential analysis of conservation potential, including developing detailed end-use baseline profiles calibrated to utility data, deriving economic potential for cost-effective actions in the residential sector, and forecasting 20-year economic and achievable savings.

Conservation Potential Study: SaskPower (2010-2011). Led residential analysis of conservation potential, including developing detailed end-use baseline profiles calibrated to utility data, deriving economic potential for cost-effective actions in the residential sector, and forecasting 20-year economic and achievable savings.

Conservation Potential Study: Terasen Gas (2010-2011). Led residential analysis of conservation potential, including developing detailed end-use baseline profiles calibrated to utility data, deriving economic potential for cost-effective actions in the residential sector, and forecasting 20-year economic and achievable savings.

DSM Potential Study: Enbridge Gas (2008). Led residential analysis of conservation potential, as part of a major update to the DSM study Marbek did in 2004. Developed detailed end-use baseline profiles calibrated to utility data, derived economic potential for cost-effective actions in the residential sector, and forecast 10-year economic and achievable savings.

DSM Potential Study: Enbridge Gas Inc. (formerly Union Gas) (2008). Led residential analysis of conservation potential for Union Gas, as part of a project similar to Enbridge project above.

CPR 2007: BC Hydro (2007). Led analysis of residential savings potential for BC Hydro, as part of a project to estimate potential for all sectors. Derived detailed end-use baseline profiles calibrated to utility data, derived economic potential for cost-effective actions in the residential sector, and forecast 20-year savings. This was an update to an earlier CPR Marbek performed for BC Hydro in 2002.

CPR: Newfoundland Power and Newfoundland and Labrador Hydro (2007). Led analysis of residential savings potential for Newfoundland and Labrador, as part of a project to estimate potential for all sectors. Project included same elements as the BC Hydro study.

Fuel Switching Potential: Ontario Power Authority (2006). Developed the residential fuel switching potential estimate as part of a full fuel switching potential study for Ontario.

DSM Potential Study: Terasen Gas (2005). Developed the residential energy savings and fuel switching potential estimate as part of a full DSM potential study for the Terasen service territory. Conducted part of the commercial energy savings and fuel switching potential analysis.

DSM Potential Study: Enbridge Gas (2004). Developed the residential energy savings potential estimate as part of a full DSM potential study for the Enbridge service territory.

DSM Study: Manitoba Hydro (2003). Led residential analysis for DSM study.

Statewide Technical and Economic Potential: Consortium of Wisconsin Utilities (1993). While at Energy Center of Wisconsin, managed the completion phase of the estimate of conservation, fuel switching and load management potential, as part of IRP filing.

### *End-Use Energy Efficiency and GHG Mitigation Modelling & Load Forecasting*

Renewable Gas Program Review – Cost Recovery: FortisBC Energy Inc. (July 2021-October 2021). FortisBC Energy Inc (FEI) is reassessing the pricing scheme of their voluntary renewable gas (RG) program, including how to recover supply costs from customers who did not volunteer to pay a premium for RNG. Posterity Group (PG) is focusing on assessing how non-participants may respond to changes in their annual gas bill from RG-related costs. Posterity Group is estimating impacts to annual demand and customer defection from price signals. The results of this project will help inform FEI's proposed design of the RG program to minimize impact on customers. Dave is acting as Advisor.

DSM Planning Support: Enbridge Gas Inc. (January 2021-January 2022). In 2019 and 2020, Posterity Group worked with EGI to develop a Navigator end-use energy model to support DSM planning. The model aligns closely to the Ontario Energy Board's 2019 Achievable Potential Study but includes adjustments that better reflect Enbridge's input and experience, and to correct for identified limitations. Model outputs are housed within Power BI to provide an interactive means to support future EGI planning efforts. In 2021, Posterity Group is working with EGI to update and enhance the end-use model dataset to support its next multi-year DSM plan submission. Priorities include: Developing evidence to position the APS in a context that more accurately reflects EGI's knowledge and experience; Make further adjustments to the APS dataset to address deficiencies and enable sensitivity analysis; and Interrogatory and Witness Support. Dave is acting as Technical Director and Lead Analyst.

Load Forecasts for the Southwest Ontario Greenhouse Sector: IESO (February 2021-August 2021). Greenhouse energy demand continues to expand in the Windsor-Essex and Chatham-Kent regions. To support planning efforts in these regions, the IESO developed three load forecast scenarios (a low growth, reference case, and high growth scenario) for greenhouse non-coincident winter-peak load. Posterity Group was hired to review the information and assumptions used by the IESO and provide additional information to validate the IESO's forecast scenarios or identify possible areas for adjustment. The main activities included in this project were data collection, review and analysis, scenario development, modelling, and a comparison of the data and model results to the IESO's assumptions and models. Dave is acting as Expert Advisor.

Energy Transition Scenario Analysis: Enbridge (July 2020-March 2021). Posterity Group is supporting Enbridge's Energy Transition Planning team to conduct scenario analysis of the consider the financial and operational impacts of the range of climate policy related impacts Enbridge could face over the next 30 years. Posterity Group will model future load at the granular level of energy end uses, different building types, rate classes, and regions, and undertaking scenario analysis to explore several possible economic and policy scenarios under which Enbridge may operate in the future. The goal of the project is for Posterity Group to provide Enbridge with a comprehensive end-use level dataset that reflects several possible futures and a user-interface tool that allows decision makers to explore this dataset and distill quantitative impacts (e.g., how gas use and GHG emissions will change) under different forecast scenarios. Dave is acting as Technical Director and Residential Sector Lead.

Energy Management Best Practices for Cannabis Greenhouses and Warehouses: CEATI International Inc. (November 2019-May 2020). Posterity Group, in partnership with Cultivate Energy Optimization and D+R

International, will assess and document best practices of energy management for cannabis production in both greenhouse and warehouse facilities. The study will develop a five-year forecast of energy use in three regions (Ontario, British Columbia and the Pacific Northwest) for the sector and assess energy saving opportunities. The outcome of this work will form an important base of industry knowledge and bridge the gap to provide current and comprehensive information regarding energy use in cannabis facilities, from which future conservation activities might be developed. Dave acted as Senior Analyst.

Long Term Resource Plan Model Enhancement: FortisBC Gas (November 2018-ongoing). Posterity Group is adding several new features to the Long Term Resource Plan model used to support FortisBC's regulatory filings. New features include the ability to output avoided cost and customer cost of energy, ability to vary short-term and long-term elasticity of energy demand based on the latest research, and the ability to run hundreds of stochastically-generated scenarios with inputs varying probabilistically.

Long Term Resource Plan Regulatory Support: FortisBC Gas (March 2018-November 2018). Posterity Group supported FortisBC in responding to BC Utilities Commission and intervener Information Requests (IRs) regarding its 2017 Long Term Gas Resource Plan (LTGRP). Posterity Group provided FortisBC with information and analysis in support of such inquiries related to the load forecast and subsequent scenario analysis conducted by Posterity Group for inclusion in FortisBC's LTGRP.

Analysis of Fenestration Products in Support of Canadian Market Transformation Activities: NRCan (July 2017-June 2018). Posterity Group provided analysis of the current market for low-rise residential fenestration products, including windows, doors, and skylights and developed estimates of the energy savings potential from changing performance levels in ENERGY STAR or introducing national performance standards. Dave was the technical lead on this project. To produce the estimate, he developed a detailed model of HVAC consumption in different types and vintages of low-rise housing in 22 regions, and modeled the application of several different fenestration energy performance improvements. Developed from publicly available data, this model can be applied for other future projects.

Low Carbon Heating Options for Ontario: Ontario Ministry of the Environment and Climate Change (November 2017-June 2018). Posterity Group estimated the GHG reduction impact potential of strategies targeting low carbon space, water and process heating technologies and fuels in Ontario's residential, commercial and industrial sectors. The project included four main activities: Development of energy and GHG Inventory and accompanying business as usual forecast for Ontario's thermal end-uses by fuel, sector/subsector, and end use; Development of a long list of fuels and technologies with abatement potential, and an evaluation matrix to build a short list of the 10 preferred, most promising technologies and fuels for detailed analysis; Detailed analysis of the short list of fuels and technologies to understand their current market structure, barriers, and applicability; and, development of illustrative deployment scenarios to estimate the potential impacts of the shortlisted fuels. Dave developed the inventory model and the illustrative deployment scenario models.

Natural Gas Demand Scenarios: FortisBC (July 2017-November 2017). Posterity Group provided demand scenario analysis to support FortisBC demand forecasting, with Dave acting as Technical Director and Residential sector lead. This work involved analysis of six scenarios that built on the core end-use forecast completed in June 2017. The project results helped FortisBC assess the impact of various policies, including the City of Vancouver zero emissions plan and the BC Step Code. As part of this work, Posterity Group added new features to the processing software at the heart of the forecasting model. These features allow users to dynamically select the municipalities that are expected to opt into new energy efficiency requirements.

Long Term Resource Plan Model and Forecast: FortisBC Gas (October 2016-June 2017). FortisBC turned to Posterity Group to develop a new end-use forecasting model to enhance their current end-use resource forecasting approach, and to generate a new 2017 forecast. The model provides value to the load forecasting, integrated resource planning, system planning, and conservation potential teams at FortisBC. Enhancements include: a full integration of energy efficiency impacts at the individual measure level, improved transparency of the model; features to allow casual users to vary parameters and review the effects on the results; outputs for every year in the forecast period (rather than milestone years); closer linkage between the annual demand and peak demand forecasting approaches; the ability to analyze the impact of changes such as municipal policy activity, ability to analyze the impact of liquefied natural gas and natural gas transportation initiatives. Dave was technical director and lead model developer.

End Use Load Forecast: FortisBC (2012-2014). Developed an end-use based load forecasting system for FortisBC, using detailed customer data and models built for an earlier conservation potential study. The model could forecast account growth and consumption of five fuels under five economic scenarios, over a twenty-year period, for three sectors, six regions, 33 rate classes, 36 building types, and 29 end uses. The model also estimated potential for conservation programs and reported on the sensitivity of the potential to different economic scenarios.

Integrated Resource Plan: NB Power (2009). Led residential analysis as part of a project to provide input data to NB Power's integrated resource planning process.

Conservation Potential Review and 20 Year Load Forecast: Ontario Power Authority (2009-2010). Led residential analysis of conservation potential for OPA, as part of project to develop a model combining forecasting and DSM potential.

Market Characterization of the Commercial/Institutional and Residential Sectors in Yukon: YEC and YECL (2012). Prepared initial program focus assessment documents, based on results from the Conservation Potential Study. Assisted in planning and preparing interview guides for market research, and conducted interviews. Provided input to program concept documents, which will lead to commercial and residential programs offered by the Yukon utilities.

Residential Market Segmentation Study: Enbridge Gas Inc. (formerly Union Gas) (2010). Led this analysis to assess the potential for DSM technologies in specific niche markets. In a mature market for DSM activities such as Union's service territory, many measures no longer pass the TRC test in a typical or average application, but often will pass in niche applications. We provided a strategic assessment of potential niche markets, to target DSM program activities.

## EDUCATION

M.Sc., Energy Studies, University of Sussex - Brighton, Sussex, United Kingdom, 1987

B.A.Sc., Mechanical Engineering, Minor: Management Science, University of Waterloo – Waterloo, Ontario, Canada, 1986

## CERTIFICATIONS

Licensed Professional Engineer (Ontario)

## PROFESSIONAL AFFILIATIONS

American Society of Heating, Refrigeration, and Air-conditioning Engineers

**EMPLOYMENT HISTORY**

| | | |
|---|---|---|
| Posterity Group | Senior Consultant | 2016-Present |
| ICF International | Senior Technical Specialist | 2011-2016 |
| Marbek Resource Consultants | Senior Consultant | 2000-2010 |
| Energy Center of Wisconsin | Project Manager | 1993-2000 |
| Resource Management Associates | Energy Engineer | 1991-1993 |
| University of Waterloo | WATSUN Engineer | 1987-1991 |

# Alex Tiessen, P.Eng., CMVP, PMP

## Principal

### EXPERIENCE OVERVIEW

Alex brings 15 years of experience helping utilities and governments understand end-use energy within their jurisdictions to make informed energy resource planning, demand side management and policy decisions. As a founding partner of Posterity Group, he has the privilege of co-leading a team of talented professionals and supporting our progressive clients throughout North America.

Alex's career has focused on characterizing energy use in the built environment through end-use modelling. He has developed sectoral models to support clients in assessing demand side management potential and has led geo-targeted analysis to underpin resource planning activities. Alex relishes the challenge of helping clients forecast different possible futures through scenario modelling, curating complex data to distill insights, and improving organizational efficiencies by connecting planning groups with a common end-use dataset.

The supply and use of energy are evolving due to climate change, policy changes, and technology innovation. Alex is driven to help our clients navigate this changing energy landscape by providing flexible, granular, and transparent information on energy end-uses.

He holds a B.Sc. in Mechanical Engineering from Queen's University, is a Licensed Professional Engineer in the province of Ontario, a Project Management Professional, and a Certified Measurement and Verification Professional.

### PROJECT EXPERIENCE

Assessment of Additional Energy Savings from DSM Measures: FortisBC (June 2021-September 2021). Calculating the impact of building level energy and emissions reductions can be subjective. At a project level, the value can be subject the baseline, early replacement considerations, calculation methodology, spillover attributions, and free ridership attributions. The subjectivity of these factors ultimately impacts the way the FortisBC can communicate the impact of their DSM program as part of their emissions reductions efforts and tracking for their 30 By 30 targets. To assist FortisBC, Posterity Group is investigating FortisBC's current DSM programs, the provincial CleanBC Funds, and other DSM jurisdictions for new methodologies and best practices on building level emissions reductions calculations.

DSM Planning Support: Enbridge Gas Inc. (January 2021-January 2022). In 2019 and 2020, Posterity Group worked with EGI to develop a Navigator end-use energy model to support DSM planning. The model aligns closely to the Ontario Energy Board's 2019 Achievable Potential Study but includes adjustments that better reflect Enbridge's input and experience, and to correct for identified limitations. Model outputs are housed within Power BI to provide an interactive means to support future EGI planning efforts. In 2021, Posterity Group is working with EGI to update and enhance the end-use model dataset to support its next multi-year DSM plan submission. Priorities include: Developing evidence to position the APS in a context that more accurately reflects EGI's knowledge and experience; Make further adjustments to the APS dataset to address deficiencies and enable sensitivity analysis; and Interrogatory and Witness Support.

Load Forecast, Southwestern Ontario Greenhouse Sector: Independent Electricity System Operator. (February 2021-May 2022). Posterity Group supported the IESO's resource planners by reviewing and assessing energy profile and load forecast assumptions for Ontario's high-growth greenhouse sector. This involved undertaking market research and analysis to develop electric demand forecast scenarios in support of supply planning efforts. Our approach leveraged Posterity Group's previous experience undertaking greenhouse sector research in Ontario and our ability to develop load forecast scenarios using our end-use based modelling platform.

Energy Transition Scenario Analysis: Enbridge (July 2020-June 2021). To consider the financial and operational impacts of the range of climate policy related impacts Enbridge could face over the next 30 years, Enbridge retained Posterity Group to conduct the Energy Transition Scenario Analysis (ETSA) project. The purpose of this project is for Posterity Group to support Enbridge's Energy Transition Planning (ETP) project by modeling future load at the granular level of energy end uses, different building types, rate classes, and regions, and undertaking scenario analysis to explore several possible economic and policy scenarios under which Enbridge may operate in the future. In close collaboration with Enbridge, Posterity Group is developing several critical drivers that may impact Enbridge's system, modelling how each driver effects natural gas demand, and then models several scenarios of possible futures.

Prefeasibility Study and M&V Best Practices: Gas Heat Pumps and Dual-Fuel Heat Pumps: Con Edison via CEATI International Inc. (May 2020-December 2020). Posterity Group is conducting a technical, economic and market potential study for natural gas heat pumps (GHP) and dual-fuel heat pumps (Dual-Fuel HP) in Con Edison's and Orange and Rockland's residential, multi-family and commercial sectors for both retrofit and new construction applications. Technologies will be compared to two reference cases: electric air source heat pumps, and most efficient in-kind replacement. Phase 2 of the project involves developing Measurement and Verification (M&V) best practices for natural gas heat pumps technologies.

Resource and DSM Planning: Enbridge Gas (July 2019-December 2020). Enbridge Gas requires program potential and integrated resources planning (IRP) support as part of their ongoing planning and DSM activities. Posterity Group will provide support in these two related areas using their Navigator™ Energy and Emissions Simulation Suite, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. Posterity Group will help Enbridge understand outputs from their 2019 achievable potential study and leverage them in support of their program potential submission to the OEB for the next DSM framework. The scope of IRP support will include a defensible method and analysis tool to forecast consumption, demand, and carbon emissions within a defined control zone over a range of scenarios.

Prescriptive Lighting Measure Review: Ontario IESO (April 2020-July 2020). Posterity Group conducted a study to update the IESO's prescriptive lighting technology list to reflect current regional incremental costs and cover technologies that accurately reflect Ontario's lighting market baseline. As part of the project, Posterity Group also updated the IESO's incentive setting strategy to ensure that incentives continue to be used cost-effectively to address the achievable potential in Ontario's non-residential lighting market.

2022 Long Term Gas Resource Plan Demand Forecast and Resource Planning: FortisBC Energy Inc. (February 2020-July 2021). Following a successful engagement in 2017, FortisBC again engaged Posterity Group to generate a natural gas end-use forecast in support of their 2022 Long Term Gas Resource Plan (LTGRP) filing. The analysis uses baseline end-use energy intensities for over 40 customer segments

across 5 provincial regions developed by Posterity Group through the 2021 Conservation Potential Review. Forecasting analysis incorporates multiple data sources including customer end-use surveys, customer energy use data, and price and commodity forecasts. In addition to the reference case forecast, Posterity Group will conduct scenario analysis that estimates the impact on gas demand from a number of policy drivers including anticipated federal, provincial and municipal codes and standards, carbon pricing, efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and availability of district energy.

2021 Conservation Potential Review: FortisBC Energy Inc. (January 2020-September 2021). FortisBC has entrusted its 2021 Conservation Potential Review Study (CPR) to Posterity Group. The CPR will support two of FortisBC's major regulatory filings in 2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group will estimate BC's technical, economic and market potential savings over a 20-year period for natural gas using its Navigator Energy and Emissions Simulations Suite™, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group has proposed a transparent, well-documented approach to develop the CPR and will facilitate the engagement of internal and external stakeholders. Posterity Group will complete FortisBC's 2022 LTGRP in parallel with the CPR, which will ensure smooth handoffs and technical consistency across the projects.

Energy Management Best Practices for Cannabis Greenhouses and Warehouses: BC Hydo, FortisBC, Ontario IESO, Enbridge and National Rural Electric Cooperative Association via CEATI International (November 2019-August 2020). Posterity Group, in partnership with Cultivate Energy Optimization and D+R International, will assess and document best practices of energy management for cannabis production in both greenhouse and warehouse facilities. The study will develop a five-year forecast of energy use in three regions (Ontario, British Columbia and the Pacific Northwest) for the sector and assess energy saving opportunities. The outcome of this work will form an important base of industry knowledge and bridge the gap to provide current and comprehensive information regarding energy use in cannabis facilities, from which future conservation activities might be developed.

Study on the Roles, Challenges and Opportunities for Utilities in Supporting Jurisdictions with Benchmarking, Labelling and Disclosure of Energy Use: Natural Resources Canada, Office of Energy Efficiency (December 2019-March 2020). Posterity Group is working with NRCan's Office of Energy Efficiency to study the challenges, barriers and opportunities to utilities to participate in commercial sector energy benchmarking initiatives in Canada. Posterity Group will survey utilities across Canada to collect information on their experience with benchmarking initiatives, including technical considerations for data transfer to ENERGY STAR Portfolio Manager. The findings of the research will help NRCan identify opportunities to support utility participation in energy benchmarking programs.

Greenhouse Energy Profile Study: Independent Electricity System Operator (January 2019-October 2019). Posterity Group is working with the Independent Electricity System Operator and an Advisory Committee to develop an energy profile for Ontario's greenhouse sector. Teaming up with Wood, Posterity Group will help study this important sector – one that is expected to grow, particularly in regions with forecasted grid constraints. The study will: Define a baseline energy consumption in the greenhouse sector; Define a "reference case" energy use for the sector over the next 5 years; and Estimate savings potential for energy and water, demand response, local generation, and programs. Currently, there is no dataset profiling the energy footprint of the greenhouse sector, the outcomes of this study will be valuable to several stakeholders and provincial planning groups

Clean Technology and Environmental Outcomes – A Review of Approaches in other Jurisdictions: Canada's Clean Growth Hub (February 2019-May 2019). Posterity Group provided the Clean Growth Hub with a report examining administrative data in the context of how clean technology and innovation programs in other jurisdictions in Canada and abroad report on environmental outcomes. This project will support the inter-departmental initiative to enhance federal capacity to track clean technology outcomes from various programs. Posterity Group advised the Clean Growth Hub on data collected and methodologies used to assess or track environmental outcomes during all three phases of project implementation (1) application; (2) project implementation; (3) project completion. The scope included GHG and environmental outcomes such as pollution to air, water and soil and effects on biodiversity.

High-Efficiency Buildings: Case Studies: NRCan Office of Energy Research and Development (February 2019-July 2019). Posterity Group worked with NRCan to undertake literature review, interviews, and technical case-study development for the purpose of gathering information about high efficiency buildings in Canada and to better quantify the costs, energy usage, and ensuing greenhouse gas emissions of high efficiency buildings. This work combined two of Posterity Group's core competencies: The assessment of markets for energy efficient and low carbon technologies and services; and technical assessment of energy performance in the built environment. Our team developed an inventory of high performing Canadian buildings, undertook market research and interviews with leading builders and developers, assessed and developed building energy simulation models and Class D estimates of incremental costing for high performance buildings, and developed a series of case studies covering both technical and market-related aspects of high-performance building development.

Zonal Pricing Review: Independent Electricity System Operator (November 2018). Posterity Group undertook a review of Independent Electricity System zonal pricing data analysis in support of a response to a provincial stakeholder inquiry on the impact proposed changes to Ontario's wholesale electricity market. Specifically, the inquiry related to the planned changes to transition the Ontario wholesale market from the current two-schedule uniform pricing system to a single-schedule system with zonal and nodal prices; a change being proposed as part of the Market Renewal effort launched in the spring of 2016 by the IESO.

Market Characterization and Conservation Potential for Ontario's Drinking Water Treatment and Waste Water Treatment Plants: Independent Electricity System Operator (May 2018-December 2018). This project provided a detailed inventory of drinking water treatment plants and wastewater treatment plants facilities in the province; assessed baseline energy use in these facilities, including end-use level estimates of in plant energy-use and collection/distribution system pumping energy use; provided a characterization of the existing equipment stock; provided an estimate of the energy/GHG savings potential (economic) and; provided a detailed analysis of methane mitigation, demand response, and peak reduction opportunities through Combined Heat and Power and other means.

Market Characterization and Conservation Potential for Ontario First Nation Communities' Drinking Water Treatment and Waste Water Treatment Plants: Independent Electricity System Operator (July 2018-January 2019). The study involved: Developing baseline energy use in facilities on First Nations communities; Identifying opportunities to save energy, both from equipment upgrades and process improvement; Highlighting case studies from communities across the province; and Providing recommendations on how to achieve energy savings and the non-energy benefits associated with the measures.

Food Services Challenge Case Studies: Independent Electricity System Operator (July 2018-April 2020). Restaurants Canada, NRCan, and IESO are administering a program called the Food Services Challenge in

which restaurants and food service organizations are invited to improve their energy use through equipment upgrades and energy management best practices. Four participants will be shortlisted to receive energy audits of their facilities, recommendations on equipment upgrades and energy efficiency measures, and will be given around a year to implement the measures. Case studies will then be developed on the four food service facilities to help other similar organizations follow suit. Posterity Group is providing the program administrators with candidate selection support, Level 1 and Level 2 ASHRAE energy audits, development of measurement and verification plans for each candidate, post-retrofit assessments, and will be responsible for developing the final reports and case studies.

Industrial Optimization Program Evaluation: FortisBC (September 2018-May 2019). Posterity Group helped FortisBC evaluate its Industrial Optimization Program and provided recommendations on how to improve the Program moving forward by focusing on four evaluation objectives: Obtaining Program feedback from participants and consultants; Verifying Program enabled savings; Comparing the Program M&V structure to similar programs in other jurisdictions; and Assessing free-ridership and participant spillover. FortisBC used the outcomes from this evaluation to report on program enabled impact savings and establish a Program net-to-gross ratio, while at the same time drawing insights from program feedback, M&V structure research and free-ridership and spillover findings to inform future program enhancements.

Environmental Sustainability Plan Development: La Cite Collegiale (April 2018-July 2018). Posterity Group, in partnership with CDM Energy Solutions, developed a comprehensive Environmental Sustainability Plan for La Cite Collegiale's Ottawa campus. The development of the plan was informed by a review of existing and planned energy audit results, analysis of renewable energy opportunities and other campus-wide initiatives, stakeholder meetings, and the vision and leadership of La Cite. The plan provides the business case and action plan for the implementation of energy management opportunities including energy-efficiency and greenhouse gas reduction measures, renewable energy, and water-efficiency upgrades.

Analysis of Fenestration Products in Support of Canadian Market Transformation Activities: NRCan (July 2017-June 2018). NRCan engaged Posterity Group to analyze the residential low-rise fenestration market (windows, doors and skylights) in Canada as part of a broader strategy to decrease their impact on low-rise building energy use. This assignment includes technical and market analysis of proposed changes to ENERGY STAR criteria and proposed incoming Minimum Energy Performance Standards. With the support of subcontractors Arborus Consulting and David Petersen, Posterity staff will examine the impact of these proposed standards on energy use and GHG emissions; and market actors including manufacturers, consumers, dealers and homebuilders. We will also develop a stakeholder database, and critique proposed standards, suggesting modifications as needed.

Design and Implementation of an Industrial Pay-for-Performance Pilot: Independent Electricity System Operator (November 2017-April 2019). Posterity Group providing technical support for the design and delivery of the IESO's industrial pay-for-performance pilot program. Posterity Group developed a business case for the pilot program which involved iterative modelling to evaluate the impact of different incentive rates, incentive structures, cost assumptions and energy and demand savings assumptions on cost-effectiveness. Posterity Group also created facility screening criteria for participation in the pilot and a participant M&V approach for inclusion in the business case. After the pilot was launched in 2018, Posterity Group supported the IESO in its delivery the pilot program by applying their M&V expertise and knowledge of working with large industrial clients. Delivery activities involved: completing M&V feasibility assessments for potential pilot participants and providing

recommendations on whether to accept each facility into the pilot; and developing M&V plans and assisting with energy management plans for participants accepted into the pilot.

Operational Improvement Study: Enbridge Gas Distribution (September 2017-November 2017). Posterity Group, in association with TdS Dixon, completed a research study about Operational Improvement measures for hospital and university subsectors in Ontario, on behalf of Enbridge Gas. Posterity Group identified operational improvement programs offered to hospitals and universities in other jurisdictions to assess program classification type, typical implemented measures, and measure life assumptions for these measures. Posterity Group also collected input from key Ontario industry association stakeholders regarding Ontario-specific market barriers, and to identify and discuss opportunities for tying into existing or planned interventions. Enbridge will use the results of the research study to inform program design activities, including whether or not to include operational improvement measures in their custom program, and how to assess savings for the measures should they be included.

Energy Performance Contract Support Services: Defence Construction Canada (August 2017-August 2020). Defense Construction Canada has entrusted Posterity Group to provide third party review and technical services in support of their energy performance contracts to reduce energy use and cost in military installations across Canada, and to provide for capital renewal. Under this standing offer arrangement, Posterity Group is called on to support Defence Construction Canada in several ways: to provide energy audit and energy savings measure development support; to provide third party technical review of the feasibility studies undertaken as part of energy performance contracts; to provide construction-phase support during measure installation; and to provide energy measurement and verification support.

Adaption of US E-Training on EE and GHG Reduction for Canadian Federal Buildings: Natural Resources Canada (August 2017-March 2020). Posterity Group is helping NRCan's Greening Government Support Services to adapt the U.S. Federal Energy Management Program's (FEMP) webinars for the Canadian federal market. These training webinars are intended to help build capacity within federal organizations to identify and implement energy savings projects and practices; capacity that will be instrumental in helping organization work toward achieving the GHG reduction target outlined in the Federal Sustainable Development Strategy. The scope includes adaption of ten specific U.S. FEMP courses; work that will include content adaptation, translation, recording in English and French, and ongoing stakeholder consultations with NRCan and the U.S. FEMP contact person. The Posterity Group team is uniquely positioned to provide these services; in addition to established training qualifications, we are providing built environment energy management expertise, as well as Canadian energy efficiency policy expertise.

Develop Prescriptive New Construction & Retrofit Lighting Incentives: FortisBC Electric (February 2017-April 2017). Posterity Group helped FortisBC develop a prescriptive lighting offering that covered both retrofit and new construction projects. The project's primary tasks included a jurisdictional scan to evaluate the applicability prescriptive lighting programs and measures offered by other utilities, and the development of input assumptions and eligibility criteria for each measure. Posterity Group contacted local lighting distributors and mined existing FortisBC program data to create region-specific cost assumptions.

Conservation Plan and Program Process Audit: Independent Electricity System Operator (March 2017-November 2017). Deloitte, with advisory support from Posterity Group, helped the IESO to ensure there are effective risk management controls in place to review and approve the LDC Conservation Plans and Programs.

Custom and Large Volume Program Review: Factors Influencing and Mitigating Free Ridership: Enbridge Gas Inc. (formerly Union Gas) (March 2017-May 2017). Union Gas hired Posterity Group to assist in the preparation of evidence for its mid-term review submission to the Ontario Energy Board. Specifically, Posterity Group was tasked with exploring and assessing Union Gas' efforts to reduce the free ridership rate for their Custom Commercial-Industrial (CI) and Large Volume offerings under the 2015-2020 DSM Framework as compared to the previous DSM framework. These work products will allow Union Gas to identify efforts undertaken under the new framework to date, to qualitatively assess the extent of these efforts per the OEB's Decision and Orders relative to the programs, and to identify major internal and market barriers to lowering the free ridership rate for these program offerings. The work involved a literature review and jurisdictional scan of program design and implementation factors that can influence free ridership; a review of Union Gas's program documentation for both framework periods; interviews with staff; and a gap analysis exercise leading to the reporting recommendations.

Greenhouse Construction Industry Standard Practice Study: Enbridge Gas Inc. (formerly Union Gas) (August 2016-June 2017). Posterity Group in partnership with Wood helped Union Gas establish a defensible energy performance base case for greenhouse new construction and expansion projects in Union Gas' service territory by employing a study methodology that aligns with the California Public Utilities Commission's Industry Standard Practice Guide. The study findings will allow Union program staff, the Ontario Energy Board and their evaluation contractor to accurately assess impacts resulting from DSM program activities targeting the greenhouse subsector.

Study of Federal Programming Strategies to Achieve Energy Savings: Natural Resources Canada (December 2016-March 2017). NRCan's Assistant Deputy Ministers of the Office of Energy Efficiency (OEE) and Innovative Energy Technology Services (IETS) needed to explore an approach to planning and prioritizing national energy efficiency programming and research investments that leverages lessons learned from "Ecosystem" approach that the US Department of Energy's Buildings Technology Office (BTO) has deployed, which allows for greater coordination of activities, leveraging of respective outcomes, and more efficient use of resources. Together with our partners Industrial Economics, Incorporated (IEc) and Optimal Energy, Posterity Group led the Canadian effort to assist NRCan to develop a comprehensive, data-driven approach to energy efficiency programming focused on the built environment, and informed by the experience of the BTO. This arrangement took advantage of IEc and Optimal's deep knowledge of the BTO, and Posterity Group's history of working with NRCan. Posterity Group worked to provide NRCan with recommendations on how best to design, deliver, and coordinate federal energy efficiency programming and R&D investments that similar to the approach taken by the U.S., This study also equipped NRCan with the tools necessary to adapt its existing programs to maximize their positive impacts on the energy efficiency of the built environment.

Upstream Program Development Support: Enbridge Gas Inc. (June 2016-January 2017). Enbridge Gas is relying on Posterity Group to provide strategic guidance on how and where employing an upstream program approach may improve the effectiveness of its commercial program offerings. In this project, Posterity Group will: Evaluate candidate measures regarding their suitability for an upstream program delivery approach, in consultation with EGD staff; Characterize the Ontario market for two selected measures in order to determine market size, market structure, barriers to increased uptake, market actor support for an upstream delivery approach, and consistency with EGD's overarching DSM strategy. Provide support to EGD staff in the design of an upstream program.

Upstream/Midstream Commercial Program Design: Independent Electricity System Operator (September 2015-February 2016). A working group of Local Distribution Companies in Ontario

contracted Posterity Group through the IESO to undertake three upstream program designs for the commercial sector. The programs under design included three technology areas, compressed-air, unitary packaged air conditioning units (rooftop units), and variable frequency drives. The methodology for the study included a detailed market characterization of each technology area, including a literature review, program administrator interviews, and market actor interviews to determine barriers that an upstream program approach could overcome. The market characterization informed the program design phase which undertook to establish the proper intervention point for the program in the supply chain, to establish technology eligibility and program economics. The project work plan included a very aggressive timetable and a highly parallel process workflow that leveraged the contributions of a broader LDC steering committee representing four Ontario LDCs (Toronto Hydro, Hydro One, Horizon Utilities, and Entregrus).

Contractual and Technical Reviews: Independent Electricity System Operator (October 2015-September 2016). Compliance audits representing over $26 million in aggregate incentive payments were undertaken for retrofit, high performance new construction, energy audit and existing building commissioning program applications to ensure that energy savings were accurately quantified and reported.

Industrial Energy Efficiency Program Evaluation: Independent Electricity System Operator (February 2015-April 2016). Posterity Group, in partnership with Econoler and Cadmus, recently helped the IESO meet its program reporting requirements for the Industrial Energy Efficiency Program. Posterity Group supported the gross impact savings analysis by conducting desk-top reviews, site visits and telephone interviews to validate project savings for sample projects.

Run-it-Right M&V Methodology: Enbridge Gas Inc. (August 2015-May 2016). Posterity Group, with TdS Dixon, helped Enbridge define an approach to verify savings for its Run-it-Right program. An M&V method was developed that embodied three guiding principles: the M&V approach needed to be flexible, scalable and logical; substantiated; and balanced with regard to cost versus accuracy. Our project team also advised Enbridge on how customers should be engaged to improve the chances that RiR program savings will be realized, that they can be measured, and that they will persist.

IEI Technical Consultant: Independent Electricity System Operator (May 2014-October 2015). Posterity Group, in partnership M.A. Comeau Consultant Inc., helped the IESO by providing technical review support for applications received under its Industrial Electricity Incentive Program. Among other elements, industrial participants were required to submit metering plans with their application packages. Our team reviewed these metering plans and provided recommendations for corrective action to ensure metering plans were compliant with program requirements.

Development of Major Energy Retrofit Guidelines: Natural Resources Canada (February 2014-March 2016). Posterity Group, in partnership with Arborus Consulting and TdS Dixon, developed guidelines for the Office of Energy Efficiency's Buildings Division to support building sector initiatives, including the National Energy Code of Canada for Buildings and ENERGY STAR Portfolio Manager. The guidelines target decision makers in small to medium-sized commercial and institutional facilities and outline an approach to identifying and undertaking major retrofits. They include seven building –specific companion modules which present opportunities unique to office buildings, K-12 schools, hospitals, non-food retail, hotel, supermarket and food store facilities.

High Efficiency Natural Gas Laundry Dryers Pre-feasibility Study: FortisBC (June 2014-December 2014). Posterity Group assisted Fortis BC's Innovative Technologies Group to understand the opportunity for energy efficiency within the stock of residential and commercial laundry drying equipment in BC. Posterity Group developed

methodologies to assess high efficiency laundry drying equipment as a potential DSM measure; undertook interviews and secondary research including interviewing researchers and performing patent searches to characterize emerging technologies; and is led modelling activities to estimate conservation potential within FortisBC's residential and commercial customer base.

Combination Units Pre-feasibility Study: FortisBC (December 2013-May 2014). Posterity Group assisted Fortis BC's Innovative Technologies Group to understand the opportunity for energy savings through the use of combination space and water heating equipment within BC's residential sector. Posterity Group developed methodologies to assess combination space and water heating equipment as a potential DSM measure; undertook interviews and secondary research to characterize the BC market and supply chain for combination units; and led modelling activities to estimate conservation potential within FortisBC's residential customer base. Posterity Group conducted in-depth modelling of natural gas savings potential for numerous baseline and upgrade scenarios including end-of-life and early replacement, new construction and retrofit applications, and across various service regions.

Development of an Energy Management Best Practices Guide: Natural Resources Canada (February 2013-July 2013). Posterity Group developed an Energy Management Best Practices Guide, updated the Office of Energy Efficiency Building Division's Energy Management Action Plan, and provided a framework for website content on managing and retrofitting existing buildings.

Study to Determine EnerGuide Fuel Consumption Label Compliance: Natural Resources Canada - Office of Energy Efficiency (December 2012-March 2013). Posterity Group supported the OEE's Transportation Division in their evaluation of the EnerGuide Fuel Consumption Labeling program - a voluntary agreement between NRCan and the vehicle industry to label new vehicles with the EnerGuide Fuel Consumption Label. The project involved conducting market research at 580 sites in 33 cities across Canada, performing compliance analyses, and presenting aggregate findings.

Evaluation, Measurement and Verification (EM&V) Planning Services: Enbridge Gas Inc. (formerly Union Gas) (January 2015-September 2015). Posterity Group's program evaluation expertise was instrumental in helping Union Gas prepare its submission packages to the Ontario Energy Board for the 2015-2020 DSM program framework. EM&V plans were developed for eleven programs, including market transformation, low-income, resource acquisition, performance based and behavioural offerings.

Post-retrofit audits for NRCan's ecoEnergy Retrofit and Energy Retrofit Assistance Programs: Natural Resources Canada – Office of Energy Efficiency (December 2007-March 2011). Alex was responsible for managing a team of auditors and conducting post-retrofit audit work for over 70 projects, representing over 250 facilities. This project involved on-site project implementation verification, and M&V of savings using Option C of the International Performance Measurement and Verification Protocol (IPMVP).

SaskPower Industrial Energy Optimization Program Implementation: SaskPower (2012). Alex provided technical support to industrial participants. Through this role, Alex managed the development of baselines for Cargill Prairie Malt and Devon Energy, which involved working with their historical interval meter data, identifying key production, environmental, and operational drivers, and making adjustments.

Northern Industrial Electricity Rate Program – Energy Management Plan Review Services: Ontario Ministry of Northern Development and Mines (2011-2012). Alex provided training and ongoing technical support to the review team on energy baseline development best practices and measurement and verification (M&V) planning. Alex also reviewed quarterly reviewed quarterly reports submitted by participants and provided feedback on the nature of the progress being made towards their energy

management plans. The reviews focused on baseline development, updates on capital projects and M&V planning and reporting.

Market Transformation Evaluation Plan: Natural Resources Canada (2012). Alex developed a methodology to evaluate the impacts of contributions made by Natural Resources Canada (NRCan) to light emitting diode (LED) roadway initiatives. Since the objective of NRCan's funding was to accelerate the adoption of LED roadway technology in Canada, the recommended approach was founded on principals discussed in the California Emerging Technologies evaluation protocol, as well as the principals of Rogers' Diffusion of Innovations Theory.

Third-Party Review of the Home Energy Savings Program and Ontario Solar Thermal Heating Incentive: Ontario Ministry of Energy (2012). Alex reviewed the methodology used by the Ministry of Energy to evaluate the impact of the Home Energy Savings Program (HESP) and Ontario Solar Thermal Heating Incentive Program (OSTHI). The work focused on assessing the calculation methods used to derive the benefits generated by the Ontario government's participation in these two programs.

Evaluation, Measurement and Verification (EM&V) Plan Development: Enbridge Gas Inc. (formerly Union Gas) (August 2011-August 2012). Alex managed the development of seven EM&V plans for Union Gas in accordance with the Ontario Power Authority (OPA) EM&V Protocols and Requirements. These plans were prepared to accompany Union Gas' submission packages to the Ontario Energy Board for their new program portfolio.

Multi-family Buildings Program Evaluation: Ontario Power Authority (April 2009-July 2011). Alex was responsible for leading the gross impact analysis for the OPA's Multifamily Buildings Program evaluation. This was a three-year evaluation project where Alex managed and conducted desk-top and post-retrofit site visit evaluation activities. Alex also contributed to the process evaluation activities by conducting interviews with building owners, property managers, and building operators.

EcoNova Scotia's Clean Air and Climate Change Program Evaluation: Nova Scotia Environment (2010-2011). The Clean Air and Climate Change Program leveraged federal Trust Fund dollars to reduce environmental impacts in Nova Scotia as well as develop future capacity to stimulate ongoing impact reduction. Alex led the development of the evaluation framework and was responsible for managing the review of the GHG and air emissions impact claims for over 140 projects transcending Nova Scotia's transportation, commercial/institutional, municipal infrastructure, and renewable energy sectors.

Efficiency New Brunswick's Large Industry Program M&V Support: Efficiency New Brunswick (2008-2010). Alex provided measurement and verification plan review and support services for Efficiency New Brunswick's Large Industry program. This involved conducting site visits at industrial facilities in New Brunswick, undertaking technology research activities and providing M&V expertise.

Measurement and Verification Consultant – Ontario Power Authority's Demand Response (DR) 1 Program: St. Marys Paper Corp. (2007-2009). Alex provided M&V consulting services for St. Marys Paper Corp. in support of their participation in the OPA's DR1 Program. On a monthly basis, Alex reviewed and certified St. Marys Paper Corp.'s baseline energy use and curtailed MWh calculations.

## EDUCATION

Bachelor of Science (Mechanical Engineering), Queen's University – Kingston, Ontario, Canada, 2005

## CERTIFICATIONS & TRAINING

Project Management Professional (PMP)
Certified Measurement and Verification Professional (CMVP)

LEED Accredited Professional (LEED Canada NC version 1)
GHG Inventory, Accounting and Reporting (ISO 14064-1, ISO 14064-2), University of Toronto

## PUBLICATIONS

*Tiessen, Alex. (2014). "Chapter 14: Chiller Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures". Prepared for the U.S. Department of Energy's National Renewable Energy Laboratory.*

*Tiessen, Alex. (2014). "Chapter 16: Retrocommissioning Evaluation Protocol. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures". Prepared for the U.S. Department of Energy's National Renewable Energy Laboratory.*

## PROFESSIONAL AFFILIATIONS

Professional Engineers of Ontario
Efficiency Valuation Organization
Association of Energy Services Professionals
Project Management Institute
American Society of Heating, Refrigerating and Air-Conditioning Engineers

## EMPLOYMENT HISTORY

| | | |
|---|---|---|
| Posterity Group | Principal | 2012 - present |
| ICF Marbek | Manager | 2011-2012 |
| Marbek Resource Consultants | Consultant | 2007-2011 |
| Stantec Consulting | EIT | 2006-2007 |

# *Appendix B Project Descriptions*

**Exhibit 15: DSM Planning, Potential Analysis & Technology Research**

| Project | Client | Start-End Date | Team Member |
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| 2021 Conservation Potential Review | FortisBC Energy Inc. | Jan. 2020-Sep. 2021 | Alex Tiessen, Chris Pulfer, Talha Mirza, Dave Shipley, Chris Pulfer, Paula Claudino, Christine Gustafson |

FortisBC's 2021 Conservation Potential Review Study (CPR) will support two of FortisBC's major regulatory filings in 2022: the long-term gas resource plan (LTGRP) and the demand side management plan. Posterity Group will estimate BC's technical, economic and market potential savings over a 20-year period for natural gas using its Navigator Energy and Emissions Simulations Suite™, which enables complex, multi-variable modelling, detailed scenario exploration and solution optimization. The CPR is an important guiding document for ongoing conservation and energy management program development and support at FortisBC. Posterity Group has proposed a transparent, well-documented approach to develop the CPR and will facilitate the engagement of internal and external stakeholders. Posterity Group will complete end-use modelling and scenario development for FortisBC's 2022 Long Term Gas Resource Plan (LTGRP) in parallel with the CPR, which will ensure technical consistency across the projects.

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| 2022 Long Term Gas Resource Plan Demand Forecast and Resource Planning | FortisBC Energy Inc. | Feb. 2020-Jul. 2021 | Chris Pulfer, Dave Shipley, Paula Claudino |

Following a successful engagement in 2017, FortisBC again engaged Posterity Group to generate a natural gas end-use forecast in support of their 2022 Long Term Gas Resource Plan (LTGRP) filing.

The analysis uses baseline end-use energy intensities for over 40 customer segments across 5 provincial regions developed by Posterity Group through the 2021 Conservation Potential Review. Forecasting analysis incorporates multiple data sources including customer end-use surveys, customer energy use data, and price and commodity forecasts. In addition to the reference case forecast, Posterity Group will conduct scenario analysis that estimates the impact on gas demand from a number of policy drivers including anticipated federal, provincial and municipal codes and standards, carbon pricing, efficiency activity, natural gas transportation, liquefied natural gas production, renewable natural gas production, and availability of district energy.

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| Assessment of Additional Energy Savings from DSM Measures | FortisBC | Jun. 2021-Sep. 2021 | Alanna Komisar, Chris Pulfer, Alex Tiessen |

Calculating the impact of building level energy and emissions reductions can be subjective. At a project level, the value can be subject the baseline, early replacement considerations, calculation methodology, spillover attributions, and free ridership attributions. The subjectivity of these factors ultimately impacts the way the FortisBC can communicate the impact of their DSM program as part of their emissions reductions efforts and tracking for their 30 By 30 targets. To assist FortisBC, Posterity Group is investigating FortisBC's current DSM programs, the provincial CleanBC Funds, and other DSM jurisdictions for new methodologies and best practices on building level emissions reductions calculations.

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| DSM Planning Support | Enbridge Gas Inc. | Jan. 2021-Jan. 2022 | Alex Tiessen, Chris Pulfer, Dave Shipley |

In 2019 and 2020, Posterity Group worked with EGI to develop a Navigator end-use energy model to support DSM planning. The model aligns closely to the Ontario Energy Board's 2019 Achievable Potential Study but includes adjustments that better reflect Enbridge's input and experience, and to correct for identified limitations. Model outputs are housed within Power BI to provide an interactive means to support future EGI planning efforts. In 2021, Posterity Group is working with EGI to update and enhance the end-use model dataset to support its next multi-year DSM plan submission.

Priorities include:

- Developing evidence to position the APS in a context that more accurately reflects EGI's knowledge and experience;
- Making further adjustments to the APS dataset to address deficiencies and enable sensitivity analysis; and
- Interrogatory and Witness Support

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| Resource and DSM Planning | Enbridge Gas | Jul. 2019-Dec. 2020 | Chris Pulfer, Alex Tiessen, Dave Shipley |

In 2019 and 2020, Posterity Group worked with EGI to develop a Navigator end-use energy model to support DSM planning and Integrated Resource Planning (IRP). Model outputs are housed within Power BI to provide an interactive means to support future EGI planning efforts. The scope of IRP support included developing and integrating end-use load shapes into the scenario analysis model. The model is used to forecast consumption, peak-hour and peak-day demand, and carbon emissions within a defined control zone over a range of scenarios. Posterity Group also helped Enbridge understand outputs from their 2019 achievable potential study and leverage them in support of their DSM plan submission to the OEB for the next DSM framework.

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| FortisBC DSM Basics Workshop | FortisBC | Jun. 2021-Oct. 2021 | Alanna Komisar, Chris Pulfer, Paula Claudino |

Posterity Group is developing and facilitating a Demand Side Management (DSM) workshop for FortisBC to assist with employee on-boarding, strengthen the department's context of the programs, and amplify opportunities to work on energy savings initiatives with customers.

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| Heat Pump and Water Heater Rebate Review | FortisBC | May 2021-Jun. 2021 | Paula Claudino |

FortisBC wanted to evaluate and streamline its heat pump and electric water heater rebate program for commercial and multi-unit residential customers within the FortisBC electric service territory. They utility hired Posterity Group to recommend improvements to its program.

Posterity Group conducted the following reviews according to FortisBC's expected deliverables: a review of existing programs to understand the current FortisBC program and how it compares to other North American programs; a review of equipment eligibility to standardize the "Qualified Product" list, determine potential equipment additions, and recommend heating capacity limits; and a review of measure details to recommend incremental costs, baseline changes, and measure lives for each relevant equipment category.

Posterity Group wrote a final report reviewed by FortisBC staff to improve the rebate program processes and incentives.

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| Integrated and Connected Homes Prefeasibility Study | FortisBC | Mar. 2021-Sept. 2021 | Alanna Komisar, Chris Pulfer |

Posterity Group assessed the energy savings opportunity for integrated and connected home technologies across FortisBC's territories to advise opportunities to leverage these technologies. These conclusions would be used to enable more natural gas and electrical savings through their Demand Side Management (DSM) programs and reduce greenhouse gas (GHG) emissions.

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| Multifamily and Single Family Natural Gas Deep Retrofits Prefeasibility Study | FortisBC | Sep. 2020-Dec. 2020 | Chris Pulfer, Christine Gustafson |

FortisBC explored natural gas driven deep retrofits as a conservation and energy management solution for single family and multifamily customers. The goal of this study was to determine if there is a Demand Side Management (DSM) business case for natural gas driven deep retrofits and to recommend potential pathways for uptake if a business case exists, and identify and recommend opportunities and structures for future rebate programs.

This prefeasibility study is supporting decision-making for an internal steering group made up of technical and program staff. This group will work to secure funding, socialize program concepts with external stakeholders and interveners, and launch pilot programs over the next several months.

Posterity Group leveraged our ongoing measure assessment and end use modelling work with FortisBC to assess potential energy and GHG savings and worked with Harbourgreene Consulting to develop program pathways to overcome the market barriers evident in BC.

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| Prefeasibility Study: Residential Water Heater Controls | FortisBC | Apr. 2020-Aug. 2020 | Chris Pulfer, Talha Mirza |

Posterity Group conducted a prefeasibility study to assess the technical and market opportunities for smart residential water heater controllers. FortisBC was interested in finding out the technology's potential energy savings, demand response, and non-energy benefits. Posterity Group conducted literature reviews, jurisdictional scans, interviews with market actors to gather market and technical information. The information was then used to develop technical resource manuals, scenario analysis, and energy saving models.

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| FortisBC Ad-Hoc Measure Update | FortisBC | Nov. 2018-May 2019 | Chris Pulfer, Dave Shipley |

Posterity Group provided our expertise to FortisBC to further provide expert consulting services to review and update measures on an ad-hoc and as required basis. The project team helped FortisBC to explore the merits of various measure ideas or questions, and where appropriate, undertake the research that may be required to appropriately substantiate a proposed changed to any given measure or incentive. The following measures were examined: Air curtain operating hours; steam trap survey parameters, eligibility and incentive levels; appropriate heating load assumptions for insulation measures; Industrial unit heater applications; incoming codes and standards for air curtains, unit heaters and insulation; Infrared heater applications and operating assumptions for poultry barns.

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| Commercial and Industrial Prescriptive Measure Development | FortisBC | Oct. 2018-Mar. 2019 | Chris Pulfer |

Posterity Group worked with FortisBC to further develop and optimize energy saving measures under the Commercial and Industrial Product Rebate Program (PRP). This assignment built on Posterity Group's understanding of FortisBC's customer base to develop measure characterizations for proposed products, and determine product-specific considerations that should be included in PRP. Tasks included interviewing market actors, reviewing program assumptions in other jurisdictions, conducting secondary research, and developing detailed program parameters and business case inputs for prescriptive demand side management rebates in both retrofit and new construction applications.

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| Assessment and Development of Fireplace Program Savings Assumptions | FortisBC | Jul. 2018-Feb. 2019 | Chris Pulfer |

Posterity Group worked with FortisBC to develop updated savings assumptions for their EnerChoice Fireplace program. Project scope included savings assumptions for fireplaces installed in residential detached housing and MURB buildings, with particular interest on isolating behavioral and technical components affecting energy use for upgrade fireplaces. Posterity Group staff conducted technical and market research, reviewed current and proposed changes to federal and provincial energy performance standards, and modelled upgrade performance using multiple HOT2000 archetypes.

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| Prefeasibility Study: Micro CHP Technologies | FortisBC | Mar. 2018-Nov. 2018 | Chris Pulfer, Talha Mirza |

Posterity Group conducted a prefeasibility study to evaluate residential Micro-CHP (Combined Heat and Power) technologies. The client wanted to understand the various design categories, efficiencies, climate regions impact, fuel parameters, and possible configurations of micro-CHP products. The scope of this assignment includes both market and technology characterizations in the residential household market sectors.

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| Development of Prescriptive Incentives – Commercial New Construction Non-Lighting; Industrial Gas Retrofit | FortisBC Energy and FortisBC Inc. | Apr. 2017-Nov. 2017 | Chris Pulfer |

Posterity Group updated FortisBC Inc.'s (Fortis electric) commercial prescriptive non-lighting retrofit measures, and expanded the list to include new construction measures. Posterity Group also developed a list of prescriptive natural gas retrofit measures for FortisBC Energy's (Fortis gas) industrial customers. FortisBC wanted its measure lists to be comprehensive, contemporary, and applicable to a wide range of end-uses. The primary work plan tasks were to research and identify potential commercial and industrial measures for discussion with FortisBC, and to develop inputs and assumptions (i.e., energy and demand savings, cost, rebate level, TRC and PAC) for the measures FortisBC wanted to add to its commercial and industrial programs.

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| Development of Prescriptive New Construction & Retrofit Lighting Incentives | FortisBC Electric | Feb. 2017-Apr. 2017 | Chris Pulfer |

Posterity Group helped FortisBC develop a prescriptive lighting offering that covered both retrofit and new construction projects. The project's primary tasks included a jurisdictional scan to evaluate the applicability prescriptive lighting programs and measures offered by other utilities, and the development of input assumptions and eligibility criteria for each measure. Posterity Group contacted local lighting distributors and mined existing FortisBC program data to create region-specific cost assumptions.

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| Conservation Potential Study | Pacific Northern Gas | Aug. 2021-Nov. 2021 | Paula Claudino, Dave Shipley, Chris Pulfer |

Posterity Group is developing a Conservation Potential Review study for Pacific Northern Gas. This analysis will build on resource planning and conservation potential work Posterity Group has recently completed in BC, including FortisBC's 2021 CPR. It will support adjustments to PNG's current portfolio of DSM programs and PNG's 2023 DSM Plan and Resource Plan filing.

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| Residential Prescriptive Building Envelope Research | Enbridge | Apr. 2021-Dec. 2021 | Paula Claudino, Alanna Komisar, Chris Pulfer |

Enbridge would like to develop and substantiate several new DSM insulation measures for the single-family residential sector. This assignment will provide Enbridge with technical and market information to support the development of prescriptive or quasi-prescriptive measures for inclusion in the Ontario Technical Resource Manual.

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| Non-lighting Prescriptive Measure Development | Independent Electricity System Operator (IESO) | Aug. 2020-Sep. 2020 | Alex Tiessen |

Posterity Group led an effort to review and update electricity savings measures for the IESO in support of their internal DSM planning. The project team collected and reviewed energy performance data for the most efficient unitary HVAC equipment, chillers, demand-control ventilation controls, and compressed air equipment currently available in the Ontario market. Posterity Group also conducted an outreach study with local equipment manufacturers and suppliers to establish incremental costs for high-performance equipment over code-minimum equipment.

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| Prefeasibility Study and M&V Best Practices: Gas Heat Pumps and Dual-Fuel Heat Pumps | ConEdison via CEATI International Inc. | May 2020-Dec. 2020 | Alex Tiessen, Talha Mirza, Chris Pulfer |

Posterity Group is conducting a technical, economic and market potential study for natural gas heat pumps (GHP) and dual-fuel heat pumps (Dual-Fuel HP) in Con Edison's and Orange and Rockland's residential, multi-family and commercial sectors for both retrofit and new construction applications. Technologies will be compared to two reference cases: electric air source heat pumps, and most efficient in-kind replacement. Phase 2 of the project involves developing Measurement and Verification (M&V) best practices for natural gas heat pumps technologies.

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| Prescriptive Lighting Measures Review | Independent Electricity System Operator (IESO) | Apr. 2020-Jul. 2020 | Alex Tiessen, Talha Mirza |

Posterity Group conducted a study to update the IESO's prescriptive lighting technology list to reflect current regional incremental costs and cover technolog1111ies that accurately reflect Ontario's lighting market baseline. As part of the project, Posterity Group also updated the IESO's incentive setting strategy to ensure that incentives continue to be used cost-effectively to address the achievable potential in Ontario's non-residential lighting market.

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| LED Horticulture Lighting Support | Independent Electricity Service Operator (IESO) | Sep. 2019-Dec. 2019 | Alex Tiessen |

LED lighting has the greatest technical potential for electricity savings in Ontario's covered agriculture sector, but there are meaningful barriers in the market preventing adoption: growers don't trust the technology, it's expensive, and performance testing standards have only just been released.

Electricity capacity constraints are forecasted in Essex County's Leamington-Kingsville area over the next several years until planned grid solutions are built-out. To provide relief in the short-term, the IESO is exploring ways to offer demand-side solutions.

Posterity Group completed market research so the IESO could decide whether an enhanced LED horticulture lighting program for Essex County would help address capacity constraints. This market research included a scan of horticultural lighting programs offered in North America and interviews with three market actors in Essex County. Posterity Group also completed a profile of Essex County using results from the 2019 Greenhouse Energy Profile Study and interviewed a researcher from the Harrow Research and Development Centre, where LEDs are under study for horticultural applications.

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| Energy Management Best Practices for Cannabis Greenhouses and Warehouses | CEATI International Inc. | Nov. 2019-May 2021 | Alex Tiessen, Dave Shipley |

Posterity Group, in partnership with Cultivate Energy Optimization and D+R International, assessed and documented best practices of energy management for cannabis production in both greenhouse and warehouse facilities. The study developed a five-year forecast of energy use in three regions (Ontario, British Columbia and the Pacific Northwest) for the sector and assessed energy saving potential via a variety of gas and electric measures. The study also documented energy management in the cannabis sector including codes and standards, and DSM programs applicable to cannabis growers. Common barriers to DSM programs achieving success in the sector are discussed and design approaches and tools to enhance DSM success are provided. This study provides a comprehensive look at current energy use in cannabis facilities, best practices from numerous jurisdictions across North America, and opportunities for utilities and producers to conserve energy.

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| Retrofit Program Technical Review Interim Support | Independent Electricity System Operator (IESO) | Jul. 2019-May 2020 | Alex Tiessen, Talha Mirza |

Posterity Group provided retrofit prescriptive and custom application technical review services to Nexant as part of the IESO Interim Framework. Posterity Group staff reviewed seventy retrofit program applications in total. The scope of the retrofit projects included lighting, compressed air and refrigeration upgrades.

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| Analysis of Funding Programs to Support Market Transformation | Natural Resources Canada (NRCan) | Jun. 2019-Sep. 2019 | Chris Pulfer |

Posterity Group was retained by NRCan to identify federal, provincial and territorial funding programs that could support initiatives to promote the uptake of high efficiency equipment. This project supports the implementation of the "*Paving the Road to 2030 and Beyond: Market transformation roadmap for energy efficient equipment in the building sector*" plan which has 44 high-priority initiatives to overcome barriers to market adoption for high efficiency residential windows, space heating equipment and water heating equipment. This assignment involved researching and describing available funding sources which could support priority initiatives and identifying gaps in funding related to the priority initiatives.

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| Development of Lifecycle Analysis Website – Phase 2 | Canadian Mortgage and Housing Corporation (CMHC) | Jun. 2019-Nov. 2019 | Chris Pulfer, Talha Mirza |

CMHC reached out to Posterity Group to scope and develop a web-based lifecycle assessment tool that will allow builders to evaluate the Net Present Value and lifecycle costs of energy efficiency in their affordable housing projects.

In Phase 1, completed by Posterity Group in Q1 2019, Posterity Group completed the product design of the website and developed the scope of work. Phase 2 involved the software development, testing and deployment of the website.

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| Efficient Fenestration Products Cost Benefit Support | Natural Resources Canada (NRCan) | Apr. 2019-Jul. 2019 | Chris Pulfer, Dave Shipley |

Posterity Group gathered detailed costing information about fenestration products and calculated energy impacts in support of NRCan's Cost Benefit Analysis (CBA) of potential Minimum Energy Performance Standards (MEPS) for these products. Posterity Group obtained precise costing through tear down analyses and discussions with manufacturers, and modeled the fenestration products in different climate zones across Canada using the Housing Technology Assessment Program (HTAP).

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| Review of Natural Gas Achievable Potential Study Scenarios | Ontario Energy Board | Apr. 2019-Aug. 2019 | Alex Tiessen, Dave Shipley, Chris Pulfer |

Posterity Group supported the Ontario Energy Board (OEB) by reviewing detailed natural gas savings potential outputs from Ontario's 2019 Achievable Potential Study, and providing interpretation and analysis based on our knowledge of the Ontario market. Analysis included reviewing base year disaggregation, reference forecast, technical potential, economic potential, and achievable potential workbooks.

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| Covered Agriculture Energy Profile Study (alternate: Greenhouse Energy Profile Study) | Independent Electricity System Operator (IESO) | Jan. 2019-Oct.r 2019 | Alex Tiessen, Chris Pulfer, Dave Shipley |

Posterity Group worked with the IESO and an advisory committee to develop an energy profile for Ontario's greenhouse sector. Teaming up with Wood, Posterity Group helped to study this important sector – one that is expected to grow, particularly in regions with forecasted grid constraints.

The study: Defined a baseline energy consumption in five indoor agriculture and greenhouse sectors; Defined a "reference case" energy use for the sector over the next 6 years; and Estimated savings potential for energy and water, demand response, local generation, and programs.

Previously, there had been no dataset profiling the energy footprint of the greenhouse sector; the outcomes of this study will be valuable to several stakeholders and provincial planning groups.

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| Food Services Challenge | Independent Electricity System Operator (IESO) | Jul. 2018-Apr. 2020 | Alex Tiessen, Talha Mirza |

Restaurants Canada, NRCan, and IESO administered the Food Services Challenge in which restaurants and food service organizations were invited to improve their energy use through equipment upgrades and energy management best practices. Four participants were shortlisted to receive energy audits of their facilities, recommendations on equipment upgrades and energy efficiency measures, and were given a year to implement the measures. Case studies were developed on the four food service facilities to help other similar organizations follow suit.

Posterity Group provided the program administrators with candidate selection support, Level 1 and Level 2 ASHRAE energy audits, M&V plans for each candidate, post-retrofit assessments, and authored final reports and M&V case studies.

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| Market Characterization and Conservation Potential for Ontario's Drinking Water and Waste Water Treatment Plants | Independent Electricity System Operator (IESO) | May 2018-Dec. 2018 | Chris Pulfer, Alex Tiessen, Dave Shipley |

Posterity Group worked with the Independent Electricity System Operator to assess energy use, GHG emissions and opportunities for improved energy management in Ontario's water and wastewater treatment sector.

This project provided a detailed inventory of drinking water treatment plants and wastewater treatment plants facilities in the province; assessed baseline energy use in these facilities, including end-use level estimates of in plant energy-use and collection/distribution system pumping energy use; provided a characterization of the existing equipment stock; provided an estimate of the energy/GHG savings potential (economic) and; provided a detailed analysis of methane mitigation, demand response, and peak reduction opportunities through Combined Heat and Power and other means.

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| ENERGY STAR Skylight Market and Options Analysis | Natural Resources Canada (NRCan) | May 2018-Jul. 2018 | Chris Pulfer, Dave Shipley |

Following a broader assessment of the Canadian fenestration market, NRCan engaged Posterity Group to conduct a more detailed assessment of ENERGY STAR technical criteria options for the unit skylight market. Work included detailed energy savings and GHG modelling and analysis for alternate U-factor compliance options.

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| 2019 Ontario Achievable Potential Study Expert Advisory Panel | Independent Electricity System Operator (IESO) | Mar. 2018-Jul. 2019 | Dave Shipley |

David Shipley was an Expert Panel Member to the Independent Electricity System Operator (IESO) and the Ontario Energy Board (OEB) for the 2019 Ontario Achievable Potential Study (APS). Dave provided advice on the development of the integrated electricity and natural gas APS which seeks to identify and quantify energy savings, GHG emission reductions, and associated costs from demand side resources for 2019-2038. Dave helped the IESO and OEB ensure that the APS is conducted using industry best practices. Dave reviewed and provided guidance on all aspects of the APS including the methodology and workplan, base case and reference forecast, energy efficiency and conservation measures, technical and economic potential analysis, achievable potential analysis, and final report.

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| Solar Thermal Market Scan | Independent Electricity System Operator | Nov. 2017-Dec. 2017 | Talha Mirza, Chris Pulfer |

Posterity Group helped IESO and the GreenON Fund to understand the current market for residential solar thermal technologies in Ontario for both air and water heating.

We provided:

- A description of the products currently available in the Ontario market for both solar thermal water heating (i.e. evacuated tube collectors, flat plate collectors) and air heating (passive systems, such as the Solar Wall).
- A characterization of the Ontario value chain, market actors and their relationships, including a market structure diagram, a description of market actor roles, a listing of active firms.
- A characterization of market failures and barriers, with a focus on barriers that may be addressed by a future program.
- A summary of similar programs that are currently active or that operated in the past.

We assessed these four items through a combination of secondary (web) research and market actor interviews. In addition, Posterity Group made high-level program recommendations.

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| Low Carbon Heating Options for Ontario | Ontario Ministry of the Environment and Climate Change | Nov. 2017-Jun. 2018 | Chris Pulfer, Dave Shipley, Paula Claudino |

Posterity Group helped the Ontario Ministry of the Environment and Climate Change to identify and analyze the GHG reduction impact potential of low carbon space, water and process heating technologies and fuels in Ontario's residential, commercial and industrial sectors. The project involved four main segments and deliverables:

***Baseline Energy and GHG Inventory*** of Ontario's low temperature heat demand and corresponding GHG emissions by region, fuel, sector and end use for the year 2016 from which the impact of low carbon technologies and fuels can be assessed; ***Long List of Fuels and Technologies with carbon abatement potential***, which were evaluated to build a

short list of the 10 preferred, most promising technologies and fuels for detailed analysis; ***Detailed Analysis of the Short List of Fuels and Technologies*** including a qualitative analysis of measure barriers and enablers; breadth and suitability of application for the measure; measure availability; market actors and market structure; and other considerations. It also included a quantitative analysis of energy performance for the baseline and measure, including: GHG emissions and energy consumption; annual weighted average technology efficiency for baseline and upgrades; estimation of current and future deployment potential; capital, operational, and lifetime and infrastructure costs; and other ancillary benefits; and, ***Model Illustrative Deployment Scenarios*** to estimate the potential impacts of the 10 shortlisted fuels and technologies relative to the baseline energy and GHG inventory in order to meet the 2030 and 2050 provincial GHG reduction targets. Outputs for each scenario included GHG emissions reductions, energy savings, energy costs, as well as impacts of the electric grid and employment in Ontario were also estimated. The scenarios were modelled using the Posterity Group Navigator.

This project was completed with input from stakeholders from the Ontario Ministry of Energy, the Ontario Ministry of Agriculture, Food and Rural Affairs, the Ontario Ministry of Natural Resources and Forestry, the Ontario Ministry of Northern Development and Mines, the Ontario Ministry of Economic Development and Growth, and Infrastructure Ontario.

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| Design and Delivery of the Industrial Pay-for-Performance Pilot Program | Independent Electricity System Operator (IESO) | Nov. 2017-Apr. 2019 | Alex Tiessen, Paula Claudino |

Posterity Group provided technical support for the design and delivery of the IESO's industrial pay-for-performance pilot program. Posterity Group developed a business case for the pilot program which involved iterative modelling to evaluate the impact of different incentive rates, incentive structures, cost assumptions and energy and demand savings assumptions on cost-effectiveness. Posterity Group also created facility screening criteria for participation in the pilot and a participant M&V approach for inclusion in the business case.

After the pilot was launched in 2018, Posterity Group supported the IESO in its delivery the pilot program by applying their M&V expertise and knowledge of working with large industrial clients. Delivery activities involved: completing M&V feasibility assessments for potential pilot participants and providing recommendations on whether to accept each facility into the pilot; and developing M&V plans and assisting with energy management plans for participants accepted into the pilot.

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| Residential New Construction Program Design | Independent Electricity System Operator (IESO) | Oct. 2017-May 2018 | Chris Pulfer, Talha Mirza |

Posterity Group provided program design services to the IESO on behalf of the Residential Working Group of LDCs to design a new electric residential new construction program. The goals of the re-designed program were to improve the cost-effectiveness of new construction offerings, to align with new and updated performance standards and national and provincial initiatives, and to better integrate climate change policy. The project included several phases including secondary and primary market research with a workshop and program potential analysis, program concept development, program design and business case development.

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| Operational Improvement Study | Enbridge Gas | Sep. 2017-Nov. 2017 | Alex Tiessen |

Posterity Group, in association with TdS Dixon, completed a research study about Operational Improvement measures for hospital and university subsectors in Ontario, on behalf of Enbridge Gas. Posterity Group identified operational improvement programs offered to hospitals and universities in other jurisdictions to assess program classification

type, typical implemented measures, and measure life assumptions for these measures. Posterity Group also collected input from key Ontario industry association stakeholders regarding Ontario-specific market barriers, and to identify and discuss opportunities for tying into existing or planned interventions. Enbridge will use the results of the research study to inform program design activities, including whether or not to include operational improvement measures in their custom program, and how to assess savings for the measures should they be included.

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| Development of Emerging Technologies Profiles | Energy Solutions Center | Jul. 2017-Nov. 2017 | Chris Pulfer |

Posterity Group provided measure research and analysis, and ultimately produced prioritized lists of emerging natural gas technologies for ESC for their residential and commercial working groups. These prioritized lists are intended to help ESC member utilities identify opportunities and prioritize funding for further market research. Technology research for this project, which included manufacturers, market readiness of the technology, lifetime and warranty information, general costing information (where available) and how the technology is expected to save natural gas, is expected to be relevant for all members.

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| Analysis of Fenestration Products in Support of Canadian Market Transformation Activities | NRCan | Jul. 2017-Jun. 2018 | Chris Pulfer, Dave Shipley, Alex Tiessen |

NRCan engaged Posterity Group to analyze the residential low-rise fenestration market (windows, doors and skylights) in Canada as part of a broader strategy to decrease their impact on low-rise building energy use. This assignment included technical and market analysis of proposed changes to ENERGY STAR criteria and proposed incoming Minimum Energy Performance Standards.

With the support of subcontractors Arborus Consulting, Posterity Group staff examined the impact of these proposed standards on energy use and GHG emissions; and market actors including manufacturers, consumers, dealers and homebuilders. We also developed a stakeholder database, and critiqued proposed standards, and suggested modifications.

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| Custom and Large Volume Program Review: Factors Influencing and Mitigating Free Ridership | Enbridge Gas Inc. (formerly Union Gas Ltd.) | Mar. 2017-May 2017 | Alex Tiessen |

Union Gas hired Posterity Group to assist in the preparation of evidence for its mid-term review submission to the Ontario Energy Board (OEB). Specifically, Posterity Group was tasked with exploring and assessing Union Gas' efforts to reduce the free ridership rate for their Custom Commercial-Industrial (CI) and Large Volume offerings under the 2015-2020 DSM Framework as compared to the previous DSM framework. These work products will allow Union Gas to identify efforts undertaken under the new framework to date, to qualitatively assess the extent of these efforts per the OEB's Decision and Orders relative to the programs, and to identify major internal and market barriers to lowering the free ridership rate for these program offerings. The work involved a literature review and jurisdictional scan of program design and implementation factors that can influence free ridership; a review of Union Gas's program documentation for both framework periods; interviews with staff; and a gap analysis exercise leading to the reporting recommendations.

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| High Performance New Construction (HPNC) Updates | Hydro One (IESO) | Feb. 2017-Sep. 2017 | Chris Pulfer |

Following successful 2015 and 2016 assignments to develop tools to allocate saveONenergy HPNC Program incentives based on improvement over code and update these tools to reflect changing M&V requirements, Posterity Group was once again retained by the IESO HPNC sub-committee to provide technical program support. This iteration involved updating program tools to reflect changes to the Ontario Building Code.

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| Condensing Humidifiers Technology and Market Study | Enbridge Gas Inc. (formerly Union Gas) | Nov. 2016-May 2017 | Dave Shipley, Chris Pulfer |

Posterity Group worked with Union Gas to conduct a thorough market and technology characterization for gas condensing humidifiers, with the eventual aim of creating a DSM program to promote it within their service territory. This study included a detailed review of program constructs being used in other jurisdictions, a description of the structure of the market for this technology, highlighting relevant market actors, identification of key market barriers, development of substantiation documents for the technology if commercially available in Ontario, quantification of conservation potential, and determination of regulatory implications.

Our approach was divided into four broad areas: Market Research, Technology Research, Savings Analysis and Payback, and Substantiation and Reporting. This allowed for a comprehensive documentation of the market conditions, and a robust understanding and cataloguing of the commercially available gas condensing humidifiers.

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| Study of Federal Programming Strategies to Achieve Energy Savings | Natural Resources Canada | Dec. 2016-Mar. 2017 | Dave Shipley, Chris Pulfer |

NRCan's Assistant Deputy Ministers of the Office of Energy Efficiency (OEE) and Innovative Energy Technology Services (IETS) needed to explore an approach to planning and prioritizing national energy efficiency programming and research investments that leverages lessons learned from "Ecosystem" approach that the US Department of Energy's Buildings Technology Office (BTO) has deployed, which allows for greater coordination of activities, leveraging of respective outcomes, and more efficient use of resources.

Together with our partners Industrial Economics, Incorporated (IEc) and Optimal Energy, Posterity Group led the Canadian effort to assist NRCan to develop a comprehensive, data-driven approach to energy efficiency programming focused on the built environment, and informed by the experience of the BTO. This arrangement took advantage of IEc and Optimal's deep knowledge of the BTO, and Posterity Group's history of working with NRCan.

Posterity Group worked to provide NRCan with recommendations on how best to design, deliver, and coordinate federal energy efficiency programming and R&D investments similar to the approach taken by the U.S. This study also equipped NRCan with the tools necessary to adapt its existing programs to maximize their positive impacts on the energy efficiency of the built environment. The study was developed in two phases, with Phase 1 providing recommendations on program structure, and Phase 2 providing recommendations on the process of setting program goals, and the use of modeling tools and approaches to prioritize investment.

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| Gas Heat Pump Prefeasibility Study | CEATI International (Project Sponsor: FortisBC) | Jul. 2016-Jun. 2017 | Chris Pulfer |

Recent R&D has positioned gas heat pumps (GHP) as a high efficiency alternative to conventional boiler or furnace equipment, providing justification for a pre-feasibility study of the technology in British Columbia's residential and commercial building sectors. Several manufacturers of gas heat pump systems make energy savings claims, and a handful of North American utilities have shown interest in the technology; however, to our knowledge, there are no publicly available North American market characterizations or detailed technology assessments. For this reason, GHP technologies warrant further study as potential Demand Side Management strategy for FortisBC.

Posterity Group worked with CEATI and project sponsor FortisBC to conduct a pre-feasibility study on Gas-fired heat pump technologies to identify commercially available engine-driven and absorption equipment, assess technology risks and market barriers, estimate the achievable conservation potential of relevant technologies, and provide scenario-specific technical resource manuals. The scope of the study included residential and commercial applications for new construction and retrofits, with specific attention given to products that are expected to be commercially available before 2021.

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| Upstream Program Development Support | Enbridge Gas Distribution | Jun. 2016-Jan. 2017 | Chris Pulfer |

Enbridge Gas relied on Posterity Group to provide strategic guidance on how and where employing an upstream program approach could improve the effectiveness of its commercial program offerings. Posterity Group: Evaluated candidate measures regarding their suitability for an upstream program delivery approach in consultation with Enbridge staff; and characterized the Ontario market for two selected measures in order to determine market size, market structure, barriers to increased uptake, market actor support for an upstream delivery approach, and consistency with Enbridge's overarching DSM strategy.

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| Indirect-Fired and Condensing Tankless Domestic Hot Water Heater Technology Study | Enbridge Gas Inc. (formerly Union Gas Ltd.) | Febr. 2016-May 2017 | Chris Pulfer |

Posterity Group assisted Union Gas to develop an in-depth market characterization and energy savings potential analysis for indirect-fired water heaters in commercial and residential applications and large condensing DHW-dedicated boilers in commercial applications within their service territory. Working with Union Gas Posterity Group developed technical and market information that allowed Union to assess the potential for a prescriptive or quasi prescriptive DSM program for these measures. This was accomplished by developing DSM measures inputs and supporting substantiation documents, estimating conservation potential, and characterizing market barriers and intervention opportunities. Posterity Group updated the substantiation document developed during the project to align with the January 2017 updates to SB-10 of the Ontario Building Code.

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| Conservation Fund Investment Strategies | Independent Electricity System Operator (IESO) | Jan. 2016-May 2016 | Chris Pulfer, Alex Tiessen |

Posterity Group was retained by the Independent Electricity System Operator (IESO) to study the potential impact of investing Conservation Fund resources in a variety of technologies in the building envelope and glazing sectors. Involving research on secondary materials as well as interviews with key market actors, each report synthesized how

the various available technologies conserve energy, assessed the current market structure and existing penetration, and analyzed the likelihood of each technology making a significant impact in the near term.

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| Residential HVAC Zone Control Prefeasibility Study | CEATI International (FortisBC Project Sponsor) | Feb. 2016-Feb. 2017 | Chris Pulfer |

The market for forced-air gas furnaces has been largely transformed in Canada through minimum energy performance standards, leaving natural gas utilities with limited options for residential demand side management programming applicable to space heating. HVAC zone control systems for forced-air heating present a potential opportunity for cost-effective energy savings that do not depend on improved equipment efficiency. Several manufacturers of residential HVAC zone control systems make energy savings claims, however there have been few independent field tests.

Posterity Group worked with CEATI and project sponsor FortisBC to conduct a pre-feasibility study on HVAC zoning technologies to identify commercially available technologies, assess technology risks and market barriers, estimate the achievable potential of relevant technologies, and provide scenario-specific technical resource manuals. The scope of the study included residential HVAC zoning controls and equipment for forced-air heating in single family homes/duplexes, and row/townhouses for new construction and retrofitting existing housing stock.

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| Greenhouse Construction Industry Standard Practice Study | Enbridge Gas Inc. (formerly Union Gas Ltd.) | Aug. 2016-Jun. 2017 | Alex Tiessen, Chris Pulfer |

Posterity Group helped Union Gas establish a defensible energy performance base case for greenhouse new construction and expansion projects in Union Gas' service territory by employing a study methodology that aligns with the California Public Utilities Commission's Industry Standard Practice Guide. The study findings allowed Union program staff, the Ontario Energy Board and their evaluation contractor to accurately assess impacts resulting from DSM program activities targeting the greenhouse subsector.

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| Upstream/Midstream Commercial Program Design | Independent Electricity System Operator (IESO) | Sep. 2015-Feb. 2016 | Chris Pulfer, Alex Tiessen |

A working group of Local Distribution Companies in Ontario contracted Posterity Group through the IESO to undertake three upstream program designs for the commercial sector. The programs under design included three technology areas, compressed-air, unitary packaged air conditioning units (rooftop units), and variable frequency drives. The methodology for the study included a detailed market characterization of each technology area, including a literature review, program administrator interviews, and market actor interviews to determine barriers that an upstream program approach could overcome. The market characterization informed the program design phase which undertook to establish the proper intervention point for the program in the supply chain, to establish technology eligibility and program economics. The project work plan included a very aggressive timetable and a highly parallel process workflow that leveraged the contributions of a broader LDC steering committee representing four Ontario LDCs (Toronto Hydro, Hydro One, Horizon Utilities, and Entregrus).

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| Evaluation of the IESO's 2014 and 2015 Industrial Energy Efficiency Programs | Independent Electricity System Operator (IESO) | Feb. 2015-Apr. 2016 | Chris Pulfer, Alex Tiessen |

Posterity Group, in partnership with Econoler and Cadmus, helped the IESO meet its program reporting requirements for the Industrial Energy Efficiency Program. Posterity Group supported the gross impact savings analysis by conducting desk-top reviews, site visits and telephone interviews to validate project savings for sample projects.

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| Evaluation, Measurement and Verification Support Planning Services | Enbridge Gas Inc. (formerly Union Gas Ltd.) | Jan. 2015-Sep. 2015 | Alex Tiessen, Chris Pulfer |

Posterity Group's program evaluation expertise was instrumental in helping Enbridge Gas Inc. (formerly Union Gas Ltd.) prepare its submission packages to the Ontario Energy Board for the 2015-2020 DSM program framework. EM&V plans were developed for eleven programs, including market transformation, low-income, resource acquisition, performance based and behavioural offerings. Working under a very tight schedule and accommodating changing project requirements, Posterity Group provided advice and developed actionable deliverables that aligned with their evaluation budget and program portfolio priorities and followed the IESO's EM&V Protocols.

**Exhibit 16: Other FortisBC Projects**

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| Renewable Gas Program Review – Cost Recovery | FortisBC Energy Inc | Jul. 2021-Oct. 2021 | Chris Pulfer, Dave Shipley |

FortisBC Energy Inc (FEI) is reassessing the pricing scheme of their voluntary renewable gas (RG) program, including how to recover supply costs from customers who did not volunteer to pay a premium for RNG. Posterity Group is focusing on assessing how non-participants may respond to changes in their annual gas bill from RG-related costs. Posterity Group is estimating impacts to annual demand and customer defection from price signals. The results of this project will help inform FEI's proposed design of the RG program to minimize impact on customers.

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| Program Evaluation for the Industrial Optimization Program | FortisBC Energy Inc. | Sep. 2018-May 2019 | Alex Tiessen, Talha Mirza, Paula Claudino |

Posterity Group helped FortisBC evaluate its Industrial Optimization Program and provided recommendations on how to improve the Program moving forward by focusing on four evaluation objectives:

1) Obtaining Program feedback from participants and consultants;
2) Verifying Program enabled savings;
3) Comparing the Program M&V structure to similar programs in other jurisdictions; and
4) Assessing free-ridership and participant spillover.

FortisBC used the outcomes from this evaluation to report on program enabled impact savings and establish a Program net-to-gross ratio, while at the same time drawing insights from program feedback, M&V structure research and free-ridership and spillover findings to inform future program enhancements.

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| Long-Term Gas Resource Plan Information Request Support | FortisBC | Mar. 2018-Nov. 2018 | Dave Shipley, Chris Pulfer |

Posterity Group supported FortisBC in responding to BC Utilities Commission and intervener Information Requests (IRs) regarding its 2017 Long Term Gas Resource Plan (LTGRP). Posterity Group provided FortisBC with information and analysis in support of such inquiries related to the load forecast and subsequent scenario analysis conducted by Posterity Group for inclusion in FortisBC's LTGRP.

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| Natural Gas Demand Scenarios | FortisBC | Jul. 2017-Nov. 2017 | Dave Shipley, Chris Pulfer |

Posterity Group provided demand scenario analysis in support of FortisBC's demand forecasting group. This work involved analysis of six scenarios that built on the core end-use forecast completed in June 2017. The project results helped FortisBC to assess the impact of various policies on natural gas demand and CO2 emissions, including the City of Vancouver zero emissions plan and the BC Step Code. As part of this work, Posterity Group added features to the processing software at the heart of the forecasting model to allow users to dynamically select the municipalities that were expected to opt into new energy efficiency requirements.

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| Long Term Resource Plan Model and Forecast | FortisBC Gas | Oct. 2016-Jun. 2017 | Dave Shipley, Chris Pulfer, Paula Claudino |

FortisBC turned to Posterity Group to develop a new end-use forecasting model to enhance their current end-use resource forecasting approach, and to generate a new 2017 forecast. These enhancements include: a full integration of energy efficiency impacts at the individual measure level, improved transparency of the model; features to allow casual users to vary parameters and review the effects on the results; outputs for every year in the forecast period (rather than milestone years); closer linkage between the annual demand and peak demand forecasting approaches; the ability to analyze the impact of changes such as municipal policy activity, ability to analyze the impact of liquefied natural gas and natural gas transportation initiatives.

The project entailed building an entirely new modelling platform that applies an innovative approach to generating transparent data input files and results in faster more reliable operation. The forecasting project work comprised managing large volumes of data such as end-use surveys, customer energy use data, price and commodity forecasts to construct new base-case, reference case and forecast scenarios that include DSM impacts, impacts of future codes and standards, impacts of natural gas transportation, and of liquefied natural gas.

# Attachment 3.1

# FortisBC, Inc.

## Deferred Capital Expenditure Study

**July 2016**

**Prepared by:**


570 Kirkland Way, Suite 100
Kirkland, Washington 98033

A registered professional engineering corporation with offices in
Kirkland, WA and Portland, OR

Telephone: (425) 889-2700 Facsimile: (425) 889-2725

www.eesconsulting.com

EES Consulting

July 5, 2016

Mr. Keith Veerman
FortisBC, Inc.
1975 Springfield Road, Suite 100
Kelowna, BC V1Y 7V7

SUBJECT: Deferred Capital Expenditure Report

Dear Mr. Veerman:

EES Consulting, Inc. (EES) is pleased to submit a final report for the Deferred Capital Expenditure (DCE) on behalf of FortisBC. We would like to acknowledge and thank you and your staff for the excellent support in developing and providing the data for this project.

Very truly yours,

Anne Falcon
Senior Associate

570 Kirkland Way, Suite 100
Kirkland, Washington 98033

Telephone: 425 889-2700 Facsimile: 425 889-2725

A registered professional engineering corporation with
offices in Kirkland, WA and Portland, OR

# Contents

# Introduction

EES Consulting (EES) is pleased to provide you with a final draft report summarizing the results of our research and calculation of the Deferred Capital Expenditure (DCE) factor. FortisBC plans to use this DCE factor to estimate the "avoided" transmission and distribution (T&D) costs due to the implementation of demand-side management (DSM) programs. The recommended Marginal Cost methodology was selected based on the literature review of the common methodologies used to determine avoidable T&D expenditures due to DSM program implementation. Based on FortisBC's forecast growth-related capital T&D expenditure schedules and annualizing factors obtained from FortisBC, this study found the levelized T&D DCE values to be $67.03 and $12.83 respectively in 2015 dollars.

As part of the evaluation of the cost-effectiveness of demand-side management resources, utilities are including the avoided infrastructure costs for deferred transmission and distribution costs. Based on a recent survey[1] by the (ACEEE) 82 percent of the states surveyed include avoided T&D costs in the benefit-cost analysis of DSM programs.

According to the Regulatory Assistance Project's 2011 report *Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements*: "The capital cost of augmenting transmission capacity is typically estimated at $200 to $1,000 per kilowatt, and the cost of augmenting distribution capacity ranges between $100 and $500 per kilowatt. Annualized values (the average rate of return multiplied by the investment over the life of the investment) are about 10 percent of these figures, or $20 to $100 per kilowatt-year for transmission and $10 to $50 per kilowatt-year for distribution. There are also marginal operation and maintenance costs for transmission and distribution capacity, but these are modest in comparison to the capital costs."[2]

This report explores the methodologies available when assessing the deferred, or avoided, transmission and distribution costs, provide an overview of methodologies and values used by several utilities in the U.S. and Canada, and recommend a calculation and value to be used going forward for FortisBC DSM assessments.

## Estimating Avoided Transmission and Distribution (T&D) Costs

DSM has the potential to reduce or delay infrastructure investments in a utility's transmission and distribution systems. In particular, DSM can defer T&D investments that are driven by economic conditions and growing peak loads.

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[1] "A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs" http://aceee.org/research-report/u122

[2] Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements RAP, p. 6.

In the context of DSM, avoided costs are the costs that are avoided by the implementation of an DSM measure, program, or practice. Such costs are used in benefit-cost analyses of DSM measures and programs. Different elements of the T&D system can experience peak demand at different times of the day and even in different seasons. Thus, the extent to which an efficiency program can help defer T&D investment will depend on the hour and season of peak and the hourly and seasonal profile of the efficiency program's savings. In order for DSM programs to defer T&D investments, the DSM programs would need to impact loads during the peak hour on the transmission or distribution system. NV Energy, for example, assumes that 25 percent of the annual growth-related T&D costs can be avoided due to DSM programs.

The calculation of distribution avoided cost is particularly complicated because the distribution grid has been built for all existing customers and the main purpose is to provide reliability to customers. As a result, the maximum avoided cost may only be realized in areas of grid expansion due to load growth. Even in areas of growth, distribution system costs can be avoided only when the DSM programs are included in the design process, and the utility is planning to rely on these programs as a resource. Considerable avoided costs may also be realized where utilities can avoid replacing or upgrading aging equipment needed to support load growth.

In order to maximize the avoided T&D cost, targeted DSM programs can be implemented in specific locations due to constraints or the need for significant infrastructure investments.[3] However, these non-wires solutions[4] to T&D investments are specifically designed programs, rather than general DSM programs for the residential, commercial or industrial end-user. They will generally result in much higher avoided costs than are used for overall DSM cost-effectiveness evaluations.

This paper does not examine the avoided T&D costs by DSM program or for targeted distribution programs specific for the FortisBC system. Instead, it explores the different methods used by various jurisdictions in the U.S. and Canada to determine the avoided T&D costs when evaluating overall DSM programs.

Based on the survey of methodology and DCE results, the following best practices can be concluded:

[3] See for example *Energy Efficiency as a T&D resource: Lessons from recent US efforts to use geographically targeted efficiency programs to defer T&D investments*, Northeast Energy Efficiency Partnership January 9, 2015.

[4] Non-wires solutions can include for example energy efficiency, demand reduction initiatives, pricing strategies and distributed generation solutions.

- Use methodology based on specific utility data available. Estimated deferred T&D investments can vary considerably depending on the region and the utility system. Therefore, the best option for FortisBC is to estimate T&D DCE based on FortisBC data.
- Separate the calculation of transmission and distribution capital deferred expenditures and provide a DCE for each function if data is available.

- For each function (transmission and distribution) evaluate the potential on-peak impact of the potential conservation programs.

- While benchmarking may be indicative, benchmarking DCE results for FortisBC outside Western Electricity Coordinating Council (WECC) does not appear to be appropriate[5].

- Using a marginal costing approach appears to be the most common calculation methodology.

[5] Customer usage patterns, energy efficiency programs and transmission and distribution system constraints are different outside WECC than what is faced by FortisBC.

# Avoided T&D Cost Estimation Methodologies

This section of the report provides more information on each of the methodologies commonly used to value avoided T&D expenditures.

## Overview

In general, there are five different methods used to estimate the avoided T&D costs to be included in the benefit calculation of DSM programs. Many utilities calculate the avoided costs for transmission and distribution separately as the investment in these systems are different over time. The most common calculation methods are the following:

- Marginal avoided costing: estimates avoided capital costs based on the cost of adding one additional MW. This method can be performed based on a regression or based on an average of forecasted investments.

- Average investment: estimates the average amount of capital investment deferred based on the reduction of peak load and average transmission and distribution expansion costs.

- Market value: for utilities that rely on a market for transmission capacity, the market price can be used to determine the avoided transmission cost.

- Scenario-based estimation: estimates infrastructure investments with and without the DSM program. This methodology is very data intensive and the results are highly dependent on the DSM programs evaluated.

- Benchmarking: estimates are based on results from other utilities.

Each of these methods is further described below.

## Marginal Cost Method

The marginal cost reflects the savings associated with a decrease of one MW either permanently or as a deferral in costs. There are two methods that can be used to estimate the marginal cost: average forecasted value or a regression technique.

The average forecasted value relies on the utility's forecast of transmission and distribution system upgrades and expansions, and the projected peak loads increases over the same time period (typically 5-10 years). The total investments over the analysis period is then divided by the total peak increases over the same period. This calculation results in a $/kW for the analysis period. This value is then annualized by applying a carrying cost factor based on the utility's cost of capital and the length of the analysis period. Some utilities only include the investment cost in the avoided cost estimate while other utilities also include associated

avoided operation and maintenance (O&M) costs. The marginal cost method, however, is not responsive to the timing of investments or load growth, rather it considers only their cumulative effect over the planning period.

A marginal unit capital cost can also be determined by regressing the cumulative changes in investment with cumulative changes in load. The marginal unit capital cost is then annualized by using a carrying cost factor and may be grossed up for marginal expenses. Although the regression method is accurate for calculating historical marginal costs, it is predicated on the assumption that the future will resemble the past. Because of this reliance on historical data, many have found that the regression methods are unsuitable for DSM cost-effectiveness evaluations.

## Average Investment Method

The average investment method computes an arithmetic average by dividing the historical investment by the load growth during the same period. The resulting unit marginal cost is then annualized using a carrying charge factor. The carrying charge factor annualizes the marginal cost by calculating the weighted return on investment for the utility after taxes. Similar to the marginal cost method using regression analysis, the issue with this methodology is that it assumes that the historic average will reflect necessary investments in the future.

## Market Value

For some utilities, it is possible to determine the avoided cost of transmission based on a market proxy. This is particularly relevant for utilities that do not own their own transmission system, but rather they purchase transmission services from other parties. For example, FortisBC wheels power over BC Hydro's transmission system using Rate Schedule 3817. The annual wheeling rate ranges between $13,734.87 and $56,199.12 per MW of nominated wheeling demand. This translates to approximately $13.73 - $56.20 per kW-yr in transmission wheeling costs. DSM capacity savings on peak would therefore avoid between $13.73 and $56.20 per kW-yr based on BC Hydro's transmission tariff.[6]

## Scenario Method

In practice, the impact of DSM on the transmission and distribution system will vary considerably based on the location, type of program, customer mix, and other factors. Initially, the impact of these factors suggest a need to conduct in-depth studies of the transmission and distribution system. The optimum analysis would develop feeder level forecasts of the change or delay in investments and peak growth from specific DSM programs. Corresponding avoided costs can then be computed in a bottom-up manner using actual component costs or location specific planning costs.

[6] BC Hydro Transmission tariff. https://www.bchydro.com/about/planning_regulatory/tariff_filings/oatt/general-wheeling.html

However, this type of analysis is very time consuming and requires a combination of engineering judgment and multiple software simulations to examine the potential changes in the transmission and distribution systems due to DSM programs. This method is, therefore, not a viable option unless the utility is implementing a targeted program specifically used to address localized transmission or distribution limitations.

## Benchmarking

The final option that has been used by many jurisdictions is benchmarking. Because the estimation of avoided transmission and distribution costs is difficult, many utilities use data from existing studies and often average the results. The reasoning behind this methodology is that avoided costs are likely to be similar in magnitude across utilities. Of course, the different studies show that there are a wide range of estimates depending on utility load growth, the constraints on the transmission and distribution system, and the methodology used to estimate the avoided costs.

## Calculation Considerations

Within each methodology there are several variations and assumptions about the specific data. For example, the utility must consider if only the investment cost should be included in the marginal cost estimate or if an overhead adder or avoided O&M expenses should be included as well.

In addition, the utility must consider if the avoided T&D costs need to be de-rated. Some energy efficiency programs will not result in capacity savings in locations where the transmission and distribution systems are constrained. Therefore, T&D costs will only be reduced if a significant amount of load reduction is attained in an area where the utility expansion plans can be altered. Using a deration approach helps mitigate the risk of overvaluing DSM program peak reduction potential.

It should also be noted that, in some cases, the reduction in loads resulting from past DSM, rate structures, or natural changes in consumer loads lead to a case where there is surplus transmission and/or distribution capacity on the system. In this case there would not be any incremental savings in T&D costs associated with new DSM programs.

Estimated deferred T&D investments can vary considerably depending on the system condition, projected growth, and other factors the utility considers when determining how much of the investment is deferrable. At the most general level, estimates of avoided T&D costs are typically developed by dividing the portion of forecast T&D capital investments that are associated with load growth by the forecast growth in system load. As part of the analysis, T&D capital investments should exclude investments associated with replacement due to time-related deterioration or other factors that are independent of load.

Based on the review of methodologies, the following methodology best practices should be followed:

- Use methodology based on specific utility data available. Estimated deferred T&D investments can vary considerably depending on the utility system.

- Separate the calculation of transmission and distribution capital deferred expenditures and provide a DCE for each function if data is available.

- For each function (transmission and distribution) evaluate the potential on-peak impact of the potential conservation programs.

# Literature Review

As part of this project, EES performed a literature search and examined the best practices for the methodology and resulting DCE factor used by a range of utilities in the U.S and Canada. The following sources were reviewed:

- BC Hydro's Integrated Resource Plan
- Ontario Power Authority (OPA)
- Hydro One
- Northwest Power and Planning Council, 7th Power Plan Methodology
- California Public Utility Commission Standard Practice
- Avoided Energy Supply Component (AESC) Study Group Report for New England
- Regulatory Assistance Project (RAP) Reports on Valuing Avoided Costs
- Regulatory filings and proceedings by several utilities

The findings related to the methodology used to determine T&D avoided costs for DSM evaluation and the resulting values are described below.

## BC Hydro

BC Hydro is in the process of updating its conservation potential assessment. In the 2008 LTAP study performed, BC Hydro used the following values for avoided costs:[7]

- *Bulk transmission capacity:* $5 per kW-year between the Lower Mainland and Vancouver Island based on British Columbia Transmission Corporation (BCTC) estimates of the cost of incremental firm bulk transmission. Zero between the Interior and Lower Mainland because this cost is reflected in the avoided generation capacity cost. Zero between other regions because DSM is not expected to generate sufficient capacity savings in those regions to defer bulk transmission capacity investments.
- *Regional transmission capacity:* $30 per kW-year based on BCTC estimates of the cost of incremental regional transmission.
- *Distribution capacity:* $17-28 per kW-year, based on BC Hydro estimates of the cost of incremental distribution capacity in different regions of the province.

These values have been updated since then in the Amended F2012 to F2014 Revenue Requirements Application Updated DSM Plan,[8] the following assumptions were listed:

[7] Appendix K to BC Hydro's 2008 LTAP.

[8] BC Hydro Amended F12/F14 RRA – Amended New Appendix II, Attachment 6, p. 191 of 271.

- *Bulk transmission capacity:* $0 per kW-year ($ F2011) based on BC Hydro estimate because there are no bulk transmission capacity investments expected to be deferred by the Updated DSM Plan.
- *Regional transmission and substation capacity:* $11 per kW-year ($ F2011) based on BC Hydro estimate of the cost of the regional and substation capacity costs avoided by the Updated DSM Plan.
- *Distribution capacity:* $1 per kW-year ($ F2011), based on BC Hydro estimates of the distribution capacity cost avoided by the updated DSM Plan.

The methodology used to determine these avoided costs was not described.

## Ontario Power Authority

The Ontario Power Authority has developed a cost effectiveness guide and model for Conservation and Demand Side Management (CDM) resources for use by Ontario's Local Distribution Companies (LDC). This model includes avoided transmission costs of $3.83 per kW-yr ($2014) and avoided distribution costs of $4.73 per kW-yr ($2014).[9]

## Hydro One, Ontario

In the 2011 Integrated Power System Plan (IPSP), Hydro One used avoided costs to evaluate the cost effectiveness of the conservation resources proposed in the IPSP. The avoided costs were determined by using an incremental cost estimation method.[10] This methodology determined the transmission and distribution investments that could be avoided or deferred by CDM measures. The avoided transmission costs were estimated based on the magnitude of capital expenditures deferred, the deferral period, the cost of capital, the avoided annual operations and maintenance (O&M) costs, estimated at 1% of capital costs.

The annual avoided cost of transmission including both capital and operating costs were estimated at $5.40 ($2007) per kW of incremental demand at the time of the system peak load. Similarly, the avoided cost of distribution was estimated at $6.70 ($2007) per kW of incremental demand at the time of the system peak load. These incremental costs were re-evaluated, at a 4% real discount rate to be $3.40 per year for transmission and $4.20 per kW per year for Distribution.[11]

[9] Ontario Power Authority, "Conservation and Demand Management Energy Efficiency Cost Effectiveness Guide" Final v1 - October 2014. P. 58.

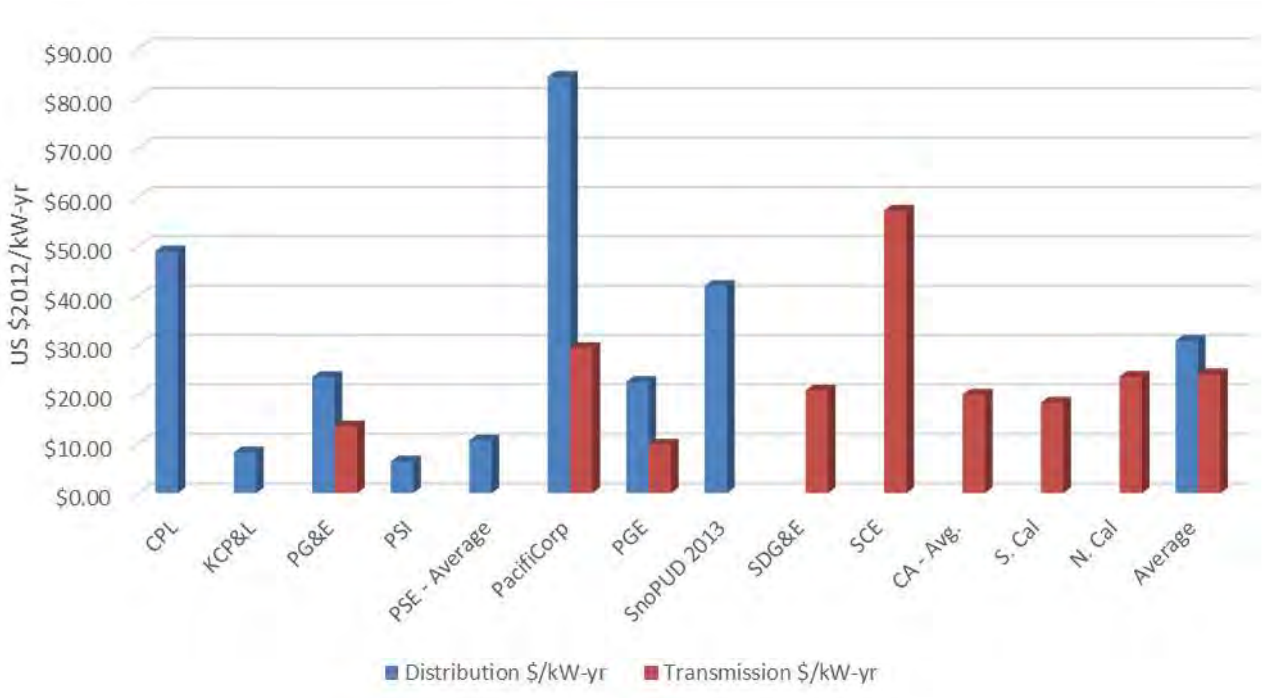
[10] Refer to EB-2007-0707, Exhibit D, Tab 4, Schedule 1, Attachment 15.

[11] Refer to EB-2007-0707, Exhibit D, Tab 4, Schedule 1, Attachment 3, p. 5 of 37.

## Northwest Power and Planning Council, 7th Power Plan Methodology

The Northwest Power and Planning Council (Power Council) develops a power plan every five years to examine the power supply and cost-effective DSM potential in the States of Washington, Oregon, Idaho and Montana. Potential T&D avoided costs from investment in DSM is included in the determination of cost-effective DSM programs. The methodology used by the Power Council includes a benchmarking survey of the avoided T&D costs used by utilities from the Northwest and California, as well as benchmarking with data from outside the WECC region. Figure 1 provides the data from the Power Council survey escalated to 2012 dollars.[12]

**Figure 1**
**Value of Deferred Capital Expenditure Survey – Pacific Northwest**




The Power Council relied on the California data described below, as well as reported data from Northwest utilities. In addition, the distribution avoided costs were compared to regional data provided in the report "*Avoided Energy Supply Costs in New England: 2013 Report.*"[13] The majority of the distribution cost information is based on 2006 data and then escalated. However, the estimate from Snohomish PUD was updated more recently.

[12] Costing Methodology for Electric Distribution System Planning.
[13] Hornby, Rick et al. (Synapse Energy Economics), *Avoided Energy Supply Costs in New England: 2013 Report*, prepared for the Avoided Energy Supply Component (AESC) Study Group, July 12, 2013.

In the recent update, Snohomish PUD developed their deferred distribution costs by determining the major upgrades and major expansion costs over a forecasted 7-year period. Next, the total value of forecasted distribution investments was divided by the forecasted peak growth. After annualizing using 5% borrowing rate over a 35-year life of assets, this methodology resulted in a $42/kW-yr deferred value.

The resulting survey shows significant differences in transmission and distribution deferred value across utilities. The standard deviations for the sample data is $26.59 (86%) for distribution and $14.65 (61%) for transmission.

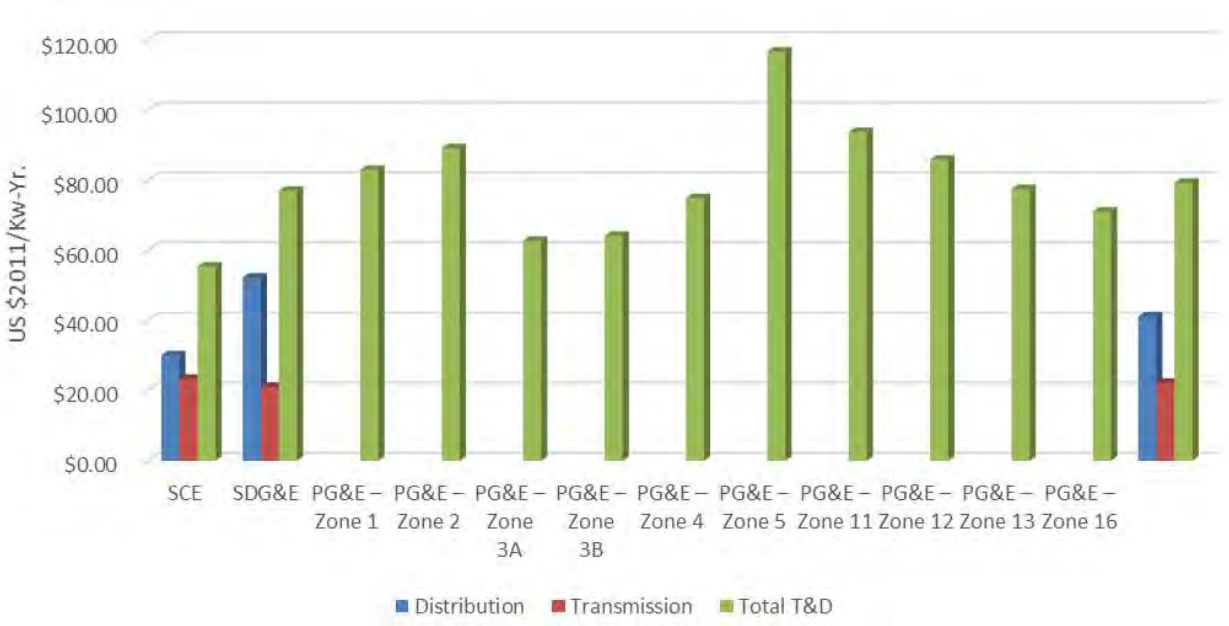
## California Public Utilities Commission (CPUC) Standard Practice

The CPUC has adopted a calculator for use by the Investor Owned Utilities (IOUs) in California to report on the cost-effectiveness of DSM programs. This model takes the marginal T&D cost determined in the IOUs' cost of service studies and uses these values to determine the avoided costs for DSM program evaluations.

The general methodology used by the utilities to develop the marginal T&D costs for the Cost of Service studies is based on forecasted investment data, forecasted load increases, and the addition of any general plant loading factor plus an avoided O&M adder. Because the avoided costs depend upon area-specific capacity conditions, the Pacific Gas & Electric (PG&E) model forecasts electric T&D avoided costs by climate zone and is based on the hours of the year that are the most likely drivers of the local peak demand. Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) calculate the utility average T&D marginal cost.

Figure 2 displays the weighted average annual T&D avoided costs for SCE, PG&E and SDG&E from the most recent study.

**Figure 2**
**Value of Deferred Capital Expenditure - California**




## New England AESC Study

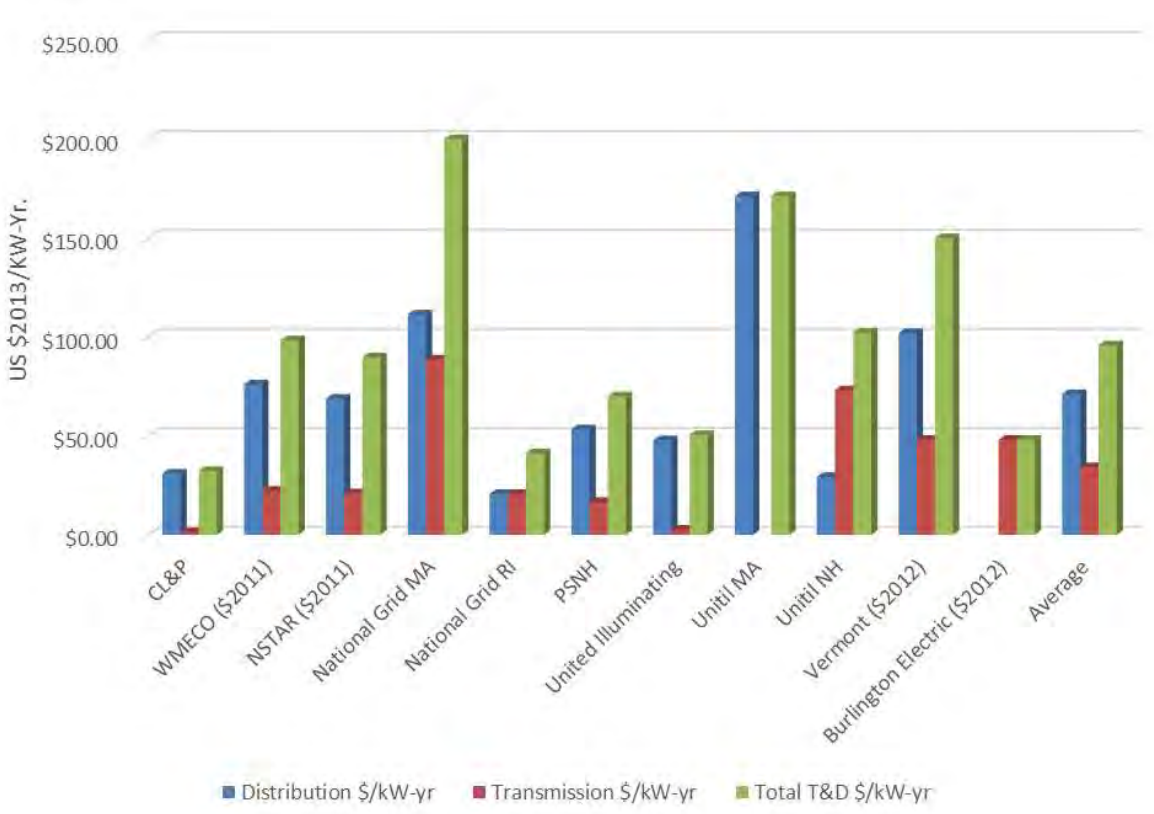
The Avoided Energy Supply Component (AESC) Study Group released the Avoided Energy Supply Cost in New England: 2015 Report.[14] The AESC provides estimates of avoided costs for program administrators throughout New England to support their internal decision-making and regulatory filings for DSM program cost-effectiveness analysis. As part of the avoided cost calculation, the AESC provides estimates of avoided T&D costs for several utilities in the region.

In 2013, the utility estimates of avoided T&D costs ranged from about $30 per kW-year (Connecticut Light & Power (CL&P)) to about $200 per kW-year (National Grid –Massachusetts) USD.[15] Figure 3 provides the estimated T&D Deferred Capital Expenditures from the 2013 Study.

[14] http://ma-eeac.org/wordpress/wp-content/uploads/2015-Regional-Avoided-Cost-Study-Report1.pdf.

[15] Hornby, Rick et al. (Synapse Energy Economics), *Avoided Energy Supply Costs in New England: 2013 Report*, prepared for the Avoided Energy Supply Component (AESC) Study Group, July 12, 2013.

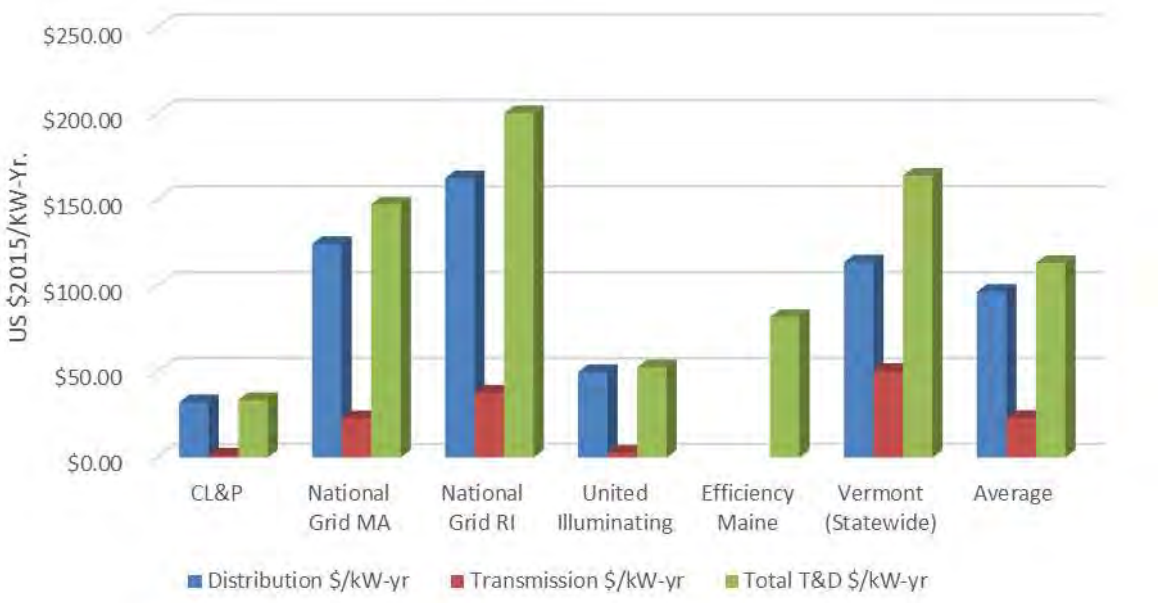
**Figure 3**
**Value of Deferred Capital Expenditure – New England 2013***




*In $2013 unless noted.

For the 2015 study, the AESC 2015 project team issued a survey to the sponsoring electric utilities requesting the estimates of avoided Transmission and Distribution costs they use in their analysis of efficiency measure cost-effectiveness tests. The 2015 update resulted in a similar range of results as can be seen in Figure 4.

**Figure 4**
**Value of Deferred Capital Expenditure – New England 2015**




These estimates of avoided T&D costs were generally developed by dividing the portion of forecast T&D capital investments that are associated with load growth by the forecast growth in system load. These T&D investments exclude investments associated with replacement due to time-related deterioration or other factors that are independent of load. Such estimates vary considerably often as a function of the utilities' assumptions regarding how much investment is deferrable. More detail on the methodology used to develop the T&D estimates for some of the utilities is provided below.

## Vermont

In 2012, the Vermont distribution utilities and Department of Public Service jointly reviewed and updated avoided T&D costs and filed those estimates with the Vermont Public Service Board. [16] The statewide estimates are based on load-related investments in the last decade ending in 1996 for which Vermont experienced significant load growth. The statewide avoided costs are reduced to reflect the reduction in line losses that would be associated with increasing T&D capacity. The annual avoided T&D costs start at $159/kW-year in 2013 and decline gradually resulting in a real-levelized value of $150/kW-year over a 29-year period

[16] Docket EEU-2011-02 – EEU Avoided Costs – T&D Component Working Group Recommendation, August 31, 2012 http://psb.vermont.gov/docketsandprojects/eeu/avoidedcosts/2011, Order Re EEU Avoided Costs for Transmission and Distribution.

($2012 US). For 2015, the total avoided T&D cost was deemed at $150/kW-yr in $2012, which resulted in $164/KW-Yr in $2015 according to the updated AESC Study.

## Burlington Electric

The Burlington Electric Department expects that no load-related distribution investments would be required over the next 20 years even without energy-efficiency programs, and, therefore, only uses the Vermont statewide avoided transmission cost.

## ICF Tool

The ICF Tool is a workbook developed by ICF Consultants as part of the 2005 Avoided Energy Supply Component (AESC) Study and was most recently updated by ICF in 2009. The inputs for the workbook are:

- Historical and budgeted future capital costs,
- Historical and future load, and
- Various accounting parameters from FERC Form 1 data.

Analysis period cost data is divided by analysis period load data to derive an average capital cost per kW-yr. This average cost is multiplied by a factor representing the percentage of capital costs that are avoidable with DSM (another input variable). The model provides default avoidable percentages that are based on ICF's expert judgement and have been accepted by the AESC study group participants. The avoidable $/kW-yr is further modified by a carrying charge, determined from the accounting inputs, to develop an annualized avoided capacity value in $/kW-yr.

Based on review of some of the carrying charge calculations in the AESC 2009 study, National Grid updated this part of the workbook to create the updated ICF Tool. Other utilities have updated the workbook at other intervals. National Grid indicated that its practice is to use five years of historical and forecast data for both transmission and distribution data in developing the avoided transmission and distribution capacity values.

## United Illuminating (B&V Report)

United Illuminating's methodology (B&V Report) is the following:

- Identification of historical and future T&D capacity additions which could have been fully or partially avoided with additional DSM programs.
- Collection of historical costs plus AFUDC associated with projects identified in the first step. Calculated project costs are then divided by each project's incremental MW load carrying capacity to derive a marginal capital cost for capacity per MW.

- Calculation of marginal O&M expenses.
- Converting marginal capital costs to annual costs adjusting for revenue requirements based on accounting inputs.
- Calculation of DSM savings based on historical and projected load growth.
- Calculations of annual avoided cost based on annual costs and identified DSM savings.

## New England AESC Study Summary

Table 1 summarizes the methodology or tool used by the New England utilities using information from both the 2013 and 2015 AESC studies.

**Table 1**
**Summary of New England Electric Utilities – Methodology**

| Company | Methodology |
|---|---|
| CL&P | ICF Tool |
| WMECO | ICF Tool |
| NSTAR | ICF Tool |
| National Grid MA | ICF Tool |
| National Grid RI | ICF Tool |
| PSNH | ICF Tool |
| United Illuminating | B&V Report |
| Efficiency Maine | Historical |
| Unitil MA | ICF Tool |
| Unitil NH | ICF Tool |
| Vermont (Statewide) | Historical |
| Burlington Electric Department | Historical |

**Notes**
NA= Not applicable
ICF Tool = ICF workbook developed in 2009.
B&V Report = United Illuminating Avoided Transmission & Distribution Cost Study Report, Black & Veatch, September 2009.

When examining the results from the New England AESC study, it is important to recognize that the T&D DCE estimates are for utilities located outside WECC. Customer usage patterns, DSM programs and transmission and distribution systems constraints are different outside WECC than what is faced by FortisBC. While the general calculation methodology can be applied, it is unlikely that these estimates from the AESC study can be used by FortisBC to accurately reflect T&D DCE.

## Michigan

In Michigan, the avoided transmission and distribution costs included in DSM cost-effectiveness analysis are specific to each utility and are generally relatively low. For example, Consumers Energy has noted that the current utility system structure would need to change substantially before the cost of building new transmission and distribution could be avoided. In its 2011 benefit cost analysis, the company used a $5/kW-yr figure for the T&D avoided cost value. This value essentially reflects reduced maintenance costs and does not represent changes in infrastructure costs.[17]

## Illinois

The Ameren Illinois Company (AIC) separates the calculation of avoided transmission and distribution into two separate calculations.[18] The methodology used to estimate avoided distribution costs attributable to DSM programs involved estimating projected system load growth and estimate marginal cost of system capacity. Distribution engineering review a variety of bulk substation and distribution substation projects to determine an average marginal cost of capacity expansion. Typical costs for distribution circuit construction and line transformers were included. Next, the expenditures to serve load growth were estimated by evaluating budget information for an extended period. This evaluation is complicated by the fact that projects serve a variety of purposes: capacity upgrades to serve incremental system load, capacity upgrades to serve relocated system load, and refurbishment or replacement of equipment to avoid imminent failure.

The avoided electric transmission costs were estimated by using three factors:

- "Usage Growth-Related Factor." This factor is designed to capture the effect that some of the transmission projects may not be deferrable from DSM because it is not driven by growth in usage, but rather it is driven by customers moving to different areas. In this case, there is local growth but not system wide growth.

- "Location-Specific Factor/Deferrable Factor." This factor captures the effect that AIC is looking at the system as an aggregate and cannot tell whether load pockets will be deferred by DSM programs. Since DSM programs are not being designed to avoid or offset specific transmission projects, there is no certainty as to which projects will actually be deferred.

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[17] Consumers Energy 2012. Consumers Energy Company, "Consumers Energy 2011 Energy Optimization Annual Report," Case No. U-16736, May 31, 2012, available at: http://efile.mpsc.state.mi.us/efile/docs/16736/0001.pdf p.19.

[18] Ameren 2013b. Ameren Illinois, "Electric and Gas Energy Efficiency and Demand-Response Plan, Program Years: June 1, 2014 – May 31, 2017 (Plan 3)," Case No. 13-0498, August 30, 2013, available at: http://www.icc.illinois.gov/docket/CaseDetails.aspx?no=13-0498. Pp 27-29.

- "Condition/Reliability Replacement Factor." This factor approximates the effect that load growth projects cause transmission asset turnover, so if AIC does not upgrade or replace a substation because of DSM, then AIC will need to spend money on additional maintenance or reliability projects that would have been avoided had new equipment been installed to meet load growth.

This methodology resulted in avoided transmission costs of $6/kW-yr and avoided distribution costs of $17/kW-yr in $2014.

## NV Energy

The methodology for quantifying T&D capital investment savings generated by DSM energy savings is based on the marginal cost study filed in Nevada Power's last general rate case.[19] The adopted valuation process reduces potential difficulties regarding uncertainty in load forecasts and T&D construction budgets, and it takes into account the ripple effect or the effect of deferred construction investments during the useful life of DSM measures.

The annual revenue requirement for the marginal cost of transmission facilities and distribution substations is estimated at US $48.92 /kW-yr. NV Energy has utilized the conservative value of 25 percent of $48.92/kW or $12.23/kW-yr in the PortfolioPro cost/benefit model. The PortfolioPro model calculates peak demand savings for each year of the measure useful life and then multiplies annual revenue requirement per kW with the peak demand savings to come up with the annual avoided revenue requirement.

## Public Service Company of Colorado 2010 DSM Case

In the 2010 DSM analysis, the Public Service Company of Colorado used a combined value of $30.00/kW-yr for 2007 avoided transmission and distribution escalating at 1.99 percent annually. This estimate was developed as part of a resource planning settlement in the Comanche 3 Settlement Agreement in Docket Nos. 04A-214E, 04A-215E and 04A-216E. No background on the calculation method was provided.

[19] Docket No. 11-06006.

## Summary of Survey

Table 2 below summarizes the methodologies used by utilities or entities in the regions reviewed for literature research. The most common valuation approach is the marginal cost methodology.

**Table 2**
**Summary of T&D Avoided Cost Methodologies in Practice**

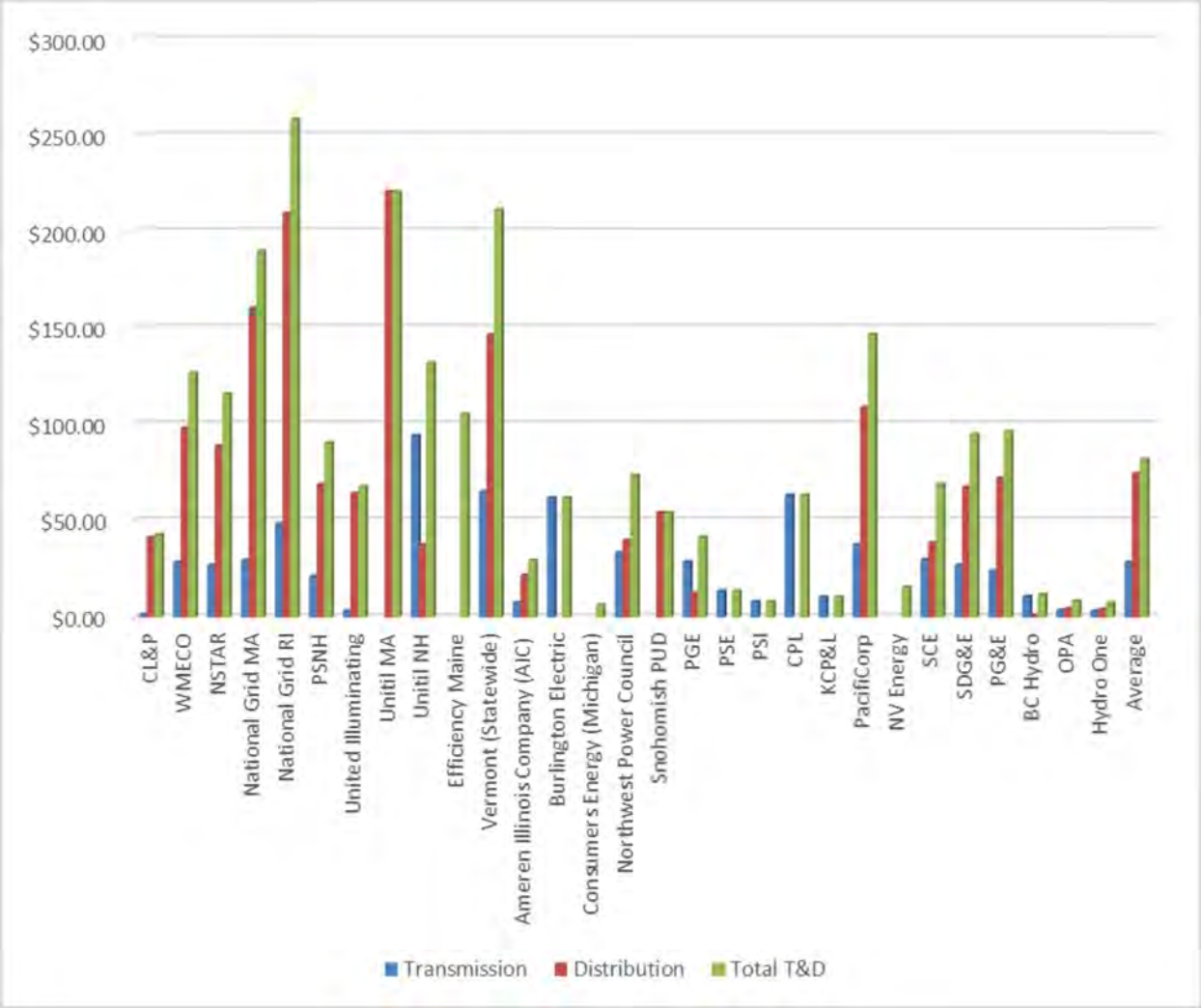
| Entity/Region | Marginal Cost | Average Cost | Market Value | Scenario | Bench-marking |
|---|---|---|---|---|---|
| BC Hydro | ■ | | | | |
| Ontario Power Authority | ■ | | | | |
| Hydro One | ■ | | | | |
| Northwest Power Council | | | | | ■ |
| Snohomish PUD | ■ | | | | |
| CPUC | ■ | | | | |
| New England AESC Study | ■ | | | | |
| Vermont | | ■ | | | |
| ICF Tool | | ■ | | | |
| United Illuminating | ■ | | | | |
| Michigan | ■ | | | | |
| Illinois | ■ | | | | |
| NV Energy | ■ | | | | |
| Public Service Company Colorado | | | ■ | | |

Figure 5 summarizes the estimated deferred T&D costs from the studies cited in this section in 2015 Canadian dollars. Appendix A containing a summary table of all the estimated DCE. The average, high and low DCE by function are provided in Table 3 below for the full survey and for utilities in WECC.

**Table 3**
**Survey Results (CA$)**

| | Transmission | Distribution | Total T&D |
|---|---|---|---|
| **Average** | | | |
| All Utilities | $28.60 | $74.39 | $81.93 |
| WECC | $20.23 | $40.39 | $52.20 |
| **High** | | | |
| All Utilities | $94.21 | $220.78 | $258.43 |
| WECC | $37.95 | $108.81 | $146.76 |
| **Low** | | | |
| All Utilities | $1.61 | $1.00 | $7.60 |
| WECC | $5.13 | $1.00 | $6.45 |

**Figure 5**
**Value of Deferred Capital Expenditure – 2015 CA$**




Based on the survey of methodology and DCE results, the following best practices can be concluded:

- Calculate separate estimates for Transmission and Distribution.
- Results differs by region and utility. Therefore, the best option for FortisBC is to estimate T&D DCE based on FortisBC data.
- While benchmarking may be indicative, benchmarking DCE results for FortisBC outside WECC does not appear to be appropriate.
- Using a marginal costing approach appears to be the most common calculation methodology.

# Updated DCE Calculation

## Introduction

As a fundamental principle, the avoided T&D costs included in a utility's DSM screening test should fairly represent the potential reduction or deferral in capital investments in the transmission and distribution system due to the addition of DSM programs. It is important to consider if the specific DSM programs are likely to reduce peak demand and, therefore, capital investments. While the averages of other utilities are useful for comparison purposes, FortisBC can develop more utility-specific numbers using data already published and available.

A sound avoided cost calculation practice should:

- Be based on forward looking avoided costs
- Be separated into two calculations: one for distribution and one for transmission
- Be annualized based on the cost of capital of FortisBC
- Reflect avoided O&M expenses, if any
- Consider the likelihood that reduction in capacity from DSM programs would occur during constrained periods and in locations that are constrained

Based on the survey of other utilities, a proposed methodology for FortisBC is provided below.

## Proposed Calculation Methodology

The following methodology is proposed for FortisBC based on the review of methodologies used by other utilities. The proposed methodology is a marginal costing approach incorporating the forecast capital investments for FortisBC. In addition, it is based on forecasted data, rather than historical, to ensure the calculation captures capital expenditures that could be deferred, not investments already made. This methodology also allows FortisBC to use load forecasts and system investments that have already been published to the extent possible. In addition, the carrying costs calculations should be calculated from the most recent revenue requirements.

***Distribution Avoided Costs***

- Determine analysis period
- Determine expected peak growth over the analysis period
- Determine the forecasted distribution system investments due to growth over the analysis period
  - Exclude capital investments needed to support current load
  - Exclude capital investments needed to repair or replace current equipment
  - Exclude new connection capital costs
- Calculate the annualized $/kW-yr avoided distribution cost as the avoided investment divided by load growth times a real carrying charge
- If applicable add avoidable general plant and O&M adders

***Transmission Avoided Costs***

- Determine analysis period
- Determine expected peak growth over the analysis period
- Determine the forecasted transmission system investments due to growth over the analysis period
  - Exclude capital investments needed to support current load
  - Exclude capital investments needed to repair or replace current equipment
  - Exclude new connection capital costs
- Calculate the annualized $/kW-yr avoided transmission cost as the avoided investment divided by load growth times a real carrying charge
- Review the proposed programs and determine if a de-ration factor needs to be applied

## Resulting DCE values

Based on the methodology described above, the following levelized transmission and distribution deferred capital expenses were determined, as shown in Table 4.

| Table 4<br>Estimated Capital Deferred Value | | | |
|---|---|---|---|
| | **Transmission** | **Distribution** | **T&D** |
| Avoided Investment ($/kW-Yr) | $686.08 | $131.30 | $817.38 |
| **Annualized DCE** | | | |
| Avoided Annual Return (6.00%)[20] | $41.16 per kW | $7.88 per kW | $49.04 per kW |
| Avoided Depreciation (2.54%)[21] | $17.44 per kW | $3.34 per kW | $20.78 per kW |
| Avoided Taxes (1.23%)[22] | $8.42 per kW | $1.61 per kW | $10.03 per kW |
| Avoided O&M (0.00%)[23] | $0.00 per kW | $0.00 per kW | $0.00 per kW |
| Total DCE | $67.03 per kW | $12.83 per kW | $79.85 per kW |

FortisBC needs to consider if the avoided T&D costs need to be de-rated. Specifically, T&D costs will only be reduced if a significant amount of load reduction is attained in an area where the utility expansion plans can be altered. Using a deration approach helps mitigate the risk of overvaluing DSM program peak reduction potential.

## Summary

The recommended Marginal Cost methodology was selected based on the literature review of the common methodologies used to determine avoidable T&D expenditures due to DSM program implementation. The methodology requires a utility-specific analysis of the growth on both the distribution and transmission system, an analysis of the investments needed to meet growth and a consideration of how potential DSM measures can impact the growth in the distribution and the transmission systems. Based on FortisBC's forecast growth-related capital T&D expenditure schedules and annualizing factors obtained from FortisBC, this study found the levelized T&D DCE values to be $67.03 and $12.83 respectively in 2015 dollars. Annual values for use in the DSM evaluation studies can be calculated by increasing these values by inflation on an annual basis.

[20] Annual Return Factor is provided by FortisBC staff.

[21] The depreciation expense factor is based on the estimate life by cost category for transmission and distribution facilities.

[22] The taxes factor is based on the 2015 Approved property taxes as percent of total utility rate base

[23] The O&M factor is set to zero, since the O&M budget does not change under PBR, except for inflationary/productivity adjustments that are not related to capital expenditures.

# Appendix A

Summary table of the estimated DCE values from review of other utilities.

| | | U.S. $ | | | Canadian $[24] | | | |
|---|---|---|---|---|---|---|---|---|
| Company | Year $ | Trans. $/kW-yr. | Dist. $/kW-yr. | Total T&D $/kW-yr. | Trans. $/kW-yr | Dist. $/kW-yr | Total T&D $/kW-yr. | Methodology |
| BC Hydro | 2011 | | | | $11.00 | $1.00 | $12.00 | |
| OPA | 2014 | | | | $3.83 | $4.73 | $8.56 | Marginal Cost |
| Hydro One | 2007 | | | | $3.40 | $4.20 | $7.60 | Marginal Cost |
| Northwest Power Council | 2012 | $26.00 | $31.00 | $57.00 | $33.54 | $39.99 | $73.53 | Benchmarking |
| Snohomish PUD | 2013 | N/A | $42.00 | $42.00 | N/A | $54.18 | $54.18 | Marginal Cost |
| PGE | 2012 | $22.56 | $9.87 | $32.43 | $29.10 | $12.73 | $41.83 | Unknown |
| PSE | 2012 | $10.71 | N/A | $10.71 | $13.82 | N/A | $13.82 | Unknown |
| PSI | 2012 | $6.43 | N/A | $6.43 | $8.29 | N/A | $8.29 | Unknown |
| PacifiCorp | 2012 | $29.42 | $84.35 | $113.77 | $37.95 | $108.81 | $146.76 | Unknown |
| **Pacific Northwest Average** | | **$19.02** | **$41.81** | **$43.72** | **$17.62** | **$53.93** | **$40.73** | |
| **Standard Deviation** | | **$8.91** | **$27.14** | **$35.81** | **$11.49** | **$35.01** | **$46.19** | |
| **Standard Deviation (%)** | | **47%** | **65%** | **82%** | **65%** | **65%** | **113%** | |
| CL&P | 2015 | $1.25 | $32.19 | $33.44 | $1.61 | $41.53 | $43.14 | ICF Tool |
| WMECO | 2011 | $22.27 | $76.08 | $98.35 | $28.73 | $98.14 | $126.87 | ICF Tool |
| NSTAR | 2011 | $21.00 | $68.79 | $89.79 | $27.09 | $88.74 | $115.83 | ICF Tool |
| National Grid MA | 2015 | $23.01 | $124.28 | $147.29 | $29.68 | $160.32 | $190.00 | ICF Tool |
| National Grid RI | 2015 | $37.86 | $162.47 | $200.33 | $48.84 | $209.59 | $258.43 | ICF Tool |
| PSNH | 2013 | $16.70 | $53.35 | $70.05 | $21.54 | $68.82 | $90.36 | ICF Tool |
| United Illuminating | 2015 | $2.74 | $49.75 | $52.49 | $3.53 | $64.18 | $67.71 | B&V Report |
| Unitil MA | 2013 | N/A | $171.15 | $171.15 | N/A | $220.78 | $220.78 | ICF Tool |
| Unitil NH | 2013 | $73.03 | $29.26 | $102.29 | $94.21 | $37.75 | $131.95 | ICF Tool |
| Efficiency Maine | 2015 | N/A | N/A | $81.67 | N/A | N/A | $105.35 | Unknown |
| Vermont (Statewide) | 2012 | $50.45 | $113.51 | $163.96 | $65.08 | $146.43 | $211.51 | Historical |
| Ameren Illinois Company (AIC) | 2014 | $6.00 | $17.00 | $23.00 | $7.74 | $21.93 | $29.67 | Marginal Cost |
| Burlington Electric Dept. | 2012 | $48.00 | N/A | $48.00 | $61.92 | N/A | $61.92 | Historical |
| Consumers Energy (MI) | 2011 | N/A | N/A | $5.00 | N/A | N/A | $6.45 | Proxy |
| CPL | 2012 | $49.02 | N/A | $49.02 | $63.24 | N/A | $63.24 | Unknown |
| KCP&L | 2012 | $8.28 | N/A | $8.28 | $10.68 | N/A | $10.68 | Unknown |
| NV Energy | 2011 | N/A | N/A | $12.23 | N/A | N/A | $15.78 | Marginal Cost |
| SCE | 2011 | $23.39 | $30.10 | $53.49 | $30.17 | $38.83 | $69.00 | Marginal Cost |

[24] Exchange rate used:1 US Dollar equal 1.29 Canadian Dollar (07/05/2016)

| | | U.S. $ | | | Canadian $[24] | | | |
|---|---|---|---|---|---|---|---|---|
| Company | Year $ | Trans. $/kW-yr. | Dist. $/kW-yr. | Total T&D $/kW-yr. | Trans. $/kW-yr | Dist. $/kW-yr | Total T&D $/kW-yr. | Methodology |
| SDG&E | 2011 | $21.08 | $52.24 | $73.32 | $27.19 | $67.39 | $94.58 | Marginal Cost |
| PG&E | 2011 | $18.77 | $55.85 | $74.62 | $24.21 | $72.05 | $96.26 | Marginal Cost |
| **Average** | | **$24.67** | **$66.85** | **$70.00** | **$28.60** | **$74.39** | **$81.93** | |
| **Standard Deviation** | | **$17.60** | **$45.81** | **$52.11** | **$22.71** | **$60.58** | **$67.85** | |
| **Standard Deviation (%)** | | **71%** | **69%** | **74%** | **79%** | **81%** | **83%** | |