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What does achieving net zero mean for clean energy jobs in Canada?

Report prepared for Clean Energy Canada

SUBMITTED TO

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SUBMITTED BY

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About Us

Navius Research Inc. is an independent and non-partisan consultancy based in Vancouver. We operate proprietary energy-economy modeling software designed to quantify the impacts of climate change mitigation policy on greenhouse gas emissions and the economy. We have been active in this field since 2008 and have become one of Canada's leading experts in modeling the impacts of energy and climate policy. Our analytical framework is used by clients across the country to inform energy and greenhouse gas abatement strategy.

We are proud to have worked with:

- Most provincial and territorial governments, as well as the federal government.
- Utilities, industry associations and energy companies.
- Non-profit and research organizations with an interest in energy, climate change and economics.

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Summary

This report builds on previous work with Clean Energy Canada to quantify Canada's clean energy economy and explore potential jobs trends, this time out to mid-century. It considers the impact of three scenarios on clean energy jobs:

- **Current policies.** This scenario includes currently legislated and announced provincial and federal policies, including the Emissions Reduction Plan (ERP).
- **Rollback scenario.** This scenario explores a future under which recent federal climate policy is repealed, including all ERP policies, the Clean Fuel Regulations and the carbon levy and output-based pricing system.
- **Net zero.** In this scenario, climate mitigation ambition is scaled up such that Canada achieves its 2030 GHG target and net zero greenhouse gas emissions by 2050.

This study also considers the impact of uncertainty in several factors, including the cost and availability of emerging low and negative carbon technologies.

Key findings

Clean energy jobs are expected to grow under all scenarios, and account for a growing share of energy related jobs.

This study focuses on energy-related jobs, which account for about 14% of all jobs in Canada. In a net zero world (i.e., one with low demand for Canada's oil), clean energy job growth is expected to outpace the decline in rest of energy jobs. Figure 1 shows that the number of clean energy jobs grows from about 388 thousand in 2020 to between 1.6 and 2.7 million in 2050.

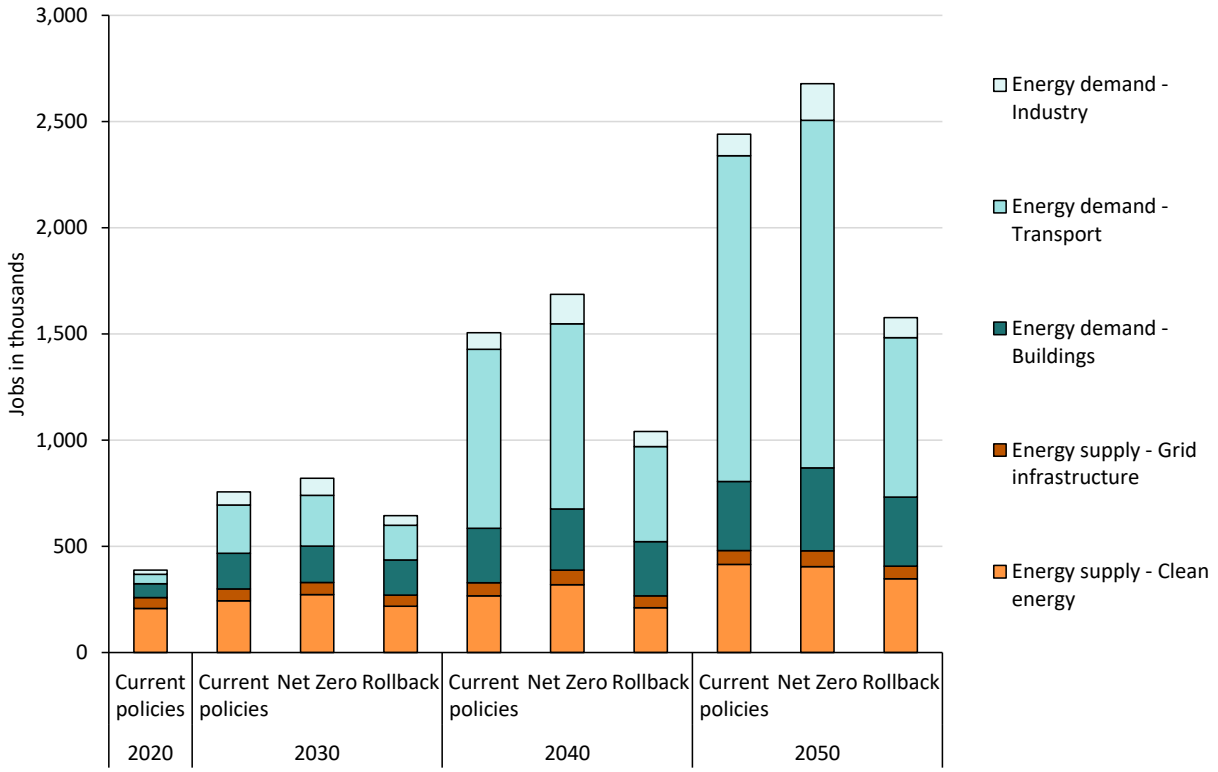
Current policies, including the federal ERP, are likely to have a large impact on clean energy job creation.

The baseline current policies forecast results in 2.4 million clean energy jobs by 2050, just shy of the 2.7 million achieved in the net zero scenario. Conversely, when key policies such as the ERP are repealed in the rollback scenario, clean energy jobs reach 1.6 million. This means that the ERP, including a federal carbon price of $170/t CO_2e, play a significant role in boosting clean energy jobs.

Today, most clean energy jobs are associated with producing clean electricity. In a net zero future, clean energy jobs are likely to be increasingly distributed across other sectors.

In 2020, most clean energy jobs are on the energy supply side, including jobs involved in renewable electricity and biofuel production. While the number of clean jobs in energy supply grows over time, it is overtaken by growth in energy demand related clean jobs. By 2050, over three quarters of clean jobs are associated with technologies that consume energy, spread across transport, buildings and industry.

Figure 1: Overview of clean jobs by scenario.



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1. Introduction

Clean Energy Canada is interested in exploring potential clean energy jobs trends out to mid century. Specifically, what does clean energy job growth look like in response to current and announced policies, such as the federal Emissions Reduction Plan? How might this growth change in a scenario with greater climate ambition that is consistent with Canada's net zero targets by mid-century? And conversely, what might be in store for clean energy jobs if key policies were rolled back?

This report builds on previous work by Navius[1] to quantify Canada's clean energy economy by extending projections beyond 2030, updating sector definitions and considering uncertainty.

It applies the same general definition of the clean energy economy, which includes "the technologies, services and resources that increase renewable energy supply, enhance energy productivity, improve the infrastructure and systems that transmit, store and use energy while reducing carbon pollution."[2]

This report is structured as follows. First, we describe the approach, including the modeling framework used for this analysis, the definition of the clean energy economy and key scenario assumptions. Second, we explore the resulting projections of clean energy jobs through mid-century.

[1] For example, see: Navius Research. 2021. Canada's Clean Energy Economy to 2030. Prepared for Clean Energy Canada. https://www.naviusresearch.com/publications/clean-energy-economy-2021/

[2] Navius Research. 2019. Quantifying Canada's Clean Energy Economy. An assessment of clean energy investment, value-added and jobs. Prepared for Clean Energy Canada. https://www.naviusresearch.com/publications/clean-energy-economy/

2. Approach

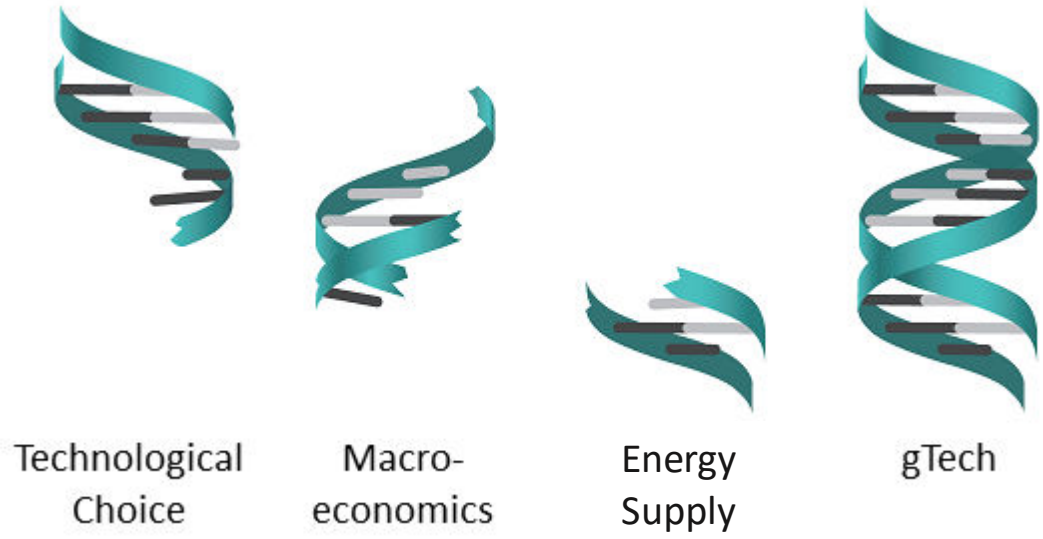
This Chapter provides an overview of the approach used to simulate Canada's clean energy economy through 2050. It begins with a description of Navius' gTech model (Section 2.1). This is followed by an explanation of how the clean energy economy is defined (Section 2.2) and the scenarios explored in this analysis (Section 2.3).

2.1. Introduction to gTech

gTech is unique among energy-economy models because it combines features that are typically only found in separate models (see Figure 2):

- A realistic representation of how households and firms select technologies and processes that affect their energy consumption and greenhouse gas emissions.
- An exhaustive accounting of the economy at large, including how provinces and territories interact with each other and the rest of the world.
- A detailed representation of energy supply, including liquid fuel (crude oil and biofuel), gaseous fuel (natural gas and renewable natural gas), hydrogen and electricity.

Figure 2: The gTech model



gTech builds on three of Navius' previous models (CIMS, GEEM and OILTRANS/IESD), combining their best elements into a comprehensive integrated framework.

Simulating technological choice

Unlike most computable general equilibrium (CGE) models, gTech contains substantial technological detail, such that it can account for the complexities of the energy economy system. Technological detail allows gTech to examine the impact of technology deployment on energy consumption, GHG emissions and the broader economy. gTech is designed to provide a forecast of how households and firms adopt technologies, and how technological adoption affects energy and emissions profiles. It simulates how energy prices, technology costs and policies affect which technologies are used to provide energy end-uses (e.g. lighting, process heating, mobility etc.). These choices in turn affect energy consumption, air emissions, capital costs, operating costs and energy costs. The model also accounts for the intangible and interactive technological, behavioural, and economic factors that accompany energy use and GHG emission policies.

Understanding the macroeconomic impacts of policy

As a CGE model, gTech represents key economic transactions within the economy allowing it to forecast the economic impacts of climate policies. These economic transactions include:

- **Interlinkages between sectors of the economy.** gTech explicitly represents 120 sectors of the economy (e.g., construction, cement manufacturing, petroleum refining). Each sector of the economy is characterized by the goods it produces (e.g., cement), and the inputs required to production (labor, capital, energy, etc.). As an equilibrium mode, gTech simulates how every sector of the economy returns to equilibrium if a policy is introduced or if economic conditions change. For example, if a policy reduces construction activity, demand for construction inputs, such as cement, would also be reduced.
- **Interlinkages between households and sectors of the economy.** Households lend their time and savings to industry in exchange for income. Any change in income generation within a province affects household income.
- **Interlinkages between regions.** gTech represents a total of 12 regions in North America, including each Canadian province, a single region representing the territories, and the United States. gTech accounts for bilateral trade between these regions as well as international trade beyond North America. Policies implemented in a given region can then affect the level of trade that occurs with the rest of the world.

Understanding energy supply markets

gTech accounts for all major energy supply markets, including electricity, refined petroleum products, natural gas and hydrogen. Each market is characterized by resource availability and production costs by province and territory, as well as costs and constraints (e.g. pipeline capacity) of transporting energy between regions.

Low carbon energy sources can be introduced within each fuel stream in response to policy, such as renewable electricity and bioenergy. The model accounts for the availability and cost of bioenergy feedstocks, allowing it to provide insight about the economic effects of emission reduction policy, biofuels policy and the approval of pipelines.

gTech: The benefits of merging macroeconomics with technological detail

By merging the three features described above (technological detail, macroeconomic dynamics, and energy supply dynamics), gTech can provide extensive insight into the effect of climate and energy policy.

First, gTech can provide insights related to technological change by answering questions such as:

- How do policies affect technological adoption (e.g. how many heat pumps are likely to be installed by 2030 or 2050)?
- How does technological adoption affect energy consumption and greenhouse gas emissions?

Second, gTech can provide insights related to macroeconomics by answering questions such as:

- How do policies affect gross domestic product?
- How do policies affect individual sectors of the economy?
- Are households affected by the policy?
- Does the policy affect energy prices or any other price in the model (e.g., food prices)?

Third, gTech answers questions related to its energy supply modules:

- Will a policy generate more supply of renewable fuels or greater demand for electricity?

- Does policy affect the cost of transporting refined petroleum products, and therefore the price of gasoline in Canada?

Finally, gTech provides insight into areas where there is overlap between its various features:

- What is the effect of investing carbon revenue into low- and zero-carbon technologies? This question can only be answered with a model such as gTech.
- What are the macroeconomic impacts of technology-focused policies (e.g. how might a fossil fuel heating ban impact GDP)?
- Do bioenergy focused policies affect (1) technological choice and (2) the macroeconomy?

This modeling toolkit allows for a comprehensive examination of the impacts of energy and climate change policy in Canada.

2.2. Defining the clean energy economy

To categorize the clean energy economy in gTech, we assign jobs into one of three categories:

- **Clean energy** (i.e., as defined below).
- **Rest of energy** (i.e., most activities related to fossil energy supply and use, other than those considered clean such as emissions control efforts).
- **Non-energy** (e.g., insurance services, education).

This report builds on previous work by Navius that defines the clean energy economy as:

> *"The technologies, services and resources that increase renewable energy supply, enhance energy productivity, improve the infrastructure and systems that transmit, store and use energy while reducing carbon pollution."*

Naturally, this definition could be applied in different ways. For example, what is the baseline level of carbon intensity that distinguishes clean from not clean? This study generally applied definitions with reference to net zero; in other words, is a technology or fuel likely to be consistent with net zero in Canada?

Table 1 lists the specific clean energy sectors that are considered under this definition for the purposes of this project. Each sector includes jobs spread out across multiple activities related to the clean technologies or fuel in questions. Jobs are attributed to one of three categories:

- **Direct.** This category includes employment of (1) sectors producing clean energy services (e.g., renewable electricity) and (2) value-added associated with the use of clean technologies in other sectors (e.g., a plug-in electric vehicle may be used to provide transport services).
- **Indirect.** This category includes indirect jobs related to the clean technology or fuel, such as construction (e.g., building an automotive manufacturing plant), manufacturing (e.g., assembling an electric vehicle) and services (e.g., selling an electric vehicle).

As a technologically-detailed macroeconomic model, gTech excels at identifying economic activity associated with specific technologies and fuels. While gTech includes detailed representation of more than 300 technologies and over 120 sectors of the economy, there are some technologies that currently aren't differentiated in the model. Technologies currently not differentiated in gTech include stationary batteries and energy storage, smart grid technology, energy-saving building materials and non-motorized transport. The model is naturally unable to quantify economic activity associated with these technologies.

Despite these limitations, gTech is well suited to the task of forecasting the development of (most) clean energy sectors because it combines the following features:

- A realistic representation of how households and firms select technologies and processes that affect their energy consumption and greenhouse gas emissions.
- An exhaustive accounting of the economy and jobs, including how provinces interact with each other and the rest of the world.
- A detailed representation of liquid fuel (crude oil and biofuel) and gaseous fuel (natural gas and renewable natural gas) supply chains.
- Incorporation of the most substantive energy and climate mitigation policies in Canada.
- Representation of how mitigation policies can change labour and capital markets, household income and household consumption of goods and services.

Table 1: Clean energy taxonomy

Sector category	Clean energy sector
Energy supply	
Clean energy	Renewable electricity
	Conventional nuclear
	Small modular reactors
	Bioenergy
	Waste to energy
	Clean hydrogen
	Carbon capture and storage
	Emission detection and control
Supply infrastructure	Electricity transmission & distribution
	Hydrogen and CO_2 pipelines
Energy demand	
Buildings	Efficient building envelopes
	Efficient HVAC and building controls systems
	Efficient appliances & lighting
Transport	Plug-in electric vehicles
	Hydrogen fuel cell electric vehicles
	Clean public transit
Industry	Low carbon machinery
	Low carbon steel
	Emission detection and control
	Carbon capture and storage
	Clean hydrogen consumption
	Direct air capture

Key changes since the last analysis[3] include:

- Conducting a detailed calibration to the latest data sources, including the National Inventory Report and energy use trends. In particular, gTech is now calibrated to 2020 data which were unavailable when the last report was released.
- Switching to the latest version of gTech, which includes the following improvements:
  - Adding new clean energy technologies, fuels and sectors such as small modular reactors, hydrogen pipelines and storage, carbon dioxide pipelines and storage, low carbon steel and direct air capture.
  - Updating the cost and performance of emerging low carbon technologies and fuels, such as battery electric and hydrogen fuel cell vehicles.
- Excluding conventional rail and transit (e.g., locomotives and buses with internal combustion engines). Even though conventional rail and transit offer energy efficiency improvements relative to trucking and private vehicle travel, these options are generally inconsistent with deep decarbonization.
- Accounting for the latest current and announced policies in Canada, including the federal Emissions Reduction Plan (please see Appendix A:).

2.3. Scenarios

The scenarios simulated for this project vary against two dimensions:

- The ambition of greenhouse gas policy and constraints, and
- Uncertainty about factors beyond the Government of Canada's control, such as the cost of emerging low carbon technologies.

Please note that to develop scenarios consistent with net zero, this analysis assumes a global oil price of 35 $2021 USD/barrel in 2030 and 24 $2021 USD/barrel in 2050, based on the IEA's World Energy Outlook 2022 Net Zero Emissions by 2050 scenario[4], and deep decarbonization in the U.S.

[3] Navius Research. 2021. Canada's Clean Energy Economy to 2030. Prepared for Clean Energy Canada. https://www.naviusresearch.com/publications/clean-energy-economy-2021/

[4] International Energy Agency (iea). (2022). World Energy Outlook 2022. Available from: https://iea.blob.core.windows.net/assets/830fe099-5530-48f2-a7c1-11f35d510983/WorldEnergyOutlook2022.pdf

2.3.1. Greenhouse gas policy & constraints

The analysis considers the following scenarios for implementation of greenhouse gas policy and constraints in Canada:

- **Current policies.** This scenario includes currently legislated and announced provincial and federal policies, such as a federal carbon price rising to $170/t CO_2e by 2030 and the Emissions Reduction Plan (ERP) policies like a federal cap on oil and gas emissions. Please note that uncertainty exists about how many of these policies will be implemented. A full list of simulated policies is provided in Appendix A:, starting on page 21. The Appendix provides details about the simulated policies and key assumptions.

- **Rollback scenario.** This scenario explores a future under which recent federal climate policy is repealed, including all ERP policies, the Clean Fuel Regulations and the carbon levy and output-based pricing system.

  In the absence of the federal carbon pricing backstop, Québec and British Columbia are assumed to continue to apply their current carbon pricing systems. British Columbia's carbon price is thereby assumed to remain at current 2022 levels ($50/ tonne CO2e), while Québec continues to apply its California-linked cap-and-trade program. All other provinces and territories are assumed to no longer have a carbon price.

- **Net zero.** In this scenario, climate mitigation ambition is scaled up such that Canada achieves its 2030 GHG target and net zero greenhouse gas emissions by 2050. Net zero is defined as emissions tracked by the National Inventory Report being virtually eliminated or offset by energy-related CO_2 removals (e.g., direct air capture). The analysis assumes that 30 Mt CO2e will be offset through Land Use, Land-Use Change and Forestry (LULUCF) in 2030[5], rising to 105 Mt CO2e LULUCF offsets in 2050[6].

[5] Environment and Climate Change Canada. (2022). Emissions Reduction Plan. Canada's Next Steps for Clean Air and a Strong Economy. Available from: https://publications.gc.ca/collections/collection_2022/eccc/En4-460-2022-eng.pdf, p. 191.

[6] Drever, C. R., Cook-Patton, S. C., Akhter, F., Badiou, P. H., Chmura, G. L., Davidson, S. J., ... & Kurz, W. A. (2021). Natural climate solutions for Canada. Science Advances, 7(23), eabd6034.

2.3.2. Sensitivity analysis

A sensitivity analysis was conducted to examine the impact of uncertainty in factors beyond the Government of Canada's control, including:

- **The cost of emerging low-carbon technologies and fuels.** What if the cost of emerging low-carbon technologies, including electric vehicles, hydrogen fuel cell vehicles and second generation biofuels, declines faster than expected?
- **The availability of direct air capture.** What if direct air capture is fully commercialized and available to offset Canada's greenhouse gas emissions?
- **The level of U.S. climate mitigation ambition.** As mentioned above, to develop a scenario consistent with net zero, this analysis assumes a global oil price of 35 $2021 USD/barrel in 2030 and 24 $2021 USD/barrel in 2050 and deep decarbonization in the U.S. We also consider a scenario in which emissions abatement efforts in the U.S. are rolled back.

3. Results

This section describes how jobs in the clean energy sector could evolve through mid-century under various potential futures for Canada. As described in the previous section, the baseline assumptions used in this analysis reflect a world that is on track to achieve net zero by mid-century (simulated using an oil price declining to 35 $2021 USD/barrel in 2030 and further to 24 $2021 USD/barrel in 2050 as well as strong climate policy effort in the US) and in which emissions reduction takes precedence over carbon dioxide removals (i.e., direct air capture is unavailable). The impact of alternative assumptions is reviewed in Section 3.2.

3.1. Clean energy jobs

This section begins by providing an overview of the clean energy job market under the three scenarios. It then presents more detailed results dividing the clean job market into energy supply side and energy demand side. The definition of clean jobs and the sectors included in each category are described in chapter 2.2.

3.1.1. Overview

Clean energy jobs are expected to grow under all scenarios, and account for a growing share of energy related jobs.

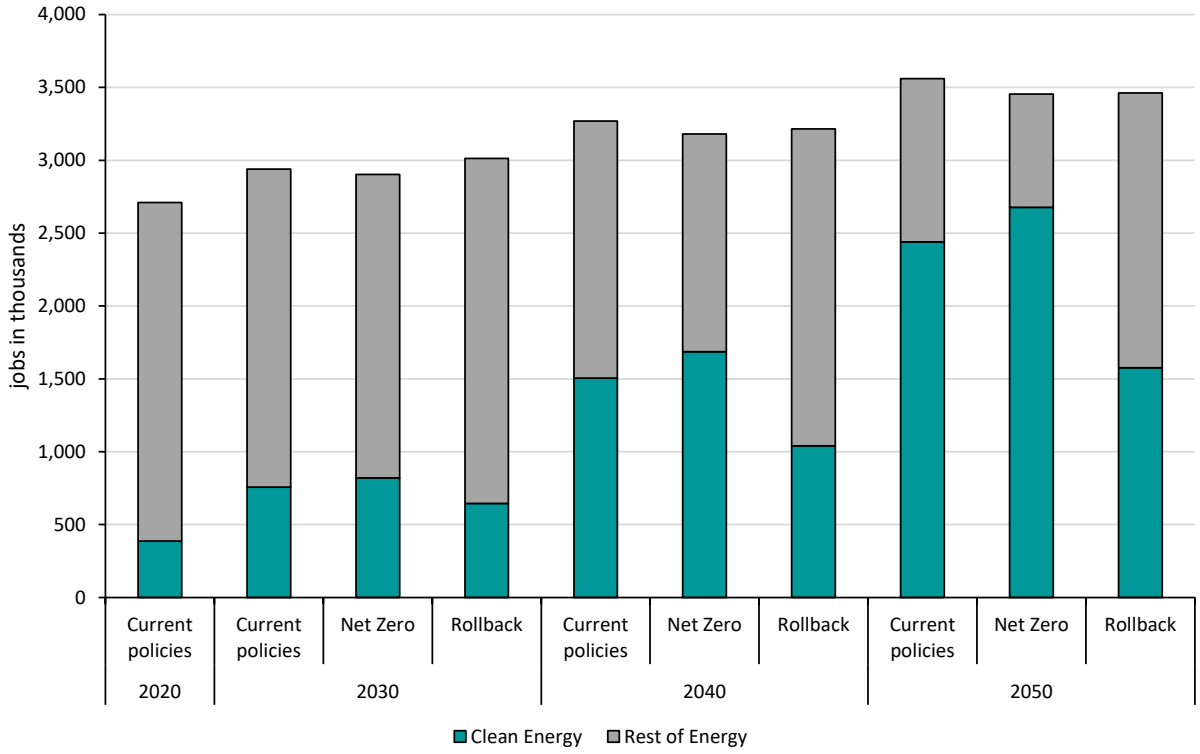
This study focuses on energy-related jobs, which account for about 14% of all jobs in Canada. In 2020, there were an estimated 2.7 million energy-related jobs, of which 388 thousand (14%) are categorized as clean.

In a net zero world (i.e., one with low demand for Canada's oil), clean energy job growth is expected to outpace the decline in rest of energy jobs. Figure 3 shows that the number of clean energy jobs grows from 388 thousand in 2020 to between 1.6 and 2.7 million in 2050. This means that the total number of energy-related jobs continues to grow, despite a reduction in jobs in the rest of energy (which fall from 2.3 million to between 1.9 million and 776 thousand).

Current policies, including the federal ERP, are likely to have a large impact on clean energy job creation.

The baseline current policies forecast results in 2.4 million clean energy jobs by 2050, just shy of the 2.7 million achieved in the net zero scenario. Conversely, when key policies such as the ERP are repealed in the rollback scenario, clean energy jobs reach 1.6 million. This means that the ERP, including a federal carbon price of $170/t CO_2e, play a significant role in boosting clean energy jobs.

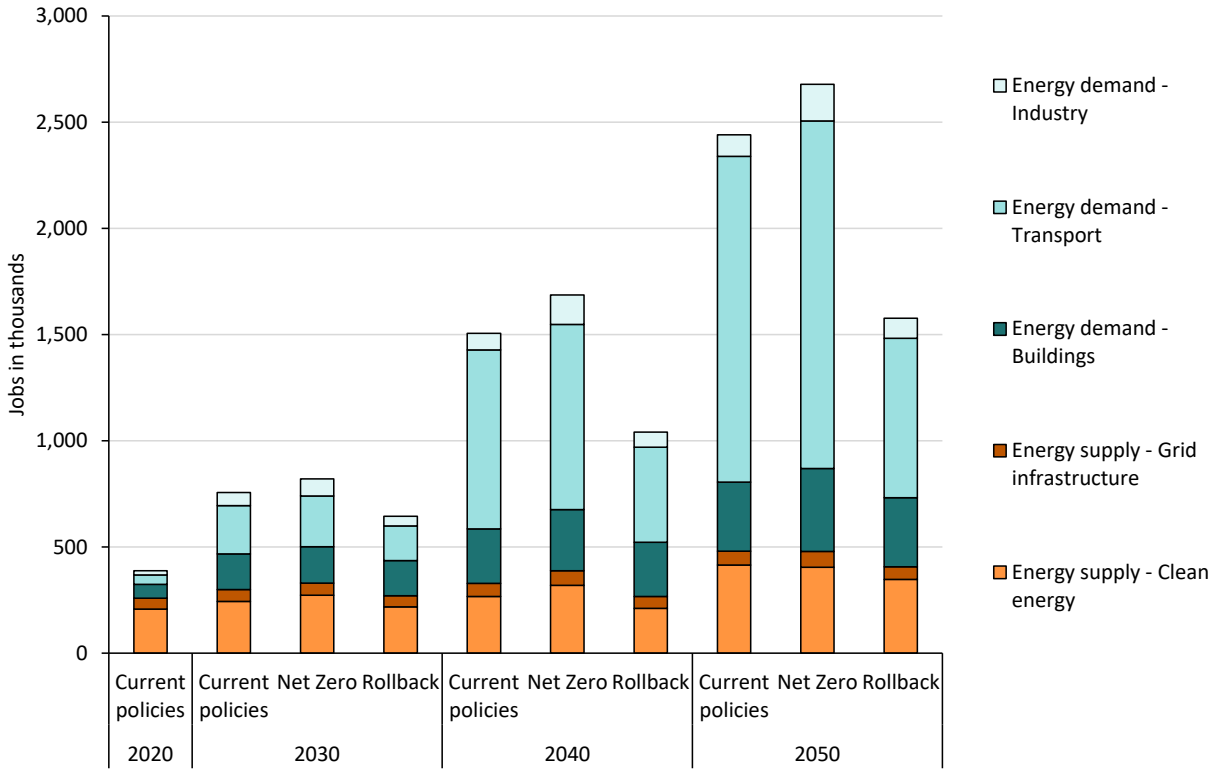
Figure 3: Energy related jobs by scenario.



Today, most clean energy jobs are associated with producing clean electricity. In a net zero future, clean energy jobs are likely to be increasingly distributed across other sectors.

Figure 4 zeroes in on clean energy jobs by sector. In 2020, most clean energy jobs are on the energy supply side, including jobs involved in renewable electricity and biofuel production. While the number of clean jobs in energy supply grows over time, it is overtaken by growth in energy demand related clean jobs. By 2050, over three quarters of clean jobs are associated with technologies that consume energy, spread across transport, buildings and industry. Transport accounts for the bulk of clean energy jobs by mid-century (between 48% and 63%) because providing transport services is relatively labour intensive.

Figure 4: Overview of clean jobs by scenario.



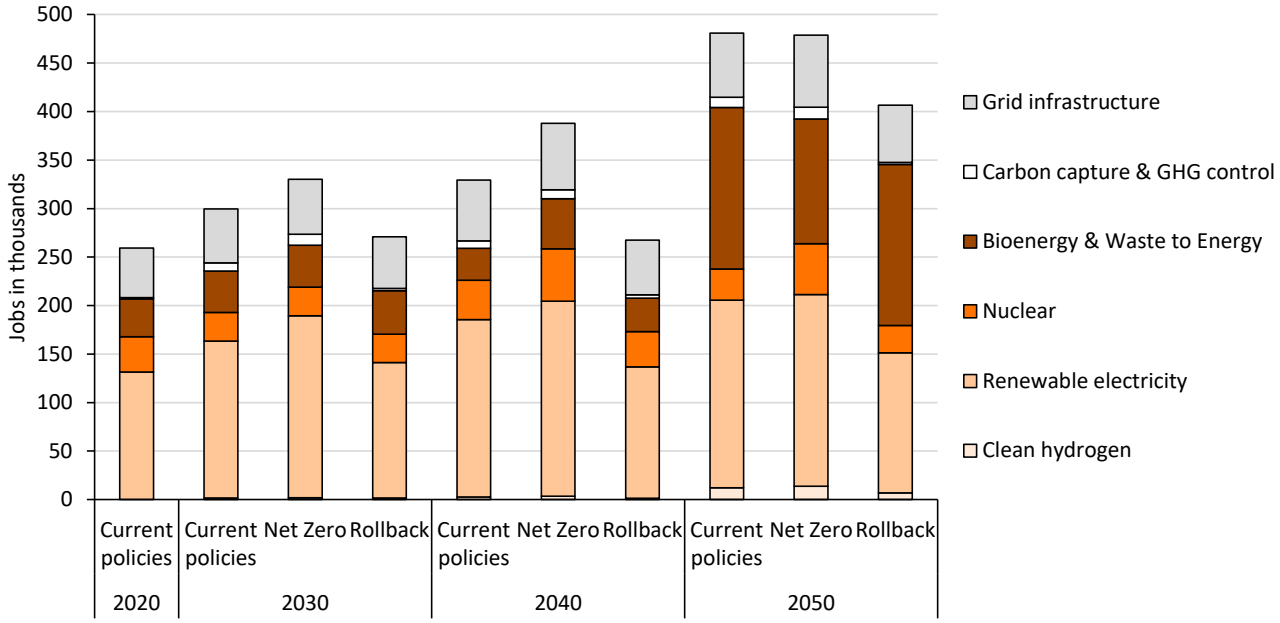
Below, we dive into greater detail about clean energy jobs trends by sector.

3.1.2. Energy supply

Figure 5 highlights growth in clean energy supply sector jobs:

- **Renewable electricity.** Most clean energy jobs on the energy supply side are in the renewable electricity sector in 2020, and most of these are associated with hydroelectricity (due to the large base of hydro capacity in Canada). In the current policies and net zero scenarios, renewable electricity jobs grow from 132 thousand in 2020 to 193-198 thousand in 2050 (an increase of about 50%). This growth is associated with multiple technologies, but wind and solar are leading options in most regions. Renewable electricity jobs still grow under the rollback scenario, due to both policy factors (e.g., the 2030 coal phase out) and non-policy factors (increasing electricity demand as the economy grows, coupled with ongoing cost improvements to technologies like solar PV). However, growth is lower under the rollback scenario (10% between 2020 and 2050). Under all three scenarios, the renewable electricity sector remains the largest source of supply side clean energy jobs in 2050.

Figure 5: Clean jobs on the energy supply side by scenario.



- **Nuclear**. The number of nuclear power related jobs fall from 36 thousand in 2020 to between 28 and 32 thousand in 2050 under the current policies and rollback scenarios, in line with refurbishment and retirement plans in Ontario and New Brunswick. Under a net zero scenario, nuclear related jobs grow to 52 thousand in 2050 due to the potential for small modular nuclear reactors. Naturally, this potential is uncertain and is dependent on the commercialization, cost and public acceptance of this technology.

- **Bioenergy.** The second largest clean energy job sector on the supply side is bioenergy, driven by the production of liquid biofuels for use in transport like biodiesel, ethanol, hydrogenation derived renewable diesel and – in the future – potentially second-generation biofuels. This sector also includes the production of solid and gaseous bioenergy for use in stationary applications. Bioenergy jobs could grow three-fold over the forecast period, from 39 thousand in 2020 to 166 thousand in 2050. Bioenergy jobs are driven both through domestic policies, such as federal and provincial renewable fuel blending mandates and low/clean fuel standards, as well as US policies (i.e., in a net zero world, Canada could export bioenergy to the US).

- **Carbon capture and GHG control.** This sector includes jobs related to carbon capture and storage (e.g., applied to thermal electricity plants or oil and gas production, but not for enhanced oil recovery) and methane management (e.g., leak detection and control efforts associated with fossil energy production). This sector grows from a low base in 2020 to between 11 and 12 thousand jobs by 2050 in the current policies and net zero scenarios, driven by policies such as the clean electricity regulation, federal oil and gas GHG emissions cap and the 75% methane reduction policy. The sector does not grow under the rollback scenario.

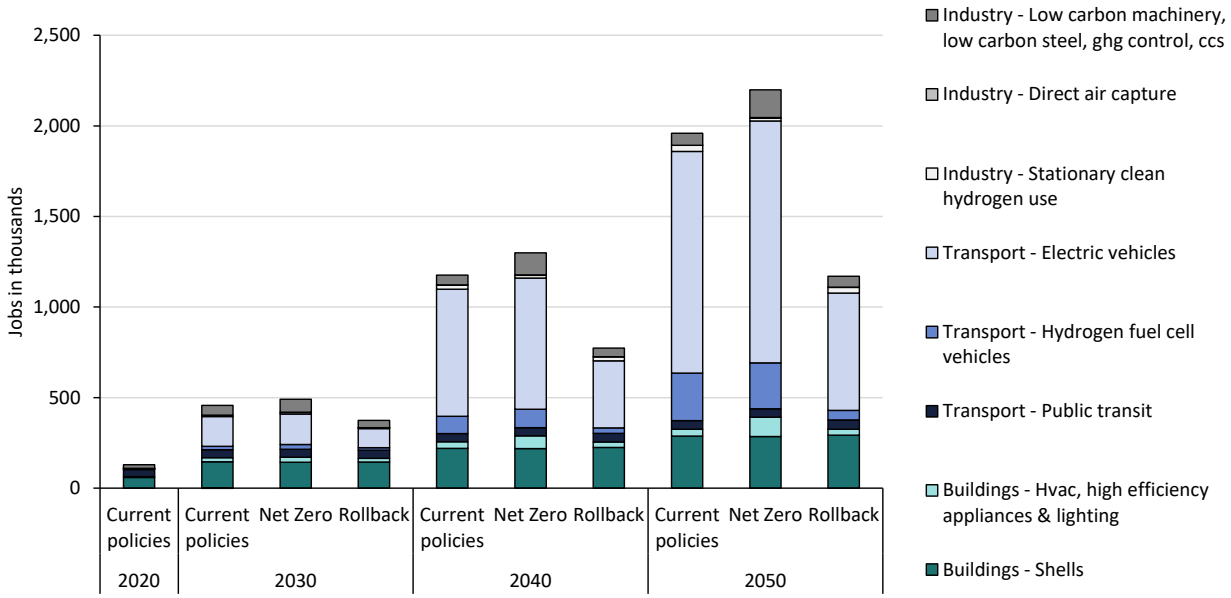
- **Clean hydrogen.** Due to lack of demand for hydrogen as a low carbon fuel, few jobs currently exist in this sector. However, increasing demand for hydrogen, mainly from the transport sector and driven by proposed federal medium- and heavy-duty vehicle sales mandates, could lead to between 12 and 14 thousand clean hydrogen supply-related jobs by 2050 under the current policies and net zero scenarios. Under the rollback scenario, clean hydrogen supply jobs reach seven thousand by 2050.

- **Grid infrastructure.** Driven by increasing electricity demand, clean jobs in grid infrastructure increase from 51 thousand in 2020 to between 59 and 74 thousand in 2050.

3.1.3. Energy demand

Figure 6 highlights growth in clean energy demand sector jobs:

Figure 6: Clean jobs on the energy demand side by scenario.



- **Buildings.** Clean energy jobs in this sector increase from 64 thousand to 325 to 391 thousand in 2050. Additional policy is required to achieve electrification of space heating in line with net zero, leading to potentially 20% more clean jobs by 2050.
  - **Efficient building envelopes.** Almost half of clean energy demand side jobs are currently in the efficient building envelope sector (60 thousand in 2020), including those involved in the construction of high efficiency buildings. The number of these jobs increases to between 285 and 293 thousand, depending on the scenario. The current policies and rollback scenarios result in a similar number of jobs in this sector as the net zero scenario because (1) a certain amount of improvements to the building stock are expected irrespective of additional policy and (2) net zero is most cost effectively achieved by focusing on electrification rather than further improvements to thermal efficiency.

- **Efficient HVAC, appliances and lighting.** This sector includes jobs related to various clean energy technologies, including heat pumps and high efficiency appliances. This sector grows from five thousand in 2020 to 38 thousand by 2050 under current policies. Under net zero, the sector grows to 106 thousand clean energy jobs by 2050, almost three times as high compared to current policies, due to additional electrification of building heating systems. This indicates that additional policy is needed to achieve building electrification in line with net zero by mid-century. Conversely, the sector reaches 32 thousand in the rollback scenario.

- **Transport.** By 2050, this sector accounts for between 48% and 63% of total clean energy jobs in Canada. Federal zero emission vehicle mandates included in current policies lead to clean energy job levels in this sector comparable with net zero.

  - **Electric vehicles.** Jobs related to plug-in electric vehicles increase significantly under all scenarios, from six thousand in 2020 to 648 thousand (rollback) and 1.2-1.3 million (current policies and net zero) by 2050. The current policies and net zero scenarios include national policies that accelerate the uptake of electric vehicles (i.e., national zero emission vehicle mandates for all vehicle classes). Yet, even without these policies, electric vehicles are likely to become popular for various applications such as delivery services and buses. The number of jobs becomes so large – the single largest clean energy sector by 2050 – because providing transport services is relatively labour intensive.

  - **Hydrogen fuel cell vehicles.** Jobs related to hydrogen fuel cell vehicles also experience high growth, from under one thousand in 2020 to between 263 and 253 thousand in the current policies and net zero scenarios. This growth is driven by the federal zero emission vehicle mandate for medium and heavy-duty vehicles, where hydrogen fuel cell vehicles can be an attractive zero carbon option. The number of jobs is lower (53 thousand) in the rollback scenario.

  - **Clean transit.** The second largest clean energy demand side sector in 2020 is clean transit. This sector includes electric light rail but not zero emission buses (which are included in the electric and hydrogen fuel cell sectors above). Clean transit jobs grow from 38 thousand jobs in 2020 to between 47 and 51 thousand in 2050.

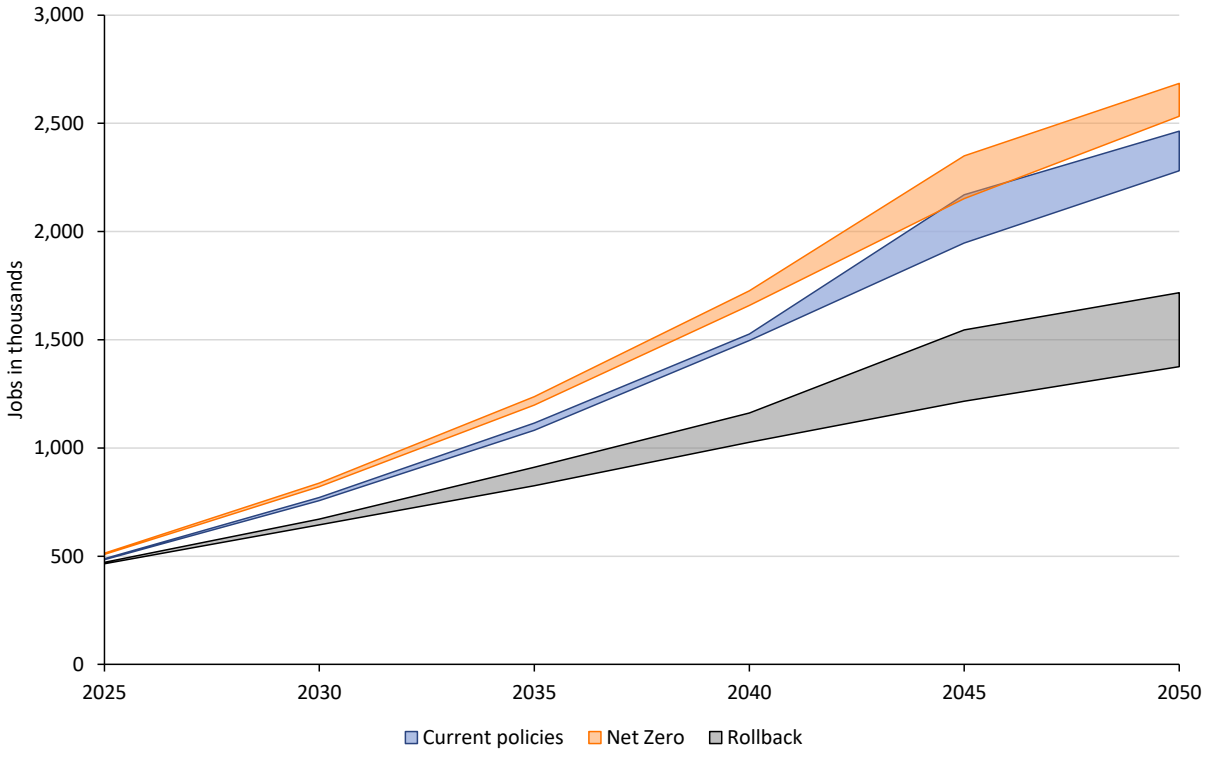
- **Industry.** Clean energy jobs in industry grow from 20 thousand to 94 to 101 thousand under the current policies and rollback scenarios. Under net zero, the sector grows to 172 thousand clean energy jobs, mostly due to additional uptake of carbon capture and storage. This indicates that additional policy is needed to drive CCS uptake in industry to a level consistent with net zero.
  - **Low carbon machinery.** Jobs related to low carbon machinery (e.g., electric compression and heating) increase from 13 thousand in 2020 to between 26 and 42 thousand in 2050. These jobs are concentrated in sectors requiring low temperature heat such as light manufacturing.
  - **Low carbon steel.** Jobs related to clean steel increase from a low base in 2020 to between 10 and 14 thousand in 2050.
  - **Carbon capture and storage.** Jobs related to carbon capture and storage in industry increase from a low base in 2020 to between 11 and 20 thousand (current policies and rollback) and 95 thousand (net zero) in 2050.
  - **GHG control.** Jobs related to GHG control (e.g., inert anode technology for aluminum smelters and landfill gas control) increase from a low base to between three and nine thousand in 2050.
  - **Clean hydrogen.** Jobs related to the use of clean hydrogen as a low carbon fuel in industry increase from essentially zero in 2020 to between 13 and 33 thousand in 2050.
  - **Direct air capture.** Emissions abatement is assumed to take precedence over carbon dioxide removals in these baseline projections. However, the sensitivity analysis, discussed in the next section, highlights that the direct air capture sector could become an important source of clean energy jobs in a net zero future.

3.2. Uncertainty

The response of the economy to current and potentially more stringent climate policies, and the resulting number of clean energy jobs, is inherently uncertain. This section quantifies the impact of key uncertainties, including the cost of emerging low carbon technologies, the availability of direct air capture and the level of climate mitigation policy in the US. These uncertainties were introduced in Section 2.3.2.

Figure 7 shows the range of clean energy jobs in thousands under each scenario, considering all explored sensitivities. It finds that the policies included in each scenario have a stronger impact on the number of clean energy jobs in Canada than the explored uncertainties. In other words, Canadian climate policy is a strong determinant of clean energy job growth. Furthermore, stronger domestic climate policy leads to less uncertainty in the size of the clean energy job market.

Figure 7: Range of clean energy jobs in thousands by scenario.



Other key findings related the sensitivity analysis include:

- **The cost of emerging low carbon technologies.** Lower electric vehicle and hydrogen fuel cell vehicle cost estimates lead to slightly more clean energy jobs. The impact is less pronounced under current policies and net zero, with an average clean job increase of less than 2%. Under the rollback scenario, there are fewer policies incentivizing the uptake of zero emission vehicles, which leads to stronger clean energy job impacts when changing electric vehicle cost assumptions (up to about 12%). The impact of varying second generation biofuel costs is small because relatively little of this fuel is manufactured in the scenarios examined.
- **The availability of Direct Air Capture.** If direct air capture is available, it could contribute to 250 Mt of negative emissions annually by 2050 under a scenario in which Canada achieves net zero. This translates to a substantial industry, employing up to 166 thousand people. The overall number of clean energy jobs in such a scenario is slightly less than one in which direct air capture is unavailable (5% in 2050) because the adoption of this technology means less abatement is required in other sectors.
- **The level of climate mitigation ambition in the US.** Less mitigation action in the US leads to lower demand and uptake of low-carbon technologies in North America, resulting in up to 13% fewer clean energy jobs in Canada in 2050. In general, the magnitude of US climate policy impacts on clean jobs in Canada depends on policy action within Canada. Under the rollback scenario, this impact is most pronounced while it is smallest under the Canada net zero scenario, as Canadian policies generate a greater domestic market for low-carbon products and actions.

Appendix A: Current policies

This section lists key policies included under the current policies reference case. It first presents policy assumptions made for uncertain federal policies, which were announced in the Emissions Reduction Plan (ERP). It then lists other key federal and provincial policies, included in this analysis under the current policies reference case scenario.

Note that we don't include provincial policies in the list below if there is an equally or more stringent federal policy (e.g., federal carbon price rising to $170/t CO_2e by 2030, federal renewable fuel requirements). As it is uncertain how provinces will change their carbon pricing systems to comply with the federal carbon pricing and output-based pricing system stringency increase, we assume that the federal fuel charge backstop applies to all provinces and territories, except for Québec. Québec's cap is assumed to be sufficiently stringent in its current design.

Announced ERP policies

Policy	Assumptions
GHG emissions cap on the oil and gas sector[7]	The federal government has announced its intention to cap greenhouse gas emissions from the oil and gas extraction sector. The Emissions Reduction Plan (ERP) does not provide detail on the policy mechanism that will be used to implement an emissions cap on oil and gas extraction. It also does not specify the level at which emissions will be capped but references a modelling analysis which projects that oil and gas sector emissions would decline to 110 Mt in 2030 under the most economically efficient pathway to achieving Canada's 2030 target. The oil and gas emissions cap is simulated as a tradable performance standard in which the oil and gas sector is required to reduce its emissions by 42% below 2019 in 2025 and to a maximum of 110 Mt CO2e in 2030 and going forward. This policy overlaps with the OBPS as the same reduction action can generate compliance credits under the OBPS and oil and gas emissions cap, for example implementing carbon capture and storage.

[7] Government of Canada. (2022). 2030 Emissions Reduction Plan. Available from: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/Canada-2030-Emissions-Reduction-Plan-eng.pdf.

Policy	Assumptions
	It is uncertain, whether this policy will also cover downstream emissions. We assume that both upstream and downstream GHGs are capped.
75% reduction in oil and gas methane emission[7]	The federal government announced its commitment to implement regulations that will reduce methane emissions from the oil and gas sector by at least 75% below 2012 levels by 2030. This builds on the federal government's current methane regulations, which seek to achieve a 40% to 45% reduction in methane emissions in the upstream oil and gas sector below 2012 levels by 2025. The current methane regulations cover upstream oil and gas emissions. The ERP does not specify if the 75% reduction will apply to upstream oil and gas emissions or both upstream and downstream (including refineries, natural gas distribution, and LNG production) emissions. The 75% methane reduction requirement is simulated as a regulatory requirement of increased uptake of abatement actions and technologies for surface casing vent flows, leaking, and venting, such as increased monitoring, flaring, and well reworking, in the upstream oil and gas sector. As the current methane regulations cover upstream oil and gas emissions, and not downstream emissions, we assume that this will also be the case for the 75% methane reduction requirement.
Clean Electricity Regulation[7]	The federal government has stated its intention to implement a Clean Electricity Regulation (CER), which will achieve net-zero emissions from electricity generation by 2035. The ERP doesn't specify the policy mechanisms that will be used to achieve this target. The CER will cover electricity generation sold to the electricity grid. The ERP does not specify whether the CER will cover cogeneration providing electricity to the grid. The Clean Electricity Regulation is simulated as a national cap close to zero, starting in 2035, in form of a tradable performance standard with regional benchmarks for the emissions intensity of utility electricity generation. Emissions intensity benchmarks are calculated to be consistent with the emissions cap. This policy overlaps with the OBPS as the same reduction action could generate compliance credits under both policies. It is uncertain if cogeneration will be covered or not. We assume that cogeneration is excluded from the regulation.
Light-duty Emissions Standard[7]	The ERP states that the federal government plans to implement a light-duty zero emissions vehicle (ZEV) sales mandate. The ZEV mandate will require at least 20% of all new light-duty vehicle sales to be ZEVs by 2026, 60% by 2030, and 100% by 2035. As no detailed information was available at the time of setting up the scenarios, we assume that the same credit system as in development in Quebec will be used federally, where the sale of a new light-duty battery electric or fuel cell vehicle generates 1 credit and a plugin-hybrid 0.5. Sales targets are set at 20% in 2026, linearly increasing to 60% in 2030 and linearly increasing to 100% by 2035.

Policy	Assumptions
Medium- and Heavy-duty Emissions Standard[7]	There is currently little information regarding the federal government's plan for implementing a medium- and heavy-duty emissions standard. The ERP states that this would be a sales mandate with the goal of achieving 35% ZEV sales by 2030 and 100% by 2040 in selected medium- and heavy-duty categories, based on feasibility, and potential interim targets for pre-2030 years. We assume that a heavy-duty zero emission vehicle mandate similar to California's Advanced Clean Trucks Regulation (ACTR) will be implemented. We assume that zero emissions vehicle (ZEV) sales targets for medium- and heavy-duty vehicles and buses will be established, requiring a minimum of 10% heavy-duty, 60% medium-duty and 100% bus ZEV sales in 2030, rising to 100% ZEV sales for all three vehicle categories by 2040. We assume that credit trading between medium- and heavy-duty vehicles will be allowed as a flexibility mechanism.

Other federal policies

Policy	Description
Multi-sectoral	
Federal Fuel Charge[8]	The federal fuel charge is a backstop policy that applies a tax on fossil fuels in provinces that don't have an equally stringent carbon pricing system. The federal government announced that the federal fuel charge will be annually increased by $15/tCO2e after 2022 until the tax reaches $170/tCO2e in 2030 and stays constant at that level thereafter.
Output-Based Pricing System[9]	The Output-Based Pricing System (OBPS) is a tradable emissions performance standard that puts a price on industrial emissions if a facility's emissions intensity exceeds the sectoral benchmark. The federal government announced that the OBPS carbon price will be annually increased by $15/tCO2e until it reaches $170/tCO2e in 2030. Furthermore, most sectoral OBPS benchmarks will be annually increased in stringency by 2 percentage points starting in 2023.
Investment tax credit for Carbon Capture, Utilization, and Storage[10]	This policy is an investment tax credit for 50% of upfront costs for carbon capture, utilization, and storage, 60% for Direct Air Capture, and 37.5% for related transportation infrastructure capital investments. The government expects this policy to cost about $2.6 billion dollars between 2022 and 2026, and $1.5 billion annually from 2027 to 2030.

[8] Government of Canada. (2021). The federal carbon pollution pricing benchmark. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/carbon-pollution-pricing-federal-benchmark-information.html.

[9] Government of Canada. (2021). Review of the OBPS Regulations: Consultation paper. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/2022-review-consultation.html

[10] Government of Canada. (2022). Budget 2022. Chapter 3: Clean Air and Strong Economy. Available from: https://budget.gc.ca/2022/report-rapport/chap3-en.html#wb-cont.

Policy	Description
Canada Infrastructure Bank Spending[11]	The Healthy Environment and Healthy Economy federal climate plan states that the Canada Infrastructure Bank (CIB) has a long-term investment target of $5 billion for clean power projects. It further outlines that the CIB has committed $1.5 billion for zero emission buses, $2.5 billion for low-carbon power projects, including storage, transmission and renewables, over 3 years, and $2 billion for commercial building retrofit upfront costs. The ERP mentions that CIB will receive a total of $35 billion with priorities to invest in green infrastructure ($5 billion), public transit ($5 billion) and clean power ($5 billion).
Buildings	
Energy efficiency regulations[12]	Federal standards exist for space conditioning equipment, water heaters, household appliances, and lighting products. Major standards include a minimum annual fuel utilization efficiency of 95% for natural gas furnaces, a minimum energy factor of 0.61 for gas water heaters and ban of incandescent light bulbs.
Greener Homes Grant[13]	$2.6 billion for residential energy efficiency improvements over seven years. 700,000 grants of up to $5,000 to help homeowners make energy efficient retrofits to their homes.

[11] Government of Canada. (2020). A Healthy Environment and a Healthy Economy. Available from: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf & Government of Canada. (2022). 2030 Emissions Reduction Plan. Available from: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/erp/Canada-2030-Emissions-Reduction-Plan-eng.pdf.

[12] Natural Resources Canada. (n.d.). Canada's Energy Efficiency Act and Energy Efficiency Regulations. Available from: www.nrcan.gc.ca/energy/regulations-codes-standards/6861

[13] Government of Canada. (2020). Fall Economic Statement. Supporting Canadians and Fighting Covid-19. Available from: https://www.budget.gc.ca/fes-eea/2020/report-rapport/toc-tdm-en.html

Policy	Description
Greener Homes Loan Program[14]	Budget 2021 also allocated $4.4 billion on a cash basis ($778.7 million on an accrual basis over five years, starting in 2021-22, with $414.1 million in future years), to the Canada Mortgage and Housing Corporation to provide interest-free loans up to $40,000 to low-income homeowners for home retrofits. Budget 2022 allocates an additional investment of $458.5 million into the low-income loan program.
Increase energy efficiency in community buildings[15]	The A Healthy Environment and a Healthy Economy plan proposed to invest $1.5 billion over three years for repairs and efficiency upgrades in community buildings and for building new energy efficient community buildings.
Transportation	
Clean Fuel Regulation[16]	The Clean Fuel Regulation is a performance-based fuel supply standard with annual reduction requirements that will come into force in 2023. The regulations will require liquid fossil fuel suppliers to reduce the lifecycle greenhouse gas intensity (CI) of their fuels, starting with 3.5 gCO2e/MJ in 2023 and increasing annually until reaching 14 g CO2e/MJ in 2030.
Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations[17]	The national government has proposed amending the Heavy-Duty Vehicle Emissions Standard to increase the vehicle emission stringency for vehicles manufactured in model years 2018 to 2027.

[14] Government of Canada. (2021). Budget 2021. Available from: https://www.budget.gc.ca/2021/home-accueil-en.html & Government of Canada. (2022). Budget 2022. Available from: https://budget.gc.ca/2022/report-rapport/chap1-en.html#2022-1

[15] Government of Canada. (2020). A Healthy Environment and a Healthy Economy. Available from: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

[16] Government of Canada. (2022). Clean Fuel Regulations: SOR/2022-140. Canada Gazette, Part II, Volume 156, Number 14. Available from: https://www.gazette.gc.ca/rp-pr/p2/2022/2022-07-06/html/sor-dors140-eng.html

[17] Government of Canada. (2018). Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and Other Regulations Made Under the Canadian Environmental Protection Act, 1999: SOR/2018-98. http://gazette.gc.ca/rp-pr/p2/2018/2018-05-30/html/sor-dors98-eng.html

Policy	Description
Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations[18]	New passenger vehicles and light-commercial vehicles/light trucks sold in Canada must meet fleet-wide GHG emission standards between 2012 and 2016, and between 2017 and 2025. Fleet targets for passenger cars are aligned with US regulation.
Renewable Fuels Regulation[19]	Specifies a minimum renewable content of 5% for gasoline and 2% for diesel, by volume. This will become part of the Clean Fuel Regulation (CFR) once the CFR comes into force in 2023.
Light-Duty ZEV Subsidy[20]	Light-duty vehicle subsidies are available at $2,500 for short-range plug-in hybrids and $5,000 for long-range plug-in hybrids, hydrogen vehicles, and battery electric vehicles. The government committed an additional $1.7 billion over five years, starting in 2022-23, with $0.8 million in remaining amortization, to Transport Canada to extend the Incentives for Zero-Emission Vehicles (iZEV) program until March 2025.
Heavy-Duty Zev Subsidy[21]	Funding of $547.5 million over four years, starting in 2022/23, will be available to Transport Canada to launch a new purchase inventive program for medium- and heavy-duty zero-emission vehicles.
Tax Write-Off[22]	Businesses can receive a 100% tax write-off when purchasing a zero-emission vehicle before

[18] Government of Canada. (2018). Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations. http://www.gazette.gc.ca/rp-pr/p2/2014/2014-10-08/html/sor-dors207-eng.html

[19] Government of Canada. (2013). Renewable Fuels Regulations: SOR/2010-189. Available from: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2010-189/index.html

[20] Government of Canada. (2022). Eligible vehicles. Available from: https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/light-duty-zero-emission-vehicles/eligible-vehicles.

[21] Government of Canada. (2022). Medium and heavy-duty zero-emission vehicles. Available from: https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/medium-heavy-duty-zero-emission-vehicles .

[22] Government of Canada. (2020). Zero Emission Vehicles. Tax Write-Off. Available from: https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles

Policy	Description
	2024. The tax write-off rate declines to 75% in 2024, 25% in 2025, and 0% in 2028. Vehicles that qualify for the federal Incentive for Zero-Emission Vehicles Program are ineligible for the tax write-off.
ZEV Charging Infrastructure Subsidy[23]	Federal funding of $400 million over five years, starting in 2022/23, is committed to funding the deployment of zero-emission vehicle (ZEV) charging infrastructure in sub-urban and remote communities through the Zero-Emissions Vehicle Infrastructure Program (ZEVIP).
Electricity Generation	
Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations[24]	This policy requires coal-fired power plants to be closed by 2030 unless they emit less than 420 tonnes CO_2e/GWh.
Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity[25]	This policy limits the emissions intensity of natural-gas fired electricity generation to 420 tonnes CO_2e/GWh.
Renewable Electricity Investments[26]	Budget 2021 allocated $964 million over four years for renewable electricity generation. An additional $600 million will be invested in renewable electricity and grid modernization and $250 million to support large clean electricity projects.

[23] Government of Canada. (2022). Budget 2022. Available from: https://budget.gc.ca/2022/report-rapport/chap1-en.html#2022-1

[24] Government of Canada. (2018). Regulations Amending the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations: SOR/2018-263. Available from: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-167/page-2.html#h-4

[25] Government of Canada. (2018). Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity: SOR/2018-261. Available from: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2018-261/index.html

[26] Government of Canada. (2021). Budget 2021. Available from: https://www.budget.gc.ca/2021/home-accueil-en.html & Government of Canada. (2020). A Healthy Environment and a Healthy Economy. Available from: https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

Policy	Description
Industry	
Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds[27]	Oil and gas facilities must adopt methane control technologies and practices.
Net Zero Accelerator[28]	The Net Zero Accelerator is simulated as an $8 billion subsidy over seven years for industrial low-carbon technologies, including carbon capture and storage technologies, electrification of industrial heat production and compression, fuel switching to wood waste and hydrogen for industrial heat production, efficient electric motors, and direct air capture.

Provincial policies

Province	Policy	Description
Alberta	Renewable Electricity Act[29]	Regulation requiring 30% of electricity produced in Alberta come from renewable sources by 2030. Interim targets of 15% by 2022, 20% by 2025, and 26% by 2028 have been established.
Alberta	Carbon capture and storage investments[30]	Alberta has contributed funding to several CCS projects, including the Shell Canada Energy Quest Project and the Alberta Carbon Trunk Line.

[27] Government of Canada. (2020). Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector): SOR/2018-66. Available from: https://laws-lois.justice.gc.ca/eng/regulations/SOR-2018-66/index.htm

[28] Government of Canada. (2021). Budget 2021. Available from: https://www.budget.gc.ca/2021/home-accueil-en.html.

[29] Alberta. (2020). Renewable Electricity Act. Statutes of Alberta, 2016 Chapter R-16.5. Available from: https://www.qp.alberta.ca/1266.cfm?page=r16p5.cfm&leg_type=Acts&isbncln=9780779814060.

[30] Natural Resources Canada. (2018). Shell Canada Energy Quest Project. Available from: www.nrcan.gc.ca/energy/funding/cef/18168. & Natural Resources Canada. (2016). Alberta Carbon Trunk Line (ACTL). Available from: www.nrcan.gc.ca/energy/publications/16233.

Province	Policy	Description
Alberta	Hydrogen projects[31]	There are two major hydrogen projects planned in Alberta. The Suncor and ATCO plant will become operational in 2028 and produce more than 300,000 tonnes of low-carbon hydrogen per year of which 20% could be used in Alberta's natural gas distribution system. Most of the remainder will be used by refineries. The Air Products project will come online in 2024 and produce 30 tonnes of liquid low-carbon hydrogen per day which will be available for the merchant market. Air products will further produce low-carbon hydrogen for refineries and electricity generation for its own operations and the grid.
British Columbia	Clean Energy Act[32]	A minimum of 93% of provincial electricity generation must be provided by clean or renewable sources. The Clean BC Roadmap to 2030[40] announced plans to increase electricity from renewable sources to 100% of supply by 2030 through phase out of remaining gas-fired facilities by 2030.
British Columbia	Low Carbon Fuel Requirement Regulation (part of the Low Carbon Fuel Standard)[33]	British Columbia introduced this policy in 2008. This regulation requires a decrease in average carbon intensity of transportation fuels by 10% by 2020 and by 30% by 2030 relative to 2010. Fuel suppliers can meet the second requirement by acquiring credits generated from fueling electric vehicles. The Clean BC Roadmap to 2030[40] announced plans to expand coverage to marine and aviation fuels.
British Columbia	Zero Emission Vehicle Standard[34]	Requires a minimum share of light-duty vehicles sold in BC to be zero-emission. This mandate

[31] Air Products. (2021). Air Products Announces Multi-Billion Dollar Net-Zero Hydrogen Energy Complex in Edmonton, Alberta, Canada. Available from: https://www.airproducts.com/news-center/2021/06/0609-air-products-net-zero-hydrogen-energy-complex-in-edmonton-alberta-canada &

Atco. (2021). Suncor and ATCO partner on a potential world-scale clean hydrogen project in Alberta. Available from: https://www.atco.com/en-au/about-us/news/2021/122920-suncor-and-atco-partner-on-a-potential-world-scale-clean-hydroge.html#:~:text=The%20project%20would%20produce%20more,sizable%20contribution%20to%20Canada's%20net.

[32] Government of British Columbia. (2010). Clean Energy Act. Available from: http://www.bclaws.ca/civix/document/id/lc/statreg/10022_01

[33] Government of British Columbia. (2020). Greenhouse Gas Reduction (Renewable and Low Carbon Fuel Requirements) Act, SBC 2008, c. 16. Available from: https://www.bclaws.ca/civix/document/id/complete/statreg/08016_01

[34] Government of British Columbia. (2019). Zero-Emission Vehicle Act. SBC 2019, Chapter 29. Available from: https://www.bclaws.ca/civix/document/id/complete/statreg/19029 & British Columbia. (2021). cleanBC. Roadmap to

Province	Policy	Description
		achieves 10% electric vehicles sales by 2025, 30% by 2030 and 100% by 2040. The Clean BC Roadmap to 2030[40] announced plans to accelerate the light-duty ZEV sales targets under the ZEV mandate to 26% by 2026, 90% by 2030 and 100% by 2035.
British Columbia	Heavy-duty Zero Emission Vehicle standard[40]	Plan to develop a medium- and heavy-duty zero emission vehicle sales requirements in alignment with California.
British Columbia	Light-Duty ZEV subsidies[35]	Provides incentives at $1,500 for short-range plug-in hybrids and $3,000 for long-range plug-in hybrids, battery electric vehicles, and hydrogen vehicles. It is unclear how long the incentives will be available for; the province has extended the policy multiple times since funding ran out since its introduction.
British Columbia	Technology and Retrofit Incentive Programs[36]	Programs offering incentives for energy efficiency measures in residential, commercial, and industrial buildings. CleanBC Better Homes programs include rebates for households including the Indigenous Community Heat Pump Incentive (funding for heat pump installation in residential and community buildings in Indigenous communities), rebates for heat pumps, electric service upgrades, and new construction programs for the construction of high-performance electric homes. The Better Buildings program provides incentives for commercial buildings including: support for upgrades, heating equipment conversions, low interest financing and ISO 5001 incentive (co-managed with federal government), and implementation of energy management systems in industrial facilities.
British Columbia	PST Exemption[37]	Use of electricity in residential and industrial buildings is exempt from provincial sales tax.

2030. Available from: https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf.

[35] Government of British Columbia. (2020). Go Electric Passenger Vehicle Rebates. Available from: https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/clean-transportation-policies-programs/clean-energy-vehicle-program/passenger-vehicles

[36] cleanBC. Better Homes. Available from: https://betterhomesbc.ca/ & cleanBC. Better Buildings. Available from: https://betterbuildingsbc.ca/.

[37] Government of British Columbia. (2017). Provincial Sales Tax (PST). Tax Rate. Available from: https://www2.gov.bc.ca/gov/content/taxes/sales-taxes/pst.

Province	Policy	Description
British Columbia	Strengthened Methane Regulations[38]	Methane emission reduction targets are: 45% by 2025 relative to 2014, 75% reduction by 2030 relative to 2025, and as close to zero emissions as possible by 2035. Regulations came into effect in January 2020 addressing primary sources of methane emissions in upstream oil and gas.
British Columbia	Industrial Electrification[39]	Supply electricity to power natural gas extraction in the Peace region, and other large industrial operations.
British Columbia	Organic waste diversion[39]	Divert 95% of organic waste from landfills.
British Columbia	Landfill Gas Management Regulation[39]	Capture 75% of landfill gas.
British Columbia	Renewable natural gas blending[39]	The 2018 Clean BC plan stated the intention to require a minimum of 15% renewable content in natural gas by 2030. The 2021 Clean BC Roadmap to 2030 plan refers to a goal, not a requirement, to achieve 15% renewable content in natural gas by 2030[40].
British Columbia	Natural Gas Utilities Emissions Cap[40]	Planned introduction of a GHG emissions cap to require gas utilities to reduce emissions to 6 Mt CO2e annually by 2030.
British Columbia	Carbon Pollution Standard in BC Building Code[40]	Plan to add a new carbon pollution standard to the BC Building Code to support the transition to zero-carbon new buildings by 2030. The standard will be performance-based, allowing for a variety of options including electrification, low carbon fuels like renewable natural gas, and low carbon district energy.
British Columbia	High Efficiency Standards for New Space and Water Heating Equipment[40]	Plan to require new space and water heating equipment in buildings to be at least 100% efficient after 2030.

[38] BC Oil and Gas Commission. (2019). New Methane Regulations and Fugitive Emissions Guidelines (IB 2019-07). Available from: https://www.bcogc.ca/news/new-methane-regulations-and-fugitive-emissions-guidelines/.

[39] Government of British Columbia (2018). Clean BC. Available from: https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_2018-bc-climate-strategy.pdf

[40] Government of British Columbia (2021). Clean BC Roadmap to 2030. Available from: https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action

Province	Policy	Description
Manitoba	Biofuels Mandate Amendment[41]	Renewable fuel content requirement at 10% for gasoline and 5% for diesel by volume.
Manitoba	Coal phase-out[42]	Manitoba Hydro phased out its last coal-fired generating unit in 2018.
Manitoba	Keeyask Hydro-electricity Project[43]	A hydro project with a capacity of a 695-megawatt (MW).
New Brunswick	Renewable Portfolio Standard[44]	The renewable portfolio standard requires NB Power to ensure that 40% of in-province electricity sales are from renewable energy by 2020. Imports of renewable energy from other jurisdictions qualify for compliance, as do energy efficiency improvements.
Newfoundland and Labrador	Muskrat Falls Hydro Project[45]	A hydro project with a capacity of 824 MW.
Nova Scotia	Cap-and-Trade Program[46]	Annual caps on certain activities in Nova Scotia, including fuel suppliers, electricity importers and large final emitters.
Nova Scotia	Cap on GHG emissions from electricity generation[47]	This policy requires emissions from the electricity sector to decline to 4.5 Mt by 2030.
Nova Scotia	Renewable Portfolio Standard[48]	This renewable portfolio standard requires that 25% of electricity consumption be provided from

[41] Government of Manitoba. (2020). Biofuels Mandate and Renewable Fuels in Manitoba. Available from: https://reg.gov.mb.ca/detail/3340256

[42] Manitoba Hydro. (n.d.). Generation Stations. Available from: https://www.hydro.mb.ca/corporate/facilities/generating_stations/

[43] Manitoba Hydro. (n.d.). Keeyask Generating Station. Available from: https://www.hydro.mb.ca/projects/keeyask/

[44] Government of New Brunswick. (2015). New Brunswick Regulation 2015-60 under the Electricity Act (O.C. 2016-263). Available from: www.gnb.ca/0062/acts/BBR-2015/2015-60.pdf

[45] Naclor Energy. (2019). Muskrat Falls Project: Project Overview. https://muskratfalls.nalcorenergy.com/project-overview/

[46] Government of Nova Scotia. (n.d.). Nova Scotia's Cap-and-Trade Program. Available from: https://climatechange.novascotia.ca/nova-scotias-cap-trade-program.

[47] Government of Nova Scotia. (2013). Greenhouse Gas Emissions Regulations made under subsection 28(6) and Section 112 of the Environment Act. Available from: www.novascotia.ca/JUST/REGULATIONS/regs/envgreenhouse.htm

[48] Government of Nova Scotia. (2020). Renewable Electricity Regulations made under Section 5 of the Electricity Act. Available from: https://novascotia.ca/just/regulations/regs/elecrenew.htm

Province	Policy	Description
		renewable resources in 2015, increasing to 40% by 2020.
Nova Scotia	Maritime Link[49]	This transmission line will connect Nova Scotia to hydroelectric generation from Newfoundland Labrador (and in particular, to the Muskrat Falls hydroelectric project).
Ontario	Coal Phase-out[50]	Ontario phased out its last coal-fired generating unit in 2014. In 2019, approximately 94% of Ontario's electricity generation was emissions free. Commitments were made under the Cessation of Coal Regulation (2007) and Ending Coal for Cleaner Air Act (2015). In 2014, the Atikokan Generating Station was converted from coal to biomass.
Ontario	Nuclear Power-plant Refurbishment[51]	Refurbishment of 10 nuclear power plants which together will provide more than 9,800 MW emissions-free capacity. Long term project in place that has been ongoing since 2016.
Ontario	Cleaner Transportation Fuels: Renewable Content Requirements for Gasoline and Diesel Fuels (O. Reg 663/20)[52]	Regulation specifying a minimum renewable fuel content of 4% for diesel, by volume. Renewable diesel life cycle GHG emissions are required to be at least 70% lower than standard petroleum diesel. Specifies a minimum renewable fuel content for gasoline of a specified amount, which increases each calendar year: 11% in 2025, 13% in 2028, 15% in 2030. Gasoline must have an average of 50% less life cycle GHG emissions than standard petroleum gasoline (previously was 45%). This is a new regulation as of November 25 2020, that replaces the now revoked O. Reg. 535/05 (Greener Gasoline) and O. Reg. 97/14 (Greener Diesel).

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Province	Policy	Description
Ontario	Steel project decarbonization investments[53]	Two major steel companies in Ontario, ArcelorMittal and Algoma, announced that they will upgrade their steel plants, which will result in greenhouse gas reductions of about 3 Megatonnes in each plant.
Québec	Cap and Trade System for Greenhouse Gas Emissions Allowances[54]	Cap and trade for industrial and electricity sectors as well as fossil fuel distributors. Revenue raised by the policy is invested in low carbon technologies.
Québec	Renewable Natural Gas Regulation[55]	This regulation requires a minimum renewable fuel content of 1% in distributed natural gas in Québec as of 2020, rising to 2% in 2023, and 5% in 2025. A recently developed amendment will increase the minimum renewable fuel content to 7% in 2028 and 10% in 2030.
Québec	Biofuels mandate[56]	In 2019, Québec released a draft regulation that would require a minimum blend of 10% renewable fuel in gasoline and 2% in diesel by volume starting in 2021 and rising to 15% for gasoline and 4% for diesel by 2025.

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Province	Policy	Description
Québec	Zero Emission Vehicle Standard[57]	Automakers that sell over 4,500 vehicles in the province are required to meet a minimum zero-emission vehicle credit quota. The credit requirement is set to rise from 3.5% in 2018 to 22% of non-ZEV sales by 2025. A recently developed amendment will change the credit accounting system and ZEV sales targets for the years 2025 and thereafter. Under the revised system, the sale of one new light-duty zero emission vehicle equals one credit. The minimum sales targets for post 2025 have been set to increase from 12.5% in 2025 to 30% in 2030 and 100% in 2035.
Québec	Heavy duty vehicle ZEV standard[58]	Plan to develop a ZEV standard for heavy-duty vehicles similar to California's current standard.
Québec	Electric Vehicle Incentives[59]	Provides incentives between $4,000 and $8,000 for the purchase of a zero-emission vehicle.
Québec	Québec New Oil Heating Ban[60]	The province is banning the installation of oil heating systems in new buildings starting 2021 and the installation in existing buildings will start in 2023.
Québec	Québec Chauffez Vert Program[61]	Québec is expecting to spend 179 million between 2022 and 2027 on the Chauffez vert program, which provides financial support for replacing oil or propane heating with a renewable heating system.

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Province	Policy	Description
Saskatchewan	Boundary Dam Carbon Capture Project[62]	This project stores and captures CO2 emissions from a 115 MW coal plant.
Saskatchewan	Ethanol Fuel (General) Regulations[63]	Regulation requiring a minimum renewable fuel content of 7.5% for gasoline by volume.

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