GEC/ED IR Responses to Enbridge Gas Inc. (numbering corrected)

N.M9.EGI-86

Reference:

Exhibit M9, page 4

Preamble:

At page 4, Energy Futures Group states:

“It is also consistent with an analysis of the availability and feasibility of the electric and gas technologies required for net zero greenhouse gas (GHG) emissions and the current cost effectiveness of electrification.”

Question(s):

Please provide the referenced study and analysis.

Response

This is a conclusion drawn from the analysis and discussion in Sections 4 and 5 of Mr. Neme’s report.

N.M9.EGI-87

Reference:

Exhibit M9, page 4

Preamble:

At page 4, Energy Futures Group states:

"The report is authored by Chris Neme, a Principal with Energy Futures Group (EFG). Mr. Neme and his firm are leading experts on the implications of decarbonization for gas customers and best practices to address those implications."

Question(s):

a) Please provide all papers, research and other documentation demonstrating expertise of the author in the area of RNG, hydrogen, CCUS, and feasibility of converting industrial customer technologies and processes to these fuels/technologies.

b) Are the papers provided in part a) peer reviewed?

Response

Mr. Neme has not published papers on RNG, hydrogen, CCUS or the feasibility of converting industrial customer technologies and processes to such fuels. However, Mr. Neme has helped clients to critically review a number of studies that include a significant (if not exclusive) focus on these topics. Examples include:

- Critically reviewing the 2019 American Gas Foundation study of U.S. RNG potential;
- participating in a roughly 6-month long stakeholder engagement process in Michigan regarding the scoping, conduct and results of an RNG potential study for the state;
- participating in a 10-month long stakeholder engagement process in Massachusetts regarding the scoping, conduct and results of a gas utility system decarbonization study which included numerous assumptions regarding cost and availability of RNG, synthetic natural gas (SNG) and green hydrogen blending with methane; and

- supporting an economy-wide decarbonization study for the Vermont Agency of Natural Resources, as well as a subsequent study (still underway) examining the costs of decarbonization pathways for the buildings and industrial sectors.

Mr. Neme also co-led a Vermont working group that developed the policy concept of a Clean Heat Standard to reduce greenhouse gas emissions currently resulting from the burning of fossil fuels in buildings and industry. He also co-authored a white paper on the policy.[1] He was subsequently involved in helping to craft legislative language related to lifecycle emissions accounting and other provisions governing the use of RNG and other biofuels as clean heat measures. Earlier this month that legislation was passed into law.[2] The CEO and other staff from Vermont Gas, Vermont's only natural gas utility, were part of the Clean Heat Standard working group (and subsequent legislative negotiations), so Mr. Neme became familiar with many of the decarbonization strategies – including RNG and a pilot green hydrogen project to displace methane at one of the state's largest industrial facilities, as well as cold climate air source heat pump and heat pump water heater incentives, district heating, and a networked geothermal pilot project – that the gas utility in his home state is pursuing.

[1] Cowart, Richard and Chris Neme, The Clean Heat Standard, published by the Vermont Energy Action Network, December 2021 (https://www.eanvt.org/chs-whitepaper/).
[2] https://legislature.vermont.gov/bill/status/2024/S.5

N.M9.EGI-88

Reference:

Exhibit M9, page 5

Preamble:

At page 5, Energy Futures Group states as one of its recommendations to the OEB:

“3. Require all new connections to be net-zero greenhouse gas emitting. This would include requiring that all new connections install hybrid heating systems with a cold climate air source heat pump meeting the vast majority of heating needs (and a back-up gas furnace functioning only during the coldest hours of winter).”

Question(s):

Please provide references to the parts of the Acts and Regulations that govern the OEB that provide the OEB with the jurisdiction to mandate what heating equipment can be installed in a building.

Response

Mr. Neme is not an attorney, so he cannot comment on the legal authority of the OEB. Thus, all his recommendations should be read as if they have the preamble “to the extent permitted by law…”

N.M9.EGI-89

Reference:

Exhibit M9, page 8

Preamble:

At page 8, Energy Futures Group states:

"Most independent decarbonization pathways studies find that high levels of full electrification of buildings will be the least expensive decarbonization pathway."

Question(s):

a) Please provide a list of independent decarbonization pathways studies for North America that show electrification will be the least expensive decarbonization pathway. Please provide copies or links.

b) Please provide a list of all decarbonization pathway studies that are focused on or include Ontario or any other Canadian jurisdiction, regardless of preferred/recommended pathway. Please provide copies or links.

Response

Mr. Neme has not conducted an exhaustive survey of all independent decarbonization pathways studies conducted in North America. The New York, Quebec and Canadian studies referenced in his report – for jurisdictions adjacent to or including Ontario – all reach the conclusion that high levels of electrification are necessary to economically decarbonize the buildings sector.

Several other notable studies for colder climates include:

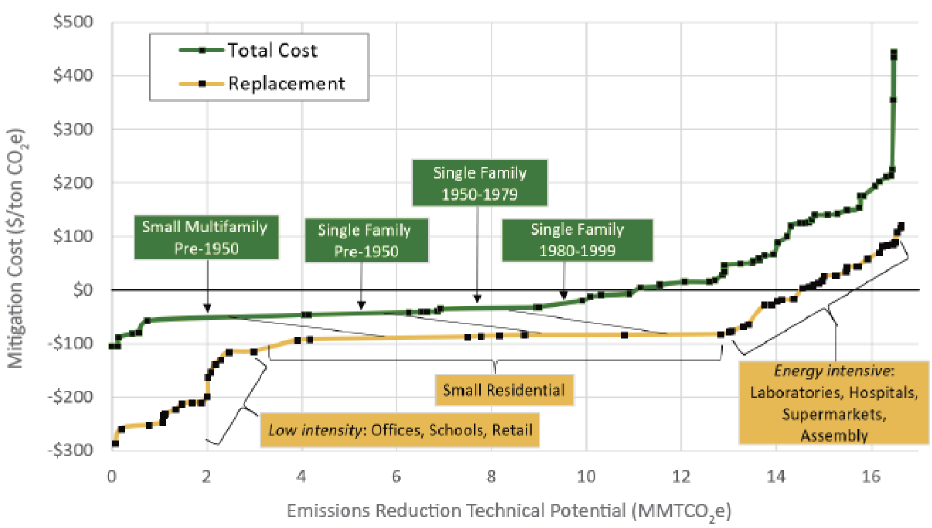
- **Washington**. A pathways study conducted by Evolved Energy for the Washington State Department of Commerce concluded that "electrification of buildings lowers costs over retaining gas use", with the "long-term benefits of avoiding the need for clean gas…" estimated to be equal to "0.2% of GDP savings annual in Electrification case vs. Gas in Buildings case by 2050."[3] The state's Energy Strategy report chapter on buildings also states that pathways

[3] Evolved Energy Research, Washington State Energy Strategy Decarbonization Modeling Final Report, December 11, 2020, published as Appendix A to the Washington State Energy Strategy (https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/).

modeling identifies "…a combination of energy efficiency and electrification as the least-cost strategy for buildings."[4]

- **Massachusetts**. A 2020 decarbonization pathways study commissioned by the Massachusetts Executive Office of Energy and Environmental Affairs[5] concluded that "high levels of building electrification lowered the long-term cost of reaching Net Zero" and that "with less building electrification, the long-term cost of the decarbonized fuel required to reach the emissions target more than offset modest cost savings from avoiding electrification in the near term." It also found that "the large quantity of decarbonized drop-in fuels required is a risk factor for a low building electrification pathway." Further, as the graph below illustrates, the study found that most of the emissions reduction potential from electrification of buildings could be achieved at a levelized cost of less an $0 per ton of CO2e reduced (i.e., it was cost-effective even without considering the benefits of emission reductions) and almost all of it could be achieved at a levelized cost of less than $200/ton of CO2e reduction.[6]

Figure 9. Emissions abatement cost curves based upon total or replacement capital costs of building electrification with only moderate efficiency to existing and new buildings. Each segment represents a building typology defined by use (e.g., office) and vintage (e.g., Pre-1950) Analysis assumes a 3% discount rate, and a 30-year lifetime period. Ordering of building typologies changes are due to different costs assumptions used across the building stock: electrifying offices, schools, and retail often can have lower upfront costs than replacement of fossil fuel equipment.



- **Canada**. A recent study by Institut de L'Energie Trottier found that electricity became the dominant fuel in residential and commercial buildings in net zero scenarios, "accounting for more than 95% of total consumption in both 2050 and 2060, which requires the virtual elimination of both natural gas and biomass as

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[4] Washington State Department of Commerce, Washington State Energy Strategy, Buildings Chapter (D) (https://www.commerce.wa.gov/wp-content/uploads/2021/01/WA_2021SES_Chapter-D-Buildings.pdf).
[5] This study was completed immediately before the gas utility funded study discussed in my report.
[6] Evolved Energy Research, Energy Pathways to Deep Decarbonization: A Technical Report of the Massachusetts 2050 Decarbonization Roadmap Study, December 2020 (https://www.mass.gov/doc/energy-pathways-for-deep-decarbonization-report/download).

energy sources for these sectors." The study also concluded that "…the replacement of fossil fuel-powered systems (natural gas in most provinces, as well as oil products and biomass in some) by electricity in space heating is a key contributor to the GHG reductions for the commercial and residential sectors, even with a short time horizon. This suggests that the building sector can be decarbonized at relatively low cost with current technologies. As a result, it is clear that policy and regulatory incentives could rapidly ensure this evolution away from business as usual…particularly by encouraging a massive shift to electric heat pumps."[7]

[7] Institut de l'Energie Trottier et al., Canadian Energy Outlook 2021 (https://iet.polymtl.ca/wp-content/uploads/delightful-downloads/CEO2021_20211112.pdf).

N.M9.EGI-90

Evidence Reference:

Exhibit M9, page 8

Preamble:

At page 8, Energy Futures Group states:

"Full electrification of homes is already highly cost-effective from a consumer price perspective in comparison to fossil methane heating, lowering total energy bills by 35-49% in the very first year and providing nearly $16,000 in 18-year net present value (NPV) savings. Full electrification will likely be even more cost-effective in comparison to decarbonized gas heating (e.g., RNG)."

Question(s):

Please provide sources or references for these cost comparisons including working papers and Excel spreadsheets.

Response

The key assumptions underpinning the analysis were provided in section 5 of Mr. Neme's report. See the attached Excel file containing the assumptions and calculations that led to the results referenced in the question attached.

Note that in reviewing the Excel file to ensure that sources of assumptions were documented, Mr. Neme discovered that a document he had referenced for assumptions about the costs and useful lives of water heaters, dryers and stoves had recently been updated. Specifically, Mr. Neme had been using a residential and commercial buildings technology forecast produced by Navigant Consulting (which has since become Guidehouse) in 2018 for the U.S. Energy Information Administration (EIA).[8] In early March 2023, an updated version of that building technology forecast was produced for EIA, this time by a consulting team of Guidehouse and Leidos.[9] Mr. Neme has updated his analysis using the updated assumptions in the new document. The attached Excel file contains the updated assumptions. The effect on the results of his analysis are small improvements in the cost-effectiveness of electrification – e.g., a 46% reduction in 18-year energy bill savings from a 2023 electrification investment instead of 44% with the old assumptions and 43% reduction in total 18-year NPV of costs from a 2023

[8] Navigant Consulting, EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, presented to the U.S. Energy Information Administration, April 2018.
[9] Guidehouse and Leidos, EIA – Technology Forecast Updates – Residential and Commercial Building Technologies - Reference Case, presented to the U.S. Energy Information Administration, March 3, 2023 (https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf).

electrification investment instead of 40% with the old assumptions. Mr. Neme will file a corrected version of his analysis with these updated assumptions.

N.M9.EGI-91

Reference:

Exhibit M9, page 8

Preamble:

At page 8, Energy Futures Group states:

"Even scenarios with significant hybrid gas-electric heating result in declines in gas demand because RNG feedstocks are expensive and very limited and the amount of hydrogen energy that can be safely blended with methane is very small."

Ontario released its Low-Carbon Hydrogen Strategy[1] in 2022 that outlines how hydrogen will play a key role as a clean and safe energy resource for Ontario. The Federal government also released Hydrogen Strategy for Canada[2] that lays out an ambitious framework for actions that will solidify hydrogen as a tool to achieve Canada's goal of net-zero emissions by 2050 and position Canada as a global, industrial leader of clean renewable fuels.

Question(s):

Please explain whether these governmental strategies were taken into consideration in Energy Futures Group's views related to hydrogen, and if so, how?

Response

First, Mr. Neme believes that green hydrogen has a potentially important role to play in a decarbonized future. In particular, green hydrogen could be essential to cost-effectively decarbonizing hard-to-electrify industrial operations. It could also potentially play a role in fueling electricity generation at times of peak demand. However, Mr. Neme does not believe that it will be practical or cost-effective to use hydrogen, particularly 100% hydrogen, to address residential and commercial customer energy needs.

The Ontario Low-Carbon Hydrogen Strategy provides a high-level overview of a range of ways in which low-carbon hydrogen *could* potentially be deployed. However, there is very little discussion of the role it could play in addressing residential and commercial heating or other energy needs. There is one sentence in the 56-page document that says hydrogen "can be used to create low or carbon-free heat for buildings and communities."[10] Moreover, there is only one reference in the entire document to

[10] Ontario's Low-Carbon Hydrogen Strategy, p. 17.

residential customers. That sentence discusses how *hydrogen blending* could help such customers reduce their carbon footprint while continuing to use their existing furnaces and other gas appliances.[11] In other words, there is no real discussion of the practicality or economics of 100% hydrogen delivery to residential or commercial customers.

With respect to the 2020 Hydrogen Strategy for Canada, the opening sentence of the section of the "Heat for Industry & Buildings" section of the report states "…hydrogen is a cleaner-burning molecule that can be a substitute for combustion of fossil fuels in applications where high-grade heat is needed *and where electric heating is not the best option*."[12] (emphasis added) Much of the subsequent discussion of hydrogen use in buildings[13] is devoted to hydrogen blending rather than 100% hydrogen delivery. The report also states that hydrogen blending of 5% to 20% by volume is possible with minimal risk. However, 5% to 20% by volume is only about 1.5% to 6% by energy content. That is consistent with the referenced statement in Mr. Neme's report that the amount of hydrogen that can be safely blended with methane is very small.

[11] Ibid., p. 29.
[12] Hydrogen Strategy for Canada, December 2020, p. 59.
[13] Ibid., pp. 60-63.

N.M9.EGI-92

Reference:

Exhibit M9, pages 8-9

Preamble:

At pages 8 and 9, Energy Futures Group states:

"The country's 2030 Emissions Reduction Plan is designed to reduce emissions from the buildings sector by 42% relative to 2019 levels."

Question(s):

Please confirm that the province of Ontario has not set a target for GHG reductions from the building sector. If GEC, ED or Mr. Neme disagrees, please provide a link to or a copy of any documents that show otherwise.

Response

Mr. Neme is unaware of any GHG reduction target that may have been established by the province of Ontario for the building sector. Because Ontario is the largest province in the country, it is reasonable to assume that it would have to make significant progress in reducing emissions from buildings in order for the federal projections to be met. That said, the point of the reference to the federal emissions reduction plan was not to suggest that there is a specific buildings target for Ontario. Rather – together with Canada's commitment to net zero emissions by 2050, commitments from various other jurisdictions to dramatically reduce emissions, and related policies and market trends – it was to support the general point that dramatic changes to Enbridge's current business are coming.

N.M9.EGI-93

Reference:

Exhibit M9, page 12

Preamble:

At page 12, in reference to a study by the Canadian Climate Institute, Energy Futures Group states:

"The study acknowledges that there is greater uncertainty with regard to the mix of technologies and fuels that will ultimately comprise the optimal solution to decarbonization by 2050. For example, it states that electric heating systems will heat between 52% and 100% of homes by 2050 (up from about 30% today), with the balance being met by wood (0% to 10%) and clean gases (0% to 40%).[10]"

"However, the study notes that there are a number of barriers to clean gases playing even that large of a role. With respect to hydrogen, barriers include high costs, limits to the ability to blend hydrogen with methane, the "significant modifications to pipelines and distribution networks" required to carry more hydrogen than that, and the need to replace methane-burning equipment in homes and businesses with hydrogen-burning equipment. With respect to biomethane, the key barriers are both high cost and "limited" supplies of feedstock "making significant cost declines from economies of scale unlikely."[12] The bottom line is that "the future of clean gases in the buildings sector is complex and uncertain."[13]"

Question(s):

a) In the report by the Canadian Climate Institute, what are the barriers discussed regarding electrification of buildings?

b) Please confirm that the referenced report states that the percentage of Canadian homes heating with electric heat pumps in 2035 is approximately 15 to 18%.

c) Regarding hydrogen and renewable natural gas, please confirm that the referenced report states the following:

    i. A promising option for reducing emissions cost-effectively in older buildings is clean gases such as hydrogen or RNG.
    ii. The costs of hydrogen could decline by 40 to 50 percent over the next decade and up to 70 percent by 2050.
    iii. New technologies that use second-generation feedstocks could potentially drive down costs and increase supply of RNG.

iv. By 2050, clean gases could potentially provide a total amount of energy equivalent to 32 percent of today's natural gas demand from Canada's buildings.
v. The scenarios modeled in this report did not include dedicated hydrogen pipelines due to modelling limitations, which may mean hydrogen's potential contribution to final energy demand has been underestimated.

d) Please confirm that in the referenced report, the sentence that states: "The future of clean gases in the buildings sector is complex and uncertain" is followed by the following: "But the gas distribution network looks likely to play a role in helping Canada's built environment reach net zero. At a minimum, it can help to reduce emissions from Canada's older buildings over the medium term by blending in clean gases with natural gas, which can act as a helpful bridge to either eventual electrification or higher rates of blending".

Response

a) The report summarizes the challenges of reliance on electricity for decarbonization as follows: "…building the infrastructure and generation capacity necessary to meet the potential demand we indicate would require large numbers of projects, with new ones developed constantly, and often with complex environmental assessment and consultation processes. And grids, grid operations, and complementary on-demand power would all need to significantly evolve to accommodate this growth."[14] Note that all strategies for decarbonization involve challenges or barriers. If they did not, our economies would be much less GHG-intensive than they are today. Thus, when comparing different pathways to decarbonization the key issue with respect to barriers is not whether they exist for each pathway, but rather which pathways present the least challenging barriers to overcome. The referenced Canadian Climate Institute report clearly concludes that the barriers to electrification are likely to be less challenging to overcome than barriers to heavy reliance on clean gases. For example, its list of "safe bets" – which it defines as solutions that "show up consistently across all of the scenarios we examine, that rely on commercial available technologies that are already being used in some places and applications, that face no major barriers to scaling, and that have a reasonable expectation of continued cost declines" – includes energy efficiency and heat pumps, but not clean fuels.[15] In contrast, it considers hydrogen, CCUS, and biofuels to be "wild cards", defined as "technologies only in the early stages of development, that face potential barriers to scalability, or that only play a role in a subset of Canada's possible pathways to net zero."[16]

[14] Canadian Climate Institute, p. 27.
[15] Ibid., p. 77.
[16] Ibid., p. 78.

b) Figure 6[17] of the referenced report suggests that the percent of home heating provided by heat pumps would grow from 2% in 2020 to somewhere in the neighborhood of 15-18% by 2035 and to between roughly 30% and nearly 70% by 2050. Note that the report also forecasts that an additional roughly 25% to 30% of homes would have electric resistance heat in 2035 and 2050 (it is a little over 25% nationwide today).
c) Responses are as follows:
   i. The report does say that clean gases are "*a* promising option". (emphasis added).
   ii. The report does say that the costs of hydrogen could decline by 40-50% over the next decade and by 70% by 2050. However, that statement appears to refer to the cost of generating hydrogen rather than the total cost of delivering it to homes and businesses, as immediately after the statement about potential cost reductions the report discusses significant infrastructure challenges and costs.[18]
   iii. The report states that if new technologies prove viable, they could potentially help further drive down costs and increase supply of RNG. However, it also states that "the prospects for this remain uncertain." Also, the preceding sentence states that supplies of feedstocks are limited, "making significant cost declines from economies of scale unlikely."[19]
   iv. Confirmed.
   v. The modelling performed for the study did not allow for dedicated hydrogen pathways. However, given the major cost and delivery challenges associated with 100% hydrogen delivery to residential and commercial buildings that are discussed in Mr. Neme's report, it is highly unlikely that the study's hydrogen modeling constraint would have led to an underestimation of the likely role of hydrogen for such buildings. Moreover, the study also did not account for other factors, such as interprovincial grid interties and time-of-use pricing in electricity markets, either of which could reduce estimates of the economically optimal level of clean gas usage in residential and commercial buildings.[20]
d) Confirmed.

[17] Ibid., p. 39.
[18] Ibid., p. 43.
[19] Ibid., p. 44.
[20] Though addressing these limitations could allow for greater use of hydrogen in electricity generation.

N.M9.EGI-94

Reference:

Exhibit M9, page 12
Canada Energy Regulator, Provincial and Territorial Energy Profiles, March 10, 2023[21]
Énergir website, Natural gas distribution[22]
Gazifère website, About Us[23]
Exhibit 1, Tab 2, Schedule 1, page 7

Preamble:

At page 12, Energy Futures Group states:

"As Figure 1 shows, the study concluded that natural gas use (systeme au gaz naturel) for residential space heating would be cut roughly in half by 2030 (relative to 2016) and essentially disappear by 2050. Fuel oil (systeme au mazout) and wood heating (poele a bois ou aux granules) also large disappear by 2050 in the decarbonization scenarios (Trajectories A, B, C and D). There is no hydrogen use in the residential sector in any scenario. Nor is there any appreciable use of biomethane. All space heating essentially becomes electric."

CER's website states:

"Ontario consumed an average of 2.7 Bcf/d of natural gas in 2020."[24]
"The residential and commercial sectors each consumed 0.8 Bcf/d."[25]

"In 2020, Quebec consumed an average of 587 million cubic feet per day (MMcf/d) of natural gas."[26]
"The commercial and residential sectors consumed 157 MMcf/d and 65 MMcf/d, respectively."[27]

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[21] Canada Energy Regulator, Provincial and Territorial Energy Profiles, March 10, 2023, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/
[22] Energir. Natural gas distribution. https://energir.com/en/about/our-energies/natural-gas/natural-gas-distribution
[23] Gazifère. About Us. 2023. https://gazifere.com/en/about-us/
[24] Canada Energy Regulator, Provincial and Territorial Energy Profiles - Ontario, March 3, 2023, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-ontario.html
[25] Ibid.
[26] Canada Energy Regulator, Provincial and Territorial Energy Profiles - Quebec, March 3, 2023, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-quebec.html
[27] Ibid.

Énergir's website states:

"Its underground network spans more than 11,000 km and serves just over 205,000 customers."[28]

Gazifère website states:

"Serving more than 43 500 residential, commercial, institutional and industrial customers, Gazifère owns and operates a 1 000 km gas supply system."[29]

At page 7, Exhibit 1, Tab 2, Schedule 1 states:

"[Enbridge Gas] serves over 3.8 million residential, commercial, and industrial customers across the province" … "through 153,000 km of natural gas transmission and distribution pipelines"

Question(s):

a) Based on data provided by the Canada Energy Regulator, please confirm that the volume of natural gas used in residential buildings in Ontario was 12x the volume of natural gas used in Quebec in 2020.

b) Based on the information provided on the Énergir and Gazifère websites, and Enbridge Gas evidence, please confirm that the natural gas system in Ontario serves approximately 15x the number of customers and has 13x the amount of pipeline infrastructure as the natural gas system in Quebec.

c) Please provide any data on and compare the amount of energy delivered by the gas and electricity systems in Ontario and Quebec on a peak day. Please include sources for any assumptions.

Response

Mr. Neme has not calculated the precise degree to which Enbridge's gas system and sales are greater than Quebec's. Nor has he attempted to compare the amount of gas or electricity delivered on peak days in Ontario and Quebec. However, he readily accepts the suggestion that the gas system and gas sales in Ontario are much larger than in Quebec.

[28] Energir. Natural gas distribution. https://energir.com/en/about/our-energies/natural-gas/natural-gas-distribution
[29] Gazifère. About Us. 2023. https://gazifere.com/en/about-us/

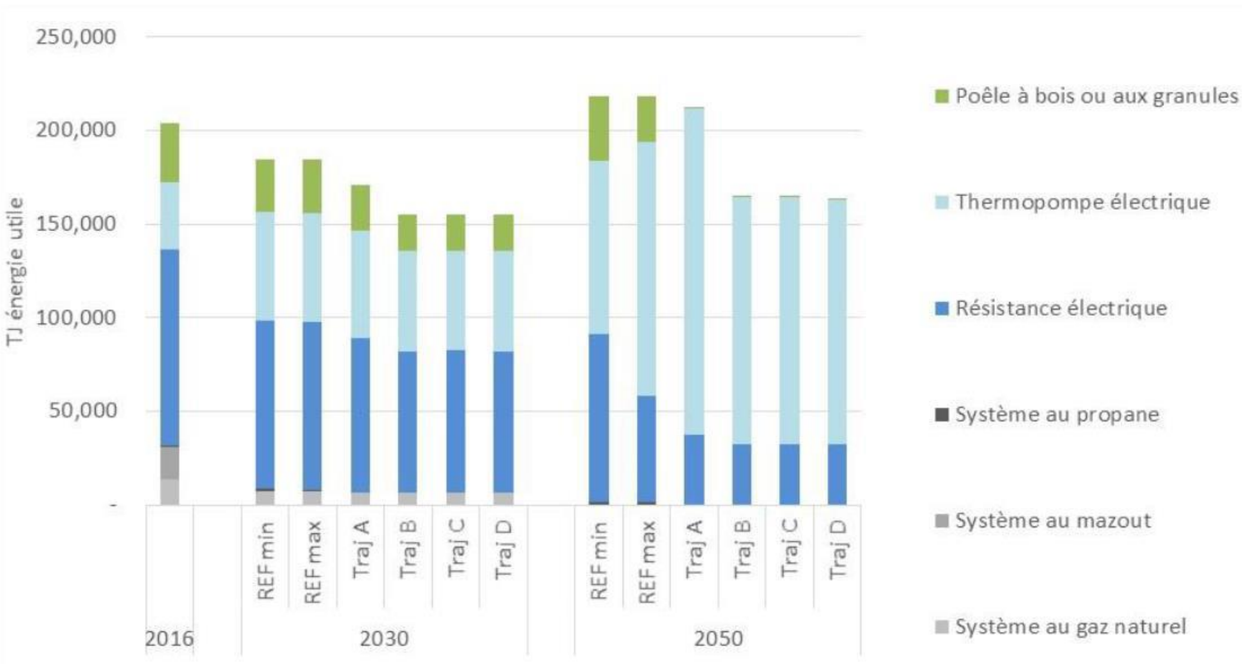
N.M9.EGI-95

Reference:

Exhibit M9, page 13, Figure 1

Preamble:

Figure 1: Quebec Decarbonization Study, Forecast Change in Residential Heating Fuel Mix[15]



Question(s):

a) Please provide English translations of each energy type for Figure 1.

b) Please confirm that the vast majority of residential space heating in Quebec is currently provided by electricity.

c) Please confirm that the replacement of electric heating with gaseous heating (including hydrogen) was not considered in the Dunsky report due to the significant existing penetration of electric residential space heating.

Response

a) Translations are as follows:
    i. “poele a bois ou aux granules” = wood or pellet stove
    ii. “Thermopompe electrique” = electric heat pump
    iii. “Resistance electrique” = electric resistance
    iv. “systeme au propane” = propane system
    v. “systeme au mazout” = fuel oil system
    vi. “systeme au gaz naturel = natural gas system
b) Confirmed.
c) Not confirmed. It is my understanding that the Dunsky study considered both RNG and hydrogen blending with RNG as an option for all customers. The model used for the study allowed for fuel-switching both from gas to electricity and from electricity to gas. The model simply did not find electric to gas conversions to be economically optimal.[30]

[30] Personal communications with Martin Poirier, Dunsky Energy and Climate Advisors, May 23, 2023.

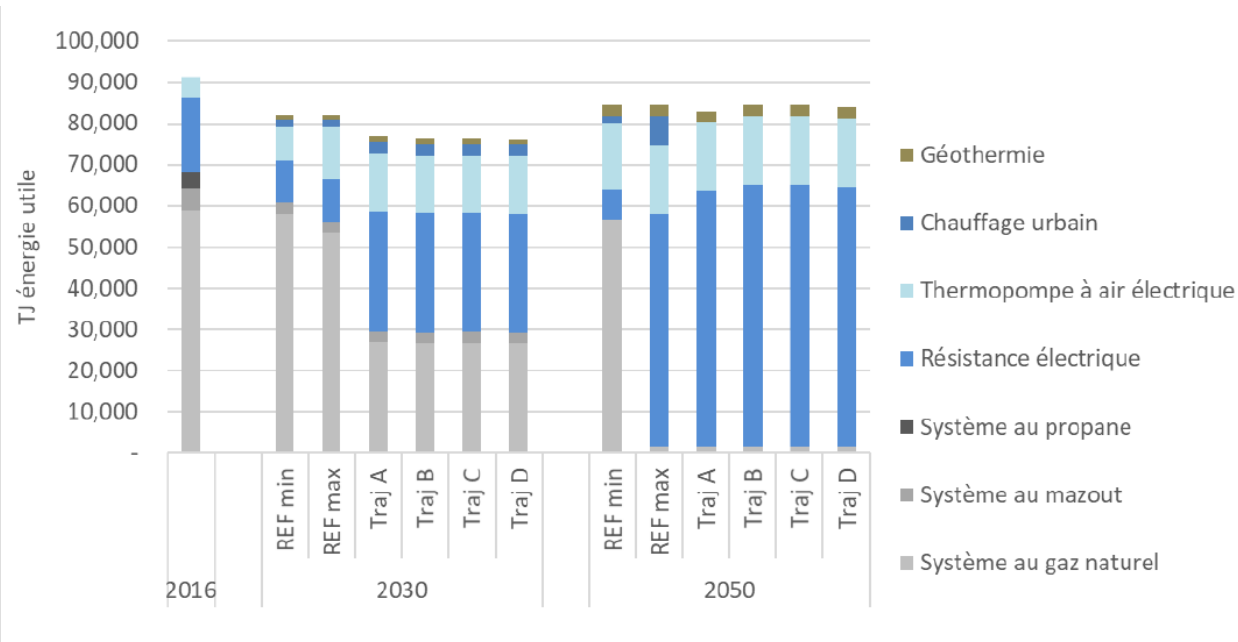
N.M9.EGI-96

Reference:

Exhibit M9, page 13, Figure 2

Preamble:

Figure 2: Quebec Decarbonization Study, Commercial and Institutional Buildings Heating Fuel Mix[17]



Question(s):

a) Please provide English translations of each energy type for Figure 2.

b) Please confirm that the Dunsky report projects that the vast majority of commercial space heating in Quebec will be electric resistance heating and that air-source and ground-source heat pumps have a limited role in commercial space heating by 2050.

Response

a) Translations are as follows:
   i. "geothermie" = geothermal
   ii. "chauffage urbain" = district heating
   iii. "thermopompe a air electrique" = electric air source heat pump
   iv. "resistance electrique" = electric resistance

v. “systeme au propane” = propane system
vi. “systeme au mazout” = fuel oil system
vii. “systeme au gaz naturel” = natural gas system

b) Approximately three-quarters of commercial space heating is forecast to be electric resistance, with the balance being some form of heat pump heating.

N.M9.EGI-97

Reference:

Exhibit M9, page 17

Preamble:

At page 17, Energy Futures Group states:

“Delivery of 100% hydrogen delivery to residential and commercial buildings is generally seen as so unrealistic that it typically isn’t even analyzed.”

Question(s):

For each of the studies summarized in Section III.3, please provide a reference showing where in each report 100% hydrogen is stated to be unrealistic and provide any reasons why it was found to be unrealistic for inclusion in the analysis in the jurisdiction studied.

Response

Mr. Neme is unaware of any explicit references in the cited studies to delivery of 100% hydrogen to residential and commercial customers. That is consistent with the statement in his report that 100% delivery of hydrogen was seen as so unrealistic that it typically isn’t even analyzed.

Mr. Neme was intimately involved in the referenced Massachusetts study, including in extensive discussions over which scenarios to analyze. To his recollection, no party – including the gas utilities for whom the study was performed or their consultant who has conducted many of these studies – suggested a scenario with 100% hydrogen delivery to residential or commercial customers. Note that the study included scenarios with 100% hydrogen delivery to segments of the industrial sector, so 100% hydrogen delivery was not a foreign concept.

It is also important to note that the initial scenario analyzed in the New York study was based on recommendations by the state’s 22-member Climate Action Council and its seven sector-specific Advisory Panels. Those recommendations were informed, in part, by extensive stakeholder outreach and public input. In other words, there were numerous opportunities for advocates for 100% hydrogen delivery to residential and commercial customers to make the case that such a pathway merited modeling and analysis. Moreover, when the initial pathway scenario recommendations were found to not produce enough emissions reductions to meet the state’s goals, the pathways study consultant (E3), which again has extensive experience with such studies, facilitated additional discussions with the Council to develop additional analytical scenarios. 100% hydrogen delivery to residential and commercial customers was not included in the three additional scenarios chosen. 100% hydrogen was included for some industrial customers and for electric generation, again making clear that the concept of 100% hydrogen was not dismissed. One can infer that it was determined to not be worth studying its delivery to residential and commercial customers.

N.M9.EGI-98

Reference:

Exhibit M9, page 20

Preamble:

At page 20, Energy Futures Group states:

"And while substations and other elements of the electric distribution system may need to have capacity upgrades when enough customers electrify, some parts of the electric distribution system will likely be able to accommodate significant electrification without such upgrades…"

Question(s):

Please provide references to reports or studies that show "some parts of Ontario's electric distribution system will likely be able to accommodate significant electrification without such upgrades…" and what percentage of the total Ontario electric distribution system these areas account for.

Response

The cited statement was not based on a study or specific reference to the Ontario electric distribution system. Rather, it is based on Mr. Neme's decades of experience with electric utility system planning across dozens of jurisdictions. While the percentages will vary based on a variety of factors, there are always some parts of every electric utility distribution system that have excess capacity and could therefore accommodate some amount of electrification without capacity upgrades. This is particularly the case in summer-peaking jurisdictions. Further, energy efficiency enhancements and appropriate application of peak shifting initiatives can amplify this availability.

N.M9.EGI-99

Reference:

Exhibit 9, pages 22 and 24

Preamble:

At page 22, Energy Futures Group states:

"I assume that the customer fully electrifies at the time that it would otherwise be replacing both its gas furnace and central air conditioner. This requires additional capital costs for a new electric heat pump water heater, new electric induction stove and new electric dryer – costs that would not be incurred for another six or seven years if the customer continued to use gas equipment for such end uses.[49]"

At page 24, Energy Futures states:

"My analysis did not assume and an electric panel upgrade would be required. Some homes will need such upgrades; others will not. However, the cost of panel upgrades - $2000 or less on average[50] – would not significantly change the conclusion that electrification is very cost effective for customers.

Question(s):

a) Please confirm if costs related to building envelope upgrades and ducting upgrades have been included in the analysis provided in Section 5.A.

b) If not already included, please update the analysis to include costs related to electric panel upgrades, internal wiring, building envelope upgrades and ducting upgrades that are required in order to install air source heat pumps in some homes.

c) Please provide an analysis demonstrating that a house built with gas and water heating as the primary source of energy and built with a 100 amp electrical panel could convert to 100% electricity as a fuel source without upgrading the panel or other infrastructure within the home. If no analysis can be provided, please provide a reference to a study in a comparable weather zone to Ontario.

Response

a) The analysis did not include costs associated with building envelope upgrades or ducting upgrades as such upgrades are often not necessary to accommodate electrification. Note that if building envelop upgrades were to be included, one would also need to account for the added benefit of electricity costs savings that are also not in the current analysis. In many cases building envelop upgrades would increase electrification cost-effectiveness.

b) Mr. Neme's analysis concludes that electrification would produce nearly $16,000 in 18-year net present value (NPV) cost savings. Thus, as explained in Mr. Neme's report, the cost of a $2000 electric panel upgrade would not materially change the conclusion that electrification is very cost-effective. Mr. Neme declines to perform a revised analysis that includes costs for additional internal wiring changes, duct changes and building envelop upgrades as such modifications are often not needed in order to electrify. It should also be noted that existing homes with non-condensing gas furnaces that are currently vented through a chimney will have to install new venting systems – and possibly do additional work to reduce air leakage through their chimney – when they install a new condensing furnace (which are now required by law). Mr. Neme also did not include any such additional expense in his characterization of the cost continuing to use gas heating because they are not always needed. That is not to say that there would not be cases in which any of the aforementioned investments might be necessary, but Mr. Neme's analysis is not intended to address every possible permutation of existing homes. Rather, it is intended to reflect a common existing home. Again, homes that would benefit from additional building envelop upgrades would not just incur the costs of such upgrades, they would also realize substantial additional energy bill savings as well as other non-energy benefits.

c) Mr. Neme agrees that most homes with 100-amp electric panels would require an electric panel upgrade to electrify both space heating and water heating. However, as noted in his report, the additional cost of such a panel upgrade would not materially affect the conclusion that electrification is cost-effective for most customers.

N.M9.EGI-100

Reference:

Exhibit M9, page 23, Tables 2 & 3

Question(s):

a) Please provide all tables and live Excel documents with formulae intact for all calculations associated with Tables 2 and 3.

b) Please provide all assumptions used to develop the analysis presented in Tables 2 and 3.

c) Please explain how the data within Tables 2 and 3 were derived and provide all sources.

Response

See response to N.M9.EGI-90.

N.M9.EGI-101

Reference:

Exhibit M9, pages 24-25

Preamble:

At page 25, Energy Futures Group states:

"As with all commodity markets, the most expensive source of RNG will ultimately set the market clearing price for all RNG."

Question(s):

Please provide a reference for this statement.

Response

This is the nature of competitive commodity markets. Note that this assumption is also made in other decarbonization pathways studies, such as the Massachusetts study referenced in Mr. Neme's report.

N.M9.EGI-102

Reference:

Exhibit M9, pages 30-31

Preamble:

Energy Futures Group observed that the Guidehouse analysis used performance degradation assumptions for air-source heat pump systems based on an NREL publication from 2006. Energy Futures Group discounted the findings of this publication based on the age of the study, and conjectured that newer variable-speed systems might show lower rates of performance degradation.

Question(s):

a) Please provide supporting evidence showing how the addition of a variable speed compressor and controls serves to reduce performance degradation, compared with older single-speed heat pump technology.

b) Please provide supporting evidence showing how a variable-speed heat pump is less susceptible to performance degradation due to improper refrigerant charge and evaporator coil air flow compared with older heat pump technology.

Response

Mr. Neme is unaware of studies of efficiency degradation of current advanced air source heat pump technology. But that is the point. The burden of proof for an assertion that current technology experiences efficiency degradation like equipment of 30+ years ago rests with Guidehouse since it decided to make such an assumption. That is particularly true when Guidehouse made no comparable assumption about the degradation of gas heat heating equipment. Guidehouse stated that it did not apply an efficiency degradation assumption to gas heat pumps because there were no studies to support such an assumption.[31] That is no different than the situation for current generations of advance electric air source heat pumps.

[31] Transcript of Technical Conference, April 27, 2023, p. 21, lines 13-19.

N.M9.EGI-103

Reference:

Exhibit M9, pages 37-38

Question(s):

a) What are current and historical annual sales of HPWHs in Ontario?

b) What quantity of heat pump water heater sales does Energy Futures Group project for Ontario in 2030, 2040, and 2050?

c) Please provide evidence to support your projections.

Response

a) Mr. Neme does not have data on current and/or historical annual sales of HPWHs in Ontario. However, current and historical sales levels are not particularly relevant to the critique Mr. Neme made about Guidehouse's assumptions about future market penetration rates for HPWHs. Leading DSM programs have been shown to be very effective at accelerating market adoption of efficient products with initially low market shares, including HPWHs. In a decarbonizing future, with higher energy prices, future technology advancements, increasing customer awareness of the technology, and government policy support, such programs would likely be even more effective. Moreover, whatever the market share of HPWHs is today in Ontario, it is higher than the current residential market share of gas heat pumps (which are not even commercially available). While Guidehouse assumed that HPWHs would obtain less than a 10% market share among residential gas conversions by 2040 in its Electrification Scenario, it assumed that 50% of all residential gas space heating in 2040 would be gas heat pumps in its Diversified Scenario. If current market share is to be a key determinant of future market acceptance, there would no basis for anything close the assumption about gas heat pump adoption rates Guidehouse made. Put simply, Guidehouse's HPWH market shares in its Electrification Scenario are not only unreasonably low, the fact that Guidehouse simultaneously assumed dramatically higher market penetrations for gas heat pumps is emblematic of a significant bias against electrification in Guidehouse's and Enbridge's scenario development.
b) Mr. Neme has not forecast HPWH sales for Ontario.

N.M9.EGI-104

Reference:

Exhibit M9, page 50, Table 10

Preamble:

Table 10: Equipment Cost, Efficiency and Energy Consumption Assumptions

	2023 Initial Capital Cost	Life	Level-ized Annual Cost	2023 Avg Heating COP	2030 Avg Heating COP	Avg Cooling SEER	Other COPs	Annual Gas m^3	Annual Electric kWh			
									Heating	Cooling	Other	Total
Heating/Cooling												
Current Avg Furnace + Central A/C				0.90		13		2117	328	779		1,107
New Gas Furnace + Central A/C	$8,000	18	$632	0.95	0.95	14		2006	328	723		1,051
cold climate ASHP	$4,600	18	$363	2.84	2.93	18			7,279	563		7,842
Water Heating												
Current Stock Avg gas water heater							0.63	441				-
Gas Water Heater	$5,089	13	$510				0.80	347				-
Heat Pump Water Heater	$2,796	13	$280				3.19		946			946
Drying												
Gas Dryer	$1,560	13	$156				3.48	53			108	108
Electric Dryer	$1,093	13	$109				3.93				608	608
Cooking												
Gas stove	$1,094	12	$117					94				-
Electric Induction Stove	$1,494	12	$159								290	290

Question(s):

a) Please provide a copy of the table in Excel with any equations intact.

b) Please explain how the data within Table 10 was derived and provide all sources.

c) For gas water heating, was a tankless water heater and its cost and efficiency, considered?

d) For the cold climate ASHP:
   i. Was a ductless system or ducted system considered?
   ii. Was the cost of an air handler included?
   iii. Was the cost of an electric resistance backup contemplated?
   iv. Were the costs of all necessary upgrades to internal wiring, breakers, and panel included?

Please state all assumptions used and references for the sources.

Response

a) See response to N.M9.EGI-90.
b) See response to N.M9.EGI-90
c) The analysis assumed a baseline of a gas storage water heater.
d) Responses to questions about the ccASHP assumptions are as follows:

i. The analysis assumed a centrally-ducted system.
ii. The ccASHP cost was the same as the cost used by Guidehouse in its modeling. It was assumed that includes an air handler.
iii. The ccASHP cost was the same as the cost used by Guidehouse in its modeling. It was assumed that includes some electric resistance back-up coils. Note that electric resistance back-up adds very little to the cost of an air source heat pump.
iv. See response to N.M9.EGI-99

N.M9.EGI-105

Reference:

Exhibit M9, Appendix A, page 50, Table 10

Question(s):

Please provide the source of information for all amounts/estimates included in Table 10 and confirm units referenced and any underlying assumptions. If amounts are derived, please provide the numerical calculation and accompanying assumptions to support the values in the table.

Response

See response to N.M9.EGI-90.

N.M9.EGI-106

Reference:

Exhibit M9, Appendix A, page 50, Table 11

Question(s):

a) Please provide the source of information for all amounts/estimates included in Table 11 and any underlying assumptions.

b) Please explain the purpose of the table and the applicability of gas and electricity prices that are held static over the forecast period.

Response

a) See response to N.M9.EGI-90
b) First, to be clear, the gas and electricity prices in Table 11 are held static in *real* dollars. In other words, they assume that prices would increase at the rate of inflation. Second, prices are held constant in real dollars because it is extremely difficult to predict how they will change over time. The significant increase in gas commodity prices between 2020 and 2022 are illustrative of that point. That said, as noted on p. 24 of the updated version of Mr. Neme's report, if ICF's 4th Quarter 2022 forecast of gas commodity prices are used instead of the gas commodity prices shown in Table 11, the impact on the results of the analysis is minimal – dropping energy bill savings from 46% to 44% over the 18-year period starting in 2023.