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February 28, 2023

British Columbia Utilities Commission
Suite 410, 900 Howe Street
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Attention: Sara Hardgrave, Acting Commission Secretary

My Sea to Sky
P.O. Box 2668
Squamish, BC
V8B 0B8

Attention: Eoin Finn, B.Sc., Ph.D., MBA

Dear Sara Hardgrave and Eoin Finn:

Re: FortisBC Energy Inc. (FEI)

Revised Renewable Gas Program Application – Stage 2 (Application)

FEI Rebuttal Evidence to the My Sea to Sky (MS2S) and the Brattle Group (Brattle) Evidence Regarding Elasticity of Demand

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In accordance with the amended regulatory timetable established in British Columbia Utilities Commission Order G-28-23, FEI hereby files its Rebuttal Evidence to the MS2S and Brattle Evidence regarding Elasticity of Demand in the above referenced proceeding.

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC ENERGY INC.

Original signed:

Sarah Walsh

Attachments

cc (email only): Registered Parties

Biomethane Energy Recovery Charge Rate Methodology and Comprehensive Review of a Revised Renewable Gas Program

Rebuttal Evidence of FortisBC Energy Inc.

to the Evidence of My Sea to Sky (MS2S) and the Brattle Group Regarding Elasticity of Demand

February 28, 2023

1. REBUTTAL TO EVIDENCE OF MS2S AND THE BRATTLE GROUP REGARDING ELASTICITY OF DEMAND

1.1 INTRODUCTION

Q1: What is the purpose of this Rebuttal Evidence and how is it organized?

A1: The purpose of this Rebuttal Evidence is to respond to Dr. Finn's evidence, filed on behalf of My Sea to Sky (MS2S) (Exhibit C6-4), and the evidence of the Brattle Group (Brattle) (Exhibit A2-4) related to the price elasticity of demand for RNG and conventional natural gas. The capitalized terms in this Rebuttal Evidence are defined in the Application. For example, "FEI" or the "Company" refers to FortisBC Energy Inc.

Although FEI has addressed a number of matters in this Rebuttal Evidence, FEI's silence on any particular matter should not be construed as agreement.

Q2: Please provide a concise definition of price elasticity of demand and its various determinants.

A2: The "own-price elasticity of demand" (the more common method of calculating price elasticity) is defined mathematically as the percentage of change in the quantity consumed divided by the percentage change in the price. For instance, an elasticity of -0.2 means that a one percent increase in price would cause a 0.2 percent decrease in demand. Goods and services are generally defined by economists as "inelastic" if the estimated elasticity is between zero and one. Similarly, goods and services are generally defined as "elastic" if the estimated elasticity is above one.

Some of the major determinants of the price elasticity of demand are as follows:

- **The availability of substitutes:** The more a consumer can substitute a particular good, the higher its price elasticity of demand will generally be. The "cross-price elasticity of demand" can be used to measure the responsiveness in the quantity demanded of one good when the price for another good changes (assuming the total consumption remains constant). For instance, RNG and conventional natural gas are almost perfect substitutes since they have the same chemical composition and can be used interchangeably, with RNG's environmental attributes being the only differentiating factor. As such, the cross-price elasticity of RNG to conventional natural gas is higher than its own-price elasticity of demand.
- **The type of service or good (luxury vs. necessity)**: The price elasticity of demand is lower if the good is something the consumer needs (e.g., space heating) and higher if the good is a luxury item (e.g., vacationing in another country).

- **The time span:** The longer the time available to adjust demand to a price change, the more elastic the response will be. For instance, the short-term elasticity of most fuel types (RNG, conventional natural gas and electricity) is always less than its long-term elasticity. Even so, over the long-term, energy demand tends to also be inelastic.

Q3: Please summarize FEI's evidence on price elasticity of RNG.

A3: FEI's evidence in this proceeding[1] concludes that it is impractical to perform a robust price elasticity analysis for <u>renewable</u> natural gas. This is because price elasticity studies require demand and price data that reflect market forces with consumer demand being driven by the pricing of competitive options. However, this kind of market data is not available for *voluntarily* purchased RNG. This is because, under the various Biomethane Energy Recovery Charge (BERC) rate setting mechanisms, the price of RNG has not been allowed to rise and fall with demand. FEI was also unable to find any third party studies that are explicitly focused on price elasticity of renewable gases.

As an alternative to a price elasticity analysis, FEI surveyed its customers on RNG and conventional natural gas price differentials to gain some directional insight into their thinking.[2] The survey results indicate that customers are sensitive to the price differential between conventional natural gas and RNG. In other words, RNG demand is likely elastic when considered relative to conventional natural gas prices since the two fuels are substitutes and a customer can easily either reduce its share of RNG or completely opt-out of receiving Voluntary RNG service.

Q4: Is the evidence prepared by Brattle regarding the price elasticity of demand inconsistent with FEI's evidence?

A4: No. FEI considers that Battle's evidence is largely consistent with that of FEI.

First, in alignment with FEI's evidence, Brattle concludes that it is "not aware of peer-reviewed academic studies that estimate the price elasticity of RNG".[3] Further, all of the third-party elasticity studies provided in Brattle's evidence relate to conventional natural gas and are characterized as such. Similarly, the elasticity estimates provided in Dr. Finn's evidence only relate to conventional natural gas, and not RNG.[4]

Second, FEI's evidence is aligned with Brattle's evidence that price is not the only determinant for RNG demand and that customer willingness to pay a premium stems from

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1 Exhibit B-11, Application, Section 5.8.

2 There can be a gap between customers' responses to a survey, and the act of enrolling for a service that will cost them more. The history of the program suggests that relatively few customers actually subscribe to a voluntary program, and when they do, they generally opt to receive only five to ten percent RNG.

3 Exhibit A2-4, p. 48.

4 In his response to FEI-MS2S IR1 1.3 (Exhibit C6-8) , Dr. Finn admits that none of the price elasticity estimates provided in his evidence relate to RNG.

the environmental attributes of the supply and the customers' interest in reducing their GHG footprint.[5] Such interest is influenced by government policy.

Third, FEI is also aligned with Brattle that, under FEI's proposals in the Application, a significant portion of the price elasticity effect will occur via the overall cost of gas,[6] as FEI has proposed that the costs of RNG will be recovered from all sales service customers.

Finally, FEI's evidence is aligned with Brattle's conclusion that under the proposed Renewable Gas Connections service, if the full cost of RNG were imposed on new gas customers, the high customer cost impact would result in very little additional RNG demand through this offering.[7] In fact, FEI has concluded that the Renewable Gas Connections service is not viable with a price higher than what FEI has proposed.[8] Brattle's conclusion also aligns with FEI's survey results[9] and FEI's position that RNG and conventional natural gas are substitutes and, therefore, have a relatively high cross-elasticity of demand. This means that if the price differential between RNG and conventional natural gas is more than a certain threshold, RNG demand would decrease.

Q5: Is Dr. Finn's evidence similarly aligned with FEI and Brattle?

A5: No.

Q6: Please summarize FEI's evidence in response to Dr. Finn.

A6: FEI's response to Dr. Finn's evidence is as follows:

- Dr. Finn makes errors in characterizing FEI's RNG demand forecasts for various customer segments;
- Dr. Finn's comment that FEI is reluctant to estimate the effect of price elasticity is incorrect, and his list of price elasticity estimates and the average price elasticity estimate are misleading and inaccurate; and
- Dr. Finn has made errors in calculating the RNG price premium and in applying his average price elasticity estimate to the RNG price premium to forecast a reduction in RNG demand, and has drawn an erroneous conclusion regarding the impact of price elasticity on the volume of RNG sold.

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[5] Exhibit A2-4, p. 52. In Exhibit B-11, Application, p. 24, FEI states: "… the program has supported the provincial government's energy objectives by increasing the volume of renewable energy consumed by British Columbians and reducing GHG emissions. Further, FEI's customers that have participated in the Renewable Gas Program have recognized the value of Renewable Gas as a low carbon energy alternative for which they are willing to pay a premium in order to reduce their GHG emissions".

[6] Exhibit A2-4, p. 57.

[7] Exhibit A2-4, pp. 57 to 58

[8] Exhibit B-17, BCUC IR1 13.4 and 14.1.

[9] Exhibit B-11, p. 59.

1.2 FEI's RNG Demand Forecasts for Various Customer Segments

Q7: Please summarize Dr. Finn's comments regarding FEI's RNG demand forecasts.

A7: On page 3 of his evidence, Dr. Finn refers to Figure 8-3 of the Application (which he erroneously refers to as Figure 8-2) and provides the following observations:

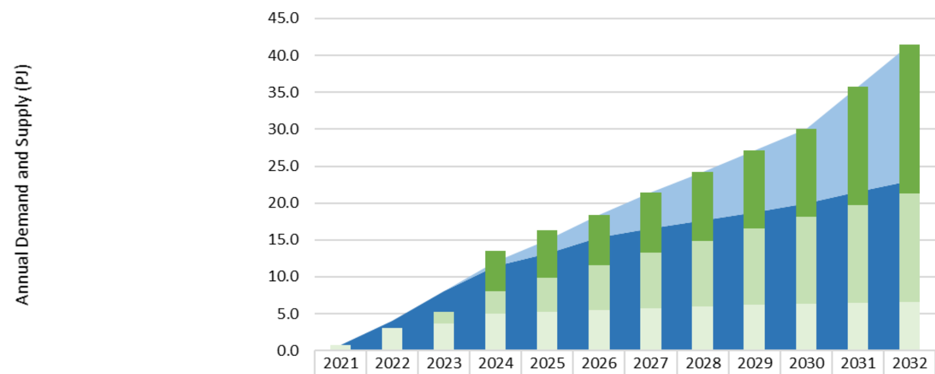
- Renewable Gas demand from Renewable Gas Blend (regular gas blend) customers will increase from 0 to 16.9 PJ annually;
- Renewable Gas demand from Renewable Gas Connections (new buildings) customers will increase from 0 to 18.5 PJ annually;
- Renewable Gas demand from Voluntary Renewable Gas Connections (opt-in) customers will increase from 4.9 to 18.5 PJ annually. The 18.5 PJ figure includes 5,000,000 GJ (5 PJ) of annual RNG demand from Voluntary Renewable Gas Connections customers. As most of these currently opt to pay for a 10% blend of RNG, that would imply signing up some 550,000 new such accounts (each with 90 GJ annual consumption, only 9 GJ of which would be RNG), with an average annual consumption of 90 GJ of the blend. That is a 55-fold increase on the ~10,000 customers FEI has, over a decade, managed to subscribe to this optional service.

Dr. Finn concludes that FEI's predictions are at odds with the economic principle of price elasticity, which predicts that increased prices will decrease, not increase, demand for a good or service.

Q8: How does FEI respond to Dr. Finn's comments regarding RNG demand forecast?

A8: As noted in BCUC-MS2S IR1 2.1 (Exhibit A-38), Figure 8-3 was revised in Exhibit B-11-1. The revised version is reproduced below.

Figure 8-3: Forecast Volumes of Renewable Gas Supply, Customer Demand and Allocation to Sales Customers (PJ)



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Supply - H2, Syngas, Lignin	0.0	0.0	0.0	0.7	1.9	3.1	4.9	6.6	8.3	10.0	14.3	18.5
Supply - RNG	0.7	4.0	8.1	11.4	13.1	15.3	16.5	17.6	18.8	20.0	21.5	23.0
Demand - Renewable Gas Blend	0.0	0.0	0.0	5.5	6.4	6.9	8.2	9.3	10.6	11.8	16.1	20.2
Demand - Renewable Gas Connections	0.0	0.0	1.6	3.1	4.6	6.0	7.5	8.9	10.4	11.8	13.2	14.6
Demand - Voluntary Renewabe Gas	0.7	3.0	3.7	5.0	5.3	5.5	5.7	6.0	6.2	6.4	6.5	6.6

According to the revised Figure 8-3, and as acknowledged by Dr. Finn in the responses to BCUC-MS2S IR1 2.2 and 2.3 (Exhibit C6-8), the demand from Renewable Gas Connections service customers is forecast to increase from 0 PJ in 2021 to 14.6 PJ in 2032 (and not to 18.5 PJ as indicated by Dr. Finn). Further, the demand from the Voluntary Renewable Gas customers is forecast to increase from 0.7 PJ in 2021 to 6.6 PJ in 2032 (and not from 4.9 PJ to 18.5 PJ as indicated by Dr. Finn).

In addition, as noted in BCUC-MS2S IR1 2.4 (and contrary to what is claimed by Dr. Finn), residential demand in the proposed Voluntary Renewable Gas service is forecast to increase by only 0.2 PJ between 2022 and 2032. Using Dr. Finn's assumptions of a 10 percent RNG Blend and 90 GJ annual consumption would require the addition of approximately 22,000 new Voluntary residential customers to the program over the 10 year period, and not 550,000 new Voluntary Renewable Gas service customers as calculated by Dr. Finn. For clarity, FEI expects that the remainder of the increase in Voluntary Renewable Gas demand will come from commercial (2 PJ) and NGV (1.4 PJ) customers, with no increase forecast increase in demand from the industrial sector.

In his responses to BCUC-MS2S IR1 2.2 and 2.3 (Exhibit C6-8), Dr. Finn downplays the inherent errors in his original analysis by questioning, without providing any underlying evidence, FEI's RNG demand forecasts for commercial and industrial customers. In particular, Dr. Finn states that "there is no evidence of sudden interest in commercial (retail) customers to renewable gas, who, together with Industrial customers, are typically the most price sensitive customers, as FEI's submission showing long-run elasticities calculated by an independent report". This is incorrect. As explained by Brattle, price is not the only determinant for RNG demand. A customer's willingness to pay a premium stems from the environmental attributes of the supply and the associated interest in reducing their GHG footprint to both comply with government policies and regulations (indeed, a significant portion of commercial sector demand relates to RNG demand by municipalities and provincial government entities who operate under the carbon neutral government regulation) and as a marketing tool to satisfy their customers' expectation for greener products and services. This is also in line with the Environmental, Social and Governance (ESG) investing concept that encourages investors to be more aware of the impact of their investments on the environment and the society as a whole. Further, FEI is not forecasting any increase in Voluntary Renewable Gas demand for the industrial sector.

Q9: How does FEI respond to Dr. Finn's claim that its forecasts are at odds with the economic principle of price elasticity?

A9: Dr. Finn's argument that FEI's demand forecasts are at odds with the economic principle of price elasticity fails to consider several of the following fundamental points in FEI's Application:

- **The supply and demand for RNG are matched by design irrespective of the price elasticity estimates for RNG**: As discussed in the response to BCUC IR1 12.2, FEI does not expect the total volume of RNG sold to customers would diminish if there was not a Renewable Gas Connections service or if the Voluntary Renewable Gas service does not meet its forecast demand. This is because, if RNG supply does not flow to the Renewable Gas Connections or Voluntary Renewable Gas service customers, FEI has proposed to increase the percentage of RNG for the Renewable Gas Blend service. In other words, the demand and supply will match irrespective of price elasticity of demand for RNG.

- **Price is not the only determinant for RNG demand**: As discussed earlier in this Rebuttal Evidence, RNG demand stems from its environmental attributes and customers' desire to reduce their GHG emissions. Further, demand for RNG (and other low carbon fuels) is also heavily influenced by government policy and its strategy to reach the legislated GHG reduction targets. Therefore, only relying on price elasticity numbers to forecast a decrease in demand would lead to erroneous conclusions.

- **Contrary to MS2S's evidence, FEI's proposals in this Application are indeed aligned with economic principles of price elasticity:** In the Application, FEI is proposing three separate services: the Renewable Gas Blend, Renewable Gas Connections and Voluntary Renewable Gas services. Due to the data limitations inherent in FEI's existing RNG Program described above in Answer 3, it is not possible to estimate own-price elasticity of RNG. However, since a significant portion of the price elasticity effect will occur via the overall commodity cost, the price elasticity of conventional natural gas can be used as a substitute for the price elasticity of RNG. According to FEI's reference values, and as noted in the response to RCIA IR1 2.3, short-term own-price elasticity of conventional natural gas for residential customers is estimated to be approximately -0.28 while long-

> term own-price elasticity of conventional natural gas for residential customers is estimated to be approximately -0.38. Put simply, in both cases the demand will remain relatively inelastic.

Please note that inelastic demand does not mean that demand stays constant. Indeed, as modelled in FEI's 2022 Long-term Gas Resource Plan (LTGRP), under its Diversified Energy (Planning) scenario, FEI is forecasting that its overall residential demand will decline slightly in the next 20 years. Nevertheless, since RNG supply and demand are matched, this decrease will be in conventional natural gas demand and not RNG demand.

In addition, FEI's proposal to set the Low Carbon Gas Charge at the same rate[10] charged to other gas customers not participating in the Voluntary Renewable Gas service is also based on economic principles of price elasticity (particularly the substitution effect). This is because RNG and conventional natural gas are substitutes and, if the full cost of RNG were imposed on new gas customers, the high customer cost impact means that the successful implementation of the offering may not be an economically viable option.[11]

1.3 ISSUES WITH DR. FINN'S LIST OF ELASTICITY STUDIES AND THE AVERAGE OWN-PRICE ELASTICITY ESTIMATE

Q10: Dr. Finn claims that FEI has been reluctant to estimate the effect of price elasticity on its gas demand and claims that other similar gas utilities have included this information in their research. How do you respond to these statements?

A10: Dr. Finn is mischaracterizing FEI's evidence. FEI is not reluctant, but rather, is *unable* to estimate the effect of price elasticity on <u>renewable</u> natural gas demand, as opposed to conventional natural gas demand. Brattle corroborates FEI's position that there is no academic study that estimates the price elasticity of RNG. Dr. Finn also does not provide any study that is focused on price elasticity for RNG.

With respect to the price elasticity estimates for conventional natural gas, and as discussed in the response to RCIA IR1 2.3, FEI retained the services of Posterity Group to conduct an extensive literature search of fuel and sector specific price elasticity of demand values. The summary of this research and the estimated values are as follows:

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[10] Equal to the Commodity Cost Recovery Charge (cost of gas) per GJ plus carbon tax per GJ as set out in Exhibit B-11, p. 2

[11] Exhibit B-17, BCUC IR1 13.4.

Table 1: Natural Gas Short Run and Long Run Elasticity Values

	Short Run (SR) Values			Long Run (LR) Values		
	SR Min	SR Reference Case	SR Max	LR Min	LR Reference Case	LR Max
Residential	-0.030	-0.278	-0.670	-0.100	-0.380	-0.880
Commercial	-0.055	-0.205	-0.530	-0.125	-0.350	-0.990
Industrial	-0.067	-0.709	-3.680	-0.142	-0.700	-0.700

The reference values in the table above are derived from the elasticity values for conventional natural gas by sector provided by the State of Washington's Department of Commerce, while the minimum and maximum values are based on an extensive literature review of various elasticity studies. The reference case indicates that the short-term own-price elasticity of natural gas is around -0.28 while its long-term price elasticity is slightly higher at -0.38.

In addition, FEI's response to RCIA IR1 21.1 provided the results of its own literature review. These results, which are reproduced in the table below, include some of the same studies that were referenced by both Brattle and Dr. Finn.

Table 2: Independent Research Entities Price Elasticity Results

Research Institution	Publication date	Natural Gas Price Elasticity of Demand (Residential)		Description
		Short-term	Long-term	
National Renewable Energy Lab[5]	Feb 2006	-0.12	-0.36	This study estimated elasticity values at state and national levels. The numbers presented here are at national level.[6]
Energy Information Administration[7]	Oct 2014	-0.07 to -0.15	-0.21	This study was referenced in FEI's 2014 Long-Term Resource Plan application.
UC Berkley, Energy Institute at HAAS[8]	Jan 2018	-0.23 to -0.17		This study does not separate the long-term and short-term elasticity and provides an average range of estimates.

Specifically, the 2018 UC Berkley study is referenced by both Brattle (on page 47, footnote 208) and Dr. Finn (Item one on page 5). In addition, the 2021 Energy Information Administration's elasticity estimates (EIA) referenced in Figure 18 of Brattle's report and Dr. Finn's evidence (item 4 on page 5)[12] is an updated version of 2014 EIA study referenced in the above table. It is worth noting that the 2014 elasticity results for natural gas (-0.07 to -0.15 for short-term elasticity and -0.21 for long-term elasticity) are almost identical to the 2021 study results (-0.08 to -0.15 for short-term elasticity and -0.23 for long-term elasticity).

[12] Although Dr. Finn's numbers -0.21 to -0.28 seem to be incorrect or are at least not confined to residential elasticity numbers.

Q11: Dr. Finn's response to FEI-MS2S IR1 1.1 states that the Long Run price elasticity average in the State of Washington's Department of Commerce study is close to the average estimate derived from the web search undertaken to support Dr. Finn's evidence. Is this correct?

A11: No. Dr. Finn's comments are misleading.

First, it is not appropriate to average price elasticity studies for different customer sectors. FEI is not aware of any credible study that uses a methodology of this kind. This is because the demand characteristics of residential, commercial and industrial customers and their ability to react to price changes, are different from each other.

Second, most, if not all, of the elasticity studies referenced in Dr. Finn's evidence are related to the residential sector and, therefore, are only comparable to the long-run price elasticity for the residential sector in the Washington Department of Commerce study, which is estimated at -0.38 percent.

Third, Dr. Finn's average estimate is the average of short-term and long-term price elasticity estimates. It is not appropriate to average short-term and long-term price elasticity estimates and compare them with the long-term price elasticity numbers from the Washington Department of Commerce Study.

Q12: On page five of his evidence, Dr. Finn provides the results of his web search for relevant price elasticity of demand for conventional natural gas and calculates an average price elasticity of -0.44 to -0.45. Does FEI have any comment on the list of own-price elasticity estimates for conventional natural gas demand and the associated -0.45 average price elasticity Dr. Finn proposes?

A12: There are a number of issues with the results of Dr. Finn's web search, which FEI addresses in turn below.

Item 2 in Dr. Finn's list is: "The price elasticity of residential district heating demand: New evidence from a dynamic panel approach. From: Energy Economics, Volume 112, August 2022, 106163, GianlucaTrotta, Anders Rhiger Hansen & Stephan Sommer".[13] As the title of this paper indicates, this study is directed at calculating the own-price elasticity of residential district heating demand in Denmark, as opposed to natural gas demand. Indeed, the author's state that a main reason for their research is that, unlike electricity and natural gas elasticity studies, there is little research regarding the district heating demand:[14]

> There is a large literature that investigates how price changes, socioeconomic and dwelling characteristics, and weather conditions

[13] https://www.sciencedirect.com/science/article/pii/S0140988322003176.
[14] Trotta et al (2022), p. 2.

> explain electricity demand (see Labandeira et al., 2017 for a meta-analysis). However, there is a much smaller literature analyzes the determinants of heating demand and most of them focus on natural gas (e. g., Alberini et al., 2011; Salari and Javid, 2016; Filippini and Kumar, 2021). Only few studies have specifically estimated the price elasticity of residential district heating demand.

In other words, the authors differentiate the results of their study from the studies done for natural gas and electricity. Therefore, it is not appropriate to use the results of this study for price elasticity of natural gas. This is especially true considering that there are a sufficient number of price elasticity studies for conventional natural gas demand, thus obviating the need to look into studies from different contexts as a proxy.

Item 3 in Dr. Finn's list is: "Alberini et al (2011): Residential consumption of gas and electricity in the U.S.: The role of prices and income, 2011". The inclusion of this study skews the average value. As the study's authors note, the results of this study should be considered as outliers to much of the literature on residential energy demand for both natural gas and electricity:[15]

> These results are in sharp contrast with much of the literature on residential energy consumption in the United States, and with the figures used in current government agency practice. In its Annual Energy Outlook, for example, the EIA historically employed a short-term elasticity of -0.15 for non-electric energy. In their 2010 report, EIA adopts an electric elasticity of -0.30 in anticipation of improved consumer awareness resulting from recent smart grid projects. Our results suggest that price elasticities are likely more pronounced than that. Moreover, they suggest that there might be considerable potential for policies which affect energy price than may have been previously appreciated. We leave it to future research to explore how people respond to changing energy prices- through energy efficiency investments, changing the stock of appliances, or merely changing conservation practices. [Emphasis added]

Item 4 in Dr. Finn's list is "EIA 2021: Price Elasticity for Energy Use in Buildings in the United States". As mentioned above, this is the same 2021 EIA study that is referenced in Brattle's evidence; however, the price elasticity estimates reproduced by Dr. Finn in his evidence do not match those in the study. In particular, Dr. Finn's evidence erroneously states that the natural gas price elasticity is between -0.21 to -0.28. As can be seen from Figure 18 of Brattle's report, the short-term and long-term price elasticity of natural gas in the 2021 EIA study is instead between -0.08 to -0.23 for residential customers and between -0.03 to -0.28 for commercial customers. Since the majority of elasticity estimates used to calculate the average results are for residential customers, the appropriate values to consider are therefore between -0.08 to -0.23.

[15] Alberini et al (2011), p. 39.

Item 6 in Dr. Finn's list is: "Gas price elasticities: the impact of gas prices on domestic consumption (June, 2016)". This study, which was published by UK Department of Energy and Climate Change, does not calculate the natural gas price elasticity estimates in the United Kingdom, but rather compares the results of a NERA study conducted in 2012 for the UK government with other elasticity studies. The study's authors review of NERA's report leads them to conclude that natural gas demand is relatively price inelastic:[16]

> The NERA report estimated, based on NEED data, that the price elasticity of domestic gas was -0.1 – in other words, for every 10 per cent increase in its price, the amount of it consumed decreases by 1 per cent. The magnitude of this estimate implies that demand for domestic gas is price inelastic, i.e. demand is relatively un-responsive to changes in price, falling proportionately less than the increase in price. The methodology used to arrive at this estimate (discussed further below) considers the average response to prices over the 2005-12 period, indicating that it is more representative of a long-term elasticity. [Emphasis added]

The report then compares the NERA report with other studies including the Alberini et al (2011) study, which was also referenced in Dr. Finn's evidence (item 3), and conclude as follows:[17]

> As Table D1 shows, there is a degree of variation in the elasticity estimates for the UK (between -0.10 and -0.28) and even more in other parts of the world (-1.5 in the EU). The NERA result is consistent with the lower magnitude end of the UK range, providing some reassurance of this finding. It should be noted that during the periods over which the previous UK studies were based (pre 2006) gas prices were generally more stable than the 2005-2012 period used in the NERA study, which may have led to some variation in the results. Similarly, different methodologies were used in each separate case, which may again explain some of the variation. The higher magnitude end of the elasticity estimate range (-0.28), when applied to historical price movements (2005-14), would imply a much greater decline in consumption than actually occurred. This places some uncertainty around this estimate, although it is possible that other influencing factors might have offset some of associated decline in consumption. It is expected, however, that most of these other factors (e.g. increases in energy efficiency), would have contributed to the decline in consumption, rather than reversed it. This provides additional evidence to suggest that the real elasticity lies towards the lower magnitude end of the range (i.e. closer to the NERA estimate). [Emphasis added]

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[16] UK Department of Energy and Climate Change (2016); "Gas price elasticities: the impact of gas prices on domestic consumption – a discussion of available evidence", p. 4.

[17] UK Department of Energy and Climate Change (2016); "Gas price elasticities: the impact of gas prices on domestic consumption – a discussion of available evidence", p. 7.

Therefore, the appropriate natural gas price elasticity estimate for this UK based study is -0.1 and at most -0.28, rather than -0.56 as contended by Dr. Finn. Indeed, as Dr. Finn acknowledges in his response to FEI IR1 1.2.1, the -0.56 is the same number presented in Alberini et al (2011) study, and therefore, including it in calculating the average price elasticity estimate amounts to double counting.

Q13: Please provide the average of the price elasticity studies referenced by Dr. Finn after correcting for errors and duplicates discussed in the answer above.

A13: As shown in the table below, the average range of price elasticity studies for natural gas demand provided in Dr. Finn's evidence, after correcting for the errors outlined above, is between -0.23 and -0.36 which is very close to Posterity Group's recommended natural gas own-price elasticity of -0.28 and -0.38.

Table 3: Average Price Elasticity of Demand from the Relevant Literature Review

	Reference	Dr. Finn's Evidence	FEI's Correction
1	"Natural gas price elasticities and optimal cost recovery under consumer heterogeneity: Evidence from 300 million natural gas bills".	-0.17 to -0.23	-0.17 to -0.23
2	The price elasticity of residential district heating demand: New evidence from a dynamic panel approach.	-0.53 to -0.638	N/A
3	Residential consumption of gas and electricity in the U.S.: The role of prices and income	-0.566 to -0.693	-0.566 to -0.693
4	Price Elasticity for Energy Use in Buildings in the United States	-0.21 to -0.28	-0.08 to -0.23
5	Gas price elasticities: the impact of gas prices on domestic consumption	-0.56	-0.1 to -0.28
6	**Average price elasticity of demand from the relevant literature review**	**-0.44 to -0.45**	**-0.23 to -0.36**

1.4 RNG Price Premium And Application Of The Average Own-Price Elasticity Estimate To The RNG Price Premium To Forecast Demand

Q14: In his evidence, Dr. Finn assumes that the current RNG premium of $7/GJ represents a 191 percent increase over the $4.63/GJ for conventional natural gas. Later in footnote 11 of his evidence he provides another version of this calculation and computes the premium to be at 175 percent over conventional natural gas. Is this calculation correct?

A14: No. As Dr. Finn acknowledges in his response to FEI-MS2S IR1 2.1, both percentages are the result of calculation errors. Indeed, there are several errors in these calculations:

First, FEI has assumed that the 191 percent quoted by Dr. Finn in his evidence is the result of dividing $7.63/GJ by $4/GJ, and not the $4.63/GJ stated in Dr. Finn's evidence. If the $7/GJ is divided by $4.63/GJ, as acknowledged by Dr. Finn in the response to FEI-MS2S IR1 2.1, the premium in percentage terms is reduced to 151 percent.

Further, in footnote 11 of Dr. Finn's evidence, he provides another version of this calculation suggesting the RNG premium over conventional natural gas is calculated by dividing $7.63/GJ over the $4.63/GJ:

> This figure is derived from multiplying the price premium for RNG over fossil gas ($7.63/GJ over $4.63/GJ = 175%) by the average demand elasticity (-0.445 or -44.5%) from the literature review.

As Dr. Finn acknowledged in the response to FEI IR1 2.1, this calculation is also incorrect as $7.63/GJ divided by $4.63/GJ would be 165 percent.

Second, despite recognizing some of his calculation errors, the revised calculation remains incorrect. This is because excluding the carbon tax from the formula to calculate the RNG premium over conventional natural gas price which incorrectly inflates the premium.

Carbon tax is a material cost that, in practice, is paid by customers receiving conventional natural gas. As such, it must form part of any premium calculations.

For example, in the response to FEI-MS2S IR1 2.1, Dr. Finn erroneously claims:

> We note that, as of January 1, 2023, customers who choose to designate a percentage of their natural gas use as RNG will pay a rate of $14.718 per GJ for the cost of biomethane on their gas bills. That represents a premium of 185% ($9.559) /GJ over the $5.159/GJ charge for fossil gas, which is higher than predicted in FEI's Application as cited in the preamble to this Information Request.

As shown above, Dr. Finn's calculation does not include carbon tax. When carbon tax of $2.559 per GJ is considered, the RNG price premium over the conventional natural gas is reduced to $7 per GJ:

RNG premium = RNG price – natural gas price – carbon tax

= [$14.718 /GJ – ($2.559/GJ + $5.159/GJ)] = $7 / GJ

Therefore, based on January 1, 2023 rates, the RNG premium is calculated at 90 percent:

[RNG price / (natural gas price + carbon tax)] – 1

= [($14.718 /GJ) / ($7.718 / GJ)] – 1 = 90 %

FEI also note that although the premium of $7 is proposed to remain constant, the percentage calculation will vary over time as the commodity cost varies, and as the carbon tax increases.

Q15: Dr. Finn further concludes that, based on the average elasticity study of 44.5 percent from his web search and the calculated percentage premium, "FEI will lose about 78% of its projected ~41.5 PJ 92032) demand over the interval though price-demand effects alone". Further, in response to FEI IR1 2.1, he revises his calculation and states that "these elasticity econometrics would predict a demand decrease of at least 44.5% *151%, i.e. 66.4% of the projected 41.5 PJ of RN, RNG demand FEI predicts will occur over the interval". Are Dr. Finn's calculations and statements on this issue accurate?

A15: No. Dr. Finn's assumptions, calculations and conclusions cannot be relied on for the reasons summarized below.

First, and as outlined above in Answer 13, the -0.445 elasticity of demand assumption is biased. A more appropriate range, based on corrected version of Dr. Finn's web research and the table provided by FEI above, supports an own-price elasticity of natural gas for residential customers in the -0.23 to -0.36 range.

Second, as discussed above in Answer 14, when the carbon tax is considered the RNG premium over conventional natural gas is reduced to 90 percent (at January 1 2023 rates). When considered in conjunction with the revised own-price elasticity above, the projected demand decrease based on Dr. Finn's methodology is approximately calculated as follows: *(23% to 36%) * 90% = 21% to 32%.* However, even this estimate is overstated given the significant proposed increases in carbon tax that will reduce the 90 percent premium over time. Further, the Renewable Gas Blend and Renewable Gas Connections customers will not pay any premium, meaning that this calculation cannot be applied to their demand. And, for the existing Voluntary customers, the premium is already in place, meaning that unlike what is implied in Dr. Finn's calculation, the price they pay does not increase by another 90 percent and therefore this calculation cannot be applied to their demand either.

Third, contrary to what Dr. Finn claims, and as discussed above in Answer 9, FEI's RNG supply and demand are matched by design, meaning that FEI would not lose any RNG demand. Any loss of demand due to higher overall commodity cost will be for conventional natural gas.

Fourth, Dr. Finn's calculation is over-simplified. As stated in the UK price elasticity study referenced in his evidence, factors other than price can have significant impact on energy demand and as such solely relying on the results of web search to forecast FEI's future

RNG demand without considering for other variables and the appropriate jurisdictional context is not appropriate:[18]

> Academic literature suggests that understanding the key drivers of gas demand is notoriously difficult; most modelling attempts fail to explain a significant degree of the observed variation in consumption. One of the main reasons for this is that human behaviour plays a very important part, and it is difficult to obtain data that sufficiently represents the nuances of individuals' behaviour within a model. In addition, it can also be difficult to disentangle price influences from other drivers of consumption – e.g. the extent to which prices have influenced lifestyle changes over time, or the ease of take up of measures offered through government policies.

1.5 CONCLUSION

Q16: Does this conclude your rebuttal?

A16: Yes.

[18] UK Department of Energy and Climate Change (2016); "Gas price elasticities: the impact of gas prices on domestic consumption – a discussion of available evidence", p. 5.