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October 13, 2023

BC Solar and Storage Industries Association
PO Box 33019
West Vancouver, BC
V7V 4W7

Attention: Steve Davis

Dear Steve Davis:

Re: FortisBC Energy Inc. (FEI)

2022 Long Term Gas Resource Plan (LTGRP) ~ Project No. 1599324

Response to the BC Solar and Storage Industries Association (BCSSIA) Information Request (IR) No. 3 on Rebuttal Evidence

On May 9, 2022, FEI filed the LTGRP referenced above. In accordance with the amended regulatory timetable established in British Columbia Utilities Commission Order G-150-23 for the review of the LTGRP, FEI respectfully submits the attached response to BCSSIA IR No. 3 on Rebuttal Evidence.

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

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC ENERGY INC.

Original signed:

Sarah Walsh

Attachments

cc (email only): Commission Secretary
Registered Interveners

20.0 Topic: The Potential for Hydrogen blending in FEI's delivery system

Reference: Exhibit B-38, FEI Rebuttal Evidence Section 2, FEI Plans for Hydrogen Blending, Answers 5 and 6, Exhibit C16-6, MS2S Intervener Evidence

In its Rebuttal Answer 5 (Exhibit B-38), FEI states that the challenges to hydrogen blending are "*well understood and can be addressed*":

> "… MS2S does not present a balanced view of the feasibility of hydrogen blending, but rather presents "challenges" to hydrogen based on a selective reading of FEI's evidence and third-party reports, without any attempt to acknowledge the existence of solutions.
>
> … the "challenges" to hydrogen blending identified by MS2S are well understood and can be addressed. For instance, Hawaii Gas has been blending an average of 12 percent hydrogen into its gas network for over 50 years,1 and Hydrogen blending has been successfully demonstrated in various jurisdictions including Markham, Ontario, and Fort Saskatchewan, Alberta in Canada, as well as in various countries in Europe."

And in Rebuttal Answer 6, FEI states:

> "As a high-level outlook, FEI suggests that 20 PJs of its supply may be hydrogen in 2030. This supply has not been broken out further into separate hydrogen types within the supply… RNG, and not hydrogen, is expected to make up a larger portion of the renewable and low-carbon gas supply in the earlier years of the planning horizon."

The "challenges" faced by hydrogen blending, as outlined by MS2S (Exhibit C16- 6, pages 4 and 5), included the following:

1. Increased risks of pipeline leaks resulting from increased operating pressure required to transport hydrogen in FEI's existing system.
2. Increased risks of pipeline ruptures and strain cracks caused by the vulnerability of existing pipeline infrastructure to embrittlement.
3. If hydrogen is injected to serve the Lower Mainland distribution system, it would have to be removed before reaching the downstream LNG plants (Tilbury, Woodfibre, and Mount Hayes). No plan is presented to do this.
4. Hydrogen is explosive over all (0-100%) concentrations in air as compared to Methane's flammability range of a much lower 5-15% methane/air mix.
5. Hydrogen is an expensive alternative fuel at almost three times the cost of fossil gas before storage and distribution costs are added.

6. Hydrogen is an indirect greenhouse gas, in that it prolongs the lifetime of methane in the upper atmosphere, and also upstream emissions may compromise FEI's ability to achieve full compliance with government (Federal & CleanBC) objectives for emissions reduction/ decarbonization.

20.1 Please describe each of the cited distribution systems (Hawaii Gas, Markham, and Fort Saskatchewan) and explain the similarities or differences between FEI's infrastructure and each of those systems, particularly as to the type of pipe and the pressures being used?

<u>Response:</u>

Hawaii Gas,[1] Enbridge Gas[2] and ATCO Gas[3] all have summaries of their individual pilot projects available on their public websites. It is not practical for FEI to describe each of the cited distribution systems in detail; however, based on the available information, FEI has summarized the key similarities between the three cited distribution systems and the FEI gas system pipeline infrastructure below.

Infrastructure Pressure and Diameter Characteristics		Hawaii Gas Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service [4]	Enbridge Gas Blending Pilot Project - Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service [5]	Atco Gas Blending Pilot Project - Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service	General Comparison to FortisBC Energy Inc. Gas Infrastructure
Low-Pressure Distribution System (Mains, Services, Headers)	Pressure Range	Specified as "relatively low pressure) in the referenced documentation, assumed to be less than 100 pounds per square inch gauge (psig)	Approximately 60 psig	Specified as "distribution system", FEI could not find reference to the actual operating pressure but expects it to be less than 100 psig	The certified maximum allowable operating pressure of FEI's low-pressure distribution system is approximately 100 psig. FEI operates the low-pressure gas distribution system at a slightly lower pressure, at approximately 60 psig (except Vancouver Island where the distribution system operates at 80 psig), which corresponds to the hydrogen blending pilot projects mentioned.
	Diameter Range	½ inch to 10" nominal diameter	Various up to 8-inch nominal diameter	FEI could not find specific details available in online research	FEI's low-pressure gas distribution system incorporates a range of pipeline diameters, which is similar to the hydrogen blending pilot projects mentioned; the largest diameter plastic pipe is 10 inch and the largest diameter steel pipe is 20 inches nominal diameter.

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1 Hawaii Gas, "Decarbonization and Energy Innovation", (2022), online at: https://www.hawaiigas.com/clean-energy/decarbonization.

2 Enbridge, "Clean hydrogen enters the Markham energy mix", (January 13, 2022), online at: https://www.enbridge.com/stories/2022/january/hydrogen-blending-project-enbridge-gas-cummins-operational-markham-ontario.

3 ATCO, "Fort Saskatchewan Hydrogen Blending Project", (2022), online at: https://gas.atco.com/en-ca/community/projects/fort-saskatchewan-hydrogen-blending-project.html.

4 Hawaii Gas, "Final IRP Report and Action Plan", (2023), online at: https://uploads-ssl.webflow.com/618c69307382fa36b31ac896/642f89e3171648bf86e7135e_Dkt%202022-0009%20Hawaii%20Gas%20Final%20IRP%20Report%20and%20Action%20Plan%2C%20filed%204-6-2023.pdf.

5 Enbridge Gas, Ontario Energy Board File: EB-2019-0294, Low Carbon Energy Project – Application and Evidence – Redacted (March 31, 2020), online at: https://www.enbridgegas.com/-/media/Extranet-Pages/About-Enbridge-Gas/Projects/Low-Carbon-Energy-Project/1_EGI_APPL_20200331_except-F-1-1_Att-6.ashx?rev=b79b2c764a744e59915388e88ca5311d&hash=2259D0E562CD68C4FAF5F6A7872582CF.

Infrastructure Pressure and Diameter Characteristics		Hawaii Gas Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service [4]	Enbridge Gas Blending Pilot Project - Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service [5]	Atco Gas Blending Pilot Project - Pipeline Infrastructure Operating Hydrogen-Natural Gas Blended Service	General Comparison to FortisBC Energy Inc. Gas Infrastructure
	Pipe Material	55 percent High Density Polyethylene (HDPE), 45 percent steel	Plastic	FEI could not find specific details available in online research	FEI's low-pressure gas distribution system includes 63 percent plastic and 37 percent steel which is similar to the Hawaii Gas low-pressure distribution system
High-Pressure	Pressure Range	500 psig (maximum allowable operating pressure)	Various pipe segments from 175 to 650 psig design pressure	FEI could not find specific details available in online research	FEI's high pressure gas transmission system infrastructure has a maximum operating pressure range from approximately 100 to 2160 psig. FEI's Coastal Transmission System serving the Lower Mainland operates at a maximum operating pressure of 590 psig, which is similar to the maximum operating pressure of the hydrogen blending projects mentioned in this table.
	Diameter Range	Up to 16-inch nominal diameter	Various pipe segments from 2 inch to 8 inch nominal diameter	FEI could not find specific details available in online research	FEI's high-pressure gas system infrastructure diameter varies in range from as small as 3 inch nominal diameter to 42 inch nominal diameter
	Pipe Material	Steel	Steel	FEI could not find specific details available in online research	Steel

Notes to Table:

1. *Low Pressure (distribution) mains, services, and header lines are the network of mains and service lines that move gas at relatively low pressures to individual homes and businesses, with a regulated maximum operating pressure typically not greater than 100 pounds per square inch and manufactured from steel or plastic pipe. These lines usually operate at a pressure slightly lower than the maximum allowable operating pressure.*
2. *High Pressure (intermediate and transmission) pipelines generally comprise larger maximum diameters, or higher operating pressures, or transport gas over longer distances compared to Low-Pressure distribution lines.*

20.2 Please provide FEI's knowledge as to how, and to what extent, each of the cited distribution systems (Hawaii Gas, Markham, and Fort Saskatchewan) have been able to deal with each of the challenges outlined by MS2S. What special measures have any of those system operators used in order to accommodate hydrogen blending?

Response:

FEI does not have specific knowledge as to how, and to what extent, each of the cited system operators (Hawaii Gas, Enbridge Gas in Markham, and ATCO Gas in Fort Saskatchewan) might have considered the challenges outlined by MS2S or any special measures that any of those system operators may have used to accommodate hydrogen.

However, the challenges outlined by MS2S are practical considerations relating to gas safety, asset integrity, end-use customer compatibility, rate impacts, and environmental issues that would, in FEI's opinion, likely be considered as part of normal due diligence work prior to blending hydrogen to displace conventional gas supply to FEI customers. Therefore, it is likely that the same considerations, especially gas safety, asset integrity, and end-use customer impacts, were successfully addressed as part of the system operators' due-diligence work to secure regulatory approvals prior to hydrogen blending. This opinion is supported in the response to BCSEA IR3 58.1, where the cited reference concludes that low hydrogen percentage blending is feasible in high-pressure transmission lines and low-pressure distribution lines as proven by international hydrogen blending demonstration projects, including the hydrogen blending projects referred to in the IR question. Therefore, it could be concluded that the challenges raised by MS2S are not an insurmountable barrier to successfully blending hydrogen at lower blend percentage levels.

FEI accepts the conclusion of the cited reference in the response to BCSEA IR3 58.1 that further research will be required to address these challenges to achieve the higher blends of hydrogen, in some cases up to 100 percent, and specifically:

- Hydrogen embrittlement as mentioned in the response to BCSSIA IR3 20.2.1;
- System capacity planning due to the difference in volumetric energy density between conventional gas and hydrogen gas mentioned in the response to BCSSIA IR3 20.2.1; and
- The need to adjust or protect customers' equipment from the issues of embrittlement or lower energy density mentioned in the response to BCSSIA IR3 20.2.2.

While FEI does not have specific knowledge regarding the measures that the system operators implemented to accommodate hydrogen, FEI provides the following comments on the challenges identified by MS2S as they relate to the system operators, based on publicly available information and FEI's own industry experience:

1. <u>Leaks due to increased operating pressure:</u> It does not appear that the operators cited in this information request increased the operating pressure of the gas system above the certified operating pressure to enable hydrogen blending; therefore, there was no increased risk of pipeline leaks resulting from increased operating pressure to transport hydrogen in the hydrogen-natural gas blended systems. FEI expects that this will also be the case for FEI's existing system if hydrogen is blended at low blend percentage concentration levels.

2. <u>Embrittlement:</u> Enbridge Gas and ATCO Gas focused initial hydrogen deployment efforts in low-pressure distribution networks where there is a lower risk of hydrogen embrittlement due to the low operating pressures of the distribution systems and constituent materials having a lower susceptibility to hydrogen embrittlement. Hawaii Gas has been safely

operating their high pressure and low pressure gas system on a blend of gas containing hydrogen for many decades. This was addressed in response A8 of FEI's Rebuttal Evidence to MS2S (Exhibit B-38). Managing pipeline integrity is a central aspect of every natural gas utility's business, and existing natural gas utilities have the experience, expertise, and systems in place to mitigate pipeline leaks, that can be advanced and adapted to suit the technical properties of the gas they transport.

3. LNG facilities: The presence of LNG facilities on FEI's system was addressed in response A13 of FEI's Rebuttal Evidence to MS2S. This response can be applied to the three utility distribution systems cited in this information request. It is not evident that there were any LNG facilities connected to the operators' gas system that received a hydrogen-natural gas blend.

4. Flammability of hydrogen: When hydrogen is delivered as a relatively low percentage blend in the gas stream, the explosive limit is dictated by the chemical composition of the gas stream, which is significantly lower than for 100 percent hydrogen.

5. Cost: This consideration was addressed in response A7 of FEI's Rebuttal Evidence to MS2S. FEI's response can be applied to the three cited gas utilities, each of which operates in an independent regulatory environment that will govern the maximum price for hydrogen.

6. GHG emissions: Hawaii Gas, ATCO, and Enbridge Gas each operate their distribution networks in accordance with local regulations governing leak surveys and fugitive emissions management. Alongside the cited utilities, FEI will monitor the changing state of climate science to minimize indirect warming potential associated with all GHGs.

20.2.1 In particular, what experience have they had with the embrittlement issue in their pipelines, or the increased pressures needed due to the low energy density of hydrogen, and how have they dealt with these issues?

Response:

Please refer to the response to BCSSIA IR3 20.2.

All three utilities have focused initial hydrogen deployment efforts in low-pressure distribution networks where there is a lower risk of hydrogen embrittlement due to the low operating pressures of the distribution systems and constituent materials having a lower susceptibility to hydrogen embrittlement.

The lower energy density of hydrogen blends can be addressed through system modifications, such as compression and pipeline diameter, rather than increased operating pressure. All cited utilities have a long history of complex hydraulic modelling for a constantly evolving energy distribution network. Existing system capacity methodologies will be used to address the distribution of hydrogen.

20.2.2 How have they dealt with the need to adjust or protect customers' equipment from the issues of embrittlement or lower energy density?

Response:

Please refer to the response to BCSSIA IR3 20.2.

It is well established in academic literature and existing industry codes and standards that the risk of hydrogen embrittlement decreases with hydrogen partial pressure in steel alloy piping systems. Customer equipment serviced in all three pilot service territories is downstream of the residential or commercial meter and pressure regulation; therefore, customer appliances operate at a very small hydrogen partial pressure on the order of magnitude of 0.1 kPag to 0.7 kPag (0.015 psig to 0.10 psig). As a result, equipment modifications are not expected to be required as a result of steel embrittlement.

No modifications to customer equipment are expected to be required as a result of the lower energy density of a hydrogen natural gas blend. The delivery of a consistent amount of energy within the Wobbe Index tolerances of customer end-use appliances will be addressed by system capacity modelling of the wider FEI distribution network.

20.3 If FEI is successful in blending 20 PJ of hydrogen, plus as much RNG as is available, into its gas supply by 2030, please calculate what the GHG emissions reductions would be from this amount of blending. Please describe which type of hydrogen technology FEI is assuming in this calculation and what is its assumed carbon intensity?

Response:

Please refer to the response to BCUC IR1 71.7, in which Table 1 explains the contribution of each of FEI's decarbonization activities as presented in the 2022 LTGRP Application to GHG emissions reductions, including the renewable and low-carbon gas supply by 2030. Please also refer to the response to BCUC IR1 71.8.1 for the supply outlook. Finally, please refer to the response to CoR IR2 6.1 for a discussion of FEI's approach to the type of hydrogen technology and carbon intensity FEI assumed in the 2022 LTGRP Application.

20.3.1 If this GHG reduction is short of the required approximately 6 mega-tonnes per year, what other measures will FEI use to make up the difference?

Response:

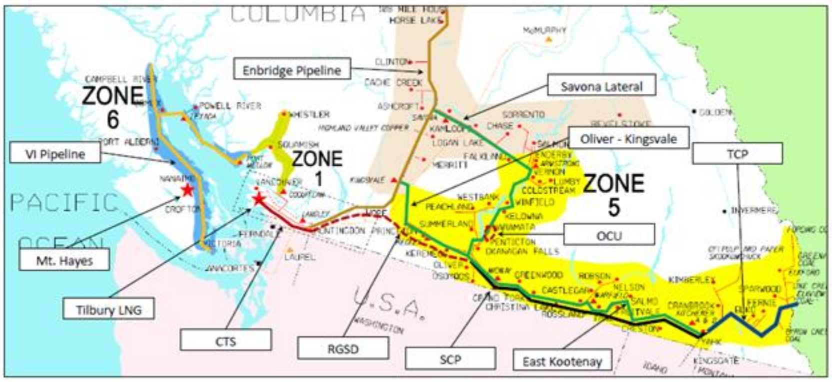
Please refer to the response to BCUC IR1 71.14.1.

21.0 Topic: The Potential for Hydrogen blending in FEI's delivery system

Reference: Exhibit B-38, FEI Rebuttal Evidence Section 2, FEI Plans for Hydrogen Blending, Answers 9, 10; and Exhibit B-11, response to BCSSIA IRs 1.5.5, 1.5.7, Exhibit B-6, response to BCUC IR 1.61.9

The map below roughly depicts FEI's pipeline system, including the proposed RGSD project (map from Exhibit B-11, pdf page 393 of 453):

Transmission Network- RGSD Strengthens Entire System



In its Rebuttal Answer 10 (Exhibit B-38), FEI states that:

> "… most of FEI's system is likely not vulnerable to hydrogen embrittlement due to the low operating pressure, and in any event, technical assessments are being conducted to ensure the safety and compatibility of hydrogen blends in FEI's infrastructure…"

And in Rebuttal Answer 9 (Exhibit B-38), FEI states that:

> "…The Coastal Transmission System (CTS), which serves Lower Mainland and Fraser Valley customers, operates at a maximum of 583 PSI. The Vancouver Island Transmission System (VITS) serves customers on Vancouver Island, Squamish, Sunshine Coast and Whistler, and operates at a maximum of 2,160 PSI…"

In its response to BCSSIA IR 1.5.5 (Exhibit B-11) FEI provided the following statements and table showing the breakdown of steel and polyethylene pipe in various segments of its pipeline grid:

> "The only material type used for transmission and intermediate pressure pipelines is steel; it is the distribution pressure (DP) mains, service pipe, and header pipe that may be either polyethylene (PE) or steel. The portion of PE to steel pipe for DP mains, services and headers, by Business Zone, is as follows:

Km of DP Mains, Services, and Headers by Business Zone				
Business Zone	PE	Steel	% PE	% Steel
Zone 1 - Lower Mainland West	4,402	5,867	43%	57%
Zone 3 - Lower Mainland East	7,154	5,775	55%	45%
Zone 4 - Interior North	4,253	2,144	66%	34%
Zone 5 - Interior South	6,995	3,190	69%	31%
Zone 6 - Vancouver Island	7,008	162	98%	2%
Total	29,813	17,137	63%	37%

> As provided in the above table, Business Zone 6 (Vancouver Island) contains the most PE pipe (versus steel) on FEI's pipeline grid, with 98 percent of the pipe being PE and 2 percent steel."

And in response to BCSSIA IR 1.5.7, FEI described other "critical pipeline components," that would be challenged by hydrogen blending, as follows:

> "Other "critical pipeline components" could include equipment such as valves, compressors and meters that are required to operate the pipeline system. FEI is currently planning to undertake the BC Gas System Hydrogen Blending and Technical Assessment Study that will leverage available data and inputs from existing literature, studies, research, and testing…"

In December 2022, in response to BCUC IR 1.61.9 (Exhibit B-6) FEI describes its development of a "Hydrogen Roadmap":

> "FEI is designing a hydrogen development roadmap plan (Hydrogen Roadmap) and has issued a Request for Proposal (BC Gas System Hydrogen Blending Study and Technical Assessment project) for external services providers to assist FEI in progressing the next major steps that are outlined below…
>
> … FEI currently aims to confirm that a 5 percent by volume blend of hydrogen by 2025 and up to a 30 percent volume blend of hydrogen is feasible by 2030..."

21.1 FEI's Vancouver Island system appears to have the highest percentage of PE pipe (98%) but also the highest maximum pressure (2,160 psi). Does that make Vancouver Island a better or a worse prospect for hydrogen blending?

21.1.1 Even if there is a very low overall percentage of steel pipe in the system (such as 2% on Vancouver Island), is that not still a significant risk, since the total system can only be as strong as its weakest link? What measures would FEI use to protect that most susceptible 2% of the system?

Response:

For clarity, the Vancouver Island Transmission System has a maximum operating pressure of 2,160 psig and is comprised of steel pipe only, as noted in the preamble to the IR above. The Vancouver Island distribution systems operates at the significantly lower pressure of 80 psig and is comprised of a mix of mainly polyethylene (PE) pipe and a small portion (2 percent) steel pipe as clarified in the table in the preamble. The higher percentage of PE pipe on Vancouver Island may provide an advantage for hydrogen blending feasibility compared to a distribution network that would have more steel pipe, particularly if the portion of steel pipe in a network is older. Regardless of the location of hydrogen injection, an assessment will be required on all assets that would be affected by the proposed injection to satisfy operational and safety considerations prior to hydrogen blending. However, given that the distribution system operates at low operating pressures and low stress levels, the small percentage of steel pipe does not represent a significant risk for hydrogen blending in the Vancouver Island gas distribution system.

21.1.2 If hydrogen were to be injected into the Vancouver Island system, where would it be optimally injected, what sources would supply the hydrogen, and where and how would the hydrogen be removed prior to supplying Woodfibre or Mt. Hayes?

Response:

If hydrogen were to be injected into the Vancouver Island system, the optimal location would be into the low-pressure gas distribution system, or at an industrial gas customer's plant operations if the hydrogen could be locally produced and used to directly replace natural gas use in the industrial host site end-use applications. For example, FEI is currently working on early-stage project development activities to produce and blend hydrogen at an industrial facility on Vancouver Island to test the use of hydrogen to displace natural gas in a lime kiln.[6] FEI is not actively working on any projects to inject hydrogen into the Vancouver Island low-pressure distribution or high-pressure transmission systems, but may in the future. Therefore, FEI has not yet identified where hydrogen would optimally be injected, sources of hydrogen supply, and options to mitigate impacts to Mt. Hayes LNG if hydrogen were to be delivered to Mt. Hayes as a blend in the gas supply.

21.2 FEI's Interior Transmission System (ITS) appears to have a reasonably high percentage of PE pipe (66% and 69%) but the operating pressure is not evident. What is the maximum operating pressure of the ITS?

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[6] Government of British Columbia, Innovation Accelerator Projects – 2022 Nanaimo Forest Products Ltd., (May 15, 2023) online at: https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/cleanbc-industry-fund/funded-projects.

Response:

The areas referenced in the preamble for which the percentage of PE pipe is 66 percent and 69 percent describe FEI's low-pressure distribution pipeline systems throughout the Interior region. The operating pressure of these pipes is 420 kPag (61 psig).

The Interior Transmission System supplies gas to the downstream distribution system and is comprised of steel pipe and has operating pressures ranging from 3,447 kPag to 9,930 kPag (500 psig to 1,440 psig).

21.2.1 Does the maximum operating pressure and percentage of polyethylene materials in the ITS make it a more feasible system into which hydrogen could be blended than the Coastal Transmission System or the Vancouver Island Transmission System?

Response:

For clarity, FEI reiterates that the only material type used for transmission and intermediate pressure pipelines is steel; it is the distribution pressure (DP) mains, service pipe, and header pipe that may be either PE or steel. The Interior and Coastal DP systems operate at 60 psig (414 kPag), the Vancouver Island DP system operates at 80 psig (552 kPag). Given the similarity in operating pressures, hydrogen blending is equally as feasible in each distribution system. As noted in FEI's Rebuttal Evidence to MS2S, A10, distribution system operating pressures and stress levels are considered low in the context of hydrogen embrittlement risk, making the DP pipeline infrastructure in all three regions suitable candidates for the incorporation of hydrogen regardless of their respective proportions of material type.

21.2.2 What other factors, including "critical pipeline components", would make the ITS more or less feasible into which to inject hydrogen, compared to the CTS or VITS?

Response:

Other factors, including "critical pipeline components", will be reviewed and identified as part of the BC Gas System Hydrogen Blending Study and Technical Assessment project scope of work. The project will also evaluate the technical implications associated with exposing valves, compressors, and meters to various hydrogen concentrations in the FEI transmission and distribution systems, and identify any required measures to manage those implications.

21.2.3 Please describe the difficulties, if any, associated with exposing valves, compressors and meters at various levels of hydrogen concentration in the FEI transmission and distribution systems. What measures can be taken to protect these critical components?

Response:

Please refer to the response to BCSSIA IR3 21.2.2.

21.3 Since 2025 is now little more than 1 year away, is FEI still on track to confirming a 5% blend of hydrogen by 2025? If not, when will this be confirmed?

Response:

Yes, FEI is on track to confirm the feasibility of a 5 percent hydrogen blend in its low-pressure gas distribution network infrastructure by 2025. For the high-pressure gas transmission network, the work to review hydrogen compatibility will be completed after 2025, at which point FEI will be able to confirm the feasibility of hydrogen blending in this part of the gas network.

21.3.1 Will the contemplated 5% blend be system wide, or will it be localized in one or more particular zones? If so, which zones are the most favoured, and where would be the hydrogen sources of supply be in 2025 or 2030?

Response:

FEI's goal is to establish a system wide standard for hydrogen blending. The introduction of hydrogen into FEI's operating zones will be defined in detail as part of Hydrogen Roadmap, a key deliverable in the BC Gas System Hydrogen Blending Study and Technical Assessment project. This roadmap will address the locations and blend percentage of initial hydrogen deployment, in addition to expected hydrogen supply sources.

21.4 What is the current status of the development of FEI's "Hydrogen Roadmap"? What are the findings to date and when can further results be expected? Will those results be filed as an update in this proceeding?

21.4.1 Is the "Hydrogen Roadmap" synonymous with the "BC Gas System Hydrogen Blending Study and Technical Assessment project"? If not, then what are the findings to date of the latter, and when can further results be expected? Will those results be filed as an update in this proceeding?

Response:

FEI is designing and advancing a hydrogen development roadmap (Hydrogen Roadmap), which is a dynamic and iterative tool that guides FEI's hydrogen planning, research and development activities. Its current central activities are described in the response to the BCUC IR1 61 series, and further activities will be developed on an iterative basis, including the results of the BC Gas System Hydrogen Blending Study and Technical Assessment project.[7] FEI expects that it will provide an update on the Hydrogen Roadmap and the results of the BC Gas System Hydrogen Blending and Technical Assessment project in the next LTGRP. Given that the Hydrogen Roadmap is a dynamic planning tool, there are no "results" to be filed, and its status is described in the response to BCUC IR1 61.9. With respect to the BC Gas System Hydrogen Blending and Technical Assessment project, the project is still in its early stages and its completion is not expected until 2025.[8] Accordingly, it is too early in the project's process to provide results.

[7] For more information on the BC Gas System Hydrogen Blending Study and Technical Assessment project, please refer to Exhibit B-6, BCUC IR1 61 Series.

[8] Exhibit B-23, BCUC IR2 106.10.

22.0 Topic: FEI serving the market for LNG as a marine fuel

Reference: Exhibit B-38, FEI Rebuttal Evidence Section 3, FEI Serving the Market for LNG as a Marine Fuel, Answers 18, 19

In its Rebuttal Answer 18 (Exhibit B-38), FEI states that:

> "MS2S's evidence does not present a balanced view on the state of industry knowledge of marine vessel emissions, on carbon accounting, or on demand for LNG as a marine fuel. MS2S's position is contrary to the conclusions of credible and reliable industry experts and market participants…"

And in Rebuttal Answer 19 (Exhibit B-38), FEI states that:

> "As expanded on further below, FEI's estimate of potential GHG reductions from the use of LNG as a marine fuel is reasonable because:
>
> a) FEI has used BC-specific emission factors;
>
> b) FEI considers recent and reliable data and industry knowledge in assessing the impact of methane slip;
>
> c) FEI follows accepted standards for measuring global warming potential; and
>
> d) FEI relies on independent, peer-reviewed lifecycle well-to-wake emissions assessments.

And with regard to using the 100-year global warming potential (GWP) for methane vs. the 20-year GWP, MS2S states (Exhibit C16-6, page 7) (emphasis added):

> "… **Excluding GWP20 is misleading regulators on the true and more accurate climate impacts of LNG as a marine fuel**. Near-term climate analysis and solutions are urgently needed to address the climate crisis and to align with 1.5-degree decarbonization pathways…"

In its Rebuttal Answer 19 (Exhibit B-38), FEI responds that:

> "… FEI is not aware of any country that uses the 20-year GWP as their sole representative measure for greenhouse gas reporting and accounting. Using the 20-year GWP and focusing on short-lived GHGs, would disincentivize the required deep reductions of long-lived carbon dioxide emissions, resulting in higher carbon dioxide concentrations and ocean acidification."

22.1 FEI states that it has relied on "independent, peer-reviewed lifecycle well- to-wake emissions assessments". Please itemize which assessments these are, and provide the studies, or links to them, for any that are not already in the evidence.

Response:

FEI confirms that all assessments and studies it relied on are presented as footnotes throughout Exhibit B-38, FEI's Rebuttal Evidence to MS2S.

22.2 What is FEI's method of accounting for the "at-sea" emissions of vessels fueled by FEI? To what extent are these "at-sea" emissions presently included as part of FEI's customers' emissions? Or will they be included, in the future, if FEI begins a program to fuel more and more ocean vessels?

Response:

FEI accounts for avoided GHG emissions as the difference between GHG emissions that occurred from LNG in marine bunkering and GHG emissions that would have occurred if conventional marine fuels (refined petroleum products) had been used instead, using baseline carbon intensity values for liquid fuels estimated by Environment and Climate Change Canada. Because refined petroleum products are an incumbent fuel, FEI accounts for the emissions differential between refined petroleum products and LNG as a component of the overall emissions reduction progress. FEI believes this approach is consistent with how the BC Low Carbon Fuel Standard also accounts for GHG emissions using a baseline or incumbent fuel intensity.

FEI's Scope 3 value includes natural gas use for both the built environment and transportation (this includes LNG marine customers). FEI utilizes the protocols from the World Resources Institute and the World Business Council for Sustainable Development for calculating Scope 3 emissions.[9]

FEI is continuing to update the approach to GHG accounting and progress to the corporate target and will align with provincial and federal policy approaches and guidelines on the attribution of emissions from various sectors.

22.2.1 If FEI is successful at increasing the amount of LNG fueling of ocean vessels, will the associated GHG reductions be credited towards FEI's required ~6 mega-tonne reduction as mandated by government policy?

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9 In particular: The GHG Protocol Corporate Accounting Standard (2015) online at: https://ghgprotocol.org/corporate-standard; Scope 3 Calculation Guidance (2013) online at: https://ghgprotocol.org/scope-3-calculation-guidance-2

Response:

At the time of writing, the Province had not yet released the details of the GHG Reduction Standard (GHGRS) that was outlined in the CleanBC Roadmap to 2030. However, based on the description of the GHGRS in the CleanBC Roadmap to 2030, which specifies that the emissions cap will apply to the buildings and industrial sectors, emissions reductions from international marine vessels are unlikely to be included. Please refer to the response to BCOAPO IR1 7.2 and the discussion contained in Section 9.2 of the 2022 LTGRP Application.

22.3 With regard to using the 100-year GWP (GWP100 = 25 or 28) versus the 20-year GWP for methane (GWP20 = 81.2): When the methane has substantially all of its global warming impact during the first 20 years, and is essentially eliminated by year 25, why does it make any sense to average out that early impact over the next 100 years? Isn't this an especially critical issue when the entire CleanBC climate plan is intended to take action against impacts that will occur prior to 2050?

Response:

While methane has a substantial impact on global warming during the first 20 years, the warming effects associated with methane can persist for up to 100 years after it is emitted. Accordingly, the 100-year Global Warming Potential (GWP) provides a more comprehensive and comparable measure of the long-term impact of methane on global warming and is the standard measure used by many countries and international climate authorities. Further, the 100-year GWP provides a common unit of measurement to compare emissions reductions from different actions and gases. Given its broad use by policy makers and other organizations, FEI has used the 100-year GWP to assess the impact of fugitive methane emissions on global warming.

22.4 How does using the 20-year GWP "disincentivize" the necessary reductions of carbon dioxide, when the 20-year GWP for CO2 is exactly the same as the 100-year GWP? Is it not only the methane that will have its global warming impact concentrated within the first 20 years?

Response:

FEI's statement regarding the 20-year GWP was meant to highlight the fact that confining the focus to near term warming impacts would overlook important long-term warming impacts and disincentivize measures that address those longer-term impacts. Instead, using the 100-year

GWP provides a more direct measure of the impact of methane on global warming over its lifecycle, which is important to the development of long-term abatement strategies.

With respect to BCSSIA's comment that "the 20-year GWP for CO2 is exactly the same as the 100-year GWP", Carbon dioxide (CO_2) has a GWP of 1 regardless of the time period used, because it is the gas being used as the reference.