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 12, 2022

British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC
V6Z 2N3

Attention: Ms. Sara Hardgrave, Acting Commission Secretary

Dear Ms. Hardgrave:

Re: FortisBC Energy Inc. (FEI) and British Columbia Hydro and Power Authority (BC Hydro) – Energy Scenarios

FEI Stage Two Submission

In December 2021, the British Columbia Utilities Commission (BCUC) initiated a process to explore energy scenarios to achieve BC's greenhouse gas (GHG) targets and the resulting interdependent long-term implications on British Columbia's primary Electric and Gas Utilities, stating:

> BC Hydro and FEI […] have a significant and correlated role in achieving these GHG reduction objectives as the electric and gas energy systems in BC display many interdependencies, such as in the emerging industries of hydrogen and syngas production, carbon capture and storage and liquefied natural gas, to name a few.

In its letter dated January 21, 2022, the BCUC requested that BC Hydro and FEI (the Utilities) share the data required to file load forecast results based on each other's scenarios contained in their respective resource plans. As part of the filings, each utility would include appropriate supporting commentary regarding the supply resource impacts, rate impacts, and associated GHG emission impacts that may be associated with each energy scenario.

In its letter dated March 9, 2022, the BCUC accepted the Utilities' request to stage the filings as follows:

- **Stage One** to provide the load forecast results for the energy scenarios which was submitted by FEI on June 15, 2022; and
- **Stage Two** to provide supporting commentary regarding the supply resource impacts, rate impacts, and associated GHG emission impacts for the energy scenarios.

In its letter dated July 6, 2022, the BCUC requested additional supporting information regarding the Stage One results be filed. Specifically:

- FEI and BC Hydro to clarify the assumptions for the volume of hydrogen supply contained within the FEI scenarios in the Long Term Gas Resource Plan (LTGRP), and modelled by BC Hydro in its Stage One filing;
- BC Hydro to confirm the incremental electricity demand in the Stage One load forecast scenarios assumed to result from the production of hydrogen contained within the FEI scenarios in the LTGRP;
- BC Hydro to discuss the assumptions used to model the incremental electricity demand resulting from customers switching from gas to electricity;
- FEI and BC Hydro to provide a breakdown of the Stage One load forecast scenarios by customer class, in table or Excel format; and
- FEI and BC Hydro to provide the peak load forecast resulting from the Stage One energy load forecasts.

This report represents the findings and conclusions of FEI's Stage Two filing.

If further information is required, please contact Ken Ross, Manager, Integrated Resource Planning and DSM Reporting at (604) 576-7343.

Sincerely,

FORTISBC ENERGY INC.

Original signed:

Diane Roy

Attachments

cc (email only): bchydroregulatorygroup@bchydro.com

British Columbia Hydro and Power Authority (BC Hydro), and

FortisBC Energy Inc. (FEI)

Energy Scenarios

FEI Supporting Commentary Regarding the Supply Resource Impacts, Rate Impacts and Associated GHG Emission Impacts

Stage Two

August 12, 2022

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List of Appendices

1. INTRODUCTION

This report represents FEI's Stage Two submission to the British Columbia Utilities Commission (BCUC) for the FortisBC Energy Inc. (FEI) and British Columbia Hydro and Power Authority (BC Hydro) shared energy modelling scenarios. As discussed in this report, the modelling of the BC Hydro scenarios with electric demand information and data provided by BC Hydro results in interesting and important observations related to energy supply resources, customer rates, and associated greenhouse gas (GHG) emission reductions. This work also identifies important challenges. FEI's key conclusions in the Stage Two report include:

- This report presents modelling results for total energy demand across scenarios from the Stage One report and FEI's analysis and observations for supply resources, customer rates, and GHG emissions across the modelled scenarios.

- This exercise has been useful for comparing scenario modelling between the utilities at a high level and informing where important informational and analytical gaps remain. BC Hydro's Reference Case is intended to model electricity demand and so does not consider energy delivery by other utilities. As such it does not explicitly exclude the potential for deep decarbonization of gas infrastructure through energy efficiency, transitioning to renewable and low-carbon gas to displace conventional natural gas for buildings and industry, and low-carbon gas for displacing higher carbon fuels in transportation.

- For this reason, there is limited consideration within the BC Hydro's scenarios of the extent to which renewable and low-carbon gases can play a role in decarbonizing British Columbia's (BC) overall energy systems.

- There are limitations to the extent of detailed conclusions that can be drawn from this common scenario exercise due to the use of very different forecast modelling tools and processes between the utilities and their respective consultants. FEI supports further collaboration in this regard.

- A review of Stage One results reported by both BC Hydro and FEI suggests that the modelling inputs and assumptions for annual and peak electricity consumption for buildings in scenarios that include extensive electrification should be examined more closely.

- While FEI looks forward to reviewing BC Hydro's Stage Two report, FEI believes that more work is need to fully understand the implications for energy costs, peak demand resources and costs, customer rates, and energy affordability for all energy consumers in BC associated with alternative decarbonization pathways. This is critically important before irreversible decisions are made by the BCUC, provincial and municipal governments, and energy consumers to pursue a single decarbonization pathway such as electrification.

This report is organized as follows:

- In the remainder of this introductory section, FEI provides the regulatory background for this report and recaps the BC Hydro and FEI Stage One filings, which presented the annual demand forecast results for the energy scenarios;
- In section two, FEI discusses the implications of the energy scenarios and results for supply resources (gas supply portfolio planning, system capacity planning and integration of renewable and low-carbon gas), rate impacts, and GHG emissions; and
- In section three, FEI describes its key observations overall on the energy scenarios.

1.1 REGULATORY BACKGROUND ON PROCESS TO EXPLORE ENERGY SCENARIOS

In December 2021, the BCUC initiated a process to explore energy scenarios to achieve BC's GHG targets and the resulting interdependent long-term implications on British Columbia's primary Electric and Gas utilities, stating:

> BC Hydro and FEI […] have a significant and correlated role in achieving these GHG reduction objectives as the electric and gas energy systems in BC display many interdependencies, such as in the emerging industries of hydrogen and syngas production, carbon capture and storage and liquefied natural gas, to name a few.

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In its letter dated March 9, 2022, the BCUC accepted the Utilities' request to stage the filings as follows:

- Stage one to be filed by June 15, 2022 will provide the load forecast results for the energy scenarios; and
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- BC Hydro to confirm the incremental electricity demand in the Stage One load forecast scenarios assumed to result from the production of hydrogen contained within the FEI scenarios in the LTGRP;

- BC Hydro to discuss the assumptions used to model the incremental electricity demand resulting from customers switching from gas to electricity;

- FEI and BC Hydro to provide a breakdown of the Stage One load forecast scenarios by customer class, in table or Excel format; and

- FEI and BC Hydro to provide the peak load forecast resulting from the Stage One energy load forecasts.

This Stage Two filing focuses on supply resource impacts, peak demand implications, the integration of renewable and low-carbon gas, rate impacts, and associated GHG emission impacts for the select scenarios. While the annual energy demand results presented in the respective Stage One reports are a consideration for long-term planning, there are many important considerations. This report provides key observations about the scenario analysis and the alternative pathways to decarbonizing BC's energy future modelled through this exercise. In addition, Appendix D provides a breakdown of FEI Stage One load forecast scenarios by customer class.

1.2 *STAGE ONE RESULTS – RECAP AND OBSERVATIONS*

FEI's Stage One filing defined the FEI and BC Hydro selected scenarios, provided total annual gas demand by scenario, key observations about the modelling results, and a discussion about the data exchanged and modelling challenges. FEI engaged energy industry consultants Posterity Group (Posterity) to support FEI in preparing the load forecast results. This Stage Two report should be read in conjunction with the Stage One report, included as Appendix A.[1]

In Section 2, pages 4 and 5, of its Stage One submission, FEI provided annual demand forecast results for the five scenarios set out below. A third BC Hydro scenario (Low Load Forecast) was found to closely approximate FEI's Economic Stagnation Scenario and was therefore not modelled further.

The BC Hydro scenarios modelled by FEI as part of this exercise are:

[1] BCUC FortisBC Energy Inc (FEI) – British Columbia BC Hydro and Power Authority (BC Hydro) – Energy Scenarios Request – Stage One, online at:
- DOC_66884_2022-06-15-BCH-Stage1-LoadForecastResults.pdf (bcuc.com)
- DOC_66883_2022-06-15-FEI-Stage1-ModellingResults.pdf (bcuc.com)

- Reference Case
- Accelerated Electrification

The FEI scenarios included in the 2022 LTGRP that were modelled with the above BC Hydro scenarios are:

- Diversified Energy (Planning)
- Deep Electrification
- Economic Stagnation

Tables 1a and 1b below illustrate the sum of the Total Energy Demand results (both electricity and gas) for residential, commercial and industrial customers as presented in each of FEI's and BC Hydro's Stage One filings for each of the scenarios for select, common milestone years. Note that Tables 1a and 1b convey the same information; the values are simply restated in either units of PJ (Table 1a) or GWh (Table 1b). Further, in Tables 1a and 1b, the electricity demand has been modelled by BC Hydro and the gas demand has been modelled by FEI. The results for electricity include 'existing and committed DSM'[2] while the results for gas are 'post-DSM'[3] as presented in Section 5 of the 2022 LTGRP.

Table 1a: Total Annual Energy Demand (Electricity and Gas) in 2025, 2030, 2035 and 2040 – Residential, Commercial and Industrial Customers (PJ)[4, 5, 6]

	2025	2030	2035	2040
BC Hydro Reference Case				
BC Hydro (electricity)	225	237	246	255
FEI (gas)	209	216	220	223
Total Energy	**434**	**453**	**466**	**478**
FEI Diversified Energy (Planning)				
BC Hydro (electricity)	228	259	271	282
FEI (gas)	193	186	180	176
Total Energy	**421**	**445**	**451**	**458**
FEI Economic Stagnation				
BC Hydro (electricity)	219	224	225	229
FEI (gas)	202	203	202	204
Total Energy	**421**	**427**	**427**	**433**
FEI Deep Electrification				

[2] The Navius model used by BC Hydro does not account for future electric Demand-side Management (DSM).
[3] Gas demand includes estimated long-term gas DSM savings.
[4] Annual Electricity Demand converted to equivalent PJ using standard unit conversion of 1 GWh = 0.0036 PJ.
[5] BC Hydro uses an April 1 to March 31 fiscal year, while FEI uses a January 1 to December 31 calendar year. For comparison purposes, the starting year of the BC Hydro fiscal year is aligned with the FEI calendar year. For example, fiscal 2026 (i.e., April 1, 2025 to March 31, 2026) is considered to be aligned with calendar 2025 (i.e., January 1, 2025 to December 31, 2025).
[6] BC Hydro did not provide FEI with the base year electricity data (F2021).

	2025	2030	2035	2040
BC Hydro (electricity)	236	276	292	299
FEI (gas)	173	146	119	101
Total Energy	**409**	**422**	**411**	**400**
BC Hydro Accelerated Electrification				
BC Hydro (electricity)	237	272	283	297
FEI (gas)	165	126	100	91
Total Energy	**402**	**398**	**383**	**388**
BC Hydro Low Load Scenario	Not modelled			

Table 1b: Total Annual Energy Demand (Electricity and Gas) in 2025, 2030, 2035 and 2040 – Residential, Commercial and Industrial Customers (GWh)[7]

	2025	2030	2035	2040
BC Hydro Reference Case				
BC Hydro (electricity)	62,624	65,844	68,463	70,825
FEI (gas)	58,056	60,000	61,111	61,944
Total Energy	**120,680**	**125,844**	**129,574**	**132,769**
FEI Diversified Energy (Planning)				
BC Hydro (electricity)	63,431	71,825	75,202	78,434
FEI (gas)	53,611	51,667	50,000	48,889
Total Energy	**117,042**	**123,492**	**125,202**	**127,323**
FEI Economic Stagnation				
BC Hydro (electricity)	60,936	62,105	62,538	63,625
FEI (gas)	56,111	56,389	56,111	56,667
Total Energy	**117,047**	**118,494**	**118,649**	**120,292**
FEI Deep Electrification				
BC Hydro (electricity)	65,661	76,703	81,028	83,026
FEI (gas)	48,056	40,556	33,056	28,056
Total Energy	**113,717**	**117,259**	**114,084**	**111,082**
BC Hydro Accelerated Electrification				
BC Hydro (electricity)	65,816	75,543	78,481	82,529
FEI (gas)	45,833	35,000	27,778	25,278
Total Energy	**111,649**	**110,543**	**106,259**	**107,807**
BC Hydro Low Load Scenario	Not modelled			

Observations[8] from these results include:

- Annual demand for electricity is higher in each of BC Hydro's Accelerated Electrification, FEI's Deep Electrification and FEI's Diversified (Planning) scenarios than it is in BC

[7] Annual Gas Demand converted to GWh using standard unit conversion of 1 PJ = 277.778 GWh.
[8] Where observations for gas use trends in each scenario cite a base year of 2019 or 2020, the base year gas data is based on demand data contained the 2022 LTGRP.

Hydro's Reference Case. The nature of this demand needs to be better understood in order to fully examine the implications of each scenario for peak electricity demand and associated costs throughout the 20-year planning period. For example, electricity demand in the two electrification scenarios includes market segments, such as upstream oil and gas, that are not currently served by FEI.

- Gas demand in 2040 in BC Hydro's Accelerated Electrification Scenario is 132 PJ lower than in BC Hydro's reference case, while electricity demand is higher by only 42 PJ. The details of and the difference in electrification assumptions between these scenarios needs to be better understood in order to assess the reasonableness of efficiency gains that may cause this result. The assumptions and implications for electricity peak demand will likewise need to be fully understood.

- Gas demand in BC Hydro's Accelerated Electrification Scenario declines at a faster rate than in FEI's Deep Electrification Scenario, while electricity demand grows at a similar rate between the two scenarios. These scenarios have the lowest total annual energy demand and the highest annual electricity demand throughout the forecast period. In the case of FEI's Deep Electrification Scenario, the underlying assumption is that 100 percent of residential and commercial demand and 20 percent of industrial demand switch from gas to electricity by 2050. FEI understands that the BC Hydro Accelerated Electrification Scenario assumes that the Province's carbon reduction targets are met primarily through electrification.[9]

Appendix B further describes key modelling inputs and outputs for the two BC Hydro scenarios to aid the reader in understanding the Total Energy Demand results (both electricity and gas) for residential, commercial and industrial customers presented in Tables 1a and 1b.

2. IMPLICATIONS FOR SUPPLY RESOURCES, RATES AND GHG EMISSIONS

This section provides additional details of the scenario modelling and presents a discussion of the implications for energy supply resources (including conventional, renewable and low-carbon gas supplies and peak demand system design considerations), rate impacts and GHG emission reductions. This discussion is set within the context of FEI's 2022 LTGRP.

2.1 *GAS SUPPLY PORTFOLIO PLANNING*

The natural gas supply portfolio planning considerations for the BC Hydro scenarios do not change materially from those that were presented in Section 6 of the 2022 LTGRP for FEI's range of scenarios. As such, this section of the report focuses on observations and implications for

[9] In contrast, FEI's Diversified Energy (Planning) Scenario assumes 25 percent of residential and commercial demand and 10 percent of industrial demand switches from gas to electricity by 2050. In addition, forecast gas DSM activities throughout the planning horizon represent a 34 PJ reduction in annual gas demand from 2020 to 2042 in the residential, commercial and industrial sectors.

integrating renewable and low-carbon gas supplies and anticipated annual gas supply resources specific to the two BC Hydro scenarios.

2.1.1 Portfolio Integration of Renewable and Low-Carbon Gas Supply

As part of its Clean Growth Pathway, which is reflected in FEI's Diversified Energy (Planning) Scenario, FEI has targeted its long-term acquisition of renewable and low-carbon gas supply to meet BC provincial targets for carbon emission reductions in 2030, 2040 and 2050. The Diversified Energy (Planning) Scenario also assumes some electrification. FEI did not constrain the modelling for its other scenarios (including its Deep Electrification Scenario) by the requirement to meet these targets. Conversely, it is FEI's understanding that BC Hydro's modelling of FEI's Deep Electrification Scenario, and BC Hydro's own Accelerated Electrification Scenario, were constrained by a minimum renewable and low-carbon gas requirement, while their Reference Case was not.

Figure 1 and Table 2 below show the resulting forecast increase in supplies of renewable and low-carbon gas for each of the five scenarios over the planning horizon as modelled by FEI. The expected result of limiting only the Deep and Accelerated Electrification scenarios to achieving the emission reduction targets is a narrow, electricity-centric view of resources required to meet the targets, without consideration for other alternatives such as those that make up FEI's Clean Growth Pathway. While the BC Hydro Accelerated Electrification scenario does include growth in renewable gas supplies late in the period in order to meet emission targets and/or renewable gas content policies, FEI questions the reasonableness of assuming the resulting increase in system costs could be born by the small number of remaining customers on the gas system at that time.

Figure 1: Forecast of Renewable and Low-Carbon Gas Supply

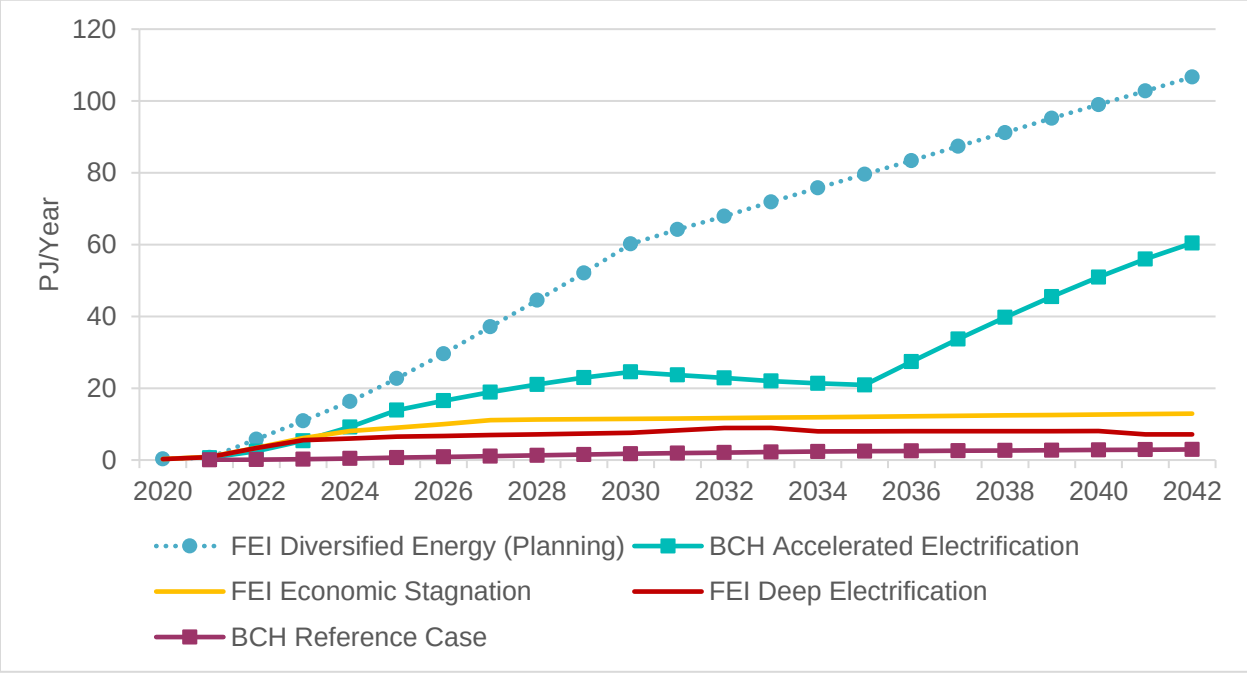


Table 2: Forecast of Renewable and Low-Carbon Gas Supply (PJ/Year)

	2025	2030	2035	2040	2042
FEI Diversified Energy (Planning)	22.7	60.2	79.6	99.0	106.7
BC Hydro Accelerated Electrification	13.9	24.5	20.9	50.9	60.4
FEI Economic Stagnation	9.0	11.5	12.1	12.7	12.9
FEI Deep Electrification	6.5	7.6	8.0	8.1	7.2
BC Hydro Reference Case	0.7	1.8	2.4	2.8	3.0

Some key observations from Figure 1 and Table 2 are as follows:

- The shape of the line in this graph for renewable and low-carbon gas supply in the BC Hydro Accelerated Electrification Scenario is a result of the renewable natural gas supply assumption data for this scenario provided by BC Hydro and Navius.

- While BC Hydro's Accelerated Electrification Scenario assumes that electrification is the primary means of carbon reduction, it also includes a substantial increase in renewable and low-carbon gas use, primarily renewable natural gas (RNG), for the industrial sector. The practical and cost implications of assuming substantial increases in deliveries of low-carbon and renewable gases in a primarily electrification scenario where overall gas demand declines significantly need to be carefully considered. For example: how would RNG be delivered with significantly scaled back volumes in the system? What would be the mechanism to recover both fixed asset costs of the then underutilized gas system and the fuel costs of RNG?

- In contrast to BC Hydro's Reference Case and Accelerated Electrification scenarios, FEI's Diversified Energy (Planning) Scenario includes the growing acquisition of renewable and low-carbon gas supply as a vital part of FEI's base annual gas supply stack, since the Greenhouse Gas Reduction Standard (GHGRS) places an obligation on FEI to reduce GHG emissions on behalf of its customers.

In its communication on July 6, 2022, the BCUC requested that FEI and BC Hydro clarify the assumptions for the volume of hydrogen supply contained within the FEI scenarios in the LTGRP, and modelled by BC Hydro in its Stage One filing. FEI did not present a specific forecast of each component of its forecast renewable and low-carbon gas supply within the total amounts of this supply as it considers these individual types of gases to be subject to a greater range of uncertainty than the overall supply of renewable and low-carbon gases. However, as a modelling exercise, FEI has examined potential trajectories for growth in the amount of hydrogen in each of its scenarios. Figure 2 and Table 3 below display linear hydrogen growth trajectories starting in 2023 for each of the five scenarios modelled by FEI over the planning horizon.

FEI acknowledges that actual growth in hydrogen supply is unlikely to be linear as depicted in Figure 2 and rather is expected to come on to the system later in the planning horizon than illustrated for the Diversified Energy (Planning) Scenario in Figure 2 and Table 3 below. The linear trajectories were modelled as a simplifying assumption for the LTGRP. FEI has since performed

a sensitivity analysis assuming more hydrogen later in the planning period and higher RNG supply growth in the early years. This sensitivity analysis showed that there would be no material difference in GHG emissions.

Figure 2: Forecast of Hydrogen Supply by Scenario

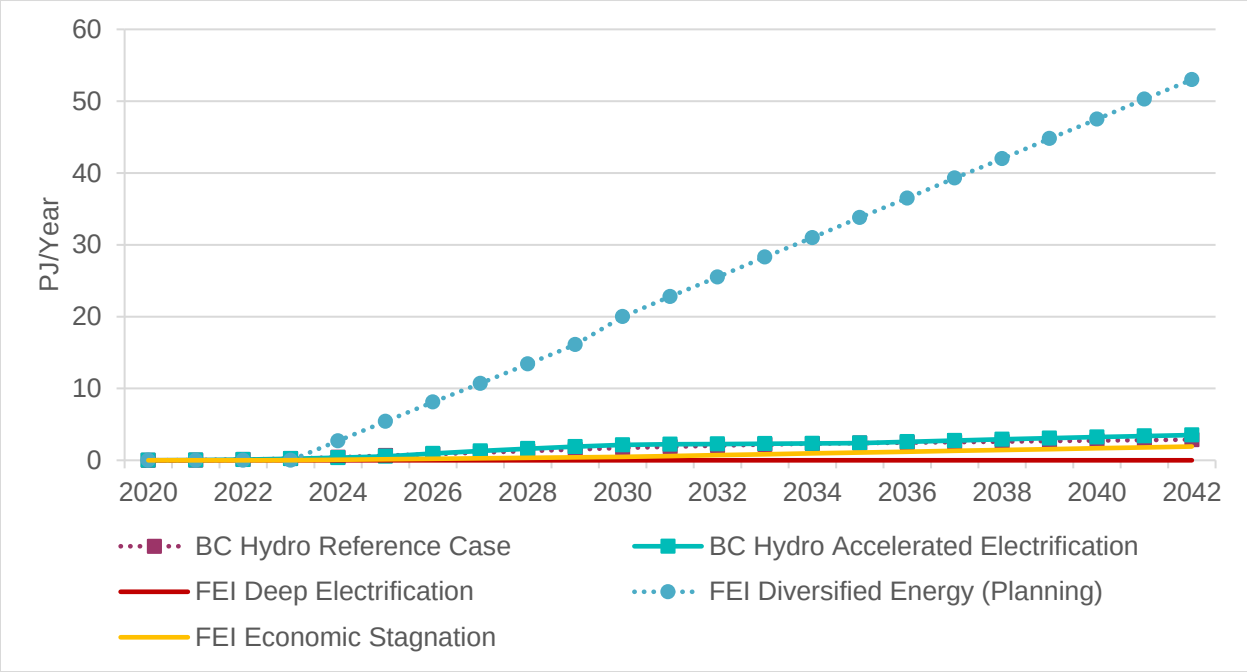


Table 3: Forecast of Hydrogen Supply by Scenario (PJ/Year)

	2025	2030	2035	2040	2042
FEI Diversified Energy (Planning)	5.4	20.0	33.8	47.5	53.0
BC Hydro Accelerated Electrification	0.5	2.1	2.4	3.2	3.5
BC Hydro Reference Case	0.7	1.7	2.4	2.7	2.9
FEI Economic Stagnation	0.1	0.5	1.1	1.7	1.9
FEI Deep Electrification	0.0	0.0	0.0	0.0	0.0

As shown above, the only scenario presented by either utility that considers a meaningful role for hydrogen in a low-carbon energy future is FEI's Diversified Energy (Planning) Scenario. In this scenario, hydrogen from off-system supply sources will be relied on in the early stages of FEI's carbon reduction transition. Physical hydrogen flows on FEI's gas infrastructure are expected to rise, but be limited to smaller amounts and portions of FEI's system early in the transition as the technologies and infrastructure needed to manage larger volumes are refined and implemented. From 2030 to 2042, while the development of on-system resources will have grown, FEI anticipates there will still be some reliance on off-system supplies. In all other scenarios, hydrogen supply remains below 4 PJ annually throughout the 20-year planning period.

In FEI's scenarios, the amount of renewable and low-carbon gas supply displacing conventional natural gas for individual customers does not change the total energy demand that FEI's infrastructure provides to customers. Additional discussion of the renewable and low-carbon gas supply integration is provided in Section 2.2.2, along with a discussion of the implications for FEI's infrastructure needs.

2.1.2 Implications of BC Hydro Scenarios for FEI Annual Gas Supply Resources

Since the implications for gas supply resources under the FEI scenarios are discussed in the 2022 LTGRP, this section discusses the implications under the two BC Hydro scenarios. FEI would expect to continue to acquire and contract for conventional natural gas commodity volumes in both of BC Hydro's energy scenarios over the planning horizon, after accounting for the forecast in supplies of renewable and low-carbon gas supply.

2.1.2.1 BC Hydro Reference Case

For the BC Hydro Reference Case, FEI anticipates acquiring nearly the same level of conventional natural gas commodity volumes each year until 2042 for its Core customers.[10] For example, the annual natural gas supply required for Core customers in 2020 is 142 PJ/year,[11] and FEI forecasts to require slightly more in 2042 at an amount of 147 PJ/year. This demonstrates that in the BC Hydro Reference Case Scenario, FEI would require a slight increase of annual baseload conventional natural gas supply.

2.1.2.2 BC Hydro Accelerated Electrification

In the BC Hydro Accelerated Electrification Scenario, overall demand for Core customers is much less than in the Reference Case, and therefore FEI expects that the amount of annual conventional natural gas commodity volumes would decrease to near 27 PJ/year in 2042. Reducing conventional natural gas supply is not expected to create a major risk to FEI's ability to contract for sufficient supply resources due to the contracting flexibility of FEI's portfolio, such as through contracting for gas commodity purchases primarily on a one-year term basis. However, FEI's purchasing power for service from these resources could be eroded if significant de-contracting by FEI were required. Further, if significant de-contracting across the region occurred, this could have broader implications for the reliability and resiliency of the overall energy system in the Pacific Northwest as services could be pared back.

Note that as the renewable and low-carbon gas supply in the BC Hydro Accelerated Electrification scenario is forecast to increase to 25 PJ/year in 2042, it is important for consideration to be given to whether this supply is expected to be on-system or off-system. To the extent that renewable and low-carbon gas supply is acquired outside of BC, it will be delivered to FEI by displacement

[10] Although the Woodfibre LNG project was included in FEI's 2022 LTGRP as a Rate Schedule 46 customer, they would receive service under RS 50 and procure their own natural gas supply, and therefore FEI did not include their demand in this section's analysis.

[11] In Section 2.1.2 the data presented considers only Rate Schedules 1 to 7 and 46.

of conventional natural gas purchases, and therefore, FEI will still require the equivalent level (compared to only conventional supply) of third-party pipeline capacity contracts, as well as infrastructure, the latter of which will be discussed in the following subsection.

2.2 *SYSTEM CAPACITY PLANNING*

2.2.1 Regional Transmission System Capacity Plans

For capacity planning purposes, FEI is split into three major transmission systems and several smaller transmission laterals. The main transmission systems are the Vancouver Island Transmission System (VITS), the Coastal Transmission System (CTS), and the Interior Transmission System (ITS). For each system, FEI discusses below:

1. How the two BC Hydro forecast scenarios compare to the three FEI forecast scenarios when under peak demand;
2. The need (if any) for system expansion alternatives to provide capacity to meet the forecasts;
3. The types of system expansion alternatives that might be required; and
4. The differences in impact of renewable gases and hydrogen on the system.

Section 7 of FEI's 2022 LTGRP contains information on the existing infrastructure of each major system, the demand and capacity balance for each of FEI's end-use peak demand forecast scenarios, the currently proposed system expansion alternatives for each system, and additional discussion on the impact of renewable gases and hydrogen.

In preparing the BC Hydro forecasts, Posterity did not have sufficient time to create the detailed regional peak use per customer (UPC_{peak}) information that FEI uses to build the regional transmission systems' peak demand forecast.[12] As a result, FEI made some adjustments using the Posterity Regional Peak demand versus FEI regional transmission end-use scenarios used in the 2022 LTGRP to apportion, in a similar fashion, the peak demand in the BC Hydro scenarios to the appropriate regional transmission system. This was necessary to ensure that the BC Hydro scenario impacts on a system like the ITS, for example, did not include peak demand for other communities in the BC Interior that are not served by the ITS (i.e., communities that would be served from other separate transmission laterals). The adjustments also accounted collectively for the line pack[13] effects FEI would traditionally apply using its established processes. These adjustments provided a basis for a reasonable comparison of the forecasts for each system, given that more detailed UPC_{peak} estimates for the communities and various rate schedules served by the systems could not be produced from the data in the time available.

[12] FEI's established forecasting methods are described in Sections 7.2.3.1 and 7.2.3.2 of the LTGRP.
[13] Line pack refers to the amount gas stored in the transmission pipelines themselves.

Figures 3, 4, 5 below illustrate the peak demand of the five select scenarios for each of FEI's transmission systems. Each figure provides a comparison of the three FEI forecast scenarios (include Demand-side Management (DSM)) from Section 7 of the 2022 LTGRP, FEI's Traditional Peak forecast, and the two select BC Hydro forecast scenarios derived from the regional breakdown and peak demand prepared by Posterity from the BC Hydro data. The peak demand impacts on each of the transmission systems is described in Table 4 below. The integration of renewable and low-carbon gas supply is described in Section 2.2.2 and summarized in Table 5.

Figure 3: Forecast of VITS Peak Gas Demand

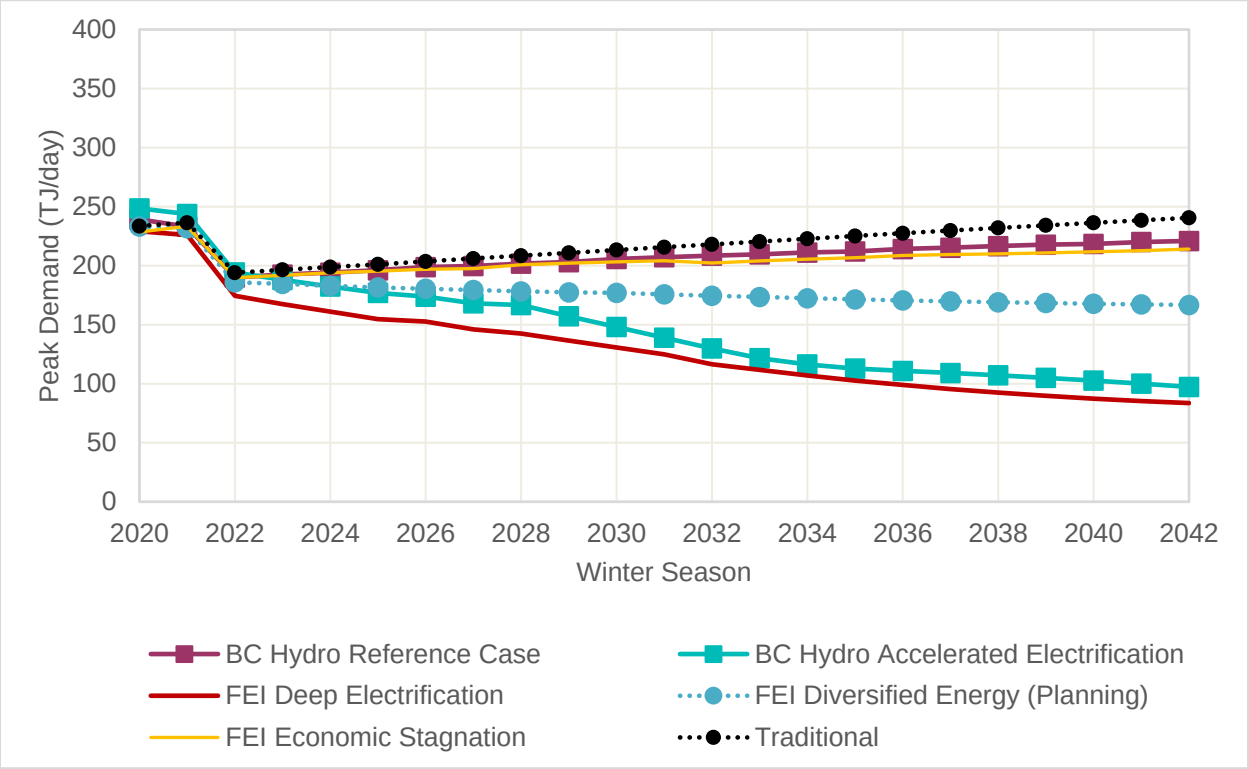


Figure 4: Forecast of CTS Peak Gas Demand

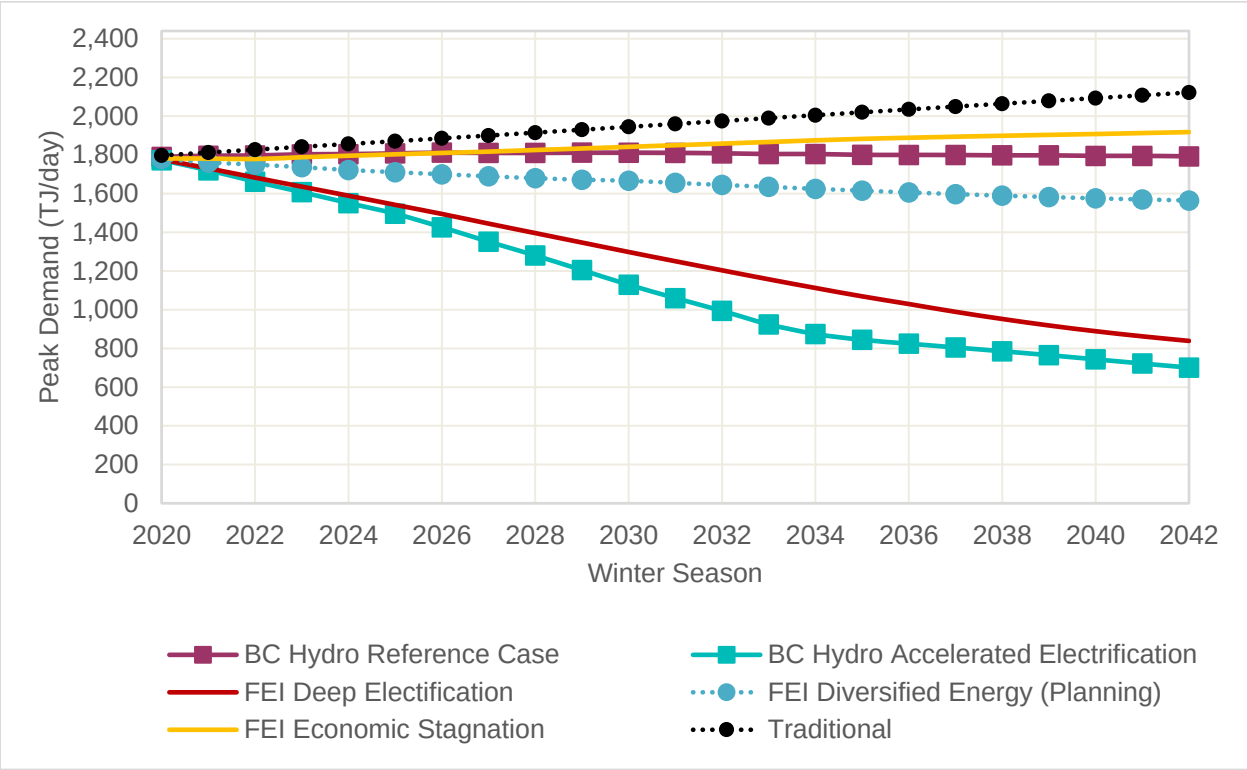


Figure 5: Forecast of ITS Peak Gas Demand

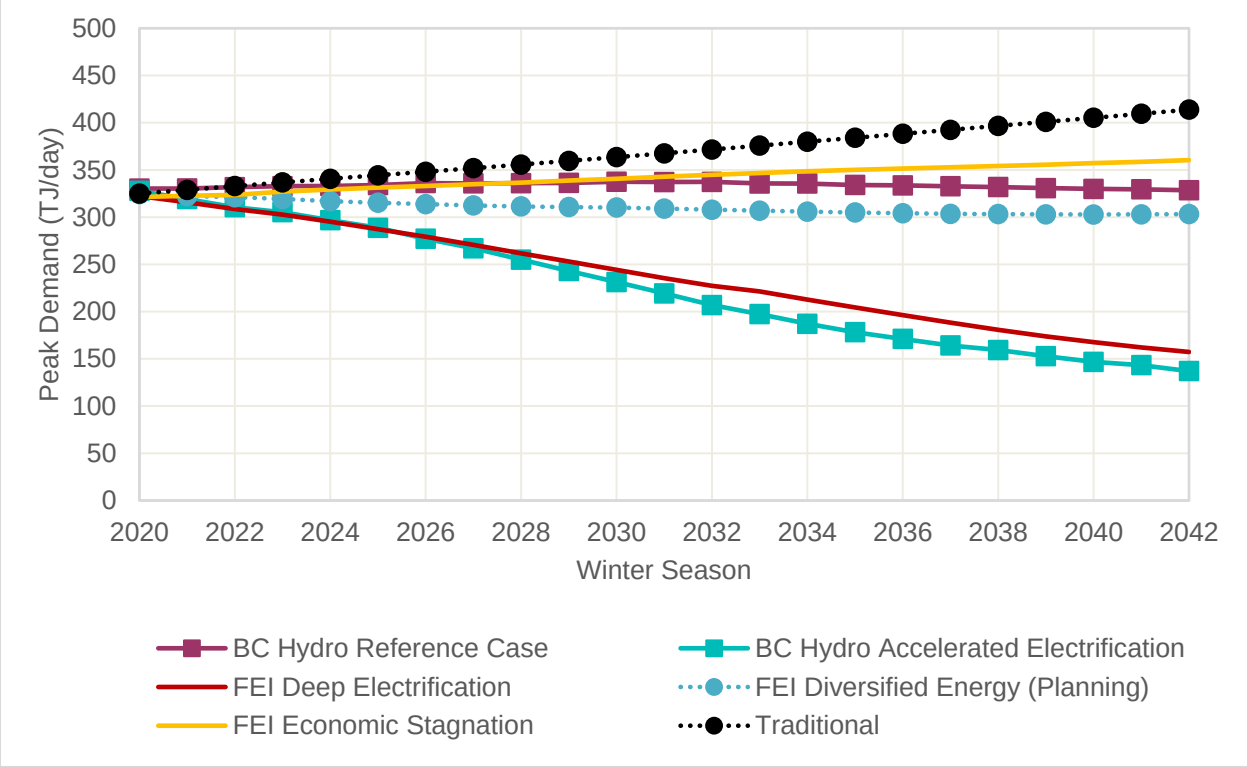


Table 4: Overview of Peak Demand Considerations for Select Scenarios

Peak Demand Considerations for Select Scenarios	Regional Transmission and Distribution Line Considerations		
	VITS	CTS	ITS
Comparison of BC Hydro to FEI scenarios	• BC Hydro Reference Case aligns with FEI Economic Stagnation • BC Hydro Accelerated Electrification has slightly greater peak demand than FEI Deep Electrification • Two BC Hydro forecasts fall in the mid to low range compared to the FEI end-use forecast. With the FEI Deep Electrification being the lowest forecast	• BC Hydro Reference Case falls just below FEI Economic Stagnation • BC Hydro Accelerated Electrification has slightly lower peak demand than FEI Deep Electrification • Two BC Hydro forecasts fall in the mid to low range compared to the FEI end-use forecast with the BC Hydro Accelerated Electrification being the lowest forecast	• BC Hydro Reference Case falls just below FEI Economic Stagnation • BC Hydro Accelerated Electrification has slightly lower peak demand than FEI Deep Electrification • Two BC Hydro forecasts fall in the mid to low range compared to the FEI end-use forecast with the BC Hydro Accelerated Electrification being the lowest forecast
Needs for System Expansion Alternatives	• Forecasts all fall within the existing capacity of the VITS system to meet peak demand throughout the forecast period • The impact of the Woodfibre Liquified Natural Gas (LNG) facility not represented as that facility will be supported with the Eagle Mountain to Woodfibre Gas Pipeline (EGP) Project	• Forecasts all fall within the existing capacity of the CTS system to meet peak demand throughout the forecast period • The impact of the Woodfibre LNG or proposed expansions to Tilbury LNG facilities not represented (Refer to Section 7.3.2.4 of the 2022 LTGRP)	• Forecasts all fall within the future ITS capacity to meet peak demand throughout the forecast period, upon approval of, and completion of, the Okanagan Capacity Upgrade (OCU) Project
Types of System Expansion Alternatives	• Capacity upgrades to support peak demand forecasts would not be required over the forecast period	• Capacity upgrades to support peak demand forecasts would not be required over the forecast period	• Approval and completion of the OCU Project is required
Impact of Renewable and Low-carbon gases	Refer to the discussion in Section 2.2.2 and Table 5.		

2.2.2 Integration of Renewable and Low-Carbon Gas Supply

In Section 7.4 of FEI's 2022 LTGRP, FEI discusses the integration of renewable and low-carbon gas. Please refer to that section of the 2022 LTGRP for more extensive detail than is reproduced here. In that discussion FEI elaborated on the challenges and opportunities of the expansion of the supply and delivery of renewable and low-carbon gases including the timing and availability of the resources, the on system and off system development of the resources and delivery modes.

In Section 7.4.1 of the 2022 LTGRP, using FEI's Diversified Energy (Planning) Scenario, FEI discussed regional considerations that might accompany that future energy forecast related to each of the major transmission systems, with an overview summarized in Table 7-2 (reproduced as Table 5 below).

As discussed in Section 7.4.1, as it is still early in the development of the production and delivery of hydrogen along with other renewable gases, FEI does not yet have sufficient definition to provide projections on their specific impact to the capacity of the system. The same lack of definition exists in all the FEI and BC Hydro energy scenarios. However, FEI in this section discusses at a higher level how these scenarios compare against what FEI included in sections 7.4.1.2 to 7.1.1.4 of the 2022 LTGRP, with respect to the FEI Diversified Energy (Planning) Scenario for each of the major transmission systems. Additionally, as mentioned in Section 7.4.1 of the 2022 LTGRP, in the early years of the planning horizon FEI's supply will predominantly be acquired and used outside of FEI's service territory. As a result, during this early part of the planning horizon, the system capacity impacts will remain largely unchanged from what FEI would have otherwise anticipated without renewable gases, as the transmission and distribution systems continue to predominantly move conventional natural gas. By 2030, and through the end of the planning horizon, on-system delivery of renewable gases supplied within FEI systems or by upstream pipeline systems will expand. FEI expects that a shift from off-system to on-system early in the forecast will have system capacity implications that will increase over time. As a result, this discussion focuses on a comparison at the end of the forecast period 2042 when the shift to on-system production/delivery will be more fully developed.

2.2.2.1 FEI Diversified Energy (Planning) Scenario Gas Forecast

FEI's Diversified Energy (Planning) Scenario is the most fully developed representation of renewable and low-carbon gases of all the forecasts presented. By 2042, in this scenario, FEI has modelled 53 PJ of hydrogen. Of the forecasts presented, the Diversified Energy (Planning) Scenario represents the highest delivery of hydrogen by far of the forecasts, with the BC Hydro Accelerated Electrification Scenario coming in a distant second delivering just under 3.5 PJ per year.

As mentioned previously, the impacts for FEI's major transmission systems are summarized in Table 7-2 of the 2022 LTGRP, which is reproduced as Table 5 below.

Table 5: Overview of Considerations for Integrating Renewable and Low-Carbon Gas in FEI Systems

Fuel Type / Other Considerations	Regional Transmission and Distribution Line Considerations		
	VITS	CTS	ITS
RNG (on-system)	• Supply potential • No detrimental impact on transmission system capacity • Reliable supply from local on-system hubs will reduce upstream supply requirements and improve available capacity	• Supply potential • No detrimental impact on transmission system capacity • Reliable supply from local on-system hubs will reduce upstream supply requirements and improve available capacity	• Supply potential • No detrimental impact on transmission system capacity • Reliable supply from local on-system hubs will reduce upstream supply requirements and improve available capacity
Hydrogen	• Supply potential from blue or turquoise production potential may require system upgrades • Green hydrogen hub will reduce upstream supply requirements and improve available capacity, but reduce available capacity downstream	• By 2030, hydrogen production anticipated with hydrogen and RNG in similar proportions. • By 2042, hydrogen supplied from upstream of Huntington Control Station and comprises a much larger portion of the fuel mix • With upstream supply, hydrogen separation facility at Huntingdon anticipated • Dedicated hydrogen "backbone" pipeline likely	• Supply potential from blue or turquoise production potential may require system upgrades • Green hydrogen hubs will reduce upstream supply requirements and improve available capacity, but reduce available capacity downstream
Syngas and Lignin	• Supply potential	• No supply potential currently identified	• Supply potential

Fuel Type / Other Considerations	Regional Transmission and Distribution Line Considerations		
	VITS	CTS	ITS
LNG and Industrial Project Impacts	• Woodfibre LNG project may preclude hydrogen blending upstream (at Eagle Mountain) • Management of hydrogen at FEI's Mount Hayes LNG facility would be required	• Flow of hydrogen likely to be separated from transmission system at Huntingdon control station due to large scale LNG production at Tilbury and Woodfibre LNG project	• Management of hydrogen at any future LNG facilities would be required
System Upgrade Requirements	• Scope and location of system upgrades not yet feasible to determine as supply volumes and locations are currently in early stages of development	• Local supply hubs and small dedicated systems eventually connected to upstream by dedicated hydrogen "backbone" • Scope and location of system upgrades not yet feasible to determine as supply volumes and locations are currently in early stages of development	• Renewable and low-carbon projects could offset the need for upgrades • Regional Gas Supply Diversity (RGSD) project under development could provide significant support for delivery of hydrogen and other renewable gas • Scope and location of system upgrades not yet feasible to determine as supply volumes and locations are currently in early stages of development

Refer also to Sections 7.4.1.1 through 7.4.1.4 of the 2022 LTGRP for a more thorough discussion.

2.2.2.2 BC Hydro Accelerated Electrification Scenario Gas Forecast

Compared to the FEI Diversified Energy (Planning) Scenario, BC Hydro's Accelerated Electrification Scenario anticipates integrating only a fraction of the hydrogen projected by FEI, delivering a total of 3.5 PJ by 2042. Integrating this quantity of hydrogen within FEI's system would not likely require system-wide blending of hydrogen in any of the transmission systems and might be completely addressed by small local hubs near points of future hydrogen production distributed across the FEI service territory. The forecast would likely not require a dedicated hydrogen "backbone" as FEI is envisaging for the CTS, or major blending in the proposed RGSD pipeline to deliver hydrogen in quantity to the Lower Mainland from the Interior.

Considering the amount of RNG, syngas and lignin, and carbon capture, utilization and storage (CCUS) forecast by FEI, the integration of those fuel alternatives and the impact on the major transmission systems would be comparable to that described in Table 7-2 and FEI's 2022 LTGRP discussion of the Diversified Energy (Planning) Scenario.

2.2.2.3 BC Hydro Reference Case Gas Forecast

In 2042, the BC Hydro Reference Case Scenario includes approximately 2.9 PJ of hydrogen, just less than the amount projected in the Accelerated Electrification Scenario. Therefore, the description of integrating hydrogen would be similar to that outlined above for the BC Hydro Accelerated Electrification Scenario forecast. The integration could be accommodated mostly through local hub production and delivery, without appreciable blending in FEI transmission systems.

The BC Hydro Reference Case forecast projects no quantities of RNG or other renewable or low-carbon gases. Other than the small quantities of hydrogen identified by 2042, the forecast is largely projecting conventional natural gas delivery to support annual and peak demand. As the peak forecast for each major transmission system falls below, but closer to FEI's traditional peak demand forecast, FEI anticipates that the forecast of BC Hydro's Reference Case Scenario could be met with no system upgrades to the existing major transmission system, except for the OCU Project identified to support current peak demand in the ITS.

2.2.3 Peak Demand Implications for the Electric System

Electrifying buildings in BC will mean adding heat sensitive, or low load factor, demand to BC's electricity grid. In the extreme, if a primarily electrification pathway is pursued as BC's decarbonization pathway, this means that BC's electricity grid will need to accommodate the addition of high peak demand for approximately one million more customers than it currently serves for such load. The practical implications of maintaining a reliable and resilient energy system through such an undertaking needs to be examined carefully, using detailed utility data and knowledge of the respective energy systems and considering generation, transmission, distribution, and beyond the meter (i.e. customer) impacts. FortisBC (FEI and FortisBC Inc.) are continuing to examine the implications of electrifying space and water heating in areas of the province, such as Kelowna, where FortisBC serves both electricity and gas. Preliminary findings indicate that capacity constraints on the electric system would be reached quickly, triggering the need for new resources and costly upgrades to the transmission and distribution grids. This work has yet to assess the impacts and costs to home and business owners for upgrading electrical systems in buildings to accommodate the increased electricity requirements. A number of studies that examine this challenge, discussed in Section 3.7 and included in Appendix A-9 of the 2022 LTGRP identify the high costs for upgrading the electricity generation and delivery system in BC as a key constraint to electrification.

2.3 *RATE IMPACT ANALYSIS*

To provide context for FEI's long-term volume forecasts, Figures 6 through 9 provide a 20-year directional view of the potential impact on customer rates under BC Hydro's Reference Case and Accelerated Electrification and FEI's Diversified Energy (Planning), Deep Electrification, and Economic Stagnation scenarios for Residential (RS 1), Small Commercial (RS 2), Large Commercial (RS 3), and Industrial General Firm Service (RS 5) customers, respectively. The

figures below do not consider future rate design changes, nor do they represent a detailed rate forecast; rather, they provide a directional, 20-year view of how FEI's rates are influenced by these scenarios over time. Furthermore, this rate impact analysis only considers gas rates in the different scenarios evaluated. However, BC energy consumers are both gas and electricity ratepayers; therefore the combined rate and bill impact is a more appropriate scope for understanding the impacts of different planning scenarios.

This rate impact analysis compares the changes in rates over the planning horizon to the current 2022 approved rates using the following assumptions:

- The 20-year annual demand for each scenario includes DSM and low-carbon transportation;
- The long-term DSM expenditures used in this analysis are drawn from the DSM setting applied for each scenario discussed in Table 5-1 of the 2022 LTGRP and Table C-1 in Appendix C;
- Commodity costs are based on a mix of supply of conventional natural gas and renewable gas, and midstream (i.e., storage and transport charges) costs assumed an escalation of inflation;
- Carbon tax under BC Hydro's Reference Case is \$50/tCO_2e[14] carbon tax (nominal) by 2022, with revenue recycled to reduce labour taxes, provided as a lump sum to households, and used to subsidize low-GHG industry. In the BC Hydro Accelerated Electrification scenario, the carbon tax is aligned with provincial GHG targets: 52 Mt CO_2e in 2025, 37 Mt CO_2e in 2030, and 25 Mt CO_2e in 2040. FEI's Diversified Energy (Planning) and Deep Electrification scenarios assume annual escalation of a carbon tax until it reaches \$170 per tonne in 2030 and then holding constant until 2042. For FEI's Economic Stagnation Scenario, the carbon tax is assumed to be eliminated. For all scenarios, the bill impact analysis includes the avoided carbon tax resulting from the mix of renewable and low-carbon gas in the commodity costs. For example, assuming the gas supply includes a 5 percent mix of renewable and low-carbon gas in 2023, then the carbon tax is applied to the 95 percent of conventional natural gas only, with no carbon tax on the remaining 5 percent;
- This analysis uses FEI's 2022 approved delivery margin as the baseline cost of service plus annual escalation by inflation as well as the incremental cost of service for the capital expenditures on FEI's major transmission systems (VITS, CTS, and ITS) related to capacity upgrades, integrity, and resiliency depending on the peak demand forecast in each scenario;

[14] Tonnes of CO_2 equivalent.

- The incremental cost of service (including any offsetting revenue) related to FEI's major capital projects recently filed (or expected to be filed) or approved by BCUC, including:
  - Inland Gas Upgrades (IGU) CPCN;
  - Pattullo Gas Line Replacement (PGR) CPCN;
  - Tilbury LNG Storage Expansion (TLSE) CPCN;
  - Advanced Metering Infrastructure (AMI) CPCN;
  - CTS and ITS Transmission Integrity Management (TIMC) CPCNs;
  - OIC Tilbury Phase 1B; and
  - EGP Project.
- The rate impacts are based on the average use per customer (UPC) between 2022 and 2042 under the Diversified Energy (Planning) Scenario:
  - Residential (RS 1): 60 GJ per year
  - Small Commercial (RS 2): 293 GJ per year
  - Large Commercial (RS 3): 3,253 GJ per year
  - Industrial General Firm Service (RS 5): 18,542 GJ per year

Figure 6: Cumulative Rate Impact (2022 – 2042) – Residential RS 1

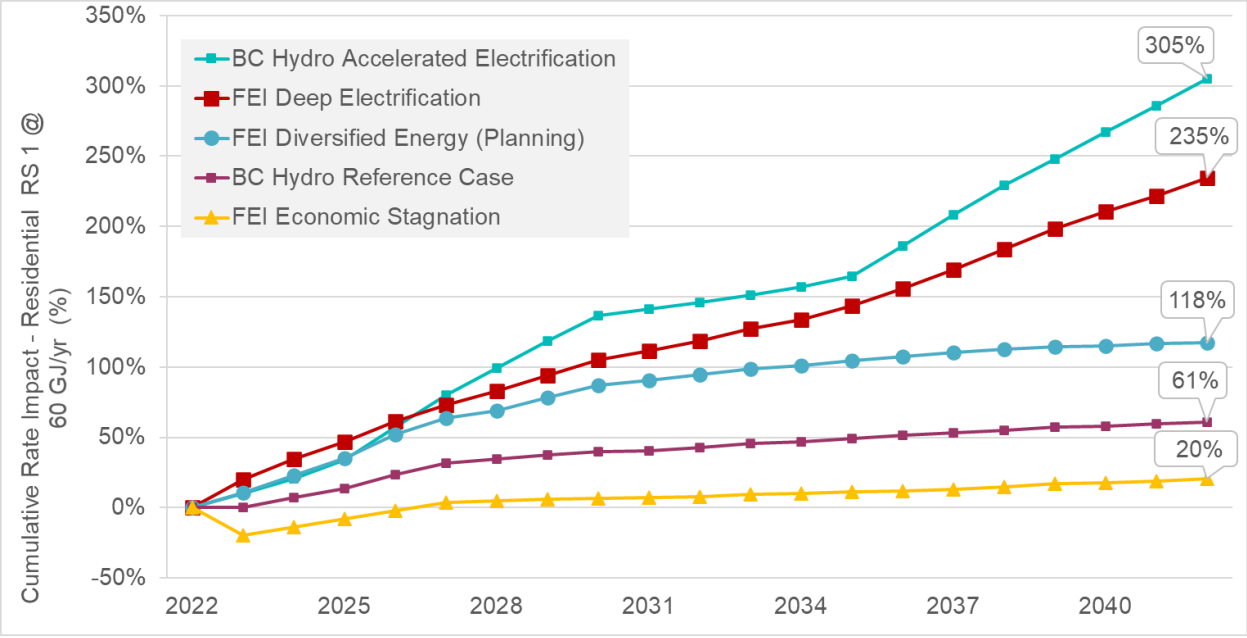


Figure 7: Cumulative Rate Impact (2022 – 2042) – Small Commercial RS 2

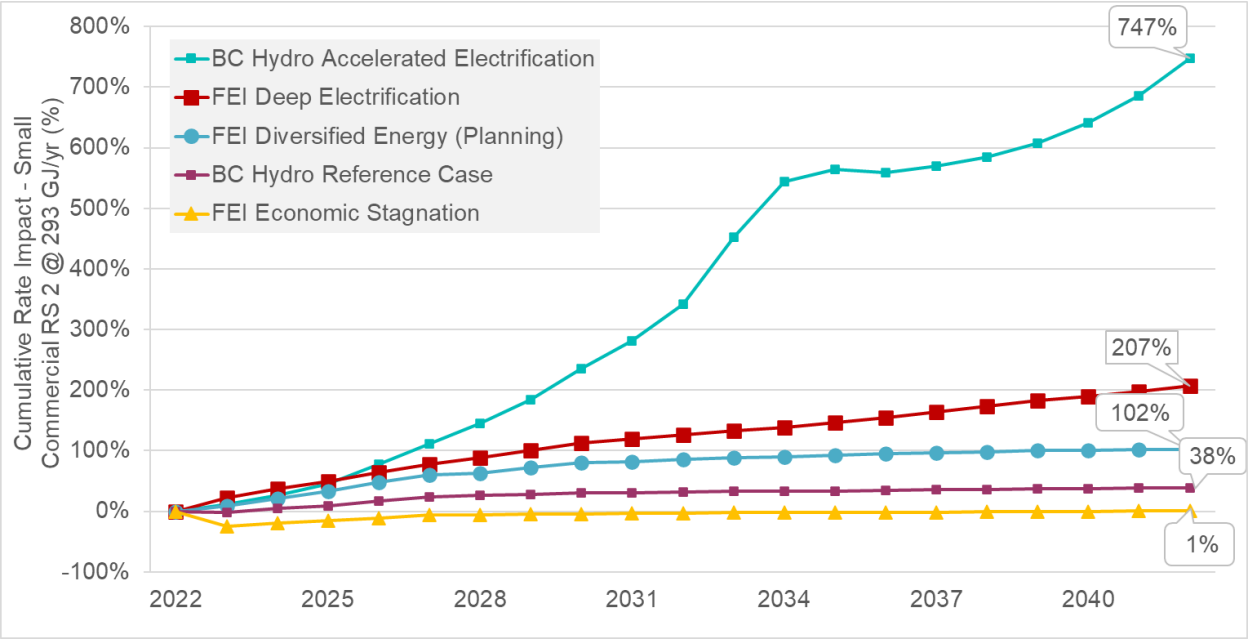


Figure 8: Cumulative Rate Impact (2022 – 2042) – Large Commercial RS 3

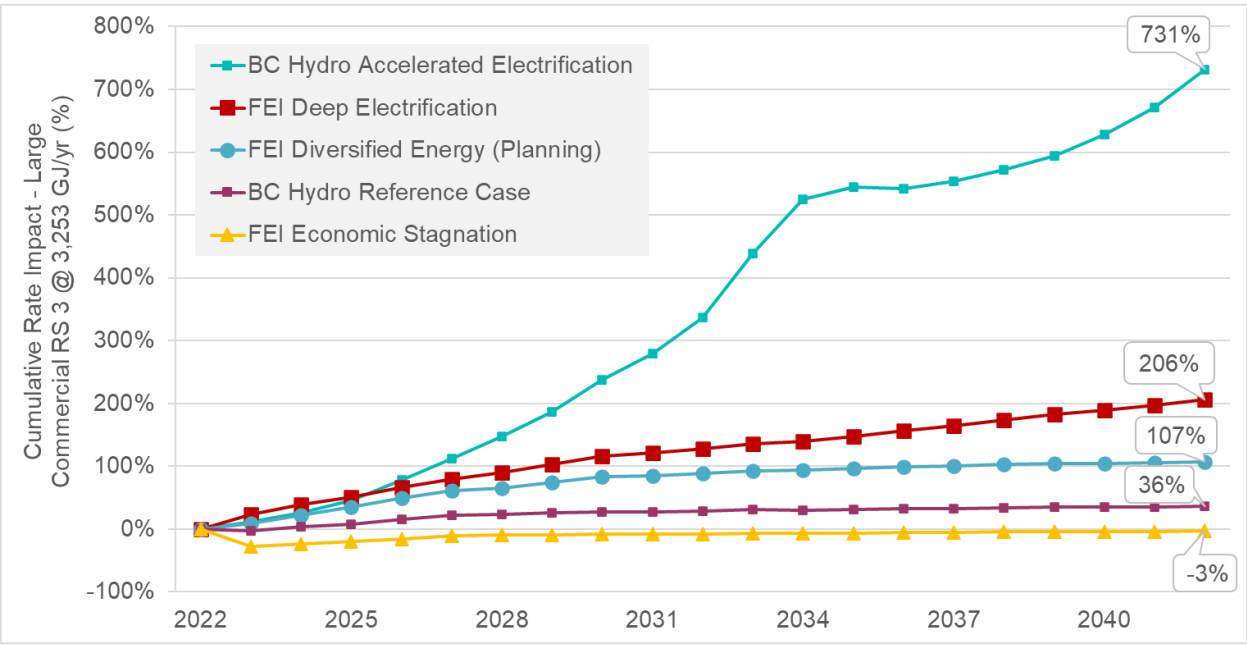


Figure 9: Cumulative Rate Impact (2022 – 2042) – General Firm Service RS 5

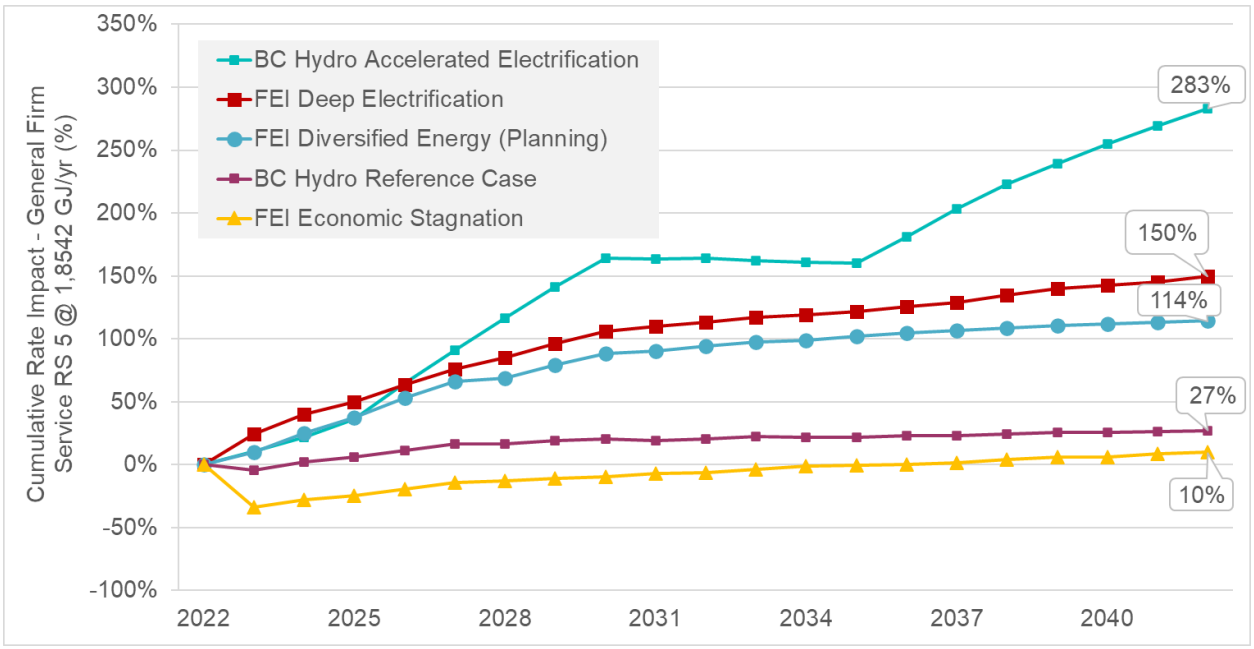


Table 6 summarizes the cumulative rate impact projections and the equivalent annual rate impact over the planning horizon for each scenario.

Table 6: Summary and Comparison of Average Projected Delivery Rate Changes – BC Hydro Scenarios

	Rate Change (2022 – 2042)				
	Average UPC (2022 – 2042)	BC Hydro Reference Case		BC Hydro Accelerated Electrification	
		Cumulative	Annual	Cumulative	Annual
Residential (RS 1)	60	61%	2.4%	305%	7.2%
Small Commercial (RS 2)	293	38%	1.6%	747%	11.3%
Large commercial (RS 3)	3,253	36%	1.5%	731%	11.2%
General Firm Service (RS 5)	18,542	27%	1.2%	283%	6.9%

Table 7: Summary and Comparison of Average Projected Delivery Rate Changes – FEI Scenarios

	Rate Change (2022 – 2042)						
	Average UPC (2022 – 2042)	FEI Diversified Energy (Planning)		FEI Deep Electrification		FEI Economic Stagnation	
		Cumulative	Annual	Cumulative	Annual	Cumulative	Annual
Residential (RS 1)	60	118%	4.0%	235%	6.2%	20%	0.7%
Small Commercial (RS 2)	293	102%	3.6%	207%	5.8%	1%	-0.1%
Large commercial (RS 3)	3,253	107%	3.7%	206%	5.7%	-3%	-0.3%
General Firm Service (RS 5)	18,542	114%	3.9%	150%	4.7%	10%	0.3%

The cumulative rate impacts shown in the figures above are made up of individual impacts in all components of FEI's rates, including delivery, cost of gas, storage & transport, and carbon tax. The large gap in rate impacts between the BC Hydro Accelerated Electrification and the FEI Deep Electrification scenarios for commercial rate classes appears to be a result of BC Hydro policy assumptions and the gas volume assumptions being much lower in the BC Hydro versus the FEI respective scenario.

2.4 GHG EMISSIONS AND EMISSIONS REDUCTIONS UNDER THE SCENARIOS

FEI's Diversified Energy (Planning) and BC Hydro's Accelerated Electrification scenarios are projected to meet the emissions reductions required by the GHGRS cap on natural gas utility emissions in the CleanBC Roadmap for the building and industrial sectors. Although FEI does not expect BC Hydro to model the Low-Carbon Transportation (LCT) and Global LNG demand category, for completeness, FEI considered these demand categories in its GHG emission reductions analysis.

2.4.1 Residential, Commercial and Industrial Emissions and Emissions Reductions

GHG emissions from residential, commercial and industrial customers will be subject to the GHGRS cap on emissions from buildings and industry. The Province's Clean BC Roadmap states that the GHGRS emissions cap on gas utilities will be approximately 6 Mt CO_2e in 2030. Accounting for the fact that FEI is not the only gas utility in BC, the portion of the cap that applies to FEI is estimated to be 5.7 Mt CO_2e.

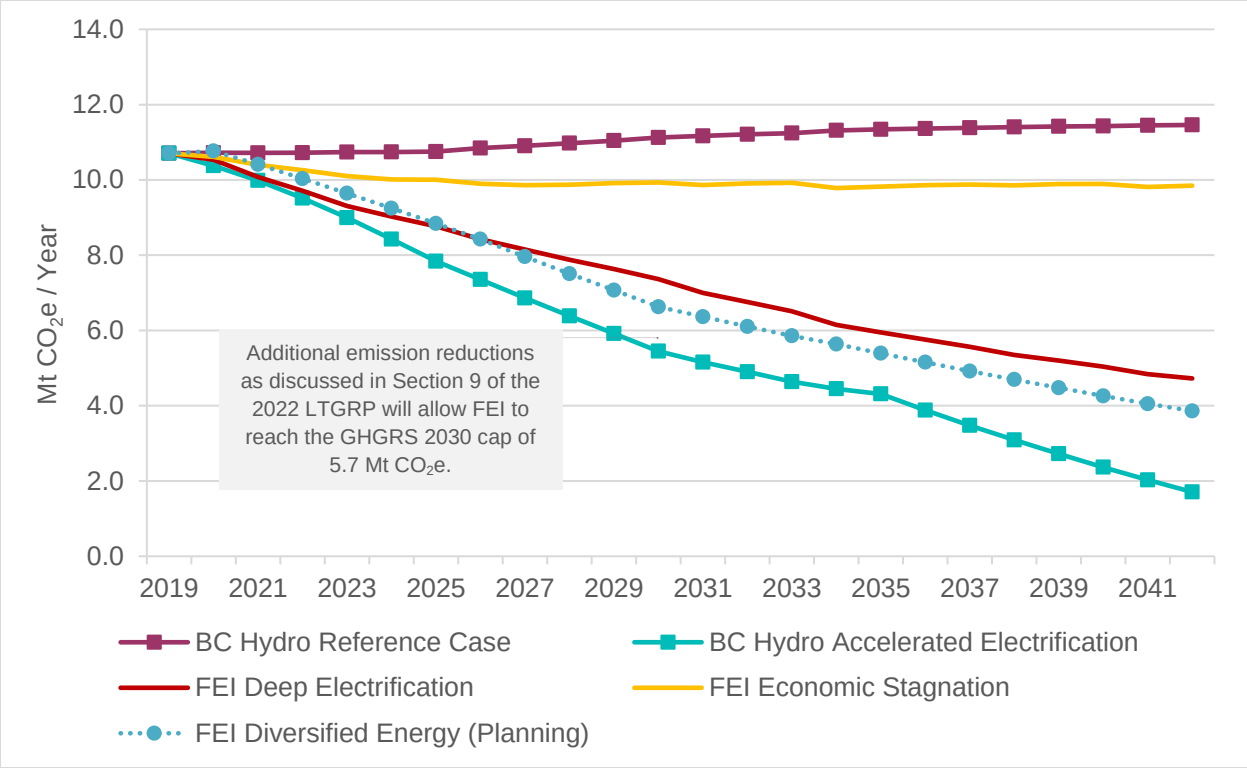
This section presents the emissions and emission reductions for residential, commercial and industrial customers. Emission reductions for these customers under the various scenarios come from changes in demand (before DSM and including fuel switching), reductions in demand as a result of DSM, and the transition to renewable and low-carbon gas supply.

In this section, FEI presents emission reductions using the end-use emission factor in order to align with the GHGRS. Sections 2.4.2 and 2.4.3 below present emission reductions using life cycle emission factors. A complete listing and explanation of the emission factors used is presented in Table 1-2 of the 2022 LTGRP.

FEI modelled GHG emissions for demand and supply for the five scenarios. The results are presented in Figure 10. FEI's Diversified Energy (Planning) Scenario does not include the additional reductions discussed in Section 9.2.1.4 of the 2022 LTGRP, related to other demand-side measures not modelled in the 2021 Conservation Potential Review (CPR) and higher than modelled CCUS implementation. With these additional reductions, FEI reaches the GHGRS 2030 cap on emissions. Further, FEI's modelling of GHG emissions reductions for the Diversified Energy (Planning) Scenario meets the Province's 2040 target emission reductions of 60 percent

and is based on the *Pathways for British Columbia to Achieve its GHG Reduction Goals*[15] (the Pathways report) Diversified Scenario, which also achieves the Province's 2050 GHG reduction target of an 80 percent reduction.[16]

Figure 10: GHG Emissions (End-Use) for Residential, Commercial and Industrial Customers



Over the long term, the gas demand from the BC Hydro Accelerated Electrification Scenario has deeper annual emission reductions than FEI's Diversified Energy (Planning) Scenario, driven by a modelled rapid decline in gas demand and the modelled transition to renewable and low-carbon gas supply. BC Hydro's Reference Case emissions increase due to gas demand growth throughout the forecast period, and since very little renewable and low-carbon gas is included in that scenario.

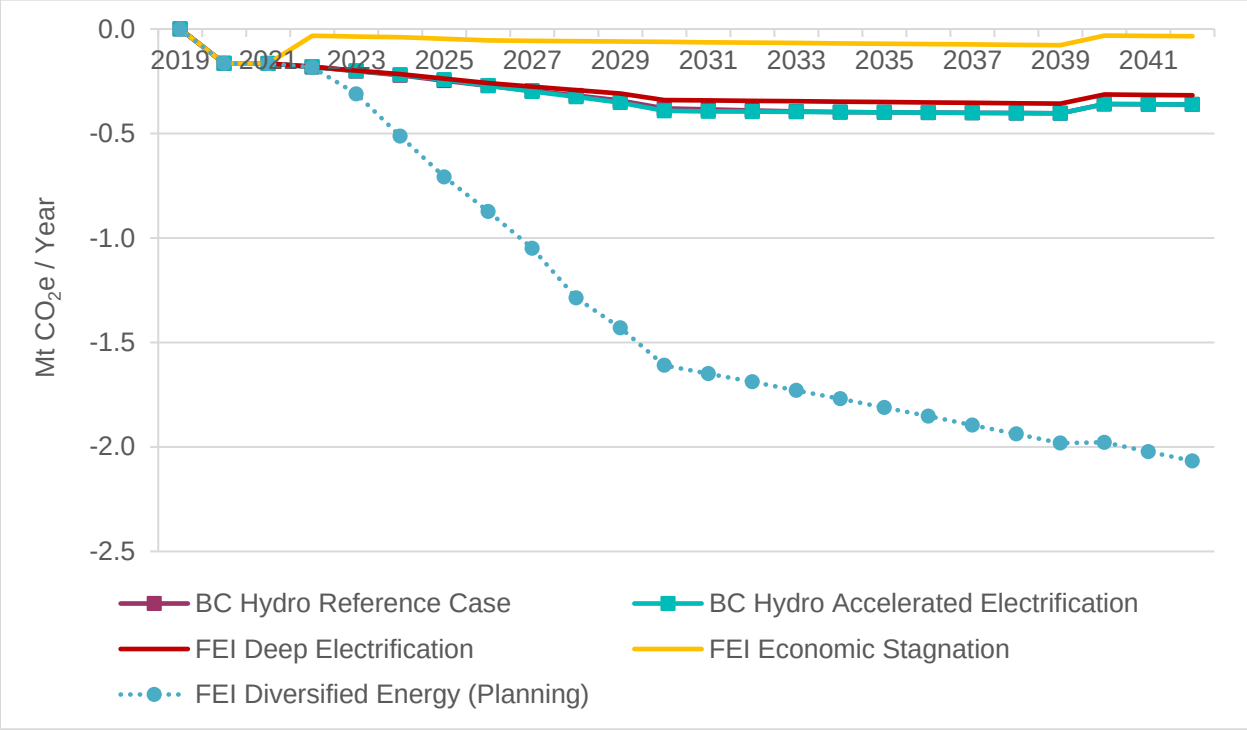
2.4.2 Low-Carbon Transportation and Global LNG

To provide a comparison of emission reduction results across the five scenarios, Figure 11 below shows the total life cycle emission reductions that occur as a result of demand from low-carbon transportation and global LNG customers. The planning environment conditions in BC Hydro's scenarios and in FEI's Deep Electrification and Economic Stagnation scenarios do not encourage diversified energy solutions as discussed in Section 3.2.2.4 of the 2022 LTGRP. FEI's understanding of the BC Hydro Reference Case Scenario is that it has a gas demand growth

[15] https://www.cdn.fortisbc.com/libraries/docs/default-source/about-us-documents/guidehouse-report.pdf.
[16] The 2040 and 2050 GHG targets are compared to 2007 levels.

trajectory throughout the planning horizon with a minor amount of renewable and low-carbon gas supply. FEI interprets the Accelerated Electrification Scenario to apply electrification as the primary means of carbon reduction, with an increase in renewable and low-carbon gas use to achieve specified GHG reductions. These conditions hinder investment in low-carbon transportation infrastructure, logistics and gas delivered by FEI, and results in minimal carbon reductions for high energy consuming users that are difficult to decarbonize.

Figure 11: Emissions Impact (Life Cycle) for Serving Low-Carbon Transportation and Global LNG Demand

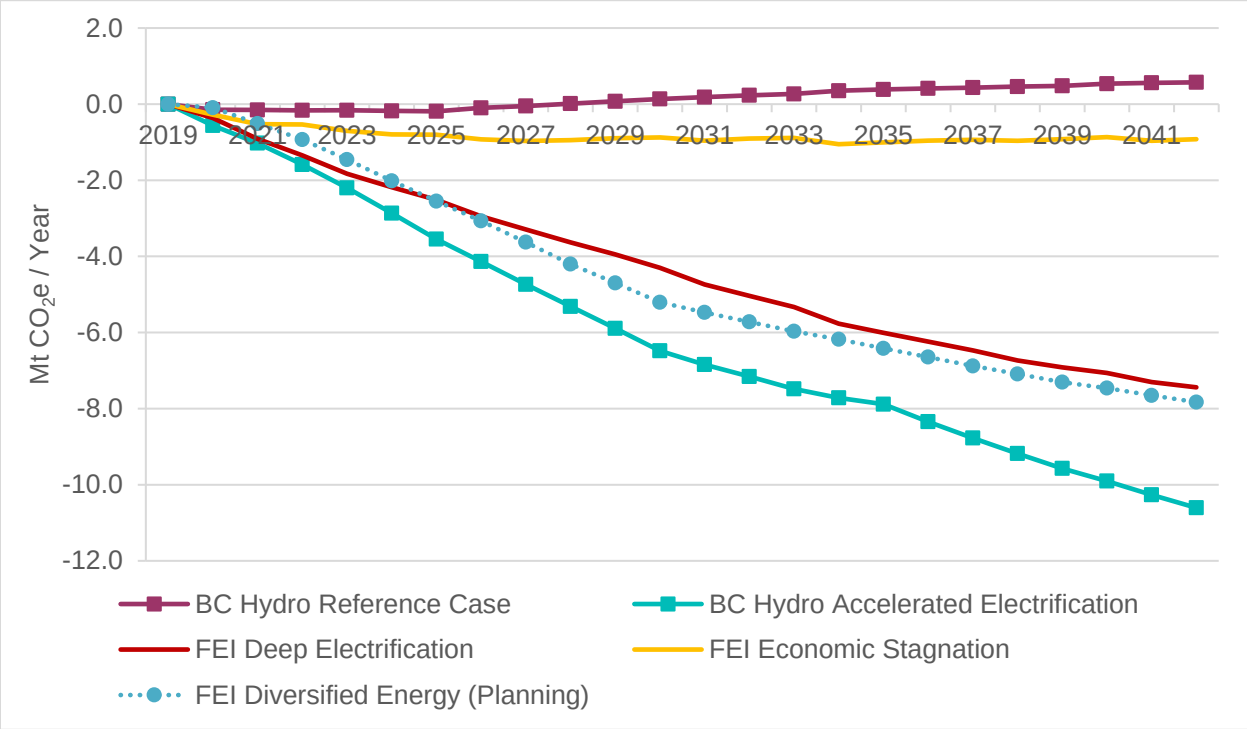


Note that in Figure 11 above the line for emission reductions resulting from FEI's modelling of BC Hydro's Reference Case scenarios is very similar to (and therefore obscured by) the line for BC Hydro's Accelerated Electrification Scenario.

2.4.3 Total GHG Emissions

Figure 12 below provides a comprehensive picture of the GHG emission reductions from serving both the residential, commercial and industrial, and the low-carbon transportation and global LNG customers throughout the planning horizon based on life cycle emission factors.

Figure 12: Total GHG Emission (Life Cycle) Reductions Due to Modelled Changes in Conventional Natural Gas Use and Displacement of Higher Carbon Fuels in Transportation in FEI's Demand Forecasts



3. KEY OBSERVATIONS

Modelling of the BC Hydro scenarios with electric demand information and data provided by BC Hydro has resulted in some interesting and important observations. This work also reveals important challenges. FEI draws the following key observations from the BCUC scenario modelling exercise as well as from the results of the supply resource, rates, and associated GHG emission analysis completed by FEI for the five energy scenarios.

3.1 *NOTES ON DATA INPUTS AND MODELLING CHALLENGES*

The FEI end-use annual demand forecast modelling conducted by Posterity uses more granular data than provided to FEI by BC Hydro for the BC Hydro scenarios. As a result, Posterity needed to interpret the BC Hydro scenarios to the best of their ability and in a number of cases selected the most relevant data points from FEI's scenarios in order to complete the modelling exercise. While the Utilities worked together to clarify much of the data and scenario narratives, this process of filling data gaps still leaves some uncertainty as to whether FEI fully captured the intent of the BC Hydro scenarios. For example:

- Since BC Hydro data did not account for DSM energy savings, FEI Medium DSM Setting inputs were added to the corresponding scenarios (See Table 5-3 of the 2022 LTGRP).

- The Navius renewable and low-carbon gas supply parameters help inform the GHG emissions impacts of the model runs. Appropriate annual values from 2020 levels were interpolated across to the 2040 final milestone year.

Further description of the process that Posterity used to complete the analysis is contained in Appendix C.

FEI also notes the following statement from the BC Hydro 2021 IRP, Appendix C regarding the BC Hydro scenarios:

> December 2020 Load Forecast – Appendix F: Navius Report:
>
> *"While this is a forecast of electricity consumption in BC, it is independent of the BC Hydro load forecast. Nonetheless, within this analysis, the forecast of electricity consumption in the absence of new GHG policies has been approximately aligned with BC Hydro's 2020 December Reference load forecast to facilitate a comparison between the two. Similarly, while this is an analysis of how provincial GHG reduction policies will affect energy consumption and GHG emissions in the province, it is independent of the work the BC government has done in this regard. For example, this analysis uses a generic emission cap to achieve the provincial GHG targets in 2025, 2030, and 2040".*

FEI assumes that this independence from the BC Hydro load forecast applies to the data exchanged and modelling completed for the BCUC Scenario modelling exercise and creates further uncertainty regarding the conclusions that can be drawn about the long-term impact of the scenario outcomes on both BC Hydro and FEI customers forecast energy use.

3.2 NOTES ON THE RESULTS

FEI provides the following general commentary on the results of the modelling exercises.

1. Total Annual Energy Demand (Electricity and Gas)

The calculation of total energy demand derived from the Stage One reports (that is, summing the annual demand forecast results from each utility) suggests that the future need for energy in BC is much lower under both the Deep and Accelerated Electrification scenarios. The reasonableness of the underlying assumptions of efficiency improvements in these electrification scenarios need to be closely examined and understood, as does the practicality of installing electric heat pumps in environments across BC subject to extreme cold weather as well as the implications for maintaining energy resiliency under extreme weather events. As discussed in Section 1.2 above:

- The nature of annual demand in BC Hydro's Reference Case versus other scenarios needs to be better understood in order to fully examine the implications of each scenario for peak electricity demand and associated costs throughout the

20-year planning period. For example, electricity demand in the two electrification scenarios includes market segments such as upstream oil and gas that are not currently served by FEI.

- Gas demand in 2040 in BC Hydro's Accelerated Electrification Scenario is 132 PJ lower than it is in BC Hydro's reference case, while electricity demand is higher by only 42 PJ. The details of and difference in electrification assumptions between BC Hydro's Accelerated Electrification and Reference Case scenarios need to be better understood in order to assess the reasonableness of efficiency gains that cause this result. The assumptions and implications for electricity peak demand will likewise need to be fully understood.

- The reasonableness of the rate of decline in gas demand in BC Hydro's Accelerated Electrification Scenario versus FEI's Deep Electrification Scenario needs to be carefully considered.

2. Midstream/Upstream Gas Supply Resources

Both the FEI Deep Electrification and BC Hydro Accelerated Electrification scenarios will substantially reduce gas flows to and across FEI's system. Although there is still uncertainty as to what the impact will be to each of FEI's service regions, both these scenarios will continue to utilize the existing regional natural gas infrastructure (pipelines and storage).

3. Temperature Sensitive Demand (Low Load Factor)

Electrification of buildings has the potential for extreme impacts on the electric system during extreme cold events, whereas the existing gas system has been designed with benefits of storage close to the load centre to serve this heat sensitive load. FEI's experience through this scenario forecasting exercise indicates that the electricity modelling of fuel switching from gas to electricity may be oversimplifying the challenges for the electric grid and overstating the efficiency benefits that can be achieved through electrification. Both FEI's Deep Electrification Scenario and BC Hydro's Accelerated Electrification Scenario have extreme implications for the electricity system in BC over the long term, as well as for costs and cost recovery of maintaining the gas infrastructure. These scenarios appear to create implausible technical and logistical requirements for alternative energy systems to be able to manage the scale of shifting energy resources, particularly to support peak energy, reliability and resiliency requirements.

4. Gas System Peak Demand

Overall, the BC Hydro scenarios fall below the highest of the FEI peak demand scenarios examined in the 2022 LTGRP for each of the major transmission systems. As a result, the forecasts do not imply that any capacity upgrades would be required to the existing systems to accommodate the forecasts that FEI has not already included and discussed in the 2022 LTGRP.

5. Renewable and Low-Carbon Gas Supply

- The BC Hydro Accelerated Electrification Scenario includes more renewable and low-carbon gas supply than the FEI Deep Electrification Scenario. One of BC Hydro's scenario assumptions is that there will be a renewable natural gas (RNG) standard requiring a minimum blend of renewable fuel in the natural gas stream even in a scenario where the Province is focused on electrification. In contrast, FEI's Deep Electrification scenario assumes the Province primarily focuses on electrification rather than decarbonizing the gas system. As stated in FEI's Stage one submission, FEI believes that since electrification initiatives are already very costly for electric rate payers, and the costs of maintaining the gas system would then be borne by the limited remaining gas customers in this scenario, adding further costs of renewable gas (which would not achieve the same economies of scale as would be expected in FEI's Diversified Energy (Planning) Scenario) would be unlikely. The fuel switching level used in FEI's Deep Electrification Scenario was based on the Electrification Pathway described in the Pathways report. The Deep Electrification Scenario also assumes CCUS is used in sectors where electrification is not possible or more difficult.

- The majority of renewable and low-carbon gas supply will be made up of RNG and hydrogen, with smaller amounts of syngas and lignin, and potentially conventional natural gas or RNG combined with CCUS later in the planning horizon. The percentage of each type of fuel within the overall amount of renewable and low-carbon gas supply is more difficult to forecast, although FEI expects its forecasts to evolve and be refined in future LTGRPs.

- As it is still early in the development of the production and delivery of hydrogen along with other renewable gases, FEI does not yet have sufficient definition to provide projections on their specific impact to the capacity of the system. Hydrogen has the most complex requirements from a system planning perspective. Considerations for hydrogen distribution is a likely and flexible way that the system can be expanded later in the forecast period considering the number of factors, yet to be fully determined, that may need to be defined and managed.

6. Residential, Commercial and Industrial GHG Emissions.

- At a high level, BC Hydro's method is a top-down approach based on economic simulations initially calibrated to a federal database of provincial GHG emissions and annual demand data, which develops all additional parameters from this headline level. Thus, BC Hydro's Accelerated Electrification Scenario achieves the GHGRS, achieving 5.4 Mt CO_2e in 2030, with the range of stronger policies and incentives considered when determining the gas energy demand.[17] Emission reductions from

[17] FEI's modelling considered the following conditions presented in the Results and Conclusions of the Executive Summary of BC Hydro's 2021 IRP, Appendix C: December 2020 Load Forecast - Appendix F: Navius Report:
- BC Hydro's Accelerated Electrification Scenario considers the implementation of stronger policies that substantially reduces British Columbia's total GHG emissions from the present.

electrification alone modelled by FEI in the BC Hydro Accelerated Electrification Scenario do not reach the 2030 GHGRS, requiring the questionable assumption of including increased supplies of renewable and low-carbon gas to do so.

- FEI's Diversified Energy (Planning) Scenario meets the GHGRS cap for gas utilities as a result of changes in demand (before DSM), DSM, renewable and low-carbon gas supply and additional reductions as explained in Section 9.2.1 of the 2022 LTGRP. This is the only scenario that examines a significant future role for hydrogen in BC.

- When modelled for the 2022 LTGRP, FEI's Deep Electrification Scenario was not seeking a specific GHG target, but rather modelled an electrification objective and calculated the resulting GHG impact. As such, this scenario did not model significant amounts of renewable natural gas being implemented for the remaining gas system customers. FEI believes that since electrification initiatives are already very costly for electric rate payers and the costs of maintaining the gas system would then borne by the limited remaining gas customers in this scenario, adding further costs of renewable gas (which would not achieve the same economies of scale as would be expected in FEI's Diversified Energy (Planning) Scenario) would likely be untenable.

7. Rate Impact Analysis

- The cumulative rate increase of 305 percent in Residential (RS 1) by 2042 under BC Hydro Accelerated Electrification Scenario is driven by growth in three rate components: 47 percent of the cumulative increase is due to delivery rate impact, 42 percent due to commodity related impacts (cost of gas and storage & transport), and 11 percent due to carbon tax increases.

- The cumulative rate increase of 118 percent in Residential (RS 1) by 2042 under FEI Diversified Energy (Planning) Scenario is driven by increases in three components: 50 percent of the cumulative increase is due to the delivery rate impact, 41 percent due to commodity-related impacts (cost of gas and storage & transport), and 9 percent due to carbon tax increases.

- In 2042 under BC Hydro's Accelerated Electrification, the cumulative rate increases for Small Commercial (RS 2) and Large Commercial (RS 3) represent increases of 747 percent and 731 percent, respectively. The difference in results appear to be driven by different input assumptions by BC Hydro and FEI and a significant decrease

- Electrification is an important GHG abatement action. With currently legislated policies, provincial GHG emissions are able the offset the growth of the population and the economy to keep GHG emissions roughly constant to 2040. By design, the stronger policy scenario hits the legislated GHG targets in 2025, 2030 and 2040.
- Navius' analysis shows that achieving BC's GHG reduction targets will result in substantially more electricity demand than would occur with current policies. The results do not show a future where other potential low-GHG energy pathways outcompete electricity. Rather, these pathways, including bioenergy, energy efficiency and some use of hydrogen fuel cell vehicles, are complementary and all contribute to deep GHG reductions.

in the commercial gas demand, which drops to 5.2 PJ at the end of the planning horizon.

- The cumulative rate increase of 747 percent in Small Commercial (RS 2) by 2042 under BC Hydro Accelerated Electrification Scenario is driven by growth in three components: 75 percent of the cumulative increase is due to delivery rate impact, 20 percent due to commodity related impacts (cost of gas and storage & transport), and 5 percent due to carbon tax increases.

- The cumulative rate increase of 102 percent in Small Commercial (RS 2) by 2042 under FEI's Diversified Energy (Planning) Scenario is driven by increase in all three components: 27 percent of the cumulative increase is due to delivery rate impact, 60 percent due to commodity related impacts (cost of gas and storage & transport), and 13 percent due to carbon tax increases.

4. CONCLUSION

The modelling common future scenarios by BC Hydro and FEI has been an important and informative exercise that provides a useful foundation for further analysis of unfolding energy issues and opportunities in BC. The process to date has identified some important limitations to acknowledge as this information is considered within the context of the respective Utilities' resources plans. FEI continues to support a collaborative approach to energy needs for the province by addressing the imperative to reduce carbon emissions, while also keeping energy costs affordable.

FEI draws the following conclusions from this work:

- BC Hydro's Reference Case does not consider energy delivery by other utilities and so does not fully assess the potential for GHG emission reductions that can occur within BC's energy system under this scenario. While not explicitly considering other carbon reduction pathways, BC Hydro's Reference Case does not exclude the potential for deep decarbonization of gas infrastructure through energy efficiency, transitioning to renewable and low-carbon gas to displace conventional natural gas for buildings and industry, and low-carbon gas for displacing higher carbon fuels in transportation.

- A complete, ongoing and collaborative assessment of a broad range energy decarbonization initiatives should be conducted before irreversible decisions are made by the BCUC, provincial and municipal governments, and energy consumers to pursue a single decarbonization pathway such as electrification. Such an assessment should include a complete and detailed assessment of impacts on energy costs, peak energy resources and costs, customer rates and energy affordability for all energy consumers in BC for alternative decarbonization pathways. FEI has initiated such analysis within the context of its own service territory and looks forward to BC Hydro's assessment of energy

supply resources, peak demand implications, and customer rate implications within its Stage Two filing.

- These considerations should include generation and storage requirements, transmission and distribution needs, deployment rates and costs for various key electrification end-use technologies on both the utility and customer side of the meter, as well as technology advancement and commercialization of renewable and low-carbon gas supply, delivery and end-use solutions.

- FEI acknowledges that technology advancements and cost considerations for energy resources, including the supply of renewable and low-carbon gas supplies, are evolving rapidly. FEI appreciates this collaborative exercise as a means of bringing new knowledge of these advancements to bear on energy planning in BC.

- Further analysis of alternative decarbonization pathways should include the evaluation of sectoral interdependencies particularly within the transport sector and load impacts of commercial vehicles.

- Limitations to acknowledge within the current work include:

    - The models used by each of the utilities to conduct the forecasting exercise and on which the discussion of implications is based are very different, with differences in the types of inputs required and the drivers embedded within the respective models. While each of the models and modelling processes has strengths and weaknesses, these differences suggest caution in drawing detailed conclusions from the modelling outputs. FEI believes that a comparison of the modelling outputs between the two utilities offers high-level conclusions only and insights into where additional information should be sought out.

    - The extent to which the temperature-sensitive nature of demand for gas in buildings in BC has been accurately portrayed and modelled in electricity demand for scenarios that assume extensive fuel switching from gas to electricity in uncertain given the total energy demand outcomes identified for the scenarios reported on in the Stage One filings.

In summary, FEI believes that a collaborative, informed and transparent approach to assessing and planning a decarbonization pathway for BC's energy systems as a whole is critical. FEI appreciates the BCUC's efforts to advance this work through the Energy Scenarios for BC Hydro and FEI proceeding.

Appendix A

FEI STAGE ONE SUBMISSION – MODELLING RESULTS

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

June 15, 2022

British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC
V6Z 2N3

Attention: Mr. Patrick Wruck, Commission Secretary

Dear Mr. Wruck:

Re: FortisBC Energy Inc. (FEI) and British Columbia Hydro and Power Authority (BC Hydro) – Energy Scenarios

FEI Stage One Submission – Modelling Results

In December 2021, the British Columbia Utilities Commission (BCUC) initiated a process to explore energy scenarios to achieve BC's greenhouse gas (GHG) targets and the resulting interdependent long-term implications on British Columbia's primary Electric and Gas Utilities, stating:

> BC Hydro and FEI […] have a significant and correlated role in achieving these GHG reduction objectives as the electric and gas energy systems in BC display many interdependencies, such as in the emerging industries of hydrogen and syngas production, carbon capture and storage and liquefied natural gas, to name a few.

In its letter dated January 21, 2022, the BCUC requested that BC Hydro and FEI (the Utilities) share the data required to file load forecast results based on each other's scenarios contained in their respective resource plans. As part of the filings, each Utility would include appropriate supporting commentary regarding the supply resource impacts, rate impacts, and associated GHG emission impacts that may be associated with each energy scenario.

In its letter dated March 9, 2022, the BCUC accepted the Utilities' request to stage the filings as follows:

- **Stage One** to be filed by June 15, 2022 will provide the load forecast results for the energy scenarios; and
- **Stage Two** to be filed by August 12, 2022 will provide supporting commentary regarding the supply resource impacts, rate impacts and associated GHG emission impacts for the energy scenarios.

This report represents FEI's Stage One filing, and focuses on annual demand only.

In addition, FEI considers that the submission of the Stage One report fulfills and concludes the monthly update submissions for the Utilities.

If further information is required, please contact Ken Ross, Manager, Integrated Resource Planning and DSM Reporting at (604) 576-7343 or ken.ross@fortisbc.com.

Sincerely,

FORTISBC ENERGY INC.

Original signed:

Diane Roy

Attachments

cc (email only): bchydroregulatorygroup@bchydro.com

British Columbia Hydro and Power Authority (BC Hydro), and

FortisBC Energy Inc. (FEI)

Energy Scenarios

FEI Modelling Results

Stage One

June 15, 2022

Table of Contents

1. INTRODUCTION AND BACKGROUND

In this report, FEI presents the results of its modelling of annual gas demand for select scenarios from FEI's and BC Hydro's respective long-term resource plans.

In December 2021, the British Columbia Utilities Commission (BCUC) initiated a process to explore energy scenarios to achieve BC's greenhouse gas (GHG) targets and the resulting interdependent long-term implications on British Columbia's primary Electric and Gas Utilities, stating:

> "BC Hydro and FEI […] have a significant and correlated role in achieving these GHG reduction objectives as the electric and gas energy systems in BC display many interdependencies, such as in the emerging industries of hydrogen and syngas production, carbon capture and storage and liquefied natural gas, to name a few."

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This report represents FEI's Stage One filing and focuses on annual demand only. FEI engaged consultants Posterity Group (Posterity) to support FEI in preparing the load forecast results.

The respective scenarios selected by the Utilities for analysis are set out below.

BC Hydro Scenarios:

- <u>BC Hydro Reference Case</u>
  Reflects 'current policies' that are legislated or have firm announcements. These include the BC carbon tax, rising to $50 per tCO_2e[1] by 2022 and other policies that generally date from the first BC Climate Action Plan, released in 2008. This scenario also includes the announced light-duty (passenger) vehicle zero-emission vehicle (ZEV) standard that requires a minimum fraction of sales be ZEVs and is trending towards a phase-out of

[1] tCO_2e = tonnes (t) of carbon dioxide (CO_2) equivalent (e).

conventional vehicles by 2040. (This represents the 'Current Policy' scenario outlined by the BC Hydro 2021 IRP, Appendix C: December 2020 Load Forecast – Appendix F: Navius Report).

- Accelerated Electrification
  A range of stronger policies and incentives, plus an emissions cap that achieves BC's 2025, 2030 and 2040 GHG reduction targets. These represent a 16 percent reduction from 2007 emissions by 2025, a 40 percent reduction by 2030 and 60 percent reduction by 2040. The incentives and regulatory policies include:
  - A strengthening of the Renewable and Low-Carbon Fuel Requirement;
  - A ZEV standard with some additional requirements for medium and heavy-duty vehicles;
  - A renewable natural gas (RNG) standard requiring a minimum blend of renewable fuel in the natural gas stream;
  - Incentives for the efficient electrification of buildings (e.g. with heat pumps);
  - Requirement for building envelope energy retrofits from after 2030; and
  - A zero-emissions building requirement, which affects new heating system installations after 2035.

  (This corresponds with the 'Stronger Policies' scenario outlined in the BC Hydro 2021 IRP, Appendix F: Navius Report).

- Low Load Forecast
  This scenario maintains all sectors and annual demand at the base year level. This scenario was determined by FEI to closely approximate FEI's Economic Stagnation Scenario as further discussed below.

FEI Scenarios:

- Diversified Energy (Planning) Scenario
  The key planning assumptions build upon a diversified approach to energy delivery and emissions reductions to British Columbians. Under this scenario, customer growth occurs for electric and gas utilities and the existing gas infrastructure is used to deliver low-carbon energy solutions to customers. FEI uses the Diversified Energy Scenario as its planning scenario in the 2022 Long-Term Gas Resource Plan (LTGRP). In the Diversified Energy scenario FEI meets the 2030 GHG emissions cap for buildings and industry set out in the BC government's proposed GHG Reduction Standard for gas utilities as well as the Province's 2040 GHG emission reductions target.

- Deep Electrification

The BC government does not dramatically increase carbon taxes above currently announced levels to avoid electoral backlash but uses all other policy levers to electrify the economy in order to achieve domestic carbon abatement. Government also promotes Carbon Capture Utilization and Storage (CCUS) for non-electrified sectors. Such policies create constraints for the BC economy and reduce the uptake of FEI's low-carbon gas transportation (LCT) solutions and also renewable gases. To support economic growth, the BC government supports liquified natural gas (LNG) exports to other jurisdictions. Despite these exports, the domestic shift towards electricity causes a regional conventional natural gas supply glut, leading to low regional gas prices.

- Economic Stagnation
  In this scenario the BC economy tightens, influenced by other North American and global trends, leaving fewer dollars available to the government and utility customers in BC to aggressively pursue decarbonization initiatives. Regional growth in natural gas demand slows, keeping BC's gas demand/supply balance abundant. Global economic performance reinforces trends towards the right of the political spectrum and causes governments to focus on areas other than climate policy. The economic environment has some negative impact on LNG exports and significant negative impact on natural gas as a transportation fuel. This scenario is not intended to model a 20-year recession, but rather a general trend over the planning horizon in which spending is reined in.

As described above, BC Hydro's Low Load Forecast represents a scenario where electricity demand over the long term remains constant with little to no growth or decline. The implication for a gas demand scenario of this nature is that demand would also stay relatively constant. With respect to annual gas demand, FEI's Economic Stagnation scenario results in a fairly constant level of future demand over the planning horizon, such that modelling and presenting this additional gas demand scenario would not provide value. Thus, the results of this report present only five scenarios – the two other BC Hydro Scenarios and the three FEI scenarios.

2. Results

The results of modelling the total annual gas demand for each of the five scenarios are shown in Figure 1 and Table 1 below.

Figure 1: Forecast of Total Annual Gas Demand by Scenario - All Sectors[2]

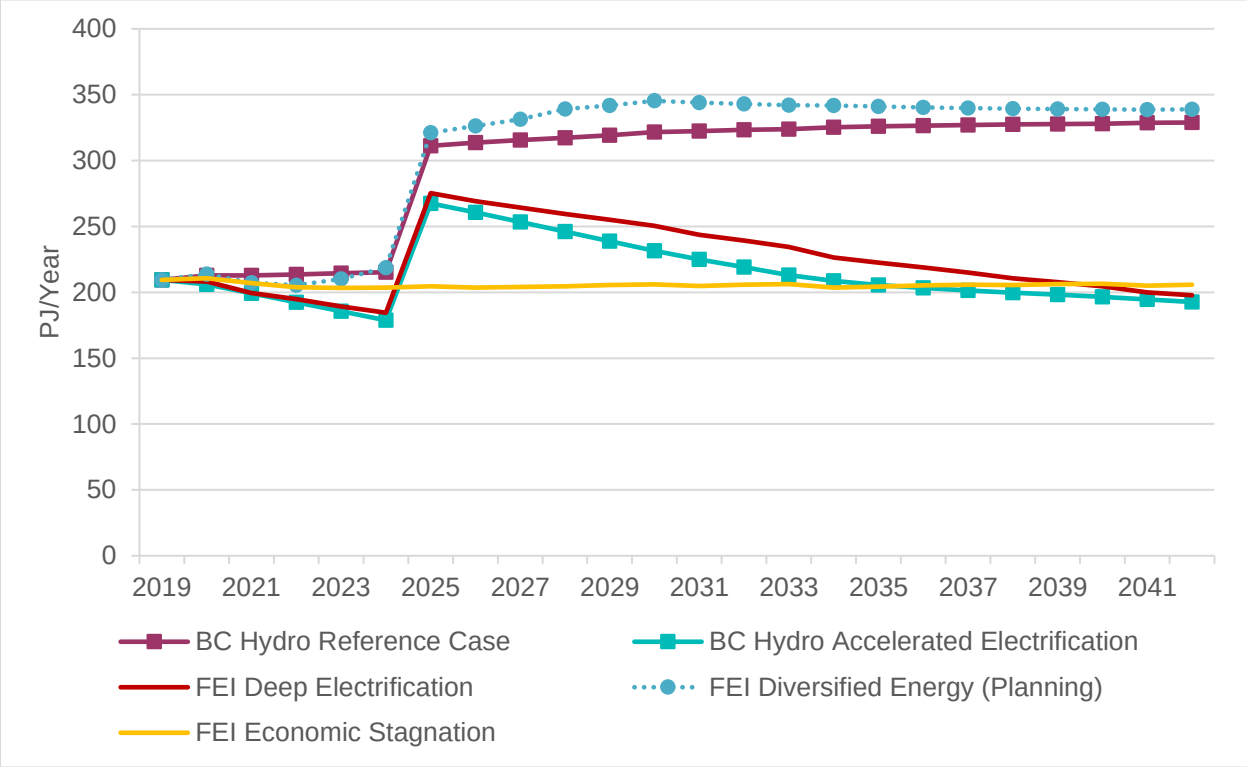

Table 1: Forecast of Total Annual Gas Demand (PJ/Year) by Scenario – All Sectors

	2025	2030	2035	2040	2042
FEI Deep Electrification	275	251	223	205	198
BC Hydro Accelerated Electrification	267	231	206	196	193
FEI Diversified Energy (Planning)	321	345	341	339	339
BC Hydro Reference Case	311	322	326	328	329
FEI Economic Stagnation	205	206	204	206	206

Notable in this scenario modelling exercise is the outcome of annual energy demand forecasts for FEI's residential, commercial and industrial customer demand categories because this is the demand category where a more significant shifting of load between the gas and electric systems is modelled in the Deep and Accelerated Electrification Scenarios, impacting the majority of FEI's customers. The forecast of combined annual gas demand for these customers under each of the scenarios is presented in Figure 2 and Table 2 below.

[2] To be consistent with the 2022 LTGRP, demand from the Woodfibre LNG project was not included in the Economic Stagnation Scenario. Further, though a later expected in service date for the facility has recently been announced by Woodfibre LNG, the date modelled in the 2022 LTGRP has been used for the BC Hydro scenarios for consistency.

Figure 2: Forecast of Total Annual Gas Demand by Scenario – Residential, Commercial and Industrial Customers[3]

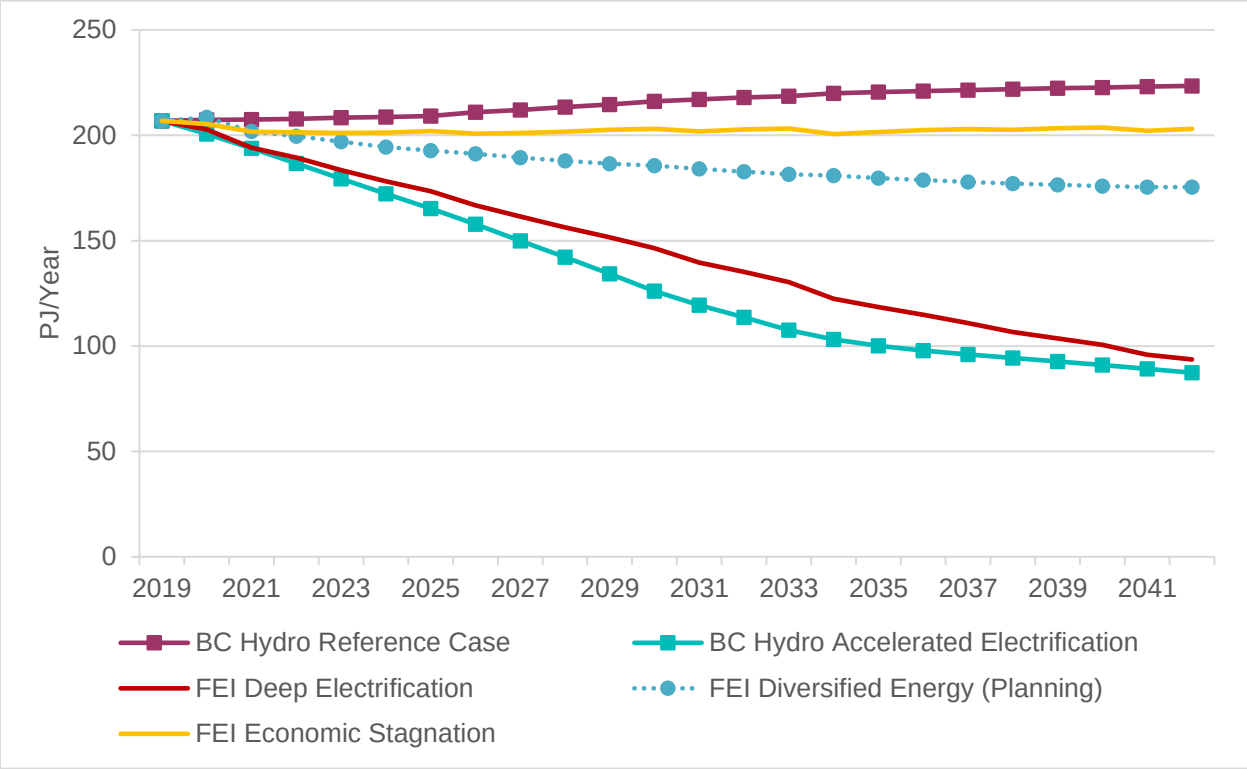

Table 2: Forecast of Total Annual Gas Demand (PJ/Year) by Scenario – Residential, Commercial and Industrial Customers

	2025	2030	2035	2040	2042
FEI Deep Electrification	173	146	119	101	94
BC Hydro Accelerated Electrification	165	126	100	91	87
FEI Diversified Energy (Planning)	193	186	180	176	175
BC Hydro Reference Case	209	216	220	223	223
FEI Economic Stagnation	202	203	202	204	203

The other two FEI categories of demand that are included in the total annual gas demand shown in Figure 1 and Table 1, but not included in Figure 2 and Table 2, are FEI's Low-Carbon Transportation (LCT) and Global LNG demand category and the Large New Industrial Load Category. FEI does not expect BC Hydro to model these categories as part of BC Hydro's future demand. However, for completeness, Posterity modelled for FEI these demand categories for each of the BC Hydro scenarios as follows:

[3] Results exclude FEI rate classes TPT-1, TPT-2 and Company Use (consistent with the 2022 LTGRP).

- The reference case setting for LCT and Global LNG was used to complete the total annual gas demand for the BC Hydro Reference Case and Accelerated Electrification scenarios. This setting was used to avoid FEI bias in interpreting the BC Hydro scenario narratives for this demand category and for consistency in the absence of data with which to use or develop other settings.

- FEI's planning setting for Large New Industrial demand was used, which is made up of the expected load from the Woodfibre LNG project. Since the project has announced its intention to proceed to construction, FEI has used this setting for both of the BC Hydro scenarios modelled. FEI notes that although the in-service date for the Woodfibre facility has recently been revised, for consistency with its LTGRP, FEI used the same timing (2025) for the facility's in-service date as was used for the FEI scenarios which were modelled before the in-service date was extended.

Since the resulting demand forecasts for these scenarios are a product of FEI's 2022 LTGRP modelling and not a result of separate modelling for these categories as part of the BCUC Scenarios request, they are not presented separately or discussed in further detail in this report.

3. KEY OBSERVATIONS

FEI makes the following key observations on the results of the modelling for the residential, commercial and industrial demand categories.

1. The BC Hydro Reference Case Scenario has the greatest gas demand (natural gas, RNG and hydrogen) throughout the forecast period. Specifically, the BC Hydro Reference Case Scenario has a greater demand than that of FEI's Diversified Energy (Planning) Scenario and FEI's Economic Stagnation scenario. To match the gas demand in the BC Hydro Reference Case, it was necessary to model substantial electricity-to-gas fuel switching for the major end uses in all three sectors. FEI's 2022 LTGRP did not contemplate any scenarios where fuel switching away from electricity and towards natural gas would occur on this scale.

2. Gas demand in FEI's Diversified Energy (Planning) Scenario falls in the mid-range of the various scenarios. BC Hydro's Reference Case and FEI's Economic Stagnation scenarios are at the higher end and the two Electrification scenarios are at the lower end.

3. Gas demand for BC Hydro's Accelerated Electrification Scenario tracks relatively closely to FEI's Deep Electrification Scenario. In 2030 there is a difference of about 20 PJ, and the gap is less than 10 PJ by 2040. This means that both scenarios forecast a similar decline in gas demand, although BC Hydro's scenario results in a gas demand forecast that is slightly lower.

4. Although supply resource implications are not part of the Stage One submission, FEI has observed that the BC Hydro Accelerated Electrification Scenario includes more renewable

and low-carbon gas supply than the FEI Deep Electrification Scenario. One of BC Hydro's scenario assumptions is that there will be an RNG standard requiring a minimum blend of renewable fuel in the natural gas stream even in a scenario where the province is focused on electrification. In contrast, FEI's Deep Electrification Scenario assumes the Province primarily focuses on electrification rather than decarbonizing the gas system, since investing in renewable and low-carbon gas resources would cause inordinate pressure on rates that would already be strained by maintaining a gas system for a dwindling demand. This observation will be explored further in FEI's Stage Two submission.

4. DATA EXCHANGED AND MODELLING CHALLENGES

In addition to the scenario descriptions presented in Section 1, BC Hydro and Navius provided FEI with the following data for all of the BC Hydro service territory and for multiple energy sources (see below) for the milestone years 2020, 2025, 2030, 2035, and 2040:

- 'Drivers of growth': GDP growth, population growth, natural gas price, and oil price;
- Scenario indicators: natural gas production, commercial and institutional floor area, residential floor area, housing starts, and retail spending;
- Economic sectors used in the modelling (i.e., segments);
- Residential and Commercial building area and thermal energy demand intensity by building type and end use (including energy consumption for load served by electricity and energy resources other than electricity like natural gas including RNG, oil, wood and other);
- Natural gas, including RNG, and electricity consumption by industrial sub-sector;
- Carbon prices and gas supply costs; and
- Forecasts for hydrogen, renewable natural gas (RNG) and carbon capture, storage, and utilization (CCUS) by sector.

In addition to scenario descriptions, FEI and Posterity provided BC Hydro with the following data for FEI's service territory and for gas demand only (natural gas and renewable gas) for each year over the planning horizon:

- Gas consumption by sector, fuel and segment;
- CNG/LNG consumption by fuel and segment;
- Tertiary load by sector, end use and segment;
- Industrial production forecast;
- FEI customer accounts by sector and segment;
- Units by segment for the Residential (dwellings) and Commercial (m^2) sectors;

- Fuel share by sector, end use, segment and fuel;
- Marginal avoided cost of renewable gases (RNG and hydrogen); and
- Electricity price (retail rate and avoided cost).

At a high level, BC Hydro's method is a top-down approach, based on economic simulations initially calibrated to federal GHG emissions and annual demand data, that develops all further parameters from this headline level. In contrast, FEI's method is a bottom-up approach based on customer end use demand and customer-specific data sources.[4] This difference resulted in some challenges for FEI and Posterity in converting the BC Hydro scenarios and data into inputs to FEI's forecasting model. The following adjustments were employed to meet these challenges:

- FEI / Posterity adopted 2020 as the common base year for this exercise;
- In some cases, FEI data was used if and when BC Hydro did not have explicit data on an input required for the FEI models;
- Where necessary, an iterative, targeting approach was employed to match the overall level of the residential, commercial and industrial sectors end use changes in the Posterity end use model to the overall percent changes in fuel use in the Navius modeling inputs; and
- In some cases, FEI / Posterity made adjustments to fuel switching assumptions when the practical limitations of the end use forecasting model were exceeded, creating logic errors. For example, once all end uses in the end use model were converted, further fuel switching could not continue.

The method employed to complete this conversion is not presented in detail in this report; however, where this necessary step in the modelling process may have implications for considering impacts on supply resources, GHG emissions and/or customer rates, additional discussion will be included in FEI's Stage Two submission.

5. NEXT STEPS

This Stage One report presents the results of FEI's modelling of total annual gas demand for select scenarios from FEI's and BC Hydro's respective resource plans. The Stage Two report,

[4] Additional data sources used to develop FEI's Reference Case and Alternate Future Scenarios include:

- 2021 Conservation Potential Review (2021 CPR);
- FEI's 2017 Residential End Use Survey (REUS) which represents FEI's most recent REUS at the time the forecast modelling was undertaken;
- FEI's 2019 Commercial End Use Survey (CEUS) which represents FEI's most recent study of its commercial customers; and
- Research and data analysis from the 2017 LTGRP which FEI included to utilize and build upon.

due August 12, will provide further supporting commentary for this scenarios modelling project regarding implications for:

- supply resources;
- rates; and
- associated GHG emissions.

Since a discussion of supply resources and rate impacts necessitates the consideration of the peak load and long-term system capacity requirements associated with each of the scenarios, FEI will also be including this information in its August 12 submission.

FEI appreciates the opportunity to participate in the BCUC Energy Scenario modelling project in which the Utilities are collaborating in developing a long-term supply resource outlook for BC's energy system as a whole. This project recognizes the roles for both the electric and gas energy systems in BC as being a complementary part of a resilient energy future and is an important step in planning for British Columbia's decarbonization transition with the objective of supplying safe, reliable, and affordable energy for all British Columbians.

Appendix B

KEY MODELLING INPUTS AND OUTPUTS FOR BC HYDRO SCENARIOS

APPENDIX B: KEY MODELLING INPUTS AND OUTPUTS FOR BC HYDRO SCENARIOS

Tables B-1 and B-2 describe key modelling inputs and outputs for the two BC Hydro scenarios to aid the reader in understanding Table 1. This Appendix excludes the FEI's scenarios since at the time of preparing this Stage Two submission FEI has not been provided with the modelling assumptions and outputs for electricity demand in BC Hydro's modelling for these scenarios.

Table B-1: Key Modelling Inputs and Outputs - BC Hydro Reference Case Scenario

Category	BC Hydro Assumptions for Electricity Demand obtained from BC Hydro's 2021 IRP	FEI Assumptions for Gas Demand interpreted for the scenario based on information provided by BC Hydro
Transportation	In 2040: ▪ Electric light-duty vehicles: 50 percent market capture ▪ Electric buses: 34 percent market capture ▪ Electric medium-duty vehicles: 10 percent market capture ▪ Electric heavy-duty vehicles: 20 percent market capture	The transportation segment for gas demand is mapped in the Low-Carbon Transportation sector.
Natural Gas Production	In 2040 the fraction of electric compressors is 19%.	The natural gas production segment is excluded from FEI's 2022 LTGRP as it represents supply activity upstream from the FEI gas system and therefore is not served by FEI.
Buildings	Electric heat pump adoption in 2040: ▪ Residential - space heating adoption: 6 percent market capture ▪ Commercial electric heat pump for space heating adoption: 23 percent market capture	In 2040 relative to 2020 data: ▪ Residential gas consumption for space heating decrease: 12 percent (6 PJ) ▪ Commercial gas consumption for space heating increase: 3 percent (1 PJ)
Mining and Other Industry[1]	In 2040, electric heat pumps supply 0.1 percent of industrial process heat.	In 2040 relative to 2020 data: ▪ Gas consumption increase: 26 percent (17 PJ)

[1] The Natural Gas Production, Conventional Light Oil Production, LNG, Hydrogen Production, District Energy System, Utilities and CoGeneration Vancouver Island sub-sectors are either not served by the respect utilities or are not included in this category.

Table B-2: Key Modelling Inputs and Outputs - BC Hydro Accelerated Electrification Scenario

Category	BC Hydro Assumptions for Electricity Demand obtained from BC Hydro's 2021 IRP	FEI Assumptions for Gas Demand interpreted for the scenario based on information provided by BC Hydro
Transportation	In 2040: ▪ Electric light-duty vehicles: 64 percent market capture ▪ Electric buses: 75 percent market capture ▪ Electric medium-duty vehicles: 30 percent market capture ▪ Electric heavy-duty vehicles: 24 percent market capture	The transportation segment for gas demand is mapped in the Low-Carbon Transportation sector.
Natural Gas Production	▪ In 2040 the fraction of electric compressors is 48%.	The natural gas production segment is excluded from FEI's 2022 LTGRP as it represents supply activity upstream from the FEI gas system and therefore is not served by FEI.
Buildings	Electric heat pump adoption in 2040: ▪ Residential - space heating adoption: 24 percent market capture ▪ Commercial electric heat pump for space heating adoption: 67 percent market capture	In 2040 relative to 2020 data: ▪ Residential gas consumption for space heating decrease: 73 percent (35 PJ) ▪ Commercial gas consumption for space heating decrease: 92 percent (30 PJ)
Mining and Other Industry[2]	In 2040, electric heat pumps supply 12.6 percent of industrial process heat.	In 2040 relative to 2020 data: ▪ Gas consumption decrease: 16 percent (10 PJ)

[2] Natural Gas Production, Conventional Light Oil Production, LNG, Hydrogen Production, District Energy System, Utilities and CoGeneration Vancouver Island are either not served by the respect utilities or are not included in this category.

Appendix C
MODELLING INPUTS AND ASSUMPTIONS

APPENDIX C: MODELLING INPUTS AND ASSUMPTIONS

Posterity Group (PG) modelled the gas demand forecasts of the BC Hydro scenarios. The scenarios were developed using an iterative process of goal-seeking to meet the percentage change in conventional natural gas demand based on gas demand forecasts provided by BC Hydro. This approach was used because PG's end-use model differs in forecasting method from BC Hydro's econometric model, and because the input data and assumptions provided by BC Hydro did not perfectly map to PG's model of FEI's customers. The differences are largely due to model scope as BC Hydro's model is of the entire province whereas FEI's is for its service territory only, and due to differences in assumptions about fuel switching potential in certain customers/end uses.

BC Hydro provided scenario input data for milestone years (5-year increments starting in 2020 to 2040). Some inputs and assumptions aligned with PG's model while others required further interpretation. PG also had to interpolate assumptions between milestone years and extrapolate from 2040 to 2042 to obtain annual values out to the end of the 2022 LTGRP planning horizon.

The data used by BC Hydro/Navius to determine gas loads for BC Hydro's scenarios was different than FortisBC's own demand data, largely due to the differences in the models as explained above. To accommodate the differences in absolute values, PG calculate the percent change in gas demand starting with FEI's 2019 base year actuals, to develop a 2040 gas demand target for each sector and scenario[1]. PG selected model parameters to populate with BC Hydro data and parameters to adjust to meet the 2040 gas demand targets for each BCH scenario. Specifically, PG adjusted fuel switching and fuel share assumptions to calibrate to the 2040 gas demand targets. While BC Hydro did provide electrification assumptions, it was necessary for PG to adjust fuel switching assumptions in order to meet the 2040 gas demand target. Without doing so, the targets could not be reached.

Table C-1 below details the assumptions applied to each model parameter to develop the gas demand forecasts for the BC Hydro scenarios.

[1] Using the conventional natural gas consumption forecast provided by BC Hydro, PG calculated annual targets for percent change in gas demand from FEI's 2022 LTGRP base year (2019) out to 2040 for each BC Hydro Scenario. As FEI's base year is calibrated to 2019 actuals, PG applied the percent change to FEI's base year consumption, rather than applying the change in absolute values. For each sector and scenario, PG extrapolated the BC Hydro values by one year back to 2019, calculated the percent change in the BC Hydro values from 2019 to 2040, and applied this percent change to FEI's 2019 base year to calculate a 2040 gas demand target.

Table C-1: Modelling Input Parameters and Considerations in Setting Model Runs

Parameter	Considerations
Natural Gas Demand: the annual natural gas consumption: • by sector • industrial segment • milestone year • scenario	▪ **Key target parameter** for each of the scenario model runs. ▪ Targeted the Navius percentage change in Natural Gas Demand over the base year as the Navius model encompasses energy demand for the entire province.
Dwelling Stocks: the commercial and residential square meters, inferred residential unit count, and industrial production levels by: • sector • milestone year • scenario	▪ Percentage change in Navius Dwelling Stocks was used as a **boundary parameter** as the Navius model encompasses stock for the entire province**.** ▪ Navius supplied information on how its scenarios expect industrial output to change over time, so these assumptions were matched via the size factor in the industrial sector of the FEI model runs.
Fuel Share: the natural gas fuel shares for existing and new stock and end-use appliances, by: industrial sector commercial/residential end-use milestone year scenario	▪ FEI natural gas and electric Fuel Shares are the **key variable parameter** for the goal seeking process. ▪ At the end of the setup model run, PG checked FEI Fuel Shares to ensure natural gas or electric fuel shares did not exceed 100 percent or fall short of 0 percent, and that end-use equipment/stock replacement did not exceed the rate of natural stock replacement from the 2022 LTGRP.
End Use Efficiency & Thermal Demand Intensity: the space heating thermal demand intensity, by: • residential/commercial segment • milestone year • scenario	▪ Used as a **key boundary parameter.** ▪ Posterity understood that Navius received professional advice from RDH Engineering on how space heating thermal demand intensity may behave in the future within the context of provincial energy and emissions policy. Since these results are not comprehensively available, they were not used for the FEI model runs.
Demand-Side Management (DSM) Energy Savings not accounted for by Navius.	▪ FEI DSM Energy Savings scenario inputs were added to the corresponding scenario model runs before initiating the goal seeking process. ▪ FEI Medium DSM Setting inputs were added to the corresponding scenarios.
Navius Renewable and Low-Carbon Gas Supply parameters.	▪ The Navius Renewable and Low-Carbon Gas Supply parameters help inform the GHG emissions impacts of the model runs. ▪ Appropriate annual values from common base year levels, were interpolated across to the 2040 final milestone year.

Low-Carbon Transportation, Global LNG and New Industrial Load settings

To develop total annual demand for the BC Hydro Scenarios, PG applied FEI's demand settings to develop demand forecasts for Low-Carbon Transportation, Global LNG Market and New Large

Industrial demand for the BC Hydro Scenarios. This was required to avoid FEI bias in interpreting the BC Hydro scenario narratives for this demand category and for consistency in the absence of data with which to use or develop other settings.

Table C-2 shows the FEI demand settings applied to the BC Hydro scenarios.

Table C-2: FEI's LCT, Global LNG and New Large Industrial Demand Settings Applied to BC Hydro's Scenarios

BC Hydro Scenario	LCT and Global LNG	New Large Industrial
BC Hydro Reference Case	Reference	Planning
BC Hydro Accelerated Electrification	Reference	Planning

Appendix D

ANNUAL DEMAND FORECAST BY CUSTOMER CLASS

REFER TO LIVE SPREADSHEET MODEL

Provided in electronic format only

(accessible by opening the Attachments Tab in Adobe)