July 13, 2023

VIA RESS

Ontario Energy Board
Attention: Registrar
P.O. Box 2319,
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Marconi,

Re: Enbridge Gas Inc. ("EGI")
2024 Rebasing Application
Board File No.: EB-2022-0200

We are counsel to Three Fires Group Inc. ("**Three Fires**) in the above-noted proceeding. Please find enclosed Three Fires' compendium in aid of cross-examination for EGI's Panel 1 on Day 3 of the oral hearing on July 18, 2023.

Sincerely,

DT Vollmer

c. All Parties to EB-2022-0200

Encl.

ONTARIO ENERGY BOARD

IN THE MATTER OF the Ontario Energy Board Act, 1998, S.O. 1998, c.15 (Schedule. B);

AND IN THE MATTER OF an Application by Enbridge Gas Inc., pursuant to section 36(1) of the Ontario Energy Board Act, 1998, for an order or orders approving or fixing just and reasonable rates and other charges for the sale, distribution, transmission and storage of gas as of January 1, 2024.

EB-2022-0200

CROSS-EXAMINATION COMPENDIUM

EGI PANEL 1

THREE FIRES GROUP INC.

July 13, 2023

EB-2022-0200

Enbridge Gas 2024 Rebasing

TFG Compendium for Panel #1

Tab 1

INTEGRATING ENERGY TRANSITION INTO THE BUSINESS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes the energy transition assumptions that Enbridge Gas has incorporated into the Company's forecasting and planning processes, and the impacts on the Company's Asset Management Plan (AMP), finance and regulatory approaches.

2. This evidence is organized as follows:
    1. Forecasting
    2. Planning
    3. Finance and Regulatory Approaches

1. Forecasting

1.1. Introduction

3. This section provides details on how Enbridge Gas has considered energy transition in the Company's forecasted number of customers, average use, design day and design hour demand, and distribution contract customer demand.

4. These forecasts are important inputs into the Company's planning activities, such as the Asset Management Plan (AMP) development, gas supply planning, and rate setting. To ensure Enbridge Gas's planning activities appropriately consider the impacts of climate policies and energy transition, the Company undertook a review of each forecast to determine what energy transition adjustments to make at this time.

5. Historically, these Enbridge Gas forecasts only considered climate policies that have been implemented. For example, Enbridge Gas's general service average use forecast includes the cost of carbon, based on existing carbon pricing policies in the model's price variable.

6. Enbridge Gas reviewed the following sources of data and insights to develop energy transition assumptions:
   a) The Energy Transition Scenario Analysis (ETSA) study, provided at Exhibit 1, Tab 10, Schedule 5, Section 1 (please also see the report provided at Exhibit 1, Tab 10, Schedule 5, Attachment 1);
   b) A review of current climate policies, provided at Exhibit 1, Tab 10, Schedule 3, Section 2; and
   c) Input from stakeholder engagement, provided at Exhibit 1, Tab 10, Schedule 5, Section 2 and a review of market trends

7. Using the insights gained, Enbridge Gas reviewed the aforementioned forecasts and their inputs to determine the appropriateness of including adjustments to reflect energy transition. This review contemplated both policy certainty and the risks of including or not including energy transition adjustments. As a result of this review, certain adjustment factors were developed and applied to the Company's forecasts and/or their input variables, where deemed appropriate. The adjustment factors included in each forecast are discussed below.

8. Enbridge Gas recognizes that incorporating energy transition assumptions into the Company's forecasting and planning process has had a relatively small impact during the rate rebasing period; however, this evidence demonstrates that Enbridge Gas is accounting for known energy transition factors, is incorporating changes as policy signals become more certain, and is building increased transparency into the

ENBRIDGE GAS'S ENERGY TRANSITION PLAN (ETP) AND SAFE BET ACTIONS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes emerging federal, provincial, and municipal climate change policies and the uncertainty around what energy transition pathway may unfold due to the differing greenhouse gas (GHG) emission reduction targets and areas of focus at each level of government. The evidence then describes Enbridge Gas's Energy Transition Plan (ETP) and the actions outlined within the ETP that Enbridge Gas proposes to move forward with during the rebasing term despite current policy uncertainty. Enbridge Gas's ETP ensures that progress towards 2030 targets and a net-zero future continues despite policy uncertainty, while also ensuring Ontario's energy demands are met in the most reliable, resilient, secure, and cost-effective manner.

2. This evidence is organized as follows:
    1. Emerging Climate Change and Energy Transition Policies
    2. Enbridge Gas's Energy Transition Plan (ETP) to Reduce GHG Emissions
    3. Summary of GHG Reductions Driven from Enbridge Gas's ETP
    4. Evolution of Enbridge Gas's ETP

1. Emerging Climate Change and Energy Transition Policies

1.1 Introduction

3. The need to act against climate change has led the federal, provincial, and municipal governments to develop targets, plans, and policies to reduce GHG emissions, to develop lower carbon sources of energy and to transition to a low-carbon economy. Please see Exhibit 1, Tab 10, Schedule 3, Section 2 where Enbridge Gas describes the current climate policies that impact the Company. This

natural gas will have a role to play in replacing higher emitting fuels, particularly replacing coal/coke use in the steel industry. This is supported by Ontario's updated Emissions Scenario[29] and funding announcements[30] from the Ontario Government made earlier in 2022.

30. The combination of federal targets, aggressive municipal net-zero plans and a lack of provincial GHG emissions reduction goals beyond 2030 creates great uncertainty around the pace and nature of the energy transition pathway that the Ontario Government will take. Energy policy resides with Ontario Government and absent provincial policies or frameworks, Enbridge Gas does not have clarity on what pathway will unfold. It is for this reason, that the Ontario Electrification and Energy Transition Panel's pathways report and the continued consultation on energy related discussion papers is so critical. The information gained via these initiatives will help to define Ontario's energy transition pathway and its associated climate policies, plans and targets. This will provide clarity around how Ontario's electric and gas systems can together support an orderly transition to a net-zero future while also maintaining today's level of energy security, reliability, resiliency, and affordability for all Ontarians.

31. An understanding of these evolving climate policies, plans, and targets will remain a key input into Enbridge Gas's ETP. This ensures that Enbridge Gas complies, where applicable, and aligns its business processes, plans and activities with policies as they are implemented.

---

[29] Ontario Emissions Scenario as of March 25, 2022, 2022, https://prod-environmental-registry.s3.amazonaws.com/2022-04/Ontario%20Emissions%20Scenario%20as%20of%20March%2025_1.pdf
[30] Government of Ontario. (2022 February 15). Province Invests in Clean Steelmaking Technology in Hamilton to Support Future of Ontario's Auto Sector. https://news.ontario.ca/en/release/1001604/province-invests-in-clean-steelmaking-technology-in-hamilton-to-support-future-of-ontarios-auto-sector

ENBRIDGE GAS INC.

Answer to Interrogatory from
Three Fires Group Inc. (Three Fires)

Interrogatory

Reference:

Exhibit 1, Tab 10, Schedule 4

Preamble:

Enbridge describes the energy transition assumptions that Enbridge Gas has incorporated into the Company's forecasting and planning processes, and the impacts on the Company's Asset Management Plan ("**AMP**"), finance and regulatory approaches. It states that the forecasts are important inputs into the Company's planning activities, such as the AMP development, gas supply planning, and rate setting. It further states that historically these Enbridge Gas forecasts only considered climate policies that had already been implemented.

Question(s):

a) Please explain the considerations that helped determine Enbridge's decision to begin to include in its forecasting policies that have not already been implemented.

b) Please explain Enbridge's reasoning in previously including only climate policies that had already been implemented.

c) Please describe any disadvantages to the new approach of including in Enbridge's forecasting policies that have not already been implemented.

d) Please describe the general composition of internal teams that Enbridge has used for the purposes of developing and applying its energy transition assumptions, and/or towards performing the reviews set out at paragraph 6 of Cara-Lynn Wade and Jennifer Murphy's evidence. In particular, please include details such as the number and seniority of personnel responsible, the approximate portion of their time devoted to analyzing energy transition issues, their general experience in the area, and any resources of significance that they have available to them in performing this aspect of their work.

e) With respect to Enbridge's statement at paragraph 11 that insufficient certainty exists concerning future requirements for new build and retrofit building codes, why does Enbridge not incorporate some form of scenario analysis as opposed to excluding the effects of new build and retrofit building codes?

f) Please describe the general thinking behind the forecasts set out in Table 2. In particular, please describe any scenario analysis that Enbridge has performed and why Enbridge has settled on the figures set out in the table.

g) Does the Customer Additions Forecast take into account any impact of increased cost to remaining consumers resulting from other customers transitioning away from use of natural gas?

h) What new or increased challenges will Enbridge face – for example with respect to increased costs or customer retention – in the event Ontario assumes a more status quo orientation to energy transition in the short-term, then pivots sharply to more drastic electrification scenarios in the medium term (i.e., over the next 3-6 years)?

i) What would the scenario referenced in question (h) immediately above mean for Enbridge customers in terms of new or increased challenges? Will these effects be uniform, or will they be felt disproportionately by certain individuals or groups?

Response:

a -c) Historically, Enbridge Gas only included the policies that were implemented because the impacts of future policies were not known and/or quantifiable. As provided at Exhibit 1, Tab 10, Schedule 6, paragraph 20, there has been significant development of climate and energy transition targets and plans in Canada at all levels of government in the last few years. While there remains a significant lack of details on how these targets will be met, and development of detailed policies is still in progress, Enbridge Gas believes it is prudent to incorporate energy transition assumptions into the Company forecasts where there is reasonable certainty based on policy signals, market trends and stakeholder feedback.

In the development of energy transition adjustments to the forecasts, Enbridge Gas took a conservative approach. Overestimating the impact of climate and energy transition policies could create a risk that Enbridge Gas does not have sufficient assets in the Company's Asset Management Plan (AMP) and/or Gas Supply Plan. Enbridge Gas has prudently incorporated energy transition related assumptions and, therefore, does not consider there to be disadvantages to the Energy Transition review and adjustment process that it has implemented.

As provided at Exhibit 1, Tab 10, Schedule 6, Section 4 and Exhibit 1, Tab 10, Schedule 4, paragraph 8, Enbridge Gas plans to continue evolving the Company's stakeholder engagement and evaluating the impacts of policies as certainty of implementation date and impact on the Company's forecasts is established.

d) The development of energy transition assumptions and the reviews set out at Exhibit 1, Tab 10, Section 4, paragraph 6 was led by the Carbon and Energy Transition Planning team. The Carbon and Energy Transition Planning team is led by Jennifer Murphy, Manager Carbon and Energy Transition Planning, and Cara-Lynne Wade, Director Energy Transition Planning, and their CVs are provided at Exhibit 1, Tab 1, Schedule 5 pages 61 and 89, respectively. Please see response at Exhibit I.1.6-CCC-22 for a description of the team composition. Additional departments that supported the development and application of energy transition assumptions include Finance, Customer Care, Engineering, Business Development and Regulatory, and Energy Services.

e) Enbridge Gas undertook the Energy Transition Scenario Analysis (ETSA) Project as provided in Exhibit 1, Tab 10, Schedule 5, Attachment 1 as a means of visualizing possible outcomes from various scenarios. As provided at Exhibit 1, Tab 10, Schedule 4, paragraphs 6 and 7, the ETSA project was used as one of several inputs to develop energy transition adjustments to the forecast. From a forecasting and planning perspective, it is not practical to undertake scenario analysis for the numerous possible individual future changes that could occur in the future. The level of effort to create multiple forecasts and plans is prohibitive.

f) Please see the response at Exhibit I.1.10-STAFF-27 part a), and Exhibit I.1.10-GEC-10 part c).

g) Enbridge Gas's Customer Additions Forecast does not take into account any impact of increased cost to remaining consumers resulting from other customers transitioning away from use of natural gas.

h - i) Please see response at Exhibit I.1.10-SEC-19. Enbridge Gas cannot determine if different customer types will be disproportionately impacted by other customers fuel-switching without undertaking further analysis which cannot be carried out at this time.

ONTARIO ENERGY BOARD

FILE NO.: **EB-2022-0200** **Enbridge Gas Inc.**

VOLUME: **Technical Conference**

DATE: **March 22, 2023**

that.

MR. ELSON: So, Ms. Murphy, if I understand you correctly, the only thing that has value is running the report with the assumptions by the folks on this panel and there's no value running it with alternative assumptions that, for example, may reflects what the IESO thinks.

MS. MURPHY: Well I was just going to say and I'll let Cara-Lynne jump in as well.

I did not say that that's the only thing of value. Enbridge undertook this work and looked at two scenarios.

We don't think these are, you know, this is the hard and fast way that net zero will be achieved is in one of these path ways. We believe these are just two possible scenarios.

So while I agree there are other scenarios, I'm just not sure that in this proceedings is the place for those to be modelled when we know that the government is currently undertaking a modelling exercise and ultimately is the right party to be looking at the best way for Ontario to reach net zero, and that work is under -- being undertaken right now.

But I'll let Ms. Wade -- if there's anything you'd like to add?

MS. WADE: No, I think Ms. Murphy has captured it.

I would just add that the panel is going to be looking for short-term, medium term, and long-term opportunities, and they will be looking at a Pathway similar to this.

So I think we could come up with an endless list of scenarios to run. We are just trying to determine what's of the most value to the Board in making their decision, and we believe that the Ontario Energy Transition Panel and the Pathway, that report is going to provide guidance on policy and long-term planning, and that that is the best place to see the next scenario that's run.

And we would also note that, you know, as highlighted in 1.10, section 6, within our plan and safe bets, we believe, you know, the next best scenario also, you know, post a provincial Pathway study that is being run is together with the electric industry and doing a joint study that takes into consideration what you've noted in probably many more.

MR. ELSON: I'm not asking that a different scenario be run. The report has an error in it. It mistakenly refers to the theoretical potential as being the RNG potential, and the study that it relies on has a drastically lower number for the feasible RNG potential.

That isn't broken up into how much the feasible potential is for Ontario.

What I'm asking is that the model be rerun, which I understand takes ten minutes of computational time as long as there is a solvable result, with a figure of 30 PJs of RNG, which is a very -- it is a higher estimate than what the IESO assumed in its potential result.

So if there is any value in this proceeding of the Guidehouse report, then there would also be value for this response.

Tab 2

PATHWAYS TO NET-ZERO AND THE ROLE OF GASEOUS FUELS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes the energy transition studies commissioned by Enbridge Gas to understand how net-zero goals could impact natural gas demand and what role the gas system can play in Ontario achieving its GHG reduction targets. This evidence also provides a summary of the stakeholder engagement Enbridge Gas has undertaken.

2. An overview of Enbridge Gas's vision of energy transition in Ontario and the role of gaseous fuels, which was informed by the studies and stakeholder engagement, is also provided.

3. This evidence is organized as follows:
    1. Energy Transition Studies
    2. Stakeholder Engagement
    3. Enbridge Gas's Vision of Energy Transition in Ontario: A Diversified Pathway

1. Energy Transition Studies

1.1. Introduction

4. In this section, Enbridge Gas describes two studies that the Company undertook to understand the impact of energy transition and associated climate policies on Ontario's natural gas demand and Enbridge Gas's transmission, distribution, and storage system. These studies have informed the Company's demand forecast, vision of Ontario's energy sector, and energy transition plan (ETP).

12. The modeled results provided by the ETSA Project are for illustrative purposes only and are not intended to replace Enbridge Gas's OEB-approved forecasting methodologies; however, the results of the ETSA Project were used to inform Enbridge Gas's forecasting and planning inputs, where deemed appropriate, as provided at Exhibit 1, Tab 10, Schedule 4, Sections 1 and 2.

13. The four scenarios modeled in the ETSA Project were:
    a) Reference case (i.e., business as usual) scenario where there were no changes to the climate policies that were in place as of October 2020;
    b) Steady progress scenario that represented announced policies or proposed programs, as of April 2021, that had yet to be enshrined in law or approved, but had reasonable certainty of being implemented;
    c) Diversified portfolio scenario that assumed implementation of policies to support a wide-spread use of low-carbon gases, including renewable natural gas (RNG) and hydrogen, and carbon capture utilization and storage (CCUS), in addition to electrification to achieve net-zero emissions by 2050; and,
    d) Electricity centric scenario that assumed implementation of policies to support aggressive electrification, with a limited role for low-carbon gases and CCUS to achieve net-zero emissions by 2050.

14. Further information on each scenario, including the scenario narratives, key policies and exogenous conditions associated with each scenario, and the critical drivers that are most influential in each scenario are provided at Attachment 1, pages 40-41.

15. Each scenario considers key variables (critical drivers) that have the potential to affect gas demand and/or GHG emissions. The critical drivers included were carbon price, the price of natural gas, building and equipment codes and standards, equipment choice, population growth, and adoption of low-carbon fuels (e.g., RNG and hydrogen) and technologies (e.g., CCUS). The assumptions for critical drivers in each scenario are provided at Attachment 1, pages 41-45.

16. The scenario narratives, list of critical drivers and input assumptions for critical drivers in each scenario were developed by Posterity Group through consultation with internal subject matter experts and were presented to external stakeholders to solicit feedback. Where possible, publicly available third-party information was also used to inform the input assumptions. Data inputs and assumptions are provided at Attachment 1, pages 80-112.

17. Internal subject matter experts included members of the following departments at Enbridge Gas: Energy Transition Planning, Business Development, Marketing and Energy Conservation, Customer Care, Finance, Regulatory, Engineering, Energy Services, and Public Affairs.

18. External input was sought from a second consultant, Building Knowledge Canada, on the impact of building codes on building energy usage. Additionally, an external stakeholder consultation was held with members of Toronto District 2030, which is a public-private initiative comprised of IESO, Toronto Hydro, Canadian Green Building Council, Enwave, housing developers, architects, and academics. Feedback received was generally supportive of the ETSA work and encouraged Enbridge Gas to continue with energy transition planning, and to work towards a goal of absolute zero GHG emissions by 2050.

ENBRIDGE GAS INC.

Answer to Interrogatory from
Three Fires Group Inc. (Three Fires)

Interrogatory

Reference:

Exhibit 1, Tab 10, Schedule 5
Exhibit 1, Tab 10, Schedule 5, Attachment 1

Preamble:

Enbridge retained Posterity Group Consulting ("**Posterity**" or "**PG**") to work on an Energy Transition Scenario Analysis ("**ETSA**") project. The ETSA project provides Enbridge Gas with theoretical scenarios of the future to help assess the potential impacts from climate policies and economic conditions that Enbridge's system could experience over the next 20 years. Four scenarios were modelled of future gas demand and greenhouse gas emissions over a twenty-year time horizon. Probabilities are not assigned to the scenarios and Enbridge does not endorse or oppose any of the scenarios presented in the report.

Question(s):

a) Why did the ETSA project not assign (or why did Enbridge not request or otherwise submit for the purposes of this Application) probabilities to the likelihood of each scenario occurring or include analysis of the cost implications of each scenario?
b) What are PG's views concerning the likelihood of each scenario occurring, as well as the cost implications of each scenario?
c) What are Enbridge's views concerning the likelihood of each scenario occurring, as well as the cost implications of each scenario?
d) Please produce the long list of critical drivers referenced at page 22 of the report.
e) Please confirm whether page 27 of the report sets out a full list of all variables considered by Enbridge and/or PG for the purposes of page 22 of the report that:
   i. Satisfied the criterion that it could have a material impact on Enbridge Gas annual volume, peak hour and day, and/or GHG emissions in the next 20 years;
   ii. But did not satisfy the criterion for sufficient available data to predict what the variable could be in the next 20 years

   If page 27 does not set out the full list of such variables, please provide a full list of variables that meet the above criteria.
f) Please explain the rationale for the maximum setting for each of the following variables set out in Exhibit 14, including any consideration given to drawing from international policy developments and thinking:

i. Codes and standards: retrofit
ii. Codes and standards: new construction

g) Please confirm whether PG and Enbridge considered any international examples or discussions for the purposes of its critical driver analysis for:
    1. Codes and standards, as discussed in Appendix C of the report
    2. Non-price driven fuel switching, as discussed in Appendix D of the report (in addition to the examples from the United States set out in Appendix D)

    If international sources were considered, please provide details. If they were not considered, please explain why.

Response:

a) As stated at Exhibit 1, Tab 10, Schedule 5, page. 3, Enbridge Gas undertook the Energy Transition Scenario Analysis (ETSA) project to understand the impact of climate policies on the gas distribution system under a range of possible scenarios. Assigning probabilities to the scenarios was considered speculative and highly subjective. Enbridge Gas considered assignment of probabilities to be of limited value for forecasting and planning purposes and therefore did not include it in the scope of the study.

    Based on the project's objective provided above, cost analysis of each scenario was not included in the scope of work for the ETSA project; however, the Pathway to Net-Zero Emissions in Ontario (P2NZ) Study, which is underpinned by the Diversified Portfolio and Electricity Centric scenarios developed in the ETSA project, provides a cost comparison under these two pathways, as provided in Exhibit 1, Tab 10, Schedule 5, Attachment 2.

    Enbridge Gas agrees with the findings of the P2NZ Study "which concluded that a diversified approach that included a targeted approach to electrification tied with deployment of low-or zero-carbon gases, including renewable natural gas (RNG), hydrogen, and natural gas with carbon capture, is the most cost-effective and resilient method to achieve net zero emissions in Ontario." Enbridge Gas is unable to comment on the likelihood of the diversified scenario or any other scenario occurring.

b) The following response was provided by Posterity Group:

    Please see response at Exhibit I.1.10-ED-19 part e). Assessing the cost implications of each scenario was not within the project scope.

c) Please see part a).

d-e) The following response was provided by Posterity Group:

Please see response at Exhibit I.1.10-SEC-35.

f) The following response was provided by Posterity Group:

Appendix C of the report provides detailed rationale for how we developed ‘high stringency’ and ‘medium stringency’ settings with respect to changes to new construction codes, retrofit codes and appliance standards. Please see Exhibit 1, Tab 10, Schedule 5, Attachment 1, pages 100 to 107. The maximum settings for the variables set out in Exhibit 14 are based on the ‘high stringency’ settings.

Exhibit 1, Tab 10, Schedule 5, Attachment 1, page 100 outlines our approach to selecting and modelling codes and standards. “We focused on C&S’s that were implemented, planned, or drafted. The goal was to capture the impacts of defined codes, and to avoid speculating on possible future codes that were not yet determined, with the exception of the potential retrofit codes for which the timing and impact were also estimated.”

Exhibit 1, Tab 10, Schedule 5, Attachment 1, pages 100 to 101 presents the list of codes included in the analysis and a discussion on codes that were excluded. While international policy developments and thinking were not explicitly considered, NECB 2020 Tiered Code (Part 3), NBC 2020 Tiered Code (Part 9), and Canada’s Energy Efficiency Regulations are all influenced by international policy developments, including the International Energy Conservation Code (IECC).

g) The following response was provided by Posterity Group:

1. Please refer to response at Exhibit 1.10-Three Fires-5 part f).

2. While no additional international examples were considered, beyond the examples from the United States, the non-price driven fuel switching input settings were not limited by the research. The research provided examples of what might cause switching from gas to electricity and what sectors and end-uses are being targeted by policies, codes, and programs. The maximum rate of change is determined by characteristics of the built environment, including new construction rates and the effective useful life of the underlying natural gas end-use equipment being replaced.

The Electricity Centric input settings for non-price driven fuel switching represent the maximum setting for this CD. They represent an upper bound for non-price fuel switching impacts. See Exhibit 1, Tab 10, Schedule 5, Attachment 1, page 43.

Appendix D Critical Driver Data Inputs and Assumptions: Non-Price Driven Fuel Switching

The appendix provides more details on the data inputs and assumptions used for the CDs that required more extensive research and analysis. This appendix focuses on non-price driven fuel switching.

Scope of the Non-Price Driven Fuel Switching Critical Driver

This CD was meant to reflect Enbridge Gas customers switching from gas to electricity for reasons other than price. Reasons such as altruism, consumer preference, and regulations that require or incentivize switching from gas to electricity were within the scope of this CD. Changes in energy use intensity from building codes and equipment standards were captured in the C&S CD, and changes to the number of Enbridge Gas customers from fuel switching were captured in the customer growth/accounts CD. Price-driven fuel switching were caused by changes in carbon and gas prices.

The space and water heating end-uses were of focus for this CD, because they were the end-uses which switch away from natural gas most often. The focus was on the residential and commercial sectors where fuel switching from gas to electricity is common. Also, the policies and incentives for decarbonization of energy use in buildings tend to focus on the residential and commercial sectors. The Industrial sector was excluded as space and water heating represent a lower portion of energy use there. Decarbonization was expected in the Industrial sector, but the biggest levers for industrial decarbonization were captured in other CDs.

Electric to natural gas fuel switching from non-price signals was not explored because it is unlikely there will be incentives/regulations supporting such a switch.

Possible Causes of Gas to Electric Fuel Switching

Switching from gas to electricity for reasons other than fuel price may be caused by the following:

- *Individual preference* for low-carbon fuels for altruistic reasons or interest in emerging low-emission technologies, like heat pumps, may cause individuals to switch from gas to electric equipment.[30]
- *Policies that limit the use of natural gas* like setting carbon intensity limits for buildings, requiring zero emissions from space and water heating technologies, and/or banning the uses of natural gas for some applications/building segments. Examples of such policies include:
    - The City of Vancouver Zero Emissions Building Plan aims to have all new buildings achieve zero emissions by 2030. The plan sets GHG and energy intensity targets for new construction MURBs, offices and detached homes.[31] The Vancouver Building Bylaw, amended in the spring of 2020, requires all new and replacement heating and hot water systems by zero emissions by 2025.[32]

[30] Environics. "Exploratory Assessment of Energy Needs." December 2019.
[31] https://vancouver.ca/green-vancouver/zero-emissions-buildings.aspx#zero-emissions-building-plan
[32] https://council.vancouver.ca/20200331/documents/9.pdf

  - Many cities in the U.S have banned natural gas equipment in new buildings including several in California (San Francisco, Berkley, San Joe, Mountain View, Santa Rosa, Brisbane), as well as Brookline, Massachusetts. Several other cities are reportedly considering implementing similar policies.[33] New York City aims to end the use of fossil fuels in large building systems by 2040, with mandatory carbon intensity limits for existing buildings beginning in 2024[34]
  - Some U.S states, including New York and California, are actively pursuing the electrification of heating and hot water equipment in both the residential and commercial building sectors. According to the report, "Toward a Clean Energy Future: A Strategic Outlook 2020-2023" from the New York State Energy Research and Development Authority (NYSERDA), NYSERDA has included the electrification of buildings as one of the focuses of its strategy for becoming a carbon-free electricity system by 2040 and eventually a carbon-neutral economy.[35]
- *Stringent building codes* that may cause builders to pick whether the home has a gas or an electricity connection, as it would be too expensive to pick both.
- *Incentives for low carbon/electric technologies* the IESO/electric LDCs and the green stimulus fund may shift the market away from gas and towards electricity. There may also be incentives for net zero homes from the Canadian Infrastructure Bank. Incentives from the federal government may be available soon, as the federal plan includes provisions for providing grants for home energy improvements starting in 2021 and mentions working to increase the uptake of low emission space and water heating equipment. Financial incentives may not be sufficient to significantly affect consumer choice but could be effective if combined with consumer and HVAC contractor education campaigns and other efforts to address non-price barriers to adopt electric technologies.

---

[33] https://rmi.org/fossil-gas-has-no-future-in-low-carbon-buildings/, https://sfgov.legistar.com/LegislationDetail.aspx?ID=4584221&GUID=1DA24E52-38A0-4249-9396-270D0E9353BB , https://durkan.seattle.gov/2020/12/mayor-durkan-announces-ban-on-fossil-fuels-for-heating-in-new-construction-to-further-electrify-buildings-using-clean-energy/ , https://www.smartcitiesdive.com/news/san-jose-oakland-join-growing-list-of-california-cities-to-ban-natural-gas/591507/

[34] https://www1.nyc.gov/office-of-the-mayor/news/064-20/state-the-city-2020-mayor-de-blasio-blueprint-save-our-city#/0

[35] https://www.nyserda.ny.gov/About/Publications/Program%20Planning%20Status%20and%20Evaluation%20Reports/Strategic%20Outlook

Modelling Approach

A two-pronged approach was used to model the non-price driven fuel switching CD. The two levers used to reflect a decrease in gas use were:

- *Accounts:* It would not be economical for new buildings to connect to the gas system if space and water heating loads were not met by gas.
- *Fuel Share:* For existing homes that had multiple end-uses supplied by natural gas, we assumed that they remained connected to the gas system even if water heating and/or space heating end-uses were switched off gas because they may still use gas for cooking, fireplaces or BBQs. While some customers may have decided to disconnect from the gas system if they switched to a heat pump, we assumed that it was valuable for Enbridge Gas to explore the impacts to annual volumes and peaks due to reductions in gas use rather than changes in accounts. Hence, we proposed to use fuel shares as the mechanism to model changes in gas demand in existing accounts when switching away from gas. To explore potential disconnections of existing totals in response to electrification of specific end-uses, we would require much more granular survey data regarding end-use saturation by building type and the presence of other end-uses.

Method for Developing Modelling Assumptions

To establish the modelling assumptions for fuel share changes, we applied a turnover rate based on average equipment lifetimes for space and water heating[36] to the average 2019 gas fuel share for the space and water heating end-uses in residential and commercial models. We applied the turnover rate starting in 2026 with the assumption that equipment was replaced with non-gas fueled appliances. Details of this analysis are in an Excel workbook called "ETSA – non-price fuel switch assumptions estimation."

The baseline residential fuel shares for space and water heating were from Enbridge Gas' 2019 residential end-use study. The commercial figures were estimates back-calculated from the 2019 APS by comparing electricity and gas consumption for a given end-use.

[36] Assumed lifetimes for gas equipment are 18 years for space heating equipment and 12 years for water heating equipment.

Tab 3

Staff Working Paper/Document de travail du personnel—2023-27

Last updated: May 29, 2023

An Investigation into the Effects of Border Carbon Adjustments on the Canadian Economy

by Y.-H. Henry Chen,[1] Hossein Jebeli,[2] Craig Johnston,[2] Sergey Paltsev[1] and Marie-Christine Tremblay[2]

[1]Massachusetts Institute of Technology

[2]Financial Stability Department, Bank of Canada

*Corresponding author: hosj@bankofcanada.ca

DOI: https://doi.org/10.34989/swp-2023-27 | **ISSN** 1701-9397

Acknowledgements

We are grateful for comments and suggestions from Madanmohan Gosh, Miguel Molico Nicholas Rivers, and comments received from participants of the 2022 Canadian Economics Association Annual Meeting and the 2022 Bank of Canada Annual Conference. All remaining errors are our own. The views presented in this paper are those of the authors and do not represent the Bank of Canada's position.

Abstract

This paper examines how border carbon adjustments (BCAs) may address the unintended consequences of uncoordinated global climate action, focusing on the economic implications for Canada. We investigate these implications under different BCA design features and by considering a coalition of countries and regions that adopt BCAs. We find that BCAs, in the form of import tariffs, reduce Canada's carbon leakage to the rest of the world and improve its domestic and foreign competitiveness when Canada is part of a coalition of countries and regions that implement BCAs that includes the United States. We show that these results may change if Canada imposes BCAs on a different set of sectors than the rest of the coalition or includes export rebates and free emissions allowances to firms. When the United States is not part of the coalition, we show that Canada's carbon leakage increases, domestic competitiveness dampens and foreign competitiveness improves. Compared with a case where no countries have BCAs, welfare improves in Canada if revenues from BCAs, in the form of import tariffs, are transferred to households. This finding holds regardless of the United States' participation in the coalition.

Topics: Climate change; International topics; Trade integration
JEL codes: C68, F1, H2, Q5, Q37

Résumé

Notre étude examine comment les ajustements carbone aux frontières peuvent pallier les conséquences imprévues d'une action pour le climat non coordonnée à l'échelle mondiale, plus particulièrement les incidences économiques pour le Canada. Nous étudions ces effets en fonction de diverses caractéristiques des ajustements carbone et en tenant compte d'une coalition de pays et de régions les adoptant. Nous constatons que les ajustements carbone aux frontières, sous la forme de droits de douane, réduisent les fuites de carbone du Canada vers le reste du monde et améliorent la compétitivité intérieure et étrangère du Canada lorsqu'il fait partie d'une coalition de pays et régions comprenant les États-Unis qui mettent en œuvre ce type d'ajustements. Nous démontrons que les résultats peuvent changer si le Canada impose des ajustements carbone dans un ensemble de secteurs différents de ceux du reste de la coalition, ou s'il inclut des ristournes d'exportation et des allocations gratuites d'unités d'émission aux entreprises. Nous montrons que lorsque les États-Unis ne font pas partie de la coalition, les fuites de carbone du Canada augmentent, la compétitivité intérieure diminue et la compétitivité étrangère s'améliore. Si l'on compare avec une situation où aucun pays n'a de mécanisme d'ajustement carbone aux frontières, le bien-être s'accroît au Canada si les revenus découlant de ces mesures, sous la forme de droits de douane, sont transférés aux ménages. Cette conclusion reste valide peu importe si les États-Unis font partie ou non de la coalition.

Sujets : Changements climatiques; Intégration des échanges; Questions internationales
Codes JEL : C68, F1, H2, Q5, Q37

1. Introduction

In 2015, 196 countries around the world adopted the Paris Agreement with a goal to limit global warming to well below 2 degrees Celsius, and preferably to 1.5 degrees Celsius, compared to pre-industrial levels (UN 2015). Under the Paris Agreement, countries are expected to pledge climate action and submit their plans as National Determined Contributions (NDCs) every five years to the secretariat of the United Nations Framework Convention on Climate Change (UNFCC). As of late 2022, 166 countries have submitted new or updated NDCs, covering an estimated 94.9% of the total global emissions in 2019 (UNFCCC 2022).

The NDCs are based on an approach whereby individual countries pledge their climate actions at the domestic level.[1] These pledges create variations in climate policy across countries, including in terms of policy ambition (e.g., reflected in differences in emission reduction levels or the corresponding carbon prices) and sectoral coverage. A key implication of this is an uneven global playing field, leading to an erosion of the global competitiveness of sectors in countries implementing more stringent climate actions. Another implication, key for climate change, is carbon leakage—namely when climate policies in a country may cause increases in emissions in countries with weaker policies.[2]

Border Carbon Adjustments (BCAs) have been proposed as a mechanism to mitigate the drawbacks from global policy fragmentation. BCAs are intended to complement existing domestic climate policies by allowing countries to pursue and achieve their climate targets while limiting carbon leakage and the erosion of global competitiveness resulting from countries pursuing less stringent climate policies. BCAs may take the form of an import charge and sometimes rebates on exports. In the case of an import charge, BCAs may include a charge on imported goods, typically reflecting the difference in carbon pricing between trading partners and considering the emission intensity of the imported good. In the case of export rebates, domestic sectors exposed to carbon pricing in the home country may receive a financial transfer to preserve their global competitiveness. Likewise, export rebates can be calculated based on the regional differences in carbon pricing and reflecting the emissions intensities of the exported goods.

There is increasing momentum around the use of BCAs as countries move forward with the implementation of their domestic climate policy frameworks. For example, the Government of Canada initiated public consultations exploring the use of BCAs for a variety of fossil fuel and emissions-intensive trade-exposed (EITE) sectors, which account for more than 70% of Canada's exports.[3] Similarly, the European Union (EU) has recently started to implement BCAs across a subset of EITE sectors.[4]

Against this backstop, this paper examines the role played by BCAs in addressing the unintended consequences associated with uncoordinated global climate action. The analysis focuses on Canada-

[1] For instance, Canada's latest NDC pledge is to cut its emissions by 40% to 45% below 2005 levels by 2030, with an additional commitment to achieve net-zero emissions by 2050.
[2] See Paltsev, 2001, and Babiker, 2005.
[3] These sectors include oil and gas, mining, food and beverage, wood, pulp and paper, chemicals, petroleum and coal products, motor vehicles and parts, primary and fabricated metals, plastic and rubber products, aerospace products and parts, non-metallic mineral products, and transportation of natural gas (Government of Canada 2021).
[4] Council of the European Union, 2022.

specific implications on carbon leakage, domestic and foreign competitiveness (measured as changes in market shares), and welfare (measured as changes in equivalent variation[5]). We investigate these implications under different BCA design features and in consideration of the countries adopting BCAs. To help frame country participation, and consistent with related papers in the literature, we take a coalition versus non-coalition approach.[6] The coalition represents a group of countries pursuing and achieving their climate actions as set out under their respective NDCs. In this paper the coalition comprises Canada, the United States, the EU, Japan, Korea, and Mexico. The non-coalition represents a group of countries assumed to not achieve their NDCs, though they follow their policies and measures in place in 2022 (i.e., their baseline path). This framework also enables us to analyze the implications for Canada when its major trading partner, the US, is not in the coalition. The role of BCAs on the Canadian economy is indeed heavily dependent on whether BCAs are applied in the US, and the degree with which the US pursues climate action.[7]

This paper offers the following contributions to the literature. First, it provides a quantification of Canadian economic impacts resulting from BCAs. Focusing on a country like Canada helps shed light on the role played by the carbon content of a country's traded goods, the role these play in domestic production supply chains, and who the country trades with. Second, the paper considers different BCA design features and the interaction of BCAs with other policies that may also play a role in addressing carbon leakage and competitiveness matters. Specifically, our analysis accounts for the impact of existing regimes in Canada and the EU that are offering free allowances (compliance credits at no charge) to firms to assist them in meeting their greenhouse gas (GHG) emissions limits.

We find that when Canada is part of a broad coalition of BCA-implementing countries, including the US, BCAs, in the form of import tariffs, reduce Canada's carbon leakage and improve its domestic and foreign competitiveness. In addition, when the import tariff revenues are transferred to households, BCAs are welfare improving. We show that these results may differ when the BCA scheme considers differences in sectoral coverage, the addition of export rebates, and Canada's existing regime of free allowances to firms through the output-based pricing system. When the US is not part of the coalition, we show that Canada's carbon leakage increases. While domestic competitiveness is dampened, we show improvements in foreign competitiveness. Independent of whether the US participates in the coalition, the analysis finds that BCAs (only in the form of import tariffs, not export rebates) are welfare improving for Canada in comparison to the case where there are no BCAs.

While important, several challenges were not considered in the present analysis. With regard to compliance with the World Trade Organization (WTO), trade between countries will be exposed to different levels of adjustments, creating concerns BCAs could be in violation of the non-discrimination clause. However, some have argued that since a common mechanism would be used in determining

[5] Economic welfare impacts are reported as Hicksian equivalent variation in income, which denotes the amount necessary to add to (or subtract from) the benchmark income of the representative consumer so that she enjoys a utility level equal to the one in the counterfactual policy scenario on the basis of ex-ante relative prices.
[6] See Bellora and Fontagne, 2022.
[7] About 56% of Canada's imports in EITE sectors in 2020 come from the US (based on the authors calculations from the MIT-EPPA model, described in the following section).

these adjustments, varying BCAs by trading partner might not, on its own, violate this principal (Bellora & Fontagne 2022). Yet other aspects of BCA design create WTO compliance concerns, including discrimination based on foreign countries' emissions intensities, ensuring BCAs reflect the full spectrum of climate change mitigation policies beyond just carbon prices, the redistribution of revenues generated by BCAs, and concerns over the potential rebates to industry.

Beyond the WTO, there are additional challenges to the implementation of BCAs. For one, the introduction of BCAs could trigger retaliation by relevant trading partners, confounding the economic impacts. In Canada, questions remain whether BCAs would be compliant with existing free trade agreements, including the United States-Mexico-Canada Agreement (USMCA).[8] In addition, Canadian provinces have led the development of carbon pricing schemes, and imposing additional tariffs as a BCA measure at the federal level would be another challenge (Cosbey et al. 2021).[9] Conscious of the many limitations of implementing BCAs, this paper focuses on a set of illustrative scenarios intended to shed light on their potential economic impacts in Canada.

The paper is organized as follows. Section 2 reviews the research related to BCAs. Section 3 outlines the modelling framework used in this study. This section also provides a detailed description of how embodied emissions, BCAs, carbon leakage, and competitiveness are calculated, as well as an overview of the scenarios considered for the analysis. Section 4 presents the results of our analysis, considering various BCA design features (sectoral coverage, export rebates, interaction of BCAs with free allowances) as well as the implications for when the US is out of the coalition. Concluding remarks follow.

2. Relevant research

The literature examining BCAs has focused on carbon leakage, international competitiveness, and economic efficiency and welfare.[10] In terms of carbon leakage, the literature argues for two main channels. The first is the competitiveness channel, where carbon-intensive sectors reduce their domestic production because of higher operating costs associated with domestic climate policies, while production by sectors in countries facing less stringent climate policies increases, thereby increasing their emissions. The second is the fossil fuel price channel, where the decreased demand for fossil fuels

[8] Lilly et al., 2022 shows that while a carefully designed Canadian BCA could be both WTO-legal and permissible under Canada's major trade agreements, serious political and economic challenges are likely to arise.

[9] In addition, our study is silent on some of the macroeconomic implications of imposing BCAs, such as changes in exchange rates. This is examined in McKibbin et al., 2018.

[10] Our results are generally aligned with what is found in the literature at the global level. First, BCAs can improve global cost-effectiveness by partially transferring carbon pricing via trade flows to trading partners without emissions pricing policies. However, the magnitude of the efficiency gains may be limited due to the small fraction of emissions abroad (those that are imported in covered goods) that can be targeted, and foreign EITE industries may also reroute part of their exports to other non-regulated markets (Bohringer et al. 2012). Furthermore, the impact of BCAs on economic welfare has been investigated, with Winchester (2017) arguing that US welfare is lower when it met its Paris pledge as compared to when it faced BCAs but did not regulate GHG emissions—concluding that BCAs will not be effective in enforcing climate commitments in the US. Import adjustments on embodied carbon applied by richer, industrialized countries may also shift some of the burden of emissions pricing to poorer, developing countries. Such equity concerns can be addressed by returning the revenue from carbon import adjustments to paying countries or using it for technology transfer and international climate finance (Bohringer et al. 2022).

driven by abating countries puts downward pressure on the price of fossil fuels in world markets, which further increases their use and emissions in countries with less stringent climate policies. The consensus in the literature is that BCAs are moderately successful at reducing carbon leakage (Winchester et al. 2011).[11]

Studies that have looked at the competitiveness dimensions of BCAs generally find that BCAs modestly impact production losses or market share of domestic EITE sectors in favour of countries with weaker climate policies (Bohringer et al. 2012, Fouré et al. 2016). Several analyses using computable general equilibrium models have shown that significant output losses occur in energy-intensive sectors when a domestic climate policy is enacted (e.g., cap-and-trade or carbon price), and that BCAs are insufficient to counteract the impacts of the other policies (Burniaux et al. 2010; Mattoo et al. 2009, Winchester et al. 2011). Burniaux et al. (2010) attributes this to the fact that energy-intensive industries are affected primarily by the contraction of the overall market size that comes from carbon pricing, rather than by losses accruing to the international competitiveness channels. Similarly, Aldy and Pizer (2015) argue that most domestic production loss stems from energy price increases and reduced overall consumption rather than the loss of competitiveness in its product markets. Monjon and Quirion (2011) analyzed European climate policy and found that a decrease in EU production of energy-intensive products can be expected, but mainly due to a reduction in European demand rather than a shrinking global market share.

The efficacy of the EU's BCA scheme has been analyzed in Bellora and Fontagne (2022). Using a dynamic general equilibrium model, the authors simulate various BCA schemes consistent with the EU's proposed plan that covers non-fossil-fuel emissions-intensive sectors. The authors find the proposed plan is effective in reducing carbon leakage, but only partially effective in mitigating competitiveness losses. The authors argue that BCAs push up the domestic price of carbon, leading to increased prices for intermediate products used in downstream sectors. The authors further investigate the impacts of the design of BCAs as they relate to WTO rules and find that, while BCAs are most effective when constructed to discriminate against export markets, they indeed run the risk of violating WTO rules.

3. Modelling framework

3.1 General equilibrium model

We employ the MIT Economic Projection and Policy Analysis model (the MIT-EPPA model), which is a recursive-dynamic general equilibrium model representing the world's economy across several

[11] The 29th study by the Energy Modeling Forum (EMF), which considers a 20% emissions reduction in the industrialized world (countries listed in Annex 1 of the Kyoto Agreement), found that the BCAs for EITE industries reduce leakage rates by about one-third (Bohringer et al. 2012). In the reference scenario in Bohringer et al. (2012), leakage rates range between 5% and 19% with a mean value across all models of 12%. BCA is effective in reducing leakage. Leakage rates under BCA range between 2% and 12% with a mean value of 8%. Thus, the carbon-based import tariffs and export rebates to EITE products reduce the leakage rate on average by a third compared to the reference scenario with uniform emission pricing only. Analysing 25 studies, Branger and Quirion (2014) show that in the majority of the cases, the leakage ratio reduction due to BCAs stands between 1 and 15 percentage points. Their meta-regression analysis shows that all parameters being constant in the meta-regression analysis, the ratio drops by 6 percentage points with the implementation of BCAs.

countries/regions and sectors relevant for the consideration of climate policy design and BCAs (Chen et al. 2022a). An important characteristic of the MIT-EPPA model is the representation of links among sectors through each firm's use of domestic and imported intermediate inputs. Purchases of intermediate inputs are captured in input-output tables calibrated in the base year to aggregated data from the Global Trade Analysis Projection dataset (Aguiar et al. 2019). For each sector, these tables list the value of output produced and the value of each input used, which can be linked to physical quantities (e.g., tonnes of coal).[12] Further details on the MIT-EPPA model can be found in Appendix A, including the regional and sectoral representations used in this paper.

For the assessment of BCA impacts, we enhance the MIT-EPPA model in several dimensions. First, we disaggregate the energy-intensive sector in the MIT-EPPA7 model into three subsectors (i.e., iron and steel, cement, and other energy-intensive industries). Second, we use dynamic emission intensities in calculating embodied emissions. Third, the model now treats oil as a heterogenous globally traded commodity. Finally, we introduce a representation of BCAs in the form of import charges and export rebates.[13] The following subsections expand further upon some of the key assumptions and calculations in our analysis of BCAs, with additional information on the MIT-EPPA model provided in Appendix A.

3.2 Embodied emissions

Embodied emissions, which are important for the analysis of BCAs, refer to the total life cycle emissions associated with the production of a good. One can think of this as representing both the emissions directly associated with the production of end products plus any emissions passed through the supply chain. The ability for the MIT-EPPA model to capture links across sectors enables a detailed tracking of both direct and indirect emissions embodied within end products. Embodied emissions are therefore a function of the direct emissions and indirect emissions of producing a good, given as:

$$e_i^r = d_i^r + \sum\nolimits_j e_j^r \cdot \alpha_{ij}^r \cdot \delta_j^r$$

where e_i^r is the embodied emissions in good *i* produced in region *r*. The first term on the right-hand side is the direct emissions of production of good *i* in region *r*, given as d_i^r. The second term on the right-hand side is the indirect emissions embodied in input *j* used to produce good *i*, where α_{ij}^r refers to the input j per unit of good i, and δ_j^r is the share of j sourced domestically. Re-arranging this equation allows one to solve a system of n equations with n unknowns e_i^r:

$$e_i^r \cdot (1 - \alpha_{ii}^r \cdot \delta_i^r) - \sum\nolimits_{j \neq i} e_j^r \cdot \alpha_{ij}^r \cdot \delta_j^r = d_i^r$$

3.3 Border carbon adjustments

BCAs primarily take the form of import tariffs, and sometimes rebates on exports. In the case of import tariffs, BCAs may include a charge on imported goods based on their emissions intensity or embodied emissions. The import tariff is represented as an ad valorem tariff, calculated as follows:

[12] For example, the coal power sector will use inputs of capital and labour and outputs from the coal mining sector along with other intermediate inputs to produce electricity.

[13] More details of these changes will be presented in subsections 3.2-3.3.

$$\tau_i^d = \frac{(CP^d - CP^o) \times e_i^o}{p_i^o}$$

where CP^d and CP^o are the carbon prices in the importing and exporting region, respectively, e_i^o is the tonnes of carbon dioxide (CO_2) emissions embodied in each unit of good *i* in the exporting country, and p_i^o is the unit price of good *i* exported from region *o* to region *d*. Carbon prices in the model are represented by shadow prices. These prices are calculated endogenously in the model and represent what could be a broad range of climate policy actions needed to meet the emission reduction targets specified for each region/country.

In the case of export rebates, domestic sectors exposed to carbon pricing in the home country may receive a financial transfer to preserve their global competitiveness. When export rebates are considered in this paper, the export rebate is calculated as follows:

$$R_i^o = \frac{(CP^o - CP^d) \times e_i^o}{p_i^o}$$

Some of the import tariff rates and export rebates calculated based on these definitions are presented in Figure 9 and Figure 10 in Appendix B.

3.4 Carbon leakage and competitiveness definitions

Carbon leakage is defined as the amount of domestic emission reductions that gets offset by the increases in emissions abroad. To measure carbon leakage, one can compare emissions changes in the non-coalition countries with those in the coalition countries as follows:

$$Carbon\ leakage\ rate = \frac{Emissions_{NCOA}^{policy} - Emissions_{NCOA}^{baseline}}{|Emissions_{COA}^{policy} - Emissions_{COA}^{baseline}|} \times 100$$

where COA refers to coalition countries, NCOA refers to non-coalition countries, baseline refers to the baseline scenario, and policy refers to scenarios where at least some countries pursue more ambitious climate policy as compared to the baseline (NDCs for COA and baseline for NCOA). The denominator is represented as an absolute number to represent leakage based on how much non-coalition countries emissions change given the reduction in emissions in coalition countries. For example, an 8% leakage ratio implies that 8% of the emissions reduction achieved in coalition countries is offset through increased emissions in non-coalition countries.

In this study, foreign competitiveness is defined as the change in a country's export market share in total global exports. Domestic competitiveness in turn is measured for each sector *i* and is calculated as follows:

$$Domestic\ market\ share_i = \frac{Production_i - Exports_i}{Domestic\ supply_i}$$

where we have:

$$Domestic\ supply_i = Production_i - Exports_i + Imports_i$$

3.5 Free emissions allowances

Other climate policy measures, including in the EU and Canada, are also aimed at addressing the potential for carbon leakage and competitiveness loss associated with the relative stringency of their climate policies. The scenarios constructed as part of this analysis were developed considering the role of such policies, namely, the role of free allowances.

To safeguard the competitiveness of industries covered by the EU's Emissions Trading System (ETS), industrial facilities deemed to be exposed to significant risk of carbon leakage receive a higher share of free allowances compared to other industrial facilities. One of the main components of the EU's Carbon Border Adjustment Mechanism (CBAM) is the progressive phasing out of free allowances under the ETS over a ten-year period.[14] As of 2026, when the CBAM will come into effect, free allocations to European emitters will be gradually reduced by 10% per year, with the system fully replacing the free allowances by 2036. As stated by the European Commission, the CBAM is an alternative to free allocation, and as such the two measures should not overlap.[15]

In Canada's federal output-based pricing system (OBPS), registered industrial facilities are exempt from the carbon pricing scheme for fuel purchases but are required to pay for the portion of their emissions that exceed their annual facility GHG emissions limit.[16] Specifically, the OBPS establishes emission intensity performance standards for regulated industries, and using those standards, GHG emission limits are calculated for facilities based on their annual economic production. Facilities are issued compliance credits up to their annual GHG emissions limits at no charge. Facilities that exceed their annual limit may purchase additional compliance credits from facilities with surplus credits, acquire verified offset credits from elsewhere (e.g., verified GHG mitigation projects in other jurisdictions or non-regulated sectors), or purchase compliance credits from the government. Over time, stringency

---

[14] The CBAM was applied from 1 January 2023 with a transitional period until the end of 2026, and European Parliament believes it must be fully implemented for the above-listed sectors of the EU ETS by 2032. Sectors that are included under EU's ETS phase 3 (2013–20) are power stations, oil refineries, coke ovens, iron and steel plants, cement clinker, glass, lime, bricks, ceramics, pulp, paper and board, aluminium, petrochemicals, ammonia nitric, adipic and glyoxylic acid production, CO_2 capture, transport in pipelines and geological storage of CO_2, and aviation. For more details see EU ETS Handbook. The corresponding sectors in the EPPA model that receive the free allowances are iron and steel, cement, other energy-intensive industries, and electricity. Sectors that are included under CBAM are iron and steel, cement, fertilizer, aluminium, electricity generation, organic chemicals, plastics, hydrogen, and ammonia. For more details see European Commissions documentation on CBAM.

[15] https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542

[16] Under the OBPS that is designed for industrial emitters with GHG emissions of 50,000 tonnes CO_2e or greater, a facility's annual emission limit would be calculated by multiplying the facility's total annual production by the applicable emission intensity performance standards for its activities. Each facility would pay for any GHG emissions that exceed its limit at a rate of \$10 per tonne of CO_2e in 2018, rising by \$10 per year, up to \$50 per tonne of CO_2e in 2022. Sectors covered under the OBPS include oil and gas production, mineral processing, chemicals, pharmaceuticals, iron and steel, mining and ore processing, lime and nitrogen fertilizers, food processing, pulp and paper, automotive, electricity generation, and cement. For each of these sectors a benchmark emission intensity is specified in the policy, which can be found in Canada's Output-Based Pricing System Regulations (see Government of Canada 2019). These sectors correspond to the following sectors in the EPPA: oil and gas, cement, iron and steel, other energy-intensive industries, other manufacturing industries, food, and electricity.

levels can be increased by adjusting emission intensity performance standards to allow for fewer GHG emissions per unit of production and by increasing the price of compliance credits.[17]

3.6 Scenarios

To examine the effects of BCAs on the Canadian economy, we take a coalition versus non-coalition approach, where coalition countries represent a group of countries that are assumed to pursue and achieve their climate ambitions as set out under their respective NDCs. The non-coalition countries are assumed to follow current policies in place in 2022 as outlined under stated and current policies and targets.[18] The time horizon chosen for this study is until 2030. We select this time horizon given our interest in examining the contemporaneous impacts of BCAs on key indicators. Also, the NDCs generally cover this period.

To determine coalition countries, we follow Bellora and Fontagne's (2022) approach in assuming that countries with existing and mature domestic carbon pricing schemes are credible in their efforts to achieve their climate objectives as outlined in their NDCs. Based on the Carbon Pricing Dashboard developed by the World Bank, 18 countries and regions had national carbon pricing systems in 2021: Argentina, Canada, Chile, Colombia, the EU, Iceland, Japan, Kazakhstan, Korea, Mexico, Montenegro, New Zealand, Norway, Singapore, South Africa, Switzerland, United Kingdom, and Ukraine. Of these countries, Canada, the EU, Japan, Korea, and Mexico are distinct regions in the MIT-EPPA model (see Figure 8 in Appendix A). As such, these countries and regions are retained in our analysis. Further, to draw attention of the role played by Canada's main trading partner, the US, we first assume that the US is in the coalition. This assumption will be relaxed, enabling the comparison of results when the US is out of the coalition.[19]

We developed three main scenarios, which are outlined in Table 1. Under the first scenario, the *baseline scenario*, emission targets are aligned with the current climate policies for all countries/regions, though they are considered insufficient to achieve the emission reduction targets. In the second scenario, the *uncoordinated scenario*, coalition countries/regions pursue and achieve their NDCs,[20] while the non-coalition countries/regions continue along their baseline path. Contrasting the uncoordinated and baseline scenarios allows us to shed light on the consequences of a lack of global climate policy coordination.

[17] While such allowance systems allow domestic carbon-pricing schemes to both change relative prices and incentivize decarbonization, they alleviate the economic pressures on carbon-intensive industries, mitigating the consequences of the domestic policy design.
[18] Renewable shares are one of these targets, which are plotted in Figure 11 in Appendix C for some of the regions.
[19] For results related to the consequences of unilateral policy design and the number of countries implementing emissions reduction commitments, see Reinaud 2008, Bohringer et al. 2012.
[20] The emission targets of the coalition countries/regions under NDC are outlined in Table 6 in Appendix C.

Table 1 Scenario description

Scenarios	Coalition	Non-coalition	BCA design	BCA imposed	Free allowances	Sectoral coverage
1) Baseline	Baseline	Baseline	-	-	No	-
2) Uncoordinated	NDC	Baseline	-	-	No	-
2a) Uncoordinated with allowances	NDC	Baseline	-	-	Yes	-
3) Allowances + BCA (partial coverage | tariffs only)	NDC	Baseline	Imp tariff	Coalition	Yes	Partial

Coalition = Canada, US, EU, Japan, Korea, and Mexico
Non-coalition = all other countries
NDCs = nationally determined contributions
Baseline = current policies
Full = sectoral coverage refers to cement, coal, food, gas, iron and steel, oil, other energy-intensive sectors, other manufacturing sectors, and refined oil
Partial = sectoral coverage excludes fossil fuels and only includes cement, iron and steel, other energy-intensive sectors, and other manufacturing sectors

We also consider another version of the *uncoordinated scenario* that examines the implications of free allowances, introduced in section 3.5. Building on the *uncoordinated scenario*, the *uncoordinated with allowances scenario* (Scenario 2a in Table 1) assumes that specific sectors in Canada and the EU receive free allowances according to a constant portion of what they pay under the respective carbon pricing schemes. To determine what fraction of facilities receive these free allowances, we examined data from the EU's ETS and Canada's OBPS. In the case of the EU, over the period 2013–20, 57% of the allowances on the ETS were auctioned, while the remaining 43% were freely allocated to sectors deemed to be exposed to a risk of carbon leakage.[21] Based on this information, when considering scenarios that include free allowances, we assume in the MIT EPPA model that the EU's sectors that are regulated under the ETS receive free allowances equivalent to 43% of their carbon price costs.[22] For Canada, based on facility-level 2019 emissions data, 32% of Canadian emissions were on average from facilities emitting GHG emissions of 50,000 tonnes CO_2e or greater per year and fell under the OBPS.[23] We assume these Canadian facilities receive free allowances equivalent to 32% of their carbon price costs.[24]

[21] See Bellora and Fontagne 2022.
[22] For the EU, these sectors are iron and steel, cement, other energy-intensive industries, and electricity generation. For Canada, these sectors correspond to oil and gas, cement, iron and steel, other energy-intensive sectors, other manufacturing sectors, food, and electricity.
[23] To calculate this number we leveraged the facility-reported greenhouse gas data and provinces' total GHG emissions from National GHG inventory reports. Considering jurisdictions that either have their own OBPS, a cap-and-trade system, or fall under the federal OBPS system, in 2019, on average, 32% of Canada's total GHG falls under this system.
[24] This assumes that the OBPS emission intensity benchmark for each sector is the same as the average emission intensity of the sector in the model. In addition, total payment of the firms that have emission intensity higher than the sector's benchmark is equal to what the firms who are below the benchmark receive in that sector, resulting in no payment by sector in total. Since the MIT-EPPA model is at the sector level, we cannot model the heterogeneity within sectors in this paper to study the effects of the OBPS with more accuracy. Therefore, we assume that a representative firm of a sector included in the OBPS and the EU's ETS receives a fraction of what it pays under carbon pricing, and that fraction is the same as the share of emissions that fall under the OBPS. This means sector *i*, which is included in the OBPS and the EU's ETS, receives $R_i = \beta \times CP \times e_i$, where β is the fraction of emissions that fall

Under the third scenario, coalition countries/regions impose BCAs on imports from the non-coalition countries/regions. We call this third scenario the *Allowances + BCA (partial | tariffs only) scenario.* In this scenario, BCAs take the form of import tariffs (no export rebates) and are imposed on a partial set of emissions-intensive sectors (i.e., cement, iron and steel, other energy-intensive sectors, and other manufacturing sectors). We first study the case where BCAs are imposed on only this partial set of EITE sectors. The *Allowances + BCA (partial | tariffs only) scenario* also assumes the inclusion of free allowances. Finally, under all scenarios, revenues raised from imposing BCAs (from the import tariffs) are redistributed back to households via lump-sum transfers.[25] Given our interest in examining whether the design of the BCA scheme matters, we later explore the effects of expanding sectoral coverage, adding export rebates on top of import tariffs, and the interplay of free allowances and BCAs.

4. Results

4.1. Impacts on carbon leakage, competitiveness, and welfare

Table 2 shows the cumulative impacts on carbon leakage, domestic and foreign competitiveness, and welfare (measured as changes in equivalent variation) of the different scenarios over the 2020–30 period and relative to the baseline. Under the *uncoordinated scenario*, around 6.1% of Canada's emission reductions are offset by increases in emissions outside of Canada.[26] In addition, Canadian producers lose 0.43 percentage points of their domestic market share and 0.05 percentage points of their foreign market share due to the stricter climate policies that they face. This scenario also shows that welfare declines by 0.67 percentage points.

under these policies, CP is national carbon price, and e_i is the emission level of the sector (which is a function of its production level).

[25] BCA revenues can also be used to reduce distortionary taxes (McKibbin et al. 2018). Allocation of BCA revenues to the exporting countries is another option that can avoid shifting the burden of BCAs to developing countries (Bohringer et al. 2012; Fischer and Fox 2012). In fact, returning the BCA revenue to the paying countries or using it for technology transfer and international climate finance would likely improve a BCA regime's chance of success in meeting GATT's exception requirements by helping to demonstrate the BCA's environmental objectives (Cosbey et al. 2019, Bohringer et al. 2022). In this study, given the model limitations in terms of labour or capital distortionary taxes and to avoid implications of international transfers, we assume revenues raised from the import tariffs are redistributed back to households via lump-sum transfers.

[26] In this study, since countries/regions are constrained to reach their emission targets in 2030, emission variations are expected to be lower than those studies that do not impose constraints on emissions. For example, see Ecofiscal Commission (2016), which calculates Canada's leakage rate to be around 20%.

Table 2 Cumulative impacts over the 2020–30 period relative to baseline

Scenarios	**Carbon leakage rate** (percentage)	**Domestic market share** (percentage point change)	**Foreign market share** (percentage point change)	**Welfare** (percentage changes in equivalent variation)
2) Uncoordinated	6.10	-0.43	-0.05	-0.67
2a) Uncoordinated with allowances	4.38	0.12	-0.03	-0.78
3) Allowances + BCA (partial | tariffs only)	-1.07	0.52	0.04	-0.71

When introducing free allowances, Canada's carbon leakage is reduced from 6.1% to 4.38%. Free allowances also bring down the costs of production, improving competitiveness both domestically (0.55 percentage point change) and internationally, albeit at a lower level (only 0.02 percentage point change). Despite the introduction of free allowances, welfare declines further due to deadweight losses associated with this form of support.[27]

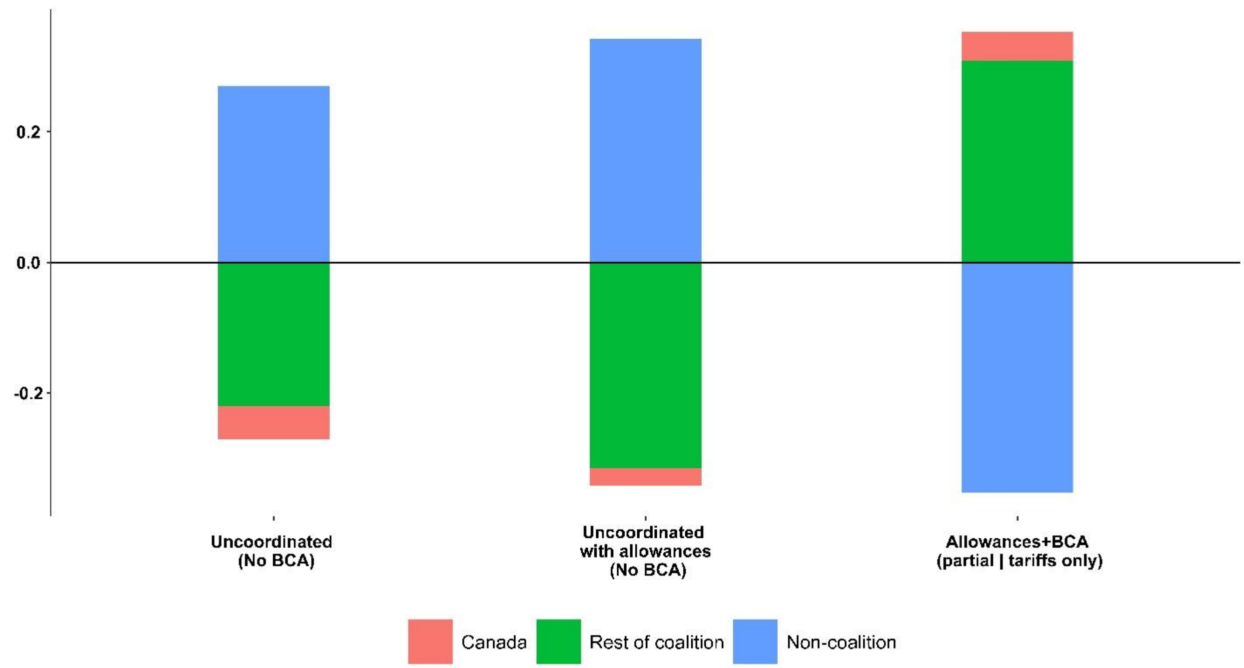
When BCAs are introduced on top of free allowances, we find that BCAs are effective in reducing carbon leakage from Canada to the rest of the world. Cumulative carbon leakage between 2020–30 might even become negative when BCAs are imposed, showing that non-coalition countries/regions might emit below their baseline under this scenario. Negative leakage is more likely when the elasticity of substitution between the good produced in the coalition countries/regions and the good produced in the non-coalition countries/regions is lower (as this reduces the terms-of-trade effect).[28] In terms of welfare changes, imposing BCAs on top of free allowances mitigates some of the welfare loss relative to the *uncoordinated scenario* (from -0.78 to -0.71 percentage change). Here, revenues from imposing BCAs, which are only in the form of import tariffs and returned to households, provide some compensation for losses due to higher prices (discussed below) resulting from the implementation of BCAs.

[27] This result is akin to the deadweight loss typically associated with production subsidies, namely the higher costs to government relative to the additional benefits accruing to consumers and producers.

[28] Negative leakage can also occur when the elasticity of substitution between clean inputs and fossil fuels is higher, as this increases the abatement resource effect. The abatement resource effect happens when increased demand for capital and labour to replace fossil fuels in carbon-taxed regions attracts factors of production from unregulated regions, which decreases unregulated output and ultimately emissions. For more explanation on negative leakage rates see Winchester and Rausch (2013). Given that in the EPPA model used in this study there is no capital and labour movement across countries, negative leakage ratios cannot be attributed to the abatement resource effect. Overall, negative leakage means non-coalition countries/regions might emit below their baseline after coalition countries/regions impose BCAs.

In terms of competitiveness, the results suggest that BCAs are effective in improving the domestic and foreign competitiveness of Canadian producers. Figure 1 shows the changes in average export market shares in the EITE sectors relative to the baseline under the three scenarios covered in Table 2. Under the *uncoordinated scenario*, coalition countries/regions (i.e., Canada, the EU, the US, Japan, Korea, and Mexico) lose market share due to their implementation of more stringent climate policies. While free allowances (introduced only in Canada and the EU) improve the average export market share for Canada, they are not as effective as BCAs in flipping this share in favour of the coalition. When BCAs are introduced on top of free allowances, Canada and the rest of the coalition gain export market shares and non-coalition countries/regions lose shares.

Figure 1 Average export market share changes in EITE sectors (2020–30) relative to the baseline scenario (percentage point change)



Another important implication of BCAs is the creation of a wedge between domestic prices and international prices. In the model, the sectoral price is the price that all producers in the economy pay for purchasing that sector’s output and is an Armington composition of domestic and import prices. As shown in Figure 2, the introduction of free allowances generally put downward pressure on sectoral prices (orange bars). Adding BCAs, however, mitigates some of the downward pressure on sectoral prices (blue bars), but only for those sectors covered by the import tariff (cement, iron and steel, other energy-intensive sectors, and other manufacturing sectors). Since Canada is a net importer in these four sectors, we find an increase in the sectoral prices due to BCAs.

Figure 2 Average sectoral price changes (2020–30) relative to the uncoordinated scenario (%)

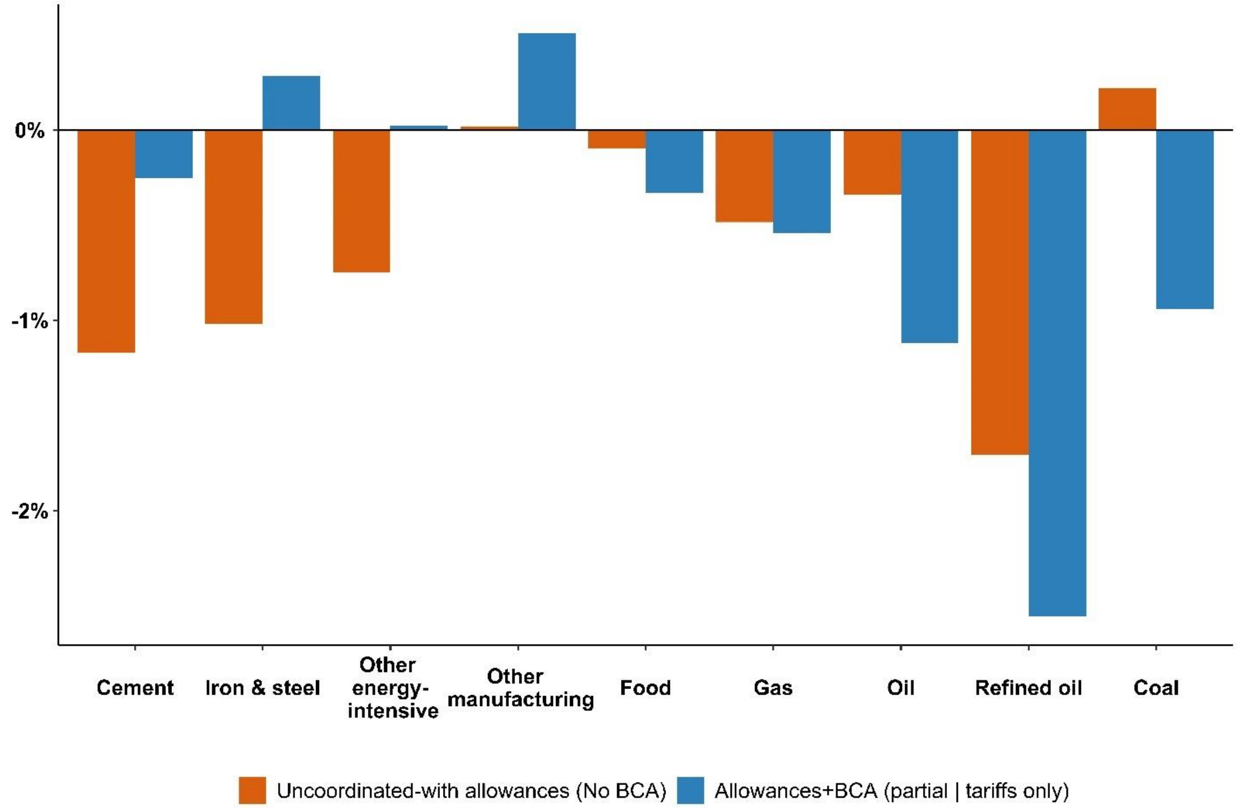
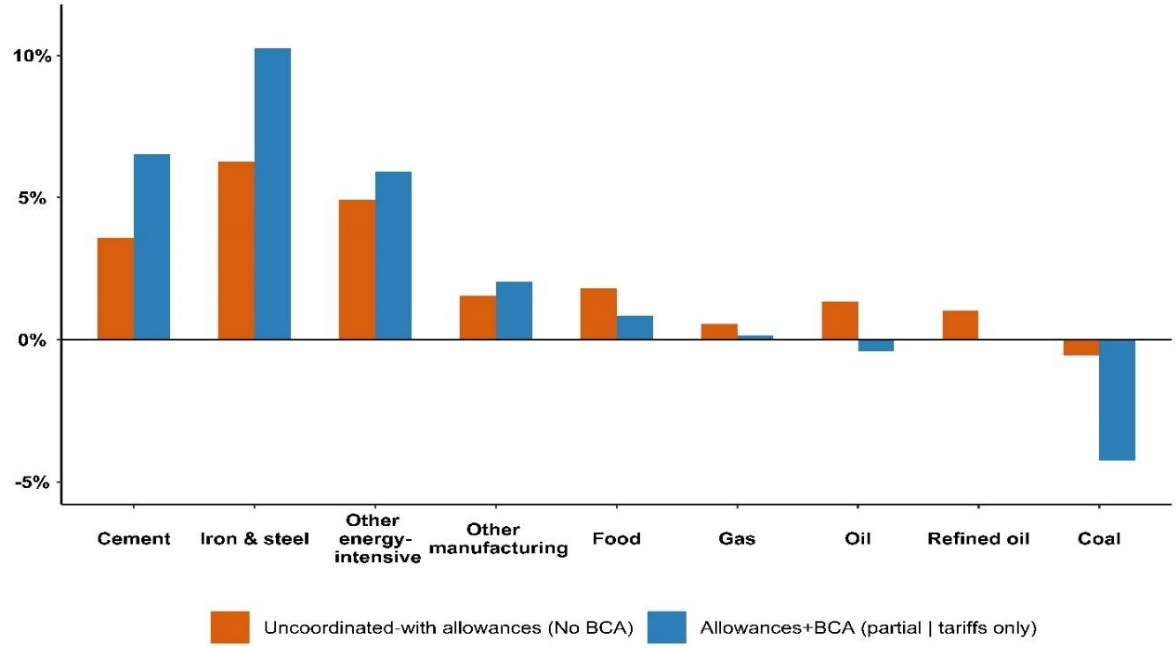


Figure 3 shows the positive financial impacts (defined as the difference between revenues and costs) for the cement, iron and steel, other energy-intensive sectors, and other manufacturing sectors. Producers benefit from higher prices for their output and higher domestic market shares because of the implementation of BCAs in the form of an import tariff.

Figure 3 Cumulative (2020–30) sectoral financial impacts relative to the uncoordinated scenario (%)



4.2. Does the design of BCAs matter?

To examine the design implications of BCAs, we consider the following features: 1) expanding the sectoral coverage to include fossil fuels and food sectors;[29] 2) adding export rebates (as defined in section 3.3) on top of import tariffs, with part of the revenues from the import tariffs now returned to EITE sectors; and 3) replacing free allowances with BCAs starting in 2020.[30] Table 3 summarizes the results associated with these additional design features. For ease of comparison, Table 3 also presents the previous relevant results, namely those related to the scenario considering the joint implementation of free allowances and BCAs, and when the later are in the form of import tariffs and applied to a partial set of sectors.[31]

First, expanding the sectoral coverage does not significantly change the effects of BCAs on carbon leakage (from -1.07 to -1.16 percentage point change). Part of the reason for this is because import tariffs are most relevant for sectors for which imports play a key role in the domestic economy—which in the Canadian context are those partial sectors (cement, iron and steel, other energy-intensive, and other manufacturing). In the case of fossil fuels, for example, Canada is a net exporter, and BCA import

[29] The food sector is an energy-intensive trade-exposed sector according to the Government of Canada (2021).
[30] As explained in section 3.3, the phasing out of free allowances is a scenario that is closer to what is proposed under initiatives like the CBAM. In fact, keeping free allowances while imposing import tariffs can be interpreted as double protection for domestic industries, raising challenges with WTO rules. It is for this reason that we consider the phasing out of the free allowances.
[31] We focused on scenarios shown in Table 3 to explain the effects of changing only one aspect of the policy design each time. Results from other scenarios studied are presented in Table 7 in Appendix D.

tariffs do little to affect carbon leakage from those sectors. However, expanding the sectoral coverage does increase the basket of imports exposed to tariffs, leading to an increase in the domestic market share relative to partial coverage (from 0.52 to 1.01 percentage point change). The foreign market share in turn remains unchanged at 0.4% change, as BCA import tariffs do not explicitly target exports. This case does not affect aggregate welfare.

Second, when export rebates are combined with import tariffs, carbon leakage is further reduced (-1.85 compared with –1.07) as less domestic production is lost in foreign markets to foreign competitors with weaker domestic climate policies. The results for this case show that the improvement in the domestic market share remains relatively unchanged (from 0.52 to 0.55 percentage point change), though the foreign market share increases (from 0.04 to 0.08 percentage point change). The addition of export rebates further levels out climate policy costs embedded in the price of goods between trading partners, alleviating losses in competitiveness in foreign markets. Yet the costs of this redistribution, as well as the general upward pressure on prices that export rebates induce (also discussed below in Figure 4), leads to a slight reduction of welfare (from -0.71 to -0.78 percentage point change).

Finally, as expected, replacing free allowances with BCAs is less effective in mitigating carbon leakage than when they are combined (0.75 compared with -1.07 percentage point change). This case also reduces domestic market share (0.01 compared with 0.52 percentage point change) and foreign market share (0.02 compared with 0.04 percentage point change) for relevant Canadian sectors. However, aggregate welfare loss is smaller when free allowances are replaced with BCAs (-0.59 compared with -0.71 percentage point change). This is because (as shown previously in Table 2), free allowances result in welfare loss while BCAs improve welfare.

Table 3 Cumulative (2020–30) impacts of different BCA design features relative to baseline

BCA design features	**Carbon leakage rate** (percentage)	**Domestic market share** (percentage point change)	**Foreign market share** (percentage point change)	**Welfare** (percentage changes in equivalent variation)
Allowances and import tariffs				
Allowances + BCA (partial | tariffs only)	-1.07	0.52	0.04	-0.71
1. Expanding the sectoral coverage				
Allowances + BCA (full | tariffs only)	-1.16	1.01	0.04	-0.71
2. Combining import tariffs and export rebates				
Allowances + BCA (partial | tariffs & rebates)	-1.85	0.55	0.08	-0.78
3. Replacing allowances with BCAs				
BCA (partial | tariffs only)	0.75	0.01	0.02	-0.59

Full = sectoral coverage refers to cement, coal, food, gas, iron and steel, oil, other energy-intensive sectors, other manufacturing, and refined oil
Partial = sectoral coverage excludes fossil fuels and only includes cement, iron and steel, other energy-intensive sectors, and other manufacturing

In terms of impacts on sectoral prices, Figure 4 shows that while expanding sectoral coverage does not have significant impacts on sectoral prices, combining import tariffs with export rebates slightly increases these prices. In addition, replacing free allowances with BCAs generally results in higher sectoral prices in comparison to the case when BCAs are combined with free allowances. This is due to the downward pressure of free allowances on sectoral prices. Also, under all design features considered, we generally observe price increases (or if they drop, the decrease is smaller than for other sectors) for those sectors in which imports have a higher share in domestic supply (cement, iron and steel, other energy-intensive sectors, other manufacturing sectors, and food).

Figure 4 Average sectoral price changes (over 2020–30) relative to the uncoordinated scenario (%)

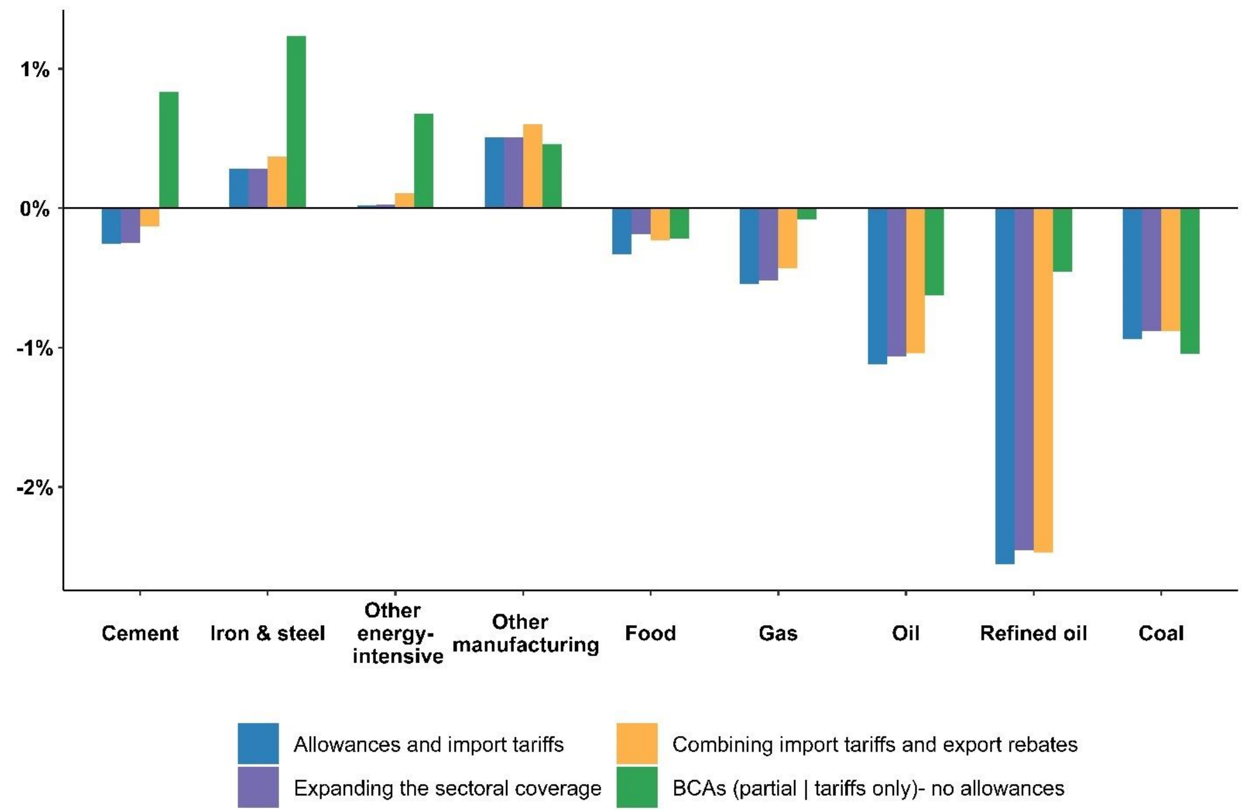
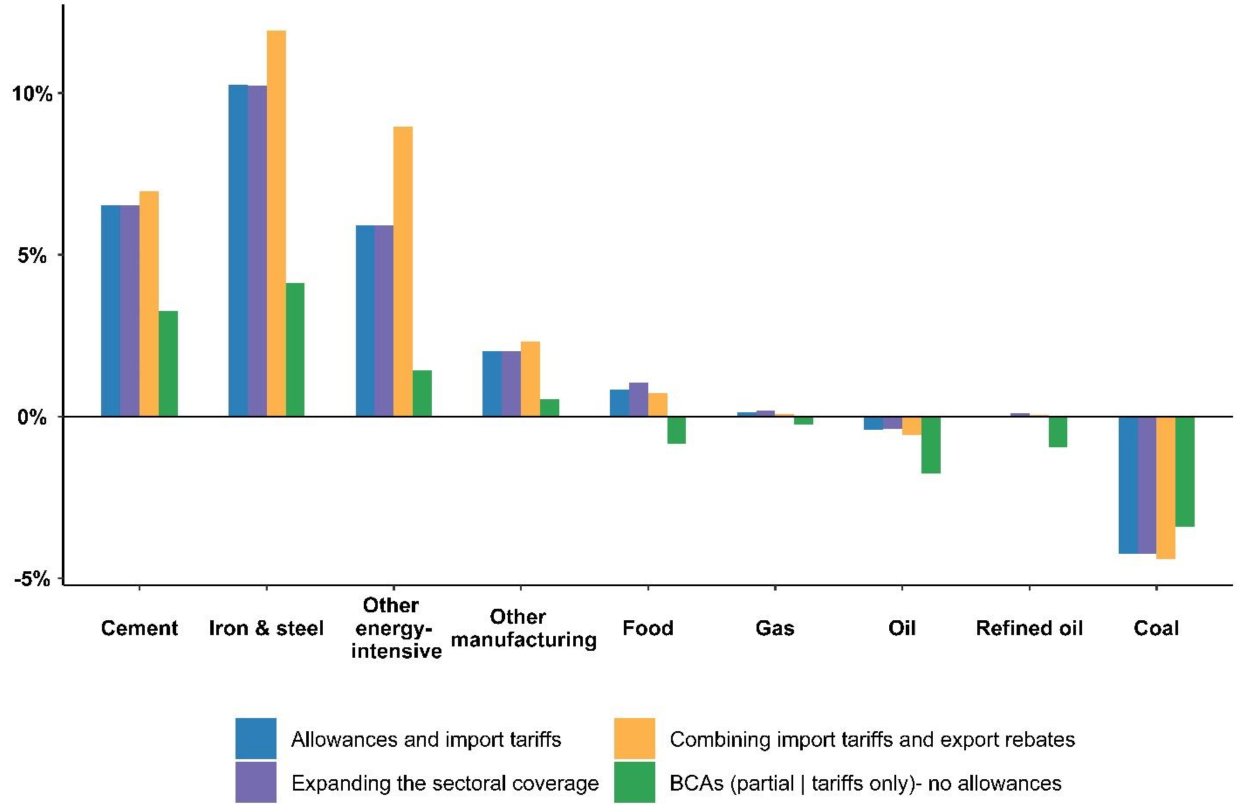


Figure 5 shows the sectoral financial impacts for the different BCA design features studied. First, while expanding sectoral coverage does not have significant financial impacts, combining import tariffs with export rebates provide benefits for some sectors, such as the energy-intensive sector. Second, combining BCAs with free allowances provides more benefits for some producers relative to replacing free allowances with BCAs. There are multiple channels through which BCAs affect producers. On the one hand, as shown above in Figure 4, sectors with higher rates of imports benefit from the upward pressure of import tariffs on sectoral prices in addition to increasing their domestic market shares. Producers also benefit from the addition of export rebates. On the other hand, producers face higher input costs due to the upward pressure BCAs have on prices, part of which are passed through to consumers. The net effect of these forces depends on the sector. Generally, we see that sectors for which imports have a higher share in domestic supply (cement, iron and steel, other energy-intensive sectors, other manufacturing sectors, and food) gain more domestic market share under BCAs. In Canada, those sectors are better off, while net-exporting sectors like fossil fuel sectors are slightly worse off.

Figure 5 Cumulative (2020–30) sectoral financial impacts relative to the uncoordinated scenario (%)



4.3. What happens when the US is out of the coalition?

Table 4 summarizes results when the US is not in the coalition relative to the case when the US was in the coalition for the same scenarios covered in Table 2 to capture the broader implications around the adoption of BCAs. In the absence of BCAs, Canada's carbon leakage to the rest of the world increases. In fact, the carbon leakage rate for Canada is higher for all the scenarios studied. In this case, domestic competitiveness deteriorates further since producers in the US now face less stringent climate policies, creating a comparative advantage for them.

When BCAs are introduced, Canada's domestic competitiveness is improved, since in this case Canada imposes tariffs on its main trading partner, the US, as well. However, BCAs result in larger upward pressure on prices in Canada (as shown in Figure 6), deteriorating Canada's foreign market share relative to the case when the US was in the coalition.

Furthermore, when the US is out of the coalition, the welfare loss due to the uncoordinated climate policy (no BCAs) is smaller for Canada to begin with (-0.34 relative to -0.67 percentage point change). This shows that more stringent climate policy in the US would have some negative impacts on Canadian welfare. Similar to the case when the US was in the coalition, adding free allowances when the US is out decreases welfare (from -0.34 to -0.45), while combining BCAs with free allowances increases welfare (from -0.45 to -0.28). However, when the US is out of the coalition, the revenues from imposing tariffs on imports coming from the US is larger, resulting in larger welfare gains when the schemes are combined (from -0.45 to -0.28 instead of going from -0.78 to -0.71 percentage change).

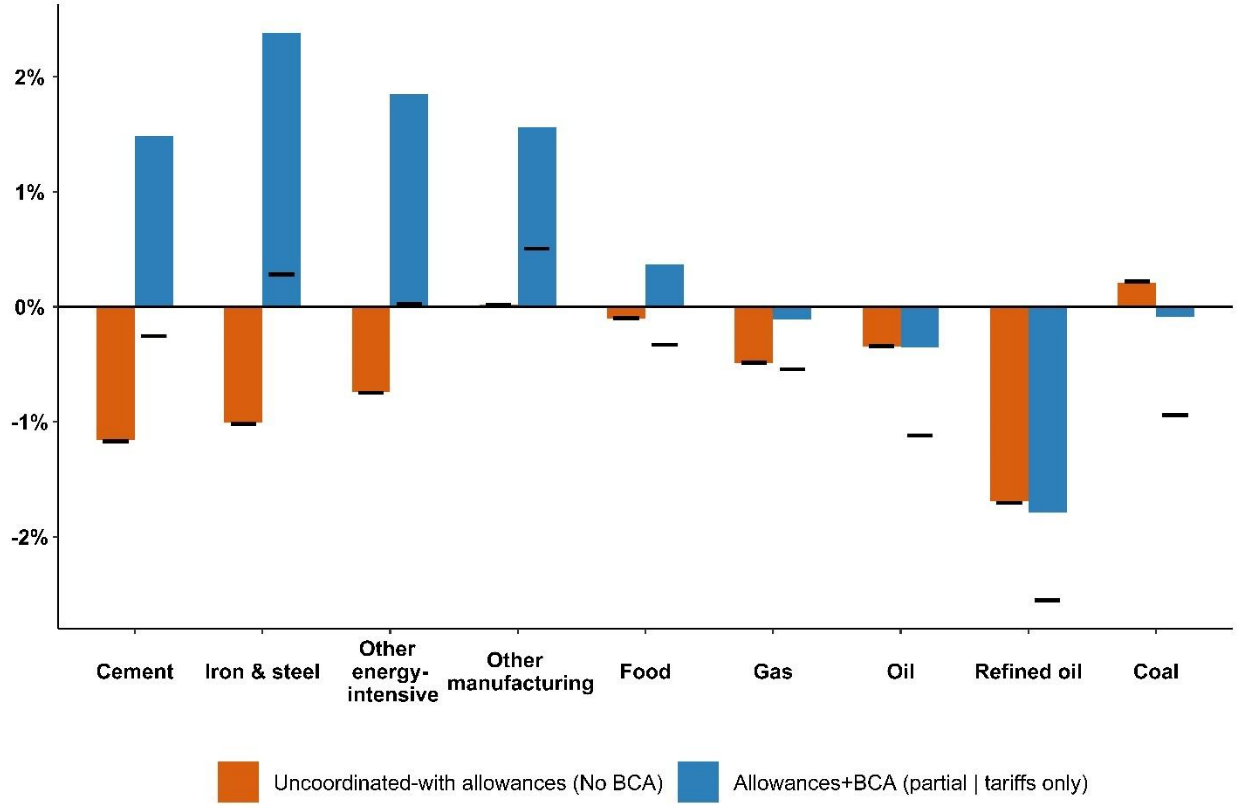
Table 4 Cumulative effects (2020–30) relative to baseline—US out of the coalition

Scenarios	**Carbon leakage rate** (percentage)	**Domestic market share** (percentage point change)	**Foreign market share** (percentage point change)	**Welfare** (percentage changes in equivalent variation)
2) Uncoordinated	9.10 (6.10)	-0.64 (-0.43)	-0.03 (-0.05)	-0.34 (-0.67)
2a) Uncoordinated with allowances	8.43 (4.38)	-0.09 (0.12)	-0.01 (-0.03)	-0.45 (-0.78)
3) Allowances + BCA (partial | tariffs only)	3.34 (-1.07)	0.66 (0.52)	-0.01 (0.04)	-0.28 (-0.71)

Note: The numbers in parenthesis show the results for the case when the US is in the coalition, previously shown in Table 3.

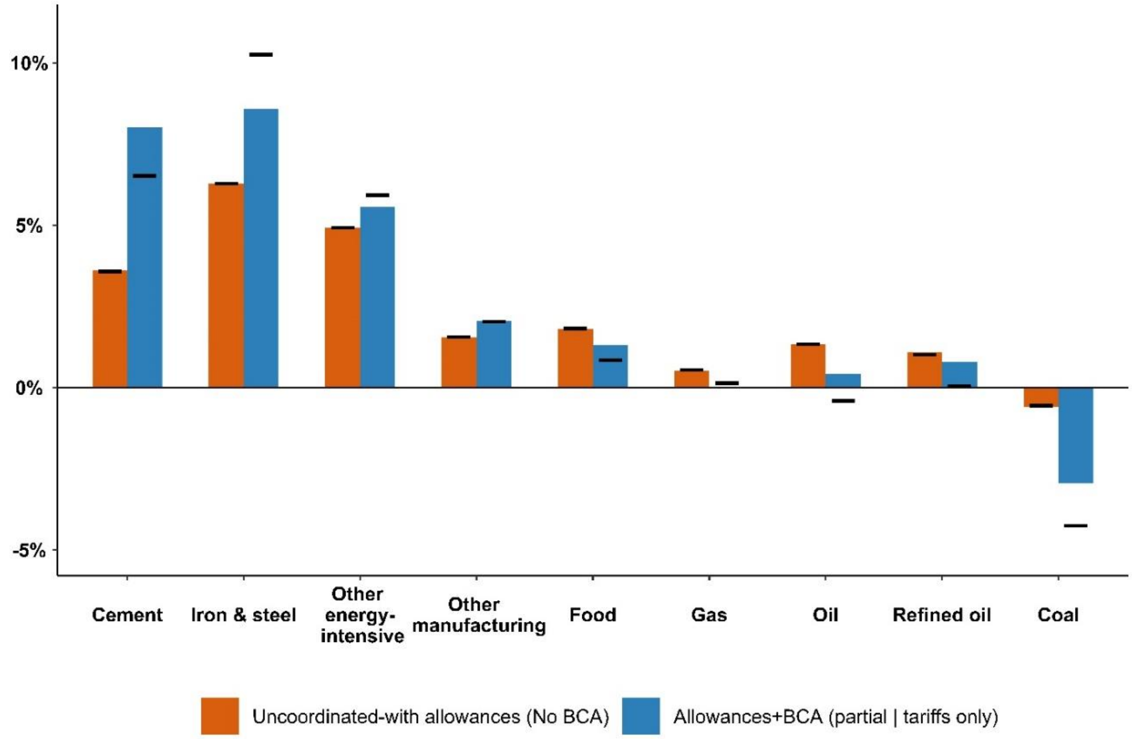
As shown in Figure 6, sectoral prices rise more when BCAs are imposed on US imports in addition to imports from other non-coalition regions to Canada. However, whether the US is in the coalition or not does not have significant financial impacts on Canadian producers (see Figure 7). On the one hand, when the US is not part of the coalition, Canadian producers benefit through increased domestic market share when tariffs are imposed on US imports relative to the case where they are not. On the other hand, as shown in Figure 6, sectoral prices rise more when BCAs are imposed on US imports. This in turn increases the input costs for Canadian producers, partly offsetting the gains in the domestic market share.

Figure 6 Average sectoral price changes (2020–30) relative to the uncoordinated scenario (%)—US out of the coalition



Note: The graph bars show the case when the US is out of the coalition, and the solid black lines represent the case when the US is in the coalition.

Figure 7 Cumulative (2020–30) sectoral financial impacts relative to the uncoordinated scenario (%)—US out of the coalition



Note: The graph bars show the case when the US is out of the coalition, and the solid black lines represent the case when the US is in the coalition.

5. Conclusion and discussion

Differences in the stringency of climate policy across countries have raised questions about their implications for carbon leakage and competitiveness, in particular for industries in countries subject to more stringent climate policies. Measures such as BCAs have been proposed to offset these implications.

This paper provided a quantification of Canadian economic impacts resulting from the implementation of BCAs. We examined implications related to which countries implement BCAs, different BCA design features, and the interaction of BCAs with existing measures also used to address carbon leakage and competitiveness matters. We have shown that the carbon leakage and economic impacts (domestic and foreign competitiveness as well as welfare) resulting from the implementation of BCAs for a country like Canada depend on the role played by the carbon content of a country's traded goods, the role these goods play in domestic production supply chains, and who the country trades with. Our analysis presents both the potential upside and downside of these different considerations, providing valuable insights into understanding the implications to the Canadian economy.

It is important to note that many challenges exist in implementing the various combinations of BCA and free allowance schemes represented in this paper, which presents an opportunity for further investigation in the future. For one, since Canadian provinces have led the development of carbon pricing schemes, imposing additional tariffs as a BCA measure at the federal level would be a significant challenge in reality (Boessenkool et al. 2022). As a result, one direction for future research is to account for potential differences in BCA measures at the provincial level, provided that regional input-output data for the Canadian economy are available. Another avenue is to explore an additional scenario where retaliations are triggered by trade partners suffering from Canada's BCAs imposed on their exports. To make this feasible, the regional resolution presented in this research may need to be significantly reduced for simplification and computational reasons.

Appendix A: MIT's Economic Projection and Policy Analysis model

The MIT-EPPA model represents interactions among three types of agents in each region of the model: producers, consumers, and the government. In each sector of the model, producers maximize their profits and minimize their costs of production by combining factors of production (capital, labour, land, resources) and intermediate inputs (i.e., goods produced by other sectors) subject to production functions and costs. Consumers are depicted by a representative agent in each region that maximizes households' welfare. Households own the primary factors of production, which they rent to producers (firms). Households then use the income from the rents received to purchase goods and services. The government sets policies and collects tax revenues and then spends the revenues on providing goods and services for households and on transfer payments to households. In addition, a carbon price can be imposed on all or a subset of GHG emissions, with the revenues raised redistributed back to households via lump-sum transfers. Equilibrium is obtained through a series of markets—for both factors of production and goods and services—that determine prices so that supply equals demand, firms earn economic profit, and income balances.

Growth in population and economic activity, as measured by GDP, are the key drivers of changes over time. For population growth, a central estimate from the United Nations (UN 2019) is used, which projects that the world population will increase from 7.8 billion in 2020 to 9.7 billion in 2050. The fastest growth is expected to occur in Africa, the Middle East, and Australia/New Zealand, where the model assumes average annual population growth rates of 2.1%, 1.2%, and 1%, respectively, over the 2020–50 period. Some countries—such as Japan, Russia, China, and South Korea—are projected to experience negative population growth over this period. While the scenario projections from the model are up to 2100, in this study we focus on 2030 as the period for which most of the NDCs for the Paris Agreement are currently specified.

Forecasts from the International Monetary Fund (IMF 2021) are adopted for near-term GDP growth. Assumptions about long-term productivity growth are taken from the MIT Joint Program on the Science and Policy of Global Change (MIT Joint Program 2021), leading to an assumed average annual growth rate of world GDP of about 2.5% for the 2020–30 period. We assume slower growth in advanced economies than in developing and emerging economies. For example, GDP growth in 2030 is projected to be 1.7% in the US, 2.4% in Canada, and 1.4% in Europe, but in the same period India grows by 5.8%, Africa by 4%, and China by 3.8%. Annual average GDP growth rates for all model regions and all periods in the baseline scenario are provided in Chen et al. (2022b). While we assume the same region-specific population growth in all scenarios, GDP growth is affected by economic and climate policies and as such is different under different policy scenarios.

Figure 8 Regions in MIT's Economic Projection and Policy Analysis model

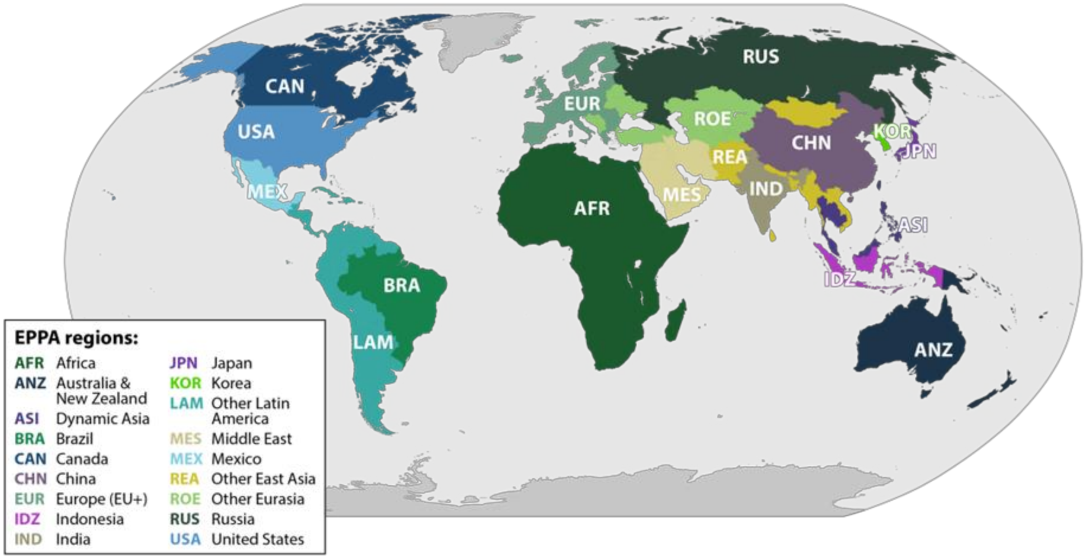


Table 5 Sectors in the MIT's Economic Projection and Policy Analysis model

Sectors	Electricity subsectors
Cement	Coal electricity
Iron and steel	Natural gas electricity
Other energy-intensive	Petroleum electricity
Other manufacturing	Nuclear electricity
Services	Hydro electricity
Crops	Wind electricity
Livestock	Solar electricity
Forestry	Biomass electricity
Food processing	Wind combined with gas backup
Coal production	Wind combined with biofuel backup
Oil production	Coal with CCS
Oil refining	Natural gas with CCS
Natural gas production	Advanced nuclear electricity
Electricity	Advanced natural gas
Private transportation: gasoline and diesel vehicles	
Private transportation: electric vehicles	
Commercial transportation	
First-generation biofuels	
Advanced biofuels	
Oil shale	
Synthetic gas from coal	

Note: CCS is carbon capture and storage.

Appendix B: Tariff/rebate rates

Figure 9 and Figure 10 show the average import tariff and export rebate rates imposed on the imports from all other origins to Canada, Europe, and the US and exports from these three regions to all destinations as an example. These import tariff rates and export rebates are calculated based on carbon price differentials across regions and embodied emissions (as explained in section 3.3).

Figure 9 Average ad valorem tariff rates imposed on imports (%)

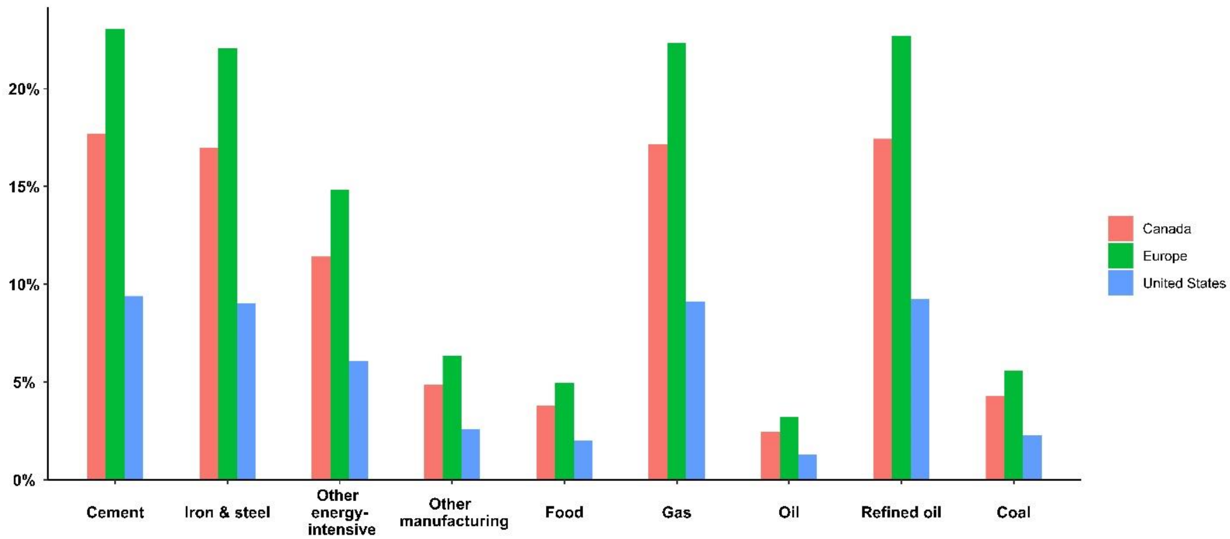
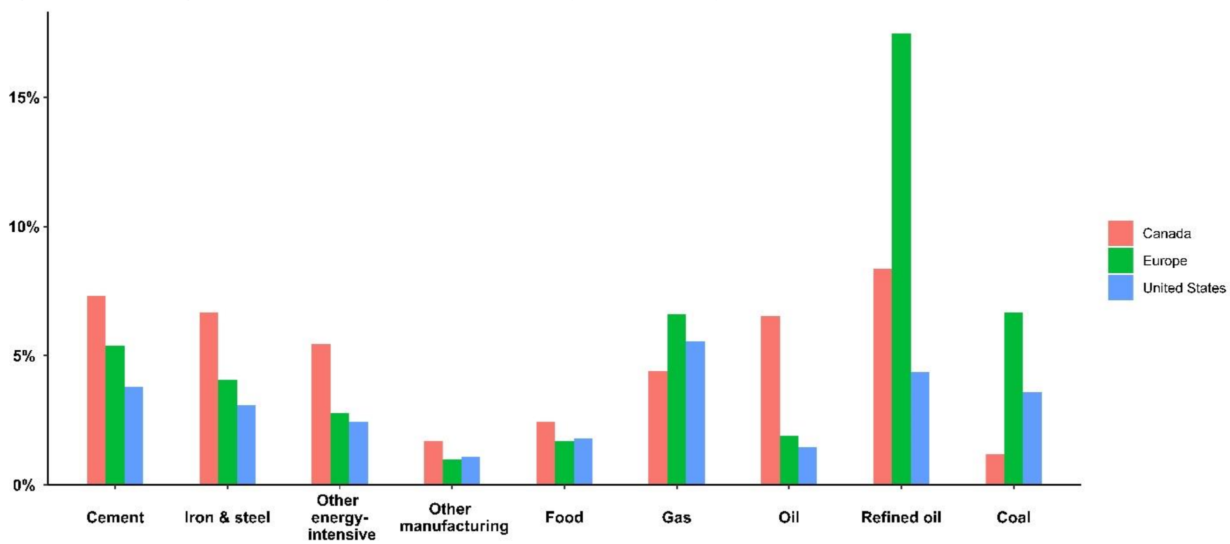
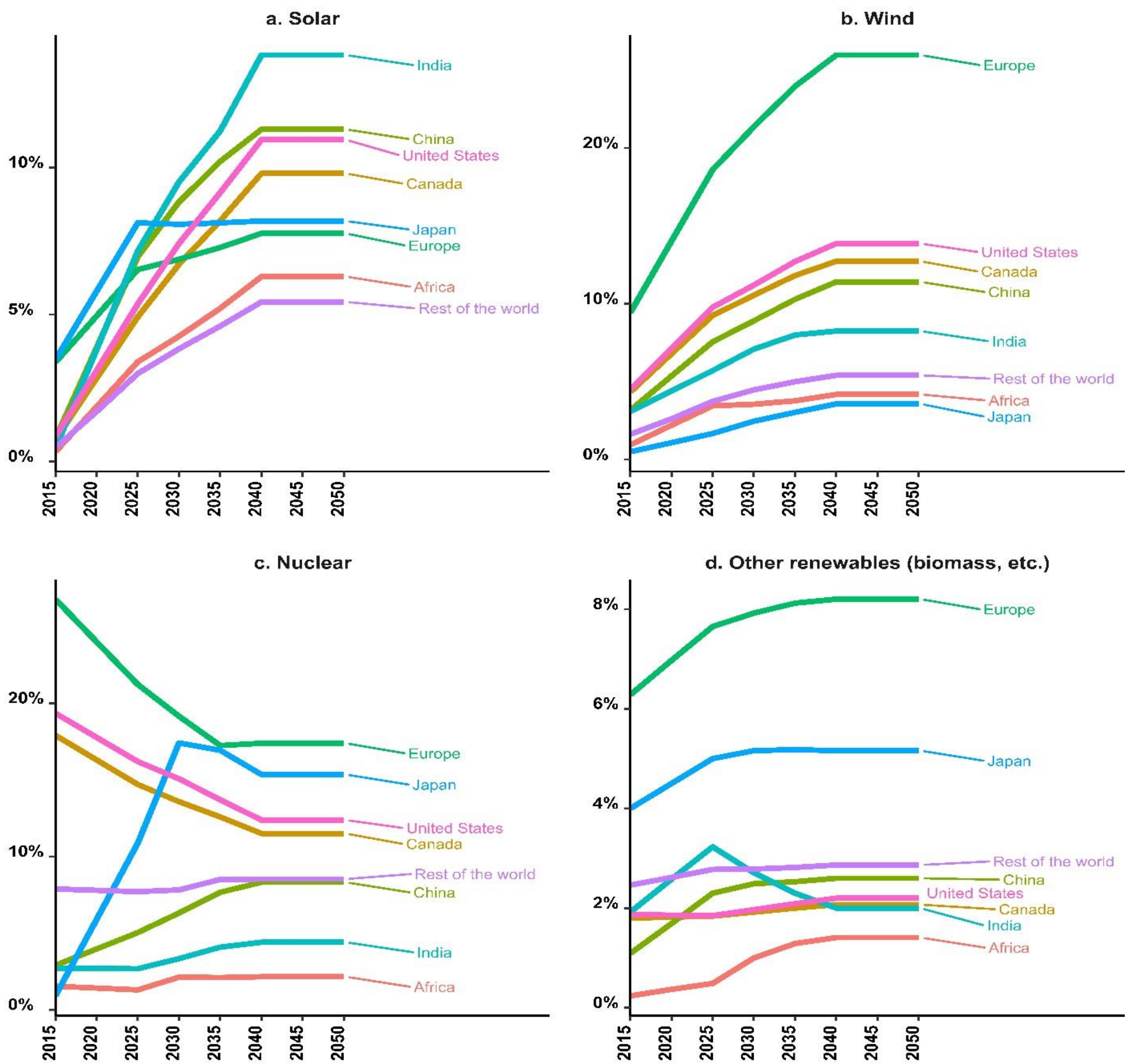


Figure 10 Average ad valorem export rebates imposed on exports (%)



Appendix C: Modelling details

Figure 11 Renewable shares in total electricity generation, by type and region based on IEA's World Energy Outlook (2019)



Emission targets

The following table shows the emission ratio targets that are used in the MIT-EPPA model to generate different scenarios. Table 6 shows emission targets (relative to 2015 levels) that were used to build the uncoordinated and BCA scenarios. These emission ratios are based on information from different sources such as Climate Action Tracker, NGFS phase 3 climate scenario release, and MIT Global Change Outlook (MIT Joint Program on the Science and Policy of Global Change 2021).

Table 6 NDC emission targets (relative to 2015 levels)

Country	United States	Canada	Mexico	Japan	Europe	South Korea
2020	0.894	0.899	0.885	0.854	0.833	0.962
2025	0.749	0.756	0.834	0.735	0.710	0.808
2030	0.604	0.613	0.829	0.616	0.587	0.655

Appendix D: More detailed modelling outputs

We also explore the scenarios in which import tariffs cover all the sectors and are combined with export rebates (i.e., full | tariffs and rebates). In addition, all the cases of sectoral coverage and export rebates are examined when free allowances are replaced with BCAs. Table 7 shows the results from the complete set of scenarios under different design features.

Table 7 Cumulative (2020–30) impacts of different BCA design features relative to baseline

Scenarios	**Carbon leakage rate** (percentage)	**Domestic market share** (percentage point change)	**Foreign market share** (percentage point change)	**Welfare** (percentage changes in equivalent variation)
Uncoordinated (No BCA)	6.1	-0.43	-0.05	-0.67
Uncoordinated-with allowances (No BCA)	4.38	0.12	-0.03	-0.78
Combining allowances with BCAs				
Allowances + BCA (partial | tariffs only)	-1.07	0.52	0.04	-0.71
Allowances + BCA (full | tariffs only)	-1.16	1.01	0.04	-0.71
Allowances + BCA (partial | tariffs & rebates)	-1.85	0.55	0.08	-0.78
Allowances + BCA (full | tariffs & rebates)	-1.17	0.57	0.08	-0.8
Replacing allowances with BCAs				
BCA (partial | tariffs only)	0.75	0.01	0.02	-0.59
BCA (full | tariffs only)	0.66	0.5	0.02	-0.59
BCA (partial | tariffs & rebates)	0.07	0.03	0.05	-0.65
BCA (full | tariffs & rebates)	0.7	0.04	0.05	-0.66

References

Aguiar, A., M. Chepeliev, E. Corong, R. McDougall, and D. van der Mensbrugghe. 2019. The GTAP Data Base: Version 10. *Journal of Global Economic Analysis* 4(1), 127.

Aldy, J., and W. A. Pizer. 2015. The Competitiveness Impacts of Climate Change Mitigation Policies. *Journal of the Association of Environmental and Resource Economists* 2(4), 565-595.

Babiker, M. H. 2005. Climate Change Policy, Market Structure, and Carbon Leakage. *Journal of International Economics*, 65(2): 421-445. http://dx.doi.org/10.1016/j.jinteco.2004.01.003

Bellora, C., and L. Fontagne, 2022. EU in Search of a WTO-Compatible Carbon Border Adjustment Mechanism. Working paper.

Boessenkool, K., Moffatt, M., Cosbey, A., and Bernstein, M. 2022. Policy Forum: Border Carbon Adjustments—Four Practical Challenges. *Canadian Tax Journal/Revue fiscale canadienne 70*(1), 41-56.

Bohringer, C., E. Balisteri, and T. F. Rutherford. 2012. The Role of Border Carbon Adjustments in Unilateral Climate Policy: Overview of an Energy Modelling Forum Study (EMF 29). *Energy Economics* 34(S2): S97-S110.

Bohringer, C., C. Fischer, K. E. Rosendahl, and T. F. Rutherford. 2022. Potential Impacts and Challenges of Border Carbon Adjustments. *Nature Climate Change* 12, 22-29

Burniaux, J.-M., J. Château, and R. Duval. 2010. Is there a Case for Carbon-Based Border Tax Adjustments? An Applied General Equilibrium Analysis. Economics Department Working Paper No. 794, OECD.

Chen, Y.-H. H., S. Paltsev, A. Gurgel, J. Reilly, and J. Morris. 2022a. A Multisectoral Dynamic Model for Energy, Economic and Climate Scenario Analysis. *Low Carbon Economy*, 13(2) (doi: 10.4236/lce.2022.132005)

Chen, Y.-H. H., E. Ens, O. Gervais, H. Hosseini, C. Johnston, S. Kabaca, M. Molico, S. Paltsev, A. Proulx, and A. Toktamyssov. 2022b. Transition Scenarios for Analyzing Climate-Related Financial Risk. MIT Joint Program Report 356. http://globalchange.mit.edu/publication/17757

Cosbey, A., S. Droege, C. Fischer, and C. Munnings. 2019. Developing Guidance for Implementing Border Carbon Adjustments: Lessons, Cautions, and Research Needs from the Literature. *Rev. Environ. Econ. Policy* 13, 3–22.

Cosbey, A., M. Bernstein, and S. Stiebert. 2021. Enabling Climate Ambition: Border Carbon Adjustment in Canada and Abroad. Report, International Institute for Sustainable Development and Clean Prosperity.

Council of the European Union. 2022. Draft Regulation of the European Parliament and of the Council Establishing a Carbon Border Adjustment Mechanism. Council of the European Union, Brussels, 15 March 2022. https://data.consilium.europa.eu/doc/document/ST-7226-2022-INIT/en/pdf

Ecofiscal Commission. 2016. Choose wisely: Options and Trade-offs in Recycling Carbon Pricing Revenues.

Fischer, C., and A. K. Fox. 2012. Climate Policy and Fiscal Constraints: Do Tax Interactions Outweigh Carbon Leakage? *Energy Economics* 34 (S2), S218–S227.

Fouré, J., H. Guimbard, and S. Monjon. 2016. Border Carbon Adjustment and Trade Retaliation: What Would Be the Cost for the European Union? *Energy Economics* 54, 349–362.

Government of Canada. 2019. Output-Based Pricing System Regulations: SOR/2019-266, *Canada Gazette*, Part II, Volume 153, Number 14. https://gazette.gc.ca/rp-pr/p2/2019/2019-07-10/html/sor-dors266-eng.html

Government of Canada. 2021. Exploring Border Carbon Adjustments for Canada. Department of Finance Canada, Ottawa, Ontario. https://www.canada.ca/en/department-finance/programs/consultations/2021/border-carbon-adjustments/exploring-border-carbon-adjustments-canada.html

IEA (International Energy Agency). 2019. World Energy Outlook 2019. Paris: IEA.

IMF (International Monetary Fund). 2021. World Economic Outlook: Recovery During a Pandemic. Washington DC: IMF.

Lilly, M., E. M. Walter, and D. Balkissoon. 2022. Policy Forum: Trade Policy Pain for Marginal Climate Gain? The Complex Case for Border Carbon Adjustments in Canada. *Canadian Tax Journal/Revue fiscale canadienne*, *70*(1), 57-72.

Mattoo, A., A. Subramanian, D. van der Mensbrugghe, and J. He. 2009. Reconciling Climate Change and Policy, World Bank Policy Research Working Paper no. WPS 5123.

McKibbin, W. J., A. C. Morris, P. J. Wilcoxen, and W. Liu. 2018. The Role of Border Carbon Adjustments in a U.S. Carbon Tax. *Clim. Change Econ*. 9, 1840011.

MIT Joint Program on the Science and Policy of Global Change. 2021. Global Change Outlook. https://globalchange.mit.edu/news-media/jp-news-outreach/why-earth-needs-course-correction-now

Monjon, S., and P. Quirion. 2011. Addressing Leakage in the EU ETS: Border Adjustment or Output-Based Allocation? *Ecological Economics* 70, 1957–1971.

Paltsev S. 2001, The Kyoto Protocol: Regional and Sectoral Contributions to the Carbon Leakage. *Energy Journal*, 22(4), 53-79. https://www.iaee.org/en/publications/ejarticle.aspx?id=1372

Reinaud, J. 2008. Issues Behind Competitiveness and Carbon Leakage. Focus on heavy industry, IEA information paper, International Energy Agency, OECD/IEA Paris.

United Nations. 2015. The Paris Agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

UN (United Nations). 2019. World Population Prospects 2019, Online Edition, Rev. 1. United Nations Department of Economic and Social Affairs, Population Division.

United Nations Framework Convention on Climate Change (UNFCC). 2022. NDC Synthesis Report. United Nations, New York, NY. https://unfccc.int/ndc-synthesis-report-2022#Scope-and-Approach

Winchester, N., S. Paltser, and J. Reilly. 2011 Will Border Carbon Adjustments Work? *Journal of Economic Analysis & Policy* 11(1): Article 7.

Winchester, N. 2017. Can Tariffs Be Used to Enforce Paris Climate Commitments? MIT Joint Program on the Science and Policy of Global Change Report 312.

Winchester, N., and S. Rausch, 2013. A Numerical Investigation of the Potential for Negative Emissions Leakage. *American Economic Review* 103(3), 320-325.

Tab 4

ENBRIDGE GAS INC.

Answer to Interrogatory from
Environmental Defence (ED)

Interrogatory

Reference:

Exhibit 1, Tab 10, Schedule 5, Attachment 1, p. 40

Preamble:

Exhibit 26 – Scenario Narratives

Scenario Title:	Reference Case	Steady Progress	Diversified Portfolio	Electricity Centric

Question(s):

a) For each scenario, please provide relative cost-effectiveness of residential space conditioning and cooling from a customer perspective as between (i) gas equipment and a traditional air conditioner, (ii) hybrid heating, and (iii) a house fully electrified with heat pumps (and not required to pay for gas distribution charges).

b) Please confirm that the relative cost-effectiveness of the above options will impact gas demand.

c) Page 40 states: "The ETSA project team built off the scenario narratives envisioned by Enbridge Gas prior to beginning the project to draft scenario narratives." Please provide a copy of what Enbridge provided.

d) This question is for Enbridge: How did Enbridge develop the scenario narratives provided to Posterity Group? Please provide any reports or memos in relation the development of those narratives.

e) Please assess the relative probability of the future being more similar to the reference case, study progress, diversified portfolio, or electricity centric scenarios.

Response:

a-b) The following response was provided by Posterity Group:

> The Navigator model can conduct cost-effectiveness tests on individual measures, but is not designed to produce the kind of cost-effectiveness calculation contemplated in this question. Also, developing costs estimates were not part of the study scope.

c) The following response was provided by Posterity Group:

> Scenario narratives were developed via discussions with the Enbridge Gas team. Enbridge Gas did not provide a document describing what the organization envisioned.

d) As noted by Posterity in part c), scenario narratives were developed via discussions between Enbridge Gas and Posterity. Enbridge Gas and Posterity worked collaboratively and through an iterative process to develop the scenarios and critical driver settings. The process describing the development of scenario narratives and the final scenario narratives is provided in Exhibit 1, Tab 10, Schedule 5, Attachment 1, pages 39 to 41.

e) The following response was provided by Posterity Group:

> We did not assign any probabilities to any of the scenarios. We view the multi-scenario modeling approach as a way to mitigate risk. We advise our utility clients to develop plans that are robust in the face of a range of plausible scenarios, particularly in cases where future policy, prices, and economic variables are uncertain.

Tab 5

ENBRIDGE GAS'S ENERGY TRANSITION PLAN (ETP) AND SAFE BET ACTIONS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes emerging federal, provincial, and municipal climate change policies and the uncertainty around what energy transition pathway may unfold due to the differing greenhouse gas (GHG) emission reduction targets and areas of focus at each level of government. The evidence then describes Enbridge Gas's Energy Transition Plan (ETP) and the actions outlined within the ETP that Enbridge Gas proposes to move forward with during the rebasing term despite current policy uncertainty. Enbridge Gas's ETP ensures that progress towards 2030 targets and a net-zero future continues despite policy uncertainty, while also ensuring Ontario's energy demands are met in the most reliable, resilient, secure, and cost-effective manner.

2. This evidence is organized as follows:
    1. Emerging Climate Change and Energy Transition Policies
    2. Enbridge Gas's Energy Transition Plan (ETP) to Reduce GHG Emissions
    3. Summary of GHG Reductions Driven from Enbridge Gas's ETP
    4. Evolution of Enbridge Gas's ETP

1. Emerging Climate Change and Energy Transition Policies

1.1 Introduction

3. The need to act against climate change has led the federal, provincial, and municipal governments to develop targets, plans, and policies to reduce GHG emissions, to develop lower carbon sources of energy and to transition to a low-carbon economy. Please see Exhibit 1, Tab 10, Schedule 3, Section 2 where Enbridge Gas describes the current climate policies that impact the Company. This

Working Group (FEIWG) and as part of the Regional Planning Process Advisory Group. Specifically, the FEIWG report notes "The need for more integration between gas and electricity planning was discussed on numerous occasions. Natural gas and electricity utilities may need to consider one another's system plans to optimize their respective assets. These issues were also identified by the Regional Planning Process Advisory Group in its recommendations to the OEB."[45]

75. Integrating gas and electric system planning is a safe bet as it supports near term GHG reductions, it is required regardless of which pathway comes to fruition and it supports maintaining the gas system in a way that considers pathway uncertainty. Beyond these benefits, integrating gas and electric system planning would enable optimized pathway modeling for Ontario and by region, ensuring that the most cost-effective, safe, reliable, and resilient transition is planned for and implemented. Without an integrated electric and gas approach to planning, decisions could be made based on a shorter-term, siloed view and not on the long-term implications for the province.

76. Integrated gas and electric system planning would support cost-effective near term GHG emission reductions via the two sectors working together to identify, plan for and implement initiatives that maximize the use of existing infrastructure while also fulfilling energy needs and reducing GHG emissions.

77. An example of this integration is hybrid heating. Hybrid heating can drive significant annual gas use reductions as compared to a furnace, thereby driving reduced GHG emissions, and reduce peak electricity needs as compared to an electric heat

[45] Framework for Energy Innovation Working Group Report – Report to the OEB. June 30, 2022. https://www.rds.oeb.ca/CMWebDrawer/Record/750359/File/document

pump, thereby driving reduced electrification costs. With the gas and electric sectors working together, the benefits and the potential of this solution could be understood and planned for within each region and the implementation could be done in partnership to ensure success within the market.[46]

78. Evolving the integration of gas and electric system planning will be required regardless of the pathway that unfolds, to ensure that required energy system changes are properly understood, planned for, and implemented in a safe, reliable, resilient, and secure manner throughout the transition.

79. Finally, the integration of gas and electric system planning supports the maintenance of the gas system amidst uncertainty, as it ensures that the same need is not forecasted or planned for by both sectors, and that the potential to co-deliver an IRP alternative, for example a demand response program, in a co-constrained area is identified. This concept was discussed as part of the OEB's Framework for Energy Innovation Working Group (FEIWG). Specifically, "the FEIWG recommends that the distributors (natural gas and electricity), transmitters and IESO co-ordinate planning and forecasting in the energy sector. The FEIWG recognized that through improved OEB guidance in relation to BCAs, utility incentives and integration of DERs distributors, transmitters, and the IESO will be aided in coordinating and integrating their planning."[47], and "we also acknowledged the importance of breaking down energy silos including those between natural gas and electricity planning, as reflected in the OEB's recent acceptance of the

---

[46] A good example of gas and electric utilities working together is the partnership between Énergir and Hydro-Quebec to convert gas heating systems to a hybrid heating system. Énergir. (2022 May 19). Green light to launch dual energy offer to decarbonize the heating of buildings. https://www.energir.com/en/about/media/news/decision-decarbonation-des-batiments-binergie/
[47] Framework for Energy Innovation Working Group Report – Report to the OEB. June 30, 2022. p.16. https://www.rds.oeb.ca/CMWebDrawer/Record/750359/File/document

Regional Planning Process Advisory Group's recommendation to enhance the coordination of other planning processes with regional planning. More work in this area is warranted."[48]

80. Enbridge Gas believes that having the OEB and government support and endorse integrated gas and electric planning would help to ensure that Ontario's energy transition is successful; that is, that the most cost-effective, reliable, and resilient pathway to net-zero is understood, planned for, and implemented.

2.5 Supporting Consumer Choice and the Energy Transition Journey

81. As noted above, uncertainty currently exists around which energy transition pathway will unfold within Ontario. The last safe bet action does not involve any particular GHG emissions reduction technology; instead, it is based on two concepts:

a) Energy consumers should have the ability to choose solutions that suit their individual needs on the path to net-zero; and
b) Until the path to net-zero in Ontario is clear, steps should be taken to ensure all pathways remain open and available.

82. Initiatives within this safe bet action are safe bets, because they maintain (1) consumer choice amidst uncertainty, (2) a safe and reliable gas system in a manner that considers pathway uncertainty, and/or (3) pathway optionality until greater certainty around how best to transition is obtained.

83. Specifically, the initiatives that enable this safe bet are:

---

[48] Framework for Energy Innovation Working Group Report – Report to the OEB. June 30, 2022. P.16. https://www.rds.oeb.ca/CMWebDrawer/Record/750359/File/document

ENBRIDGE GAS INC.

Answer to Interrogatory from
Pollution Probe (PP)

Interrogatory

Reference:

Reference: Guidehouse Pathways to Net Zero Emissions for Ontario Report
"While this study aims to adequately simulate an increasingly integrated electricity and gas system in Ontario, the results of this analysis are not intended to dictate when and where infrastructure investments will take place." [Exhibit 1, Tab 10, Schedule 5, Attachment 2, Page 2]

Question(s):

a) Please confirm that the Guidehouse report referenced by Enbridge in its Energy Transition evidence is only a simulation and not intended to dictate infrastructure or timing. If that is incorrect, please explain why this disclaimer has been applied to the modelling and report.

b) Please explain how Enbridge has translated information from the Guidehouse report into specific infrastructure investments in the USP, AMP and other investment planning documents (e.g. capital plan, revenue plan, etc.).

c) Please provide a copy of the RFP, contract and statement of work for the Pathways to Net Zero Emissions for Ontario project and report.

d) Please confirm that the Pathways to Net Zero Emissions for Ontario Report was funded and/or under-taken in partnership with IESO and if not, please explain why not given the significant assumptions on electricity use in Ontario.

e) Please provide which accounts (e.g. O&M, Capital, DSM, IRP Deferral Account, etc.) were used to pay for the Pathways to Net Zero Emissions for Ontario Report and the percent of funding per account if funding was split between accounts.

Response:

a) Confirmed. As provided at Exhibit 1, Tab 10, Schedule 5, Attachment 2, pages 2 to 3, the Pathways to Net-Zero Emissions for Ontario (P2NZ) Report was intended to evaluate two different scenarios that achieve net-zero emissions for Ontario by 2050, and to examine the feasibility of these scenarios based on overall feasibility, energy system capacity, system reliability and resiliency, GHG reductions and costs. The purpose of the report was not to dictate when and where infrastructure investments would take place.

b) Enbridge Gas used the P2NZ Report to support the development of its Energy Transition Plan, including the safe bet actions, driving the proposed investments in hydrogen and RNG as provided at Exhibit 1, Tab 10, Schedule 6. The safe bet actions and the related investments will support energy transition in Ontario regardless of the pathway to net-zero. Costs related to Enbridge Gas's safe bet actions are included in the Utility System Plan and the Asset Management Plan.

c & e) Please see Attachment 1 for the RFP. Response at Exhibit I.1.2-CCC-3 provides the consultant contracts and costs.

d) Not confirmed. The P2NZ Report was paid for and undertaken by Enbridge Gas. Due to the timelines for preparing the P2NZ Report in advance of this Rebasing Application, Enbridge Gas did not have adequate time to coordinate with the IESO. The report found, however, that integrated energy planning is required, and this is a safe bet action outlined in Enbridge Gas's Energy Transition Plan provided at Exhibit 1, Tab 10, Schedule 6, Pages 28 to 31.

ENBRIDGE GAS INC.

Answer to Interrogatory from
School Energy Coalition (SEC)

Interrogatory

Reference:

1-10-6, p.14, 21

Question(s):

Please explain why Enbridge has no proposal for the integration of gas and electricity planning.

Response:

Enbridge Gas believes that a collaborative approach is critical for energy planning in Ontario and that utilities should not plan or operate energy systems in silos. It is imperative to remove barriers to collaboration so that a holistic approach to optimizing energy systems can be achieved along a pathway toward Ontario's net-zero future. Planning energy systems collaboratively will achieve a safe, reliable, and resilient energy system at the least cost, while reducing GHG emissions and maintaining customer choice by leveraging the different benefits of each system. Further, collaboration can contribute to an open and solution-based environment for energy system planning and low emission energy development.

The outcomes and recommendations from the Electrification and Energy Transition Panel's work are needed to inform the approach for achieving more integrated or collaborative energy system planning. Enbridge Gas believes it is prudent to understand the Ontario government's and the OEB's perspective and to better understand the roles that the IESO as the electricity system planner, Enbridge Gas as the gas system planner, local distribution companies (LDCs) and the OEB will have and play through the energy transition, before a proposal can be made.

While Enbridge Gas has not made a specific proposal on integration of gas and electricity planning, the Company is committed to taking a collaborative approach. Enbridge Gas's participation in various working groups with LDCs, municipalities, indigenous groups, builder community, and industry groups demonstrates the Company's desire and on-going efforts to do so. For example, Enbridge Gas:

- Has presented the Pathways to Net Zero Emissions for Ontario (P2NZ) Report to municipalities, LDCs, IESO to prompt and facilitate discussions about the benefits of a diversified pathway and the need for collaborative and integrated gas and electricity system planning to realize a net-zero future in Ontario;

- Has initiated discussions with the IESO to understand each organizations' respective planning processes, i.e., RPPAG and IRP.

- Has begun working with the City of Ottawa regarding IRP and the City's energy planning, as described in the response at Exhibit I.1.10-PP-9 part e).

Ontarians expect – and deserve – access to reliable, resilient, and cost-effective energy systems. A collaborative and integrated approach to energy planning in Ontario can result in better investments in both the gas and electricity systems, and drive optimal solutions for individual communities, that have unique energy needs, requirements, and system constraints.

ENBRIDGE GAS INC.

Answer to Interrogatory from
Green Energy Coalition (GEC)

Interrogatory

Reference:

E1/T10/S4, pp. 17-18

Question(s):

Enbridge has suggested that an Economic Planning Horizon (EPH) for depreciating assets “is not appropriate at this time” because of uncertainty about how the energy transition would affect its system, but that “if a diversified pathway to net-zero is not adopted in Ontario, Enbridge Gas would seek to introduce an EPH on its system to mitigate the risk of stranded assets.” Enbridge further states that “if a system-wide 2050 EPH were to be implemented starting 2024, the 2024 Test Year depreciation expense would increase by $282 million, from $921 million to $1.2 billion.”

a) Why is uncertainty about how the energy transition will affect Enbridge’s system a reason not to adopt an EPH? Doesn’t the uncertainty about the impacts of the energy transition create risk for future ratepayers which an EPH can mitigate? In other words, isn’t an EPH, at least in part, a ratepayer risk mitigating strategy? If not, why not?

b) Would Enbridge agree that there will always be uncertainty about the impacts of the energy transition twenty or more years into the future? If so, does that mean Enbridge would never find it appropriate to put an EPH in place? If not, please explain in detail how much “certainty” there must be for Enbridge to support adoption of an EPH?

c) How does Enbridge define a “diversified pathway to net-zero”? Please be specific about exactly what features a pathway would need to have to be considered by Enbridge to be “diversified”. Is there a minimum or maximum amount of gaseous energy throughput through Enbridge’s system? Is there a minimum or maximum amount of peak hour demand to be served by Enbridge?

d) What information would Enbridge need to have that it does not currently have in order to propose an EPH? Put another way, please provide the specific conditions under which Enbridge would pr

e) Would Enbridge agree that there is at least a significant possibility that Ontario's pathway to decarbonization will involve significantly lower annual volumes of gas distributed by the Company? If not, why is that not at least a significant possibility?

f) Is the estimated increase in 2024 Test Year depreciation expense of $282 million associated with the application of an EPH to all assets, both (1) those for which capital investments have already been made but not yet fully depreciated and (2) new assets? If so, what would the 2024 Test Year depreciation expense increase be if a 2050 EPH was just applied to new capital investments?

g) Please provide an Excel file, with formulae intact, showing the actual calculation of the $282 million increase in 2024 Test Year depreciation expensive associated with adoption of a 2050 EPH.

<u>Response:</u>

a) Enbridge Gas agrees that an EPH is appropriate as a risk mitigation strategy to address energy transition. However, the Company is not proposing to incorporate this assumption into the depreciation rates at this time as there is not enough known regarding the impacts of energy transition on the system and the impact of implementing an EPH is significant to rate payers. This view is also supported by Concentric and is provided at Exhibit 4, Tab 5, Schedule 1, Attachment 1, page 19. It may not be appropriate to apply the EPH scenario to all of the utility assets; however, which assets will actually be impacted is not yet determinable. In addition, climate and energy transition legislation is still evolving and there are no specific programs in place that would provide guidance as to future utilization levels of Enbridge Gas's assets. Concentric recommends, and Enbridge Gas supports, that an additional study of changes is required prior to implementation of an EPH and will re-evaluate applying an EPH in future studies.

b) Enbridge Gas agrees that there will continue to be uncertainty about the impacts of energy transition in the future, but that does not necessarily mean that it would never be appropriate to implement an EPH. The Company will reassess the need to implement an EPH at the next depreciation study and will look for 'sign posts' such as government policy changes or commitments from municipalities to convert to alternative fuels to determine what an appropriate EPH might be. If implemented in the next study, the EPH assumptions would be revisited in subsequent studies and as more certainty regarding future usage of assets is known, depreciation rates would be adjusted to either reflect an acceleration due to faster transition or decreased to reflect the lengthening of asset lives.

c) As provided at Exhibit 1, Tab 10, Schedule 5, page 23, paragraph 73 “It is also important to note that Enbridge Gas believes that the diversified pathway outlined in the P2NZ Study is just one version of what a diversified pathway could look like; there are many different permutations of how it could unfold in Ontario. Enbridge Gas believes that to develop the most optimal diversified pathway, that it must work closely with the electricity sector to undertake an integrated approach to energy transition modeling and planning.” It is for this reason that Enbridge Gas has not yet defined exactly what a diversified scenario would mean for each sector and for each part of its system. At a high-level, however, Enbridge Gas would define a diversified pathway as one where energy choices are not mandated by government policy, rather customers have the ability to meet emissions reductions targets by making energy choices that meet their affordability, reliability and resiliency requirements. Energy system utilization and build out would respond to customer preferences. The gas system would serve all sectors of the economy including buildings, industrial, transportation, and power generation. Customers would have the choice of natural gas paired with carbon capture utilization and storage (CCUS), low and zero carbon fuels and low carbon electricity. Depending on customer preferences, gaseous fuels could be used to meet year-round requirements, peak season demands, back up for resiliency or not at all. Enbridge Gas believes that the degree to which each sector utilizes the gas system would vary by region, as each region would leverage and optimize the gas and electric infrastructure in place as well as optimize any required buildouts. Optimization will consider safety, energy system cost, reliability, resiliency, customer choice and maintaining a competitive industry.

d) Enbridge Gas notes that this question is incomplete and is replying in terms of the first sentence in the question. As described in part a), Enbridge Gas would need to have more data to support the expected changes in utilization to a more specific subset of system assets. For example, a change in utilization for distribution as compared to transmission or storage assets.

e) Enbridge Gas would agree that Ontario’s pathway to decarbonization could involve lower annual gas volumes as a result of continued focus on energy efficiency, the uptake of technologies like hybrid heating and some from fuel-switching away from gaseous fuels. It does not, at this point, however, agree that this is a significant possibility, due to two key reasons. First, natural gas consumption could be replaced with the consumption of RNG and hydrogen, and second some larger customers could maintain their current natural gas consumption and pair it with CCUS, and others could increase their consumption of natural gas as they move away from higher emitting fuels to natural gas as part of their long-term plan to transition to hydrogen.

f) Please note that the impact of applying the 2050 EPH scenario to the 2024 Test Year depreciation expense has been updated to $290 million, please see Exhibit 1, Tab 10, Schedule 4, page 18, updated March 8, 2023.

The rates are applied to total balances which would include assets that are not yet fully depreciated. Enbridge Gas is unable to calculate the 2024 Test Year depreciation expense if the 2050 EPH was only applied to new capital investments due to the nature of the depreciation forecasting models used.

g) Please see response at Exhibit I.4.5-LPMA-34 Attachment 1.

Tab 6

ENBRIDGE GAS'S ENERGY TRANSITION PLAN (ETP) AND SAFE BET ACTIONS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes emerging federal, provincial, and municipal climate change policies and the uncertainty around what energy transition pathway may unfold due to the differing greenhouse gas (GHG) emission reduction targets and areas of focus at each level of government. The evidence then describes Enbridge Gas's Energy Transition Plan (ETP) and the actions outlined within the ETP that Enbridge Gas proposes to move forward with during the rebasing term despite current policy uncertainty. Enbridge Gas's ETP ensures that progress towards 2030 targets and a net-zero future continues despite policy uncertainty, while also ensuring Ontario's energy demands are met in the most reliable, resilient, secure, and cost-effective manner.

2. This evidence is organized as follows:
    1. Emerging Climate Change and Energy Transition Policies
    2. Enbridge Gas's Energy Transition Plan (ETP) to Reduce GHG Emissions
    3. Summary of GHG Reductions Driven from Enbridge Gas's ETP
    4. Evolution of Enbridge Gas's ETP

1. Emerging Climate Change and Energy Transition Policies

1.1 Introduction

3. The need to act against climate change has led the federal, provincial, and municipal governments to develop targets, plans, and policies to reduce GHG emissions, to develop lower carbon sources of energy and to transition to a low-carbon economy. Please see Exhibit 1, Tab 10, Schedule 3, Section 2 where Enbridge Gas describes the current climate policies that impact the Company. This

government and stakeholders work to determine how best to achieve net-zero, Enbridge Gas believes that if energy transition is to be implemented in an orderly manner, that delaying all action is not an option. Despite the uncertainty that exists, there are safe bet actions that can and need to be taken now.

36. Enbridge Gas considers an action to be a safe bet if it:

a) Supports Ontario's near term GHG reductions, including achievement of the 2030 target; and/or
a) Is required, regardless of whether a diversified or an electrification pathway unfolds in Ontario; and/or
b) Maintains consumer choice, a safe and reliable gas system in a manner that considers pathway uncertainty, and/or pathway optionality until greater certainty around how best to transition is obtained.

37. The safe bet actions that have shaped Enbridge Gas's ETP are:

a) Maximizing energy efficiency;
b) Increasing the amount of RNG in the gas supply;
c) Reducing GHG emissions from the industrial and transportation sectors via fuel switching and CCUS;
d) Integrating gas and electric system planning; and
e) Supporting consumer choice and the energy transition journey.

38. With the ETP based upon these identified safe bets and objectives, Enbridge Gas believes the ETP, and its associated rebasing application proposals, are prudent as they support continued progress towards a net-zero future despite current policy uncertainty, but they don't overinvest in a particular pathway prior to the Ontario government defining its future energy transition plans in more detail.

INTEGRATING ENERGY TRANSITION INTO THE BUSINESS

CARA-LYNNE WADE, DIRECTOR, ENERGY TRANSITION PLANNING
JENNIFER MURPHY, MANAGER, CARBON AND ENERGY TRANSITION PLANNING

1. This evidence describes the energy transition assumptions that Enbridge Gas has incorporated into the Company's forecasting and planning processes, and the impacts on the Company's Asset Management Plan (AMP), finance and regulatory approaches.

2. This evidence is organized as follows:
    1. Forecasting
    2. Planning
    3. Finance and Regulatory Approaches

1. Forecasting

1.1. Introduction

3. This section provides details on how Enbridge Gas has considered energy transition in the Company's forecasted number of customers, average use, design day and design hour demand, and distribution contract customer demand.

4. These forecasts are important inputs into the Company's planning activities, such as the Asset Management Plan (AMP) development, gas supply planning, and rate setting. To ensure Enbridge Gas's planning activities appropriately consider the impacts of climate policies and energy transition, the Company undertook a review of each forecast to determine what energy transition adjustments to make at this time.

depreciation rates are supported by a depreciation study conducted by Concentric Energy Advisors, Inc. (Concentric), which is provided at Exhibit 4, Tab 5, Schedule 1, Attachment 1.

51. In developing the proposed depreciation rates, Enbridge Gas and Concentric considered the introduction of an 'Economic Planning Horizon' (EPH) or truncation date to reflect the potential impact that energy transition could have on the economic life of Enbridge Gas's system.

52. There is potential that climate change legislation, such as municipal or provincial plans to phase out the use of natural gas, could have a life-shortening effect on Enbridge Gas's system. However, there is also the possibility that service lives could be lengthened or maintained if low-carbon fuels, such as hydrogen and RNG, are determined to be viable sustainable alternatives to natural gas. Also, as demonstrated in the P2NZ Study provided at Exhibit 1, Tab 10, Schedule 5, Attachment 2, and Exhibit 1, Tab 10, Schedule 5, Section 3, Enbridge Gas's system will be a key contributor to achieving net-zero in the province.

53. Enbridge Gas and Concentric concluded that introducing an EPH is not appropriate at this time. There remains uncertainty around the impacts that energy transition could potentially have on Enbridge Gas's system as discussed above. However, future depreciation studies may warrant the introduction of regional or system wide EPHs, as the energy transition unfolds and more information on the future utilization of Enbridge Gas's assets becomes available.

54. If a diversified pathway to net-zero is not adopted in Ontario, Enbridge Gas would seek to introduce an EPH on its system to mitigate the risk of stranded assets. For illustrative purposes, if a system-wide 2050 EPH were to be implemented starting

ENBRIDGE GAS INC.

Answer to Interrogatory from
Ontario Greenhouse Vegetable Growers (OGVG)

Interrogatory

Reference:

Exhibit 1 Tab 10 Schedule 4 Pages 17, 18

Question(s):

Enbridge Gas and Concentric concluded that introducing an EPH is not appropriate at this time. There remains uncertainty around the impacts that energy transition could potentially have on Enbridge Gas's system as discussed above. However, future depreciation studies may warrant the introduction of regional or system wide EPHs, as the energy transition unfolds and more information on the future utilization of Enbridge Gas's assets becomes available.

If a diversified pathway to net-zero is not adopted in Ontario, Enbridge Gas would seek to introduce an EPH on its system to mitigate the risk of stranded assets. For illustrative purposes, if a system-wide 2050 EPH were to be implemented starting 2024, the 2024 Test Year depreciation expense would increase by $282 million from $921 million to $1.2 billion. The depreciation study used to calculate this is provided at Exhibit 4, Tab 5, Schedule 1 Attachment 1.

a) Please confirm that regional EPHs in conjunction with EGI's one rate zone proposal would mean that customers in regions where natural gas use remains robust enough to obviate the need for an EPH would nevertheless experience increased rates associated with the more rapid depreciation of assets in regions with EPHs. If not confirmed, please explain how customers in a non-EPH region would be protected against the increased depreciation costs associated with a region where an EPH has been implemented.

b) Please confirm that were EGI to maintain separate rate zones for both cost allocation and rate design purposes, an EPH implemented in one (regionally based) rate zone would not adversely impact rates in any of the other rate zones.

Response:

a-b) Enbridge Gas agrees that in principle, under one rate zone the introduction of an EPH to one region would likely have an impact of increased rates to customers in all other regions. However, it should be noted that the Company has not evaluated the practicality of regional EPH's versus a system wide approach should the Company move to applying an EPH in a subsequent rate application. Please see response at Exhibit I.1.10-OGVG-1 part b).

ONTARIO ENERGY BOARD

FILE NO.:	**EB-2022-0200**	**Enbridge Gas Inc.**

VOLUME: **Technical Conference**

DATE: **March 23, 2023**

MR. MILLAR: Yeah, Jay, you are right at your time.

MR. SHEPHERD: Okay. Then I want to ask one more question. Hang on.

No, I think I'll stop there. Thank you.

MR. MILLAR: Thank you very much, Mr. Shepherd.

Mr. Daube, I believe, or -- it's Three Fires Group; is that you, Mr. Daube?

MR. DAUBE: Yes, that's right.

MR. MILLAR: Okay. Please go ahead. I have you down for -- is it -- 45 minutes, 45 minutes or less.

MR. DAUBE: Okay, thanks.

MR. MILLAR: Optimistically. Okay. Go ahead.

MR. DAUBE: I think you can be optimistic. I think I'll be shorter than that --

MR. MILLAR: Mr. Daube, I'm sorry to interrupt. Just one more thing. I've been asked to remind parties to do their best to not to speak over each other, even though I just spoke over Mr. Daube. That was meant to be an example of what not to do.

So I'll ask for everyone's continued cooperation in that regard. It is just, it is impossible for the court reporter to keep track of things if more than one person is speaking at once.

MR. DAUBE: Great. Thank you.

EXAMINATION BY MR. DAUBE:

MR. DAUBE: Can we start with Exhibit I.1.10-Three Fires-4, please.

And we are going right to the end of those responses to the answer to questions (h) and (i), so this is on the third page. And I'm zeroing in on the statement that "Enbridge Gas cannot determine if different customer types will be disproportionately impacted without further analysis."

So I guess, question number 1, I asked this question with specific reference to a scenario.

Is this -- are you saying this in general, that it's impossible to make that determination in general for the various scenarios that we're discussing in this proceeding?

MS. WADE: Cara-Lynne Wade, Enbridge Gas.

We're saying that at this time we have not looked at the disproportionate impact on different customers with fuel-switching, but I would note that one of the key elements that we've outlined in 1.10.6 as part of our energy transition plan and also 1.10.5 at the end related to our vision is that an orderly transition that accounts for the impacts on all customer types is critical and something that we have taken into consideration and what we believe a diversified pathway could potentially support.

MR. DAUBE: Okay. But no analysis in general of the kind that's being described here has been undertaken to this point; is that correct? What you are describing for me are the principles that will apply if and when we get to that point?

MS. WADE: That's correct.

MR. DAUBE: What, if anything, is preventing Enbridge from carrying out that sort of analysis?

MS. WADE: Cara-Lynne Wade. I wouldn't say there's anything stopping us from carrying out that analysis. I think, as noted, that is a key principle that's going to be at the forefront as we continue to move forward with -- if approved, the proposals within our energy transition plan.

MR. DAUBE: Okay, what would be involved in that sort of analysis if you were to undertake it now?

MS. WADE: I don't think I can speak to that right now. I think that's something that we would be putting together, something as we look forward in the implementation of our proposals, if approved.

MR. DAUBE: Okay, now I'm sure you're aware in Enbridge's application there's reference from one of your experts to the risk of a death spiral scenario, and that, in part, in informing questions like this.

So is the company's position it really doesn't know how it would go about assessing the risk as it would apply to specific customer groups?

MS. WADE: I'm just saying I cannot speak to that right now, in terms of how we would go about assessing the risk at this point.

MR. DAUBE: Okay, so I guess question number 1, then, is has the company given any consideration to that issue beyond the -- sorry, let me phrase that a better way.

Has the company given any consideration as to how it could determine likely impacts on specific customer groups?

MS. WADE: At this point in time, no, we have not determined how we would go about the analysis.

I would just -- I think note again, that it has been a key principle that has been considered and has been included within our plan.

MR. DAUBE: And I want to be fair. Not -- determined wasn't quite what I was asking. Have there been early considerations given as to how you would determine what the impacts would be?

MS. WADE: No, there has not been at this point. And I think I just restate that for Enbridge Gas, as noted in section 1.10.5, our vision is of a diversified pathway which we believe would create greater customer choice and prevent the death spiral, as you have noted. And so it's a key principle that I can't speak to it further.

MR. DAUBE: Okay. Is there any early consideration beyond what I'm going to find in those sections that you've referenced as to how those principles will apply to lower income customers?

MS. WADE: No, at this point I would not be able to speak to that for a specific customer segments except where those considerations would be at the forefront, as I noted as we moved forward in the implementations of any proposals that are approved.

MR. DAUBE: And when you say would you not be able to speak to, is that Enbridge's position as well or should I ask for an undertaking for the company's ability to do so?

MS. WADE: Can I actually just confer with the panel?

MR. DAUBE: Yeah, and I'm going to be asking the same question about Indigenous communities, including remote

[Witness panel confers.]

MS. WADE: Cara-Lynne Wade. So I'll just start with the lower income population.

We would agree that there could be a greater impact to those communities if there are not policies that could support, say, reduced cost for those communities to be able to uptake, say, a potentially new technology.

And for remote Indigenous communities, I think it will depend on the community, but we would agree that there could be particular instances where, say, access to renewable electricity or, depending on the solution on the gas system, if that could also exist.

MR. DAUBE: Thank you. I have two more chapters here and for both of them you may tell me that you're the wrong panel and then we can talk about where I should be asking them or how I can get answers to the questions, so happy to have that conversation if that's your view, but hopefully you're the right people.

I would like to go, please, to exhibit I.1.6-Three Fires-1, and specifically answer (b).

So the first paragraph I'm going to ask a question, but just for general context, I'm just trying to reconcile a statement in here with the conversations that we're having with this particular panel on energy transition and the pretty significant changes that we discuss in pretty well every scenario, so the statement that I'm zeroing in on is sentence number 2 in answer (b):

"This application does not have a physical impact

on traditional lands or on Aboriginal and treaty
rights, and therefore Enbridge Gas has not
undertaken a consultation program and so on."

So it's really the first part of that sentence that I'm hoping you can help me to reconcile with, with the kinds of changes that are anticipated in each of the scenarios.

So can you -- can you reconcile for me what the company's position is, whether you want to provide further context to the first part of this sentence or whether, notwithstanding the various considerations and developments that we've discussed with this panel, the company's position really is that this application will not have a physical impact on the traditional lands or Aboriginal and treaty rights, full stop?

MR. STEVENS: Thanks, Nick. It is David Stevens, counsel for Enbridge. I just want to give a little bit of context, and then the witnesses may have something more to say. I just want to be clear that this is primarily a cost-of-service application for 2024.

MR. DAUBE: Yeah.

MR. STEVENS: It also presents context and budgets, et cetera, that support the upcoming incentive regulation term to 2028, whereas the reports that have been submitted around Pathways and Energy Future go much beyond that and deal with, you know, much broader questions of what may be coming or what might not be coming, but in the context of this answer, we're talking about what's being asked for

Tab 7

ENBRIDGE GAS INC.

Answer to Interrogatory from
Green Energy Coalition (GEC)

Interrogatory

Reference:

Ex.1, Tab 10, S.2

Question(s):

"Enbridge Gas has over $14 billion in regulated assets". What proportion of those assets (in dollar value) will need to be modified to enable the predominantly hydrogen-based pathway the evidence suggests?

Response:

Currently it is not known what proportion will require or may not require modifications to enable hydrogen on Enbridge Gas regulated assets. Enbridge Gas plans to undertake a Hydrogen Blending Grid Study during the IR term to address this and other questions related to hydrogen in the gas distribution system. Please see Exhibit 4, Tab 2, Schedule 6 pages 16-18 for more details.

ENBRIDGE GAS INC.

Answer to Interrogatory from
Green Energy Coalition (GEC)

Interrogatory

Reference:

Exhibit 1, Tab 10, Schedule 5, Attachment 2, Page 3 of 86

Question(s):

Guidehouse indicates that its study mandate included examining each pathway in terms of feasibility. Please describe in detail the assumptions used by Guidehouse for the physical change-over of the distribution system from methane to hydrogen. For example, would a neighborhood being switched require simultaneous appliance upgrades and universal changeover or would there be a need for the duplication of portions of the system to accommodate gradual transitions? Please indicate what costs and timing were assumed for each aspect of this changeover. How has Guidehouse spread the transition from methane to hydrogen out over time to make the transition manageable?

Response:

The following response was provided by Guidehouse Canada Ltd.:

The Guidehouse assumptions regarding gas network transitions from methane to hydrogen service are described in response at Exhibit I.1.10-GEC-15 i-j). The P2NZ study modeled pathways to net-zero emissions on a province-wide basis and did not model the transition at a neighborhood level of granularity. Costs for upgrading methane distribution pipelines to accept hydrogen blending and for the development of hydrogen distribution systems within Ontario are outside the scope of the P2NZ analysis and not included. This is because a more detailed regional analysis is needed to understand how new hydrogen networks would develop depending on projections of regional demand centers and potential opportunities for collocating supply with demand.