Canada Energy Regulator | Régie de l'énergie du Canada

Canada's Energy Future, including Net-Zero Analysis: Approach and Scenarios Discussion Paper

About the Canada Energy Regulator

The mission of the Canada Energy Regulator (CER) is to regulate infrastructure to ensure safe and efficient delivery of energy to Canada and the world, protecting the environment, recognizing and respecting the rights of the Indigenous peoples of Canada, and providing timely and relevant energy information and analysis.

The CER produces relevant, accessible, and transparent publications, data, tools, and expert advice on Canada's energy system and CER-regulated facilities. Find out more on our website.

About the Canada's Energy Future Report

A key publication of the CER's energy information core responsibility is Canada's Energy Future. Canada's Energy Future is a series of reports that explore possible energy futures for Canadians over the long term. It analyzes and provides data for all provinces and territories, and all energy commodities like crude oil, natural gas, electricity, renewables, and more. It uses economic and energy models to make projections about how the future might unfold, while making assumptions about certain trends, including climate policies, technology, and consumer behaviour.

The CER has a long history (including as the National Energy Board) of doing long-term energy supply and demand outlooks. The first such outlook was published in 1967. The latest version of Canada's Energy Future was published in December of 2021 (EF2021).

The CER's analysis is increasingly focused on exploring what Canada's energy transition to a low-carbon economy could look like in the long term. The Canada's Energy Future 2021 report, aside from updating the main scenarios (*Current Policies and Evolving Policies*), introduced six new scenarios to explore a net-zero[1] future. Specifically, these scenarios explored what Canada's electricity system might look like in a net-zero world under different assumptions about future technologies, climate policies, and electricity use.

Exploring Net-zero in the Next Canada's Energy Future Report

In December 2021, the Honourable Jonathan Wilkinson, Minister of Natural Resources and the Minister responsible for the CER, wrote a letter to the Chairperson of the CER's Board of Directors, Cassie Doyle. The letter requested that the CER undertake scenario analysis consistent with Canada achieving net-zero emissions by 2050 as soon as possible.

In her response, Chairperson Doyle both welcomed the clarity provided by the Minister's letter, and confirmed the next Canada's Energy Future report will include modelling consistent with Canada's commitment to achieve net-zero emissions by 2050.

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[1] Net-zero refers to when anthropogenic (or human-caused) emissions of GHGs into the atmosphere are balanced by anthropogenic removals of greenhouse gases (GHGs) from the atmosphere over a specified period.

In the spring of 2022, Chairperson Doyle provided an update to the Minister on the progress of the next Canada's Energy Future report. The update described the CER's scenario approach and specified that the report **will be released in the Spring of 2023**.

Purpose of this Engagement

The purpose of this engagement initiative is to gather feedback on our approach to the next Energy Futures report. Your responses to the questions below will inform how the scenarios, assumptions, and methodologies are developed. This engagement is also an opportunity to inform interested Canadians about the high-level approach to the next report, including how the net-zero analysis will be conducted.

Your answers will help the CER obtain:

- ✓ High-level feedback on the modelling approach and preliminary assumptions;
- ✓ Insights about alternative modelling scenarios that are of interest to Canadians; and
- ✓ Any other input, suggestion, or feedback that could enhance the content of the report.

Canada's Energy Future is part of the CER's Energy Information Core Responsibility and is separate from the CER's role in regulating energy infrastructure in Canada. As such, this engagement initiative is not a regulatory proceeding or inquiry, but rather an avenue for the CER to gather feedback to improve the energy information it provides to Canadians.

The Scenario Approach

The next Canada's Energy Future report will include two sets of scenarios:

1) Net-zero analysis exploring multiple pathways to net-zero for Canada.

   Research and discussions with experts suggest that using scenarios to explore uncertainties in reaching net-zero improves the credibility and relevance of the analysis. The CER is proposing to develop scenarios where Canada achieves its net-zero goals under different assumptions about the future, including where the world achieves the Paris Agreement goal of limiting warming to 1.5 degrees Celsius, compared to pre-industrial levels.

2) A scenario to provide a baseline for comparison to net-zero, based on existing policies or announced but not yet finalized policies with enough detail available for modeling purposes.

   The premise of this scenario will be similar to the Current Policies Scenario in EF2021. This scenario would enable a comparison of how different energy systems, technological developments, investment needs, and other economic indicators would differ between our current energy system and the net-zero scenarios.

To focus efforts on net-zero analysis, the Evolving Policies Scenario will not be updated.

Instructions

Please respond to the discussion questions in the boxes below. You do not need to answer all the questions, only those that are of interest to you.

The deadline for feedback is 24 June 2022.

The detailed feedback received will be for internal use and will not be published on the CER website or elsewhere. The CER will compile the feedback and develop a summary document that will be posted on the CER Energy Futures page, without attribution to individual respondents.

Topic 1: Contact Information

Please tell us a little bit about yourself. The information provided here is only to serve as context for the responses provided. The feedback received will be posted as a summary report, with no attribution to individual respondents or organizations. With your permission, your contact information may be used by the CER to contact you for further clarification about your input. Notes will be stored, secured, and deleted as per the CER's retention and disposition standards. Please see our terms and conditions for more privacy information.

Name:	
Role/job title:	
Organization (if you are providing this submission on behalf of your organization):	
Email address:	
Does the CER have your permission to contact you for further clarification on your feedback? (Y/N)	
The CER's Energy Information unit is looking for feedback on our publications. May we contact you about your experiences using CER publications? (Y/N)	

Topic 2: Scope of Net-zero Analysis in the next Canada's Energy Future report

The report and net-zero scenario analysis will have the following parameters:

- Consistent with Canada achieving net-zero emissions by 2050;
- Inclusion of fully modelled scenarios of supply and demand for all energy commodities in Canada;
- Consistent with a global context in which the world achieves its Paris Accord goal of limiting warming to 1.5°C; and
- Inclusion of relevant uncertainties, including future trends in low-carbon technology and energy markets.

Discussion question:

1) **Are there other factors that the CER should scope in (or scope out) of our net-zero analysis? What are they?**

(type your response here)

Topic 3: International Assumptions for Net-zero Scenarios

The CER is developing multiple analyses of a net-zero future. The feedback received here will inform this analysis in the next Canada's Energy Future report. Central to the CER net-zero analysis will be a scenario in which the world achieves the Paris Agreement goal of limiting warming to 1.5°C. The CER is seeking feedback on our preliminary assumptions of this scenario, particularly those related to international factors.

The core premise of this scenario is that actions to reduce the greenhouse gases (GHGs) emitted by Canada's energy system and other human activities are consistent with achieving net-zero by 2050. This scenario will also assume that the world achieves its Paris Agreement goal of limiting warming to 1.5°C.

As an energy trading nation, what happens outside of Canada has a significant impact on any scenario. The CER does not model international energy outcomes and instead makes assumptions[2] on these factors.

For the international assumptions in this scenario, the CER is considering relying in part on the Net-Zero Emissions by 2050 Scenario (NZE) from International Energy Agency's (IEA) Net Zero by 2050 analysis, released in May 2021. The IEA's NZE Scenario is consistent with limiting the global temperature rise to

[2] In the context of Energy Futures, assumptions are inputs to our energy and economic models. We make assumptions on factors such as crude oil and natural gas prices, liquified natural gas exports, and climate policies. Assumptions are often made when a factor is necessary for the analysis but are not something that can be explicitly modelled. Modellers often develop different sets of assumptions to generate different scenarios to understand how the energy future might look under different circumstances.

1.5°C. The assumptions from the NZE Scenario (such as crude oil and natural gas prices, the costs of various energy technologies, and global economic growth), could be input into the CER's models to ensure the CER's scenario is consistent with a 1.5°C global context. The results of this Energy Futures scenario would differ from the IEA's NZE Scenario's results that are specific to Canada because of differences in modelling techniques and assumptions that are domestic in nature.

The IEA energy modeling work is well established as a premier international long-term energy supply and demand outlook, and recently introduced net-zero scenarios. The IEA's analysis is publicly available, and the assumptions are transparent.

The NZE Scenario depicts wide-spread transformation of global energy systems. In the NZE Scenario, global demand for fossil fuels drops dramatically and adoption of low-carbon technologies accelerates. A small selection of the results and assumptions from this report include:

- All countries are working together to achieve the Paris Agreement commitment to limit global warming to 1.5°C.
- The global crude oil price is 35 US$/barrel by 2030 and 24 US$/barrel in 2050 (in inflation-adjusted terms) because of lower demand.
- The North American natural gas price is 1.90 US$/Million British thermal unit (MMBtu) in 2030, and 2.00 US$/MMBtu in 2050 (in inflation-adjusted terms).
- The levelized cost of electricity (LCOE) of solar energy will go from $50/megawatt hour (MWh) in 2020 to $20/MWh in 2050. The LCOE of onshore wind will go from $35/MWh to $30/MWh.[3]

Discussion questions:

1) **What is your perspective on relying on the IEA's NZE Scenario as a source for assumptions on international energy outcomes in the next Energy Future report? Are there any caveats to consider when relying on the IEA's NZE Scenario?**

2) **Are there any other sources the CER should consider for international assumptions in its net-zero scenarios? What would be the purpose and benefit(s) of relying on those other sources?**

(type your response here)

[3] The LCOE is the average price an electricity generator must receive for each unit it generates over its lifetime to financially break even.

Topic 4: Additional Net-zero Analysis

The CER will develop additional modelling analysis in which Canada achieves its net-zero goals under different assumptions about the future. The purpose of this analysis is to address the uncertainty of what a net-zero future could look like for Canada by analyzing different pathways to 2050.

Themes for this analysis could include:

- The rest of the world does not act as quickly as Canada to reduce GHG emissions;
- Variations to the costs and effectiveness of different emerging energy production and end-use technologies, including:
    - Hydrogen
    - Biofuels
    - Carbon capture and storage
    - Negative emissions technologies, such as:
        - Direct air capture
        - Bioenergy with carbon capture and storage
        - Nature-based solutions
    - Nuclear power, including small modular reactors (SMRs)
    - Renewables like wind and solar
    - Batteries (for utility-scale electricity storage and electric vehicles)
- Different expectations about behavioral and societal changes regarding energy use;
- Higher or lower economic activity;
- Different global oil and natural gas price assumptions than in the scenario described in topic 3, and;
- An international context that limits the global temperature rise to 1.5 °C, but a different pathway than described in the IEA NZE Scenario.

Discussion questions:

1. **Of the potential themes for additional net-zero modelling analysis mentioned above, which do you think are most important to model and analyze? If so, why?**

2. **Are there other areas of uncertainty that the CER should consider including in its analysis?**

(type your response here)

Topic 5: Methodology and Net-zero Analysis

The CER will use the Energy Futures Modelling System for the next Canada's Energy Future report. An overview of the modelling system is available as an appendix to EF2021. With upgrades made over the past two years, the CER is well-positioned to model net-zero in the next report.

The approach used to model net-zero differs from the approach used in past Canada's Energy Future reports. Typically, the CER develops a set of assumptions for each scenario and then runs its models with those inputs. The results show what the energy system might look like in those circumstances, with no constraints on the outcomes. This is how the "Current Policies Scenario" in the upcoming report will be modelled. Modelling net-zero requires a constraint on the outcome of the model: Canada reaches net-zero GHG emissions by 2050.

The CER's net-zero modelling will begin with a set of input assumptions on factors such as global energy markets, economic conditions, consumer behaviour, technology costs, and known policy initiatives. To model net-zero we will run our models multiple times, increasing the strength of climate policies (such as the price of carbon) each time. Stronger policies will generate a response in the models to further reduce GHGs (such as greater energy efficiency, switching to non-emitting fuels and technologies, or lower activity levels in high-emission sectors). We will continue this process until the GHG emission results are consistent with net-zero.

To illustrate this concept, the application of this methodology to one aspect of the CER's Energy Futures Modelling System, the oil sands model, is described here:

> The initial inputs for this model include crude oil prices (such as those from the IEA's NZE Scenario), costs for inputs such as natural gas, costs for various decarbonization options in the sector, and known policy initiatives. The model would then generate results for oil sands production, energy use, and GHG emissions based on those inputs and the model's parameters. Once all models have generated results, if Canada's total GHG emissions are net-positive in 2050, stronger future climate policies would be input and all of the CER's models would be run again. In the oil sands model, these stronger policies would again be factored into the model, generating new results for production, energy use and GHG emissions.

The CER's analysis will also consider negative emission options. This includes nature-based activities such as reforestation and technologies that could generate net negative emissions, such as direct air capture technology.

Discussion questions:

1. **Some regulations are still under consultation and development (such as the proposed Clean Electricity Standard or regulated sales mandate for zero emission vehicles). To what extent, and how, should these draft policies be included in the net-zero analysis assumptions?**
2. **How should policy initiatives that are yet to be announced, but are necessary for Canada to reach net-zero emissions by 2050, be chosen and modelled?**
3. **Negative emissions are an important part of most net-zero scenarios. How should these be considered in the modelling process? Options could include allowing the model to determine the level of negative emissions based on costs and incentives for capturing emissions or fixing negative emissions to a certain level.**

(type your response here)

Topic 6: General Feedback

Over the upcoming months and years, the CER will continue to build on decades of energy systems modelling to provide analysis that is relevant and useful to Canadians. The CER is dedicated to engaging with Canadians to ensure that the report continues to improve.

Discussion questions:

1. **Is there anything else you can think of that could be relevant to the analysis or modelling of Canada's net-zero future?**
2. **What is the most meaningful way to reflect the interests of Indigenous peoples in this analysis?**
3. **How do you expect to use the next Canada's Energy Future report, including the net-zero analysis, for your own knowledge, research, or decision-making about energy in Canada?**
4. **Do you have any other feedback or general comments?**

(type your response here)

Next Steps

The information gathered through this survey will be used internally to shape the approach and analysis. This information also will be summarized in a report (without attribution) that will be published on the CER's website in the summer of 2022.