Towards a National Energy Vision

The Realm of the Possible for Canada: Hitting Above Its Weight to Reduce Global Emissions

Final

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STRATEGIC POLICY ECONOMICS

Executive Summary

The world's need for energy is growing as developing nations seek to deliver prosperity to their populations. Unfortunately, along with that growth come the adverse effects of climate change. Against this backdrop, the Paris Agreement aligned 194 countries to reduce global emissions.[1] Yet, achieving these goals involves an unprecedented transition in how the world consumes energy.

Unlike most other countries, Canada is blessed with substantial energy resources in the form of hydro, nuclear, biomass, natural gas, and oil. With these resources, Canada has the potential to hit above its weight in reducing global emissions through environmentally responsible development and export of these resources. Achieving this will require the effective and sustainable management of Canada's energy resources for both domestic needs and export to others. Developing supporting transmission and distribution networks to export energy resources is also required. To date, progress on these two objectives has been hindered by the material environmental, economic, and social policy challenges that these developments face. There is an urgent need for Canada to embrace dialogue to create a National Energy Pact that can unlock the benefits to Canadians and combat global climate change.

Study Scope

Several studies have been undertaken to assess Canada's energy potential in a global context, its role in reducing emissions, and the benefits of its exports.[2] While considering these efforts, this study differs in three respects: (1) providing an integrated compendium of Canadian energy assets and development projects, shining a light on the regional diversity of the initiatives; (2) identifying the contribution these assets can provide in achieving emission reduction objectives, both domestically and globally; and, (3) framing the challenges in developing these assets in the context of the complexities and interests of the myriad pan-Canadian stakeholders.

This study explores the fundamentals underlying Canada's energy resources, their potential to address global emissions, the global need for Canada's clean and sustainably developed energy resources, and the conditions that will enable the development of related infrastructure. The purpose of this exploration is to help inform affected stakeholders across Canada, including the federal government, provinces, territories, and Indigenous peoples[3], and to foster a dialogue on a collaborative National Energy Pact to further development of Canada's energy assets.

Findings

Canada is one of the world's most significant sources of clean energy, natural gas, and oil. These energy resources are well suited to addressing domestic and international climate change challenges. However, demand for Canada's resources exceeds its export capability. Canada's three largest trading partners, the U.S., China, and the EU, consume over half of the world's energy and are experiencing a growing

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[1] Government of Canada, The Paris Agreement.

[2] CCPA, Canada's Energy Outlook, 2018; CAE, Becoming a Sustainable Energy Powerhouse, 2014.

[3] Indigenous peoples referred to in this report include First Nations, Inuit, and Metis peoples. This term is recognized The Canadian Encyclopedia, Indigenous Peoples in Canada, 2018 to collectively embrace these diverse peoples and used here acknowledging the factors described in UBC, Indigenous Foundations, Aboriginal Identity & Terminology. Website.

need for secure clean energy.[4] Developing Canada's energy resources may not only help meet their energy needs but also reduce their emissions in light of the alternative resources available to them.

In recent years, several major energy developments have been proposed in Canada – including electricity generation and transmission, oil and gas extraction, pipelines, and other infrastructure. However, in the face of complex obstacles, many of these developments have been impeded by a failure to reach consensus among the myriad pan-Canadian interests. This diversity of interests includes all levels of government, Indigenous peoples, environmentalists, and commercial interests. Achieving consensus among these key stakeholders is necessary to enable the regionally appropriate development of Canada's energy resources to drive environmental sustainability and prosperity across the country.

Detailed Findings: The Realm of the Possible for Canada: Hitting Above Its Weight to Reduce Global Emissions

Finding #1: Canada's considerable energy resources are well suited to address climate change.

Canada is the world's 9th largest emitter of greenhouse gas emissions (GHG), a status that is primarily associated with its role as a globally significant source of energy resources. Canada is a global leader in the production and export of zero-emissions electricity, natural gas, crude oil, and uranium as shown in Figure ES-1 and Figure ES-2.

Figure ES-1: Canada's Share of Global Energy Resources, 2018

(% share of Global Production and Reserves; with global rankings)

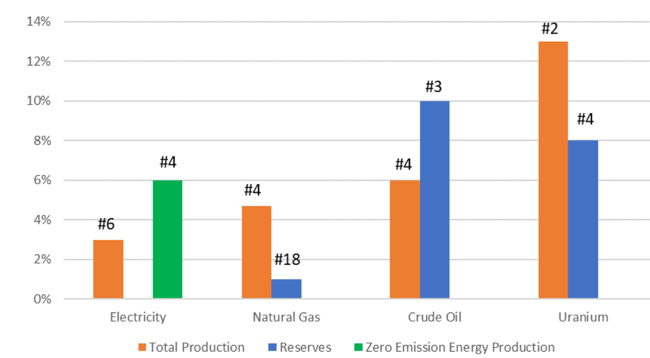
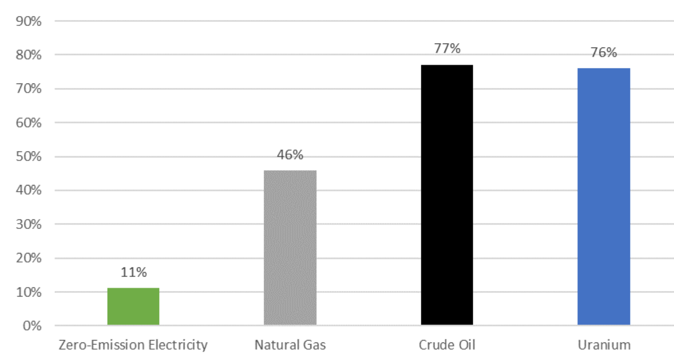


Figure ES-2: Percentage of Canada's Energy Production Exported, 2018

(Exports as % of Production)



Sources: Figure ES-1: NRCan, Energy Facts; CER, Canada's Energy Future 2019, 2019; Enerdata, Website; World Bank, World Development indicators; Strapolec Analysis; NRCan, About Uranium, 2014; NRCan, Uranium and Nuclear Power Facts, 2020; Note: Clean Energy Production based on 2015 data. Figure ES-2: CER, Canada's Energy Future 2019, 2019; NRCan, Energy Facts, Website.

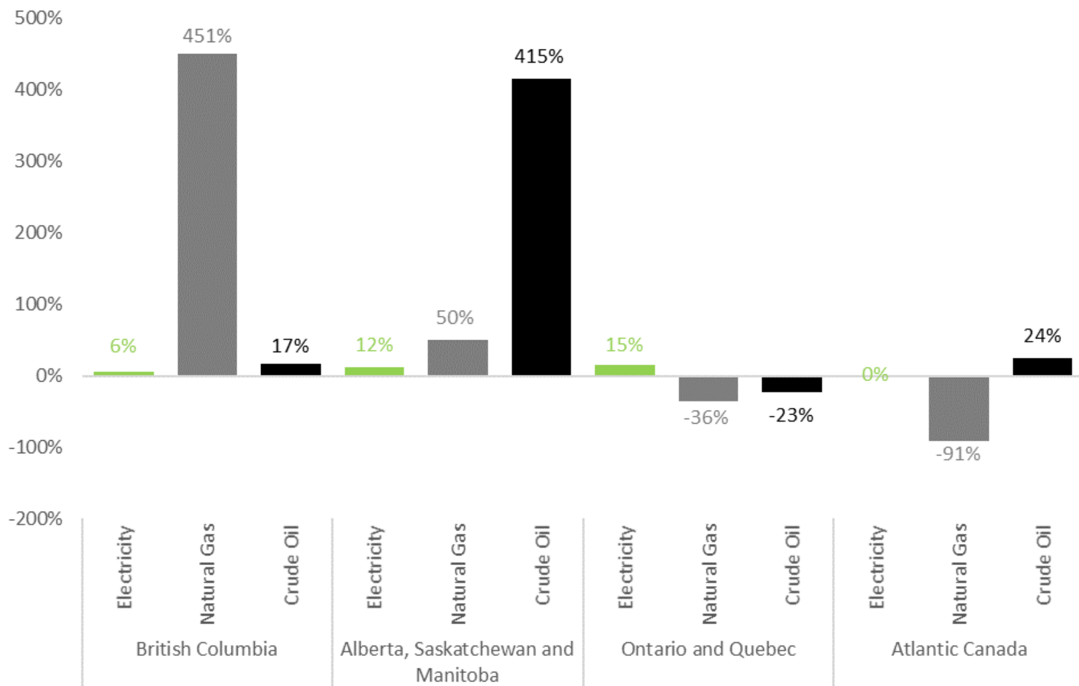
Canada has committed to reducing emissions to support the Paris Agreement. Nevertheless, like the rest of the world, Canada's economy relies on emission-intensive energy resources to heat buildings, fuel transportation, enable industry, and to help with the extraction and processing of minerals and fossil fuels. Significant emission reductions are possible in these economic sectors as new electrification technologies emerge. In turn, these technological advances represent opportunities for Canada to further decarbonize its economy and expand the exports of sustainably-developed energy resources.

Canada's energy assets, however, are a story of regional diversity. Each region has different energy import and export characteristics as shown in Figure ES-3. Thus, each region has different interests when

[4] BP, BP Statistical Review of World Energy 2019, 2019; Strapolec Analysis

it comes to developing Canada's energy assets. Natural resources dominate the conversation in the west, electricity is the focus of attention in the east, and energy security concerns arise as domestic reserves are exhausted and out-of-country energy imports increase in Atlantic Canada.

Figure ES-3: Canada's Regional Net Energy Exports as Percentage of Consumption, 2018
(Net Exports as % of Consumption)



Sources: CER, Canada's Energy Future 2019, 2019; Statistics Canada, Commodity Statistics, Website. Note: Uranium not shown because Saskatchewan is the only producer and does not consume it locally but either exports it or supplies it to fuel Ontario's and New Brunswick's nuclear power reactors, as well as research reactors across the country.

Electrification of the economy requires developing and leveraging sources of low carbon electricity, including Canada's domestic, regionally diverse hydro, nuclear, and biomass advantages. Developing these domestic assets offers several benefits for Canadians:

- Investing in Canada's domestic energy assets keeps the "energy" dollars at home;
- Domestic control over Canada's energy inputs and the development of "home-grown" technologies enhances Canada's energy security and innovation capability;
- Canada's low-cost electricity provides a competitive advantage for Canadian businesses and industries and may enable exports of clean energy and technologies to the U.S.; and,
- Reducing the domestic consumption of fossil fuels will free up Canadian-produced oil and gas for export.

The success of any plan to develop Canada's potential energy resources will be a function of foreign market demands and the ability to expand the delivery infrastructure to supply those markets. The existing infrastructure system reflects Canada's dependence on the U.S. for both its exports and imports of energy and the U.S.'s similar dependence on Canada. Canada's energy security and the ability to provide energy resources to the world requires diversification of existing extraction, generation, and delivery infrastructure.

Finding #2: Canada's largest trading partners have a compelling need for Canada's energy resources.

Canada's largest trading partners, the U.S., China, and the EU, represent over 50% of global energy demand. Canada, with its extensive clean electricity, natural gas, and oil resources, good reputation, and favourable geographic position, is well-placed to serve their growing energy needs and to respond to their emerging policy imperatives regarding decarbonization and energy security.

The potential demand among these trading partners for Canada's energy assets is shown in Table ES-1. This demand is significantly greater than what Canada provides today. The U.S. will need Canadian clean electricity to decarbonize, especially in the Northeast, and will continue to be a market reliant on Canadian natural gas and oil in its Northwest. The U.S. Midwest relies on Canadian imports for 60% of its refinery inputs. Natural gas demand is set to increase in China and the EU due to coal phase-out policies, spurring demand for liquid natural gas (LNG) that Canada could provide from its west and east coasts. Finally, oil demand remains strong in the EU and China, and Canadian supply may be regarded as a safer and more secure option than supplies from other trading partners.

Table ES-1: Demand for Energy by Export Market and Resource

Export Market	Resource	Anticipated Import Demand (2030)	Current Exports by Canada (2018)	Units	Current Exports as a % of Anticipated Import Demand
The U.S.	Electricity	332	72	TWh/y	22%
	Natural Gas	228	76	Bcm/y	33%
	Oil	6.8	3.5	MMb/d	52%
China	Natural Gas	435	0	Bcm/y	0%
	Oil	14	0	MMb/d	0%
The EU	Natural Gas	333	0	Bcm/y	0%
	Oil	19	0	MMb/d	0%

Sources: US Demand: EIA, Annual Energy Outlook 2020. Represents electricity provided by coal-fired generation in regions bordering Canada. China Demand: The Oxford Institute for Energy Studies, 2018; Shell International and The Development Research Center (Eds.), 2017; Zhongyuan et. al, 2018; Petro China Research Institute of Petroleum Exploration & Development, 2018; CNPC Economics & Research Institute, 2017; Strapolec Analysis. EU demand: Gas Infrastructure Europe, LNG Map 2019, 2019; Eurostat Data. Exports to Markets: CER, Commodity Tracker; CER, Electricity Interchange; CER, Canada's Energy Future 2019, 2019.

However, Canada's potential is limited by the lack of infrastructure capacity to support increased exports. Transmission line expansion to the U.S. is required to secure Canada's role as a primary source of low-carbon electricity. Enhanced pipeline delivery infrastructure to the U.S. is required to sustain Canada's roles as its primary source of reliable imports of natural gas and oil. Energy infrastructure is necessary to support natural gas and oil exports to China and the EU, including delivery systems to seaports and processing infrastructure on both the Pacific and Atlantic coasts.

Finding #3: Low carbon Canadian energy exports can reduce emissions in the U.S., China, and Europe.

Canada can hit above its weight and be a world leader in the global effort to reduce carbon emissions. Pursuing Canada's 2030 target of 30% below 2005 emissions levels requires electrification of key sectors of the economy, an achievement that would yield a reduction of 209 Mt. Canada is well positioned to achieve these objectives with its zero-emission electricity generation options. New technologies such as Small Modular Reactors (SMRs) could help reduce emissions from its domestic fossil fuel sector. Such an outcome would support the environmental sustainability of Canada's oil sector assets. These uniquely Canadian opportunities could enable the export of emissions-reducing energy options.

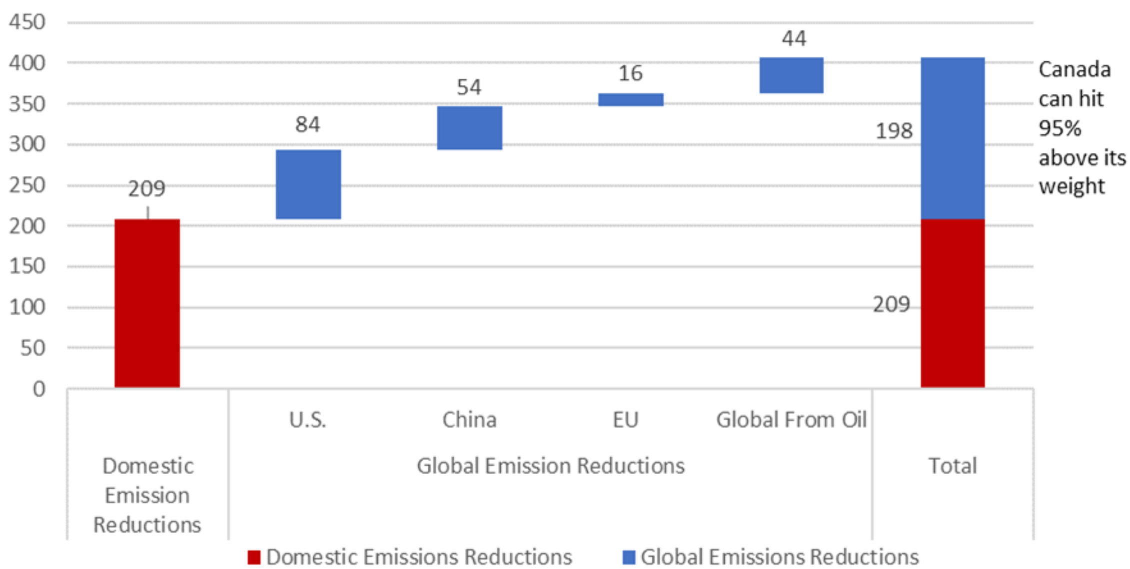
Exporting Canada's clean energy assets could help reduce the world's annual emissions by 407 Mt -- almost double Canada's committed emission reduction over the next 10 years as shown in Figure ES-4.

Canada can help the U.S reduce its emissions by 84 Mt/year by providing emissions-free electricity exports, hydrogen blended natural gas from Ontario's Dawn Hub, and increasing natural gas exports to the Western U.S. to help accelerate the transition from coal-fired generation in those states.

Canadian liquified natural gas exports to China and Europe would help reduce the use of coal – for electricity generation in both those regions as well as a multitude of other applications in China, including home heating. Combined, global emissions reductions could be 70 Mt.

Canada's oil sector has the opportunity to help reduce global emissions in two ways: reducing its own emissions to help Canada achieve its domestic targets; and displacing global use of oil that relies on sources with higher upstream emissions than Canada's could have. Global emissions could be reduced by 44 Mt per year.

Figure ES-4: Global Emissions Reductions from Canadian Electrification and Energy Exports
(MT CO_2eq/year)



Source: Strapolec Analysis.

Finding #4: Canadian energy projects continue to face complex obstacles associated with pan-Canadian economic, environmental, and social impacts.

Many energy projects have been proposed, started, or completed in recent years. These include: electric power and transmission projects; major natural gas pipelines; LNG export terminals; and, several oil pipelines. Energy investments of all types promise to deliver on similar benefits and also face challenges of similar complexity.

Development of Canada's energy resources provide several prosperity benefits for Canadians:

- Economic Benefits

  It is well understood that investments in energy infrastructure provide economic benefits by generating opportunities for businesses, building globally sought expertise, enabling exports, creating new jobs, generating higher tax revenues, stimulating more innovation, and driving wealth creation.[5]

- Energy Security

  Improving energy security includes reducing reliance on energy imports. Canadian hydro facilities, the nuclear refurbishment program, and delivering Canadian energy resources to eastern Canada all improve Canada's energy security. The retention of Canada's energy expenditures within the country improves the economic competitiveness of Canada's businesses and industries.

- Climate

  Enhanced low cost environmentally sustainable energy projects are essential to Canada's commitments to reduce emissions and combat climate change.

Despite these benefits, energy projects continue to face challenges in addressing the concerns and interests of many stakeholder groups, and in successfully executing projects.

- Indigenous Concerns

  Canada's legislative framework provides for the protection, rights, and sharing of benefits from any development project with Indigenous peoples. Many past grievances remain unsettled and resource-sharing remains an ongoing challenge in today's energy projects. These concerns have been particularly present in projects that cross traditional lands, such as the Coastal Gaslink pipeline and the Manitoba-Minnesota electric transmission line.

- Environment Impacts

  Public surveys show Canadians are increasingly concerned about the environmental impact that strategic investments in Canada's energy resources and delivery infrastructure may have. These include climate change concerns, the health impacts of other forms of pollution, and the projects' impact on lands and water. Opposition to oil and gas projects on the basis of their connection to climate change and risks of spills are common examples of these issues.

- Benefits sharing

  When multiple inter-jurisdictional rights and interests are impacted by an energy resource project, cost-benefit sharing is at center stage. Public and Indigenous opposition to hydropower projects such as the Site C Dam in B.C. shows what can happen when this allocation is insufficient, while the

[5] Government of Canada, Energy and the Economy, 2020.

partnership between Ontario Power Generation (OPG) and Indigenous communities for the Lower Mattagami project illustrates that success is possible.

- Project Management

  Realizing shared benefits is impacted by the ability to manage projects on cost and schedule. Project approval is contingent on the expectation of success by almost all parties involved, and the track records have too often been poor. Failure can cause yet further issues: in the Muskrat Falls case, for example, poor project management compromised a key commitment to local Indigenous communities.

Notwithstanding these challenges, successful energy projects have the potential to bring benefits to communities across Canada. Support of affected stakeholders is now considered by many to be a prerequisite for success in energy development projects.

Finding #5: A broad, inclusive, collaborative pan-Canadian approach is needed to unlock Canada's clean energy benefits.

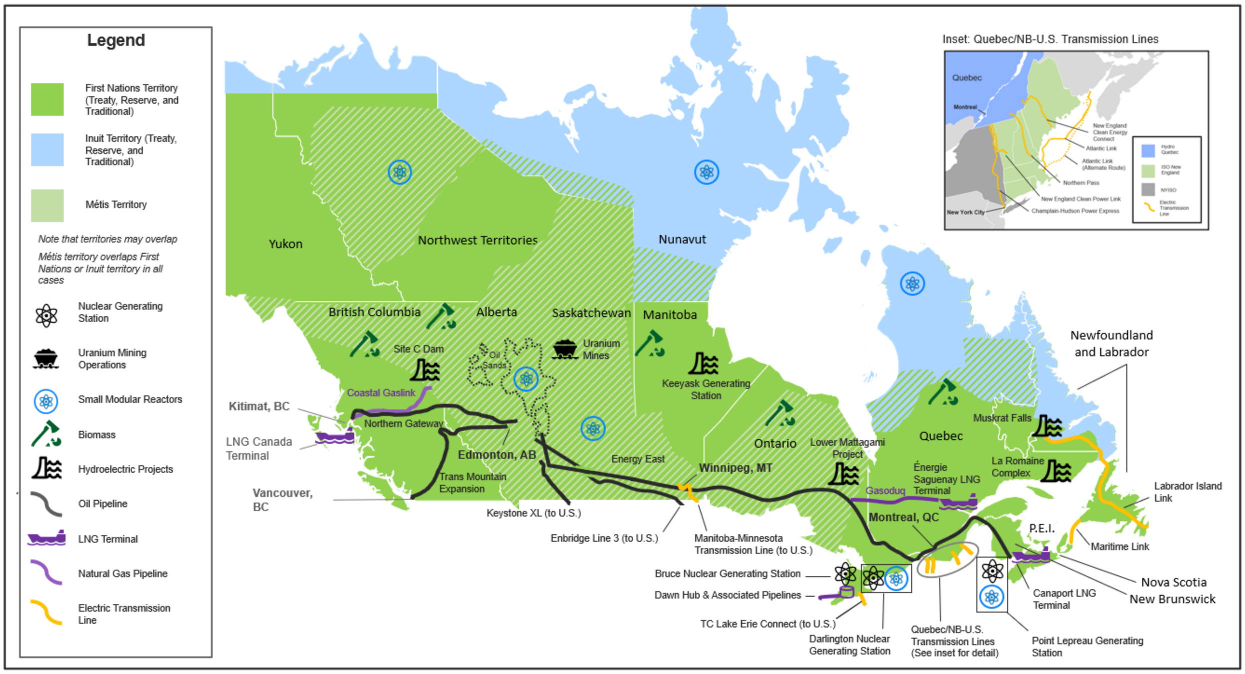
Energy projects have the potential to enhance national prosperity and achieve multiple stakeholder objectives. As such, these benefits provide an underpinning that could form the basis for collaboration in seeking and supporting successful project approval and completion.

The full portfolio of Canada's energy resource projects includes those under development or recently pursued as well as additional nuclear, biomass, transmission, natural gas, and oil opportunities. The portfolio of potential projects spans provincial and international boundaries as well as the traditional territories of a large number of Indigenous stakeholders. The pan-Canadian considerations of energy projects are illustrated in Figure ES-5. Collaboration between governmental, Indigenous, environmental, and commercial stakeholders will, therefore, be crucial to project success. Relations with U.S. stakeholders, as the target market for many Canadian energy developments, are an additional consideration.

Indigenous stakeholders – The diversity and geographic location of Canada's Indigenous people and their demographics present other layers of complexity. Additionally, political unity within these communities is challenged by current governance issues — some Indigenous peoples are effectively governed by elected Chiefs, while others award greater influence to hereditary leadership. Successful engagement must also recognize and address reconciliation objectives. Strategic investments in Canada's energy advantages can support and secure reconciliation with Indigenous peoples across the country. These kinds of investments can generate new employment and business opportunities and support Indigenous initiatives to provide their own programs — housing, education, health, policing, and other services — to their communities.

Governments – Canada's constitution shares governance rights and responsibilities among the federal, provincial and territorial governments over resource development — including energy resources that are not equally distributed across the country. Canada's history of settlement, economic development, and constitutional discourse has been influenced by this distribution. The economic prosperity of several individual provinces and territories within Canada's Confederation, in part, reflects the share of energy resources within their respective jurisdictions. Success means ensuring that each province and territory can appropriately benefit from the development of pan-Canadian assets.

Figure ES-5: New and Existing Canadian Energy Projects and Indigenous Land



Source: Native Land. Website; Strapolec Analysis.

Commercial Interests – Developers, financiers, engineering firms, etc., will continue to be important partners for these projects to succeed. All too frequently, investors are viewing Canada as a risky jurisdiction in which to invest. Commercial interests will need to be assured of the risks they are expected to undertake.

U.S. Interests – The U.S. is an important stakeholder in Canadian energy projects, as a competitor in world markets and as an independent actor that has shown willingness to influence projects in Canada.

The interests and perspectives of all stakeholders will need to be considered to successfully move forward on a National Energy Pact to develop Canada's diverse energy resources. The benefits brought by the portfolio of projects must be appropriately distributed among stakeholders to minimize the risks of projects encountering opposition from any group that is left with too much risk and/or contribution for too little benefit.

Closing

This report has laid out the realm of the possible for the development of Canada's energy resources. The results present a call to action for Canada's stakeholders to collaborate and ensure that the full and broad interests of Canadians are addressed in growing Canada's economy, addressing climate change, and ensuring the well-being and prosperity of future generations. If these diverse stakeholders can work together, then Canada can achieve its energy and related economic potential and hit above its weight in the global fight against climate change.

Achieving a collaboration-based consensus on a National Energy Pact from such myriad interests will require an extraordinary nation-wide consultation process. Principles of inclusiveness, comprehensiveness, transparency, disclosure, and facts should underpin the outreach, engagement, information sharing, and discussions moving forward. Developing this process is fundamental to successfully enabling a Canada-wide energy investment program. It's equally clear that the significant economic, environmental, and social benefits of Canada's energy resources will not be realized without fundamentally changing the way these critical investment decisions are made.

In recent months, post COVID-19 pandemic discussions have included proposals from various stakeholders for how Canada's energy resources should be developed for the greater good. Climate policy objectives are focusing on fuel switching, including greater electrification of key economic sectors like transportation, buildings, and industry. Climate change is also raising the public profile of other environmental externalities such as air pollutants, waste management, and water availability and quality. In turn, investors are advocating for, and being influenced by their shareholders, to adopt investment taxonomies that recognize these important environmental considerations in related financial spending.

This renewed interest in energy policy presents an opportunity to gather the various stakeholders and present a common energy strategy for the country. There may be no better time to start a national conversation about the energy policy issues facing Canada.

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1 Introduction

The world's need for energy is growing as developing nations seek to deliver prosperity to their populations. Unfortunately, along with that growth come the adverse effects of climate change. Against this backdrop, the Paris Agreement aligned 194 countries to reduce global emissions.[6] Yet, achieving these goals involves an unprecedented transition in how the world consumes energy.

Unlike most other countries, Canada is blessed with substantial energy resources in the form of hydro, nuclear, biomass, natural gas, and oil. With these resources, Canada has the potential to hit above its weight in reducing global emissions through environmentally responsible development and export of these resources. Achieving this will require the effective and sustainable management of Canada's energy resources for both domestic needs and export to others. Developing supporting transmission and distribution networks to export energy resources is also required. To date, progress on these two objectives has been hindered by the material environmental, economic, and social policy challenges that these developments face. There is an urgent need for Canada to embrace dialogue to create a national energy pact that can unlock the benefits to Canadians and combat global climate change.

Study Scope

Several studies have been undertaken to assess Canada's energy potential in a global context, its role in reducing emissions, and the benefits of its exports.[7] While considering these efforts, this study differs in three respects by (1) providing an integrated compendium of Canadian energy assets and development projects, shining a light on the regional diversity of the initiatives; (2) identifying the contribution these assets can provide in achieving emission reduction objectives, both domestically and globally; and, (3) framing the challenges in developing these assets in the context of the complexities and interests of the myriad of pan-Canadian stakeholders.

This study explores the fundamentals underlying Canada's energy resources, their potential to address global emissions, the global need for Canada's clean and sustainably developed energy resources, and the conditions that will enable the development of related infrastructure. The purpose of this exploration is to help inform affected stakeholders across Canada, including the federal government, provinces, territories, and Indigenous peoples, and to foster a dialogue on a collaborative National Energy Pact to further develop Canada's energy assets.

1.1 Canada in the Context of the Global Energy and Climate Discourse

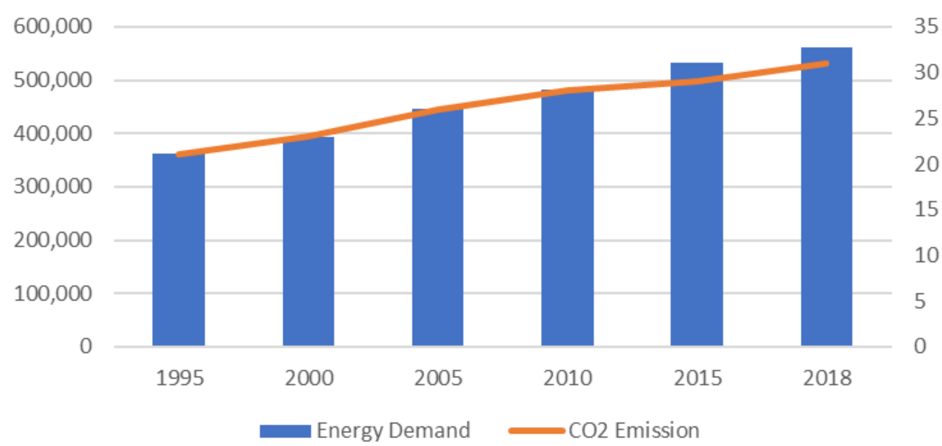
The world is entering a decade where clean, reliable energy is of ever-increasing importance. This need for energy and the impacts of climate change are inextricably linked. Fossil fuels, the primary culprit for climate change, remain a crucial energy source and the world is seeking low emitting electrification alternatives.

[6] Government of Canada, The Paris Agreement.
[7] CCPA, Canada's Energy Outlook, 2018; CAE, Becoming a Sustainable Energy Powerhouse, 2014.

Global energy needs have grown by 60% since 1990[8] and reliance on carbon-emitting fossil fuels is expected to continue. The IEA predicts that fossil fuels will account for nearly 60% of global energy production by 2040, even if nations take significant steps to reduce their emissions output.[9] Since 1995, CO_2 emissions from global energy consumption have increased by over 60% from 20.5 gigatonnes (GT) to 31 GT per year, as shown in Figure 1. With GHG emissions hitting a new high in 2018,[10] many policymakers and experts are concerned about the previously unperceived impacts of climate change: melting ice sheets, rising ocean levels, expanding deserts, and increasingly intense and frequent wildfires, hurricanes and droughts.[11]

Figure 1: Global Energy Demand and CO_2 Emissions

(PJ of energy and gigatonnes of CO_2 emissions; 1995-2018)



Source: IEA, Tracking Progress, 2019. Our World in Data, Global Primary Energy Consumption, 2018.Website.

Between 2018 to 2019, CO_2 emissions flattened,[12] as advanced economies built more wind and solar resources, switched from coal to natural gas generation, and, to a lesser extent, increased nuclear energy output.[13] These trends point to the global energy transition getting underway.

Canada represents a microcosm of this global dilemma and is uniquely positioned in the global energy landscape with its extensive fossil and hydro resources and world-class nuclear expertise.

1.2 Document Structure

This report reviews Canada's current energy assets, illustrates their potential benefits, and explores the issues inhibiting Canadians from realizing this potential by exploring the following questions:

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[8] In 1990, total primary energy consumption was 98,507 TWh, while in 2018 it was 157,063 TWh. Our World in Data, Global Primary Energy Demand. 2018.

[9] IEA, Global CO_2 emissions in 2019.

[10] IEA, World Energy Outlook 2019, Executive Summary.

[11] The Guardian, Climate emergency: global action is 'way off track' says UN head. 2020.

[12] IEA, Tracking Progress, 2019.

[13] IEA, Global CO_2 emissions in 2019.

a) What is Canada's potential to increase its supply of low emission energy to the world?
b) Can these resources help reduce global emissions?
c) What are the barriers facing Canada's abilities to achieve these opportunities?
d) Who are the stakeholders that may have interests in developing these resources?
e) Are there common/shared interests that collaboration could help in overcoming these barriers?

The structure of this report presents the findings of these lines of query as follows:

- Section 0 reviews the methodology used in this report, provides the key sources used for energy demand, consumption, and production in Canada and elsewhere, and presents relevant assumptions.
- Section 3 represents the bulk of this report, providing an integrated compendium of Canada's energy assets and infrastructure. It reviews the supply, demand, regional diversity, and trade of Canada's electricity, natural gas, and oil resources and infrastructure, providing a subsection devoted to each that includes maps and relevant regionally specific considerations such as trade and energy security implications. This section also places these resources in the context of Canada's climate change objectives with a subsection devoted to the sources of emissions in Canada, how those emissions vary by province, and the imperative to develop clean energy. Finally, a subsection is devoted to the options for emissions reduction in Canada's energy sector, including the potential for reducing the emissions-intensive nature of Canada's oil sands.
- Section 4 examines the demand for energy by Canada's largest trading partners – the U.S., China, and the EU – and the potential role for Canada to supply that energy.
- Section 5 explores how Canada, by supplying its clean energy assets to its major trading partners, could reduce emissions worldwide.
- Section 6 completes the compendium of Canada's energy landscape by providing a comprehensive overview of ongoing or recent power, transmission, natural gas, and oil energy projects in Canada. This section explores the anticipated benefits of those projects and also the major challenges that hindered their progress and/or blocked their successful completion.
- Section 7 summarizes the portfolio of potential Canadian energy projects and the pan-Canadian stakeholder interests relevant to their development, including the role of the U.S. in Canadian energy projects. This section makes a case for broad and inclusive collaboration on a National Energy Pact directed to overcome the barriers to Canada's clean energy resource development.

2 Methodology

This report set out to characterize the relevance of Canada's diverse energy assets to the prosperity of Canada and the potential contribution to emissions reduction. Four investigations were conducted to underpin the findings in this report:

1. Establishing the scope of Canada's energy resources and their potential role in reducing emissions;
2. Identifying viable foreign export markets for Canada's energy resources;
3. Determining Canada's potential to help reduce global emissions; and,
4. Analyzing the challenges potentially inhibiting the development of Canada's energy resources and delivery infrastructure.

Investigation 1: Establishing Canada's energy resource context

Five main sources were consulted to assess Canadian and global energy resources. These sources provided statistics on current and projected resource consumption, production, exports, and imports based on different scenarios. Primary sources included:

1. Canada's Energy Regulator's (CER) – 2019 Canada's Energy Future
    - The CER provides forecasts for Canada's projected energy production, consumption, imports, and exports based on the current economic outlook, a moderate view of energy prices and technological improvements, a data-oriented perspective on climate and energy policies, and enough statistics and details required for modelling. The CER forecast reflects a moderate expectation for achieving emissions reductions in Canada.
2. The International Energy Agency (IEA) – World Energy Outlook 2019
    - The IEA provides two projections for global energy demand by resource. Their 'Stated Policies Scenario' is based on existing and announced global energy and climate policies, and their 'Sustainable Development Scenario' is based on achieving universal energy access, reducing the severe impacts of pollution, and limiting global temperature rise to 2° C above pre-industrial levels.
3. Environment and Climate Change Canada – Greenhouse gas and air pollutant emissions projections: 2019
    - This biannual report submitted to the UN assesses Canada's greenhouse gas projections under two scenarios, both of which were used in this study. The Reference Case is based on federal, provincial, and territorial measures in place as of September 2019. The Additional Measures Case considers all policies from the Reference Case as well as those not yet fully implemented.
4. The Canadian Centre for Policy Alternatives (CCPA) – Canada's Energy Outlook: Current Realities and Implications for a Carbon-Constrained Future
    - This report analyzes Canada's energy resources in a global context and assesses trends in the nation's energy production and consumption to determine how Canada can

maintain a secure energy supply while minimizing environmental impacts. The report also examines the future economic impact of Canada's energy resources in terms of jobs and government revenues.

5. The Canadian Academy of Engineering – Canada: Becoming a Sustainable Energy Powerhouse
    - This report assesses the energy production and carbon footprint impacts of developing nine new large-scale energy projects across Canada concludes that completing these projects could increase the nation's export opportunities and decrease the carbon content of its energy products.

Investigation 2: Identifying Foreign Markets

Several sources were used to characterize the potential for Canada's energy exports and the role they may play in lowering global CO_2 emissions. This study focused on Canada's current major trading partners which are the U.S., China, and Europe.

Demand forecasts for Canada's clean energy resources, specifically electricity demand from the U.S., rely primarily on three sources:

1. U.S. Energy Information Administration (EIA) Annual Energy Outlook 2020, 2020.
    - The EIA provides modeled projections of U.S. energy markets through 2050 and includes cases with different assumptions about economic growth, energy prices, and technological progress.
2. EIA Analysis of the Impacts of the Clean Power Plan, 2015.
    - The EIA provided an analysis of the Obama Administration's climate plan, the Clean Power Plan, and developed projections for the U.S. electricity system to 2050.
3. Strapolec Renewable-Based Distribution Energy Resources in Ontario, 2018.
    - Strapolec's previous research on the economics of DERs in Ontario was used to show how Canada will have an attractive energy supply for neighbouring U.S. states.[14]

Data on China's current supply of oil and natural gas was drawn from the China Customs database, which provides information on all commodities imported and exported from China on a monthly basis. Insights about China's energy security issues related to oil imports were drawn from EIA's analysis of China's energy mix, published in 2015.[15]

For China's LNG demand, a range of projections was developed based on four sources:

1. The Oxford Institute for Energy Studies: The Outlook for Natural Gas in the War Against Air Pollution, 2018.

[14] Strapolec. Renewables DER in Ontario – Cost & Implications Assessment, 2018

[15] EIA, China: International energy data and analysis, 2015.

- This report reviews the context for China's switch from coal to natural gas as a means for combating air pollution and presents several official projections for natural gas demand published by the Chinese Government.

2. Shell International and The Development Research Center (Eds.) China's Gas Development Strategies, Advances in Oil and Gas Exploration & Production, 2017.
    - A report by Shell discussing China's present and possible natural gas reserves and production forecasts.
3. Zhongyuan et. al. Natural gas utilization in China: Development trends and prospects, 2018.
    - An academic report that provides natural gas consumption forecasts for 2020 and 2030, as well as forecasts for other types of fuel per end-use.
4. Petro China Research Institute of Petroleum Exploration & Development. Natural Gas in China: Development trend and strategic forecast, 2018.
    - An academic report that provides projections for China's natural gas production, consumption, pipeline imports, and LNG imports.

For Europe, data from the Eurostat database was used to determine oil and natural gas trade statistics for EU countries. Eurostat is the statistical office of the European Union and has a publicly available database searchable online.

Investigation 3: Determining Canada's potential to reduce global emissions.

The analysis of Canada's ability to reduce emissions in the U.S. via clean energy exports was based on three main sources:

1. EIA's Annual Energy Outlook 2020, Reference Case Projections Tables
    - These data tables provide forecasts for the future electricity mix in given U.S. regions.
2. House of Commons, Strategic Electricity Interties, 2017.
    - Contains data on transmission line capacity between the provinces and border states.
3. Strapolec's Ontario's Emissions and the Long-Term Energy Plan: Phase One report, 2016
    - Contains previous research by Strapolec on the feasibility and emissions reduction potential of various technologies and assets.

This report includes an analysis of the potential for nuclear energy to reduce emissions in the oil sands that is based on three main sources:

1. Nimana et al. Energy consumption and greenhouse gas emissions in the recovery and extraction of crude bitumen from Canada's oil sands. University of Alberta, 2015.
    - Study on the energy inputs and emissions content of bitumen extraction in Alberta.
2. Nimana et al. Energy consumption and greenhouse gas emissions in upgrading and refining of Canada's oil sands products. University of Alberta, 2015

- Study on the energy inputs and emissions content of bitumen upgrading in Alberta.

3. Masnadi et. al, Global carbon intensity of crude oil production. Stanford, 2018.
   - Study showing the carbon intensity of crude oil production in all major oil-producing countries of the world, including Canada.

Investigation 4: Analyzing the challenges inhibiting the development of energy resources and delivery infrastructure.

A review of recent Canadian energy resource and infrastructure projects was conducted to identify the anticipated benefits of those projects and the major challenges that either hindered their progress and/or blocked their successful completion. Both ongoing and recently cancelled projects were reviewed. Projects included oil pipelines, natural gas pipelines and LNG projects, electricity transmission lines to the U.S., and hydroelectric projects.

To characterize the projects, basic information for each was drawn from respective websites and promotional materials of the project developers. Such information included the size of projects, their intended purpose, and potential benefits.

To identify the major challenges that impeded their success, news media was a primary source of information. Challenges looked for included opposition from stakeholders, such as environmental groups and Indigenous peoples,[16] but also issues that related to benefits sharing and project execution effectiveness.

[16] Indigenous peoples referred to in this report include First Nations, Inuit, and Metis peoples. This term is recognized by The Canadian Encyclopedia, Indigenous Peoples in Canada, 2018 to collectively embrace these diverse peoples and used here acknowledging the factors described in UBC, Indigenous Foundations, Aboriginal Identity & Terminology. Website.

3 Sustainable Development of Canada's Energy Resources is Required to Reduce Emissions

This section provides an integrated compendium of Canada's energy assets and infrastructure and how the imperative to reduce emissions requires their development. Canada has an abundance of low-carbon electricity, natural gas and oil resources, and is a net exporter of each. Concurrently, Canadians are increasingly aware of the need to seriously address climate change.[17]

A review of the supply, demand, regional diversity, and trade of Canada's electricity, natural gas, and oil resources and infrastructure is provided by subsections devoted to each, exploring relevant regionally specific considerations such as trade and energy security. The context of Canada's energy consumption within Canada's climate change objectives is provided by a subsection devoted to the sources of emissions in Canada, how those emissions vary by province, and the imperative to develop clean energy in general and low emission electricity in particular. Finally, a subsection is devoted to the options for emissions reduction in Canada's energy sector, including the potential for reducing the emissions-intensive nature of Canada's oil sands.

3.1 Canada's Low-Emission Electricity Resources Are Significant

Canada's significant low carbon electricity resources are the foundation for one of the cleanest electricity grids in the world. These low emitting resources have allowed Canada's power sector to support national CO_2 emission goals while electricity exports have displaced fossil fuel use in the U.S..

This subsection first describes the importance of low carbon electricity in the world's energy mix and how Canada's low emission electricity mix compares to other countries. This is followed by an overview of Canada's electricity supply and demand by region. Canada's electricity generation, transmission, and trade, including the potential to develop more low-carbon resources are then examined. A summary of key findings concludes this subsection.

3.1.1 Global and Canadian Electricity Consumption

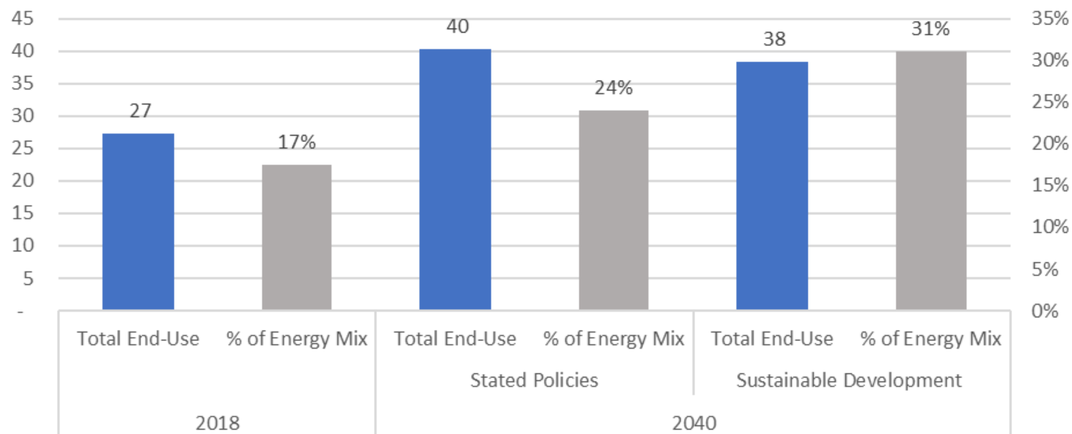
The share of electricity in the world's energy mix is increasing. Currently, electricity accounts for 17% of global end-use energy consumption with its share expected to grow to 24% by 2040. However, this assumes that current global climate policies to reduce emissions are not accelerated. To reflect the imperative to reduce emissions, the IEA has created a Sustainable Development Scenario. Under this scenario, the share of electricity within global energy consumption could become as high as 31%, as shown in Figure 2.[18] The global growth in electricity demand is occurring as the electricity sector undergoes a shift from fossil fuel-fired generation to non-emitting sources. This paradigm shift has put electricity and electrification at the forefront of the world's clean-energy transition.

[17] National Observer, 'Climate change number 1 concern for Canadians, poll says', 2019.

[18] The Sustainable Development Scenario is based on achieving universal energy access, reducing the severe impacts of pollution and limiting global temperature rise to 2° C above pre-industrial levels. IEA, World Energy Outlook 2019, 2019.

Figure 2: Global Electricity Consumption, 2018-2040

(Thousands of TWh; Electricity as a percentage of energy consumed, 2018-2040)

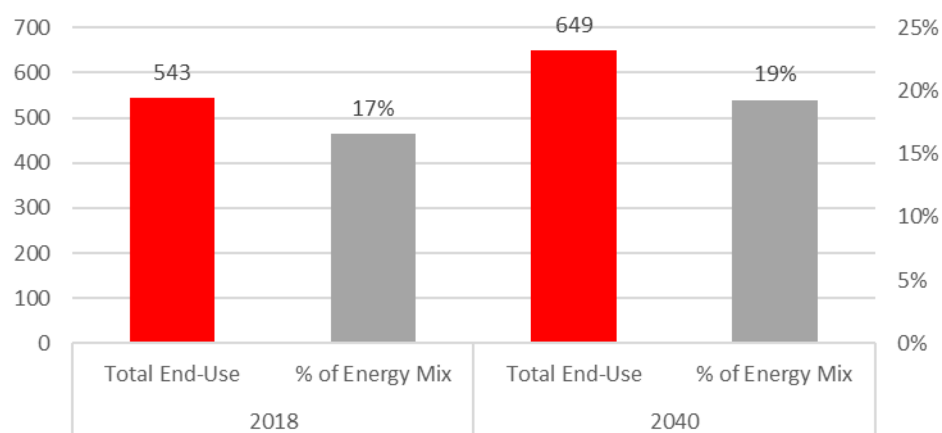


Source: IEA, Electricity, 2019.

In Canada, the share of electricity in energy consumption is currently 17%, virtually identical to the global average. Under current policies, growth in consumption of electricity is only expected to modestly increase its share to 19% of overall energy consumption, as shown in Figure 3. This is significantly more modest than the 24% or 31% share projections for the rest of the world, despite the availability in Canada of non-emitting sources such as nuclear, hydro, biomass, wind, and solar.

Figure 3: Canadian Electricity Consumption, 2018-2040

(TWh; Electricity as a percentage of energy consumed)

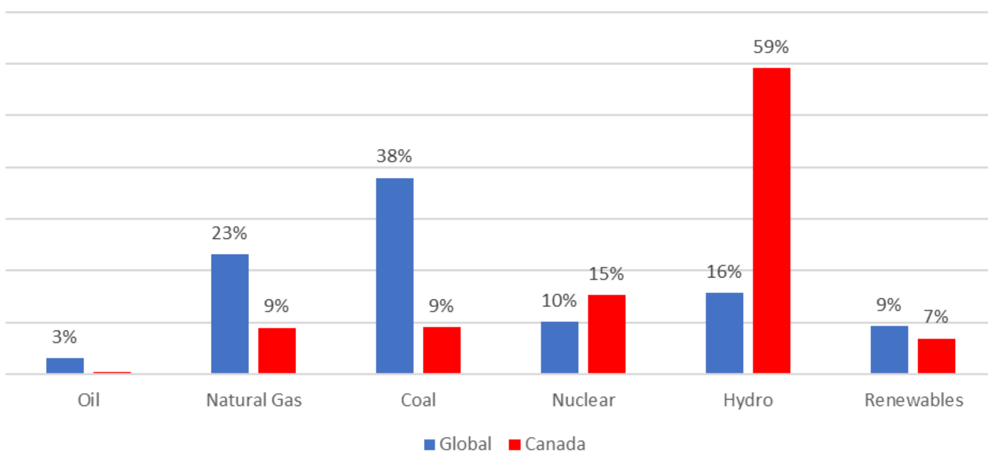


Source: CER, Canada's Energy Future 2019, 2019

3.1.2 Canada is the World's Fourth Largest Producer of Low Emissions Electricity

Canada is the world's sixth-largest producer of electricity[19] and has one of the cleanest electricity systems in the world, with 82% of its electricity coming from non-emitting sources like hydro and nuclear, as shown in Figure 4. Canada is, in fact, the fourth-largest producer of low emission electricity.[20]

Figure 4: Fuel Used to Generate Electricity – Global vs. Canada, 2018
(Percentage breakdown by electricity sources)



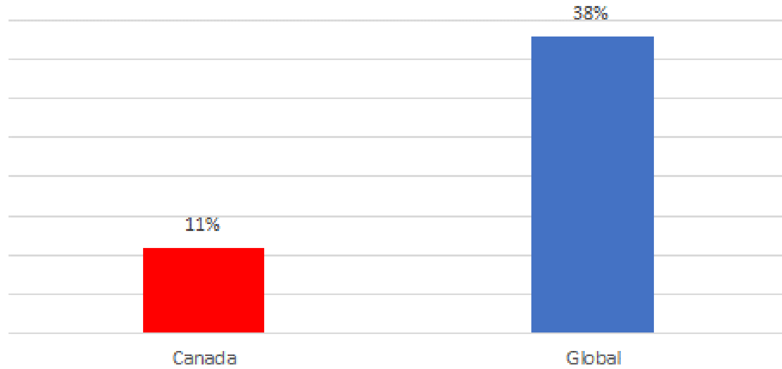
Sources; IEA, Electricity, 2019. CER, Provincial Energy Profiles.

The global electricity sector accounts for 38% of the world's GHG emissions, as shown in

Figure 5. The high global emissions intensity is due to the extensive use of coal, the most emissions-intensive fuel in broad use today. Coal accounts for 38% of the global generation.[21] Since coal forms only 9% of Canada's electricity generation, electricity system emissions represent only 11% of the total for the nation.

[19] NRCan, Electricity facts. Website.
[20] Enerdata, 2015; Strapolec Analysis.
[21] In order to align with the IEA's Sustainable Development Scenario (which would limit average global temperature increase to below 2 °C above pre-industrial levels) coal's share of the global electricity mix would need to decline to 5% by 2040. IEA, Tracking Power, 2018. Website.

Figure 5: Electricity Share of Total Emissions – Canada vs. Global, 2018
(Electricity emissions as percentage of overall emissions)

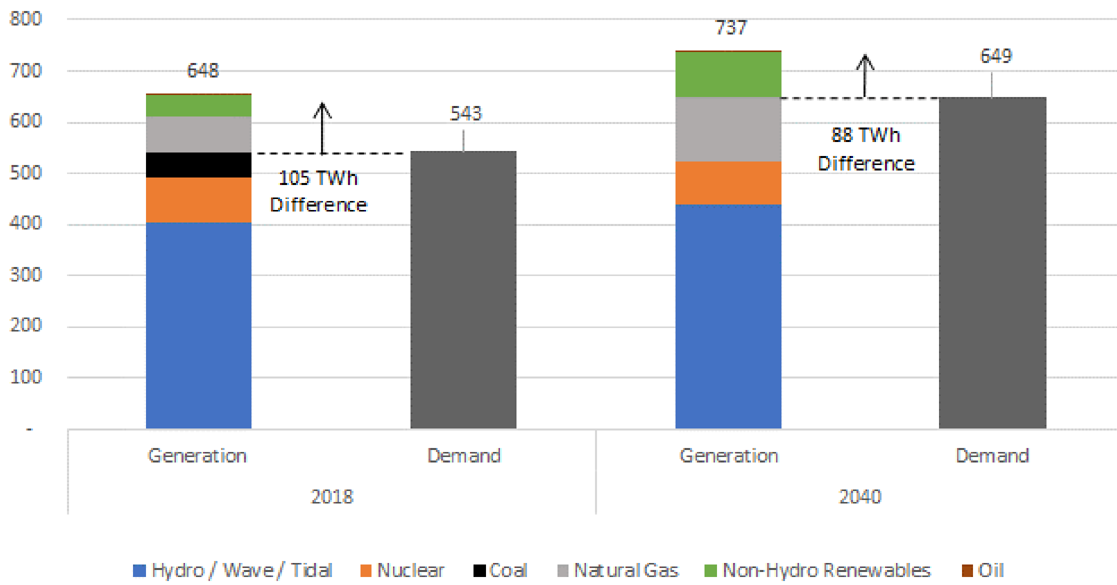


Source: IEA, Global CO_2 Emissions in 2019. Environment and Climate Change Canada, Canada's Official Greenhouse Gas Inventory.

3.1.3 Electricity Supply and Demand

Canada currently generates more electricity than it consumes, as shown in Figure 6. This capacity enables Canada to export electricity. However, by 2040, the CER forecasts that Canada's annual electricity generation will increase by 11% to 737 TWh, but demand will increase by 20% to 649 TWh, representing a 16% reduction in exportable capacity from today.[22] Canada's role as an exporter may be changing.

Figure 6: Canada's Electricity Generation by Source and Total Demand, 2018-2040
(TWh)



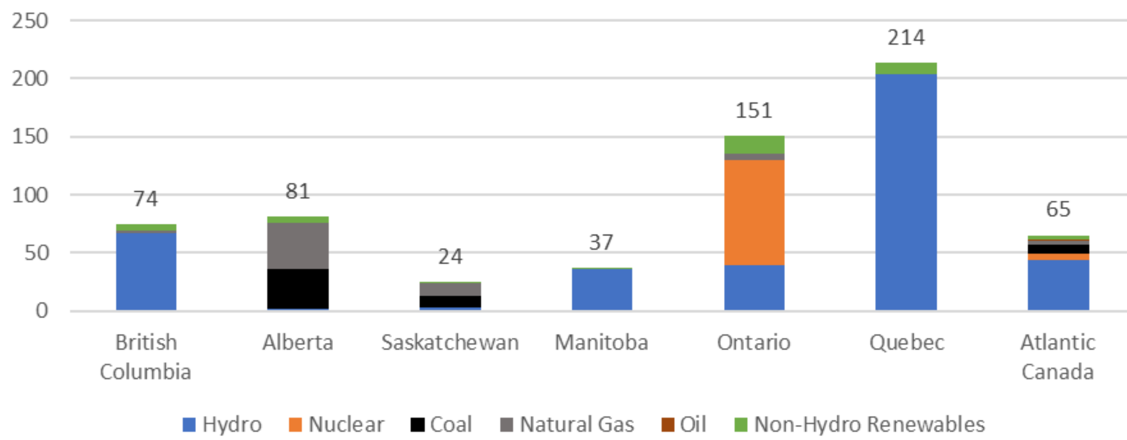
Source: CER, Canada's Energy Future 2019, 2019.

[22] Electricity transmission system losses may not be reflected.

3.1.4 Electricity Generation

Canada's electricity-generating resources are regionally diverse and vary across the country, as shown in Figure 7. The majority of electricity generated in Canada is in Ontario and Quebec. Most of Canada's low carbon hydro resources exist in B.C., Quebec, Manitoba, and Newfoundland and Labrador, who rely almost entirely upon hydro. Developable hydro resources are scarcer in other regions. Ontario obtains about 60% of its electricity from nuclear generation, with about 25% provided by hydro resources.[23] In New Brunswick, nuclear generates the largest share at about 39% of energy supply, followed by hydro at about 21%. By comparison, most of the electricity in Alberta and Saskatchewan is generated from fossil fuels.

Figure 7: Provincial Electricity Generation Mix, 2018
(TWh)

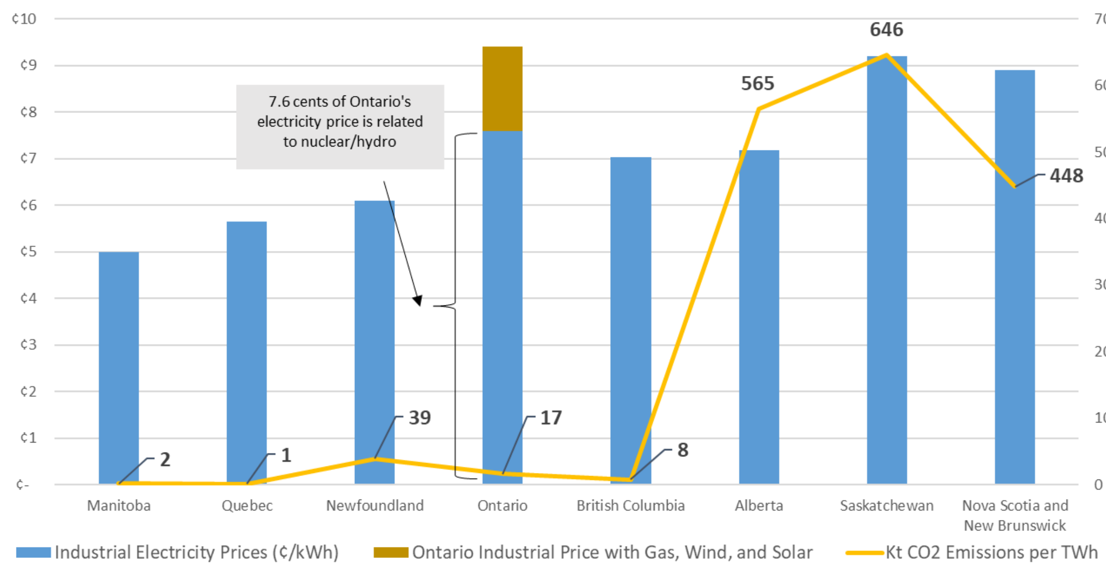


Source: CER, Canada's Energy Future 2019, 2019.

Provinces with lower emitting electricity grids also typically benefit from generating at a lower cost, as demonstrated in Figure 8. In contrast, Alberta, Saskatchewan and Nova Scotia's reliance on coal correlates with having the highest-emitting electricity portfolios of all the provinces, along with high industrial electricity prices.

[23] CER, Canada's Energy Future, 2019.

Figure 8: Provincial Industrial Prices and Electricity Emissions, 2017-2018
(¢/kWh and Kt CO_2/TWh)



Source: CER, Electricity Facts, Website; OEB, Regulated Pricing Plan Price Report; Ontario Energy Quarterly, Q4 2018, 2018; Strapolec Analysis.

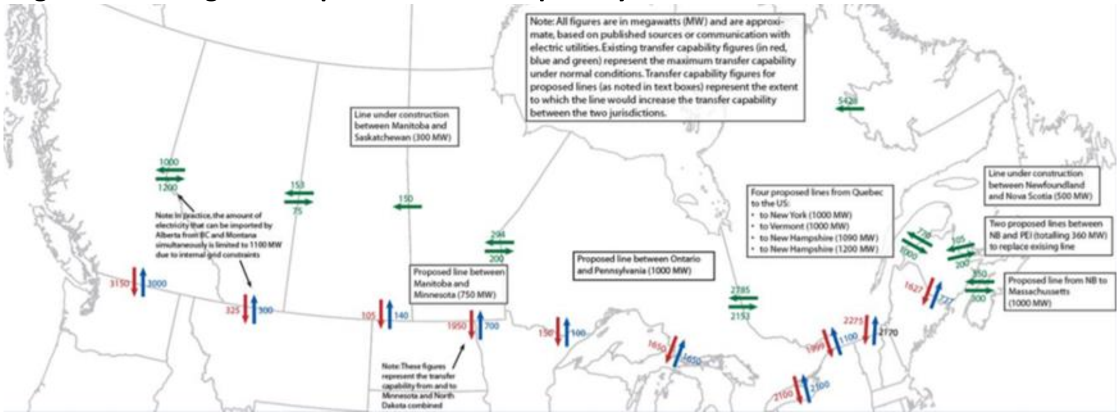
Figure 8 also shows that Ontario is unique among the provinces in that even with clean electricity production, the province has the highest industrial electricity prices. However, nuclear and hydro, which represent 84% of Ontario's supply mix, only account for about 75% of Ontario's average electricity costs to industrial consumers at 7.6 cents per kWh.[24] Ontario's high prices are due in large part to historical provincial policy decisions that resulted in over investments in natural gas, wind, and solar assets.

3.1.5 Electricity Transmission Infrastructure and Interties

In addition to generation capabilities, most of the provinces have a robust electricity transmission infrastructure that enables both interprovincial transfers and exports to the U.S. These capabilities are summarized in Figure 9.

[24] Strapolec, Renewable-based Distributed Energy Resources in Ontario, 2018.

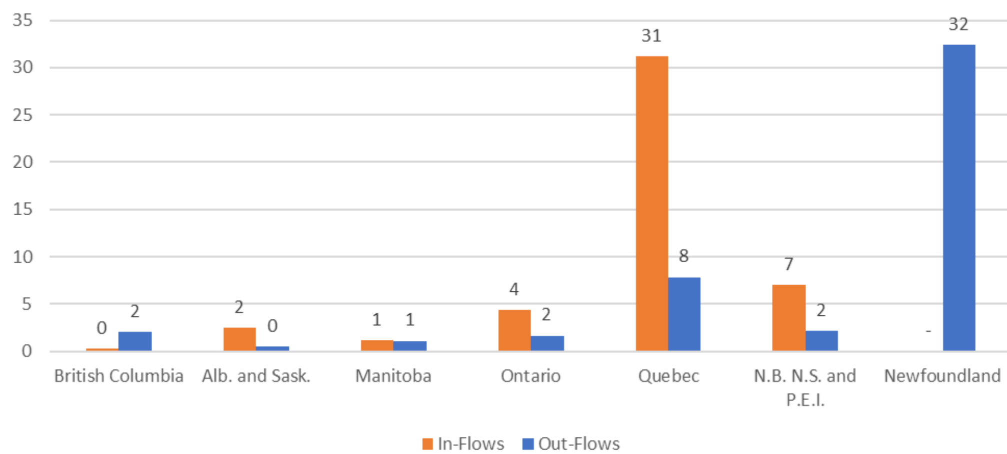
Figure 9: Existing and Proposed Transfer Capability Between Canada and U.S. Jurisdictions



Source: House of Commons, Strategic Electricity Interties.

All provinces that border on the U.S have associated interties. The majority of Canada's network of interprovincial electricity interconnections facilitate electricity exchanges between Quebec and the rest of Eastern Canada, as shown in Figure 10. Relatively little interprovincial exchange occurs west of Ontario.

Figure 10: Interprovincial Electricity Transfers, 2018
(TWh)



Source: CER, Canada's Energy Future, 2019.

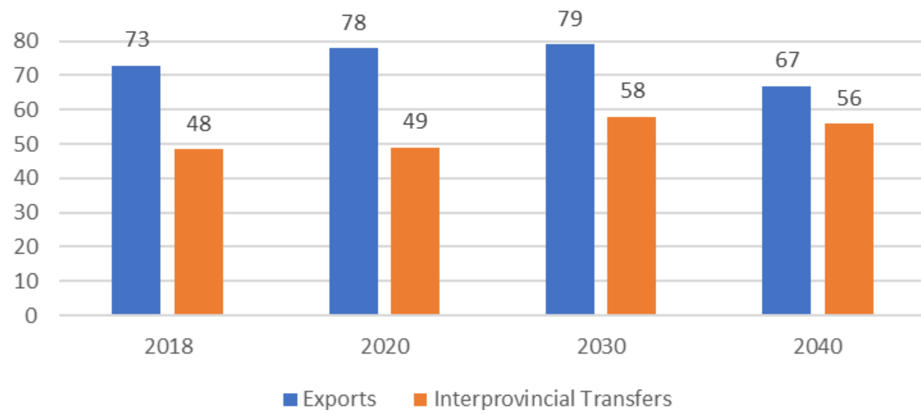
Newfoundland and Labrador produce 7% of Canada's electricity, including from Churchill Falls, one of the largest electricity-generating facilities in Canada. Much of this flow is currently committed to supplying Quebec.

Ontario has interconnections with Manitoba and Quebec with most of the inflows sourced from Quebec. Alberta and Saskatchewan produce 17% of Canada's electricity, however, both provinces have high domestic demand and are net importers of electricity.

The CER states that there is potential for growth in aggregate interprovincial trade volumes and net exports out of Canada, as seen in Figure 11.[25] The CER projects that inter-provincial electricity transfers will remain stable through to 2040 and that an expanded interprovincial grid network in Atlantic Canada will facilitate increased inter-provincial transfers after the mid-2020s.[26] The CER also speculates that optimizing the interconnections to take advantage of differences in peak demand periods could reduce the reliance on fossil fuel sources.[27]

Figure 11: Electricity Exports to U.S. and Interprovincial Transfers, 2018

(TWh)



Source: CER, Canada's Energy Future 2019, 2019.

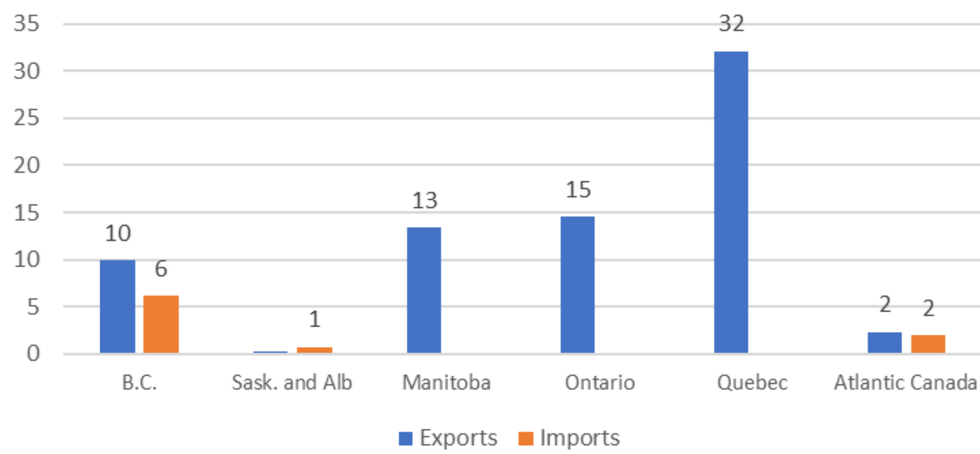
3.1.6 Electricity Exports and Imports

Canada is the world's second-largest exporter of electricity, after Germany. Its exports represented 5.8% of global electricity exports in 2019.[28] About 11% of Canada's electricity, 72 TWh, is exported to the U.S. via 34 major international transmission lines. The volume of exports varies regionally as shown in Figure 12.

Most of Canada's electricity export activities occur in the east where much of the large-scale generation, demand and interties exist. Quebec is the largest electricity exporting province, followed by Ontario, Manitoba, and British Columbia. By comparison, exports from Alberta and Saskatchewan are minimal at less than 0.1 TWh each in 2018. British Columbia produced 11% of Canada's electricity, and has both large export and import flows with the U.S. In 2019, B.C. was a net importer of electricity.

[25] The basis for this decline is not explained by the CER and the forecast does not account for climate policies or clean electricity targets.
[26] CER, Canada's Energy Future 2019, 2019.
[27] CER, Canada's Energy Future 2019, 2019.
[28] World's Top Exports, Electricity Exports by Country.

Figure 12: Regional Electricity Exports and Imports to the U.S., 2018
(TWh)



Source: CER, Energy Futures, 2019, 2019.

Lack of transmission capacity is a limiting factor to increasing exports and many provinces are proposing to expand their export capacity to the U.S., as summarized in Table 1. Quebec has proposed doubling its existing capacity, while Ontario, New Brunswick, and Manitoba have proposals to increase export capacity by between 25% to 60%.

Table 1: Export Infrastructure by Province
(MW)

Existing Interties			Proposed Interties	
Origin	Destination	Capacity	Destination	Capacity
Quebec	Vermont	2,275	Vermont	1,000
	New York	2,000	New York	1,000
			New Hampshire	2,290
Ontario	New York	2,100	Pennsylvania	1,000
	Michigan	1,650		
	Minnesota	150		
New Brunswick	Maine	1,627	Massachusetts	1,000
Manitoba	Minnesota	1,950	Minnesota	750
British Columbia	Washington	3,150		
Total		**14,902**		**7,040**

Source: House of Commons, Strategic Electricity Interties, 2015.

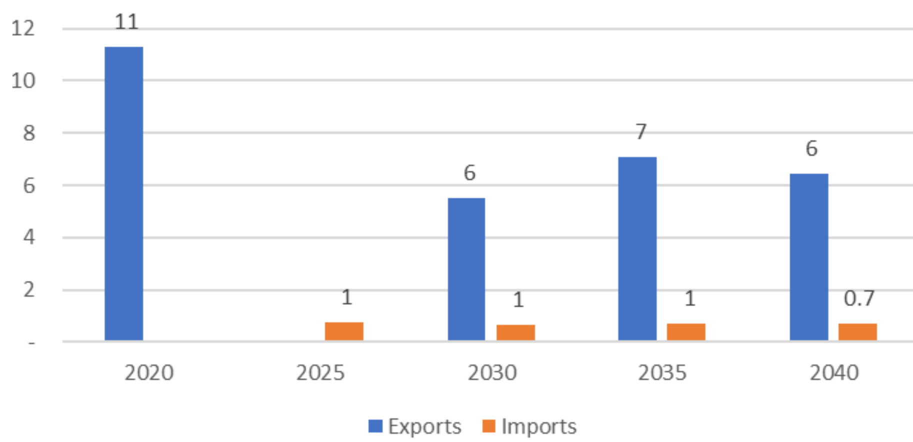
The CER projects a decline in net Canadian exports to the U.S. by 2040, which may be partially driven by a decline in surplus generation from Canada's two largest exporting provinces, Ontario and Quebec.

3.1.7 Ontario And Quebec Electricity Trade Balance

A closer look at Ontario and Quebec's electricity systems offers some insight into the future of electricity trade with the U.S.

The CER forecasts that Ontario's electricity exports to the U.S. will drop from around 11 TWh in 2020 to zero by 2025, as shown in Figure 13. Ontario's IESO attributes this decline in exports to the retirement of the Pickering Nuclear Generating Station and the refurbishment of the nuclear reactors across the province. The retirement of the Pickering Nuclear Station will negatively impact the province's energy trade balance by increasing the province's reliance on natural-gas fired generation and the accompanying price implications. Although not expected to reach 2020 levels, the balance of trade is forecast to shift back toward exports in the 2030s, after the nuclear refurbishment program is complete.[29]

Figure 13: Ontario's Forecasted Electricity Trade with the U.S., 2020-2040
(TWh)

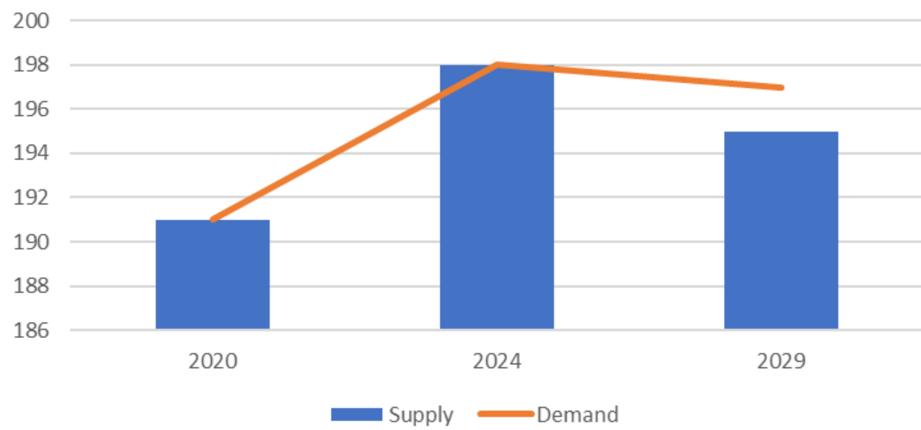


Source: CER, Canada's Energy Future 2019, 2019.[30]

Hydro-Québec forecasts that provincial electricity demand will exceed the utility's generation output by 2 TWh in 2029, as shown in Figure 14. This demand forecast includes Hydro-Québec's domestic consumption and exports to other markets. Hydro-Québec anticipates that demand will grow from 2020 to 2024 due to an increase in EV adoption, the province's export market development initiatives, and natural growth. Beyond 2027 demand is expected to decline due to energy efficiency measures.[31] However, supply may decline more rapidly as some contracted generation supply agreements expire.

[29] IESO, Annual Planning Outlook, 2020.
[30] 2020 exports are expected to be 4 TWh less than 2018.
[31] Hydro-Québec, Overview of Hydro-Québec's Energy Resources, 2019.

Figure 14: Hydro-Québec's Electricity Supply and Demand Forecast, 2020-2029
(TWh)



Source: Hydro-Quebec, Portrait des resources énergétiques d'Hydro-Québec, 2019.

Quebec may need to develop additional resources to support planned electricity exports to New England, New York, Ontario, and New Brunswick.

3.1.8 Summary of Canada's Electricity Asset and Infrastructure Implications

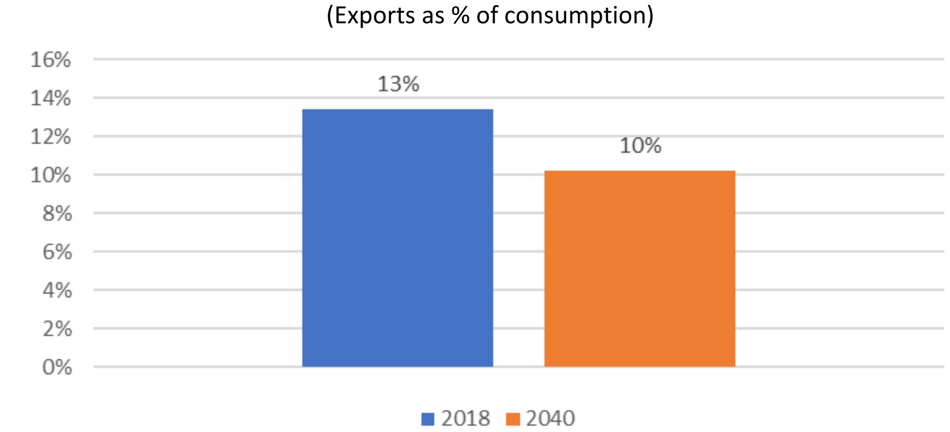
Canada is the 6th largest global producer of electricity and the fourth-largest producer of low emission electricity due to its hydro and nuclear assets.

Canada's electricity infrastructure is a regional dichotomy of provinces with low emission resources (B.C., Manitoba, Ontario, Quebec, Newfoundland and Labrador) and those without. In Canada, provinces with a low emission energy supply enjoy a cost advantage for their industries, the exception being Ontario.

Canada has an extensive network of electricity interconnections with the U.S. which are used to export around 10% of its electricity – all from provinces with significant hydro or nuclear resources. These provinces are pursuing additional transmission interties.

However, current forecasts suggest some provinces in Canada may be increasing their dependence upon fossil fuels as domestic demand grows, and existing assets are retired. This may be contributing to the forecasted drop in relative exports shown in Figure 15. The development of additional Canadian low emitting generation resources may be a critical prerequisite for maintaining and expanding Canada's status as a clean electricity generator and exporter.

Figure 15: Canada's Electricity Exports as a Percentage of Consumption, 2018-2040



Source: CER, Canada's Energy Future 2019, 2019

3.2 Canada's Uranium Production Is Critical for Domestic and Export Markets

Uranium mining in Canada is a major domestic industry that underpins both an important export market and a domestic nuclear industry. This subsection provides an overview of Canada's uranium mining industry.

Uranium is primarily used as a fuel in world nuclear power plants, with a small portion (less than 1%) used to fuel research reactors or create medical isotopes. [32] Global annual uranium consumption is expected to be 64,240 tonnes of elemental uranium (tU) in 2020. Demand is dominated by the U.S., China and France, who account for 54% of world demand collectively. Canada generally ranks 9th among global uranium consuming countries, and is expected to consume 2.3% of the world total in 2020. [33]

Canada is the second-largest producer of uranium in the world, and accounted for 13% of global production in 2018. All of Canada's uranium production occurs in Saskatchewan, which is home to the highest-grade deposits in the world and the world's largest uranium mine, Cigar Lake. Mining is performed using open pit, underground, and in-situ methods. Production of Saskatchewan uranium requires 100 times less GHG emissions than the production of natural gas to produce the same amount of electricity.[34] Canada's uranium reserves are estimated at 500,000 tU, accounting for 8% of the world total and enough to support current production levels for another 40 years.[35]

These mining operations support a large export industry and a domestic nuclear supply chain. Around 26% of Canada's domestic uranium production is sent to facilities in Ontario for refining, conversion, and

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[32] NRCan, Uranium and Nuclear Power Facts, 2020.
[33] World Nuclear Association, World Power Reactors & Uranium Requirements, 2020.
[34] CAMECO, 2019 Annual Report, 2019.
[35] NRCan, Uranium and Nuclear Power Facts, 2020.

fuel fabrication. These end products are then used to power CANDU reactors in Ontario and New Brunswick, as well as in research reactors in B.C., Saskatchewan, Ontario and Quebec. [36]

The remaining 76% of Canada's uranium production is exported worldwide, making Canada the 4th largest exporter of uranium in the world. Canada accounted for 12% of the world's uranium exports in 2018. Approximately 42% of these exports go to Asia, 41% to North America, and 16% to Europe. Canada is the largest foreign supplier of uranium to the U.S., and supplied 24% of the uranium purchased by U.S. power reactors in 2017.[37]

Several Canadian mines are currently non-operational due to low prices on the global uranium market. However, uranium commodity prices follow a cyclical pattern, experiencing regular low periods followed by increased demand. Analysis suggests that the world's nuclear plants will need to procure 1.5 billion pounds of uranium fuel by 2035. Given this need, the Canadian uranium industry expects demand to rise in coming years, stimulating increased production and exports.[38]

3.3 Canada's Natural Gas Assets Are Available for Export

Natural gas is widely considered to be the lower emitting fossil fuel option and Canada has both an abundance of it and extensive use for it.

This subsection first describes the importance of natural gas to global energy consumption and confirms Canada's role as one of the world's largest producers of natural gas. This is followed by an overview of how Canada's supply and demand for natural gas varies across regions. An examination of the regional differences in production, distribution, and trade is then undertaken, highlighting how exports are presently limited primarily to the United States in the west, and conversely that the east is dependent on imports from the United States. A summary of the key findings completes this subsection.

3.3.1 Global and Canadian Natural Gas Consumption

Natural gas accounts for almost a third of global energy consumption, and demand continues to grow rapidly. In 2018, the demand for natural gas accounted for nearly half of global energy demand growth.[39] Since 2010, 80% of this consumption growth has occurred in just three regions: the United States, where abundant shale gas has increased supply and led to lower prices; China, where economic growth and pollution related to coal-fired electricity generation have increased natural gas consumption; and, the Middle East, where natural gas provides economic diversification from its oil sector.

The IEA estimates that continuing existing policies will result in more natural gas consumption -- increasing from 28% to 33% of the global energy mix. As previously discussed, this increase is expected to result from greater dependence on natural gas-fired electricity generation. Under the IEA's

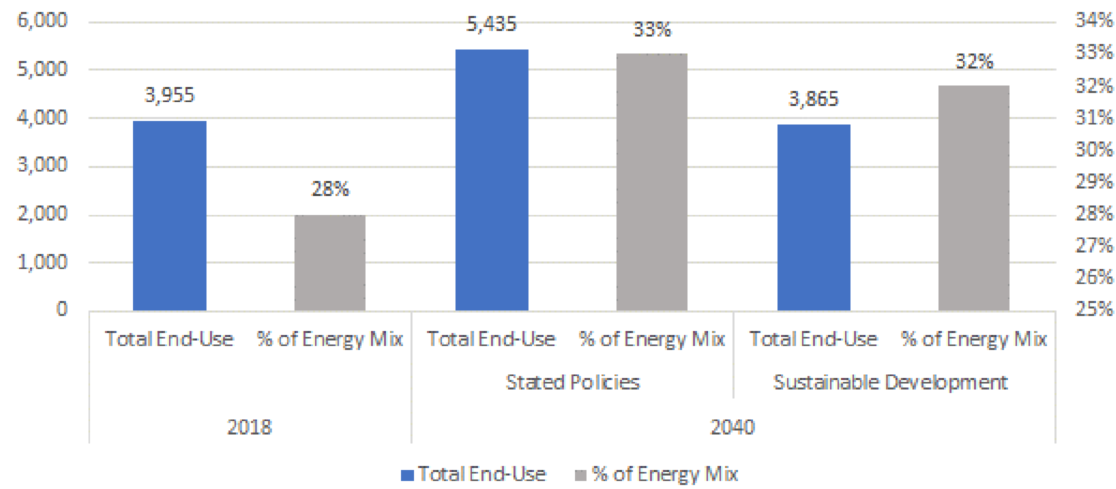
[36] NRCan, Uranium and Nuclear Power Facts, 2020.
[37] NRCan, Uranium and Nuclear Power Facts, 2020.
[38] CAMECO, 2019 Annual Report, 2019.
[39] IEA, Gas, 2019.

Sustainable Development scenario,[40] natural gas is forecast to account for 32% of global consumption by 2040, as shown in

Figure 16.[41]

Figure 16: Global Natural Gas Consumption, 2018-2040

(bcm/y; Natural gas as % of total energy consumption)



Source: CER, Canada's Energy Future 2019, 2019; IEA, Gas, 2019.

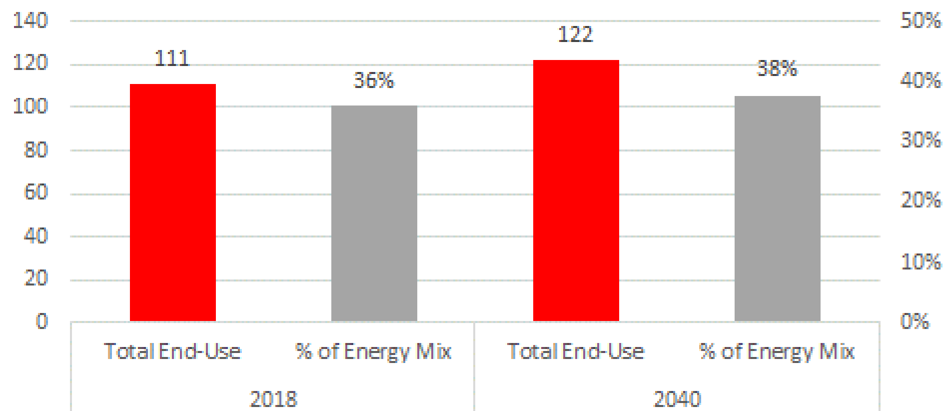
While still a significant CO_2 emitter, natural gas has a lower emission intensity than coal. As a result, many coal-fired electricity generation facilities around the world are being replaced by natural gas-fired generation plants.

In Canada, natural gas currently accounts for 36% of total energy consumption, much higher than the global average mostly because of the need for heating in Canada's climate. With anticipated economic growth, Canadians will use more natural gas for home heating, industrial operations, and electricity generation, causing its share of energy consumption to increase to 38% by 2040, as shown in Figure 17.

[40] The Sustainable Development Scenario is based on achieving universal energy access, reducing the severe impacts of pollution and limiting global temperature rise to 2° C above pre-industrial levels. IEA, World Energy Outlook 2019, 2019. Website.

[41] IEA, World Energy Outlook 2019, 2019. Website.

Figure 17: Canada's Annual Natural Gas Consumption, 2018-2040
(bcm/y; Natural Gas as % of total energy consumption)

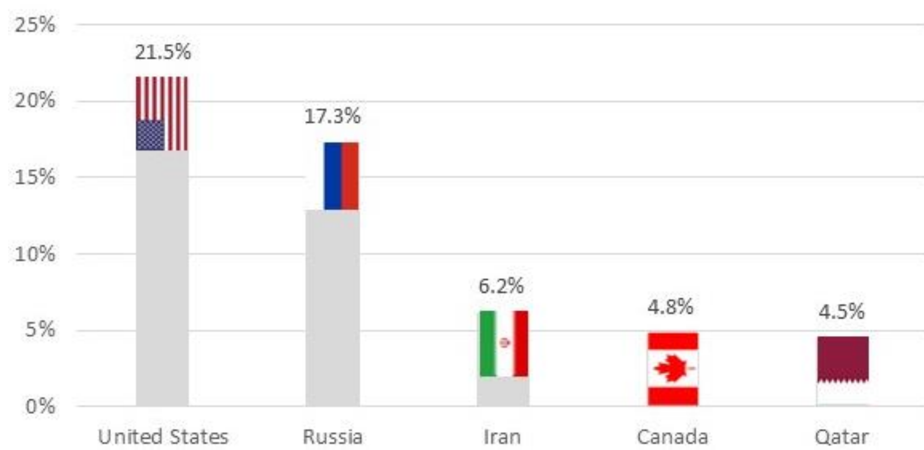


Source: CER, Canada's Energy Future 2019, 2019

3.3.2 Canada is one of the World's Top Natural Gas Producers

Canada is the fourth-largest producer of natural gas in the world, behind the U.S., Russia, and Iran, as shown in Figure 18. Canada provides approximately 5% of global production. Canada produces 164 bcm/y of natural gas, comfortably exceeding domestic consumption, with around 75 bcm/y exported in 2018.

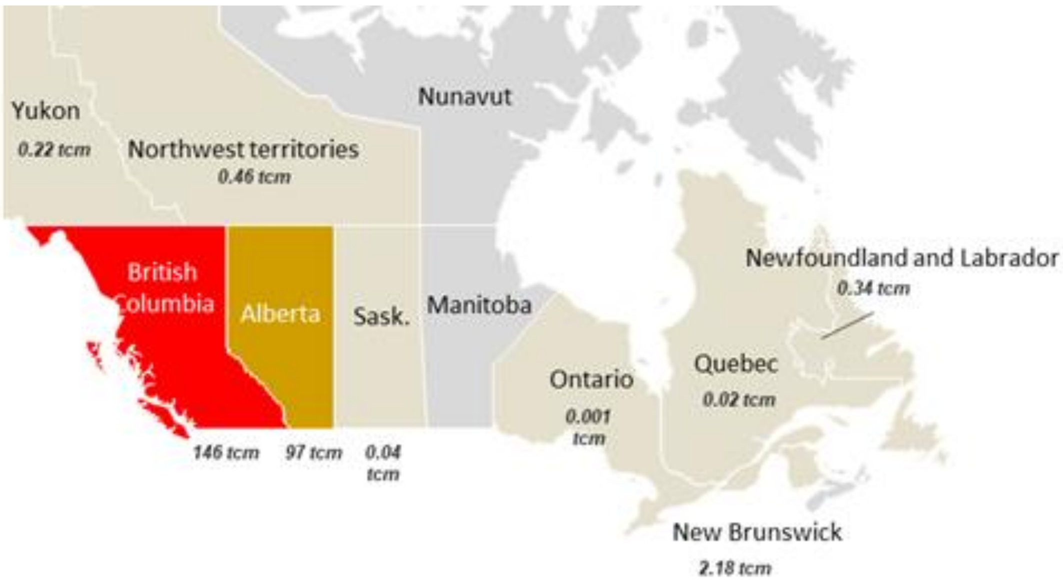
Figure 18: Top 5 global producers of Natural Gas, 2018
(Percentage of global production)



Source: BP, BP Statistical Review of World Energy 2019, 2019.

Canada has about 105 trillion cubic meters (tcm) of proven conventional and shale reserves and an additional 150 tcm of technically recoverable reserves, composed of both conventional and shale gas. These reserves are distributed regionally across the country as shown in Figure 19. British Columbia has the largest conventional reserves and a large amount of technically recoverable reserves, which may or may not be economically viable to exploit.[42]

Figure 19: Significant Provincial Natural Gas Reserves
(Trillion cubic meters)



Source: NRCan, Shale and Tight Resources; CER, Canada's Energy Future 2019, 2019.

Most of Alberta's natural gas reserves are in the form of shale. The facilities required to extract shale gas resources are more complex than those for conventional natural gas production and take longer to develop. The rest of Canada has negligible reserves of natural gas.

Western Canada's natural gas reserves, if developed, could sustain the current production pace for 300 years.[43]

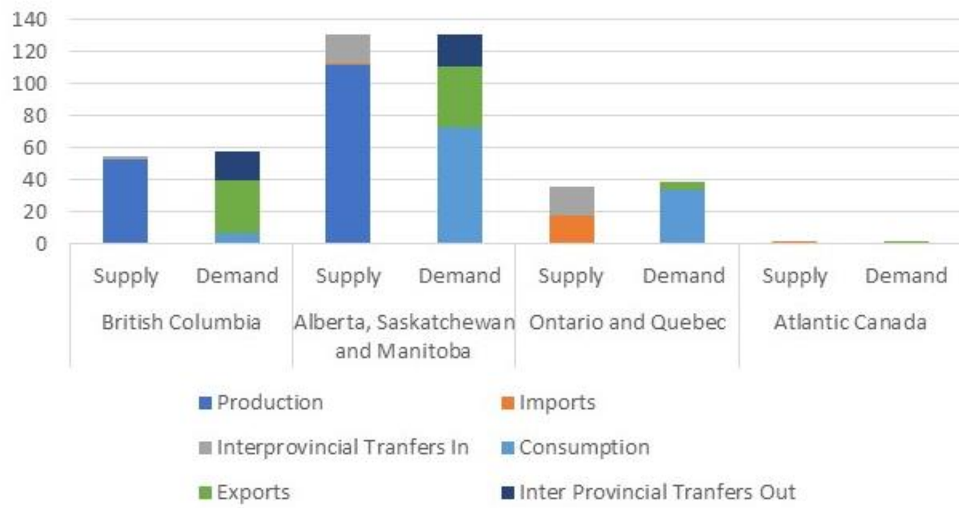
3.3.3 Natural Gas Supply & Demand – Regional Breakdown

The provincial-level supply and demand reveals that natural gas in Canada is a four-region story, with each region having its own specific characteristics, as shown in Figure 20. These characteristics are a function of local production, consumption, interprovincial transfers, and trade with the U.S.

Given that most of Canada's natural gas assets are in the west, B.C. and Alberta have large production output and significant exports and interprovincial transfers to the markets that need them. The Prairie provinces are notably the largest consumers.

[42] Technically recoverable reserves refers to the total potential, some of which may not be cost effective to produce. NRCan, Natural Gas Facts. Website.
[43] NRCan, Natural Gas Facts. Website.

Figure 20: Canada's Regional Natural Gas – Supply and Demand, 2018
(bcm/y)



Source: CER, Canada's Energy Future 2019, 2019; Statistics Canada, Commodity Statistics, Website; Government of Canada, Pipeline Throughput and Capacity Data Set. Note: 1. Intra-Canada flows from Alberta to the U.S. via Foothills system are included as exports for B.C. 2. An adjustment factor has been used to account for minor differences in sources, the use of conversion factors or rounding of fractions to whole numbers.

Alberta's industrial sector consumed 55 bcm of natural gas in 2018, accounting for 87% of its natural gas consumption as shown in Figure 21. This high level of industrial consumption is primarily related to oil sands extraction and processing.

Figure 21: Alberta Natural Gas Consumption by Sector
(bcm, 2018; Total=63 bcm)

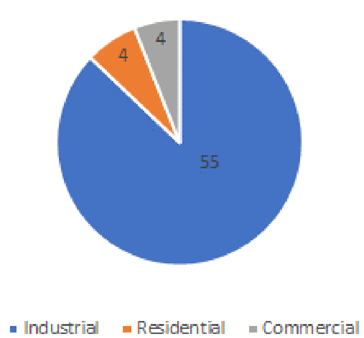
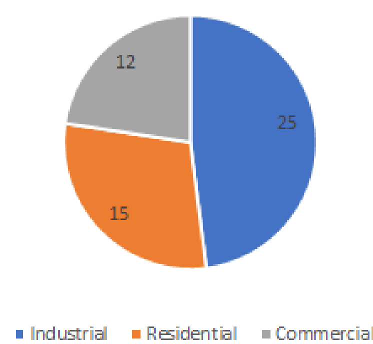


Figure 22: Rest of Canada's Natural Gas Consumption by Sector
(bcm, 2018; Total=52 bcm)



Source: CER, Provincial and Territorial Energy Profiles.

Quebec is not currently producing any natural gas while Ontario's production in 2018 represented less than 0.1% of Canada's output. Ontario and Quebec rely on incoming interprovincial transfers and on imports from the U.S. to meet demand. These imports are primarily a cost decision for these provinces. Since U.S. shale gas is less costly, pipelines connecting the U.S. and Ontario have recently been re-calibrated to flow into Ontario and Quebec.

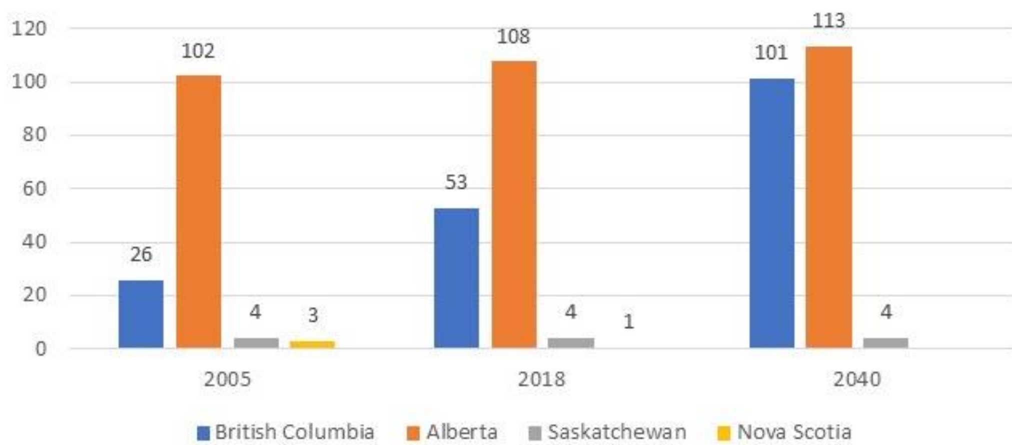
In Atlantic Canada, Newfoundland and Labrador's natural gas production is used for oil extraction.[44] New Brunswick has modest undeveloped natural gas reserves, and no plans to develop them given environmental concerns associated with the extraction process.[45] Like Ontario and Quebec, Atlantic Canada relies on imports to meet natural gas demand. These imports come not only from the U.S. but also in the form of LNG through the Canaport terminal in New Brunswick.

3.3.4 Natural Gas Production

Canada's natural gas production is expected to increase by about 20% from 2018 through 2040 when production is expected to reach over 200 bcm/y. Regionally, the large and growing production in the west is juxtaposed with the minimal and declining production in the east, characterized by the decline in Nova Scotia's production since 2005, as shown in Figure 23.

Figure 23: Provincial Natural Gas Production, 2005-2040

(bcm/y)



Source: CER, Canada's Energy Future 2019, 2019.

Natural gas production is expected to double between now and 2040, primarily to serve the planned LNG export facilities in B.C. Forecasts indicate that natural gas production will also increase in the Prairies but at a much lower rate. However, the Prairies, given their production capacity and available volumes, will continue to be the top producing region in Canada. Much of this growth is expected from the Montney Formation, which covers parts of B.C. and Alberta.

The Eastern provinces present a different picture. Ontario and Quebec produce almost no natural gas, and the Atlantic Provinces, specifically Nova Scotia, have now ceased production.

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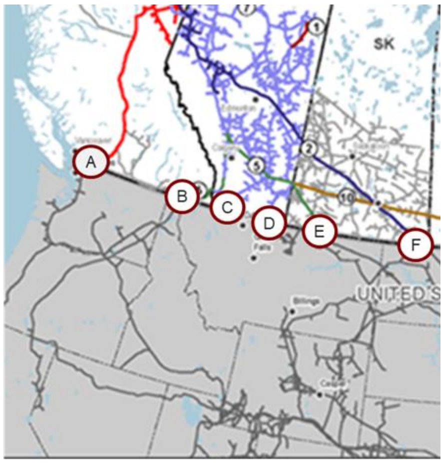
[44] CER, Provincial and Territorial Energy Profiles, Newfoundland and Labrador. Website.

[45] NRCan, Shale and Tight resources, New Brunswick. Website.

3.3.5 Natural Gas Distribution Network

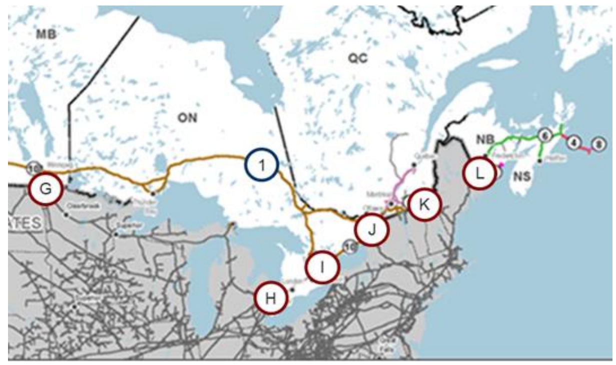
The majority of Canada's natural gas pipeline system was developed to facilitate trade with the U.S. as shown in Figure 25. Only the TC Mainline sends natural gas from Western Canada to Eastern Canada. The TC Mainline ends in Quebec, leaving no direct interprovincial transfer capability to support Atlantic Canada.

Figure 24: Western Canada Natural Gas Key Points



A- Huntington;
B- Kingsgate, B.C.
C-Cardston, AB
D- Coutts and Aden AB
E-Monchy, Sask.
F- North Portal and Elmore, Sask.

Figure 25: Eastern Canada Natural Gas Key Points



1 – TC Mainline
G- Emerson and Sprague, MB
H- Sarnia, Courtright and Windsor, ON
I- Niagara Falls and Chippawa, ON
J- Iroquois and Cornwall, ON
K- Napierville, Phillipsburg and East Hereford, QC
L- St. Stephen, NB

Sources: CER, Provincial and Territorial Energy Profiles; CER, Natural Gas Annual Trade Summary – 2018. Website.

The TC Mainline is not currently operating at full capacity. The throughput at the Prairies key point[46] declined by roughly 45% from 2008 to 2018 as a result of the competition from the low-cost shale gas in the Eastern U.S.[47] The discovery and development of shale based natural gas extraction facilities in the Marcellus Reservoir allowed the U.S. to increase its natural gas production from 664 bcm in 2014 to 868 bcm in 2018. [48] As a result, the U.S. now supplies more of its domestic demand, has increased exports to Canada and Mexico, and has reduced imports from Canada.

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[46] A Key Point refers to the point of entry or exit of gas or oil from a pipeline. These are typically located at a production/processing facility, or along international borders.
[47] The Marcellus Reservoir spans several U.S. states including Kentucky, Maryland, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. USGS, How much gas is in the Marcellus Shale? Wesbite. While estimates vary on how much recoverable natural gas is available in the Marcellus Reservoir, the EIA estimates that there is approximately 3.9 trillion cm of unproven technically recoverable natural gas reserves, 10-30% of which is likely recoverable. Penn State, How much Natural Gas can The Marcellus Shale Produce? 2012.
CER, Natural Gas Annual Trade Summary – 2018. Website.
[48] Shale Directories, "FERC report tells the story as the Shale revolution moves ever forward", 2018.

3.3.6 Natural Gas Exports and Imports

Canada's exports and imports reflect its regional production availability. In the west, Canada has large export-oriented production, while the lack of production in the east makes imports and inter-provincial transfers necessary. Natural gas trade is also important to the U.S. Canada's exports to the U.S. accounted for approximately 9% of total U.S. natural gas consumption in 2017, while 17% of Canada's consumption came from the U.S.[49] This situation impacts both existing natural gas supply infrastructure and Canada's future economic opportunities.

British Columbia is a large and rapidly growing natural gas exporting region and provided over 40% of Canada's exports in 2018, as shown in Figure 26. The province's imports are minimal. Developing LNG export facilities presents an opportunity to drive natural gas production growth in B.C.

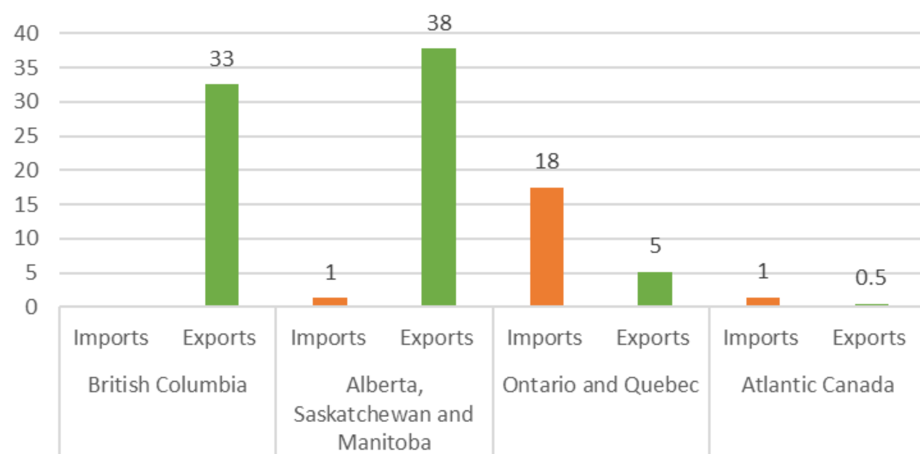
Alberta, Saskatchewan, and Manitoba are the largest exporters of natural gas, reaching approximately 38 bcm of exports in 2018.

In 2018, the U.S. supplied about 18 bcm to Ontario and Quebec, making them the largest importers of natural gas in Canada. The two provinces did export about 5 bcm of natural gas in 2018, although these exports originated from Alberta via the TC Mainline and were then exported to the U.S., mostly Upstate New York.[50] Historically, Ontario exported more to the U.S. than it imported. However, this has changed in recent years due the U.S. shale gas economics noted earlier.

Atlantic Canada imported roughly 1.5 bcm of natural gas from the U.S. and LNG through the Canaport LNG terminal that it sources in the Caribbean. Atlantic Canada's decline in production and lack of supply from Western Canada makes it dependent on imports to meet its energy needs.

Figure 26: Canada's Regional Natural Gas Imports and Exports, 2018

(bcm)



Source: Statistics Canada, Supply and Disposition of Natural Gas, Website.

[49] NRCan, Natural Gas Facts.

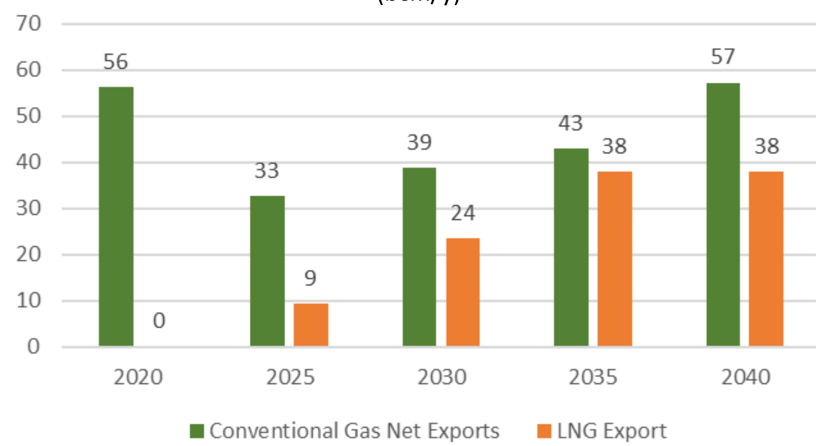
[50] Government of Canada, Pipeline Throughput and Capacity Data Set; Strapolec Analysis.

3.3.7 British Columbia's Forecasted LNG Exports

The growth of natural gas production in British Columbia is driven by the planned development of LNG exports. CER projections indicate that Canada's net conventional natural gas exports will decline by 15 bcm between 2020 and 2025. Figure 27 indicates that from 2025 onwards, forecasted rising natural gas prices and demand from the U.S. will lead to increased production, mostly from British Columbia LNG exports. By 2035, LNG exports overseas are predicted to rival conventional natural gas exports to the U.S.

Figure 27: Canada's Conventional Natural Gas Net Exports vs. LNG Exports, 2020-2040.

(bcm/y)



Source: CER, Canada's Energy Future 2019, 2019

3.3.8 The Dawn Hub Natural Gas Supply

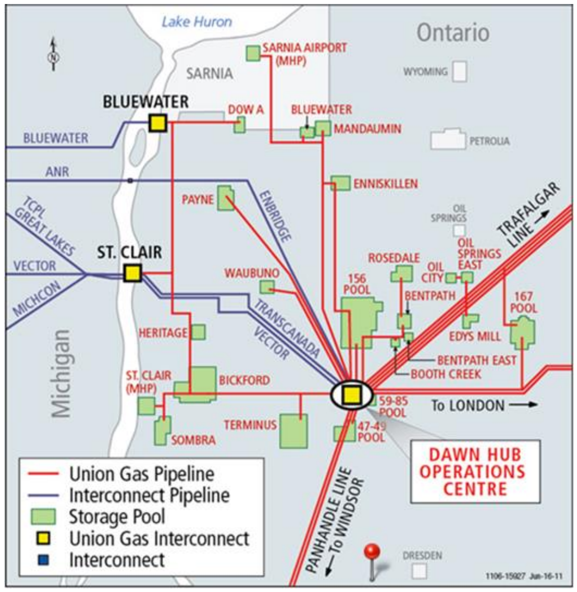
Ontario is the centre of natural gas distribution for Eastern Canada, with one of its main advantages being the Dawn Hub storage facility situated in Southwestern Ontario, as shown in Figure 28. The Dawn Hub effectively acts as a battery to support peak natural gas demand for the province. Ontario relies on the U.S. natural gas imports that supply the Dawn Hub. The underground natural gas storage reservoirs can hold as much as 7.9 bcm of natural gas at any one time, or over 30% of the province's demand. This capacity is essential for supplying Ontario's peak winter heating needs.[51] In 2018, these caverns took in 14 bcm of natural gas imports from Michigan for storage — half of Ontario's consumption.

The Dawn Hub's natural gas trade with the U.S. is facilitated by the Bluewater, St. Clair, and Windsor key points for importing and exporting natural gas. While Ontario's demand and the need for imports from the Dawn hub have been stable for the last ten years, exports have declined by 70%.[52]

[51] Enbridge, Enbridge Natural Gas Storage, 2020.

[52] Natural gas exports from the Dawn Hub have been modest at less than 10% of its throughput, and have now declined to less than 3%, which likely represent storage withdrawals back to Michigan. RBN Energy, Return to Sender Natural Gas Exports - The Battle for a New Dawn, 2013.

Figure 28: Dawn Operations Centre – Storage Pools and Pipelines

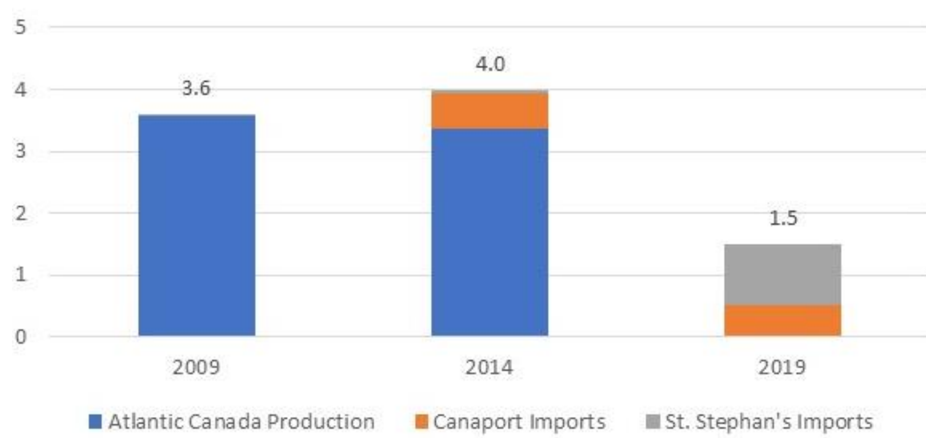


Source: Enbridge

3.3.9 Atlantic Canada's Natural Gas Supply

Atlantic Canada's natural gas supply mix has changed significantly over the past ten years due to the disappearance of natural gas production in the region. In 2009, the region produced roughly 3.6 bcm of natural gas, meeting all their needs. However, this declined to zero in 2019, as Figure 29 shows. Atlantic Canada is not serviced by Canada's pipeline infrastructure, making it reliant on foreign supplies.

Figure 29: Atlantic Canada Natural Gas Production and Imports, 2009-2019
(bcm/y)

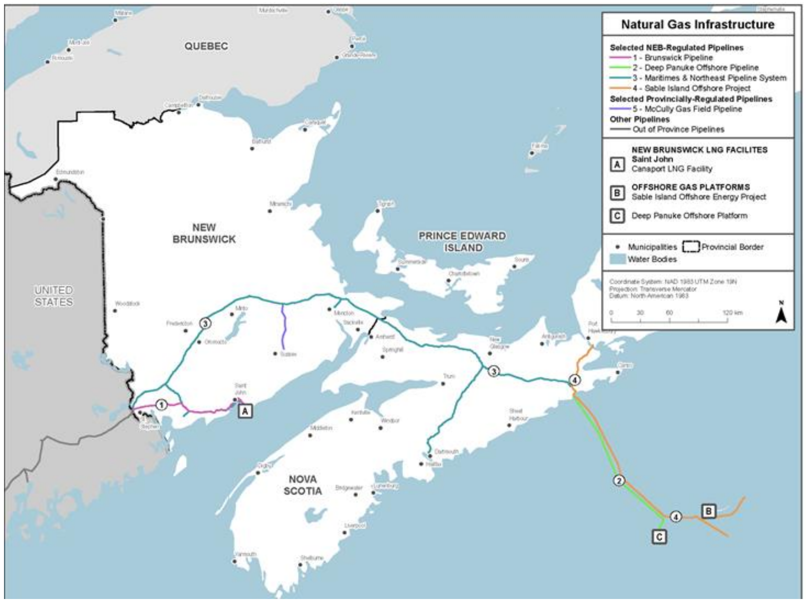


Source: CER, Commodity Statistics, Natural Gas and LNG

The natural gas infrastructure in Atlantic Canada is now focused on the Canaport LNG facility and the St. Stephens connection point between Maine and New Brunswick on the Emera Brunswick pipeline as shown in Figure 30. Although the Canaport facility and Brunswick pipeline are capable of supplying 20%

of Northeastern U.S. natural gas demand, Canaport imported less than 1% of its potential capacity in 2018[53] and the Brunswick Pipeline exported only 5% of its potential capacity.[54] The Canaport LNG facility and the pipeline are currently significantly underutilized.

Figure 30: Natural Gas Infrastructure in New Brunswick



Source: CER, Provincial and Territorial Energy Profiles, New Brunswick.

3.3.10 Summary

Canada is the fourth-largest producer of natural gas with the 17th largest known reserves in the world – positioning Canada as a significant natural gas supplier to rapidly growing global demand.

Canada's natural gas infrastructure is a story of three regions:

Western Canada: Canada's natural gas infrastructure is highly developed in the west, with pipelines designed to serve the U.S. Midwest. The U.S. Midwest currently relies on Canadian natural gas for roughly 21% of its needs.[55] However, 25% of Alberta's natural gas production is consumed by oil sands operations. Future natural gas production growth is forecast for U.S. demand and LNG exports to China. The latter is dependent upon the construction of pipelines and an LNG terminal.

Central Canada: Flows from Alberta to Eastern Canada have declined and this region now imports low-cost U.S. shale gas. Ontario has a critical asset in the Dawn Hub which can store over 30% of the natural gas Ontario needs, an essential supply capability in winter. The Dawn Hub is currently supplied by natural gas imported from the U.S.

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[53] Canaport LNG, Website.
[54] CER, Provincial and Territorial Energy Profiles.
[55] EIA, Natural Gas Consumption by End-Use. Website; CER, Natural Gas Annual Trade Summary – 2019. Website.

Atlantic Canada: Cut off from Canadian natural gas resources, the region relies on imports from the U.S. and LNG from the Caribbean. Shifting imports in favor of U.S supplies has left an underutilized LNG port in New Brunswick.

3.4 Canada's Oil Resources Are Substantial

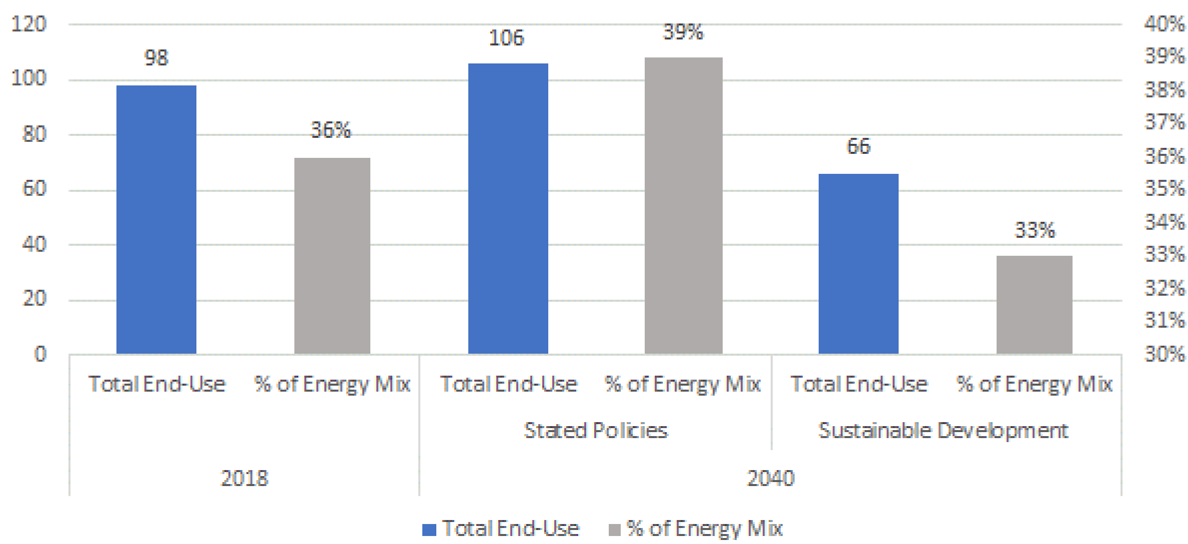
Oil is widely considered to be the enabling energy source for the 20th and 21st century economies and Canada has an abundance of it. This subsection outlines global oil consumption and reviews the role of Canada's resources given infrastructure limitations that constrain exports and create energy insecurity.

This subsection first describes the importance of oil to global energy consumption and confirms Canada's role as one of the world's greatest sources for and largest producers of it. This is followed by a review of how Canada's supply and demand for crude oil varies across the country and underpins regional differences in production, distribution, and trade. Exports are presently limited primarily to the United States from the west, and conversely, the east is dependent on imports from the U.S. and overseas. The subsection concludes with a summary of key findings.

3.4.1 Global and Canadian Oil Consumption

Oil represents over a third of the world's energy needs and the IEA anticipates that it will remain an important part of the global energy mix, even under its climate policy-responsive Sustainable Development scenario, as shown in Figure 31.[56]

Figure 31: Global Oil Consumption, 2018-2040
(Consumption in MMb/d; % of energy mix)

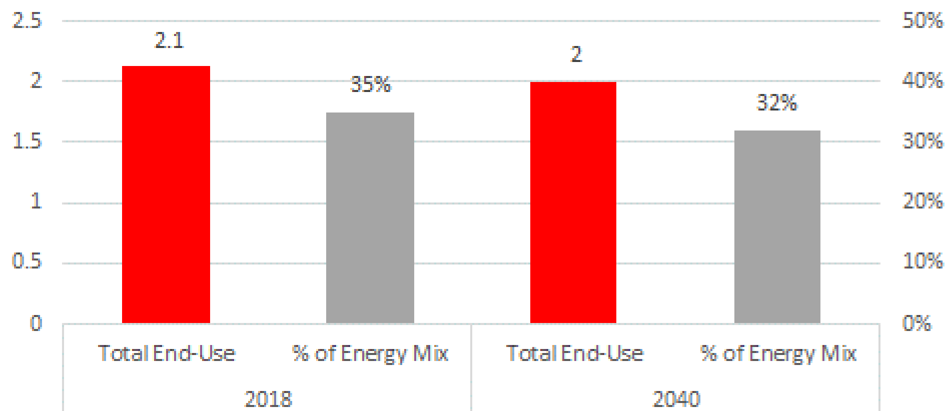


Sources: IEA, Oil, 2019. Notes: Global Consumption Forecast based on IEA's Sustainable Policies Forecast. The Sustainable Policies Forecast notionally reflects climate concerns and projects oil to be a smaller share of consumption

[56] IEA, World Energy Outlook 2019, 2019. Website.

Oil plays a similarly significant role in Canada's energy mix, and consumption aligns with global patterns. However, Canada's existing policies are expected to modestly reduce the role of oil in the national energy mix from 35% in 2018 to 32% in 2040, as shown in Figure 32. This is less than at the global level and more reflective of IEA's Sustainable Development Policies forecast.

Figure 32: Canadian Oil Consumption, 2018-2040
(Consumption in MMb/d, % of energy mix)



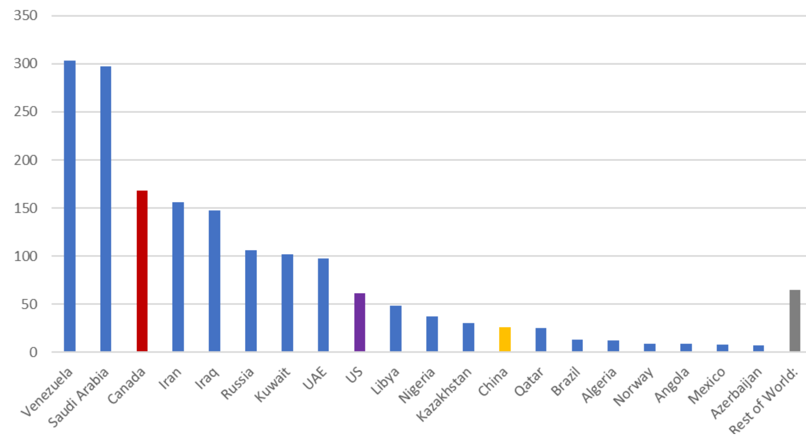
Sources: CER, Canada's Energy Future 2019, 2019.
Note: Canada's oil consumption refers to refined petroleum products.

3.4.2 Canada Has the World's Third Largest Oil Reserves

Canada accounts for 10% of the world's proven oil reserves. Its reserves are the third-largest in the world after Venezuela and Saudi Arabia and exceed those in the U.S., Russia, and most Middle Eastern countries, as shown in Figure 33.[57]

[57] Canada's oil can also be considered "ethical oil", compared to many other large oil producing nations. The Toronto Sun, EDITORIAL: Just say yes to Frontier mine, 2020.

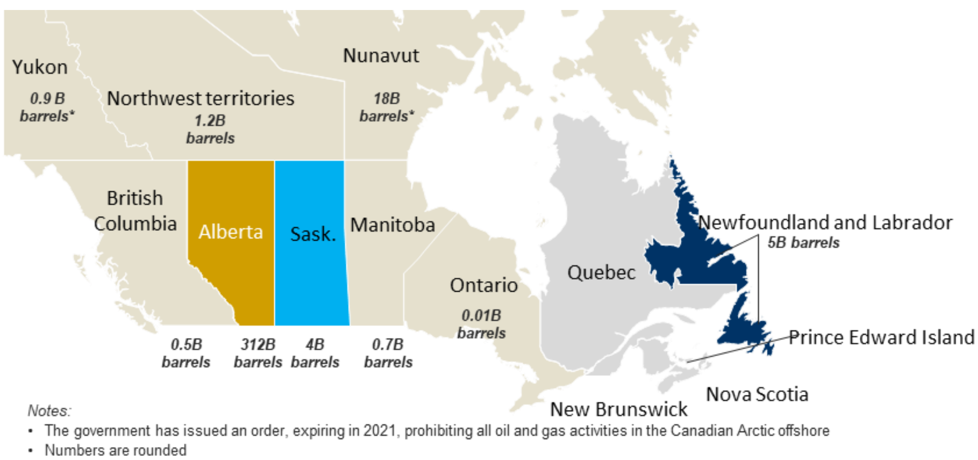
Figure 33: Top 20 Countries by Size of Proven Oil Reserves, 2018
(billion barrels of oil)



Source: BP, BP Statistical Review of World Energy 2019, 2019.

Alberta has the majority of Canada's oil reserves with approximately 167 billion of Canada's 171 billion barrels of proven reserves, and around 150 billion barrels of technically recoverable reserves, as shown in Figure 34.[58]

Figure 34: Canadian Provincial Oil Reserves
(billion barrels of oil)



Source: CER, Provincial and Territorial Energy Profiles.

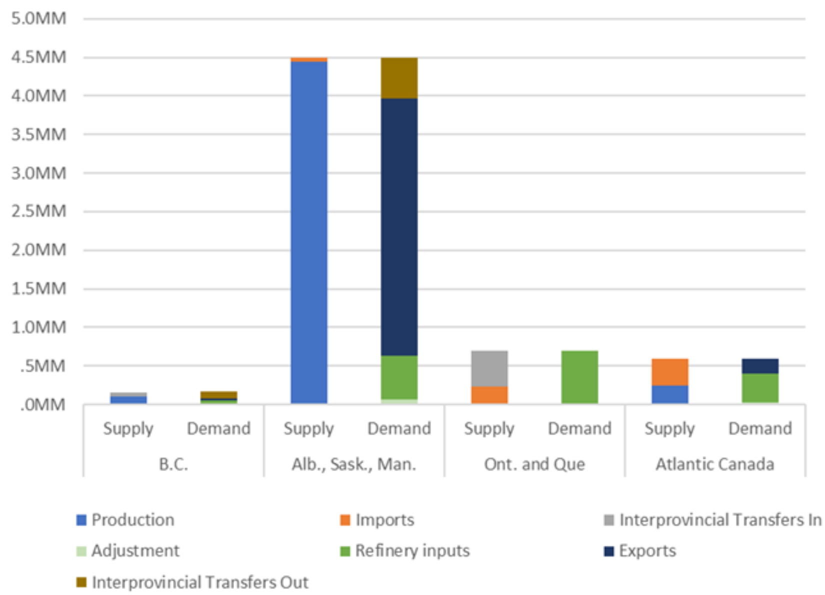
These reserves underpin Canada's position as the fourth-largest producer of oil in the world at 4.8 MMb/d and the fourth largest exporter in the world at 3.6 MMb/d.

[58] NRCan, Provincial and Territorial Energy Profiles.

3.4.3 Crude Oil Supply & Demand – Regional Breakdown

While Canada is a large exporter, paradoxically it also imported 0.6 MMb/d of crude oil in 2018. A review of the provincial trade balances reveals that crude oil in Canada is a four-region story and each region has its own supply and demand characteristics, as shown in Figure 35.

Figure 35: Canada's Regional Crude Oil – Supply & Demand, 2018
(MMb/d)



Sources: CER, Canada Energy Futures 2019, 2019; NRCan, Provincial and Territorial Energy Profiles, Canada; Statistics Canada, Commodity Statistics, Website; Canadian International Merchandise Trade Database; Statistics Canada, Table 25-10-0041-01, Refinery supply of crude oil and equivalent, monthly. Notes: 1. B.C. supply is mostly condensates and pentane plus. These are shipped to Alberta as diluents for the crude oil; 2. Refined Petroleum Products are not included in this chart; 3. An adjustment factor has been used to account for minor differences in sources, the use of conversion factors or rounding of fractions to whole numbers.

Canadian oil production is centered in the Western Canadian Sedimentary Basin (WCSB), a massive wedge of sedimentary rock covering 1.4 million square km, as shown in Figure 36. The region covers most of the Prairie provinces as well as smaller portions of British Columbia, the Northwest Territories, and the Yukon.

British Columbia is on the edge of the WSBC and produces 2% of Canada's crude oil in the northeastern part of the province. Only 38% of this production is light crude oil. The rest is natural gas condensate,[59] which is recovered from natural gas wells and removed from the gas stream. Condensate serves as a diluent for transporting oil sands bitumen via pipelines. The remaining production is insufficient for British Columbia's needs and it is largely dependent on Alberta for oil. British Columbia exports small volumes of crude oil, primarily to the U.S. west coast and Asia.

[59] Energy B.C., Oil Infrastructure Map in B.C.

The Prairies are the most significant producers of oil, representing over 90% of Canada's production and the greatest source for exports in Canada. The Prairies have a large number of refineries, processing about a third of Canada's refinery inputs.

Figure 36: Western Canadian Sedimentary Basin

Source: Oil and Gas Investments Bulletin, Don't Fall Off Your Chair, But CDN Natgas Stocks Are Not Looking Good. Website.

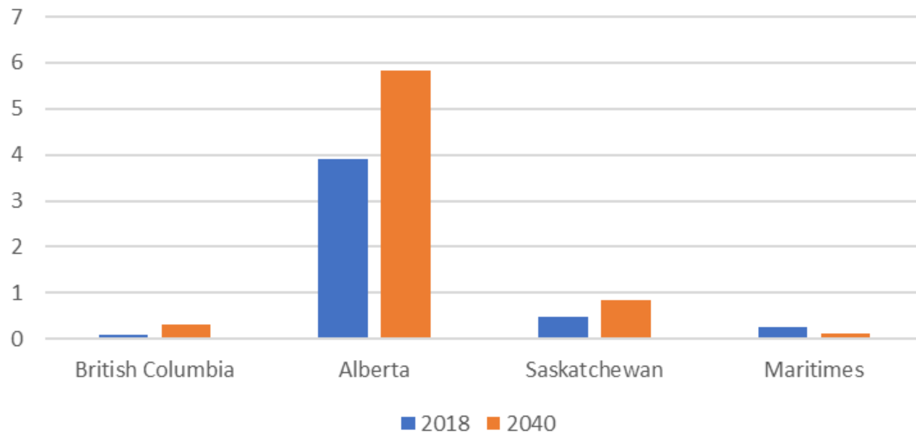
Ontario and Quebec are large consumers of crude oil representing 41% of Canada's domestic refinery inputs. The region receives 66% of its refinery input crude oil from the Prairies and most of the remainder from U.S. sources. Oil imports to the two provinces represent 36% of Canada's overall oil imports. Ontario's production is negligible at 500 b/d. Quebec does not produce crude oil.

The Atlantic provinces are responsible for over half of Canada's crude oil imports. Newfoundland and Labrador is the major producer in the Atlantic Provinces and Canada's third-largest producer. It produces 0.2 MMb/d for export, primarily to the U.S. Northeast. The remaining Atlantic provinces do not produce crude oil.

3.4.4 Crude Oil Production Growth

Canada's crude oil production is primarily located in British Columbia, Alberta, and Saskatchewan, where production is anticipated to increase over the next 20 years, as shown in Figure 37.

Figure 37: Regional Crude Oil Production – Current and Forecasted
(MMb/d)



Source: CER, Canada Energy Future 2019, 2019.

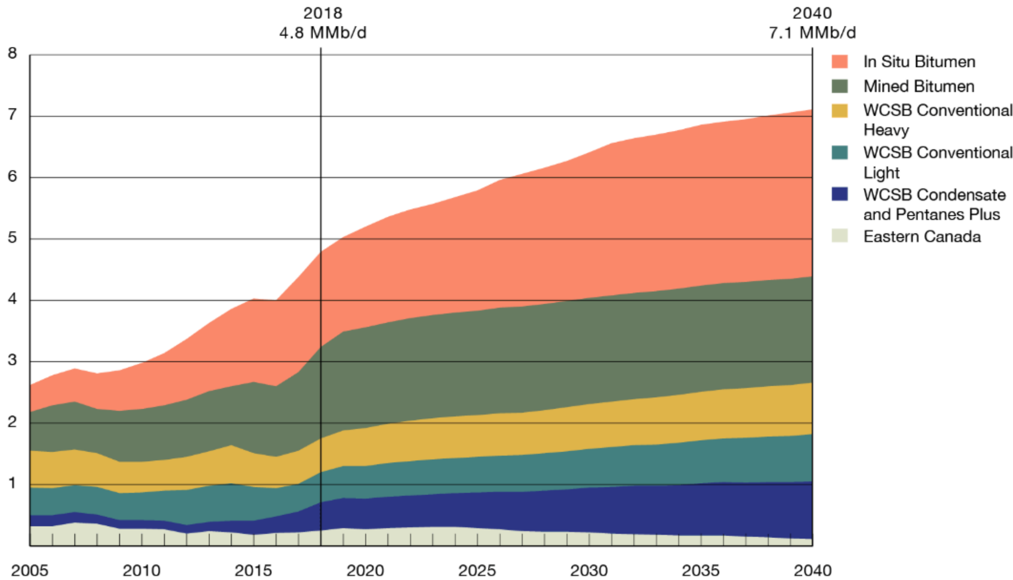
Canadian production of oil is projected to increase by 49% from 4.8 MMb/d to 7.1 MMb/d by 2040. The WCSB is the only region expected to see production increase. Projections show that the WCSB share of production will continue to increase, from around 4.4 MMb/d in 2018 to 6.7 MMb/d in 2040, as shown in Figure 38.

While production growth in the Prairies is expected to continue for all types of crude oil, in situ and mined bitumen are expected to increase their share of production. With the growth of diluted bitumen,[60] the western Canadian supply is increasingly producing heavy oil.[61]

Newfoundland's oil production is expected to grow to 0.3 MMb/d by 2025, after which a decline to 0.1 MMb/d by 2040 is forecasted.

[60] The end product of blending bitumen and condensate or pentanes plus is referred to as diluted bitumen, or "dilbit".
[61] Oil Sands Magazine, Differentials Explained: Why Alberta crude sells at a deep discount, 2018.

Figure 38 Canada's Crude Oil Production by Type 2005-2040
(MMb/d)



Source: CER, Canada's Energy Future 2019, 2019.

3.4.5 Oil Delivery Infrastructure

Once extracted, crude oil has to be delivered to domestic and international refineries for processing. Four forms of infrastructure are used to transport crude oil:

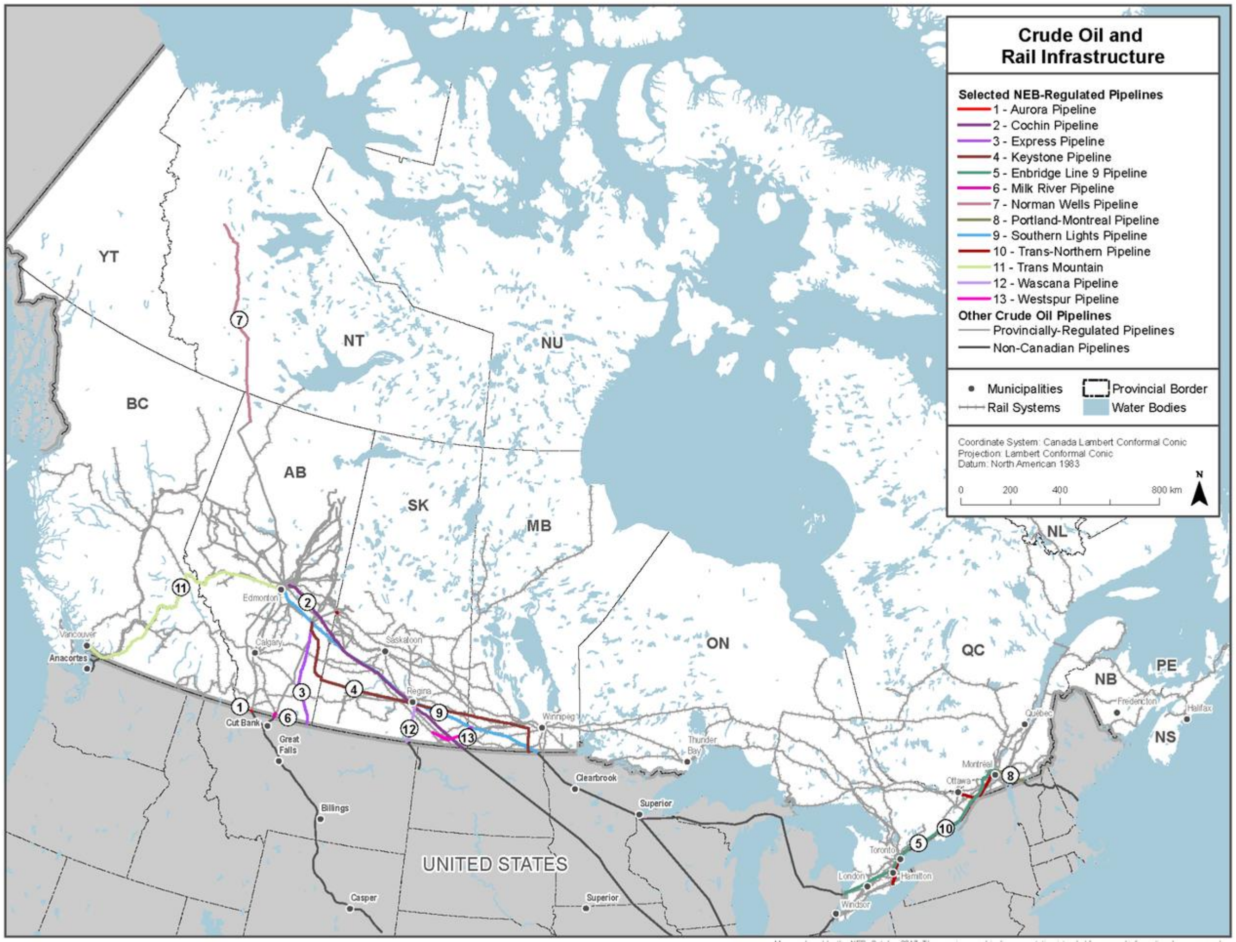
- *Pipelines*, which require significant capital outlays, are the most efficient land-based transportation mechanism. Canada's extensive pipeline network is shown in Figure 39.
- *Oil tankers* are the world's most common mechanism for oil transport. While marine transport is the most cost-effective, it is also the slowest. Canada uses marine channels on both its east and west coasts for shipments.
- *Rail transportation* is a less efficient method of shipping crude and is considered relatively less safe (e.g., the Lac-Mégantic rail disaster of 2013).[62] However, rail lines extend across Canada and remain an important and alternative part of the delivery infrastructure.
- *Trucks* to transport crude oil are often a mechanism of last resort for producers that need to ship their crude a relatively short distance. Trucks play a minimal role in exporting Canadian oil.

Much of Canada's pipeline infrastructure has been built to facilitate trade with the U.S., while the rail network serves smaller volume domestic routes as shown in Figure 39. The infrastructure from the WCSB helps supply most of Canada's crude oil needs. British Columbia has direct pipeline access to WCSB oil via the Trans Mountain pipeline. Ontario and Quebec are supplied by the Enbridge Mainline that travels through the U.S and then reconnects with Canada at Sarnia, ON.

[62] Fraser Institute, Pipelines are the safest way to transport oil and gas. Website.

Atlantic Canada is not connected to Canada's national pipeline infrastructure, precluding direct transfers from WCSB.

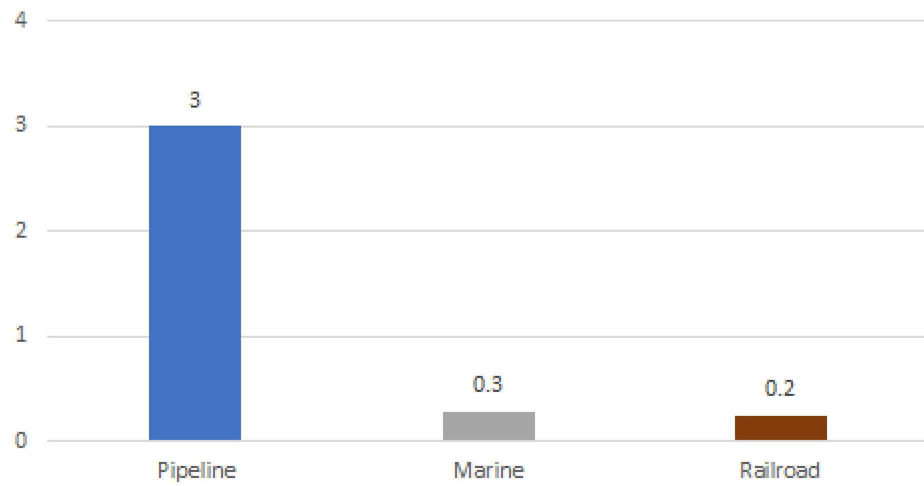
Figure 39: Canada's Crude Oil Transportation Infrastructure



Sources: CER, Canada's Energy Future 2019, 2019; CER, Provincial and Territorial Energy Profiles, Canada.

Due to the U.S. orientation of Canada's export activities, crude oil exports by pipeline dwarf those of other means of transportation, as seen in Figure 40. In 2018, approximately 86% of crude oil exports moved to the U.S. by pipeline. Approximately 6% were exported by rail and 8% by marine vessel to the U.S. or various destinations throughout the world.

Figure 40: Canada's Crude Oil Exports by Transport Mode, 2018
(MMb/d)



Sources: CER, Crude Oil Annual Export Summary – 2018

3.4.5.1 Regional Oil Refining Capability

While crude oil products are delivered to export markets, domestic consumption requires that crude oil is transported to refineries that convert it to refined petroleum products. Canada has 17 refineries, 14 of which produce gasoline, as shown in Figure 41.

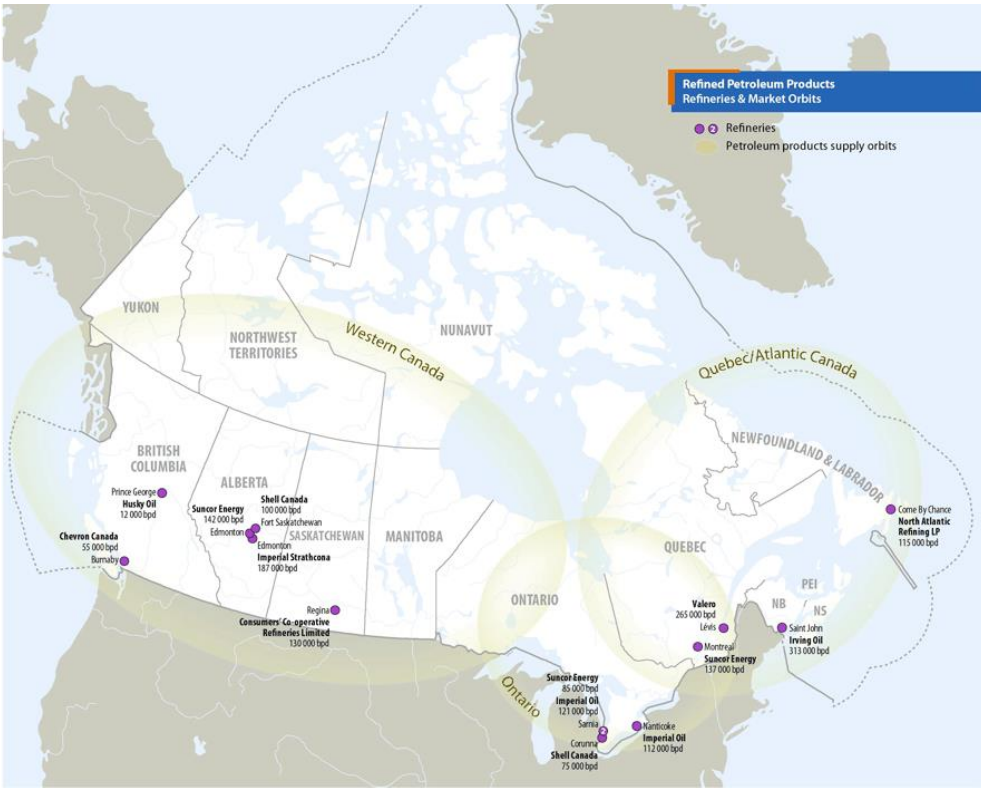
Typically, refineries are located on major waterways, near major cities and consumers, otherwise known as supply orbits, or near crude oil production. Canadian refineries generally do not process the heavier crude oil that is increasingly coming from the oil sands.

In the Western Canada orbit, Alberta's refineries are collocated with production from the WCSB while B.C.'s refineries are connected to the Trans Mountain pipeline.

In the Ontario orbit, Ontario's refineries are located in Sarnia and southwestern Ontario where they have ready access to the Enridge Mainline supply as it re-enters Canada. The Enbridge Mainline extends as the Enbridge Line 9 pipeline where it supplies the Quebec/Atlantic Orbit refinery in Montreal.

The Atlantic orbit consists of refineries in Newfoundland and Labrador and New Brunswick that are supplied from sources overseas.

Figure 41: Canadian Refineries & Supply Orbits



Source: CER, Raffineries au Canada en 2015 (en barils par jour). Website.

3.4.5.2 British Columbia

British Columbia's crude oil distribution network includes pipelines, marine, and rail channels, as shown in Figure 42. British Columbia is an important conduit for crude oil travelling from the Prairies to the U.S. West Coast and other international markets.

The vast majority of crude oil in the province is transported through two major pipelines: the Plateau Pipeline from the oil fields in northeastern British Columbia; and, the Trans Mountain Pipeline from Edmonton, Alberta.

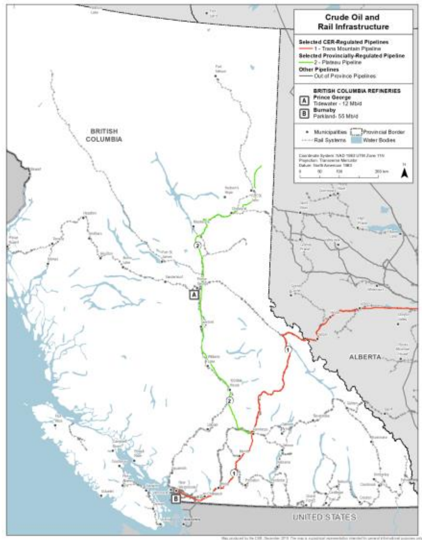
The Plateau Pipeline connects northeastern British Columbia to the Trans Mountain Oil Pipeline at Kamloops, B.C. On its way to Kamloops, the Plateau Pipeline feeds the Prince George Refinery, one of only two refineries in B.C.[63]

The Trans Mountain Oil Pipeline transports oil from Edmonton, Alberta to Kamloops and Burnaby in British Columbia, and to the Sumas Terminal in Abbotsford, which connects to refineries in Washington State via the Trans Mountain Puget Sound Pipeline System. It also provides 60 Mb/d crude oil to the

[63] Energy B.C., Oil Infrastructure Map in B.C. Website.

Westridge Marine Terminal which facilitates marine exports.[64] British Columbia also ships via some crude-by-rail connections to the U.S.

Figure 42: British Columbia's Crude Oil Transportation Infrastructure



Sources: CER, Canada's Energy Future 2019, 2019; CER, Provincial and Territorial Energy Profiles, Canada.

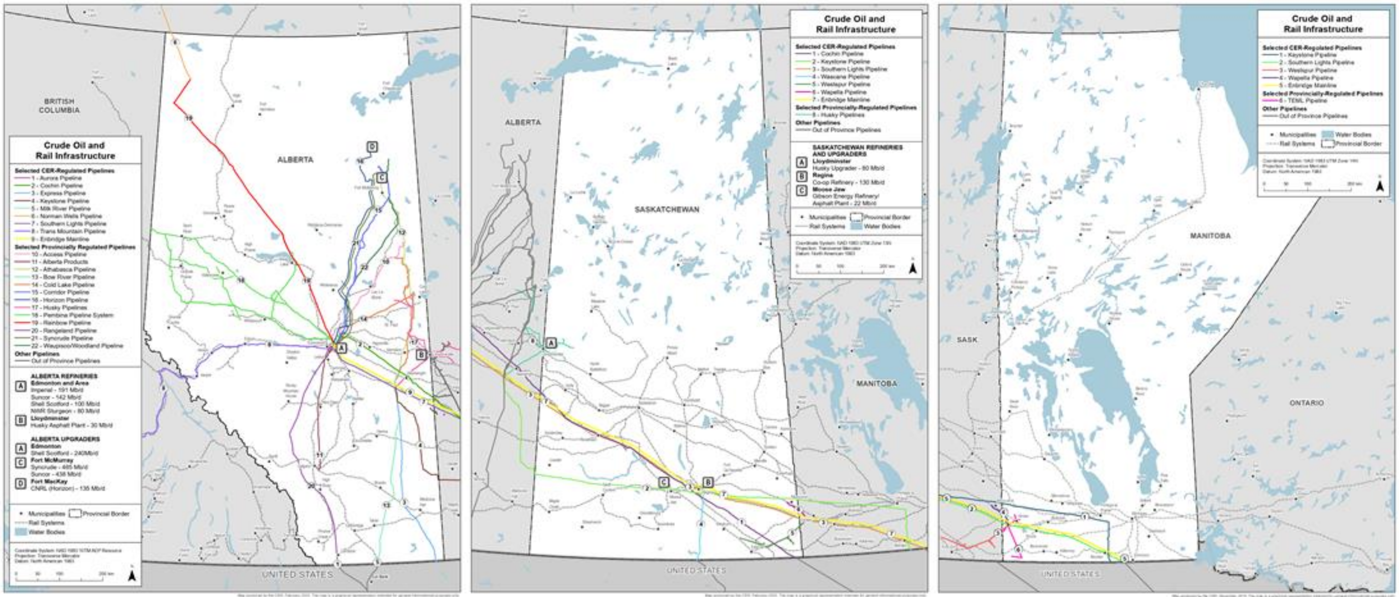
British Columbia uses its crude production to meet some of its needs but remains reliant on the Prairies and the Trans Mountain Pipeline for most of its supply. B.C. also provides a large proportion of diluents from its northeastern gas fields to the Prairies. This is beneficial to Canada's oil sands production since the costs to ship these liquids from B.C. are lower than the costs of moving the same product into the Prairies from the U.S.[65]

3.4.5.3 Prairies

Alberta, Saskatchewan & Manitoba are mostly dependent on pipelines to transport oil from the WCSB for export and interprovincial transfers to B.C, Ontario, and Quebec, as shown in Figure 43. While the vast majority of oil is transported by pipeline, a small but growing trade of crude-by-rail also exists.

[64] Government of Canada, Pipeline Throughput and Capacity Data Set.
[65] The Narwhal, The resource B.C. is piping to Alberta that nobody is talking about, 2018.

Figure 43: Alberta, Saskatchewan and Manitoba's Crude Oil Transportation Infrastructure



Sources: CER, Canada's Energy Future 2019, 2019; CER, Provincial and Territorial Energy Profiles, Canada.

Four main pipeline systems form the bulk of transportation infrastructure from the Prairies to domestic and international markets. These represent over 95% or 4 MMb/d[66] of Canada's total pipeline capacity:

- Enbridge Mainline, which is the largest of the four, has 66% of the total Canadian pipeline capacity and delivers crude oil, natural gas liquids, and refined petroleum products from Edmonton, Alberta to the U.S. Midwest and Ontario.
- Keystone Pipeline, which has 14% of Canada's pipeline capacity, delivers crude oil from Hardisty, Alberta to the U.S. Midwest and U.S. Gulf Coast.
- Trans Mountain Pipeline, which represents 7% of Canada's capacity, delivers crude oil and refined petroleum products from Edmonton, Alberta to Vancouver, B.C., Washington State, and offshore markets.
- Express Pipeline, has 7% of Canada's capacity and delivers crude oil from Hardisty, Alberta to Casper, Wyoming.

Several other pipeline systems carry smaller volumes of oil to other U.S. markets, such as the Milk River Pipeline, which has 2% of Canada's capacity, and the Rangeland/Aurora Pipeline system.

3.4.5.4 Ontario and Quebec

Ontario and Quebec are pipeline destinations for oil from WCSB, and also have some additional rail and marine links with the U.S. These provinces receive most of their crude oil via the Enbridge Mainline, which originates in Edmonton, Alberta and extends east across the Prairies crossing the Canada-U.S.

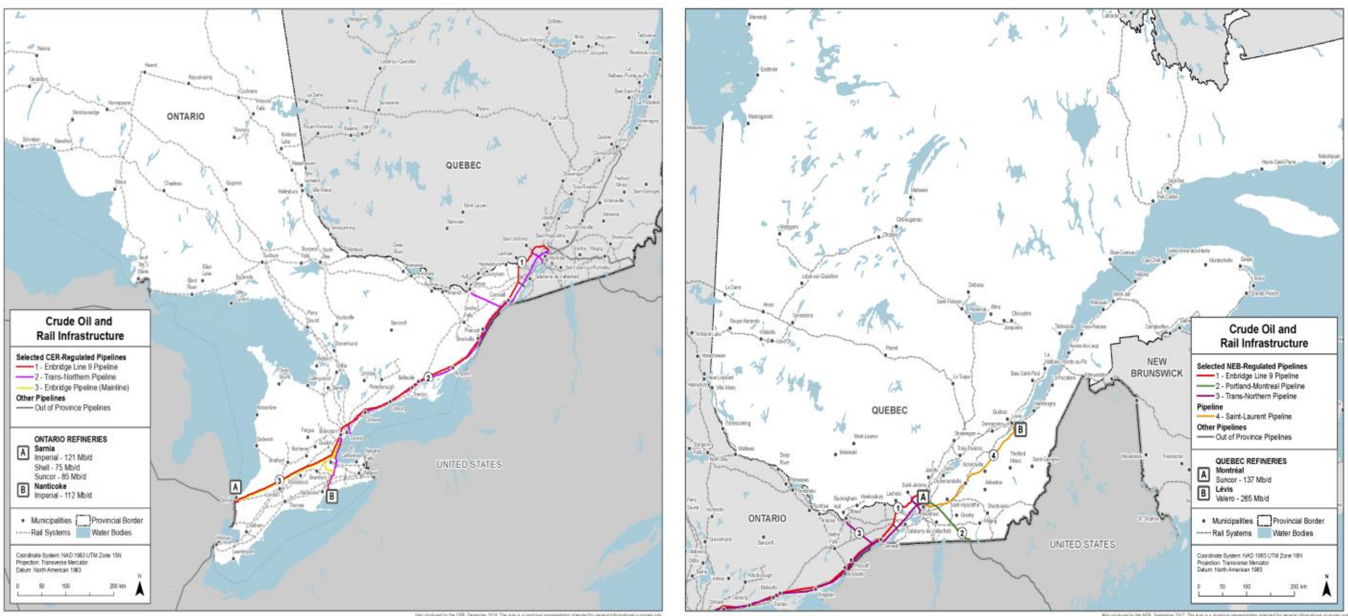
[66] NEB, Western Canada Crude Oil Supply, Markets, and Pipeline Capacity.

border near Gretna, Manitoba, where it joins with the Enbridge Lakehead system. At Clearbrook, Minnesota, the Mainline connects with the Enbridge North Dakota pipeline and receives additional U.S. sourced light crude oil supplies. It also connects here with the Minnesota pipeline to deliver crude oil to refineries in Minnesota and Illinois. It then passes through Wisconsin, Michigan, Illinois, and Indiana, before re-entering Canada.

After passing through the U.S., the Enbridge Mainline delivers the mix of Canadian crude from the WCSB and U.S. sources to refineries near Sarnia, as shown in Figure 44. The crude is then shipped to Nanticoke, via Enbridge Line 7 and 11. It also connects to the Enbridge Line 9 which continues on to Quebec, bringing crude oil to the Montreal refinery.

In addition to Line 9, Quebec is supplied by tankers and railways, and from the Portland-Montreal Pipeline, which can bring crude oil from the state of Maine.

Figure 44: Ontario and Quebec's Crude Oil Transportation Infrastructure



Source: CER, Provincial and Territorial Energy Profiles, Canada.

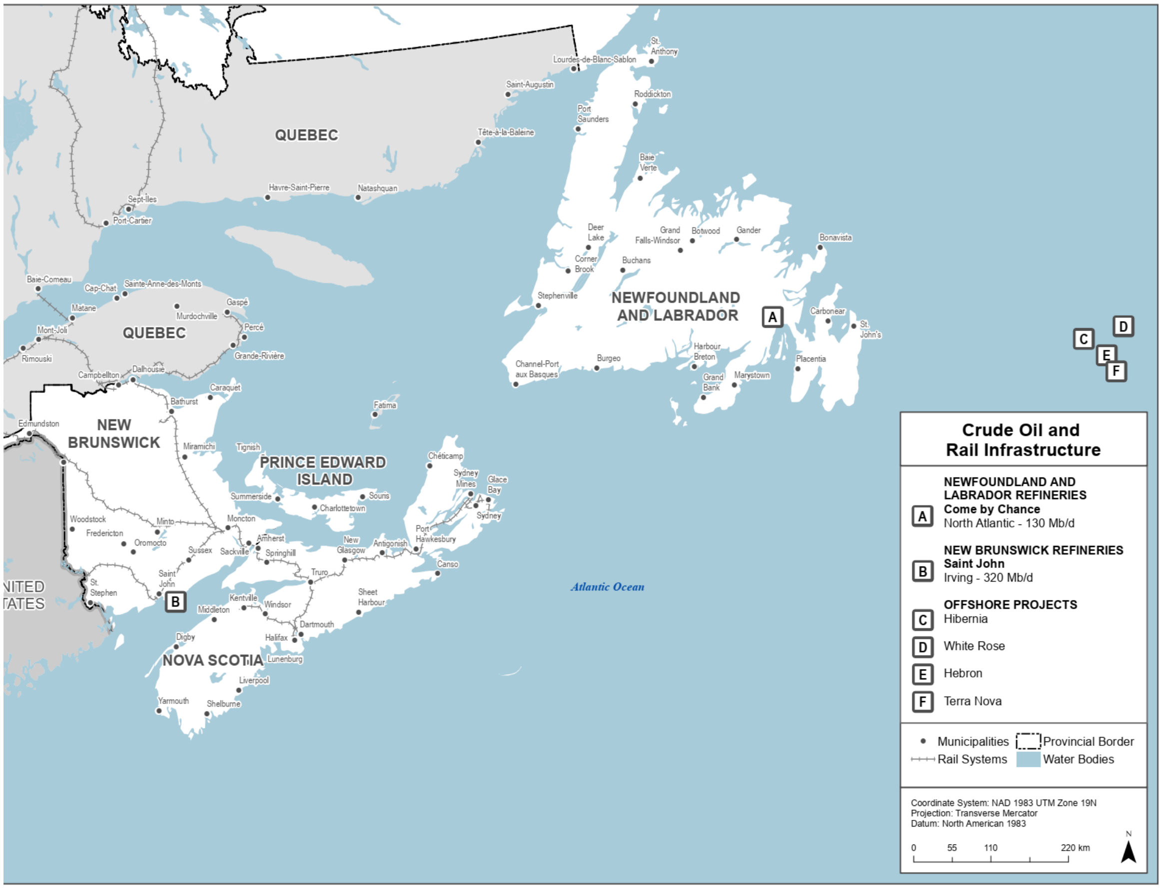
The other significant pipeline in this region is the Trans-Northern pipeline which does not transport crude and only delivers refined petroleum. This pipeline delivers petroleum to Toronto from the refineries in Montreal and Nanticoke.

3.4.5.5 Atlantic Provinces

The Atlantic Provinces are mostly dependent on marine transportation to meet their crude oil needs and have some rail connectivity with Quebec and the U.S., as illustrated by Figure 45. Canada's crude oil pipeline infrastructure does not extend to the Atlantic Provinces, although New Brunswick does source a small portion of its supply from WCSB by rail.

This region has two large refineries, including the country's largest, the Saint John Refinery in New Brunswick, which is responsible for about 75% of Canada's gasoline exports to the U.S., equating to 19% of U.S. gasoline imports. The Come by Chance refinery in Newfoundland also exports refined petroleum products to the U.S. East Coast.[67] Both refineries are located on deep sea ports to facilitate the seaborne trade.

Figure 45: Atlantic Provinces' Crude Oil Transportation Infrastructure



Source: CER, Provincial and Territorial Energy Profiles, Canada.

3.4.6 Crude Oil Exports and Imports

Canada is a large net exporter of oil in aggregate but does import 0.6 MMb/d. In 2018, Canada exported 3.6 MMb/d of crude oil, 97% of which was destined for the U.S.[68] This supply accounts for 48% of total U.S. crude oil imports, which represent 22% of U.S. refinery crude oil intake.[69] Two-thirds of Canada's imports are from the U.S., while the rest come from overseas.

[67] Dun & Bradstreet, Irving Oil Limited Company Profile. Website.
[68] CER, Commodity Tracker, Oil Exports; BP Statistical Review of World Energy, 2019. Website; Strapolec Analysis.
[69] NRCan, Crude oil facts, 2020.

Canada's international crude oil trade partners vary substantially by region. British Columbia, through the Port of Vancouver, exports small amounts to the U.S. West Coast., China, and Korea.[70] The Prairies' large production output satisfies a large proportion of U.S. needs. Ontario & Quebec import from the U.S., while Atlantic Canada exchanges both imports and exports of crude oil with the U.S and international sources.

3.4.6.1 British Columbia

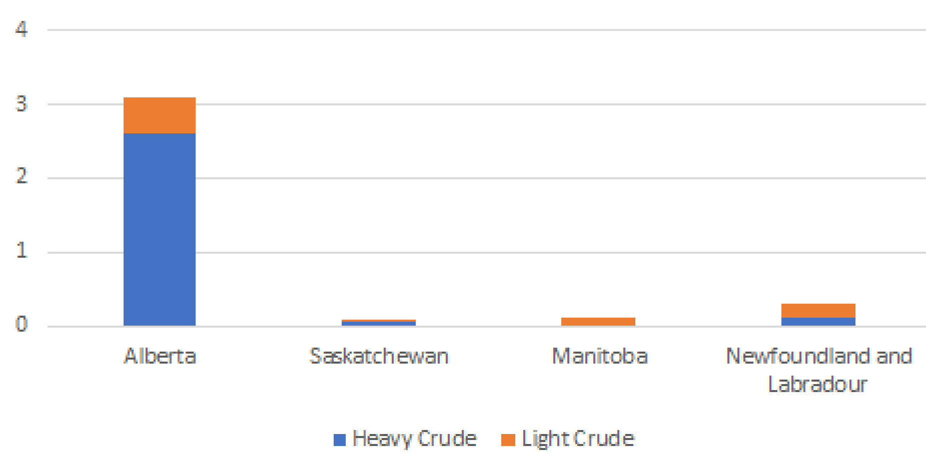
British Columbia exports to the Pacific Northwest, California and Asia. About 20% of Canada's crude oil exports via marine tankers are from Canada's West Coast. This crude oil originates in the WCSB and is transported via rail or on the Trans Mountain Pipeline to the Westridge loading dock in Burnaby.[71] About 64% goes to the U.S., 30% to China, and 7% to South Korea.

3.4.6.2 The Prairies

Alberta, Saskatchewan, and Manitoba comprise the largest oil-exporting region, providing over 90% of Canada's oil exports. These exports are mostly heavy crude oil delivered via pipeline to the U.S. as shown in

Figure 46. The vast majority of oil from the Prairies travels to the U.S. Midwest. The U.S. Midwest is dependent on Canada to meet 60% of its needs. Refineries in the U.S. have a much greater capacity to handle Canada's oil sands' heavy sour crude than refineries in Canada's east.[72]

Figure 46: Annual Crude Oil Exports by Type and Province, 2018
(MMb/d)



Sources: CER, Crude Oil Annual Export Summary – 2018.

[70] Vancouver Sun, Chinese demand leads to huge jump in crude oil exports from B.C., 2019.
[71] EnergiMedia, Canadian crude exports: How much and where do they go, 2019.
[72] Oil Sands Magazine, Differentials Explained: Why Alberta crude sells at a deep discount, 2018.

Alberta, Saskatchewan, and Manitoba account for a small portion of Canada's oil imports from the U.S. Similar to the interprovincial transfers received from B.C., these imports are mainly condensate or diluent for mixing with bitumen to facilitate its transportation by pipeline.

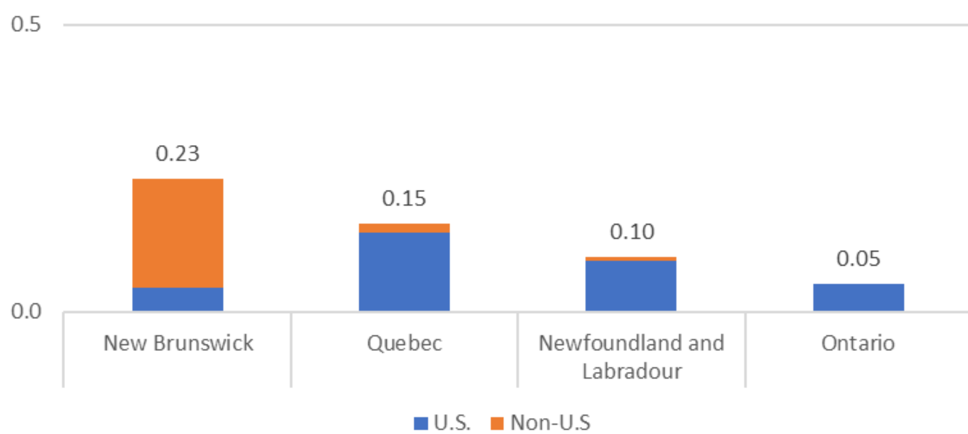
3.4.6.3 Ontario and Quebec

Ontario and Quebec are mainly dependent on crude oil imports from the U.S. The two provinces are responsible for a third of Canada's imports, almost all of which come from the U.S. Ontario and Quebec do not export crude oil.

Ontario imports oil from North Dakota, Indiana, and Texas via the Enbridge Mainline pipeline that also carries Western Canadian crude oil.[73] Its U.S. imports are one-third of those for Quebec.

Quebec shifted its crude oil sourcing following the 2015 decision by Enbridge to reverse the flow of Line 9.[74] This has enabled Quebec to reduce its dependence on foreign oil. Canadian crude, which only represented 8% of its supply in 2012, now meets almost half of Quebec's needs. This shift was important as flows from the Portland-Montreal pipeline, which imported oil from Maine, show a decline from 32 Mb/d in 2016 to almost zero in 2018.[75] Over half of Quebec's crude oil supply comes from the U.S. representing more than 90% of its foreign imports.

Figure 47: Annual Crude Oil Imports – Eastern Provinces, 2018
(MMb/d)



Sources: CER, Market Snapshot: Imports of Crude Oil – 2019.

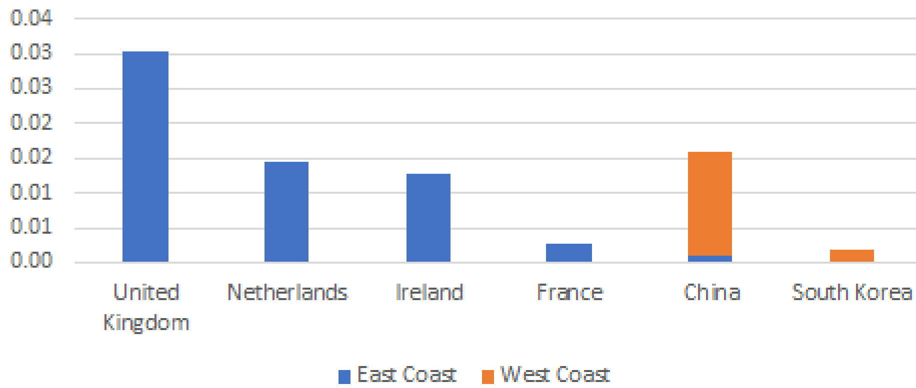
3.4.6.4 Atlantic Canada

Atlantic Canada is reliant on both the U.S. and overseas markets for its crude oil trade. More than half of Atlantic Canada's exports head to the U.S. Canada's non-U.S. exports represent only 3% of total oil

[73] National Observer, Guess where Quebec gets it oil, 2018.
[74] National Observer, National Energy board approves Enbridge's Line 9 pipeline, 2015.
[75] Strapolec Analysis.

exports.[76] Over 80% of these were from Atlantic Canada, and 75% of Atlantic Canada's exports were to Western Europe, as shown in Figure 48 which also contrasts exports from B.C.

Figure 48: Canadian Crude Oil Exports to Non-U.S. Countries,
(Top 6 Countries, 2018, MMb/d)



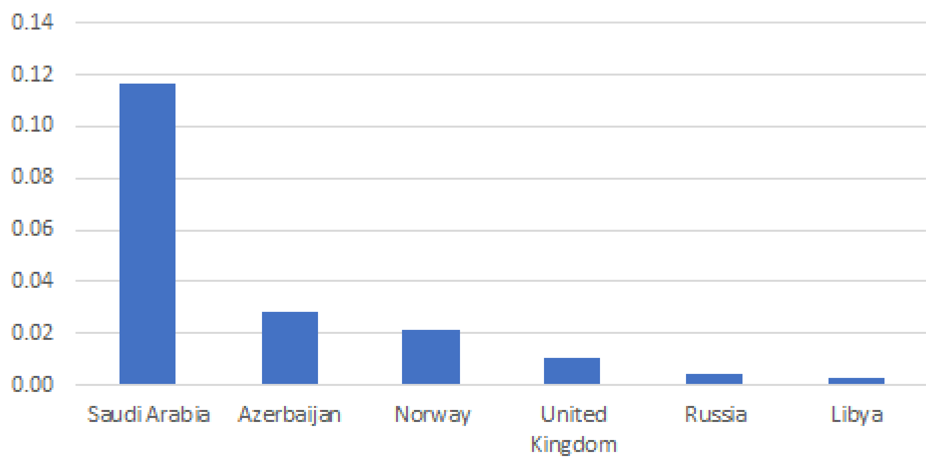
Source: CER, Commodity Statistics. Website.

The Atlantic provinces are also responsible for over half of Canada's imports. Canada's easternmost refineries process imported crude from the U.S., the Middle East, Africa, and Europe.

Atlantic Canada imported 0.2 MMb/d from the U.S. in 2018, as well as roughly 0.18 MMb/d from the rest of the world. Overseas imported crude oil to the refineries in New Brunswick and Newfoundland and Labrador arrives by marine tankers, the majority of which comes from Saudi Arabia, as shown in Figure 49.[77,78]

[76] BP Statistical Review of World Energy, 2019. Website. CER, Canada's Transportation System, 2016.
[77] CER, Market Snapshot: Imports of crude oil continue to decrease in 2018, 2019. Website.
[78] Newfoundland's only refinery, Come by Chance, was built before the discovery of offshore oil in the Province. Therefore, the refinery was built to process imported oil, it did not begin to process Newfoundland oil until 2014. Even now only 20% of its inputs are from within the province.

Figure 49: Canadian Crude Oil Imports from Non-U.S. Countries, Top 6 Countries, 2018
(MMb/d)



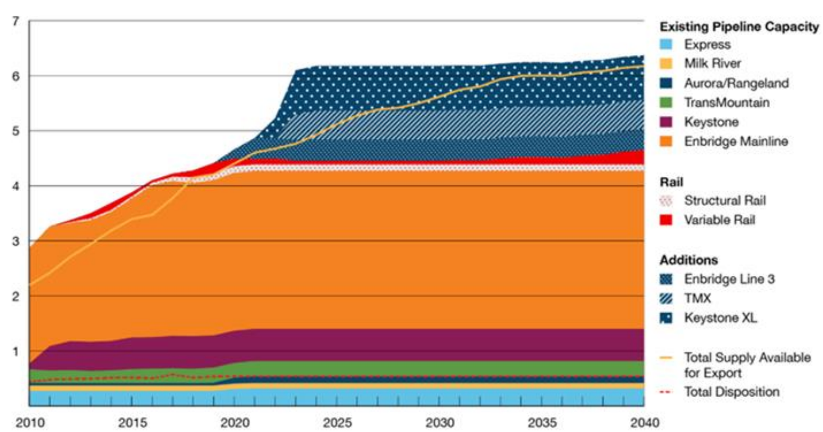
Source: CER, Commodity Statistics, Website.

Atlantic Canada's crude oil production is primarily from Newfoundland and the forecasted decline of this light oil by 2040 will similarly erode Canada's long-term overseas exports and at the same time increase dependence on imports and energy insecurity for the region.

3.4.6.5 Planned Export Oriented Pipeline Capacity

Canada's planned available supply for export is contrasted with the current and anticipated pipeline capacity in Figure 50. Crude oil available for export is expected to increase to 6.2 MMb/d by 2040.

Figure 50: Canada's Announced Oil Pipeline Capacity, 2010-2040
(MMb/d)



Source: CER, Canada's Energy Future 2019, 2019.

Given the pipeline projects announced to date, Canada's pipeline capacity could increase from 2.9 MMb/d to 6 MMb/d by 2025. In addition, crude by rail capacity could grow to 0.4 MMb/d.[79] This increase in capacity would be sufficient to accommodate planned production growth in the Prairies over the next 20 years.[80]

3.4.7 Summary

Canada has the third-largest oil reserves and is the fourth-largest producer in the world. Canada meets 75% of its own crude oil needs and provides 48% of all U.S. crude oil imports. While climate policies are expected to reduce the world's consumption of oil, the IEA forecasts that oil will remain an important staple in the world's energy mix through to 2040.

Canada's oil supply and demand dynamics can be characterized as a regional story. The west exports large quantities to the U.S., and the east imports large quantities from the U.S. The provinces of Alberta and B.C. are co-dependent on their respective resources and production capabilities. The oil distribution infrastructure makes Ontario and Quebec dependent upon U.S. supply networks, which ironically also provide these provinces with their access to Canadian oil. Concurrently, the U.S. Midwest relies on Canadian imports for 60% of its refinery feedstock.

Atlantic Canada, despite production from Newfoundland, depends on the U.S. and overseas supplies as it does not have access to Western Canadian oil. Today, Canada exports small volumes to Western Europe from the East Coast, and to Asia, mostly from the West Coast. Eastern Canada's energy security and ability to continue its role as a provider of oil to the world could be further compromised as production from the offshore Hibernia fields declines over the next 20 years.

The development of Canada's potential oil resources is a function of both foreign market demand and the expansion of delivery capabilities to those markets. Existing infrastructure and refining capabilities keep Canada dependent upon the U.S. both as a major export market and also for imports.

3.5 Climate Change Requires Canada To Develop Clean Energy

Climate change is an established global concern and was the focus of the Paris Agreement in December 2015. Canada has committed to supporting the Paris objectives and continues to develop emission reduction policies. This subsection first discusses Canada's position in the world with respect to its emission contributions, national emission reduction targets, and related federal and provincial policies. An examination is then provided of the sources of greenhouse gas emissions, nationally and regionally. Finally, the imperative for Canada to leverage its energy sector to help meet its Paris commitments is discussed. This subsection concludes with key findings regarding the potential achievement of Canada's emission targets.

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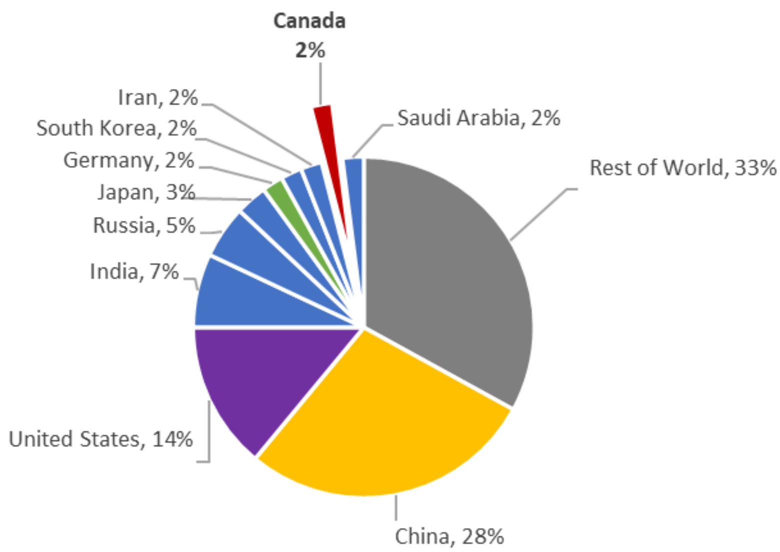
[79] Structural Rail refers to crude oil that is likely to be exported by rail regardless of a given WCS-WTI differential. Variable Rail refers to crude oil rail exports supported by the WCS-WTI differential, and in response to potential pipeline constraints.
[80] Note that these figures exclude the Canada-East pipeline, which was cancelled in 2017.

3.5.1 Canada is the 9th Largest Emitter of Greenhouse Gases.

In December 2015, at the United Nations' Council of the Parties (COP-21), 194 countries including Canada signed the Paris Agreement.[81] Canada is the world's 9th largest emitter of greenhouse gases, but only represents 2% of global emissions, as shown in Figure 51.

Figure 51: Top 10 Emitting Countries, 2017
($Mt\ CO_2$)



Source: Union of Concerned Scientists, 2020.

The top 10 emitting nations can be characterized by either their significant population and use of coal generation (China, India, U.S., Germany) or by their status as one of the top five oil-producing nations (Russia, Iran, Saudi Arabia, Canada). Canada's role in global oil production makes it one of the top emitters.

3.5.2 Canada's Emission Reduction Targets

As a party to the Paris agreement, Canada set an annual emission reduction target of 511 Mt of CO_2 by 2030, a 30% reduction over 2005 levels.[82,83] The longer-term objective is to achieve an 80% reduction from 2005 levels by 2050.[84]

In 2016, the federal government established the Pan-Canadian Framework on Clean Growth and Climate Change with the participation of most provinces and territories. The plan contains more than 50 actions covering all sectors of Canada's economy and is intended to help Canada achieve its Paris climate target.

[81] Governement de France, COP 21. Website.
[82] Or equivalent.
[83] Government of Canada, Progress towards Canada's greenhouse gas emissions reduction target, 2020.
[84] Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy, submitted to the UNFCCC in 2016 as cited in Canada's Fourth Biennial Report on Climate Change, 2019.

This Framework includes a nation-wide carbon pricing system that is still facing provincial and political opposition.[85]

The Paris Agreement influenced several provinces to set their own targets and implement actions for meeting them. Quebec's target is to reduce emissions 20% below 1990 levels in 2020, and 37.5% by 2030. The province is a member of a Cap and Trade program with California. Over $4.8 billion from the proceeds of the program are being invested in Quebec's climate plan that includes 30 priorities and over 150 actions.[86] Ontario's target is to reduce emissions 30% below 2005 levels by 2030, reflecting the federal target. Ontario had been a member of the aforenoted Cap and Trade initiative but withdrew in favour of a Made-in-Ontario climate plan.[87,88] In 2018, the federal government announced regulations to phase-out coal-fired electricity generation by 2030.[89] In response, provincial initiatives have recently been announced by Nova Scotia, Alberta, Saskatchewan, and New Brunswick to eliminate coal-fired generation, an outcome that has already been achieved by Ontario and Manitoba.[90,91]

75% of Canadians agree Canada needs to do more than it is currently doing to address climate change.[92] Furthermore, many of Canada's major industries and companies support moving to net-zero emissions by 2050.[93, 94] This will make it difficult for any future governments to deviate from Canada's committed reduction target.

3.5.3 Canada's Sources of Emissions

Canada's emissions have been characterized into six broad categories: buildings, industry, electricity, transportation, the oil, gas, and mining sector (which includes a subsector for oil sands production), and agriculture. The emissions contribution of each category is shown in Figure 52. The primary source of emissions across all these sectors is the consumption of fossil fuels.

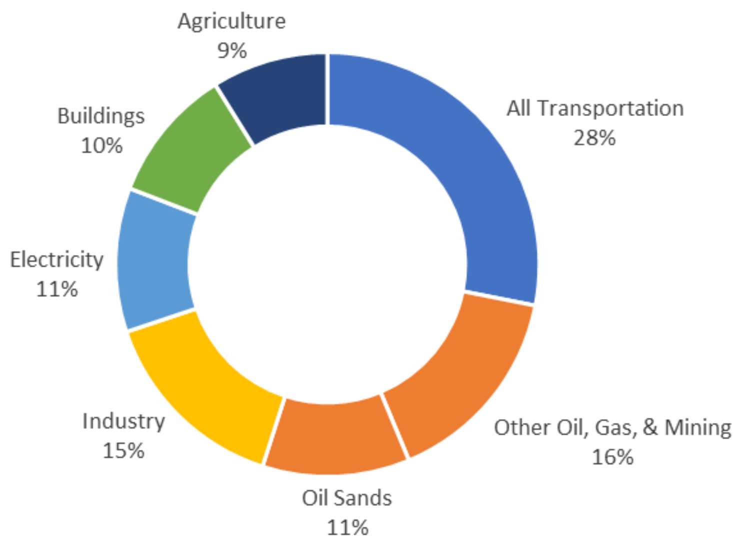
The ***transportation sector*** is the largest contributor to Canada's emissions, accounting for 28% of the total. This sector includes all vehicles, from cars and trucks to trains and aircraft. Transportation emissions result primarily from gasoline and diesel-burning cars and trucks.

The ***oil, gas, and mining*** sector accounts for 27% of Canada's greenhouse gas emissions. The oil sands account for 40% of this or 11% of Canada's total emissions. Oil sands emissions stand out for several reasons. First, the oil sands are a globally significant resource extraction operation involving extensive resources. Second, oil sands production requires a combination of energy-intensive processes and

[85] Government of Canada, Complete text for Pan-Canadian Framework on Clean Growth and Climate Change second annual report, 2019.
[86] Environment et Lutte contre les changements climatiques Quebec, Website.
[87] Quebec, A brief look at the Quebec cap-and-trade system for emission allowances.
[88] Ontario Ministry of the Environment, Conservation and Parks, A Made-in-Ontario Environment Plan, 2018.
[89] Government of Canada, Coal phase-out: the Powering Past Coal Alliance, 2019.
[90] Climate Scorecard, Making Progress in Phasing-out Coal-fired Electricity, 2019.
[91] Global News, Estevan, Sask. preparing for coal phase-out putting hundreds of jobs at risk, 2019.
[92] Ipsos, Three Quarters (75%) Say Canada Needs to Do More to Address Climate Change, 2018.
[93] Global News, Calgary-based oils ands producer Cenovus aims for 'net zero' GHG emissions by 2050, 2020.
[94] CSPA, Canada's Steel Producers Set A Goal to Achieve Net Zero CO_2 Emissions by 2050, 2020.

carbon-intensive sources of energy.[95] Natural gas is used on-site to power most in-situ extraction and bitumen upgrading operations. As the oil sands industry expands, assuming current extraction approaches continue, it will become a larger source of Canada's emissions.[96] Reducing these emissions by improving extraction processes could enable Canada to exit the top 10 emitters group.

Figure 52: Sources of Canada's GHG Emissions, 2018
(Percent of total)



Data source: Environment and Climate Change Canada, Canada's Official Greenhouse Gas Inventory.

Industry produced 15% of Canada's emissions in 2018. Most of these emissions result from burning fossil fuels, which provide the high-temperature heat necessary for many industrial processes. These fuels include natural gas, coal, coking coal, and oil, among others. Process heating accounts for 75% of all energy use in the industrial sector.[97,98]

The ***electricity sector*** contributes 11% to Canada's total emissions. Coal generation represents 77% of these emissions. Natural gas generation contributes another 16%, and the remaining 7% is from biomass and oil products.[99] Electricity sector emissions vary regionally as a function of their electricity generation supply mix.

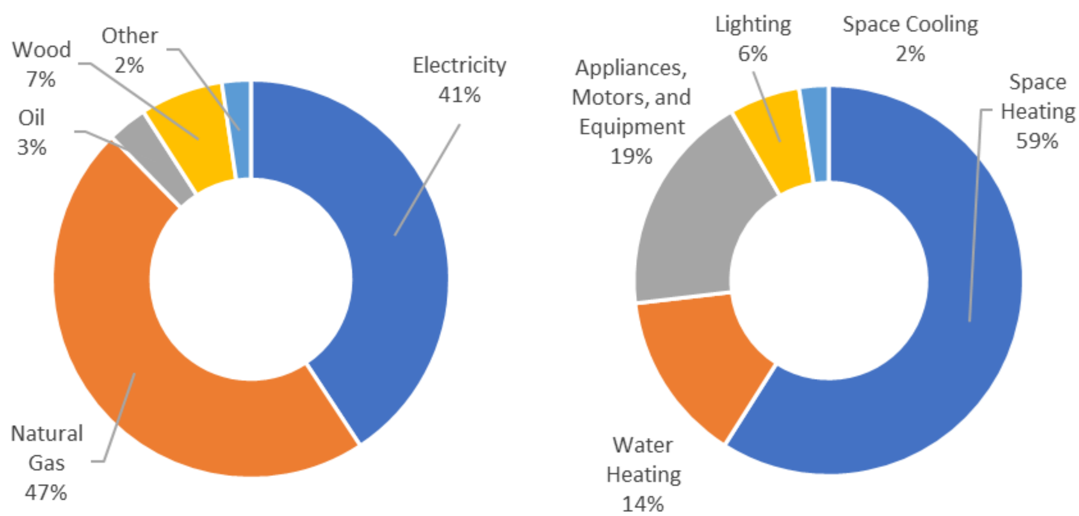
The ***buildings sector*** includes residential, commercial, and public buildings and accounts for 10% of Canada's emissions. This sector consumes mainly electricity and natural gas to meet its energy needs. Emissions from the buildings sector result primarily from burning natural gas, as shown in Figure 53. In

[95] Environment and Climate Change Canada, National Inventory Report 1990-2017: Greenhouse Gas Sources and Sinks in Canada, 2019.
[96] Oil sands producers, under COSIA, are heavily investing in R&D to reduce the emissions footprint of the oil sands. See COSIA, Greenhouse Gases Management.
[97] Council of Canadian Academies, Toward a Low-Emission Energy System, 2015.
[98] Pembina Institute, The Oil sands in a Decarbonizing Canada, 2018.
[99] NRCan, Energy and Greenhouse Gas Emissions, 2020.

most parts of the country, space and water heating as well as stoves and clothes dryers are often fueled by natural gas.[100] The majority of the sector's emissions, over 72%, come from these applications.

Figure 53: Canada's Building Sector Energy Use & Emissions, 2017

(Percent of total)



Source: NRCan, Residential Secondary Energy Use (Final Demand) by Energy Source and End Use; NRCan, Commercial/Institutional Secondary Energy Use (Final Demand) by Energy Source, End Use and Activity Type; NRCan, Residential GHG Emissions by Energy Source and End Use; NRCan, Commercial/Institutional GHG Emissions by Energy Source, End Use and Activity Type– Including Electricity-Related Emissions.

The ***agriculture sector*** accounts for the remaining 9% of Canada's emissions. Most emissions from this sector are not in the form of CO_2, but rather other greenhouse gasses such as methane and nitrogen dioxide that are bi-products of raising livestock and other farming activities.

3.5.4 Canada's Projected End-Use Fuel Consumption and Demand by Region

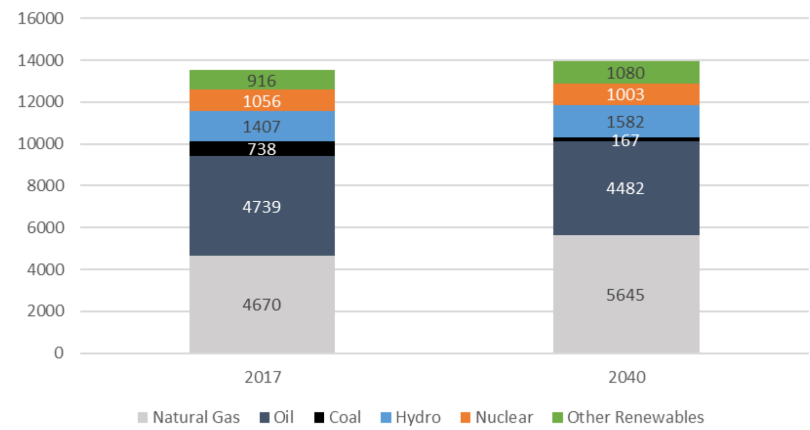
Canada's energy mix is characterized by the prevalent consumption of natural gas, coal, and refined oil products which represent 75% of Canada's energy consumption. The CER projects that with the current policies, Canada will continue to remain heavily reliant on fossil fuel generation through to 2040, as shown in Figure 54.[101]

Overall, Canada's energy use is anticipated to grow by only 5% over the next twenty years. The CER predicts that coal and oil end-use energy consumption will collectively decline by around 800 petajoules during that time. However, much of that consumption will be replaced by another fossil fuel, natural gas. End-use consumption of natural gas is forecast to increase by nearly 1,000 petajoules by 2040.

[100] Council of Canadian Academies, Toward a Low-Emission Energy System, 2015.

[101] CER, Canada's Energy Future 2019, 2019.

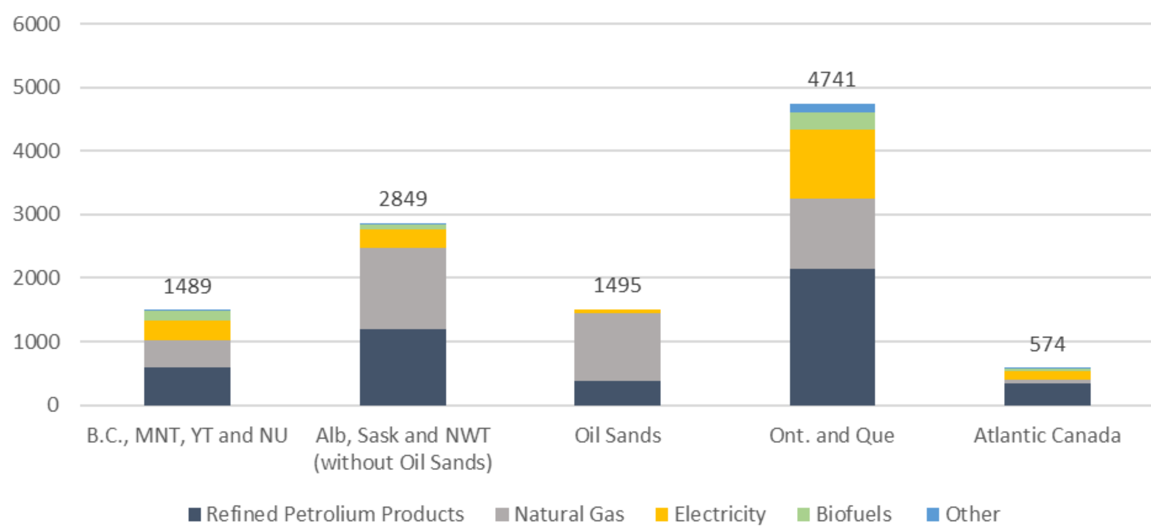
Figure 54: Total End-Use Energy Consumption by Source, 2017 vs 2040
(Petajoules)



Source: CER, Canada's Energy Future 2019, 2019.

Canada's reliance on fossil fuels varies by region, as shown in Figure 55. Alberta and Saskatchewan are particularly reliant on fossil fuels which meet 90% of their energy needs, with demand from the oil sands alone accounting for over 50% of that consumption.[102] Both of these two provinces are larger consumers of energy than Atlantic Canada and B.C. combined. Although Ontario, Quebec, and B.C. have very clean electricity systems, these provinces still rely on petroleum and natural gas to meet other needs, such as transportation and building heating.

Figure 55: End-Use Energy Demand by Region, 2016
(Petajoules)



Source: CER, Provincial and Territorial Energy Profiles; Strapolec Analysis based on Nimana et al., Energy Consumption And Greenhouse Gas Emissions In The Recovery And Extraction Of Crude Bitumen From Canada's Oil Sands, 2015 and Nimana et al., Energy Consumption And Greenhouse Gas Emissions In Upgrading And Refining Of Canada's Oil Sands Products, 2015.

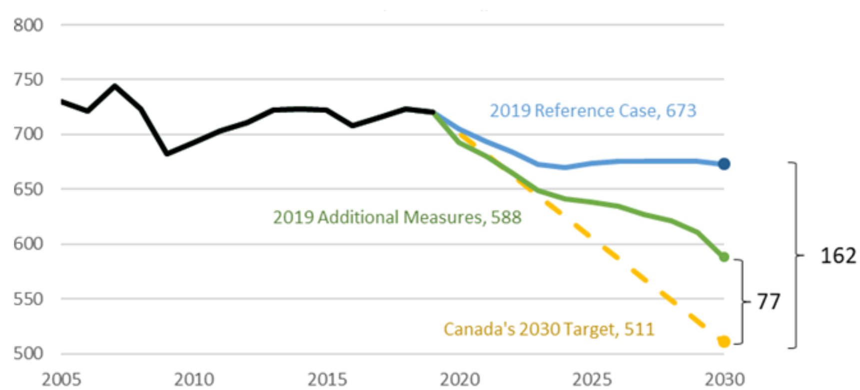
[102] CER, Canada's Energy Future 2019, 2019

3.5.5 Achieving Canada's Emission Reduction Targets Requires Low Emission Energy Alternatives

As of 2019, Canada's emission reduction policies are not expected to achieve its climate targets. The policies proposed in the federal government's Pan Canadian Framework are expected to miss the 511 Mt/year 2030 target by 162 Mt/year. Even under the federal government's more ambitious "Additional Measures" case, Canada is expected to miss the target, as shown in Figure 56. [103]

Figure 56: Canada's Annual Emissions Projections and Targets

($Mt\ CO_2\ eq$)



Government of Canada, Greenhouse Gas and Air Pollutant Emissions Projections: 2019.

Looking forward to 2050, Canada's objective is to reach an 80% reduction below 2005 levels, which equates to a target of about 146 Mt/year. To achieve this goal, Canada must find solutions that eliminate 584 Mt/year of emissions from the economy with respect to "business as usual" emissions growth. Presently, the Government of Canada is signalling a desire to achieve a net-zero emissions goal by 2050.[104]

3.5.6 Summary

As a party to the Paris Agreement, Canada has committed to reducing its yearly emissions to 80% below 2005 levels. Without significant changes in policy, Canada is expected to remain highly dependent on fossil fuels to meet its energy needs with coal, oil, and natural gas accounting for 74% of its future energy supply.[105] Even with the suite of proposed policies in the Pan Canadian Framework, Canada will miss its 2030 targets.

With the majority of emissions resulting from the use of fossil fuels, Canada must find alternative energy sources that do not produce emissions. Fuel-switching for oil sands extraction, such as replacing fossil fuel use with low emissions electricity, represents one of the largest opportunities to reduce Canada's emissions in the future.

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[103] Government of Canada, Greenhouse gas and air pollutant emissions projections: 2019, 2020.
[104] Government of Canada, Government of Canada releases emissions projections, showing progress towards climate target, 2019.
[105] CER, Canada's Energy Future 2019, 2019.

3.6 Canada is Equipped to Meet the Challenges of Electrification

Transitioning away from emission-intensive fossil fuel energy sources like coal, oil and natural gas will require significant changes in how Canadians use energy. Electrification is the key to this transition. In the Canadian context, electrification means leveraging Canada's extensive clean electricity assets in applications where fossil fuels are currently used. Fortunately, Canada has many clean energy resources available to support this transition.

This section examines the options available to electrify the largest sources of emissions in Canada, discusses the implications for the amount of electricity that would be required, and illustrates how investing in Canada's clean electricity assets – hydroelectricity, conventional and next-generation nuclear, and biomass – can enable this low-carbon future while providing significant economic benefits to Canadians.

3.6.1 Potential for Electrification

Electrification can help decarbonize Canada's energy supply and meet its carbon targets. This subsection focuses on the potential for electrification in three major sectors of Canada's energy demand - transportation, building heating, and the oil sands.

3.6.1.1 Transportation

The transportation sector accounts for 28% of Canada's greenhouse gas emissions and is a prime candidate for electrification. Gasoline and diesel currently meet 85% of Canada's transportation needs.[106] However, this situation is poised to rapidly change. Electric vehicles are coming down in cost, spurring consumer adoption: projections see 14 million electric vehicles on the road across Canada by 2040.[107] The operation of these vehicles will be nearly emission-free if charged with electricity produced from carbon-free sources. Similarly, the attractiveness of hydrogen-fueled vehicles is increasing especially in the heavy truck sector. If the fuel for these vehicles is produced from electrolysis using low-carbon electricity, their emissions content will also be next to zero.[108] The adoption of these technologies will support the electrification of Canada's transportation sector and emission reductions.

3.6.1.2 Building Heating

This country's cold climate causes space heating to account for 61% of the energy used in an average Canadian home. Natural gas is the main heating fuel in most parts of the country, and space heating currently accounts for over half of all emissions from the building sector.[109] A report by the Council of Canadian Academies recently found that electrification of buildings coupled with energy efficiency upgrades is achievable.[110] The electrification of the building sector can be achieved by installing newer and more efficient boilers, lighting, stoves, and smart thermostats to allow for better temperature

[106] Council of Canadian Academies, Toward a Low-Emission Energy System, 2015.
[107] Government of Canada, Zero-emission vehicles, 2020.
[108] Strapolec, Ontario's Emissions and the Long-Term Energy Plan. Phase 1 - Understanding the Challenge, 2016.
[109] NRCan, Residential GHG Emissions by Energy Source and End Use; NRCan, Commercial/Institutional GHG Emissions by Energy Source, End Use and Activity Type– Including Electricity-Related Emissions.
[110] Council of Canadian Academies, Toward a Low-Emission Energy System, 2015.

control and demand management, and switching from fossil fuel-sourced space heating to air or ground-source heat pumps.[111]

3.6.1.3 Oil Sands

The oil sands, as a single industry, accounts for a disproportionately large share of Canada's emissions, at 11% of the annual total in 2018. This is due to a combination of energy-intensive processes and a fossil-heavy energy supply. These processes include the trucking required for extracting and transporting surface-mined bitumen, steam and heat production for in-situ extraction, and electricity sourced from Alberta's coal-reliant electricity grid.[112] New nuclear technologies, such as small modular reactors (SMRs) have the potential to provide a low-carbon solution to meet these needs. An SMR could potentially provide on-site clean heat, steam, and electricity, providing all the energy inputs required for in-situ extraction and powering fleets of electric vehicles for surface mining.

3.6.2 Achieving Electrification of the Economy Requires Significant Low Emission Energy

The large amounts of low-emission electricity required to achieve this electrification represent a significant infrastructure challenge as identified in several provincial and national studies.

In 2016, a study investigated the potential of electrification to help Ontario meet its climate targets.[113] At the time, Ontario had committed to reducing its emissions to 37% of 1990 levels by 2030. The study considered the methods that could be used to achieve this target, both through electrification and other identifiable approaches. It showed that achieving this target would require electrification of end-uses in buildings, transportation, and industrial heat.

The associated emissions from Ontario's buildings would have to be reduced by 50% below expected 2030 levels. The analysis assumed a 5.5% energy efficiency improvement across the province's entire building stock, and found that a 44.5% reduction in the sector's emissions through electrification of natural gas area and water heaters in both residential and commercial buildings would be necessary.

Achieving significant emission reductions from Ontario's transportation sector would require fuel switching from gasoline and diesel to cleaner fuel sources. The analysis assessed electric battery and hydrogen fuel-cell options for both passenger and heavy-duty vehicles and considered the evolving fuel efficiency assumptions for gasoline and natural gas-powered vehicles.

Replacing fossil fuels in these various applications with low emission electricity would result in greater demand for electricity. The study found that an electrified Ontario would require an additional 92 TWh of electricity per year to achieve a 52 Mt reduction in provincial emissions, as shown in Figure 57. This result suggests that, on average across the economy, approximately 1.8 TWh of new electricity is required for every Mt of emission reduction.

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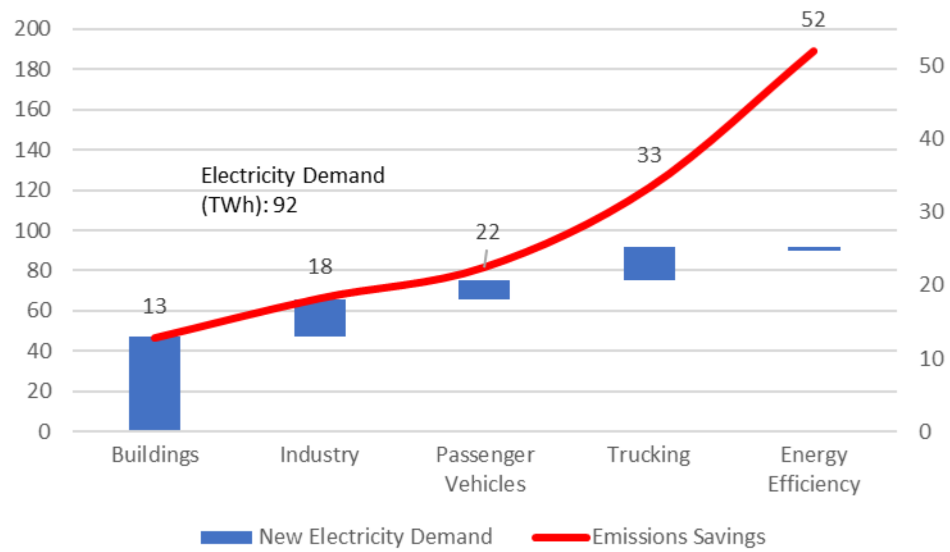
[111] Strapolec, Ontario's Emissions and the Long-Term Energy Plan. Phase 1 - Understanding the Challenge, 2016.
[112] Nimana et. al, Energy Consumption and Greenhouse Gas Emissions in The Recovery and Extraction of Crude Bitumen from Canada's Oil Sands, 2015.
[113] Strapolec, Ontario's Emissions and the Long-Term Energy Plan. Phase 1 - Understanding the Challenge, 2016.

Figure 57: Electrification Implications of Emission Reductions in 2030
(TWh, Mt CO_2 emissions)



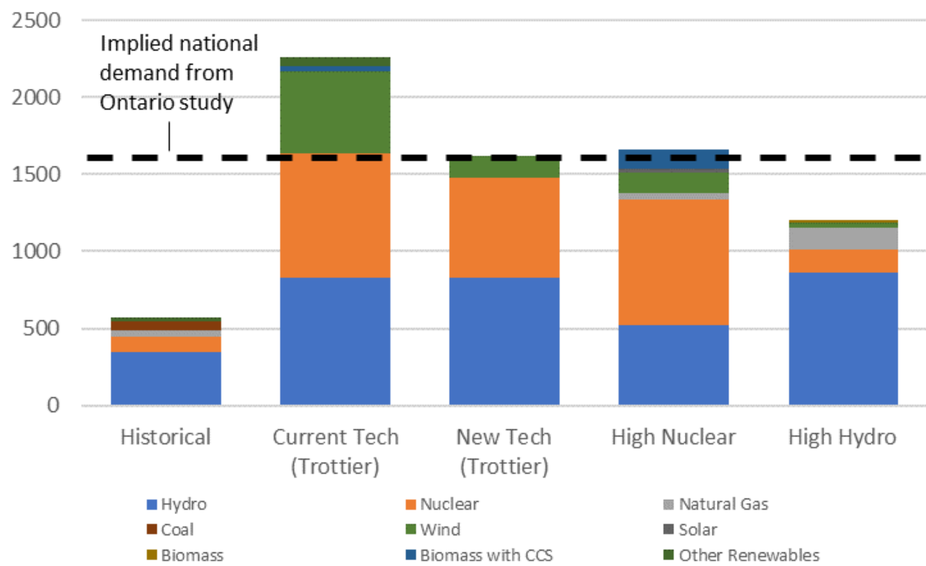
Source: Strapolec, Ontario's Emissions and the Long-Term Energy Plan, 2016.

A similar increase in demand for electricity is expected to occur across Canada should emission reduction initiatives be pursued. National-level studies have been conducted by Trottier and Environment and Climate Change Canada to assess the electrification implications of reducing emissions by 60% below 1990 levels and 65% below 2005 levels, respectively.[114] Results from these studies are summarized in Figure 58. Canada will need to generate anywhere from two to four times its current electricity production to meet this need – all of which must come from low-carbon sources. As a point of reference, the 1.8 TWh/MT factor from the Ontario study suggests that Canada will need about 1000 TWh more low emission electricity to achieve the aforenoted 2050 emission reduction target of 580 Mt. This is consistent with the ranges from other studies, as illustrated in Figure 58.

To decarbonize, Canada will need to develop more low emission electricity, which in turn means developing more clean electricity assets. It is worth noting that all of these studies indicate a significant need for nuclear and hydro generation to meet Canada's reduction target.

[114] Trottier Energy Futures Project, Canada's Challenge & Opportunity, 2016.; Environment and Climate Change Canada Global Change Assessment Model as detailed in Government of Canada, Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy, 2016.

Figure 58: Scenarios of Canada's Non-Emitting Electricity Generating Supply
(TWh)



Sources: Government of Canada, Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy, 2016

3.6.3 Canada Has the Clean Energy Assets Required for Electrification

In popular media today, the discussion about clean energy often presents wind and solar generation as the panacea for achieving global emission reductions. Canada's solar and wind resources, however, are less robust than in other jurisdictions due to geographic and climate-related limitations.[115] The manufacturing of these technologies is also dominated by a number of large foreign countries, which have a significant head start on Canada's manufacturing supply chain. For example, China dominates the global solar panel manufacturing industry while the wind turbine industry is split between Chinese and European firms.[116,117]

Fortunately, Canada's clean energy resources are more diverse and, despite their regional variability, offer significant national and regional opportunities for emission reductions and made-in-Canada benefits. Canada has extensive hydroelectric resources in both the western and eastern parts of the country. Ontario hosts a mature, world-leading nuclear power industry whose benefits also affect other provinces like New Brunswick and Saskatchewan. Canada's vast renewable, agricultural, and forest biomass resources represent a significant, sustainable, carbon-neutral source of energy. As well, there are tidal and geothermal resources, but these are geographically limited and have small potential compared to the others.

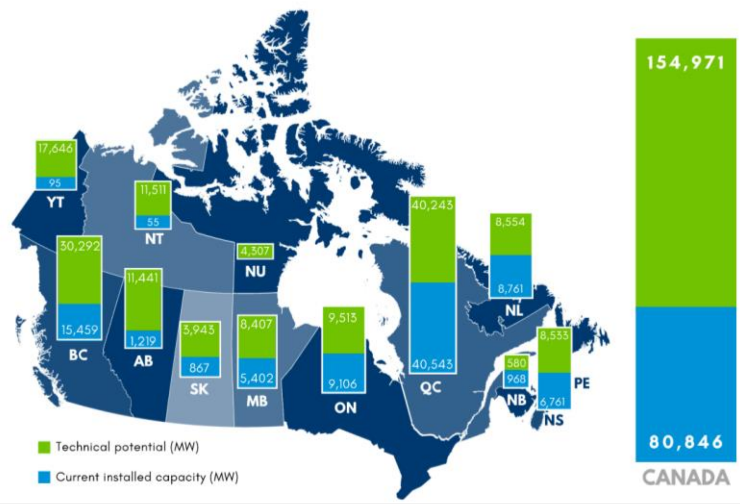
115 Strapolec, DER in Ontario, 2018.
116 Nikkei Asian Review, China's solar panel makers top global field but challenges loom, 2019.
117 NS Energy, Who were the world's top five wind turbine manufacturers in 2018? 2019.

This Canadian advantage suggests that optimal economic and environmental benefits could be achieved if Canada developed its other clean energy resources. This subsection examines the nature and potential of developing Canada's low-emitting hydro, nuclear, and biomass energy assets.

3.6.3.1 Hydroelectricity Assets

In Canada, the word "hydro" has become synonymous with the word "electricity" because of the country's vast existing hydroelectric generation assets. The untapped potential for development that exists across Canada is shown in Figure 59.

Figure 59: Canadian Hydro Capacity and Potential
(MW)



Source: Waterpower Canada. Website.

While the country's hydroelectric potential may appear large, the remaining resources are remote, expensive to develop, and not environmentally benign due to flooding implications. The large new developments required to meet the demand for electrification would be on the scale of Quebec's James Bay project, which flooded 11,500 square kilometers of land.[118] Several projects of similar scale would be required to meet this new demand.

Stakeholder acceptance is a major challenge for today's hydroelectric projects due to the land required for the reservoirs; flooding; impacts on aquatic and terrestrial communities, existing economic activities, and communities in the affected area; and, the rights of Indigenous peoples.

Hydroelectric development stakeholder challenges are not unique to Canada. There is significant opposition to new international large-scale hydroelectric projects currently being developed such as those indicated in Figure 60.

[118] The Canadian Encyclopedia, James Bay Project, January 31, 2011.

Figure 60: Global Hydropower Megaprojects

China has the most installed hydro capacity in the world, at 350 GW. It has built some of the world's largest hydroelectric projects, and is currently constructing a series of dams on the Mekong river.

Ethiopia is currently building Africa's largest dam on the Nile River, the Grand Ethiopian Renaissance Dam. When complete, it will have a capacity pf 6 GW, and will produce 15 TWh of electricity per year. Its reservoir will have a volume of 10.4 million cubic meters.

Sources: Salini Impreglio, IHA

Even given these negatives, it is possible to improve the efficiency of both new and existing hydro capacity in Canada. These impacts can potentially be mitigated by the way the water for the existing or new development is managed. For instance, projects can maximize water flow and availability and account for the upstream and downstream needs of other users. Annual and long-term precipitation – rain and snow – are two other important factors to be considered.

Reservoirs are required for hydroelectric facilities in order to match the availability of water to the demand for electricity. Figure 61 shows how precipitation levels vary in Quebec. Considering that Quebec's demand for electricity is much higher in the winter than in the spring and fall, the need to store the water so it can be used when needed is evident.

The location of the reservoir, the hydroelectric generating station, and upstream and downstream control dams can be managed to help reduce flooding. B.C.'s Site C dam is being sited downstream of the 177,300-hectare W.A.C. Bennett dam, as shown in Figure 62. The Site C dam will produce 35% of the Bennett dam's hydroelectricity output while only adding 5% of its reservoir area.[119] Ontario's Lower Matagami project, Quebec's La Romaine project, and China's multiple dams on the Mekong river follow a similar pattern.[120]

Leveraging these efficiency benefits can enable Canada's existing hydroelectric assets and new development to meet the demand required for the energy transition to lower emission resources. However, even if most of Canada's technically and economically feasible remaining hydropower

[119] Site C Clean Energy Project. Website.
[120] Hydro Quebec, Romaine Project. Website.

Figure 61: Average Hydrograph for Quebec Hydroelectric Dams over 30 Years

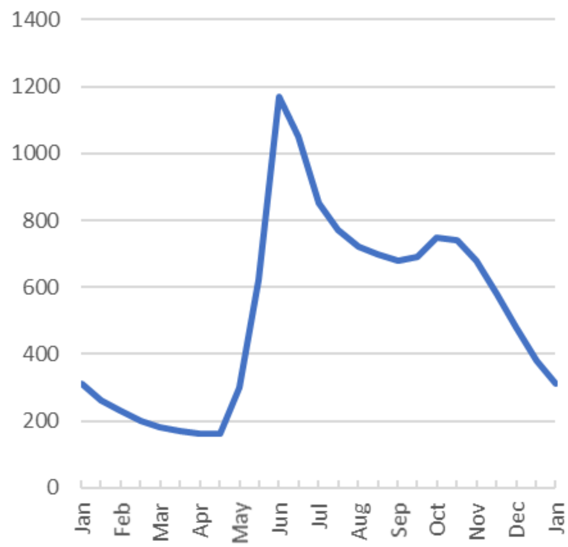
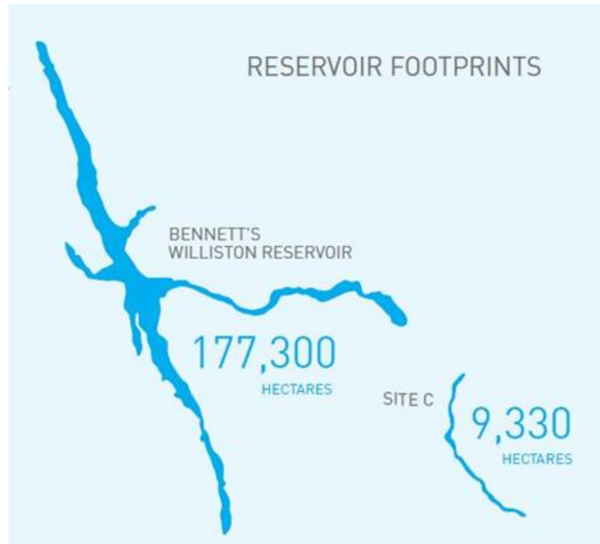


Figure 62: Site C and W.A.C. Bennet Reservoir Footprints



Sources: Vescovi et al. Water and Climate Change in Quebec, 2009; Site C Clean Energy Project. Website.

potential is leveraged, it will be insufficient to meet the electrification needs of the transition.[121] Additional low emission resource options will be required.

3.6.3.2 Biomass Assets

Biomass comes from organic materials sourced from both the forestry and agricultural sectors, either as waste materials like wood slash, or purpose-grown crops such as phragmites grass. Canada has vast amounts of available renewable biomass across the country. Canada's boreal forest, as shown in Figure 63, is logged to make lumber and other products.

Biomass is considered to be carbon neutral if harvested sustainably in accordance with existing international standards. While there is some existing use in Canada, biomass is used extensively in Europe and Asia to generate electricity and heat (as compressed pellets or in an unprocessed form). Scandinavia has developed a world-leading integrated bioeconomy, which has enhanced its energy security by reducing reliance on imported fossil fuels, reduced carbon emissions, and created new jobs and innovations for export. This includes the integration of municipal waste streams in the supply chain for use in combined heat and power plants.[122]

Sweden's increased use of bioenergy between 1990 and 2015 is the primary reason the country was able to decrease its GHG emissions by 25% while increasing gross domestic product by 75%.[123] During the last 100 years, Sweden has used improved forest management practices successfully increasing

[121] Government of Canada, Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy, 2016; Strapolec Analysis as shown in Figure 58.
[122] Svebio, The Bioenergy Landscape in Sweden, 2019.
[123] Government Offices of Sweden, Sweden's Seventh National Communication on Climate Change, 2017.

forest growth, harvesting, and standing stock despite using more biomass for energy.[124] In 2017, biopower was the country's fourth-largest power source at 7.3%—half for district heating and the other half for the pulp industry.[125]

A report by the Pembina Institute indicated that Ontario has sufficient, readily available biomass wastes that can be leveraged from the province's forestry sector alone.[126] These logging residues would make up 88% of a potential biomass supply mix, which can be supplemented by residues from sawmills.

Utilizing Canada's biomass resources offers several significant benefits for the economy and the environment. At the local/regional level, investments in biomass-fuelled combined heat and powerplants can create jobs and economic growth in the agriculture and forestry-harvesting, trucking, manufacturing sectors; kickstart new businesses in district heating; and, bring social and environmental benefits for northern Indigenous communities. Biomass-generated electricity is also a dispatchable energy resource that can respond to consumer demands. Processing the biomass into pellet form or other biomass-based fuels would also create local jobs, and enable greater Canadian participation in the growing global energy markets for these products.

Figure 63: Canada's Boreal Forest

Source: NRCan, Boreal Forest. Website.

The Pembina Institute found that Ontario's biomass resources have the potential to supply 3.4 TWh of electricity annually to communities in the northern part of the province. While this would make a relatively small contribution to Ontario's overall need, it is not small for the affected communities. It would displace the use of fossil fuels and provide regional energy security.

[124] Svebio, About Bioenergy, n.d.
[125] Svebio, The Bioenergy Landscape in Sweden, 2019.
[126] Pembina Institute and OPG, Biomass Sustainability Analysis, 2011.

3.6.3.3 Nuclear

Canada pioneered the development of one of the world's first nuclear power reactors, the CANDU. The rights to the CANDU reactor technology are owned by Atomic Energy of Canada Limited, a crown corporation, and are licensed to a Canadian company, SNC Lavalin.

Canada has four operating CANDU nuclear-generating stations, three of which are in Ontario and one is in New Brunswick. [127] Many of these facilities were built several decades ago, but decisions have been made to refurbish this fleet to secure long-term, reliable, low carbon electricity for the future. Ontario's Bruce Nuclear Generating Station is Canada's largest nuclear facility with eight reactors and an installed capacity of 6,323 MW.[128] The Bruce station's operating license was recently extended to 2028, guaranteeing the medium-term life of the plant. Ontario's second facility, Darlington Nuclear Generating Station is also undergoing refurbishment extending its life by 30 years to 2055.[129] By contrast, the six reactors operating at Ontario's Pickering Nuclear Generating Station are scheduled to close by 2025. The Point Lepreau nuclear generation station in New Brunswick underwent a refurbishment 10 years ago.

Table 2: Canada's Nuclear Power Plants

Plant Name	Location	Capacity (MW)	Licenses Expire	Reactor Status
Bruce A and B	Ontario	6,232	2028	8 Operating
Pickering	Ontario	3,100	2024	6 Operating
Darlington	Ontario	3,512	2025	4 Operating
Point Lepreau	New Brunswick	705 MWe	2022	1 reactor operating

Table data source: Canadian Nuclear Safety Commission. Website.

Today, Canada's nuclear industry generates over $6 billion a year in revenues and directly and indirectly supports around 60,000 Canadian jobs including in areas such as uranium mining, fuel manufacturing, research, and operations.[130] Canada's nuclear industry is underpinned by a robust, comprehensive, regulated, and well-financed "cradle to grave" waste management plan.[131]

The strong Canadian content in this extensive nuclear supply chain means that investments in nuclear yield substantial domestic economic benefits. According to a Conference Board of Canada study,

[127] Canadian Nuclear Safety Commission. Website.
[128] Bruce Power. Website.
[129] Canadian Nuclear Safety Commission. Website.
[130] Canadian Nuclear Association. Website.
[131] Canadian Nuclear Safety Commission, Waste Management, n.d. Website.

Ontario's $12 billion refurbishment of the Darlington Station and the thirty plus years of operation following the project will deliver $89.9 billion economic benefits.[132]

However, despite these benefits, public acceptance remains a challenge. Concerns include the risk of accidents, the long-term storage of nuclear waste, and international weapons proliferation. For example, a poll by Innovative Research Group conducted after the Fukushima nuclear disaster found that 53% of Canadians were opposed to nuclear in some way, while only 37% were supportive.[133] However, a 2019 survey of Ontarians found that over 70% agreed that nuclear provided benefits to Ontario and Canada as a whole, while 80% supported extending the life of the existing Bruce nuclear facility.[134]

Canada has licensed nuclear sites in Ontario and New Brunswick that could accommodate new nuclear facilities, opening the possibility of further development for the traditional nuclear industry.[135] Canada is a member of the Clean Energy Ministerial (CEM), a forum of federal energy ministers from 25 of the world's leading economies who convene to promote policies and programs that advance clean energy technologies.[136] Canada has been promoting the recognition by the CEM of nuclear as a clean energy technology.[137]

3.6.3.3.1 Small Modular Reactors (SMRs)

SMRs hold much promise, both as a low-carbon energy source and a potential expansion of Canada's existing nuclear industry. Canada is pursuing the development of SMR technology. A Canadian SMR Roadmap was released in 2018 providing recommendations for governments, utilities, and industries supporting the development of this technology.[138] Natural Resource Canada convened a diverse group of stakeholders to develop the Roadmap including regulators, Provinces and Territories, power utilities, Northern and Indigenous communities, and heavy industries. A noteworthy recommendation was to commit to proactively engaging the public and Indigenous groups in the SMR dialogue.

SMRs are advanced nuclear reactors, with passive inherent safety features that differ from conventional large nuclear plants in several ways. Designs vary widely in size and output, with some small enough to fit on a truck. Models can range from 2 MW to 300 MW per unit. They can be located on small grids, at the edge of the grid, or in off-grid locations where power needs are small, such as in isolated communities and industries.[139] They offer significant flexibility as some can be configured to produce heat and/or electricity. SMRs can serve a wide variety of potential applications such as hydrogen production.

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[132] Conference Board of Canada, 2015.
[133] Innovative Research Group, 2012.
[134] Bruce Power, The Ontario Energy Report, 2019.
[135] Canadian Nuclear Safety Commission, Nuclear Licensees Across Canada, n.d.
[136] Clean Energy Ministerial. Website.
[137] Clean Energy Ministerial, NICE Future. Website.
[138] Canadian Small Modular Reactor Roadmap Steering Committee, Canadian SMR Roadmap, 2018.
[139] Canadian Small Modular Reactor Roadmap Steering Committee, Canadian SMR Roadmap, 2018.

The Canadian Nuclear Safety Commission (CNSC), Canada's Nuclear Laboratories (CNL) at Chalk River, Ontario, and Atomic Energy Canada Limited (AECL) are actively involved in the development of this technology. Several SMR vendor designs are currently in various stages of the CNSC's pre-licensing process, and CNL is working with utilities and vendors on several demonstration projects.[140,141]

Today, provincial governments across Canada are showing increased interest and support for SMR technology. In late 2019, the Premiers of Ontario, Saskatchewan, and New Brunswick announced an agreement to collaborate on developing SMRs.[142] Saskatchewan's growth plan for 2020-30 includes support for SMRs, including the province having an operational SMR in place by the mid-2030s.[143]

3.6.3.3.2 Nuclear Energy Economies of Scale

Benefits from nuclear projects can vary due to economies of scale. While SMR economics are largely predicated on having a large order of small units that can be manufactured in a factory setting, conventional nuclear plants gain scale efficiencies simply by virtue of the volume of electricity a facility is capable of producing.

Multi-unit conventional nuclear plants can have 27% lower costs than single-unit plants, as shown in Table 3.[144] These efficiency gains arise from co-locating common resources at one location and centralizing procurement from a capable supply chain that is sustained by volume.

Table 3: Cost Summary of U.S. Nuclear Plants, 2017

Category	Number of Plants/Sites	Cost ($/MWh)			
		Capital	Fuel	Operating	Total Operating
All U.S.	60	$6.64	$6.44	$20.43	$26.86
Plant Size					
Single Unit	24	$8.92	$6.42	$27.32	$33.74
Multi-Unit	36	$5.99	$6.44	$18.46	$24.90
Operator					
One Plant	12	$7.39	$6.79	$21.02	$27.82
Multiple Plants	48	$6.43	$6.33	$20.26	$26.59

Source: Data from Electric Utility Cost Group in NEI, Nuclear Costs in Context, 2018.

Scale is still an important factor for SMRs, even though their scale is "small". Analyses indicate that mass-producing SMRs on a manufacturing "assembly line" could deliver cost efficiencies. By concentrating skills in one manufacturing facility, SMR manufacturers can make more productive use of

140 Canadian Small Modular Reactor Roadmap Steering Committee, Canadian SMR Roadmap, 2018.
141 CNSC, Pre-Licensing Vendor Design Review, n.d. Website.
142 CBC, Group Of Premiers Band Together To Develop Nuclear Reactor Technology, December 1, 2019.
143 World Nuclear News, Saskatchewan Includes SMRs In Growth Plan, 15 November, 2019.
144 Data from Electric Utility Cost Group in NEI, Nuclear Costs in Context, 2018.

highly skilled labor and can enjoy the efficiency improvements from learning rates across each unit produced.[145]

Given Canada's advanced capabilities in nuclear power technologies, large-scale deployment of either conventional nuclear or SMRs should result in low-carbon electricity at low costs.

3.6.4 Decarbonizing the Oil Sands

As the oil sands account for a significant portion of Canada's emissions, it is critical to address those emissions if the national reduction targets are to be met. This subsection examines the energy demands of the oil sands and shows how these needs could potentially be met by low-carbon energy from SMRs. By leveraging low-emitting alternatives, much of the emissions output from oil sands operations could potentially be eliminated.

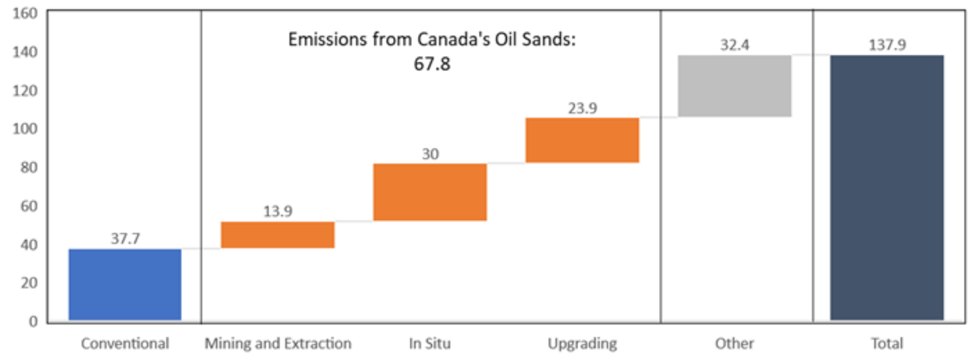
The emissions generated from oil sands operations are affected by the type of process used to extract the bitumen. There are two methods: extraction via surface mining which is relatively carbon-efficient; and the more common in situ methods, such as steam-assisted gravity drainage (SAGD), which requires energy-intensive steam generation and pumping.[146] The bitumen produced is also unsuitable for conventional refining, and requires further "upgrading" to produce synthetic crude oil (SCO), a process that requires additional energy in the form of heat and electricity. One common upgrading process, hydrocracking, requires large volumes of hydrogen currently produced from natural gas.[147]

The energy for these processes is derived from fossil fuels, using either natural gas on-site or electricity imported from Alberta's coal and natural gas-based grid.[148] This results in a very carbon-intensive product. In situ extraction and bitumen upgrading are responsible for half of the direct emissions from Canada's oil sector, as shown in Figure 64.

[145] Robert Rosner & Stephen Goldberg, Small Modular Reactors – Key to Future Nuclear Power Generation in the U.S. The University of Chicago, 2011.
[146] Nimana et. al., Energy consumption and greenhouse gas emissions in the recovery and extraction of crude bitumen from Canada's oil sands, 2015.
[147] Nimana et. al., Energy consumption and greenhouse gas emissions in upgrading and refining of Canada's oil sands products, 2015.
[148] Nimana et. al., Energy consumption and greenhouse gas emissions in the recovery and extraction of crude bitumen from Canada's oil sands, 2015.

Figure 64: Emissions from Canada's Oil Sector, 2014

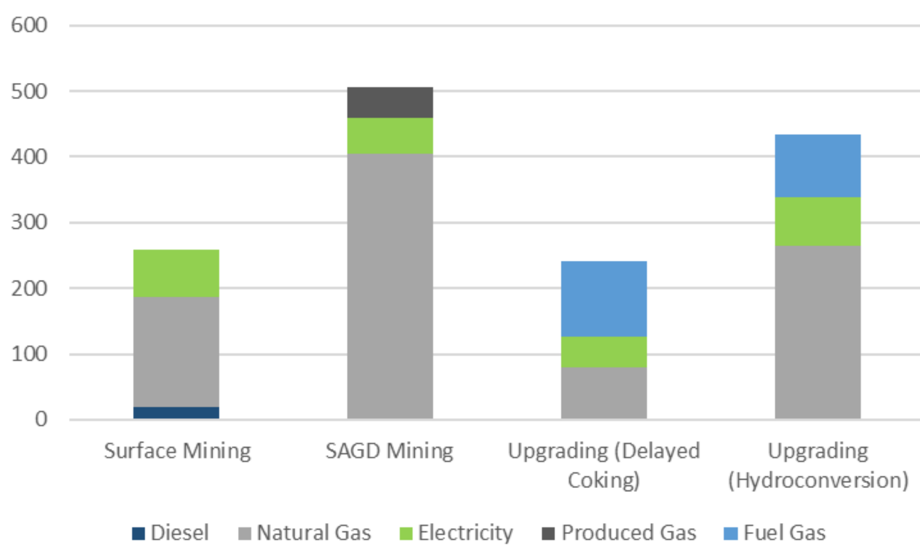
($Mt\ CO_2$ eq)



Source: Environment and Climate Change Canada. Greenhouse gas emissions, 2019. Note: the "Other" category may include indirect emissions from natural gas production.

For the oil sands operations, the emissions in each area result from the use of natural gas, electricity, and diesel for transportation as summarized in Figure 65. The upgrading process also makes use of fuel gasses produced during the process.

Figure 65: Emissions from Energy Inputs in Bitumen Mining and Upgrading



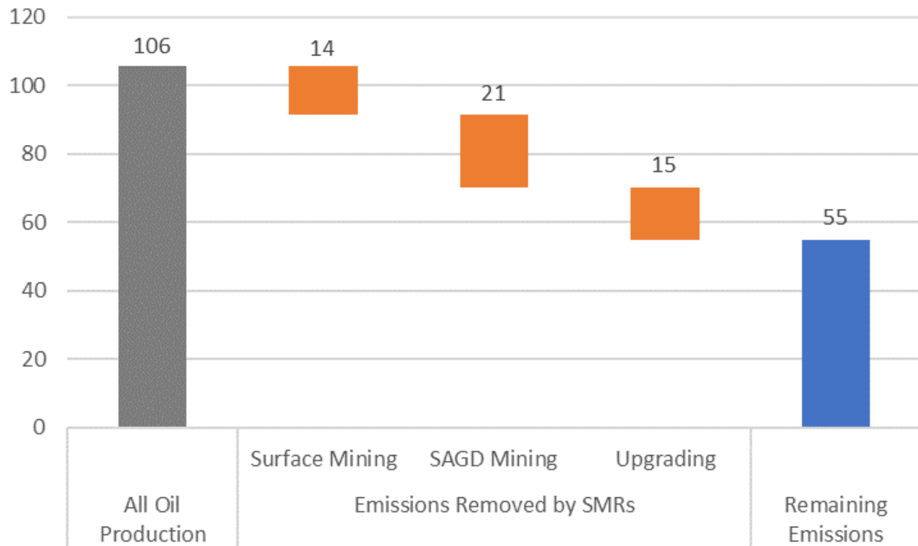
Sources: Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in The Recovery and Extraction of Crude Bitumen from Canada's Oil Sands, 2015; Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in Upgrading and Refining of Canada's Oil Sands Products, 2015.

As discussed earlier, SMRs provide flexible heat and electricity outputs. These could displace much of the use of all fossil fuels in oil sands mining, extraction, and upgrading. On-site generation of heat, steam, hydrogen, and electricity could displace the use of natural gas, and electricity and hydrogen could also be used to displace diesel fuel by powering a fleet of electric or hydrogen-powered vehicles.

Displacing the use of all fossil fuels in oil sands mining, extraction, and upgrading could reduce emissions from oil sands production by as much as 75%. This could reduce emissions from Canada's overall oil production by 48% as shown in Figure 66.

Figure 66: Emissions Reductions in Oil Production Achievable with SMRs

(In g CO_2 eq/MJ)



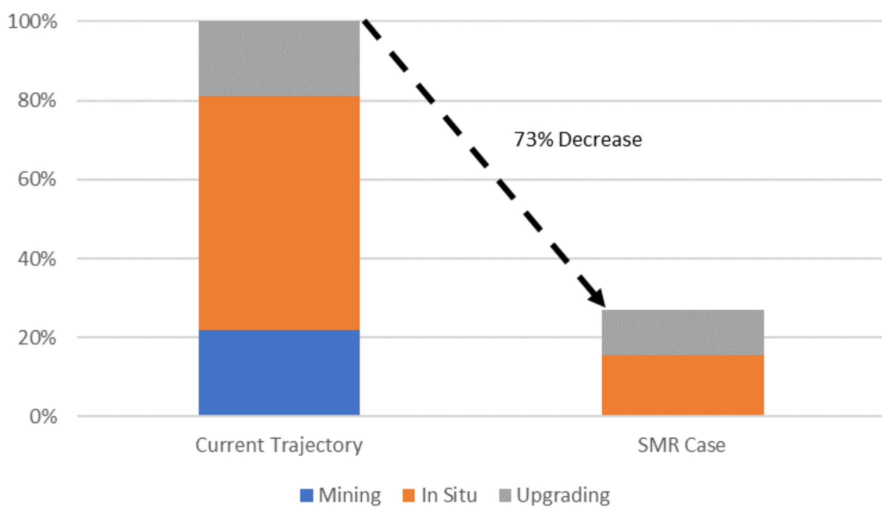
Sources: Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in The Recovery and Extraction of Crude Bitumen from Canada's Oil Sands, 2015; Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in Upgrading and Refining of Canada's Oil Sands Products, 2015; Masnadi et. al., Global carbon intensity of crude oil production, 2018.; CER, Canada's Energy Futures 2019, 2019; Strapolec Analysis. Note that numbers are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

Oil sands production is projected to increase out to 2030, resulting in a corresponding increase in emissions. Projections show that emissions from the oil sands will surpass 100 MT/year by 2030.[149] However, if SMRs were deployed at all oil sands extraction and upgrading sites, annual emissions could be reduced by approximately 73% by 2030, as shown in Figure 67.[150]

[149] Canada's Energy Future, 2019

[150] Strapolec Analysis, based on: Nimana et. al., Energy consumption and greenhouse gas emissions in upgrading and refining of Canada's oil sands products, 2015; Nimana et. al., Energy consumption and greenhouse gas emissions in the recovery and extraction of crude bitumen from Canada's oil sands, 2015; and CER, Canada's Energy Future 2019, 2019.

Figure 67: Oil Sands Emissions in 2030 – Current Trajectory vs. SMR Case
(% of total emissions)



Sources: Sources: *Nimana et. al., 2015; Nimana et. al., 2015; Masnadi et al, 2018; CER, Canada's Energy Futures 2019, 2019; Strapolec Analysis*

This improvement in emissions intensity would reduce the oil sector's emissions by 69 MT annually, almost closing the gap with Canada's 2030 emission targets identified in the Additional Measures Case in Figure 56.

3.6.5 Summary of Electrification Opportunities

For Canada to meet its international climate change commitments, domestic emissions must be urgently reduced. Today, Canada's geography, climate, and economy make it reliant on emitting energy sources to heat buildings, provide transportation, support industry, and extract resources in the mining and oil sands sectors. Recent technological trends and advances make electrification of these sectors possible and represent an opportunity for Canada to decarbonize its economy. Supporting this transition will require building new sources of clean energy generation, which are available in the form of Canada's hydro, nuclear, and biomass advantages. Given Canada's low carbon energy resources and expertise, realizing these outcomes is within reach, particularly for the future export of emission-reduced oil production from the oil sands.

3.7 Summary of Canada's Clean Energy Assets

Canada is a global leader in the production and export of zero-emissions electricity, natural gas, crude oil, and uranium as shown in Figure 68 and Figure 69.

Figure 68: Canada's Share of Global Energy Resources, 2018

(% share of Global Production and Reserves; with global rankings)

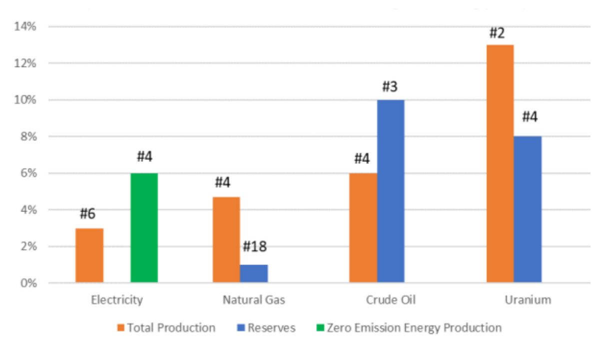
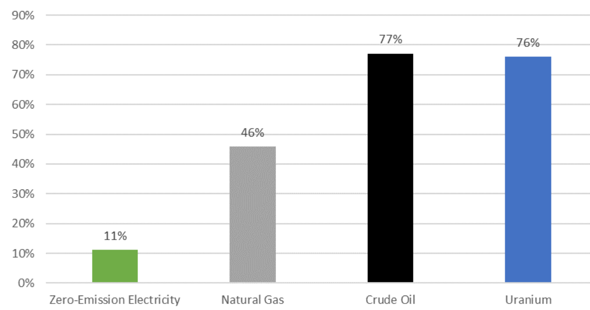


Figure 69: Percentage of Canada's Energy Production Exported, 2018

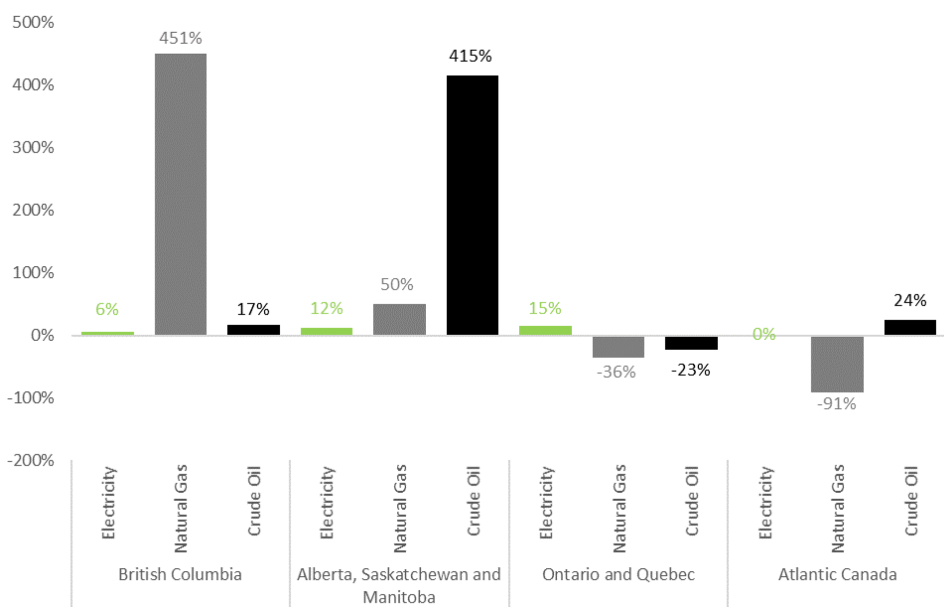
(Exports as % of Production)



Sources: Figure 68: NRCan, Energy Facts; CER, Canada's Energy Future 2019, 2019; Enerdata, Website; World Bank, World Development Indicators. Note: Clean Energy Production based on 2015 data. Figure 69: CER, Canada's Energy Future 2019, 2019; NRCan, Energy Facts. Website.

Canada's energy assets are a story of regional diversity. Each region has different energy import and export characteristics as shown in Figure 70. Each region thus has different interests when it comes to developing Canada's energy assets. Natural resources dominate the conversation in the west, electricity is the focus of attention in the east, and energy security concerns arise as domestic reserves are exhausted and out-of-country energy imports increase.

Figure 70: Canada's Regional Net Energy Exports as a Percentage of Consumption, 2018



Sources: CER, Canada's Energy Future 2019, 2019. Statistics Canada, Commodity Statistics, Website. Note: Uranium not shown because Saskatchewan is the only producer and does not consume it locally but either exports it or supplies it to fuel Ontario's and New Brunswick's nuclear power reactors, as well as research reactors across the country.

Canada is the world's 9th largest emitter of greenhouse gases, primally as a result of its role as a globally significant source of the energy resources needed around the world. Canada has committed to reducing emissions in support of the global fight against climate change by signing the Paris Agreement.

Nevertheless, like the rest of the world, Canada's economy relies on emission-intensive energy resources to heat buildings, fuel transportation, enable industry, and help with the extraction and processing of minerals and fossil fuels. Recent trends and advances in technology have made electrification of these sectors possible, presenting an opportunity for Canada to decarbonize its economy and the export of its energy resources, such as in oil sands production.

Electrification of the economy requires developing and leveraging sources of low carbon electricity generation, including Canada's domestic, regionally diverse hydro, nuclear, and biomass advantages. Developing these domestic assets offers several benefits for Canadians:

- Investing in Canada's domestic energy assets keeps the "energy" dollars at home;
- Domestic control over Canada's energy inputs and the development of "home-grown" technologies enhances Canada's energy security and innovation capability;
- Canada's low-cost electricity provides a competitive advantage for Canadian businesses and industries and may enable exports of clean energy and technologies to the U.S; and,
- Reducing the domestic consumption of fossil fuels will free up Canadian-produced oil and gas for export. This increased exportable supply could make it more attractive to invest in the infrastructure to enable access to foreign markets.

The success of any plan to develop Canada's potential energy resources will be a function of foreign market demands and the ability to expand the delivery infrastructure to supply those markets. The existing infrastructure system reflects Canada's dependence on the U.S. for both its exports and imports of energy and the U.S.'s similar dependence on Canada. Canada's own energy security and the ability to provide energy resources to the world requires diversification of existing extraction, generation, and delivery infrastructure.

Subsequent sections of this report explore the export market potential for all types of Canada's clean energy and the challenges of developing them.

4 Electricity, Gas, and Oil from Canada Can Serve Global Needs

This section explores Canada's opportunities to increase exports of low emission energy resources to its largest trading partners: the U.S., China, and the European Union. The U.S. is currently the primary export market for Canadian carbon-free electricity and is also a major consumer of Canada's natural gas and oil. China and the EU currently import modest amounts of Canadian oil. However, going forward both jurisdictions will need more oil and natural gas to support economic growth and improve their energy security. In this section, current sources of supply and projected demand growth for each jurisdiction is reviewed in the context of how Canada could increase its role as their energy supplier.

With its extensive electricity, natural gas and oil resources, good reputation, and favourable geographic position, Canada is well-placed to serve the energy needs of its largest trading partners. The demand for Canada's energy in these markets is underpinned by three common drivers: (1) growing energy needs; (2) the need to decarbonize their economies; and, (3) energy security.

1. **Growing energy needs:** These markets have the largest economies with associated high energy needs, that are forecasted to grow.

2. **The need to decarbonize:** To reduce the impacts of climate change, the U.S., China, and the EU all need to reduce their emissions of carbon and other pollutants from their energy consumption. All three must reduce their consumption of coal with the option of choice being switching to natural gas and clean electricity sources, and this latter option is important to Canada's trade with the U.S.

3. **Energy security:** The U.S., China, and the EU all have energy security concerns. The U.S. Midwest relies on Canada for 60% of its crude oil.[151] China's oil imports flow through sensitive geographic choke points in South East Asia. The EU relies on Russia for its oil and gas and this dependence is seen as a security threat.[152] Among global energy suppliers, Canada is an attractive supplier from an energy security perspective.

How these factors relate to each of Canada's major trading partners and the role Canada can help to address them are described in turn.

4.1 The U.S. Need for Canadian Energy

Currently, the U.S represents the market for 89% of Canada's energy resources exports by value – primarily electricity, natural gas, and oil.[153] Driven by climate change and energy security concerns, the U.S. demand for these resources is growing. The global imperative to address climate change will eventually cause the U.S. to decarbonize its energy use in the decades to come. This section examines Canada's role in supporting the decarbonization of U.S. electricity, natural gas, and oil consumption.

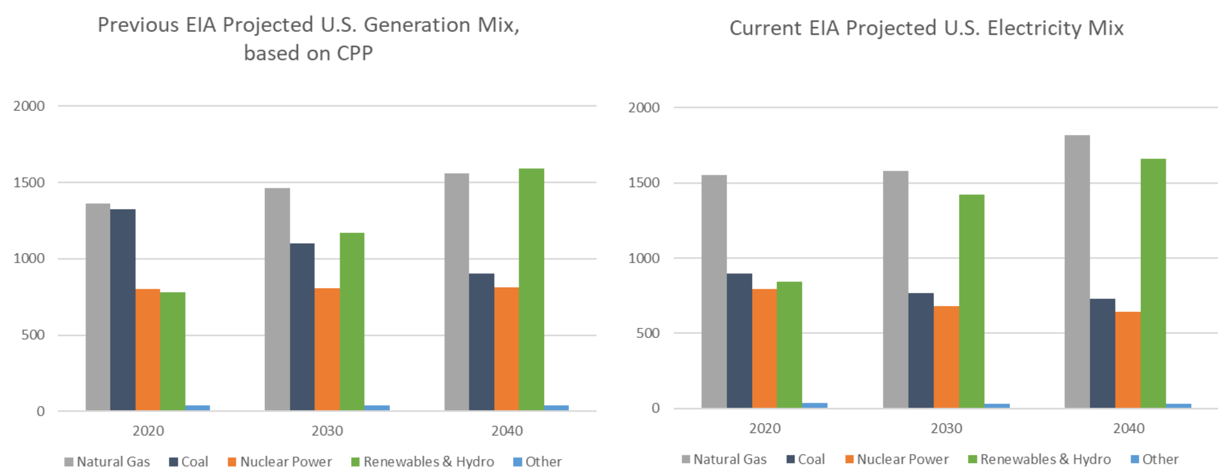
[151] Oil Sands Magazine, Differentials Explained: Why Alberta Crude Sells At A Deep Discount, 2018.
[152] Forbes, Trump Imposes Sanctions to Stop Nord Stream 2 – But It's Too Late, 2019.
[153] Government of Canada, Energy and the Economy, 2020.

4.1.1 The U.S. Needs Clean Electricity

Driven by an objective to reduce emissions, the Obama Administration put forward a Clean Power Plan (CPP) that established one pathway of decarbonization for the electricity sector. It forecasted declining coal use out to 2040, with renewables and natural gas both filling the gap to satisfy the electricity demand. It has also underpinned a need for more natural gas in the U.S. Notably however, coal was still projected to remain a major fuel source for electricity.[154] The CPP has been repealed by the Trump administration, and no policy has been created to take its place. However, sub-national governments in the U.S. are pursuing the adoption of clean energy to reduce emissions.

The U.S. Energy Information Agency (EIA) provides a reference case projection for the country's electricity sector that shows a declining use of coal, and its replacement by renewables and natural gas, as shown in Figure 71 in contrast with the CPP.[155] Interestingly, the current EIA projection forecasts a greater displacement of coal by natural gas than the CPP had.

Figure 71: EIA Projected and Current United States Energy Mix
(TWh/year)



Sources: EIA: Analysis of the Impacts of the CPP, 2015, extended CPP scenario; EIA, Annual Energy Outlook 2020, 2020. Note that figures are forecasts.

This subsection examines the potential opportunities for increased exports of low-carbon Canadian electricity to neighbouring U.S. states that may be enabled by initiatives within those jurisdictions to decarbonize their economies. It will also describe how conditions for renewables within the Northeast region may have a major impact on their ability to supply low-carbon electricity. The subsection concludes with an examination of the prospects for increased exports of Canadian low-carbon electricity.

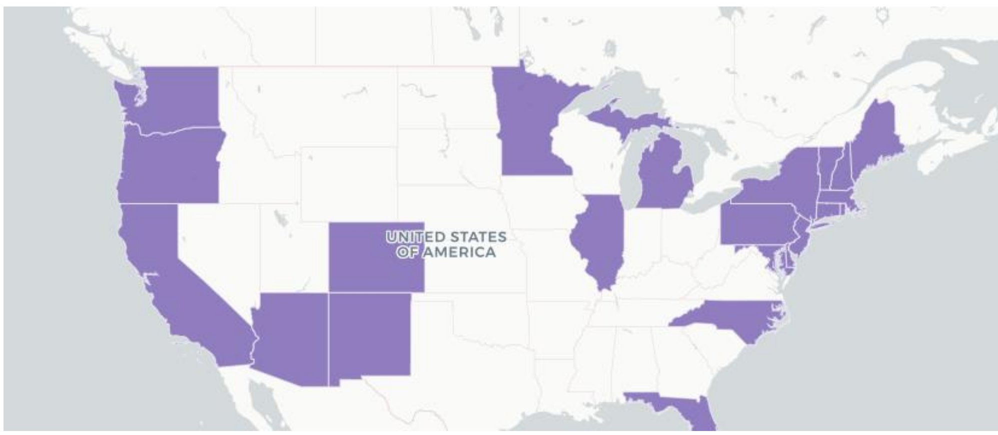
[154] EIA, Analysis of the Impacts of the Clean Power Plan, 2015.
[155] EIA, Annual Energy Outlook 2020, 2020

4.1.1.1 The Regional Nature of U.S. Clean Electricity Demand

The aforenoted EIA forecast indicated growth in natural gas generation and the declining use of nuclear power. Near-term options in the U.S. are being driven by the low cost of natural gas and minimal public support for nuclear.[156,157] Policymakers in the U.S. recognize that fuel-switching to natural gas is a beneficial option for decarbonizing the economy and that a longer-term ability to decarbonize its economy cannot be achieved without nuclear energy. U.S. states are pursuing different policies and goals for decarbonization with many implementing emission reduction targets as shown in Figure 72.[158]

Conveniently, most of the U.S. states with aggressive emission targets border Canada: Washington State, Minnesota, Michigan, and many states in the Northeast region. The remaining Northeast states, Oregon, California, and Indiana are connected to Canada's electricity grid. [159, 160, 161]

Figure 72: States with Emissions Reduction Targets



Source: C2ES. Website.

The Northeast states rely on natural gas and some coal generation for their electricity, with the supply mix expected to change as shown in Figure 73. Actions are underway to transition the current coal fleet: 5.2 GW of generation are being retired and another 5 GW is possible. Current forecasts indicate that renewables will form a large part of the supply. These states consider electrification as a way to achieve their climate goals, which will increase the demand for low-carbon electricity overall.[162]

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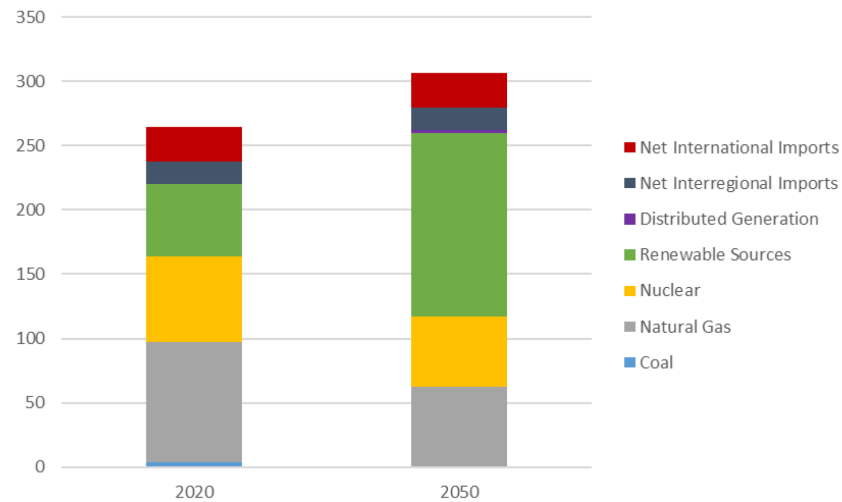
[156] IEA, The Role of Gas in Today's Energy Transitions, 2019.
[157] World Nuclear News, US Public Opinion Evenly Split on Nuclear, April 2019.
[158] C2ES, U.S. State Greenhouse Gas Emissions Targets, 2019.
[159] C2ES, U.S. State Greenhouse Gas Emissions Targets, 2019.
[160] MISO. Website.
[161] Seventy-nine per cent of B.C.'s electricity was exported to California in 2016. See CER, Market Snapshot: Electricity exports from B.C. to California are increasing, 2017.
[162] E.g., the NEEP Action Plan to Accelerate Strategic Electrification in the Northeast, 2018; Williams et. al, Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec, 2018.

Figure 73: Generation Mix in the U.S. Northeast, 2020 and 2050
(TWh/year)

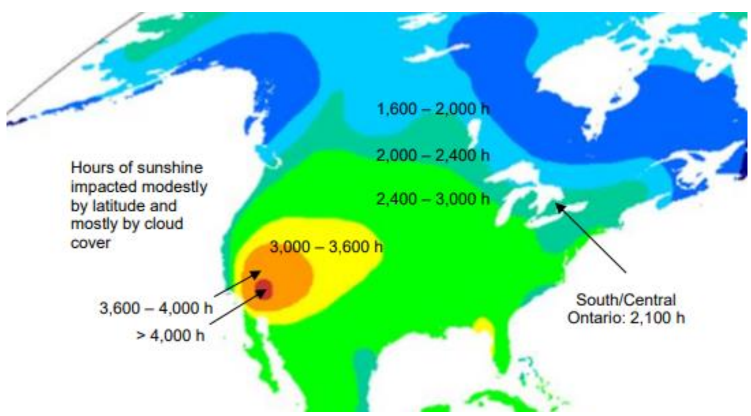


Source: EIA, Annual Energy Outlook 2020, 2020. Note that 2020 figures are EIA forecasts and not actuals.

4.1.1.2 The Renewables Conundrum in The Northeast

The economics of wind and solar energy in the Northeast and Great Lakes states present a unique challenge that enhances the attractiveness of electricity exports from Canada. Weather pattern characteristics render onshore wind generation less economic compared to other parts of the U.S. The latitudinal location of these states also makes solar generation uneconomic as they experience less than half the available hours of sunlight than Arizona for example, as shown in Figure 74.[163]

Figure 74: Annual Hours of Sunshine Across North America



Source: Strapolec, Renewables-Based Distributed Energy Resources in Ontario, 2018.

Furthermore, cloud cover variations that reduce available sunshine also cause intermittency of these resources which generally requires back up from natural gas-fired generation, adding additional costs.[164]

[163]Strapolec, Ontario's Emissions and the Long-Term Energy Plan. Phase 1 - Understanding the Challenge, 2016.
[164] Strapolec, Renewables DER in Ontario – Cost & Implications Assessment, 2018.

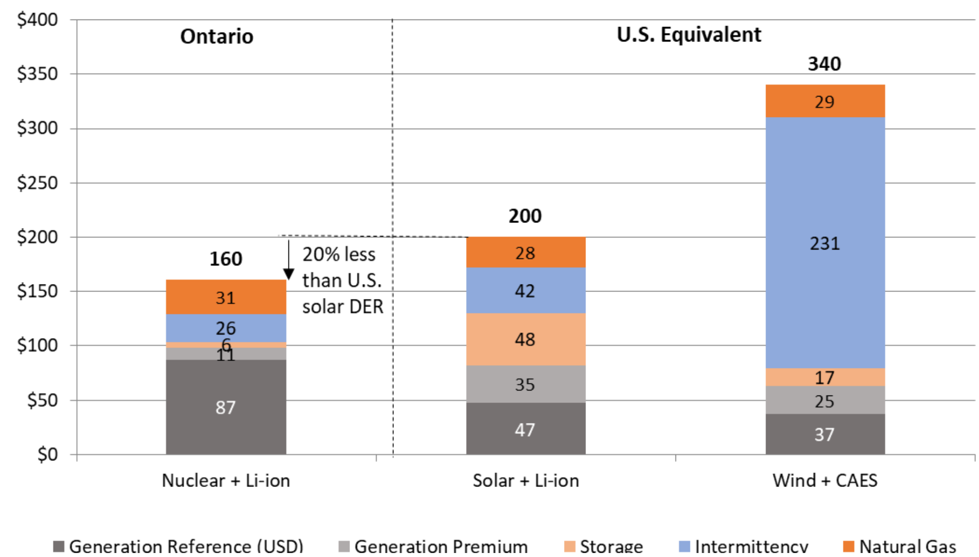
4.1.1.3 U.S. States Could Look to Canada For Low-cost Clean Electricity

The Northeast states are actively seeking to secure more electricity exports from Canada. Hydro-Quebec and New Brunswick Power have submitted bids in response to several transmission project procurements from states in the region.[165] A study of the future electricity needs in New England makes a strong case for additional supplies of hydroelectricity from Quebec.[166]

Canadian electricity exports could also be attractive from a cost perspective. The results of an analysis of the costs to displace natural gas-fired generation in Ontario and neighbouring U.S. states with distributed energy storage, renewables, and nuclear are shown in Figure 75. Imports of Canadian electricity would be 20% less expensive for the U.S. compared to investments in more renewables with storage to address their inherent intermittency limitations.[167] Low-cost hydropower from Quebec, British Columbia, and Manitoba could provide equally advantageous low-cost options for U.S. imports. The U.S. would need 332 TWh of electricity to replace just the coal-fired generation in regions bordering Canada, providing a large market for Canadian clean electricity.[168]

Figure 75: Ontario vs. U.S. DER LCOE Contributions, 2030

(CAD/MWh)



Source: Strapolec: Renewables-Based Distributed Energy Resources in Ontario, 2018. CAES = Compressed Air Energy Storage, Li-Ion = Lithium Ion batteries.

4.1.2 Natural Gas Demand by the U.S.

The demand for natural gas in the U.S. is expected to grow by almost 9% in the next 20 years. Much of this stems from U.S. electricity demand and the replacement of coal-fired generation.[169] Canada is

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[165] House of Commons, Strategic Electricity Interties, 2017.
[166] Williams et. al., Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec, 2018.
[167] Strapolec, Renewables DER in Ontario – Cost & Implications Assessment, 2018.
[168] EIA, Annual Energy Outlook 2020, 2020.
[169] EIA, Annual Energy Outlook 2020, 2020.

expected to increase its natural gas exports to the U.S. by 24 bcm/year between 2025 and 2040.[170] Canada could help meet more of this increased U.S. demand with additional natural gas exports, though the actual amount it supplies would be dependent on price conditions.

4.1.3 U.S. Oil Supply

The U.S. has a well-established need for Canadian oil. In the U.S. Midwest, Canada accounts for 99% of all foreign oil imports, and Canadian crude forms 60% of all feedstock in the region.[171] These imports provide energy security for the Midwest which is landlocked, limiting its access to foreign markets.

Infrastructure investments to support access to Canadian oil are taking place. Keystone XL is a pathway to get Canadian oil to the gulf coast and help the U.S. reduce its imports from Mexico, Iraq, Saudi Arabia, and Venezuela.[172] Investments in Enbridge line 3 are to shore up the reliability of this supply. These pipelines represent a 51% growth in U.S. oil import capacity from Canada.[173]

4.2 China Wants A Safe, Secure and Diverse Oil and Gas Supply

Today, China has the highest demand for energy in the world and, as a result, has developed a diverse global sourcing strategy for meeting its energy needs.[174] Since Canada is a stable, secure supplier of oil and natural gas, it represents an attractive opportunity for China to decrease its reliance on less reliable countries. This subsection begins by examining how China's air pollution policies are driving demand for natural gas. This is followed by an analysis of China's present and future demand for natural gas and oil, and how Canada can position itself as an attractive supplier of both resources.

4.2.1 China's Need for Clean Air

China needs to increase its imports of natural gas to replace coal and address widespread concerns about air pollution. Notably, this need to replace coal with a cleaner alternative is *not* solely driven by China's concerns about climate change. China is already well on its way to meeting its Paris climate goals, as these address emission intensity, not absolute emissions.[175] Nevertheless, the net effect of replacing coal with natural gas will be lower emissions.

Air pollution is a major problem in Chinese cities, and in recent years has become a political issue warranting government attention. Over 2006-2010, the Chinese government promoted natural gas in the power sector to reduce sulfur emissions. However, natural gas was not price competitive with coal at the time. In response, policy shifted towards displacing coal use in the urban and industrial sectors. Political pressure increased in 2011 when the U.S. embassy in China tweeted out air pollution readings.

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[170] CER, Canada's Energy Futures, 2019.
[171] Oil Sands Magazine, Differentials Explained: Why Alberta Crude Sells At A Deep Discount, 2018.
[172] These being the top 5 source countries for oil imported to the U.S. Gulf Coast. EIA, PAD District Imports by Country of Origin, 2019.
[173] Oil Sands Magazine, Oil Pipelines. Website; Strapolec Analysis.
[174] BP, BP Statistical Review of World Energy 2019. Website.
[175] New Scientist, China is on track to meet its climate change goals nine years early, 2019.

This prompted several batches of anti-pollution policies, many of which also focused on replacing coal with natural gas. Coal-to-gas switching targets for small boilers in households and industry were a common element in these policies. These measures succeeded in driving up the demand for natural gas, which was met by increased LNG imports.[176]

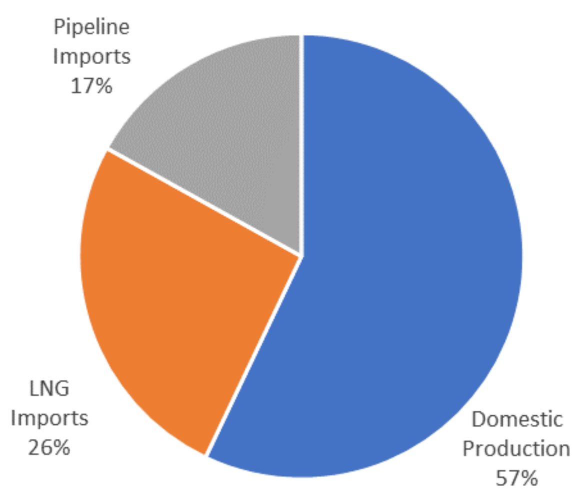
These trends present two implications for Canada. First, there is an existing market for LNG in China, which Canada can help meet: coal-to-gas switching programs are projected to result in natural gas demand increasing in all sectors of the economy, with the greatest growth expected for power generation and industry. Second, LNG sold to China can reasonably be assumed to displace coal on an energy-equivalent basis, thereby reducing net emissions.

4.2.2 Chinese LNG Demand

China currently consumes 283 bcm of natural gas annually, 43% of which is imported. China relies mostly on natural gas sourced through LNG imports and pipelines from several sources, primarily in the Pacific region, as shown in Figure 77 and Figure 76.

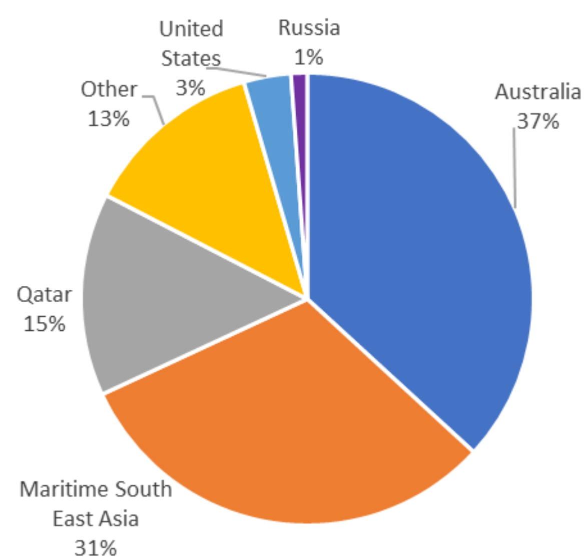
China's demand for natural gas is expected to grow by at least 83% by 2030, which will mostly be met by LNG imports when its own domestic natural gas production and international pipelines are insufficient to satisfy demand.[177]

Figure 77: China's Natural Gas Supply
(% of total natural gas supply 2018)



Source: China Customs Database

Figure 76: China's LNG Trading Partners
(% of total LNG Trading Partners 2018)



Source: China Customs Database

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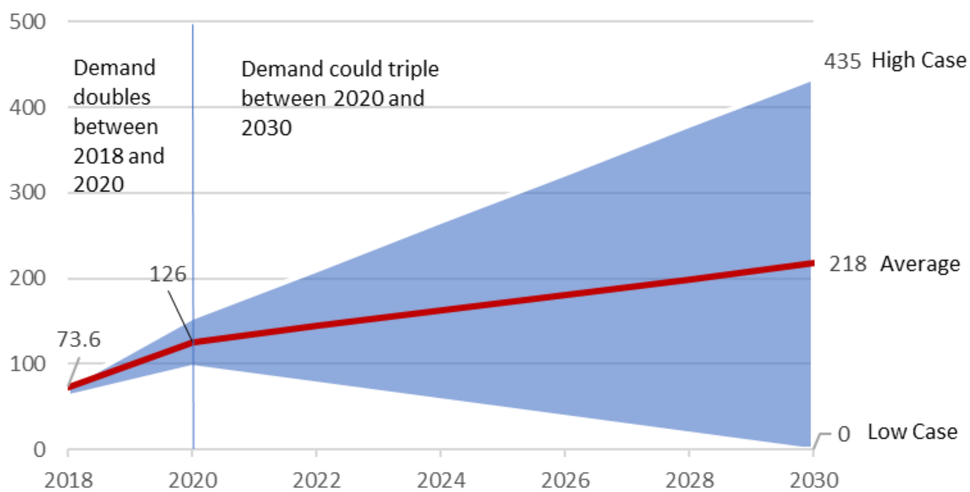
[176] The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018.
[177] The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018.

The projections of each of these variables (demand, pipeline imports, and domestic gas production) vary widely in the literature. An analysis of the sources indicates that China's LNG demand could drop to zero by 2030 or triple from 2020 levels as shown in Figure 78.[178,179] The low-end scenarios see China sourcing its natural gas from production and pipelines alone and not requiring LNG imports. These scenarios rely on several contingencies, including China completing a natural gas pipeline to Iran or the Middle East. Despite these uncertainties, Canada will remain an attractive option should China continue to need LNG. China is investing in LNG facilities in B.C. Canada's planned LNG capacity only represents 16% of the average growth in Chinese LNG demand.[180]

Figure 78: Range of Forecasts for China's LNG Demand, to 2030
(bcm/year)



Sources: The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018; Shell International and The Development Research Center (Eds.), China's Gas Development Strategies, Advances in Oil and Gas Exploration & Production, 2017; Zhongyuan et. al, Natural gas utilization in China: Development Trends and Prospects, 2018; Petro China Research Institute of Petroleum Exploration & Development, Development Trend and Strategic Forecast, 2018; Strapolec Analysis

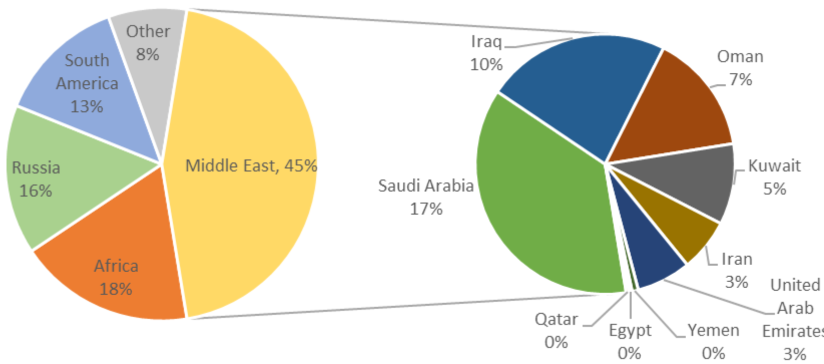
4.2.3 Chinese Oil Demand

China procures 45% of its oil supply from the Middle East, as shown in Figure 79. The security of China's oil supply is vulnerable to two significant risks: Middle Eastern shipping routes and its dependence on Russia's resources. Middle Eastern oil reaches China via sea routes that pass through the narrow Strait of Malacca, shown in Figure 80. This Strait has been identified as a "choke point" that presents energy

[178] Oil Sands Magazine, Oil Pipelines. Website; Strapolec Analysis.
[179] The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018; Shell International and The Development Research Center (Eds.), China's Gas Development Strategies, Advances in Oil and Gas Exploration & Production, 2017; Zhongyuan et. al, Natural gas utilization in China: Development Trends and Prospects, 2018; Petro China Research Institute of Petroleum Exploration & Development, Development Trend and Strategic Forecast, 2018; Strapolec Analysis.
[180] NRCan, Canadian LNG Projects, 2018 states the export capacity of the planned LNG Canada export terminal as 26 million tonnes of LNG per year. Based on the conversion factor of 1.36 million tonnes LNG to 1 bcm natural gas provided by BP, BP Statistical Review of World Energy 2019, 2019, this yields an export capacity of 35.36 bcm of natural gas per year.

security issues for China's oil supply: were it to be blocked, China's energy security would be in jeopardy. Russia is also a major supplier of China's oil via overland pipelines and has aspirations to increase its exports to China in the future.[181] Europe's experience with natural gas supplies from Russia—liable to be cut off at a moment's notice—represents another vulnerability for China's energy security.

Figure 79: Sources of China's Oil Imports, 2019
(Percentage of total)



Source: China Customs Database

Figure 80: Sea Route for Middle Eastern Oil to Reach China

Source: Google Maps

As a result, China may consider Canadian oil to be a more reliable and secure source of energy compared to these existing suppliers. Oil exported from Canada's West Coast would take a direct route across the Pacific and avoid the Strait of Malacca entirely.

China has indicated a desire to secure more reliable oil supplies as it currently imports 75% of its needs.[182] Imports from Canada could help lessen China's dependence on Russia. Between 2014 and 2017 Chinese companies invested roughly $4 billion in Canada's oil sector, suggesting interest in Canada's oil supply.[183]

[181] EIA, China: International energy data and analysis, 2015.
[182] Forbes, China Is The World's Largest Oil & Gas Importer, 2019.
[183] South China Morning Post, Chinese investment in Canadian oil shows bigger isn't always better, 2018.

However, to become a long-term supplier of crude oil to China, Canada would need to develop infrastructure to move Albertan crude to the Pacific Coast in significant quantities. This could help to either induce China and other Pacific Asian nations to retrofit their oil refineries to process the oil sands crude oil, or motivate Canada to expand its upgrading capacity to export more synthetic crude oil.[184]

China's oil demand is projected to grow by 2.8 MMb/d to 14 MMb/d in 2030, and then steadily decrease back to current levels by 2050.[185] Canada's planned west coast export pipeline capacity of 0.6 MMb/d would only represent 20% of this expected growth in demand.[186]

4.3 Europe Wants A Diversified Oil and Natural Gas Supply

Countries within the EU represent another potential market for Canada's oil and natural gas. The EU currently depends on Russia for much of its oil and natural gas supply. Following a pricing dispute between Russia and Ukraine in 2009, Russian gas flows through Ukraine were halted completely, cutting off supplies to Southeastern Europe.[187] This is a significant motivator for the EU to diversify its supply, especially from stable, trusted suppliers. This subsection examines the EU's current natural gas supply and shows that Russia's dominant supply share is aggravating security concerns that could spark demand for Canadian LNG. The EU's oil supply and opportunities for Canada to meet these needs are also discussed.

4.3.1 Canadian LNG Can Reduce Europe's Dependence on Russia

Natural gas meets about 16% of the EU's energy needs, with demand expected to grow by 10%, from 564 bcm in 2020 to 618 bcm in 2030.[188] The EU is both a producer and an importer of natural gas. In total, just over a third of natural gas traded among EU countries comes from elsewhere in Europe, as shown in Figure 81. The Netherlands and Belgium produce natural gas within the EU, while nearby non-EU countries such as Norway and the UK also provide supply. Norway, in particular, is a significant source, accounting for 22% of Europe's natural gas imports in 2017.[189]

Russia is the next-largest supplier of natural gas to Europe, accounting for 34% of imports.[190] North African countries are the next largest suppliers of natural gas to Europe via pipelines under the Mediterranean. The remainder of the EU's natural gas imports is from diverse sources around the world.[191,192] Notably, Middle Eastern countries only account for 4% of imports.[193]

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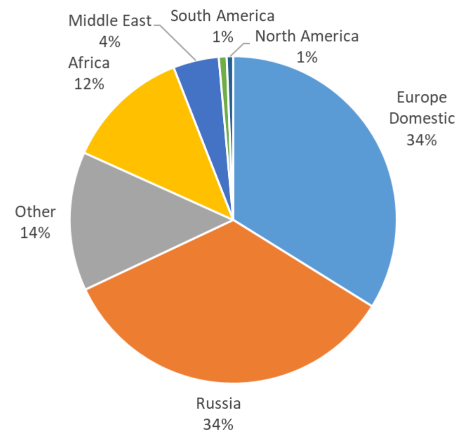
184 CBC, Canada's Oilpatch Needs New Customers. Who's Willing to Buy? 2017.
185 CNPC Economics & Technology Research Institute, China Energy Outlook 2050, 2017.
186 Based on the capacity additions from the Trans Mountain Expansion Project.
187 Reuters, Timeline: Gas Crises Between Russia And Ukraine, 2009.
188 Eurostat, Database; The Oxford Institute for Energy Studies, The Outlook for Natural Gas Demand in Europe, 2014.
189 Eurostat, Database.
190 Eurostat, Database.
191 Eurostat, Database.
192 Gas Infrastructure Europe. Website.
193 Eurostat, Database.

Figure 81: Sources of EU Natural Gas Imports, 2017
(Percentage of total)



Source: Eurostat, Database. Note: Europe Domestic does not include gas produced and consumed domestically in the producing country.

A country by country analysis of the EU's supply of natural gas indicates how dependence on Russian imports varies. Russia accounts for over 75% of total natural gas imports for most countries in south eastern Europe, as well as several countries in the Baltic region, as shown in Table 4 and Figure 82. For many of these countries, all or nearly all natural gas imports are sourced from Russia alone. Germany and Poland are also moderately dependent on Russia for natural gas, with Russian imports accounting for 52%, and 66% of their total natural gas imports, respectively. Germany's dependence is notable, given that it is both Europe's strongest economy and the single largest importer of Russian natural gas by volume.[194]

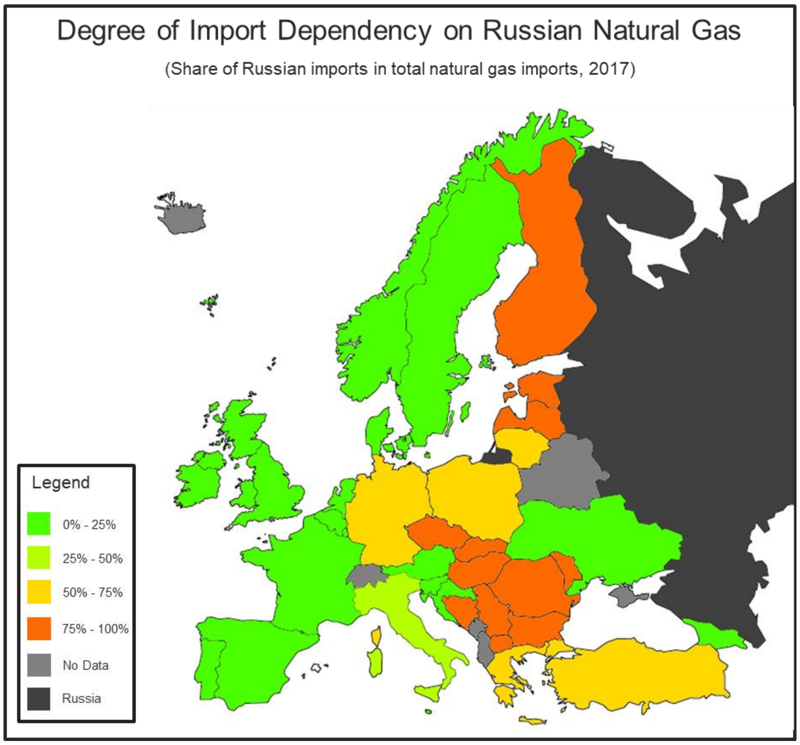
Table 4: Top 10 Importers of Russian Natural Gas in Europe

Country	Natural Gas Imports from Russia 2017	Total Natural Gas Imports 2017	% of Supply Sourced from Russia in 2017
Germany	62	119	52%
Italy	33	70	48%
Turkey	29	55	52%
Hungary	13	13	95%
Poland	10	16	66%
Netherlands	9	54	17%
France	9	49	19%
Czech Republic	9	9	99%
Slovakia	4	5	85%
Bulgaria	3	3	100%

Source: Eurostat Database; Strapolec Analysis.

[194] Eurostat Database; Strapolec Analysis.

Figure 82: European Union's Dependency on Russian Natural Gas
(Share of Russian imports in total natural gas imports, 2017)



Source: Eurostat, Database; Strapolec Analysis.

The EU is concerned about its dependency on Russian natural gas and has identified Germany's dependence on Russian imports as a particular security risk. [195] As part of its diversification strategy, 212 bcm of LNG import capacity has been developed, of which 150 bcm or 70% is currently unused.[196,197] A further 9 bcm of capacity is under construction, 112 bcm is planned, and 4 are currently suspended, bringing the EU's total potential LNG import capacity to 333 bcm per year.[198]

The new Nordstream 2 gas pipeline, shown in Figure 83, will run from St Petersburg, Russia to Germany's northern coast, doubling the amount of natural gas Germany can import from Russia.[199] Poland and other Eastern European countries have objected to this project, expressing concerns about the EU's increased energy dependence on Russia. As a result, the EU has attempted to block the project. The U.S., seeking to expand its exports of LNG to Germany, has also entered the fray, passing sanctions

[195] Forbes, Trump Imposes Sanctions to Stop Nord Stream 2 – But It's Too Late, 2019.
[196] Gas Infrastructure Europe, LNG Map 2019, 2019. Website.
[197] European Commission, EU-U.S. Joint Statement: Liquefied Natural Gas (LNG) imports from the U.S. continue to rise, up by 181%, 2019.
[198] Gas Infrastructure Europe, LNG Map 2019, 2019. Website.
[199] Houston Chronicle, New market for LNG as Germany moves to add import terminals, 2019.

on German companies in an attempt to block the pipeline. Despite these actions, the project is expected to be completed in mid-2020. [200]

Figure 83: Nordstream 2 Gas Pipeline

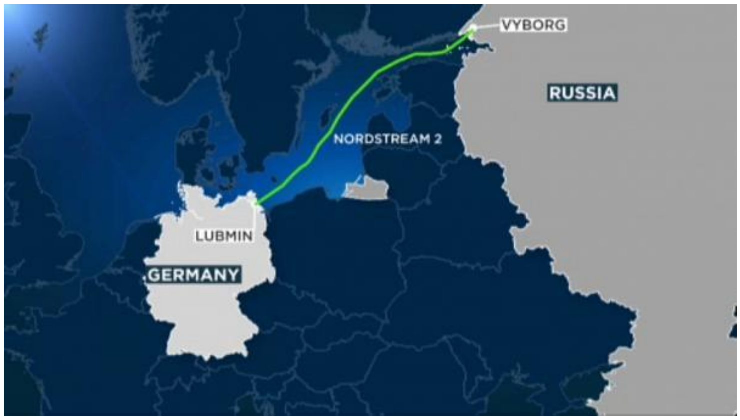


Image source: EuroNews

Germany has committed to building at least two new LNG terminals, which could increase import capacity from the current nil to 26 bcm per year.[201]

Several factors could help Canada export more natural gas to EU markets: the need for the EU to diversify its supply; the potential for the EU's significant investments in LNG infrastructure to result in an overcapacity that could be leveraged by Canada; the EU's need to lessen its dependency on Russia; and, the potential to support Germany's elimination of its coal generation.

On Canada's east coast, the Canaport facility could be repurposed to export up to 10 bcm of natural gas annually as LNG, although pipelines connecting the Canaport facility in New Brunswick to Canada's domestic natural gas supply would be required.[202] Additionally, if the Énergie Saguenay project in Quebec is successful, it could export 15 bcm of natural gas annually as LNG. Taken together, these projects could export 25 bcm of natural gas annually, enough to meet 10% of the EU's demand.

4.3.2 Europe Wants Diversified Oil Supplies

Europe currently produces 34% of its own oil supply, with Norway being a major source, and the Netherlands, the UK, and Belgium also contributing.[203] As with natural gas, Russia is also a major supplier of Europe's oil, accounting for 25% of the EU's total oil imports as shown in Figure 84.

However, unlike natural gas, the Russian oil supply is evenly distributed among European countries, with few being overly dependent.[204] The remainder comes from the Middle East, Africa, and Asia.

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[200] Forbes, Trump Imposes Sanctions to Stop Nord Stream 2 – But It's Too Late, 2019.
[201] Houston Chronicle, New market for LNG as Germany moves to add import terminals, 2019.
[202] CER, Market Snapshot: Canada's LNG imports dropped 88% since 2011, 2018.
[203] Eurostat, Database.
[204] Eurostat, Database; Strapolec Analysis.

About half of the oil from Africa is from nearby countries in North Africa as shown in Table 5. Notably, ten countries account for two-thirds of Europe's oil imports, with Russia being the single-largest source by far.[205]

Figure 84: Sources of European Union Oil Imports, 2017

(% of total oil imports 2017)

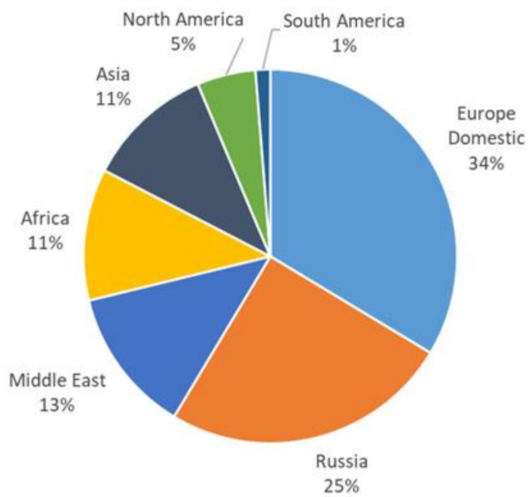


Table 5: Top 10 Non-European Source Countries for Europe's Oil, 2017

Country	Oil Imports (MMB/d)
Russia	4.78
Saudi Arabia	0.96
Iraq	0.88
Kazakhstan	0.82
Nigeria	0.7
United States	0.64
Libya	0.59
Iran	0.57
Algeria	0.49
Azerbaijan	0.49

Source: Eurostat, Database. Note: Europe Domestic does not include oil produced and consumed domestically in the producing country

Canada already exports oil to the EU, representing 10% of the share from North America.[206] The Energy East project was intended to provide Canadian oil to meet Europe's growing demand and potentially displace the supply from Russia. It would have been able to provide 1.1 MMb/d, or 6% of Europe's total demand.[207] With such a project, Canada could increase its access to this market if it can establish that its oil supplies are environmentally superior.

4.4 Canada's Role in Energy Security

Energy security for nations can involve many factors such as the aforementioned dependence on foreign sources and/or trade routes. It can also be impacted by the political and economic stability of the sources of imported energy. Canada has high ratings in international Governance, Institution, and Corruption indices and is considered by the World Bank to have political and economic stability.[208] Table 6 shows the comparison of Canada to other major energy suppliers and underscores Canada's attractiveness as a supplier of oil to the three aforementioned markets.

[205] Eurostat, Database.
[206] Eurostat, Database; Strapolec Analysis.
[207] Eurostat, Database.
[208] World Bank, Worldwide Governance Indicators. Website.

Table 6: Sovereign Ratings for Major Oil Exporting Countries
(Top Oil Exporting Nations by Fitch Sovereign Rating)

Country	Sovereign Rating	Grade
Saudi Arabia	A	Upper Medium Grade
Russia	BBB	Lower Medium Grade
Iraq	B-	Highly Speculative
Canada	AAA	Prime
UAE	AA	High Grade
Kuwait	AA	High Grade
United States	AAA	Prime
Iran	B+	Highly Speculative
Nigeria	B+	Highly Speculative

Sources: Fitch Sovereign Ratings and Research. Website.

4.5 Summary

Canada's largest trading partners, the U.S., China, and the EU, represent over 50% of the global energy demand. Canada, with its extensive clean electricity, natural gas, and oil resources, good reputation, and favourable geographic position, is well-placed to serve these markets. This enables Canada to support decarbonization initiatives and enhance energy security in these jurisdictions.

The potential energy demands of Canada's largest trading partners are shown in Table 7. The U.S. will need low-carbon Canadian electricity to decarbonize, especially in the Northeast, and will continue to rely on Canadian natural gas and oil from the west. Natural gas demand is set to increase in China and the EU due to their coal phase-out policies, spurring demand for LNG that Canada could provide. Finally, oil demand remains strong in the EU and China, and Canadian supply may be regarded as a safer and more secure option than supplies from other trading partners.

Table 7: Demand for Energy by Export Market and Resource

Export Market	Resource	Anticipated Import Demand (2030)	Current Exports by Canada (2018)	Units	Current Exports as a % of Anticipated Import Demand
The U.S.	Electricity	332	72	TWh/y	22%
	Natural Gas	228	76	Bcm/y	33%
	Oil	6.8	3.5	MMb/d	52%
China	Natural Gas	435	0	Bcm/y	0%
	Oil	14	0	MMb/d	0%
The EU	Natural Gas	333	0	Bcm/y	0%
	Oil	19	0	MMb/d	0%

Sources: US Demand: EIA, Annual Energy Outlook 2020. Represents electricity provided by coal-fired generation in regions bordering Canada. China Demand: The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018; Shell International and The Development Research Center (Eds.), China's Gas Development Strategies, Advances in Oil and Gas Exploration & Production, 2017; Zhongyuan et. al, Natural gas utilization in China: Development Trends and Prospects, 2018; Petro China Research Institute of Petroleum Exploration & Development, Development Trend and Strategic Forecast, 2018; CNPC Economics & Research Institute, 2017; Strapolec Analysis. EU demand: EU demand: Gas Infrastructure Europe, LNG Map 2019, 2019; Eurostat, Database. Exports to Markets: CER, Commodity Tracker; CER, Electricity Interchange; CER, Canada's Energy Future 2019, 2019.

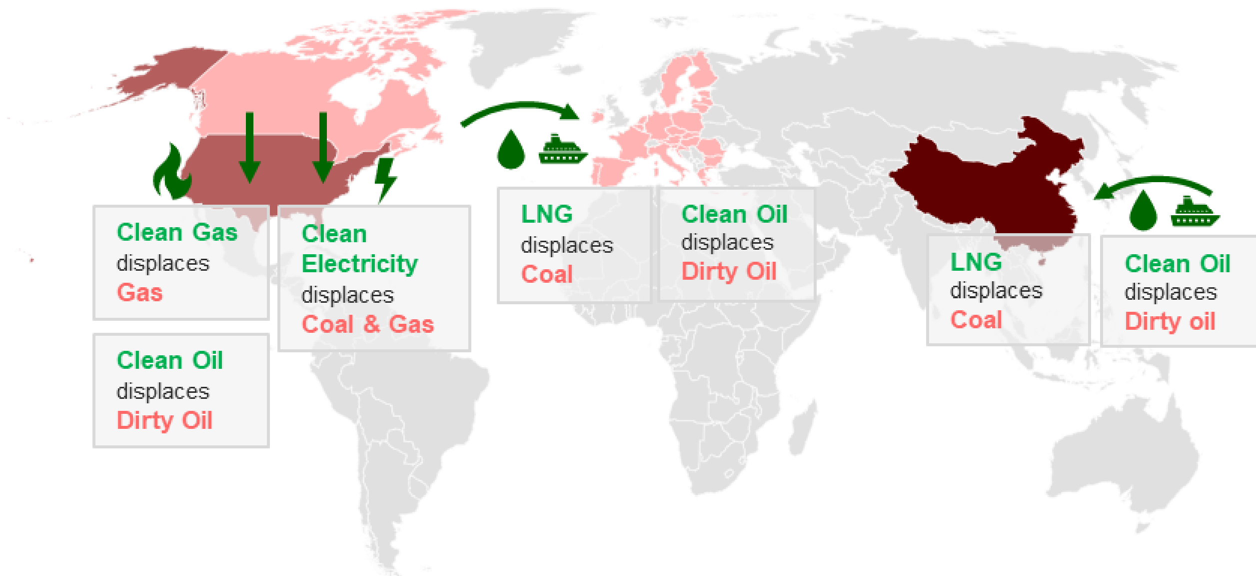
Canada's potential is not limited by market demand or resource availability, but rather the lack of integrated infrastructure capacity that is required to support increased exports. Transmission line expansion to the U.S. is required to secure Canada's role as its primary source of low-carbon electricity. Delivery systems to seaports and processing infrastructure would need to be developed on Canada's Pacific and Atlantic coasts to support natural gas and oil exports to China and the EU.

5 Canada's Low Emission Energy Supplies Can Combat Global Climate Change

This section examines how Canada, by exporting low emission clean energy resources to its major trading partners, could help reduce global emissions.

Canada could help reduce global emissions by exporting more low-carbon electricity to the U.S. and less emissions-intensive oil and natural gas to the U.S., China and the EU. This section begins with an examination of the potential for Canada to increase low-carbon electricity in the U.S. to displace coal and natural gas use, and follows with a discussion of the potential to provide hydrogen-infused natural gas to the U.S. The section then discusses how Canada's LNG exports could displace coal in China and the EU. Finally, it presents the potential for using clean energy outputs from SMRs to lower the emissions of the oil sands and improve access to these major markets. Figure 85 depicts these opportunities.

Figure 85: Potential Canadian Energy Exports to Rest of the World
(Darker red represents higher emissions)



5.1 Displacing High-Emitting Electricity in The U.S.

As previously noted, several U.S. states neighbouring Canada have set clean energy targets and could, therefore, be potential markets for increased exports of low-carbon electricity. Using the existing and proposed transmission lines between Canada and the U.S. as a reference, this subsection examines the export potential to these regional markets and the resulting potential emission reductions that could be achieved.

The EIA forecasts energy supply and demand for individual geographic areas called market module regions as shown in Figure 86 which can be used to inform the differences between states.[209] In this context, states with targets represent market opportunities for Canadian electricity that could help achieve their goals.

Figure 86: U.S. Electricity Market Module Regions

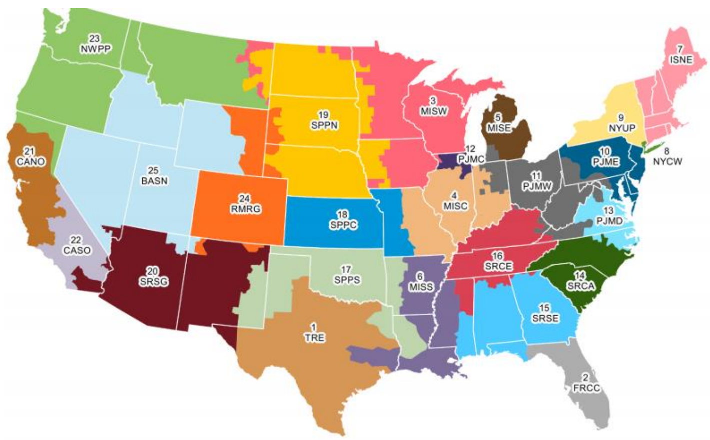


Image source: EIA, Annual Energy Outlook 2020, 2020.

The emissions reduction potential of these states is discussed in the context of five regions: the U.S. Northeast; the Mid-Atlantic; Southern Michigan; the Midwest; and the Pacific Northwest.

5.1.1 U.S. Northeast Region

The states of the U.S. Northeast fit neatly into three electricity market module regions: ISO New England, Metropolitan New York (NYCW), and Upstate New York (NYUP).[210] Every state in this region has adopted its own emission reduction target.[211]

An economic analysis of renewables in jurisdictions similar to the U.S. Northeast suggests that the projected growth in renewable generation for these states will lead to cost issues.[212] Because of this, these states will likely be in the market for a less-costly source of low-carbon electricity, which Canada could supply. Low-carbon electricity sold to the Northeast would displace natural gas-fired generation, reducing CO_2 emissions, and also impact the amount of renewable generation that would be built.

Forecasts show that the Northeast may need 205 TWh of renewable and natural gas-fired generation per year by 2050, as shown in Figure 87.[213] If all currently proposed and under-construction Tx lines between Canada and the U.S. are completed by 2050, Canada could export as much as 88 TWh of

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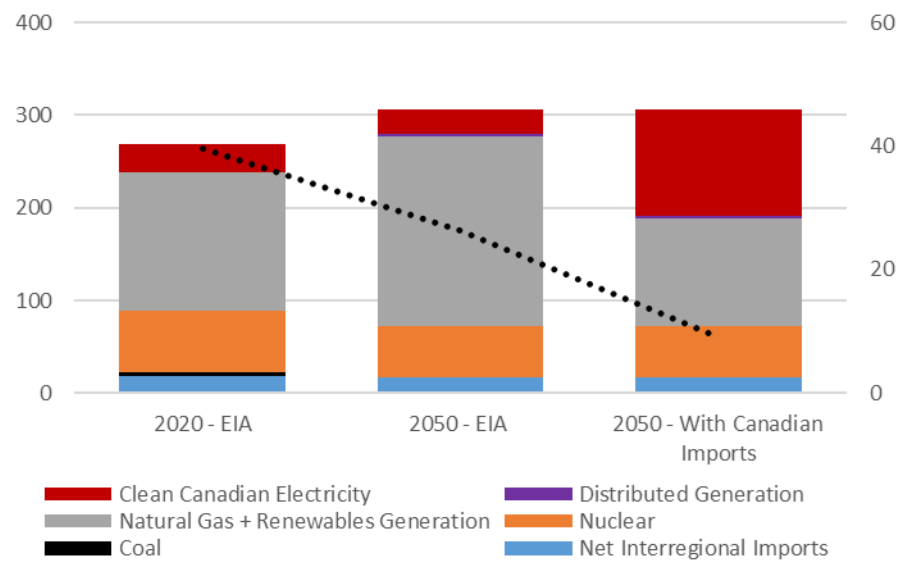
[209] Module regions do not fully reflect state boundaries, as a result the analysis presented for states that have clean energy targets may include some supply mix implications of neighboring states that do not have targets.
[210] EIA, Annual Energy Outlook 2020, 2020.
[211] C2ES, U.S. State Greenhouse Gas Emissions Targets, 2019.
[212] Strapolec, Distributed Energy Resources in Ontario, 2018.
[213] EIA, Annual Energy Outlook 2020, 2020. Data on New England, NYC and Long Island, and Upstate New York.

electricity to the U.S. Northeast per year.[214,215,216,217] This could displace natural gas-fired generation and renewables in the Northeast, which would reduce the region's CO_2 emissions by 17 Mt annually as shown in Figure 87.[218,219]

Figure 87: Effect of Canadian Imports on Northeast Supply Mix and Emissions
(TWh/year, $MtCO_2eq$)



Sources: Strapolec Analysis; EIA Annual Energy Outlook 2020, 2020; House of Commons, Strategic Electricity Interties, 2017. Note: figure excludes very minor sources of generation like pumped storage and petroleum.

5.1.2 Mid-Atlantic States – PJM East

The Mid-Atlantic region is within PJM (Pennsylvania New Jersey Maryland Interconnection) East, which encompasses all of New Jersey and Delaware, and most of the land area of Maryland and Pennsylvania. Each of these states has set climate targets.[220] The region's supply mix is currently dominated by natural gas and coal-fired generation, and some 31 TWh/year of coal generation will still be in service by

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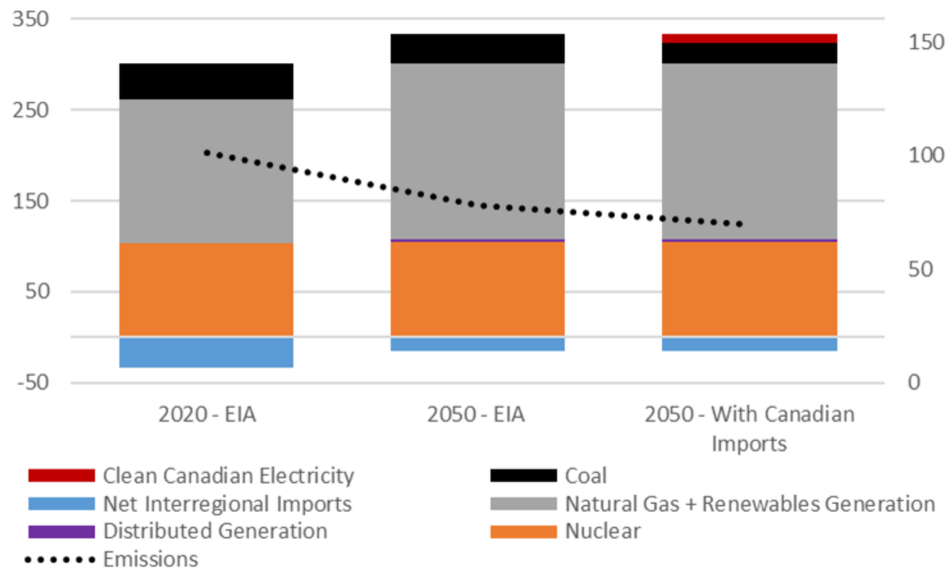
[214] Strapolec Analysis.
[215] National Observer, Construction Of Major Electricity Line From Quebec To New York City Expected To Start In 2020, 2018.
[216] Concord Monitor, N.H. Supreme Court agrees with state's rejection of Northern Pass transmission line, July 19, 2019.
[217] Clean Energy Connect, Website.
[218] Strapolec Analysis; EIA, Annual Energy Outlook 2020, 2020.
[219] A Note on Methodology -- Renewables Pairing with Natural Gas Generation: Natural gas is generally used to mitigate the intermittency of renewables. Because natural gas and renewables end up paired in this way, this analysis considers them to be one resource, as a natural gas and renewables blend that is the sum of the energy from each region's renewable and natural gas generation. The emissions intensity for each mix is based on their gas component averaged over their total generation. Because the EIA does not specify between hydro and renewables in the Annual Energy Outlook 2020 datasets, hydro is included in this mix. Including hydro dilutes the average emissions intensity, which means potential emission reductions will be on the conservative side.
[220] C2ES, U.S. State Greenhouse Gas Emissions Targets, 2019.

2050.[221] Currently, the PJM East region does not have a direct electricity intertie with Canada but could be connected by the new 1,000 MW ITC Lake Erie Connector Project between Ontario and Pennsylvania.[222] The capacity from this intertie will allow Canada to export almost 9 TWh of electricity to the region annually. This clean electricity could replace coal generation in the region and reduce emissions in the Mid-Atlantic region by 9 Mt annually, as shown in Figure 88.

Figure 88: Effect of Canadian Imports on PJM East Supply Mix and Emissions

($TWh/year$, $MtCO_2eq$)



Sources: Strapolec Analysis; EIA Annual Energy Outlook 2020, 2020; House of Commons, Strategic Electricity Interties, 2017. Note: figure excludes very minor sources of generation like pumped storage and petroleum.

5.1.3 Southern Michigan

The electricity supply for Michigan is divided among three market regions, with the Northern Peninsula belonging to Midcontinent ISO (MISO) West, most of the Southern Peninsula being covered by the MISO East region, and a small area in the southwest supported by PJM West. The Northern Peninsula is considered separately in the context of MISO West. PJM West is not analyzed as most states within it have not set reduction targets. The following analysis focuses on the Southern Michigan region covered by MISO East.

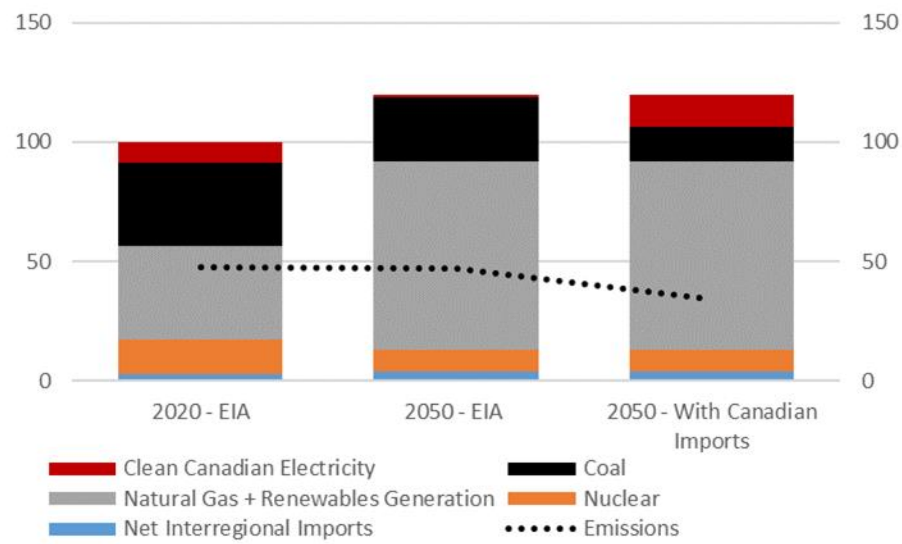
Michigan's reduction target has been set at 26-28% below 2005 levels by 2025.[223] Currently, the state's supply mix is dominated by coal and natural gas. Several coal plants in the region are expected to close in the coming years, and the EIA projects coal generation will decline by 22% by 2050.[224] However, coal

[221] EIA, Annual Energy Outlook 2020, Table 54.10, PJM East, 2020.
[222] ITC. Website.
[223] C2ES, U.S. State Greenhouse Gas Emissions Targets, 2019.
[224] EIA, Annual Energy Outlook 2020, Table 54.5. Midcontinent ISO/East, 2020.

and natural gas could still make up the majority of the region's generation in 2040, despite a strong renewable generation component.[225]

Combined with the closure of coal plants, the growth in renewable generation has sparked concerns about grid reliability. This has led MISO to consider importing more electricity into the Lower Peninsula.[226] Michigan already imports electricity from Ontario, but not to the full capacity of the current interties. Only 66%, or 1,650 TWh, of the existing interties is currently used.[227] The use of the full capacity of the interties, which would enable the Lower Peninsula to import an additional 12 TWh of electricity from Canada, is enough to displace 12 Mt of emissions from coal generation as shown in Figure 89.

Figure 89: Effect of Canadian Imports on Southern Michigan Supply Mix
(TWh/year, $MtCO_2eq$)



Sources: Strapolec Analysis; EIA Annual Energy Outlook 2020, 2020; House of Commons, Strategic Electricity Interties, 2017. Note: figure excludes very minor sources of generation like pumped storage and petroleum.

5.1.4 MISO West

The MISO West region covers most of Minnesota and Iowa, all of Wisconsin and the Northern Peninsula of Michigan. Only Michigan and Minnesota have set emission reduction targets. The region's electricity mix is dominated by coal and renewables, which includes hydroelectric generation. Notably, the region imports roughly 10 TWh of electricity from Canada annually, and exports 19 TWh of electricity to neighboring states.[228] Imports from Canada are projected to grow to 17 TWh per year by 2050.[229] Coal

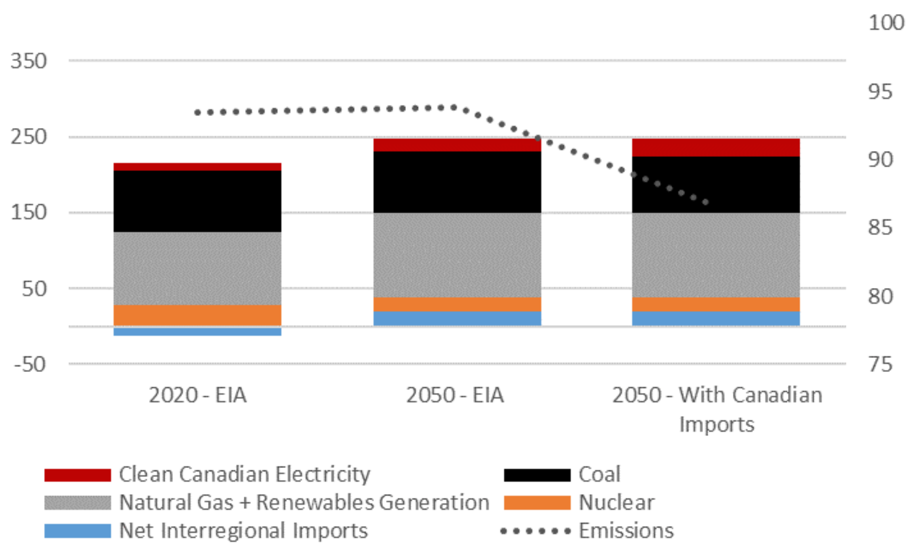
[225] EIA, Annual Energy Outlook 2020, Table 54.5. Midcontinent ISO/East, 2020.
[226] Energy News Network, Michigan Explores Importing More Electricity As Coal Plants Close, 2020.
[227] House of Commons, Strategic Electricity Interties, 2017.
[228] EIA, Annual Energy Outlook 2020, Table 54.3. Midcontinent ISO/West, 2020.
[229] EIA, Annual Energy Outlook 2020, Table 54.3. Midcontinent ISO/West, 2020.

and natural gas generation are projected to remain stable over this period, though Canadian electricity imports may prevent the construction of new fossil fuel generation that could have occurred otherwise.

Manitoba Hydro is currently building a new transmission line to Minnesota that will increase Canada's export capacity to the region by 750 MW, or 6.6 TWh per year. Combined with the capacity remaining on existing lines up to 2050, Canada would be able to export an additional 7 TWh annually of low-carbon electricity to the region.[230] This would be enough to displace 7 Mt of emissions from coal generation, as shown in Figure 90.

Figure 90: Effect of Canadian Imports on MISO West Supply Mix

(TWh/year, $MtCO_2eq$)



Sources: Strapolec Analysis; EIA Annual Energy Outlook 2020, 2020; House of Commons, Strategic Electricity Interties, 2017. Note: Negative values represent energy exports. Figure excludes very minor source of generation like pumped storage, DER, and petroleum.

5.1.5 Pacific Northwest

In the Pacific Northwest, Washington State and Oregon, as well as portions of northern California and Idaho, and the majority of Montana are covered by the Northwest Power Pool. Washington State and Oregon have emission targets, while Idaho and Montana do not.

The electricity mix in the Northwest region is already low-carbon, dominated by renewables and hydro generation. The little coal generation in place is projected to be eliminated by 2050. However, the region will have 204 TWh/year of generation from renewable and natural gas resources.

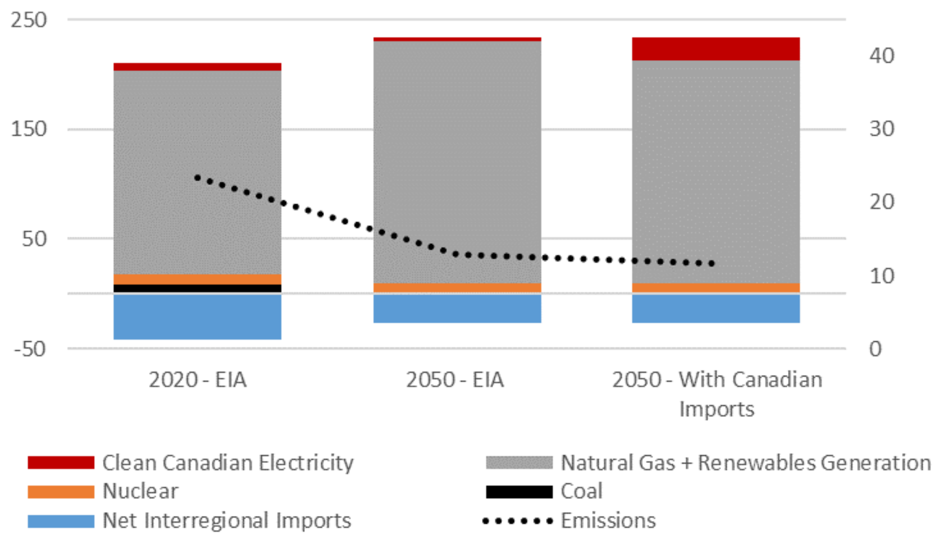
Canada has no new interties planned to the Northwest but does have 2,020 MW of spare capacity on the existing interties. At full capacity, Canada could export another 18 TWh of clean electricity to the

[230] House of Commons, Strategic Electricity Interties, 2017; EIA, Annual Energy Outlook 2020, Table 54.3. Midcontinent ISO/West, 2020; Strapolec Analysis.

Northwest annually, enough to cut renewable and natural gas generation by 8% and displace 1 Mt of emissions, as shown in Figure 91.

Figure 91: Effect of Canadian Imports on Pacific Northwest Supply Mix

(TWh/year, $MtCO_2eq$)



Sources: Strapolec Analysis; EIA Annual Energy Outlook 2020, 2020; House of Commons, Strategic Electricity Interties, 2017. Note: Negative values represent energy exports. Figure excludes very minor sources of generation like pumped storage, DER, and petroleum.

5.1.6 Summary

Canada has the potential to export about 134 TWh of low-carbon electricity to neighbouring U.S. states. This would be in addition to the 62 TWh expected to be exported to the U.S. in 2020. If Canada were to concurrently supply all of these markets with low-carbon electricity, it would reduce the U.S.'s emissions by a total of 47 Mt, as shown in Table 8.

Table 8: Potential Canadian Electricity Exports to the U.S. and Emissions Impact

U.S. Region	Forecasted 2020 Electricity Exports (TWh/year)	New Electricity Exports 2050 (TWh/year)	New Emissions Reductions ($MtCO_2eq$ /year)
U.S. Northeast	31	88	17
Mid-Atlantic	0	9	9
Southern Michigan	9	12	13
MISO West	10	7	7
Pacific Northwest	12	18	1
Total	**62**	**134**	**47**

Source: Strapolec Analysis. Note: Numbers are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

5.2 Reducing Emissions Via Natural Gas Exports to the U.S.

Canada's natural gas resources can be leveraged in two ways to help reduce emissions in the U.S.

1) Exporting more natural gas to displace the use of coal; and
2) Supporting the use of natural gas in the Great Lakes region by injecting blended hydrogen/natural gas into the distribution system

5.2.1 Canada's Natural Gas as a Displacement for Coal

Natural gas is much less carbon-intensive than coal on an energy basis. Burning 1 bcm of natural gas produces 1.82 Mt of CO_2.[231] Burning coal to produce the same amount of energy releases 3.35 Mt of CO_2 or 83% more.[232] Replacing coal with natural gas on a one to one basis would avoid 1.53 Mt of CO_2 emissions for every 1 bcm of natural gas combusted.

Fuel switching from coal to natural gas in the electricity generation sector has become a major driver for the growing demand for natural gas in the U.S. As stated previously, Canada is expected to increase its natural gas exports to the U.S. by 24 bcm/year between 2025 and 2040.[233] If all of this natural gas were to be used in electricity generation, and was used to displace coal in every case, U.S. emissions would be reduced by 37 Mt per year.

5.2.2 Blending Hydrogen into the Natural Gas system

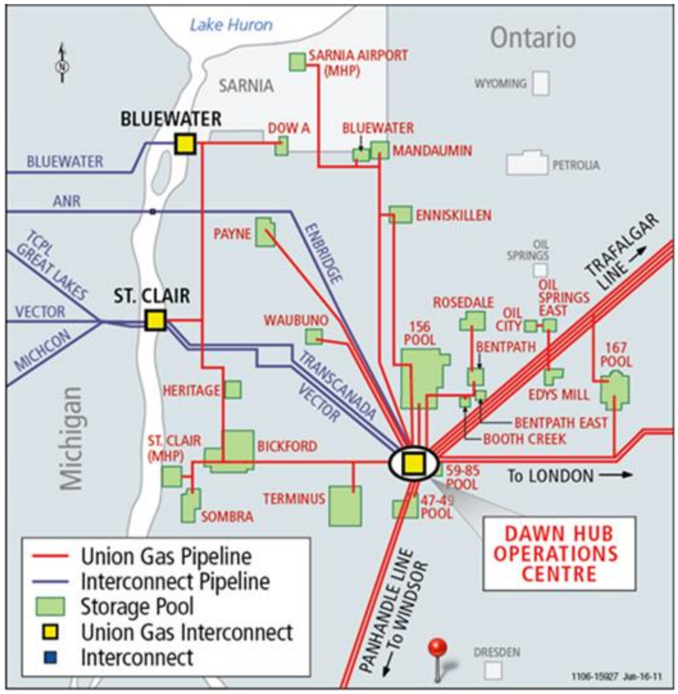
Natural gas can be blended with hydrogen produced from carbon-free sources of electricity – an application known as Power to Gas (P2G). The blending-in of hydrogen with natural gas produces a mixture with a lower emission intensity than natural gas alone. Using current infrastructure, hydrogen blending could displace 5% of the total natural gas volume on a per unit basis. With upgrades to infrastructure and end-use appliances, blends of up to 20% hydrogen could be possible. [234]

Canada has existing infrastructure that can enable selling P2G natural gas into the U.S. in the form of the storage caverns at the Dawn Hub, as illustrated by Figure 92.

Ontario's P2G natural gas with a 5% blend of hydrogen would emit 1.5% less CO_2 than regular gas, making it cleaner than other U.S. sources.[235] Today, Ontario exports 0.35 bcm of natural gas to Michigan annually, enough to emit 0.64 Mt of CO_2 annually.[236] If 5% of this 0.35 bcm of natural gas were replaced with hydrogen, it would become 1.5% less emissions-intensive, emitting 0.63 Mt of CO_2 annually for a reduction of 0.1 Mt per year.[237] This supply could be enriched to meet increased U.S. demand in the winter months. For example, using the Bluewater line to capacity in January would enable Ontario to export a further 0.05 bcm of natural gas to Michigan on an annual basis, increasing natural gas exports from the province to 0.40 bcm a year.

[231] EIA, How Much Carbon Dioxide Is Produced When Different Fuels Are Burned? 2019; Strapolec Analysis.
[232] EIA, Carbon Dioxide Emission Factors for Coal, 1994; Strapolec Analysis.
[233] CER, Canada's Energy Futures, 2019.
[234] Strapolec, Ontario's Emissions and the Long-Term Energy Plan, 2016.
[235] Strapolec, Ontario's Emissions and the Long-Term Energy Plan, 2016.
[236] EIA, Natural Gas Imports and Exports, 2020.
[237] EIA, Natural Gas Imports and Exports, 2020; Strapolec Analysis.

Figure 92: Dawn Operation Centre Storage Pools and Pipelines



Source: Enbridge

5.3 Potential for Canada's LNG to Displace China and EU Coal Consumption

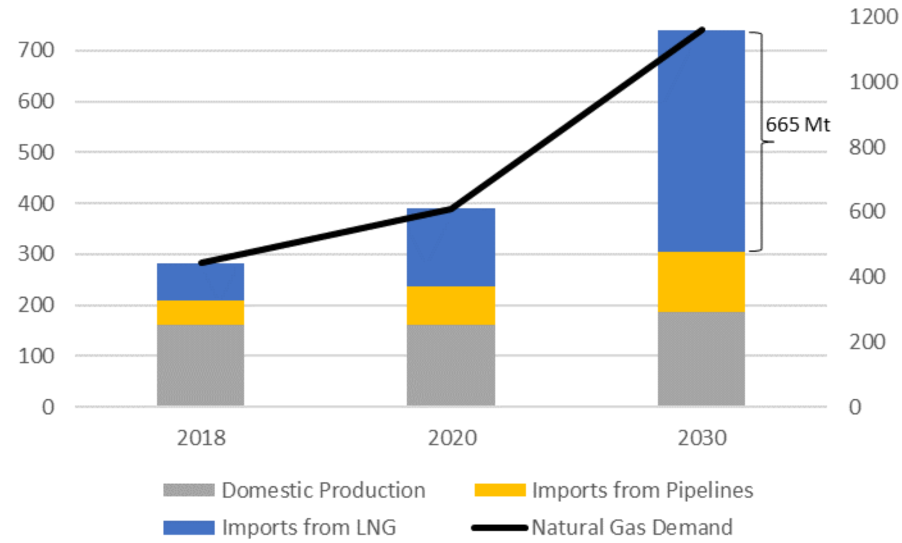
Since China is aggressively switching to natural gas as a way to replace coal, it can be assumed that any natural gas exported to China will be used for this purpose. In the most optimistic case, China would need to import 435 bcm of LNG by 2030, displacing over 665 Mt of CO_2 per year from coal combustion as shown in Figure 93. With its current LNG projects, Canada could potentially supply 35 bcm of this demand annually, enough to displace 54 Mt of CO_2 per year.[238]

In Europe, Germany has set a goal to phase out coal generation by 2038 and sees natural gas imports as a way to do so. By switching from coal to natural gas-fired electricity generation, Germany could reduce emissions from this sector by 46%. This would increase its natural gas demand by 62 bcm.[239] Much of this new demand would be met by imported LNG, which Canada could help supply through completing the Énergie Saguenay project, or if it used its Canaport facility to support exports, instead of imports as it currently does. Assuming just the Canaport possibility progresses, Canada could export 10 bcm of

[238] NRCan, Canadian LNG Projects, 2018. The LNG Canada export terminal will receive natural gas from the Coastal Gaslink pipeline and transform it into LNG for export. NRCAN cites this facility's export capacity as 26 million tonnes of LNG per annum. This is equal to 35.36 bcm of gaseous natural gas, according to the conversion factor of 1.36 provided by BP, BP Statistical Review of World Energy 2019, 2019.
[239] Eurostat Database; Strapolec Analysis.

natural gas per year to Europe.[240] If all of this natural gas were used to displace coal on an energy-equivalent basis, the EU's emissions could be reduced by 16 Mt annually.

Figure 93: GHG Reductions from Natural Gas Displacing Coal in China – High Case
(bcm natural gas per year, Mt CO_2 avoided per year)



Source: The Oxford Institute for Energy Studies, The Outlook for Natural Gas in the War Against Air Pollution, 2018; Shell International and The Development Research Center (Eds.), China's Gas Development Strategies, Advances in Oil and Gas Exploration & Production, 2017; Zhongyuan et. al, Natural gas utilization in China: Development Trends and Prospects, 2018; Petro China Research Institute of Petroleum Exploration & Development, Development Trend and Strategic Forecast, 2018; Strapolec Analysis.

Taken together, such exports from Canada to China and Europe could reduce global emissions by 70 Mt annually.

5.4 Potential for Canada to Supply Responsibly Developed Oil to the U.S., China, and the EU

Canada's oil production is subject to oversight by some of the world's strongest regulatory bodies and includes strict land reclamation policies.[241] As a result, Canada has a recognized reputation for responsibly developing its energy resources. However, Canada's current oil production methods are also some of the most carbon-intensive in the world. If Canada is to remain an oil-producing country while being serious about combatting global climate change, it will need to reduce these production-related emissions. Otherwise, the future of its oil production could very well be limited.

This subsection examines the emissions intensity of Canada's oil sands in the context of other global sources of oil and explores how emission intensity improvements coupled with increased exports could reduce the emissions intensity of oil consumption globally.

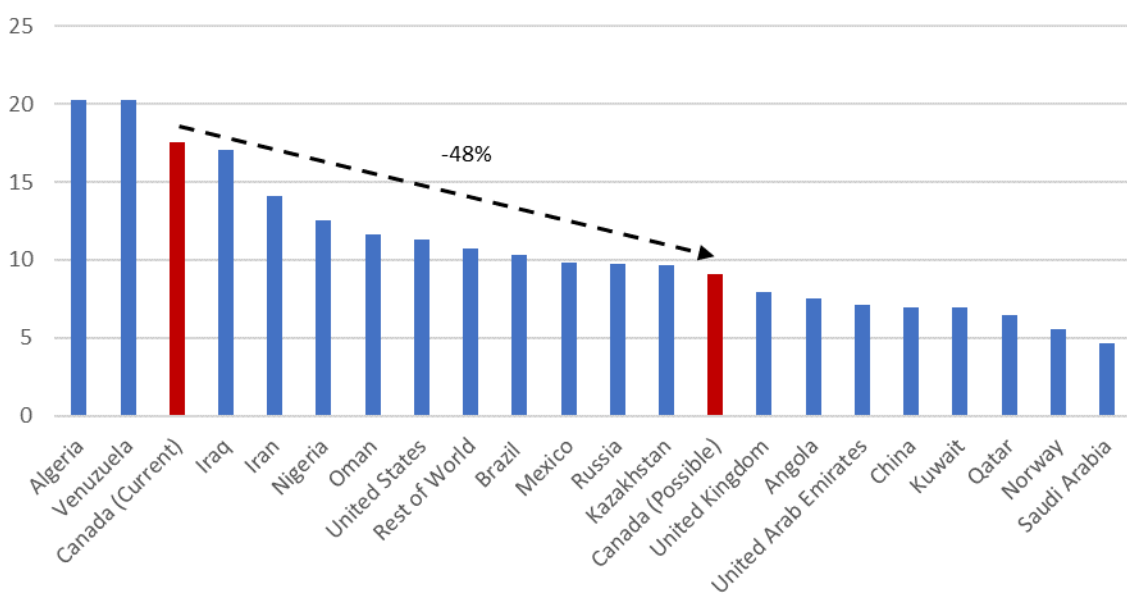
[240] The Canaport LNG terminal has a maximum export capacity of 28 million cubic meters of natural gas per day. This is roughly equivalent to 10 bcm of natural gas per year. Canaport LNG. Website.
[241]Cision, Canadian Oil is Responsible Energy, 2010.

5.4.1 Canada's Oil Sands Emission Profile in the Global Context

Canada's oil is some of the most carbon-intensive in the world, ranking behind Algeria, Venezuela, and Cameroon in terms of emissions per unit of energy produced.[242] Exporting Canadian crude in its current form will not help reduce global emissions. This is in large part due to the amount of energy it takes to extract and process bitumen from the oil sands. However, by using SMR technologies previously discussed, emission reductions could be achieved. This would significantly improve Canada's international ranking noted above, as shown in Figure 94.

Figure 94: Canada's Emissions Amongst the Top 20 Oil Producing Nations – Current vs. Possible

(g CO_2 eq/MJ crude oil)



Sources: Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in The Recovery and Extraction of Crude Bitumen from Canada's Oil Sands, 2015; Nimana et. al., Energy Consumption and Greenhouse Gas Emissions in Upgrading and Refining of Canada's Oil Sands Products, 2015; Masnadi et. al., Global carbon intensity of crude oil production, 2018; CER, Canada's Energy Futures 2019, 2019; Strapolec Analysis.

5.4.2 Emissions Effect of Oil Exports in Target Markets

By improving the carbon intensity of the oil sands output, two related emissions benefits are at play. Canada can reduce the emissions from its current exports, and enjoy a resulting reduction in domestic emissions. However, it can also improve global emissions by displacing other oil producers that have greater upstream emissions than Canada's. This would be a benefit to those concerned about the *upstream emissions* of their oil supply – the amount of carbon released by producing, refining, transporting and burning the oil products they consume. While this analysis mentions the impact on Canada's emissions, its focus is Canada's contribution to global emissions reduction.

[242] Masnadi et. al., Global carbon intensity of crude oil production, 2018.

5.4.2.1 Displacing High-Emission Oil in the U.S.

The U.S. is already a major importer of Canadian oil. The emissions released from oil sands production account for 70% of the upstream emissions for all of the oil imported by the U.S. If Canada can reduce the emissions intensity of its oil production, it could reduce the emissions associated with U.S. oil imports by as much as 77 Mt. The majority of these reductions would result from reducing the emissions content of Canada's existing export volumes to the U.S.

Canada could also reduce the U.S.'s upstream emissions by displacing more carbon-intensive oil imported from other countries. The U.S. currently imports from 17 countries that produce oil that is more carbon-intensive than Canada's could be. These countries include Algeria, Venezuela, Iraq, and Mexico. If all of Canada's oil to the U.S. only displaced oil from these countries, it would reduce the lifecycle emissions content of the U.S.'s oil supply by 10 Mt annually. These benefits are summarized in Table 9.

Table 9: Maximum Upstream Emission Reductions in U.S. Oil Supply

	Oil Imports 2018	Carbon Intensity of Oil Production	Total Emissions
	(Peta Joules)	(g CO_2/MJ)	(Mt CO_2/year)
Top Emitting Countries in Mix	3,651	(Various)	43
Growth in new pipeline capacity	8,332		
SMR Scenario			
Canada (New Exports)	3,651	9.12	33
Net Improvement Over Current Trading Partners			**-10**

Sources: EIA, Petroleum and Other Liquids, March 31, 2020; Masnadi et. al., Global carbon intensity of crude oil production, 2018; Strapolec Analysis. Note: Numbers shown are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

5.4.3 Displacing High-Emission Oil in China

Canada currently exports only small quantities of oil to China, and as a result, could only reduce the emissions content of this oil by 1 Mt by reducing the carbon intensity of the oil sands. However, Canada's export capacity to China is set to increase once the Trans Mountain Expansion pipeline project is completed, enabling greater export volumes. If all oil transported from this pipeline is exported to China, and only displaces oil from the highest-emitting countries in China's supply mix, it could reduce global emissions by 12 Mt annually. In total, Canada's exports could reduce the annual upstream emissions of China's oil supply by 13 Mt. These benefits are summarized in Table 10.

Table 10: Maximum Upstream Emission Reductions in China Oil Supply

	Oil Imports 2018	Carbon Intensity of Oil Production	Total Emissions
	(Peta Joules)	(g CO_2/MJ)	(Mt CO2/year)
Top Emitting Countries in Mix	1,289	(Various)	25
Growth in New Pipeline Capacity	1,233		
SMR Scenario			
Canada (New Exports)	1,233	9.12	11
Difference from Displacing Top Emitting Partners			-24
Net Improvement Over Current Trading Partners – Accrues Globally			**-12***

*Sources: China Customs Database for China oil imports, 2019; Masnadi et. al., Global carbon intensity of crude oil production, 2018; Strapolec Analysis. Note: *Numbers shown are rounded and may not exactly sum. Calculations were performed using unrounded numbers.*

5.4.4 *Displacing High-Emission Oil in the EU*

Canada's oil could help the EU meet its goal of reducing the emissions intensity of its fuel supply. Canada already exports oil to the EU and can save 2 Mt of upstream emissions annually by reducing the emissions intensity of these exports. Greater emissions reductions are possible: if the Energy East Pipeline would be revisited, it would allow Canada to export greater volumes of oil to the Atlantic coast; and, if all of the Energy East pipeline-transported oil was exported to EU countries to displace higher-emitting supplies from other countries, Canada could reduce the upstream emissions of the EU's oil supply by 22 Mt annually. These benefits are summarized in Table 11.

Table 11: Maximum Upstream Emission Reductions in EU Oil Supply

	Oil Imports 2018	Carbon Intensity of Oil Production	Total Emissions
	(Peta Joules)	(g CO_2/MJ)	(Mt CO_2/year)
Top Emitting Countries in Mix	2,542	(Various)	47
Growth in New Pipeline Capacity	2,300		
SMR Scenario			
Canada (New Exports)	2,300	9.12	21
Difference from Displacing Top Emitting Partners			-43
Net Improvement Over Current Trading Partners – Accrues Globally			**-22**

Sources: Eurostat, Database; Masnadi et. al., Global carbon intensity of crude oil production, 2018; Strapolec Analysis. Note: Numbers shown are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

The EU Fuel Quality Directive was passed in 2009 and includes a target to reduce the lifecycle emissions intensity of the EU's fuel supply by 6% by 2020. This reduction is calculated using a 2010 baseline of 94.1 grams (g) CO_2eq/MJ, which yields a total reduction requirement of 5.6 g CO_2eq/MJ .[243] By reducing the upstream emissions of the EU's oil supply by 24 Mt annually, Canada would reduce the carbon intensity of their oil supply by 0.6 g CO_2/MJ, helping to meet 11% of the Directive's reduction target.

5.4.5 *Implications of Oil Exports and Emissions Reductions*

In total, Canada would have to produce and export roughly 7 MMb/d per year to simultaneously achieve the aforenoted emission reductions in the U.S., China, and the EU. This volume is greater than the CER's

[243] European Commission, Fuel Quality. Website.

projection of 6 MMb/d of bitumen being available for export in 2040.[244] Since these export volumes and emission reductions would test the limits of Canada's production, they represent the maximum case.

5.5 Summary

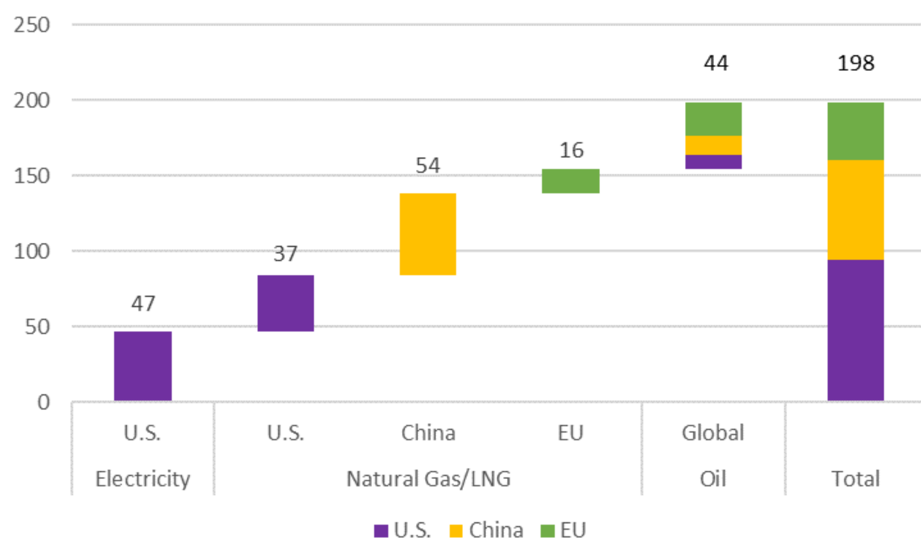
Canada's abundant energy resource options represent a competitive advantage in the global energy marketplace. Canada can produce significant amounts of electricity, natural gas, and oil for export. Canada's electricity is primarily generated by low-carbon sources with further opportunities to reduce emissions from its domestic fossil fuel sector.

Exports of Canada's low-carbon electricity could help the U.S. reduce emissions by 47 Mt annually. P2G natural gas sold to the U.S. from the Dawn Hub could reduce U.S. emissions by another 0.1 Mt per year. Replacing U.S. coal generation with Canadian natural gas could reduce their emissions by a further 37 Mt annually.

Canadian LNG exports to China and the EU to displace coal in these markets could reduce global emissions by 70 Mt. Canadian oil exports to these three markets could help reduce global emissions by 44 Mt per year by displacing higher-emitting production in the current oil supplies to these markets.

Through these exports, Canada could help reduce global emissions by 198 Mt per year, as summarized in Figure 95.

Figure 95: Global Emissions Benefits of Exporting Canadian Energy
(Mt CO_2 eq/year)



Source: Strapolec Analysis. Numbers shown are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

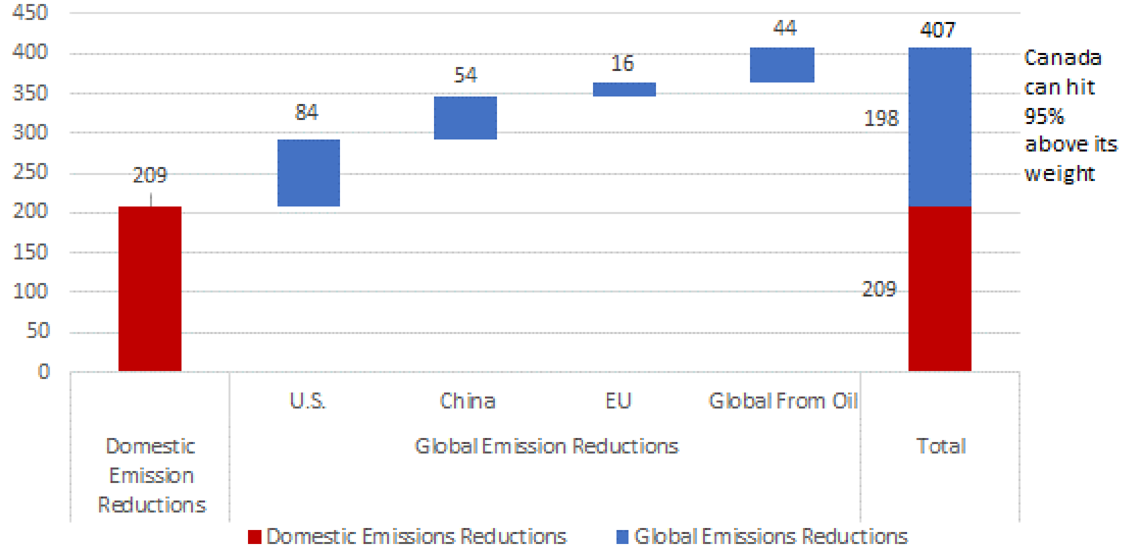
[244] CER, Canada's Energy Future 2019, 2019.

In the context of Canada's emissions, its 2030 target of 30% below 2005 emissions levels would be a reduction of 209 Mt. Together, these domestic and global emission reductions could help the world cut its annual emissions by 407 Mt as shown in Figure 96 – almost double Canada's 2030 domestic target.

These advantages enable Canada to hit above its weight and be a world leader in the global effort to reduce carbon emissions through the export of low-carbon energy.

Figure 96: Total Emissions Reductions from Electrification and Energy Exports

($Mt\ CO_2eq$/year)



Source: Strapolec Analysis. Numbers shown are rounded and may not exactly sum. Calculations were performed using unrounded numbers.

6 Recent Energy Projects Across Canada Have Encountered Challenges

This section examines the challenges inhibiting Canada in the development of its energy infrastructure. Many energy infrastructure projects have been advanced in recent years, however, most have faced significant challenges — unfavourable market conditions, stakeholder opposition, and political uncertainty – that have caused delays and/or cancellation. This section explores several recent, high-profile Canadian energy projects and the challenges they have faced. These projects include hydroelectric and nuclear projects, electricity transmission lines, LNG infrastructure, and oil pipelines as shown in Table 12. The section concludes with a summary of the pan-Canadian nature of Canada's energy projects and stakeholders involved.

Table 12: Canadian Energy Infrastructure Projects

Generation Projects			
From	To	Project Title	Capacity (MW)
B.C.	B.C.	Site C Dam	1,100
MAN	MAN	Keeyask Dam	695
ON	ON	Lower Matagami	438
ON	ON	Nuclear Refurbishment	9,744
ON		Nuclear DGR	NA
QB	U.S.	La Romaine	1,550
NL	NL, NB U.S.	Muskrat Falls	824
Transmission Projects			
From	To	Project Title	Capacity (MW)
MAN	U.S.	Manitoba-Minnesota Transmission Line	885
ON	U.S.	ITC Lake Erie Connect	1,000
QB	U.S.	Champlain-Hudson Power Express	1,000
QB	U.S.	New England Clean Power Link	1,000
QB	U.S.	Northern Pass	1,090
QB	U.S.	New England Clean Energy Connect	1,200
NB	U.S.	Atlantic Link	1,000
NL	NB, NS	Maritime Link	500
Oil Pipelines			
From	To	Project Title	Capacity (MMb/d)
AB, SASK, via B.C.	Asia	Trans Mountain Expansion	0.89
AB, SASK, via B.C.	Asia	Northern Gateway	0.53
AB, SASK, via BC	U.S.	Keystone XL	0.83
AB, SASK, via MAN, U.S.	U.S.	Enbridge Line 3	0.76
AB, SASK via MAN, ON, QB, NB	EU	Energy East	1.10
Natural Gas/LNG Projects			
From	To	Project Title	Capacity (bcm/y)
BC	Asia	Coastal Gaslink	35
AB, SASK via ON, QB	EU	Énergie Saguenay	15

6.1 Electricity Generation Projects

In recent years, several major electric generation projects have been proposed. These have been either new hydroelectric generating stations or refurbishments of existing nuclear reactors, with the exception of Deep Geological Repository projects (DGR) for long-term management of nuclear waste.

6.1.1 Hydroelectric Projects

Canada has seen five major hydroelectric projects in recent years, one of which has been completed, and four are still under construction. Most of these projects have faced opposition from First Nation communities and/or cost and schedule overruns. Indigenous peoples are concerned about large-scale flooding and negative impacts on land use on their territorial lands. Poor project management and oversight have led to ballooning project costs in almost all cases. Nevertheless, these projects when built still promise to deliver efficient, low-carbon electricity for decades to come.

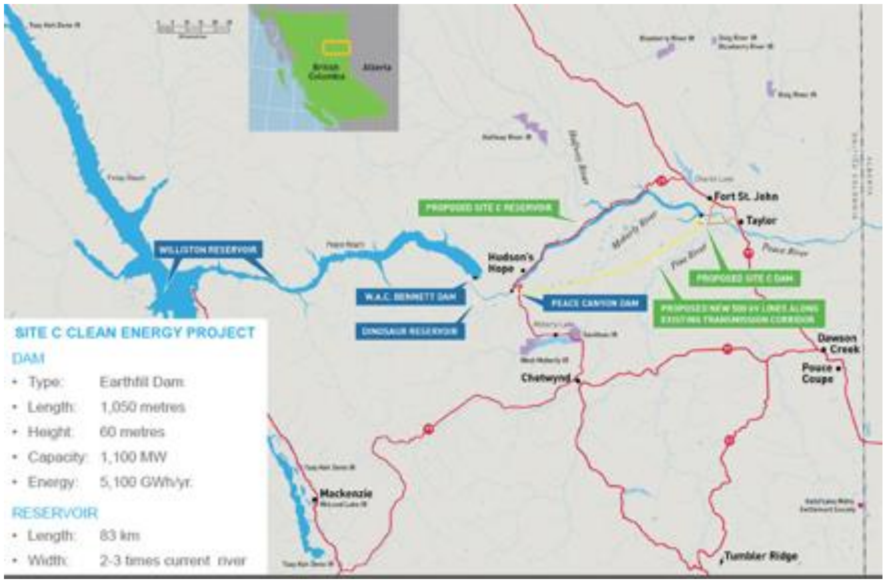
6.1.1.1 Site C Project

The Site C project is a 1,100 MW capacity hydroelectric dam currently under construction on the Peace River in BC. It is the third such dam on the river and takes advantage of the existing and much larger W.A.C. Bennett dam and Williston Reservoir upstream, shown in Figure 97. The project began construction in 2015 and is scheduled to be completed in 2025.[245] The project involves flooding 5,550 hectares of land, which has drawn opposition from local First Nations groups, farmers, and environmental groups.[246] The project is behind schedule, and its budget has grown from the original $8.3 billion to $10 billion.[247]

The West Moberly and Prophet River First Nations continue to oppose the project. They argue that clear-cutting and flooding for the dam would destroy culturally-significant habitats and ecosystems, while flooding would destroy burial grounds and inundate the last section of the Peace River Valley still available for their members to engage in traditional practices.[248] This would amount to “irreparable damage” to their territory and way of life, which are rights protected under their treaty with the Crown. In 2018, a court injunction filed on this basis was rejected on the grounds that it would “needlessly” throw the project into disarray. The two First Nations have launched another challenge and are expected to go to court in 2022, in a trial their lawyers say could result in an “11th hour” cancellation of the project.[249]

[245] Site C Clean Energy Project. Website.
[246] Global News, Everything You Need to Know About the Site C Dam, 2016.
[247] CBC, B.C. Government to Go Ahead with Site C Hydroelectric Dam Project, 2017.
[248] The Narwhal. ‘We’re going to court’: B.C. First Nation to proceed with Site C dam ‘megatrial’, 2019.
[249] CBC, Site C Dam Could Still Be Cancelled At '11th Hour' If First Nations Successful in Court, 2019.

Figure 97: Map of Site C Dam Area



Source: Andrew Weaver MLA, Wind Power or Site C Dam: What Makes Cents? 2013.

The reservoir area would also flood productive farmland, which has prompted resistance from local farmers, and wildlife habitats, which has led to resistance from environmental groups opposing habitat loss.[250]

B.C.'s Premier Horgan considered cancelling the dam when he came to power in 2017 but found that doing so would result in a 12% increase in hydro rates in 2020, with forecasted rates being twice as high for the next 20 years. As a result, the provincial government decided to proceed with the project later that year, and construction continues.[251]

6.1.1.2 Keeyask Generating Station

The Keeyask Generating Station is a 695 MW hydroelectric dam currently under construction on the lower Nelson River in northern Manitoba, as shown in Figure 98. The project is being developed by the Keeyask Hydropower Limited Partnership (KHLP), between Manitoba Hydro and four Manitoba Cree First Nations: Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation, and Fox Lake

Figure 98: Keeyask Generating Station Location

Source: Keeyask Hydropower Limited Partnership, Website.

[250] Global News, Everything You Need to Know About the Site C Dam, 2016.
[251] CBC, B.C. Government to Go Ahead with Site C Hydroelectric Dam Project, 2017.

Cree Nation. Manitoba Hydro will own at least 75% of the project, with the four First Nations sharing the remaining 25% of the partnership. [252]

The project has experienced cost and schedule overruns. Originally estimated to cost $6.5 billion and be in service by November 2019, project costs have grown to $8.7 billion and the completion date extended by 21 months.[253] A recent report suggests that the project could end up costing as much as $10.5 billion. Deficient project management and control by Manitoba Hydro was cited as a key reason for these outcomes. The project is now expected to be completed by August 2021.[254]

6.1.1.3 Lower Mattagami Project

The Lower Mattagami project, as shown in Figure 99, involved a series of upgrades to existing hydroelectric dams on the Lower Mattagami River in Ontario and was completed by OPG in 2015. Six new generating stations were added to four of OPG's existing hydroelectric generating facilities, resulting in a total capacity increase of 438 MW.[255] Since the project was replacing existing facilities no additional land was flooded.

Figure 99: Lower Mattagami Project Location

Source: Toronto Star, OPG and Moose Cree start new hydro development, 2010

The project was a partnership between OPG and the Moose Cree First Nation, in which the latter received $300 million in construction contracts, training, and employment opportunities, and a 25% equity share in the project. Given that the life of the dams is over 90 years, this equity will be a long-term revenue source for the First Nation. Some of the capital invested by the Moose Cree came from settlements associated with the construction of the initial dams.[256]

The project was completed in 2015, ahead of schedule and on-budget.[257]

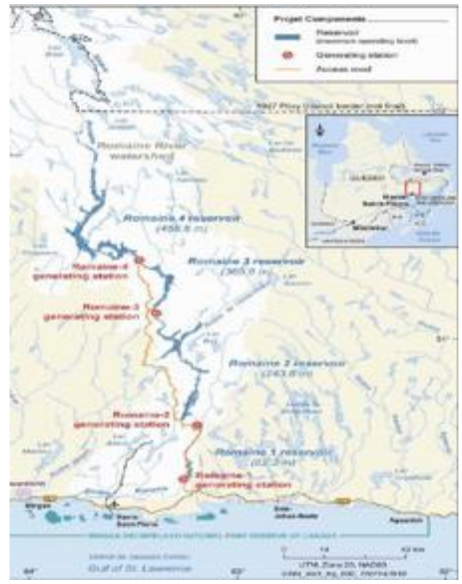
6.1.1.4 La Romaine Complex

The Romaine Complex is a 1,550 MW hydroelectric project currently being constructed by Hydro Quebec on the La Romaine River. The complex consists of four separate dams and generation facilities arranged in a sequence down the river, as shown in Figure 100. Work on the project began in 2009. Three of the stations are operational, having

[252] Keeyask Hydropower Limited Partnership. Website.
[253] CBC, Keeyask Dam Cost Estimate Balloons by $2.2B, 2017.
[254] CBC, Keeyask Dam Cost Could Reach $10.5 Billion, Report Warns, 2017.
[255] OPG, Lower Mattagami River Project. Website.
[256] The Toronto Star, OPG And Moose Cree Start New Hydro Development, 2010.
[257] Cision, Lower Mattagami Hydroelectric Project Completed Ahead Of Schedule And On Budget, 2015.

entered into service in 2014, 2015, and 2017 respectively. The last station will be complete in 2021.[258] The project appears to be proceeding without budget or schedule delays.

Figure 100: Romaine Complex Location



Source: Vlad Alicescu, Construction Of La Romaine Complex In Northern Quebec, Canada: Five Years Of Great Accomplishments, 2014.

The project was originally opposed by communities belonging to the Innu of Takuaikan Uashat mak Mani-Utenam (ITUM) First Nation, whose lands would be affected by the project. Members of the First Nation erected several blockades on roads into the site between 2012 and 2015. Protesters alleged that Hydro Quebec violated their rights by flooding basins and constructing power lines without consent from the Innu.[259,260] The First Nation came to an agreement with Hydro Quebec in 2015, whereby Hydro Quebec would provide jobs and contracts to the community, and pay them $6.6 million up front and $75 million over 60 years.

However, the actual payments of these benefits were held up by a legal impasse. The deal was contingent on the Innu dropping all legal challenges concerning the Romaine project and other hydro projects in the area. At the time, lawsuits were being put forward by both the ITUM council and several of the Innu nation's traditional families. While the council dropped their lawsuit, the families did not, and the agreement has since been declared null and void. While Hydro Quebec says the requirement for the families to drop their lawsuits was necessary to obtain unanimity in the community, the ITUM council argues it was a means to ensure the deal never went through. In February 2020, the ITUM council launched a $9.1 million lawsuit against Hydro Quebec for continuing with the project while the benefits went unpaid. In their case, they argue that the Attorney Generals of both Quebec and Canada did not do enough to resolve the legal impasse. [261]

6.1.1.5 Muskrat Falls

Muskrat Falls is an 824 MW hydroelectric project in Labrador, run by the Newfoundland and Labrador Crown Corporation, Nalcor.[262] The project has experienced cost and schedule issues. It was planned and sanctioned in 2012 and was expected to begin generating electricity in 2019.[263] As of March 2020, the project is still under construction, and its budget has doubled to $12.7 billion. Current delays may

[258] Hydro Quebec, Projet de la Romaine. Website.
[259] CBC, Quebec Urges Innu Community to Stop Blockade Near La Romaine, 2015.
[260] CBC, Police Remove Blockade At La Romaine Hydro Complex, 2012.
[261] La Presse, Entente entre Hydro et les Innus: «Les gens ont l'impression de s'être fait mener en bateau», 2020.
[262] CBC. Nalcor Announces Another Setback For Muskrat Falls Transmission Software, 2020.
[263] Global News. Audit Finds Muskrat Falls Cost Overruns Became Obvious Soon After Megaproject Got Underway, 2019.

increase this even further.[264] The project is located on the Churchill River in Labrador, as shown in Figure 101.

Most of the project's issues appear to result from poor management practices by Nalcor and its contractors. A forensic audit found that executives overseeing the project should have known that its cost and schedule targets were unrealistic. Six months after the contract was sanctioned, Nalcor had exhausted its contingency fund and should have been aware that the project was behind schedule. Bids for construction contracts exceeded Nalcor's estimates by 60% to 160%, and their selected contractor, Astaldi, was found to be responsible for $1.2 billion in cost overruns.[265] Despite these issues, full commercial power-up to the site's 824 MW capacity is scheduled for the end of 2020.[266]

Figure 101: Muskrat Falls Location

Source: Toronto Star, Harper guarantees loan for giant Muskrat Falls hydro project, 2012

Inuit communities living downstream of the dam and reservoir opposed the project due to concerns about mercury poisoning caused by flooding of the reservoir. When vegetated land is flooded, it can cause a rapid release of mercury into the water as plants and trees decompose en mass. Research indicated that the flooding of the Muskrat Falls reservoir would cause a spike in methylmercury – a toxic substance – in wild food sources used by Indigenous communities downstream.[267] This could be avoided if the reservoir was first "capped", covered in sand and clay to prevent the release of methylmercury.[268]

In October 2016, under pressure from the Inuit Nunatsiavut Government, Newfoundland and Labrador Premier Dwight Ball agreed to lower water levels in the reservoir until mercury mitigation measures could be put in place. However, cost and schedule overruns meant that the project missed the window to do so, and by the Fall of 2017 flooding of the reservoir began. [269] As a result, the project has proceeded, but without mercury mitigation

[264] CBC, Nalcor Announces Another Setback For Muskrat Falls Transmission Software, 2020.
[265] Global News, Audit Finds Muskrat Falls Cost Overruns Became Obvious Soon After Megaproject Got Underway, 2019.
[266] CBC, Nalcor Announces Another Setback For Muskrat Falls Transmission Software, 2020.
[267] Calder et. al, Future Impacts of Hydroelectric Power Development on Methylmercury Exposures of Canadian Indigenous Communities, 2016.
[268] Global News, Halt Muskrat Falls Flooding Until Methylmercury Issue Addressed: Inuit Leader, 2019.
[269] Nunatsiavut Government, Key Muskrat Falls Commitment Not Being Honoured, 2017.

measures. In response, Nunatsiavut Governor Johannes Lampe said that Premier Ball had "betrayed their trust" and put their health and culture at risk.[270]

6.1.2 Nuclear

Despite its long track record of safe and reliable operation in Canada, nuclear energy does not experience widespread public acceptance in most provinces across the country.

6.1.2.1 Refurbishment

Canada's CANDU reactors were designed to be refurbished half-way through their intended life. Refurbishment means the process of modernizing and enhancing major systems and equipment to support long-term operation.[271] In Ontario, OPG and Bruce Power (BP) have committed to refurbishing two major nuclear power plants, the 3,512 MW Darlington Nuclear Generating Station and the 6,232 MW Bruce Nuclear Generating Station. The refurbishment projects will extend the plants' operating lives to 2055 and 2064, respectively.[272,273]

The refurbishment of the Darlington plant began in 2016 and is scheduled to be completed in 2026. Each of the unit's four reactors will be shut down and refurbished sequentially, with no more than two reactors being offline at the same time. The entire project has been estimated to cost $12.8 billion.[274] OPG is an Ontario crown corporation and so the funding for the project is backstopped by the province.

Refurbishment of the Bruce plant is scheduled to begin in 2020 and conclude in 2033 and will involve six of the plant's eight reactors being shut down in sequence. Refurbishment of the reactors is estimated to cost $13 billion with an additional $5 billion being spent on other life-extension or asset management work out to 2053.[275] Bruce Power is a private company that is fully financing these projects in exchange for a long-term, conditional, Power Purchase Agreement with the Province.

The Bruce refurbishment project was criticized by the Canadian Environmental Law Association in 2019 for proceeding without a full environmental assessment required by recently-enacted federal legislation. However, the project had already received licensing from the Canadian Nuclear Safety Commission (CNSC), and Bruce Power insisted that a rigorous review of environmental effects had been conducted as part of that process. The opposition argued that the CNSC review was less comprehensive than an environmental assessment, and was therefore insufficient.[276] Despite this criticism, public support for the refurbishment project was generally high. A poll conducted by the Canadian Nuclear Association

[270] Global News, Halt Muskrat Falls Flooding Until Methylmercury Issue Addressed: Inuit Leader, 2019.
[271] Canadian Nuclear Safety Commission, Refurbishment and Life Extension. Website.
[272] Bruce Power, Life-Extension Program & MCR Project. Website.
[273] OPG, Darlington Refurbishment. Website.
[274] World Nuclear Association, Nuclear Power in Canada, 2020.
[275] World Nuclear Association, Nuclear Power in Canada, 2020.
[276] The London Free Press, Bruce Power, Regulator Defend Environmental Work Faulted by Legal Group, May 10, 2019.

found that 76% of Ontarians supported the refurbishment project, and many viewed nuclear in general in a positive light.[277]

The Saugeen Ojibwe Nation (SON), whose traditional lands host the Bruce site, also took issue with the refurbishment plans. The SON have been concerned about the effects of the plant's intake and release of coolant water, which harms fish and their eggs and increases the temperature of Lake Huron. This is contrary to the SON's cultural connection to the lake and its fisheries. The SON have worked with Bruce Power to commission studies on the plant's effect on Lake Huron and its wildlife, but were not satisfied with the collected data. As a result, SON criticized the decision to extend the life of the plant – and therefore its effects on the environment – while these issues remained outstanding. SON also alleged that Bruce Power's application to refurbish the plant was based on a faulty environmental assessment and failed to take into account the risks posed to the SON by increased volumes of nuclear waste and the longer operating timeframe in which accidents could occur. Given these issues and the short timeframes of the regulatory process, the SON claimed Bruce Power had not met its duty to consult with them over the impacts of the project. [278]

Given these objections, the SON requested that Bruce Power not proceed with the refurbishment project until several measures were agreed upon. These included commissioning a study of the plant's effect on fisheries in Lake Huron and a mitigation strategy, with direct and active participation and oversight by the SON.[279] Bruce Power has taken steps to meet this request and in 2019 the company agreed to provide three years of funding for a collaborative study with the SON on Lake Huron's coastal environment, and the Bruce plant's effects on it.[280]

6.1.2.2 Deep Geological Repository

The Nuclear Waste Management Organization's (NWMO) Deep Geological Repository (DGR) project is an ongoing effort to find a permanent, underground storage site for Canada's high-level nuclear waste (primarily used fuel). The NWMO has been consulting with municipalities and First Nations and Métis communities since 2010 and has narrowed its site options from 22 to 2 municipalities: South Bruce, ON and Ignace, ON.[281]

OPG also needs a DGR for the low and intermediate waste from both its ongoing operations and the refurbishment programs. OPG had proposed a site near Ontario's Bruce Nuclear Generating Station near Lake Huron, which would have seen low and intermediate waste buried 680 meters underground in impermeable bedrock.[282]

Permission to develop the OPG site requires agreement from local communities and the Saugeen Ojibway First Nation. Despite efforts to show that the site's design was risk-free, the perception of a

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[277] CNA and Innovative Research Group, Public Attitudes Toward Refurbishment, 2018.
[278] Canadian Nuclear Safety Commission, Oral Presentation: Submission from the Saugeen Ojibway Nation, 2018.
[279] Canadian Nuclear Safety Commission, Oral Presentation: Submission from the Saugeen Ojibway Nation, 2018.
[280] Saugeen Ojibway Nation, SON Coastal Waters Environmental Monitoring Program, March 21, 2019.
[281] NWMO, Nuclear Waste Management Organization. Website.
[282] NWMO, The NWMO's Municipal Forum. Website.

nuclear waste site situated near a Great Lake led the SON to reject the plan by a large margin.[283] Businesses near the proposed site also expressed concerns about the negative impacts the image of a nuclear waste site could have on their operations and customers.[284]

OPG has respected the SON's decision to withhold consent for the Bruce country location, and have declined to move forward with the project there. For the NWMO, the SON's vote did not concern the proposed sites in South Bruce County or Ignace in Northern Ontario.[285] However, both situations highlight the need to address these significant challenges if Canada's nuclear industry is to grow.

6.1.3 Electricity Generation Project Summary

Canada's ongoing power generation investments — four new hydro projects, two nuclear refurbishment programs and the DGR — are summarized in Table 13. The hydro projects represent 4,607 MW of new generation capacity, and are distributed across the country from B.C. to Labrador. The nuclear refurbishment projects are concentrated in Ontario and will sustain 9,744 MW of generating capacity for decades to come. While not a generating facility, the DGRs are a critical and necessary part of the nuclear lifecycle. These projects all contribute to helping Canada sustain its clean energy advantage, but also highlight issues with Indigenous participation that must be addressed. The Mattagami project is an example of what is possible with a partnership approach.

Table 13: Generation Projects Summary

Type	Name	Location	Capacity (MW)	Status
Hydro	Site C	B.C.	1,100	Approved, under construction.
	Keeyask	Manitoba	695	Approved, under construction
	Lower Matagami	Ontario	438	Complete
	La Romaine	Quebec	1,550	Approved, under construction
	Muskrat Falls	Newfoundland and Labrador	824	Approved, under construction
	Total New Hydro Capacity		**4,607**	
Nuclear	Darlington Refurbishment	Ontario	3,512	Underway
	Bruce Refurbishment	Ontario	6,232	Planned
	DGR	Ontario	0	In site-selection process
	Total Renewed Nuclear Capacity		**9,744**	

6.2 Electricity Transmission Projects

Electricity transmission line projects have encountered opposition from local communities in the U.S., as well as First Nations groups in Canada. This section highlights eight such projects.

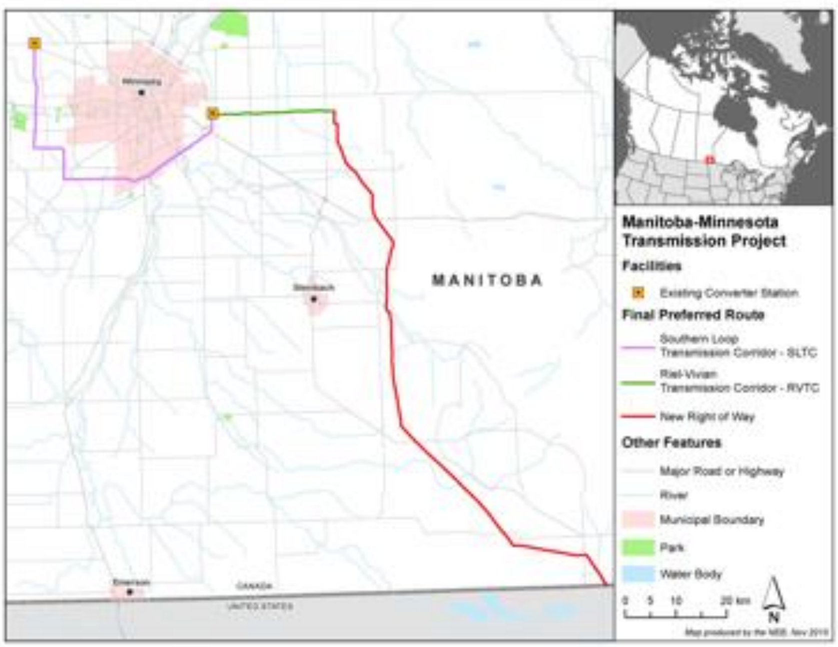
[283] APTN National News, Opportunity for Youth or Sacrifice Zone? Community Reaction to Nuclear Waste Burial Plan is Mixed, 2020.
[284] CBC, Nuclear Ice Cream Is Not How This Ontario Dessert Maker Wants to be Known, 2020.
[285] The Sun Times, OPG to explore other options to Bruce DGR proposal after SON vote, 2020.

6.2.1 Manitoba-Minnesota Transmission Line

The Manitoba-Minnesota Transmission Line is planned to run from Winnipeg, Manitoba, to the border with Minnesota, where it would connect to a separate transmission line in the U.S. as shown in Figure 102. The line is currently under construction and will increase Manitoba's electricity export capacity by 885 MW or 45%.[286] The project is running ahead of schedule and is expected to be completed by June 2020. Manitoba's government claims that the line will reduce emissions in the U.S. by 1.5 Mt by displacing coal with clean electricity.[287]

The project has been challenged in court by the Sagkeeng First Nation, who claim insufficient consultation. While the Nation's reservation is not located along the route, the line would cross their treaty territory impacting their rights to hunt, fish, and gather. While Manitoba Hydro did consult with the Sagkeeng, the Nation claims it was not a proper dialogue but just "box ticking". The Sagkeeng are seeking compensation for unavoidable impacts and want Manitoba Hydro to pledge to avoid preventable impacts on traditional lands by making route changes where necessary. A court decision is not expected until sometime in 2020. Five other First Nations – the Roseau River, Swan Lake, Long Plain, and Brokenhead – opted to address their issues with the project through the appeals process made available via the environmental licensing agreement. The Manitoba Métis Federation also took this approach.[288]

Figure 102: Manitoba-Minnesota Transmission Line Project Route



Source: Impact Assessment Agency of Canada, Manitoba-Minnesota Transmission Project, 2018.

[286] CBC, Feds approve $435M Manitoba-Minnesota Transmission Line, 2019.
[287] CBC, Manitoba-to-Minnesota Power Line Project Begins Ahead of Schedule, 2019.
[288] CBC, 'That is not consultation': Manitoba First Nation fights $453M Manitoba-Minnesota power line in court, 2019.

6.2.2 ITC Lake Erie Connector

The ITC Lake Erie Connector is a proposed electric transmission line that would connect Ontario's IESO to the PJM electricity market in the U.S. via an underwater cable submerged in Lake Erie, as shown in Figure 103. The line would begin at the site of a former coal generation facility in Nanticoke, Ontario, and end at Erie, Pennsylvania. It would have a capacity of 1,000 MW, and be capable of flows from both directions.[289]

Figure 103: ITC Lake Erie Connector Route

Source: ITC Lake Erie Connector. Website.

The line would form the first direct connection between the IESO and PJM electricity markets. PJM is the largest energy market in the world, comprising all or part of 13 U.S. states. ITC claims the project would provide benefits by adding electric transmission capacity between Ontario and the U.S., lowering transactional costs for electricity trade, and opening up the possibility of capacity and renewable energy credit trading between the two markets.[290]

The project would not cross any reserves or Indigenous treaty lands, but it would come close to two First Nations communities: the Mississauga of the New Credit and the Six Nations of the Grand River. It would also pass near a tract of land considered significant to the Six Nations.[291] ITC Lake Erie engaged with both First Nations, and both said they supported the project, were satisfied with the consultation process, and were interested in the economic opportunities it presented.[292]

While the project received approval from both Canadian and U.S. governments in 2017, ITC requires $1.2 billion in investment to move the project forward. The project has been stalled since 2017 as a result.[293,294]

[289] ITC, Lake Erie Connector, 2020.
[290] The Brattle Group, Lake Erie Connector Market Assessment Report, 2015.
[291] ITC Lake Erie, Project Description: Lake Erie Connector, 2015.
[292] Regulatory Law Chambers, Reasons for Decision: ITC Lake Erie International Power Line (Neb Decision Eh-001-2015), 2017.
[293] Environmental Protection, Canadian Government Approves Lake Erie Connector Project, 2017.
[294] The Hamilton Spectator, Lake Erie Electrical Cable Could Generate $3 Billion For Ontario Taxpayers, 2019.

6.2.3 Champlain-Hudson Power Express

The Chaplain Hudson Power Express (CHPE) is a planned electricity transmission line that will run from Montreal to New York City in the U.S. to supply the latter with electricity from Quebec. Most of the line will be underwater, travelling under rivers and lakes or buried along rail and road rights-of-way as shown in Figure 104. The line would have a capacity of 1,000 MW, which could potentially be expanded to 1,250 MW. [295]

The project encountered some opposition from U.S. communities along the route, as the line would pass under historic graveyards, rail lines transporting oil, and ecologically important marine sites. Several changes to the line's route were made to address these issues, and it gained the consent from all communities involved. Construction is now targeted to start in late 2020, and operations should commence in 2024.[296]

Figure 104: CHPE Route

Source: Transmission Developers Inc., 2014

6.2.4 New England Clean Power Link

The New England Clean Power Link is a proposed 1,000 MW underwater and underground electric transmission line that would run from Quebec to New England via Vermont, as shown in Figure 105. It is supported by the Governor of Vermont, but appears to be struggling to find investors to go forward.[297]

Figure 105: New England Clean Power Link Route

Source: National Observer, Construction of Major Electricity Line from Quebec To New York City Expected to Start In 2020, 2018

6.2.5 Northern Pass

Northern Pass is a now-cancelled electricity transmission line proposed by Eversource in 2011. It would have run from Quebec to the New England grid via New Hampshire, as shown in Figure 106. The line would have been 192 miles long, 60 of which would have been underground, and have a capacity of 1,090 MW.[298]

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[295] National Observer, Construction of Major Electricity Line from Quebec To New York City Expected to Start In 2020, 2018.
[296] National Observer, Construction of Major Electricity Line from Quebec To New York City Expected to Start In 2020, 2018.
[297] WCAX3, Scott administration lending support to Lake Champlain transmission cable, 2018.
[298] Concord Monitor, N.H. Supreme Court Agrees with State's Rejection of Northern Pass Transmission Line, 2019.

Most of the line would have been constructed above-ground. This led to significant public opposition due to the visual effects of the pylons. Communities along the route in New Hampshire believed the pylons would ruin the visual appeal of national forests in the area, which would in turn harm local tourism and lower property values. As a result of this opposition, and despite the support of New Hampshire Governor Sununu, the project was rejected by a state committee in 2018 on the grounds that it would "unduly interfere with the orderly development of the region." This decision was later upheld by the New Hampshire Supreme Court in 2019.[299] Following these decisions, Eversource officially stated that there was no path forward for the project.[300]

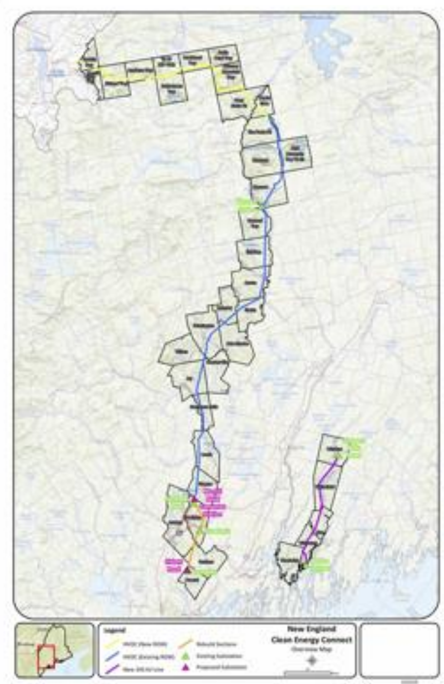
Figure 106: Northern Pass Route

Source: The Globe and Mail, Hydro-Québec's Northern Pass project met with broad criticism in U.S, 2017

6.2.6 New England Clean Energy Connect

The proposed New England Clean Energy Connect (NECEC) is a transmission line that would run from Quebec to Massachusetts via Maine, as shown in Figure 107. It would follow existing lines requiring widening these rights-of-ways. It would be entirely overhead and have a capacity of 1,200 MW. NECEC has secured contracts to deliver power to Massachusetts utilities starting in 2022.

Figure 107: New England Clean Energy Connect Route



Source: Clean Energy Connect. Website.

Like the Northern Pass line, the NECEC has encountered opposition about the visual and tourism impacts from host communities. The clearing required to expand rights-of-ways has also sparked opposition over the harm caused to forests and wildlife. Opponents also argue that this cheaper alternative would out-compete local renewable generation sources. NECEC is spending $2.2 million on lobbying and public relations efforts to build support for the project. Its outcome could be decided by referendum included on the November 2020 Presidential ballot.

6.2.7 Maritime Link

The Maritime Link is a 500 MW underwater and overland transmission line from Newfoundland to Nova Scotia built by Emera, as shown in Figure 108.[301] It was completed in 2017, but its underwater portion had to be re-buried at extra cost to accommodate a seafloor fishing boom in 2020. The line was built to supply Nova Scotia and New England with 20% of the power from Newfoundland and Labrador's Muskrat Falls hydropower project.[302]

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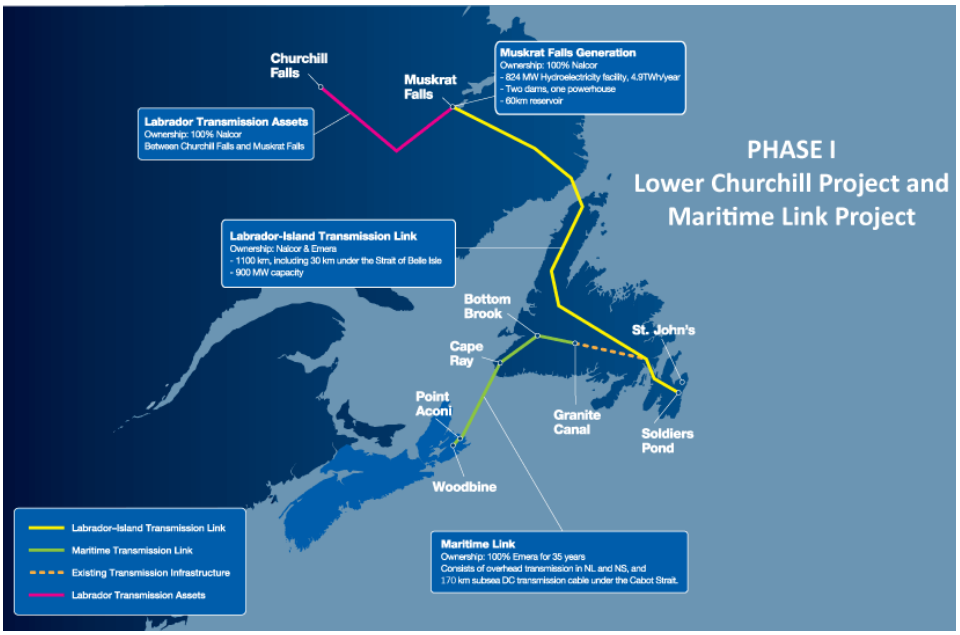
[299] Concord Monitor, N.H. Supreme Court Agrees with State's Rejection of Northern Pass Transmission Line, 2019
[300] Concord Monitor, Eversource Gives Up on Northern Pass Hydropower Project, 2019.
[301] Emera. Website.
[302] CBC, Emera Forced to Bury A Third of Maritime Link's Submarine Cable. 2019.

This power would be delivered via the associated Labrador-Island Transmission link, a separate 900 MW transmission link between Muskrat Falls and St. John's completed in 2017.[303] However, while the Maritime Link was completed on-time and on-budget, the Muskrat Falls project was heavily delayed, meaning that as of March 2020, Nova Scotia had not received any of the promised power for three years. Furthermore, the Labrador-Island Transmission link encountered software problems in 2019 that could delay its operations until well beyond June 2020.[304] Maritime Link was supposed to be funded by Nova Scotia Power ratepayers, but given these issues, regulators ordered they be refunded for any rates charged for it until it actually provides power.[305] The line will only provide its promised benefits when the Muskrat Falls project becomes operational and the issues on the Labrador-Island Transmission Link are resolved.

Figure 108: Maritime Link Route and Labrador Island Transmission Link



Source: Emera, Website.

6.2.8 Atlantic Link

The Atlantic Link is a proposed 600 km, 1,000 MW underwater transmission line from New Brunswick to southern Massachusetts as shown in Figure 109.[306,307] Owned by Halifax-based Emera Inc, the majority of the power from the line would come from wind in New Brunswick, and hydro facilities like Muskrat Falls in Newfoundland and Labrador delivered via the Maritime Link. The project responds to Massachusetts' bid for 9.4 TWh of clean energy by 2022. However, the state chose the Northern Pass option over the Atlantic Link, and despite the former project later being cancelled, its success in the RFP

[303] Emera, Website.
[304] The Telegram, Labrador-Island Link Issues Could Linger into Next Winter: Liberty Consulting, March 2020.
[305] CBC, NSP Ordered to Refund Millions to Customers, But Bills Not Likely to Shrink, 2020.
[306] Transmission Hub, Atlantic Link, 2018.
[307] Global News, Emera Officials Optimistic They'll Get Clean Energy Deal with Massachusetts, 2017.

prevented Atlantic Link from succeeding. Nevertheless, as of January 2018, Emera was reportedly continuing to advance the line through permit applications.[308]

Figure 109: Proposed Routes for Atlantic Link

Source: CBC, Emera's $2B Atlantic Link loses bid for Massachusetts clean energy deal. January 2018.

6.2.9 Summary of Electricity Transmission Projects

Altogether, Canada has 7 major electricity transmission lines currently proposed or under construction, as summarized in Table 14. The projects have a combined export capacity of 7,175 MW. Five of these interties would bring electricity to grids in the U.S. Northeast representing a combined capacity of 5,490 MW. Most of these projects have been approved by the relevant authorities but have not yet commenced construction.

[308] Natural Resources, Is Emera's Atlantic Link A Lost Cause? April 2018.

Table 14: Canada-U.S. Electricity Transmission Line Projects

U.S. Region	Name	From	To	Capacity (MW)	Status
Minnesota	Manitoba – Minnesota Transmission Line	Manitoba	Minnesota	885	Approved, under construction
PJM	ITC Lake Erie Connector Project	Ontario	PJM via Penn.	1,000	Approved
U.S. Northeast	Champlain Hudson Power Express (CHPE)	Quebec	New York City	1,000	Approved
	New England Clean Power Link	Quebec	New England via VT	1,000	Proposed
	Northern Pass	Quebec	New England via NH	1,090	Cancelled
	New England Clean Energy Connect (NECEC)	Quebec	Mass. via Maine	1,200	Contested
	Atlantic Link	New Brunswick	New England via Mass.	1,000	Proposed
	Maritime Link	NF	New England, Nova Scotia	500*	Completed
	Labrador-Island Transmission Link	NF	NF	900*	Under Construction
	Total Capacity			**7,175**	

Note: Maritime Link and Labrador-Island Transmission Link do not count towards total export capacity to the U.S. as it they are part of the Canadian Tx system that would supply New England via the Atlantic Link.

6.3 Natural Gas Pipelines and LNG

Several LNG export projects have been proposed in Canada, with many proposing to ship LNG from new ports on both the Pacific and Atlantic coasts.[309] However, of these only the Coastal Gaslink project has shown any significant progress, while another promising contender in Quebec, Énergie Saguenay, is struggling to raise funding.

6.3.1 Coastal Gaslink

The Coastal Gaslink project proposes a pipeline that would bring natural gas from North West B.C. to the coast of B.C., where it would be liquified and exported to foreign markets via a new LNG export terminal.[310] The LNG export terminal would have an export capacity of 26 million tonnes of LNG per annum, which is roughly equal to 35 bcm of natural gas per year.[311]

The Coastal Gaslink project is significant as it will be Canada's only large-scale LNG export facility to serve Asian markets. Its capacity will effectively set the volume of natural gas Canada can export to China, at least until further projects are built. However, the project is currently mired in a complex land title dispute that highlights the importance of stakeholder agreements for advancing Canadian energy resource developments.

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[309] NRCan, Canadian LNG Projects, 2018.

[310] CBC, What you need to know about the Coastal GasLink Pipeline Conflict, 2020.

[311] Based on conversion factor of 1.36 bcm natural gas per million tonnes LNG provided by BP, BP Statistical Review of World Energy 2019, 2019.

The key question at the heart of the dispute is about who has the right to approve or disapprove resource projects on land claimed by the Wet'suwet'en First Nation. The Coastal GasLink pipeline would cross the nation's traditional land, which covers 22,000 square kilometres in the interior of B.C., as shown in Figure 110.

The project is supported by the Band Councils of most First Nations along the route, who are the delegated authority over reservation lands under the federal Indian Act. Several of these bands represent Wet'suwet'en communities, and have given their assent to the project.

However, the authority of these bands is limited to the lands that comprise their respective reservations. These lands only represent a small part of the Wet'suwet'en traditional territory. Authority over this territory is claimed by the hereditary chiefs of the Wet'suwet'en First Nation. These chiefs trace their claim to the traditional form of government practiced by the nation before the imposition of the Indian Act. These leaders were also recognised in a 1997 decision by the Supreme Court of Canada.[312]

Unlike the band council leaders, the hereditary chiefs claim the responsibility for taking care of the land and the rights and title to it.[313] Their opposition to pipelines on their territory is based on concerns about construction impacts on the water, fish habitats, and wildlife. The hereditary chiefs are also concerned about the impact of transient workers on the safety of their communities.[314]

As construction work began on the project in early 2020, the hereditary chiefs issued eviction notices to Coastal GasLink workers in accordance with their traditional laws and erected blockades of a key road accessing the territory. This blockade escalated into a standoff with the Royal Canadian Mounted Police, which sparked protests and rail blockades across Canada.[315] By March 2020, the situation had de-escalated, with the blockades cleared and the hereditary chiefs in discussion with the federal and B.C. provincial governments. The ultimate fate of the project remains unclear.

Figure 110: Coastal Gaslink Route and Wet'suwet'en Traditional Territory

Source: CBC, What you need to know about the Coastal GasLink Pipeline Conflict, 2020.

[312] The Canadian Encyclopedia, Degamuukw Case, 2019.
[313] CBC, When Pipeline Companies Want to Build on Indigenous Lands, With Whom Do They Consult? 2016.
[314] CBC, Projects Like Coastal Gaslink Offer 'Life-Changing' Opportunities for First Nations: Haisla Councillor, 2020.
[315] CBC, What You Need to Know About the Coastal GasLink Pipeline Conflict, 2020.

6.3.2 Énergie Saguenay

Énergie Saguenay is a proposed LNG liquefaction and export terminal that would be located in Saguenay, Quebec, and would export natural gas from Western Canada to the EU and beyond.[316] The project is being proposed by GNL Quebec and would be supplied by a new, 650 km long underground natural gas pipeline between the terminal in Saguenay and some point along the TransCanada Eastern Triangle pipeline in northeastern Ontario, as shown in Figure 111.[317] The pipeline project is being led by Gazoduq, a company with the same investors as GNL Quebec.[318] The terminal would export 11 million tonnes of LNG per year, roughly equal to 15 bcm of natural gas per year.[319,320]

Both the pipeline and LNG terminal projects have experienced issues with timelines and investment. They were first proposed in 2014, and GNL Quebec intended to start shipping LNG in September of 2020.[321] However, GNL Quebec only submitted its Environmental Impact Statement to federal regulators in June 2020, and project timelines now slate construction for 2022-2024 and startup in late 2024.[322]

The project made major headlines when it was revealed that billionaire Warren Buffet's investment company Berkshire Hathaway had pulled $4 billion from GNL Quebec, leaving it well short of the $9 billion required. Gazoduq also reported the loss of a major investor but did not identify them. They claimed they still had over $130 million in investment, but this is far short of the $4.5 billion required for the pipeline project. The investors' withdrawal occurred as national rail blockades were ongoing in support of the Wet'suwet'en in their dispute over the Coastal Gaslink pipeline. Berkshire Hathaway cited this "current Canadian context" as their reason to withdraw from this project.[323]

As of August 2020, the project is still working through regulatory review, and it remains to be seen what impact the loss of Berkshire Hathaway's investment will have on its future.[324]

[316] Energy Saguenay. Website.
[317] Energy Saguenay, Appendix A – Project Description.
[318] Gazoduq. Website.
[319] Government of Canada, Energy Saguenay Project, 2020
[320] Based on conversion factor of 1.36 bcm natural gas per million tonnes LNG provided by BP, BP Statistical Review of 2019, 2019.
[321] Energy Saguenay, Appendix A – Project Description.
[322] Gazoduq. Website.
[323] CBC, Warren Buffett's Company Bails on Saguenay LNG Project Because of 'Canadian political context,' Promoter Says, 2020.
[324] Government of Canada, Energy Saguenay Project, 2020.

Figure 111: Proposed Natural Gas Pipeline Route for Énergie Saguenay

Source: Globe and Mail, U.S. investors back $7-billion LNG terminal for Quebec, 2014.

6.3.3 Summary of Natural Gas Pipelines and LNG

While several proposals exist to develop LNG export infrastructure in Canada, only two have made serious progress. The Coastal Gaslink project would supply 35 bcm of natural gas to Asia annually, and the Énergie Saguenay project would supply 15 bcm to the EU annually. However, Coastal Gaslink has sparked a national dispute over Indigenous land rights, which has in turn threatened investment in Énergie Saguenay. As a result, the future of both projects is uncertain.

Table 15: Summary of Natural Gas Pipelines and LNG

Type	Name	From	To	Capacity (bcm/year)	Status
Natural Gas Pipelines and LNG	Coastal Gaslink	B.C.	B.C.	35	May be contested in court
	Énergie Saguenay	AB, SASK via ON, QB	EU	15	Seeking investment

6.4 Oil Projects

Five oil pipeline projects have been proposed in recent years. All were designed to bring oil from the oil sands in Alberta and Saskatchewan to markets on the west or east coasts of Canada and/or south to the U.S. Three of the five projects have been approved and two have been cancelled. Most of the projects encountered public opposition, including from Indigenous groups in Canada and the U.S.

6.4.1 Trans Mountain Expansion

Trans Mountain is an existing oil pipeline that runs from Edmonton, Alberta, to Burnaby, B.C., via the interior of B.C. and the Fraser Valley, as shown in Figure 112. The Trans Mountain Expansion project would see a new pipeline added along the same right of way, increasing the route's capacity from the present 300,000 barrels/day to 890,000 barrels/day. The new line would carry refined products, synthetic crude oil, light crude oil, and possibly even heavy crude oil. It is expected to deliver $46.7 billion in government revenue in its first 20 years of operation.[325]

Figure 112: Trans Mountain Pipeline Expansion Route

Source: Calgary Herald, Trans Mountain scores a win as Federal Court dismisses First Nations' challenges, 2020

The pipeline expansion could potentially impact 129 different First Nations communities and has already received both support and opposition from some of them. Three First Nations groups are campaigning to purchase the project from the federal government. One, The Western Indigenous Pipeline Group, is comprised of First Nations communities through which the pipeline passes, and who see ownership as the best way to ensure their communities are safe from any risks that the pipeline might bring. TD Securities is providing the Group the capital necessary for the purchase. Other interested purchasers include the Iron Coalition, a Calgary-based group of First Nations and Métis communities in Alberta; and, Project Reconciliation, a group offering $11 billion for the pipeline and currently engaging 300 First Nations across the West. [326]

Others oppose the pipeline. A group of four First Nations in B.C. – the Tsleil-Waututh Nation, the Squamish Nation, Coldwater Indian Band, and a coalition of small First Nations communities – fought the project in court. They objected to the consultation process, which they described as a rubber stamp exercise: since the federal government owned the project, it would inevitably be approved, rendering consultation meaningless. [327] The Coldwater Indian Band wished for the line to be re-routed to avoid the reservoir they rely on for their drinking water, which could be threatened by a spill.[328]

The expansion project was originally started by Kinder Morgan and received approval from Cabinet in 2016. However, a court overturned this approval in 2018, citing insufficient consultation with Indigenous communities along the route, and a failure to properly take into account the effect of increased marine traffic on endangered species off the coast of B.C. With opposition mounting, Kinder Morgan pulled out in 2018, and the federal government purchased the project.[329] Following further consultations with

[325] Trans Mountain, Expansion Project. Website.
[326] CBC, Trans Mountain pipeline: Why Some First Nations Want to Stop It — And Others Want to Own It, 2019.
[327] Calgary Herald, Trans Mountain Scores A Win as Federal Court Dismisses First Nations' Challenges, 2020.
[328] CBC, Trans Mountain pipeline: Why Some First Nations Want to Stop It — And Others Want to Own It, 2019.
[329] Calgary Herald, Trans Mountain Scores A Win as Federal Court Dismisses First Nations' Challenges, 2020.

Indigenous groups, Cabinet issued a second approval for the project in June 2019. This approval was challenged again by First Nations groups but was ruled valid by the Federal Appeals Court in February 2020. In March 2020, the Supreme Court declined to hear any further challenges from the groups opposed to the project, and construction began.[330]

6.4.2 Northern Gateway

Northern Gateway was a proposed crude oil pipeline that would have brought oil from Alberta to the tidewater on the northern coast of B.C., where an export terminal would be built.[331] It was proposed by Enbridge in the mid-2000s, but cancelled by the Trudeau government in 2016. The project consisted of two twin pipelines running from Bruderheim, Alberta to a coastal export terminal near Kitimat, B.C., as shown in Figure 113. Petro China was originally involved but pulled out early on.[332] Its capacity would have been 525,000 barrels/day.[333]

Figure 113: Northern Gateway Route

Source: NRCan, Northern Gateway Pipelines Project, 2017.

The project was considered risky from the start as it relied on shipping oil by tanker along the north coast of B.C. — counter to a 2000s moratorium on such traffic. In 2015, the Trudeau government escalated this moratorium to a formal ban, effectively dooming the project.[334] This was confirmed in 2016 when the government advised the NEB to dismiss the project's application due to the significant and unjustified risks tanker traffic posed to coastal ecosystems.[335]

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[330] Global News, Supreme Court Will Not Hear Challenges From B.C. Groups On Trans Mountain Pipeline Expansion, March 5, 2020.
[331] Government of Canada, Northern Gateway Pipeline Project Joint Review Panel Agreement Issued, 2009.
[332] Afx News Limited, PetroChina Withdraws from Canadian Pipeline Project, 2007.
[333] Reuters, Enbridge Says Northern Gateway Line Unlikely to Start in 2018, 2014.
[334] CBC, Crude Oil Tanker Ban for B.C.'s North Coast Ordered By Trudeau, 2015.
[335] NRCan, Northern Gateway Pipelines Project, 2017.

The project was widely opposed by First Nations in B.C., with 61 joining to form the Save the Fraser Gathering of Nations.[336] The group claimed that the project could result in oil spills either on the pipeline route or from the tankers off the coast.[337] At the time, Enbridge had experienced several high-profile spills along its other pipelines in the U.S., and the Exxon Valdez disaster was still in memory.[338] However, some First Nations expressed at least nominal support, as Enbridge reportedly signed a protocol with 30 First Nations.[339]

6.4.3 Keystone XL

The Keystone XL project is an addition to an existing network of pipelines that transport oil from Alberta to refineries on the Gulf Coast. The new line is managed by TC Energy,[340] and would run from Hardisty Alberta, through Saskatchewan and the U.S. Midwest to Steele City, Nebraska. Another stretch of the line would run from Nebraska to Houston, Texas, as shown in Figure 114. Keystone XL would have a capacity of 830,000 barrels/day and would carry Albertan heavy crude.[341]

Figure 114: Keystone XL Pipeline Route and Existing Pipelines and Aquifers

Source: Natural Resources Defence Council. Tar Sands Pipelines Safety Risks. 2011.

The line was proposed in 2009 and approved by the Canadian NEB in March 2010, but the Obama administration withheld the necessary permits for construction in the U.S. President Trump signed the permits on his second day in office in 2016.[342] On March 31, 2020, TC Energy announced it was ready to build the project, and predicted it would be in service by 2023.[343]

Keystone XL improves the supply mix of oil to the U.S. by replacing supplies from less-reliable countries such as Venezuela, Iraq, and Saudi Arabia with secure oil from Canada. It would also make up for declining oil imports from Mexico.[344]

The project has been met with opposition from Indigenous groups in the U.S., and Canadian

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336 CBC, BC Natives Protest Enbridge Pipeline, 2010.
337 CBC, BC Natives Protest Enbridge Pipeline, 2010.
338 Forest Ethics, Enbridge Northern Gateway Pipeline: Community Opposition and Investment Risk (Executive Summary), 2010.
339 CBC, BC Natives Protest Enbridge Pipeline, 2010.
340 Formerly Trans Canada
341 TC Energy. Website.
342 BBC, Keystone XL pipeline: Why is it so Disputed? 2017.
343 TC Energy, TC Energy to Build Keystone XL Pipeline, March 31, 2020.
344 TC Energy, FAQ. Website.

Indigenous stakeholders are also concerned that it will lead to an expansion of the oil sands.[345] In the U.S., the Sioux and other tribes see the pipeline as a violation of their treaty rights. Construction would risk the desecration of their cultural, historical, and sacred sights - a claim that is borne out in TC Energy's permit applications that show prehistoric cultural sights would be disrupted.[346] The groups raised safety concerns about the arrival of transient workers to their communities, especially around the safety of women and children. It would also risk damaging their hunting and fishing resources and the associated tribal health and economies, impair their federally reserved water rights and resources, and carry the risk of oil spills that could cause further harm to tribal territory and natural resources.[347]

The project would also cross the Ogallala Aquifer, a subterranean body of water that irrigates 30% of crops grown in the U.S.[348] Both the tribes and landowners see oil spills as a threat to this natural resource. A study found that TC Energy underestimated the possibility of oil spills and that 91 major spills could be expected over the pipeline's lifetime.[349] These spills would pose threats to water supplies for drinking and irrigation.

The project is currently struggling to gain the required permits to proceed in the U.S. The project was denied the permits required to build over water bodies by a Montana judge in April 2020, a ruling which was later upheld by the U.S. Supreme Court in July 2020.[350] TC Energy is currently in the process of regaining the required permits, a process that could delay construction until 2021.[351]

6.4.4 Enbridge Line 3 Replacement Program

The Enbridge Line 3 Replacement Program proposes a new pipeline to replace an existing one that transports Canadian crude oil from Alberta through the U.S. to a terminal on Lake Superior, as shown in Figure 115. The existing pipeline was built in the 1960s and is aging and corroding. Its initial capacity was 760,000 barrels/day but is declining as the condition of the pipeline has worsened. The new line is expected to serve the same markets, transport the same product mix, and travel along roughly the same route.[352]

The replacement program has been opposed by Indigenous bands in Minnesota who are concerned about climate change impacts and the risks oil spills pose to their treaty-guaranteed hunting, fishing, and gathering lands. The existing line runs through the Leech Lake Ojibwe band, who have refused to

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345 CBC, Keystone XL Approval Worries Northern Alberta's Fort Chipewyan Indigenous Residents, 2017.
346 Trans Canada, Application to the South Dakota Public Utilities Commission for a Permit for the Keystone XL Pipeline Under the Energy Conversion and Transmission Facility Act, 2009.
347 Native American Rights Fund, Keystone XL Pipeline Case Updates, 2019.
348 Natural Resources Defence Council, Tar Sands Pipelines Safety Risks, 2011.
349 John Stansbury, Ph.D., P.E., Analysis of Frequency, Magnitude and Consequence of Worst-Case Spills from the Proposed Keystone XL Pipeline, 2011.
350 CBC, U.S. Supreme Court deals blow to Keystone XL pipeline project, 2020.
351 BNN Bloomberg, TC sees path for Keystone XL work despite court setback, 2020.
352 Enbridge Website, Line 3 Replacement Project, 2020.

host the new line and are forcing Enbridge to remove the old one from their territory.[353] As a result, the new line detours around the Leech Lake band.[354]

Figure 115: Enbridge Line 3 Replacement Route

Source: Enbridge Website. Line 3 Replacement Project, 2020.

Enbridge has reached an agreement with another band, the Fond du Lac Chippewa, to allow the new line through their reservation. The band's support was given reluctantly: state regulators gave them a choice between the line crossing their reservation, or their treaty hunting lands. The band liked neither option but decided the route running through the reservation presented the least risk to their way of life. As part of the agreement, Enbridge will repair existing lines on the reservation, and compensate the band for related costs.[355] Minnesota regulators recently approved the line.

6.4.5 Energy East

Energy East, Trans Canada's proposal to convert an existing gas pipeline to transport oil from Alberta to Quebec and New Brunswick, has been cancelled. The line would have involved 4,500 km of pipeline, beginning in Alberta and traversing Saskatchewan, Manitoba, Ontario, Quebec, and New Brunswick, as shown in Figure 116. It would have had a capacity of 1.1 million barrels/day, and included new port facilities on the East Coast.[356] The project would have enabled the large-scale export of Canadian oil to Atlantic markets, such as Europe.

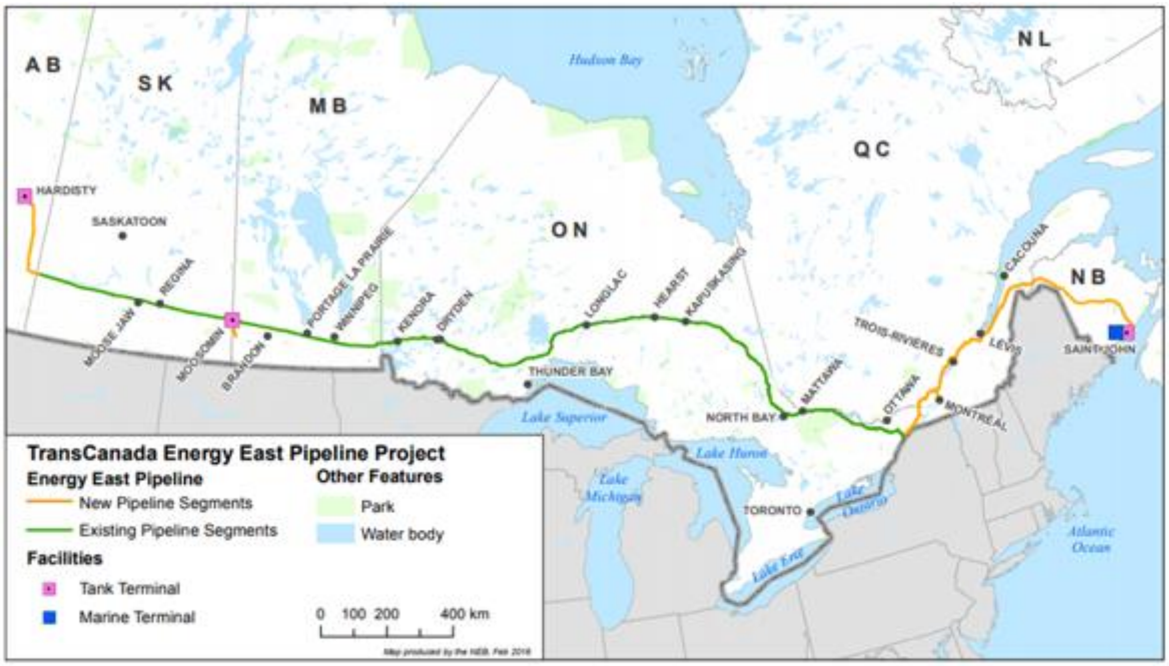
Oil transported along the new line would have been refined at existing facilities on the East Coast, filling unused refining capacity. These facilities currently import some of their crude oil from overseas. A

[353] The Bemidji Pioneer, Leech Lake, Enbridge reach agreement to remove existing Line 3 if new pipeline is built, 2018.
[354] MPR News, Enbridge, Fond du Lac Band reach deal to route Line 3 through reservation, 2018.
[355] MPR News, Enbridge, Fond du Lac Band reach deal to route Line 3 through reservation, 2018.
[356]CER, Energy East and Eastern Mainline Projects, 2020.

report by the Canadian Energy Research Institute found that refineries on the East Coast would see lower costs and emissions if they used Canadian oil instead, which Energy East would enable.[357]

The project came under heavy public opposition in Quebec, as well as from environmental groups. The latter noted that the volume of oil transported on the line would exceed the capacity of East Coast refineries, meaning much of the oil would be exported as crude.[358] The plan for a port facility in Quebec was also found to threaten beluga whales in the St. Lawrence River, sparking protests.[359]

Figure 116: Energy East Route



Source: CER, Energy East and Eastern Mainline Projects, 2020.

Trans Canada eventually abandoned the notion of a port in Quebec. This, however, made matters worse: with the loss of a port in Quebec, the project could not offer the province economic benefits. More than 80 mayors in the Greater Montreal Area opposed the project, on the basis that it presented insufficient benefits to offset the risks it posed to their communities. A corruption scandal erupted when three members of the NEB were found to have discussed the project with former Quebec Premier Jean Charest, who was working as a consultant for the project. The fallout resulted in widespread opposition from the public, with one poll finding 57% of Quebeckers opposed it.[360]

The project also encountered opposition from Indigenous communities. The pipeline's long route meant it would pass through the traditional territory of 180 different First Nations. It came under opposition from some 70 First Nations leaders and activists, as well as from First Nations communities in Ontario

[357] Financial Post, New Brunswick's new premier working to bring Energy East pipeline back from the dead, 2018.
[358] CBC, Did the Bloc Québécois really kill the Energy East pipeline? 2019.
[359] CBC, Did the Bloc Québécois really kill the Energy East pipeline? 2019.
[360] CBC, Energy East pipeline: What You Need to Know, 2016.

and Manitoba. As with other oil pipeline projects, Indigenous leaders referenced the risk of oil spills that would threaten their constitutionally-protected treaty rights to hunt, gather, and fish on their land.[361, 362, 363]

Trans Canada cancelled the project in 2017 citing "changed circumstances" such as the declining price of crude oil globally.[364] Recently, Premier Higgs of New Brunswick has expressed a desire to revive the project, but this will require support from Quebec to do so.[365] This project encountered opposition from Quebec on the grounds of insufficient consultation, environmental risks, and lack of benefits sharing – the same objections often heard from Indigenous stakeholders.

6.4.6 Summary of Canadian Oil Pipeline Projects

All told, Canada has seen five major pipeline projects in recent years, as shown in Table 16. Two would have transported oil to B.C. for export to Pacific markets, two to the U.S., and only one, Energy East, would have brought Canadian oil directly to Atlantic ports. While the two U.S. focused projects are progressing, the Energy East and the Northern Gateway projects have been cancelled amidst significant stakeholder opposition.

Table 16: Summary of Canadian Oil Pipeline Projects

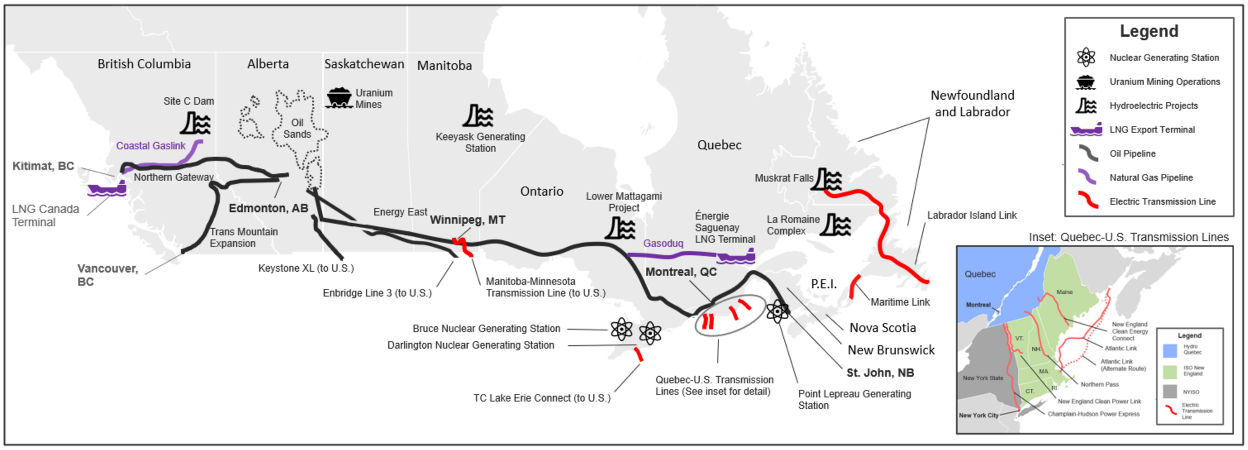
Type	Name	From	To	Capacity (barrels/day)	Status
Oil Pipelines	Trans Mountain Expansion	Alberta	B.C.	890,000 (from 300,000)	May be contested in court
	Northern Gateway	Alberta	B.C.	525,000	Cancelled
	Keystone XL	Alberta/Sask.	U.S. (Houston, TX)	830,000	Approved
	Enbridge Line 3 Replacement Program	Alberta/Sask.	U.S. (Minnesota)	760,000	Approved
	Energy East	Alberta	Quebec/NB	1,100,000	Cancelled

6.5 Summary of Stakeholders Involved in Canadian Energy Projects

The energy projects described in this section leverage energy assets across Canada as shown in Figure 117. These projects involve nine provinces and seven U.S. states as summarized in Table 17. In many cases, the projects involve other jurisdictions and stakeholders: Alberta and Saskatchewan's oil and gas resources must get to port through B.C., Ontario, Quebec, and New Brunswick. Likewise, electricity produced from low-carbon hydroelectric facilities in Quebec, Manitoba and Newfoundland and Labrador is intended for export to several U.S. states. These projects are also national projects that affect stakeholders across the country. The success of each is dependent, to a large degree, on support from Indigenous peoples. Their land and treaty rights are an essential part of the dialogue. These matters are explored further in the next section.

[361] National Post, Pipe Dreams: Energy East Proved Just How Difficult Indigenous Consultations Can Be, 2018.
[362] The Globe and Mail, Energy Companies Struggle With Aboriginal Needs On Pipelines, 2013.
[363] The Globe and Mail, First Nations Prepare For Fight Against Energy East Pipeline, 2014.
[364] CBC, Did the Bloc Québécois Really Kill the Energy East Pipeline? 2019.
[365] Financial Post, New Brunswick's New Premier Working To Bring Energy East Pipeline Back From The Dead, 2018.

Figure 117: Canadian Energy Projects Across the Country



Source: Strapolec Analysis

Table 17: Summary of Canadian Energy Project Types and Jurisdictions Involved

Type		From	To	Capacity	Units
Power Projects	Hydro	West Coast	Alberta	1,100	MW
		Prairies	U.S.	695	MW
		Eastern Canada	Domestic, U.S.	2,812	MW
	Nuclear	Ontario	Ontario	9,744	MW
Electricity Transmission		Prairies	U.S.	885	MW
		Quebec	U.S.	4290	MW
		NB	U.S.	1,000	MW
		NF	NS	500	MW
Natural Gas & LNG		B.C.	Asia	35	bcm/year
		Quebec	EU	15	bcm/year
Oil Pipelines		Alberta	B.C.	1,115	Thousand barrels/day
		Alberta	U.S.	1,590	Thousand barrels/day
		Alberta	Quebec/NB	1,100	Thousand barrels/day

Source: Strapolec Analysis

7 Collaboration Unlocks Pan-Canadian Stakeholder Benefits from Energy Projects

While the development of Canada's resources can deliver benefits to stakeholders across the country, development challenges may be insurmountable without inclusive, consistent collaboration. This section summarizes the benefits and challenges of energy resource projects and the stakeholders involved. This review includes underway, planned, and potential new energy projects, and the broad range of affected/interested stakeholders: Indigenous peoples, environmental groups, provincial and federal governments, and the private sector. Specific attention is paid to the complexities associated with Indigenous peoples. The U.S. is separately discussed as a special stakeholder given its role in many of Canada's possible energy projects. The section concludes with a discussion on the critical importance of a collaborative approach to each stakeholder group for achieving successful project outcomes.

7.1 Many Diverse Energy Resource Projects Could be Pursued

To overcome the challenges standing in the way of Canada's energy potential and achieve the resulting benefits, it may be helpful to revisit past, planned, and underway projects, and investigate new options.

7.1.1 Benefits and Challenges of Canadian Energy Projects

Canada has seen several energy projects proposed, started, and completed in recent years. These have included electric power and transmission line projects, a major natural gas pipeline and LNG export terminal, and several oil pipelines in Canada and the U.S. The lessons of these projects described in Section 6 shows that they offer a variety of economic and environmental benefits to Canada but face remarkably similar challenges.

7.1.1.1 Benefits of Canadian Energy Projects

Economic Benefits: It is well understood that investments in energy infrastructure provide substantial benefits to Canada that build the prosperity of the nation and are material to gaining project support from stakeholders. Economic benefits are measured by how well the projects sustain and leverage established businesses, expertise, and exports; create new jobs, generate higher tax revenues, stimulate more innovation; and, drive wealth creation.[366] Such advantages have been evident in the Canadian energy projects proposed to date.

Energy Security Benefits: Investments in new Canadian hydro facilities, the nuclear refurbishment program, and delivering Canadian energy resources to the east coast improve the country's energy security. Enhanced, low cost, environmentally sustainable energy security helps enable the economic competitiveness of Canada's businesses and industries.

Export Market Benefits: New investments in electricity and oil and gas delivery infrastructure open up new markets for Canada's energy resources. Canada's energy exports to its major trading partners can help them secure cleaner and more reliable energy supplies.

[366] Government of Canada, Energy and the Economy, 2020.

Climate Benefits: The discussion in Section 5 showed how Canadian energy resource projects could help reduce domestic and global GHG emissions in the fight against climate change.

Every one of the Canadian energy projects discussed promises to offer each of these benefits in some manner.

7.1.1.2 Barriers to Canadian Energy Projects

Despite the well-documented benefits, many of these projects have run into serious challenges that have impeded their progress.

Opposition from Indigenous peoples: Canada's legislative framework provides for the protection of the rights and sharing of benefits from any development project with Indigenous peoples. Many past grievances remain unsettled and resource-sharing is an ongoing challenge in all of today's energy projects.

Opposition from Environmental Groups: Achieving general public support for a National Energy Pact and resulting energy investments is also a critical requirement. There are continuing concerns about the environmental impacts that strategic investments in Canada's energy resources and delivery infrastructure may have. These include concerns about climate change, other forms of pollution, and the overall impacts on land and water use.

Benefits sharing: When multiple inter-jurisdictional rights and interests are impacted by an energy resource project, cost-benefit sharing occupies center stage. Examples include opposition to Alberta and Saskatchewan's efforts to get oil and gas to Canadian seaports; public and Indigenous peoples' opposition to the Site C Dam in B.C.; costs and Indigenous challenges to Muskrat Falls in Newfoundland and Labrador; and, Quebec's challenges in securing transmission capacity to export low-carbon electricity to the U.S.

Project Management: The ability for projects to be managed to the cost and completion objectives impacts the success of benefit sharing. Approval of projects is contingent on the expectation of success by almost all parties involved, and the track records have too often been poor.

These issues are common across all Canadian energy projects and need to be resolved in each case for the expected benefits to be realized.

7.1.2 New Canadian Energy Projects

As discussed in Section 6, many pipelines and transmission lines have been proposed, with varying degrees of success. Many may still be possible. For example, the various transmission line proposals for New England, have, to date, been considered to be mutually exclusive, as each was responding to the same competitive bids. However, they could feasibly coexist under different circumstances. The same can be said for the ITC Lake Erie transmission line, which is currently stalled due to inadequate funding. These projects are realistic and could be revitalized if the need arises.

Some projects, however, may no longer be viable. The Northern Gateway oil pipeline is one such case: the degree of public opposition the project suggests that stakeholder buy-in is unlikely, especially now that the government has blocked the project with legislation. Nevertheless, it is only one of the many projects that could transport Canadian oil to the West Coast.

In addition to the above, a variety of new Canadian energy projects have been postulated in this report that could offer benefits.

7.1.2.1 Expand Canada's Biomass Capacity

Biomass represents a large, untapped sustainable energy resource for Canada. When paired with sustainable forestry practices, biomass could allow Canada to use its extensive boreal forest as an electricity generation fuel source while sustaining the environment via better forestry management practices. It could also represent an opportunity for Canada's North, offering employment, revenues, and a reliable source of clean energy to remote communities.

7.1.2.2 Convert Canaport Terminal to Export and Build Natural Gas Pipelines East

Reconfiguring the Canaport terminal in New Brunswick to export LNG could open up markets for Canadian natural gas in the EU to address the low emissions and energy security concerns. As there is presently no pipeline to supply Canadian natural gas for export, that infrastructure would be a necessary part of the project.

7.1.2.3 New Exports from Dawn Hub

Canada could blend natural gas stored in Ontario's Dawn Hub facility with hydrogen produced from Ontario's low-carbon energy, and export this P2G gas to the U.S. This would leverage a domestic P2G industry in Ontario, improve Canada's natural gas trade balance with the U.S., and provide the U.S. with a lower-emissions source of natural gas, reducing their total emissions proportionately.

7.1.2.4 Developing SMRs in Alberta to Clean Up the Oil Sands

SMRs are viewed as the next generation of nuclear technologies. A pan-Canadian effort to develop these technologies would provide not only low cost, low-carbon electricity, but also options for decarbonizing the oil sands. Using SMRs could significantly reduce oil sands emissions and enable Canada to reduce global emissions. This would provide emission reduction benefits for Alberta, Saskatchewan, and B.C., and be the basis for ongoing investments in those resources. Greater investment would also accrue to Eastern Canada where SMR technologies could be manufactured. With their existing nuclear assets and supply chains, Ontario and New Brunswick are well-suited to become manufacturing hubs for SMRs.

7.1.2.5 Re-do Energy East

The Energy East project represents the only large-scale initiative to export Canadian oil from the Prairies to the Atlantic Coast. As such, it would enable Canada to export large quantities of oil to the EU, while also improving domestic energy security for the Eastern Provinces. Several provincial governments appear to be open to the idea of revisiting this project– with the notable exception of Quebec.[367]

[367] Global News, N.B. premier still hopes to convince Quebec of Energy East benefits, December 2018.

7.1.2.6 Summary of Potential Energy Projects

These new projects could bring a multitude of benefits to Canada. A Canadian biomass industry would deliver a new source of secure energy for Canada, while an SMR-powered oil patch would maintain Canada's domestic oil supply as the nation pushes to meet its climate goals. Enabling LNG exports through the Canaport terminal would facilitate the export of Canada's natural gas to foreign markets and help satisfy the energy needs of these markets, as would a renewed Energy East pipeline and P2G gas exports through the Dawn Hub. All of these projects would bring economic benefits to Canada while reducing domestic and global emissions. Finally, each of these projects involves the land of at least one First Nation, Métis, or Inuit group and represent opportunities to improve Canada's relationship with its Indigenous peoples through dialogue, cooperation, inclusion, and economic opportunities.

7.2 Stakeholders Across Canada have Interests in Energy Resource Development

Key stakeholders in Canadian energy projects include the federal and provincial governments, environmental groups, commercial interests, and Indigenous peoples. Their support or opposition can decide the fate of an energy project.

7.2.1 Indigenous Stakeholders

Indigenous communities, leaders, and governing bodies are important and unique stakeholders in Canadian energy projects. To work effectively with these stakeholders, it is important to understand their history, perspectives, and challenges. Indigenous peoples in Canada fall into three broad groups: First Nations, Métis, and Inuit. This subsection lays out the distinctions between these groups, and the forms of representation and leadership that exist for each, to inform how they may wish to be engaged as stakeholders. The challenges facing Canada's Indigenous people and their unique concerns will also be considered. As well, the concept of reconciliation, the Truth and Reconciliation Report, and the UN Declaration on the Rights of Indigenous Peoples will be discussed.

7.2.1.1 First Nations

First Nations is a broad term used to describe indigenous peoples in Canada who live on reserves or are closely associated with them.[368] Much of how modern-day First Nations are organized has to do with the Indian Act, a complex and wide-ranging piece of legislation passed in 1876, which defined the federal government's relationship with Indigenous peoples in Canada. It is still in place today.[369]

The term First Nations refers to people who are defined as status or treaty Indians under the Indian Act and are registered with their home reserve, band, or community. Because of this broad definition, the term First Nations encompasses a wide group of peoples with varying backgrounds and cultures, accounting for 634 communities, roughly 900,000 Canadian citizens, and over 50 distinct languages. [370]

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[368] UBC, Indigenous Foundations, Aboriginal Identity & Terminology. Website.
[369] The Canadian Encyclopedia, Indian Act, 2018.
[370] The Canadian Encyclopedia, First Nations, 2019.

First Nations are not a single stakeholder, but rather many different stakeholders with different backgrounds.

First Nations bands are represented by chiefs. Before colonization, many indigenous nations had their own systems of government and leader selection, from group consensus to inheritance by hereditary title. The Indian Act imposed a single form of governance on all First Nations communities under its purview. Indigenous communities were organized into governing units called "bands" and led by band Chiefs and councils. Under the Act, Chiefs and council members could only be chosen by election, and all other traditional forms of government were banned. Until recently, the federal government has only recognized chiefs chosen in this manner. [371] At a national level, First Nations bands are represented by the Assembly of First Nations (AFN).[372]

Most bands hold reserve lands, tracks of land set aside by the federal government for their exclusive use. Under this framework, reserve lands are held in trust by the Crown, meaning that the bands do not own the land itself.[373] Reserves are often far smaller in area than a nation's traditional lands and may be located elsewhere entirely.

Despite the Indian Act, hereditary chiefs are still leaders of many First Nations. They function as traditional knowledge keepers and sacred cultural leaders and may exercise authority over traditional lands.[374] Hereditary and elected chiefs do not always agree, which can lead to conflicts between the two forms of leadership – especially since Canadian authorities usually only recognize elected chiefs.

Treaty rights also make First Nations a critical stakeholder. For hundreds of years, Indigenous groups have been signing treaties with the Crown that underpin Indigenous and Crown land tenure. While the treaties led to Indigenous groups ceding their land to the Crown, they also often guaranteed Indigenous signatories the rights to trade, fish, hunt, or gather on those same lands.[375] Such treaty rights are protected in the Canadian Constitution, meaning that many First Nations groups have rights on land beyond the boundaries of their reserves. [376]

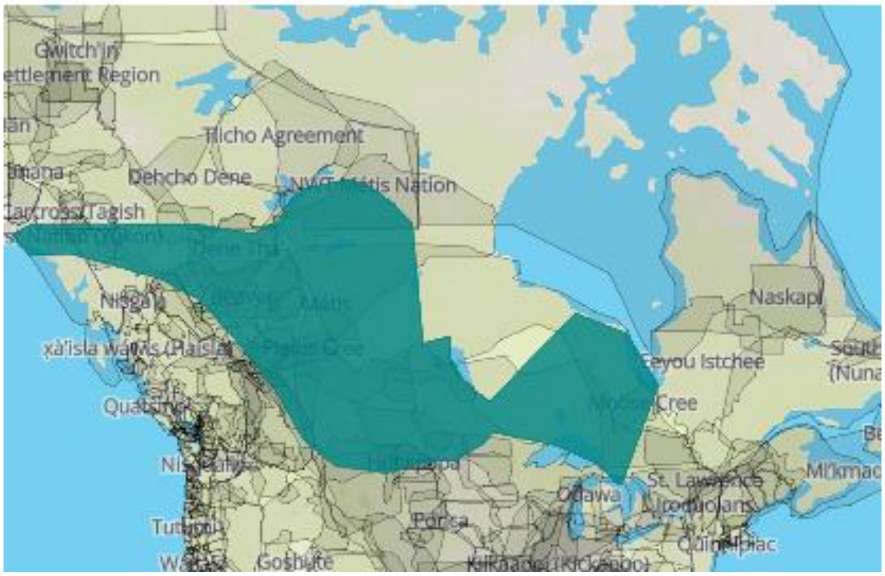
In many areas of the country (most of B.C., the Yukon, the Northwest Territories, Quebec, and Atlantic Canada) non-Indigenous settlement proceeded without the official cession of land through treaties. The Indigenous inhabitants of these areas were nevertheless relocated to reserves and fell under the control of the federal government via the Indian Act. Since the 1970s, First Nations without treaties with the Crown have argued that they retain title over their land. Such cases of "unceded" land have led to conflicts in recent years, as well as efforts to settle land title through modern-day treaties.[377] These circumstances make it essential that First Nations be included in any energy resource development that affects their rights. In Canada, this will apply to nearly all conceivable energy projects.

[371] The Canadian Encyclopedia, Chief, 2018.
[372] The Canadian Encyclopedia, Assembly of First Nations, 2019.
[373] UBC, Indigenous Foundations, Reserves. Website.
[374] The Canadian Encyclopedia, Chief, 2018.
[375] The Canadian Encyclopedia, Treaties with Indigenous Peoples in Canada, 2017.
[376] UBC, Indigenous Foundations, Constitution Act, 1982 Section 35. Website.
[377] The Canadian Encyclopedia, Treaties with Indigenous Peoples in Canada, 2017.

7.2.1.2 Métis

Métis are people of mixed European and Indigenous ancestry across Canada.[378] The Métis are one of the three recognized Aboriginal peoples in Canada, with rights enshrined in the Constitution of Canada and more clearly defined in a series of Supreme Court of Canada decisions. Métis people generally do not see themselves as being included in the term "First Nations."[379]

Figure 118: Approximate Métis Traditional Territories



Source: Native Land. Website.

In what is known as "the Powley case", in 1990 the Supreme Court ruled that Métis rights are protected under the Canadian Constitution. While the case only actually awarded hunting rights to one Métis community in Sault St. Marie, legal experts believe it may serve as a foundation for the Métis to acquire further rights. It also established a test to determine who counts as Métis, which notably includes Métis communities outside of Manitoba and the Prairies.[380]

Métis communities in Canada are represented by provincial-level organizations in B.C., Alberta, Saskatchewan, Manitoba, and Ontario, and by the Métis National Council at the federal level.

7.2.1.3 Inuit

The Inuit are an Indigenous people who occupy the northern, Arctic regions of Canada, as well as portions of Alaska and Greenland. The Inuit were never subject to the Indian Act but still experienced interference and subjugation by the Crown. Notably, this included a forced shift from nomadic living off

[378] The Canadian Encyclopedia, Métis, 2009.
[379] UBC, Indigenous Foundations, Aboriginal Identity & Terminology. Website.
[380] UBC, Indigenous Foundations, Powley Case. Website.

the land to permanent settlements, which has disrupted their way of life and caused socioeconomic issues.[381]

Canada's Inuit are divided across four regions: the Inuvialuit region, which comprises much of the north coast of the Northwest Territory and all or part of several arctic islands; the Canadian territory of Nunavut; Nunavik, which encompasses much of Northern Quebec; and, Nunatsiavut, which covers portions of the coast of Labrador.[382] These territories are shown in Figure 119. Separated from the North West Territories in 1999, Nunavut is majority Inuit, meaning that the Inuit in the territory are effectively self-governing. Nunatsiavut has also been self-governing since 2005. Some level of self-government is also being worked towards in Inuvialuit and Nunavik.[383]

Figure 119: Inuit Homelands

Source: Inuit Tapiriit Kanatami. Website.

Inuit communities have been represented by the aforenoted governments in recent resource projects. For example, Inuit communities expressed concerns about mercury pollution from the Muskrat Falls

[381] Canadian Encyclopedia, Inuit, 2010.
[382] Inuit Tapiriit Kanatami, About Canadian Inuit. Website.
[383] Canadian Encyclopedia, Inuit, 2010.

project. They were represented by the Nunatsiavut Government in discussions with the provincial government of Newfoundland and Labrador.[384]

7.2.1.4 Indigenous Challenges and Concerns

A history of colonization, subjugation, and forced assimilation by colonial powers and the Canadian government has deeply impacted Indigenous communities' socioeconomic health and way of life. While conditions vary between communities, Indigenous people in Canada generally have lower rates of employment, education, and income than the non-Indigenous population. Indigenous people also struggle with access to healthcare and have lower life expectancies than the general population. Conditions on reserves are often poor, much of the housing is in poor condition, and a lack of safe drinking water remains a widespread problem.[385]

Canada's Indigenous cultures place paramount importance on their connection to the land and their ability to live off of the land by hunting, fishing, and gathering. In these cases, land has meaning beyond just property, encompassing "culture, relationships, social systems, spirituality, and law."[386] This deep connection means that issues of land title and ownership are linked to the socio-economic issues discussed above. In the context of energy projects, disruption to the land from logging, construction, resource extraction, or flooding can be of significant importance to Indigenous stakeholders. Moreover, it may constitute a violation of their rights as enshrined in treaties and the Canadian Constitution.

Many Indigenous stakeholders in Canadian energy projects have found specific issues with the consultation process.[387] Provincial and federal governments have the duty to engage in meaningful consultation with Indigenous groups when making decisions that may impact the latter's rights. The duty to consult is most apparent on projects that have environmental impacts, as they may affect rights to land, water, and resources.[388] In recent years, the consultation process has been criticized on several occasions as a formulaic and paternalistic exercise, rather than meaningful dialogue.[389]

7.2.1.5 Reconciliation

Reconciliation means the process of repairing the relationship between Indigenous and non-Indigenous peoples. It involves working to overcome the inequalities that exist between the two groups (as outlined above) as well as prejudice and racism.[390] Major commissions such as the Truth and Reconciliation Committee (TRC) have been mandated to explore the history of wrongdoing experienced by Indigenous peoples in Canada and have made recommendations to redress them and repair these relationships.

[384] Nunatsiavut Government, Key Muskrat Falls Commitment Not Being Honoured, 2017.
[385] Canadian Encyclopedia, Social Conditions of Indigenous Peoples in Canada, 2011.
[386] UBC, Indigenous Foundations, Land & Rights. Website.
[387] See Section 6.
[388] The Canadian Encyclopedia, Duty to Consult, 2018.
[389] E.g., CBC, 'That is not consultation': Manitoba First Nation fights $453M Manitoba-Minnesota Power Line in Court, 2019.
[390] OISE, What is Reconciliation? Website.

The TRC published a list of 94 such recommendations in 2015, which included calls to action for governments, educational and religious institutions, civil society groups, businesses, and Canadians.[391]

The federal government has committed to implementing the TRC's recommendations and advancing the process of reconciliation.[392] However, recent events such as broken promises related to the Muskrat Falls project, the RCMP's forced entry into the Wet'suwet'en First Nation's traditional territory for the Coastal Gaslink project, and the federal government's purchase of the Trans Mountain pipeline over Indigenous opposition have led many to question this commitment.[393]

7.2.1.6 United Nations Declaration on the Rights of Indigenous Peoples

One of the key recommendations of the TRC was its call to action for governments and the corporate sector to adopt and implement the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as a framework for reconciliation.[394] The UNDRIP is an international instrument adopted by the United Nations (UN) in 2007 that seeks to protect the rights of Indigenous peoples.[395] Included in the instrument is the right to Free, Prior, and Informed Consent (FPIC), which allows Indigenous peoples to withhold or grant consent to any project that may affect them or their territories. Once granted, this consent may be withdrawn at any stage. FPIC further enables Indigenous peoples to negotiate the conditions of the project in question.[396] Recognizing Indigenous peoples' right to FPIC is an explicit component of the TRC's calls to action for governments and the corporate sector.[397]

Canada endorsed UNDRIP in 2007, and as of April 2020, the federal government has been moving to adopt it into law.[398] The provincial government of B.C. has gone further, having enshrined the resolution into law in November 2019.[399]

There has been some debate about whether FPIC constitutes a veto for Indigenous groups on energy projects in their territory, since in theory withholding consent would mean a project could not go ahead. This appears to have been the case with OPG's DGR project in Bruce county, Ontario, which was cancelled after the Saugeen Ojibwe Nation declined to give consent for the DGR to be built on their land. Members of the Nation described the cancellation of the project as an application of the FPIC principle.[400]

However, FPIC is not considered to be a legal veto. B.C.'s implementation of UNDRIP does not allow groups to sue the government over violations of the rights, meaning projects that lack consent could still

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391 Government of Canada, Delivering on Truth and Reconciliation Commission Calls to Action, 2019.
392 Government of Canada, Delivering on Truth and Reconciliation Commission Calls to Action, 2019.
393 The Toronto Star. 'Reconciliation is Dead and We Will Shut Down Canada,' Wet'suwet'en Supporters Say, 2020.
394 Truth and Reconciliation Commission of Canada, Calls to Action, 2015.
395 UBC, Indigenous Foundations, UN Declaration on the Rights of Indigenous Peoples. Website.
396 Food and Agricultural Organization of the United Nations, Indigenous Peoples, Free Prior and Informed Consent. Website.
397 Truth and Reconciliation Commission of Canada, Calls to Action, 2015.
398 CBC, Trudeau Government Moving Forward on UNDRIP Legislation, Says Minister, 2019.
399 CBC, What Does 'implementing UNDRIP' Actually Mean? 2019.
400 The Sun Times, OPG to explore other options to Bruce DGR proposal after SON vote, 2020.

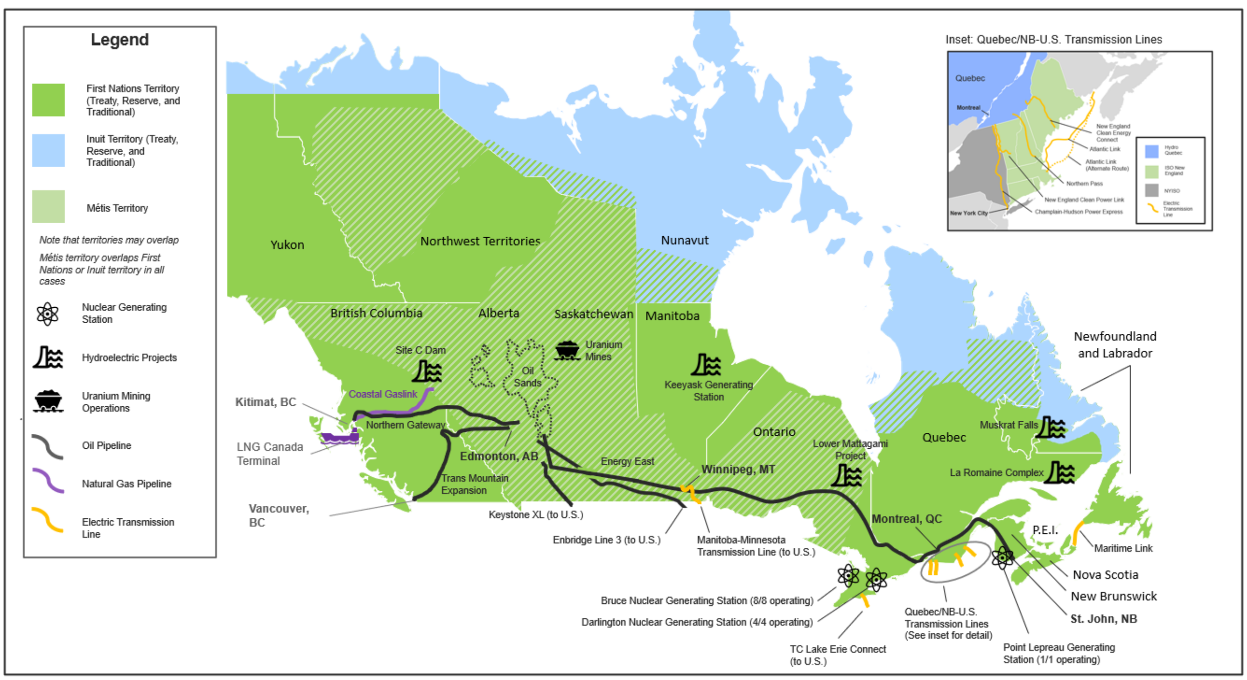
go forward.[401] The Federal Court of Appeal has ruled that the current consultation process does not allow Indigenous peoples to veto projects, though UNDRIP was not adopted federally when this ruling was made.[402] Rather than a veto, FPIC could mean a requirement for shared decision-making, similar to how management and unions negotiate benefits.[403]

The TRC's call to action and adopting the principle of FPIC may be a way for governments and the corporate sector to form a better relationship with Indigenous stakeholders across the country.

7.2.1.7 Summary of Indigenous Considerations for Energy Projects

First Nations, Métis, and Inuit communities and governments have been key stakeholders in Canadian energy projects and will continue to be going forward. Practically all the land in Canada is the traditional territory of at least one First Nation, Métis, or Inuit group, as shown in Figure 120. This makes them key stakeholders in every energy project in Canada. They have legitimate concerns with rights protected by the constitution and are supported by a growing consensus that reconciliation is an essential element of Canada's fabric going forward. Understanding and incorporating their unique perspectives and challenges will be key to the success of these projects.

Figure 120: Canadian Energy Projects and Indigenous, Métis, and Inuit Land



Source: Native Land. Website; Strapolec Analysis.

[401] CBC, What Does 'Implementing UNDRIP' Actually Mean? 2019.
[402] CBC, In A Major Victory for Trans Mountain, Federal Court Dismisses Indigenous Appeal of Project's Approval, 2020.
[403] CBC, What Does 'Implementing UNDRIP' Actually Mean? 2019.

7.2.2 Environmental Groups

Environmental groups in Canada are generally concerned about conserving natural areas, protecting habitats for plants and wildlife, and halting climate change. They often object to large-scale energy projects for the disruption they pose to the environment and, in cases involving fossil fuels, the impacts on climate change.

Environmentalists express concerns about oil spills and also object to continued exports of fossil fuels on climate change grounds. From their perspective, the entire world will need to stop producing fossil fuels altogether to avoid climate change, and therefore fossil fuel developments – such as oil and LNG pipeline projects – should be opposed in any case.[404] These groups also commonly express concerns about the impact of tanker traffic on marine life, which has led to their opposition to oil export terminals in B.C. and Quebec.[405]

Environmental groups commonly object to large hydro projects given their negative impacts on ecosystems caused by reservoir flooding and disruptions in downstream river flows. For example, the Sierra Club opposed the Site C dam project on the grounds that it would reduce water flows from the Peace River, thereby harming riverine ecosystems in Wood Buffalo National Park downstream.[406]

Environmental groups often oppose nuclear power because of the associated risks of accidents and the long-term management of nuclear waste. Several environmental organizations have criticised the Ontario government for extending the life of the Darlington and Bruce nuclear plants on these grounds, and have recommended that Ontario implement more extensive nuclear emergency response plans.[407]

Many of these concerns overlap with those expressed by Indigenous stakeholders, and as a result, environmental organizations often lend their support to Indigenous opposition of large-scale energy projects. For example, the Sierra Club and the David Suzuki Foundation were among 25 signatories to a letter urging Prime Minister Justin Trudeau to halt the construction of the Site C dam given its impact on the environment and Indigenous people.[408]

Environmental groups generally endorse renewable sources like wind and solar and energy efficiency as the way forward for Canada's energy supply.[409,410] Canadian energy projects may begin addressing their concerns by engaging them early in the planning process, developing mitigation strategies for environmental effects, and better illustrating the climate benefits that new projects could deliver.

[404] Sierra Club BC, Fossil Fuels. Website.
[405] Greenpeace, Greenpeace Canada Launches Aerial Bridge Blockade in Path of Trans Mountain Oil Tanker Traffic, 2018.
[406] Sierra Club BC, Site C Dam. Website.
[407] Greenpeace, A Call for Public Safety: Addressing Nuclear Risks on the Great Lakes, 2017.
[408] Sierra Club BC, Federal Government Faces Growing Calls to Halt Site C Dam, 2016.
[409] Greenpeace, #EnergySolution. Website.
[410] Sierra Club Canada, Green Energy. Website.

7.2.3 Provincial Governments

While provincial governments juggle many priorities, creating employment, increasing economic growth, and protecting the environment are three that are particularly relevant to this discussion. The scope of many of Canada's energy projects span multiple provincial and territorial boundaries. Collaboration among the affected jurisdictions is a prerequisite for the success of these energy projects. Collaborative Canadian energy projects represent significant opportunities to align these benefits with the objectives of all levels of government—Indigenous or non-Indigenous. At the crux of the challenge is the need to fairly share the costs and benefits that result from each project. The provinces that are affected by existing and proposed energy projects are shown in Table 18.

Table 18: Canadian Energy Projects by Provinces Affected

Energy Projects		British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	Newfound land	Maritimes
Existing Projects	Nuclear Power Projects					✓			✓
	Hydro Power Projects	✓			✓	✓	✓	✓	
	Transmission Projects				✓		✓		✓
	Natural Gas & LNG	✓	✓	✓					
	Oil Pipelines	✓	✓	✓	✓	✓	✓		✓
New Projects	Biomass	✓	✓	✓	✓	✓	✓	✓	
	Canaport Terminal	✓	✓	✓					✓
	P2G from Dawn Hub	✓	✓	✓		✓			
	SMRs in Oil Sands	✓	✓	✓		✓			✓
	Energy East		✓	✓	✓	✓	✓		✓

Source: Strapolec Analysis

7.2.4 Canadian Federal Government

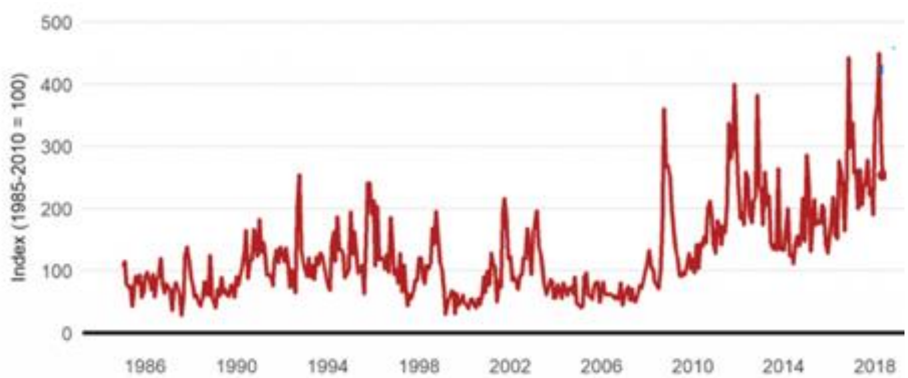
Canada's current federal government has made commitments to meet Canada's climate targets and achieve reconciliation with the country's Indigenous peoples. The energy file has proven to be challenging for meeting both of these commitments. Canada's continuing reliance on fossil fuels has prevented it from sufficiently reducing its carbon emissions, and project conflicts with Indigenous groups are complicating reconciliation. The federal government is also committed to developing Canada's economy and increasing the well-being of its citizens from coast to coast. The latter is difficult without positive federal/provincial relations. All of these policy drivers indicate the need for national collaboration to develop a Canadian energy pact.

7.2.5 Commercial Interests

Commercial interests are key drivers behind most Canadian energy projects. However, the way in which they are involved varies for several reasons. The type of energy development is one factor: natural gas and oil pipelines, for example, are generally developed by private enterprises that are subject to federal and provincial regulations. Electricity power projects in many provinces in Canada are typically a mix of private enterprise and Crown corporations. Electric transmission line projects are generally undertaken by Crown corporations and public-private partnerships, although in certain provinces, influential Crown corporations dominate the power sector and cover transmission, distribution, and generation. This is the case with BC Hydro, Manitoba Hydro, and Hydro Quebec. Meanwhile, electric transmission lines to the U.S. are generally merchant lines run by private enterprises dependent on investment. In all cases, business cases determine the level of participation and return on investment.

Today, some economists believe that Canada's current economic policies are creating greater uncertainty. Economists from Stanford, Northwestern, and the University of Chicago have constructed a national measure of economic policy uncertainty that is based on a detailed analysis of the content from major news outlets. This analysis found that uncertainty in Canada is becoming higher and more volatile. Canada's economic policy uncertainty has been increasing over time, as shown in Figure 121.[411]

Figure 121: An Index of Economic Policy Uncertainty in Canada, 1986-2018
(Index 1985 = 100)



Source: Baker et. al, 2020. Note: Displays the monthly uncertainty index from January 1985 to May 2018. Detailed data and methodology are available at www.policyuncertainty.com.

There is an evident decline in the willingness of lending domestic and foreign institutions to finance large Canadian energy and infrastructure projects. The predominant world view is that Canada is such a poor place to undertake large scale energy infrastructure projects that it is "becoming un-investable".[412] Factors include an unstable political environment with politicized decision making, an increasingly complex, protracted, and uncertain regulatory environment, and unclear rule of law.

[411] Maclean's, Economic Uncertainty in Canada Is Rising – And It's Partly Our Own Fault, 2019.
[412] Council for Clean & Reliable Energy, 2018 Annual Energy Leaders Roundtable, 2018.

7.3 The U.S.

Canada's largest trading partner and the world's largest economy is the U.S. It is important as a stakeholder in Canadian energy projects, as a competitor in world markets, and as an independent actor that has shown willingness to influence projects in Canada.

7.3.1 The U.S. as a Stakeholder

The U.S. is a customer for several Canadian energy exports making it a critical stakeholder in several Canadian energy projects. The Keystone XL and Enbridge Line 3 pipelines will export oil to the U.S., while the various electric transmission lines proposed between Canada and the U.S. would export Canadian electricity. As a customer country, the U.S. has its own energy security and employment concerns, which will influence its willingness to invest in energy produced outside its borders. However, the U.S. also has established capacity needs for the energy Canada has on offer and will continue to require this supply. As Canada's interface with the U.S. state and federal governments, the Canadian federal government should have a role to play in influencing U.S. stakeholders and advancing interests for the benefit of Canada.

7.3.2 The U.S. as an Outside Influence

The U.S. also functions as an outside influence in Canada, as advocacy within the U.S. tends to spill over and affect Canadian energy projects. The Keystone XL pipeline and the electricity transmission project proposals are direct examples of how advocacy within the U.S. bears on the viability of Canadian energy projects. An indirect example is a recent case with the DGR project in Ontario, where several U.S. state lawmakers on the Great Lakes publicly opposed the project.[413] U.S. interests have known to be substantial funders of Canadian advocacy groups. The Rockefeller Foundation, for instance, is known to contribute funds to Canadian environmental groups where they have mutual environmental objectives. The degree to which this may influence domestic discussion around pipelines and the oil sands is debated.[414] It is worth questioning the legitimacy of accommodating such foreign influence in the decision-making process for Canadian energy projects.

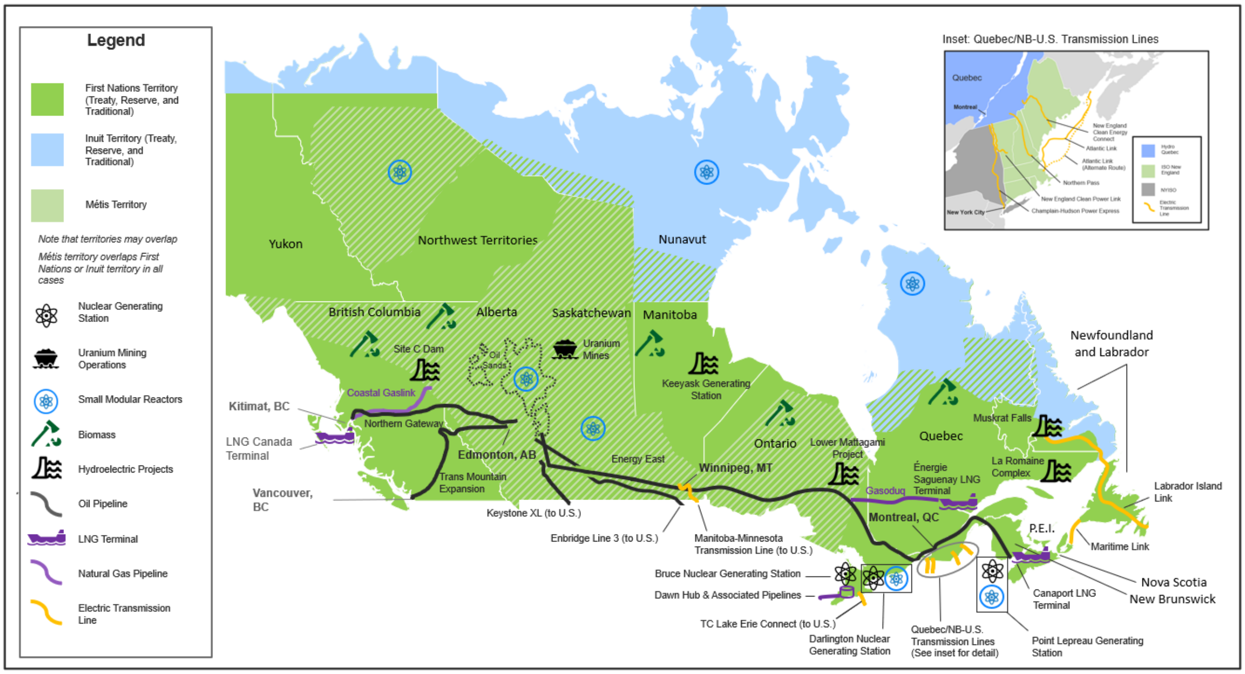
7.4 Summary of Pan-Canadian Stakeholder Considerations

The successful approval and completion of future energy infrastructure projects has the potential to deliver substantial benefits to communities across Canada. The projects span provincial and international boundaries, and many would cross the traditional territories of a large number of Indigenous stakeholders as shown in Figure 122.

[413] Michigan Radio, Michigan congressmen Urge U.S. And Canadian Governments to Reject Nuclear Waste Site Near Lake Huron, 2017.
[414] CBC, U.S. Foundations Funding Canadian Anti-Pipeline Protests: Fair or Foul? 2019.

The pan-Canadian nature of Canada's energy portfolio provides a solid foundation for collaboration among all levels of government and Indigenous, environmental, and commercial stakeholders, which is crucial to achieving the benefits of energy resources development.

Figure 122: New and Existing Canadian Energy Projects and Indigenous Land



Source: Native Land. Website; Strapolec Analysis.

The diversity and geographic location of Canada's Indigenous peoples and demographics present other layers of complexity. Additionally, political unity is challenged by current governance issues — some Indigenous peoples are governed by elected Chiefs while others prefer hereditary leadership. Success must also recognize and address reconciliation objectives. Strategic investments in Canada's energy advantages can support and secure reconciliation with Indigenous peoples across the country. These kinds of investments can generate new employment and business opportunities and support their initiatives to provide their own programs — housing, education, health, policing, and other services — to their communities.

Canada's constitution shares governance rights and responsibilities with the Provinces and Territories over resource development — including energy resources. In Canada, provincial and federal governments will have to use their influence and legislative ability to help regulatory regimes respond to the unique facets of each energy resource, resolve differences between interest groups, and incorporate the perspectives and concerns of environmentalist and Indigenous groups in meaningful and material ways.

The private sector —developers, financiers, engineering firms, and others — will continue to be important partners for these projects to succeed. All too frequently, investors are regarding Canada as a risky jurisdiction in which to invest. Commercial interests will need to be assured of the risks they are expected to undertake.

On the global stage, energy projects represent a competitive environment for resources, both natural and financial. Much of the financial success of energy projects depends on who gets there first. The federal government will be critical in ensuring the success of export projects in target markets, as well as managing the influence of the U.S. in Canada’s domestic affairs.

All of these issues will need to be considered and addressed to successfully develop and move forward a National Energy Pact that drives strategic investments in Canada’s diverse energy resources. All stakeholders will need to ensure that the benefits brought by the portfolio of projects are appropriately distributed, to minimize the risks of projects encountering opposition from any group that is left with too much risk and contribution for too little benefit. If these diverse stakeholders can work together, then Canada may be able to achieve its energy potential.

8 Conclusion

As the world's need for energy grows unabated, so do the adverse effects of climate change. These circumstances are driving an unprecedented energy transition. Canada is the world's 9th largest emitter of greenhouse gases, primally as a result of its role as a globally significant source of the energy resources that the world needs. Canada is a global leader in the production and export of low-carbon electricity, natural gas, and oil.

Canada has committed to reducing emissions in support of the global fight against climate change. Recent trends and advances in technology are presenting a tremendous opportunity to decarbonize its economy and expand exports of the resulting sustainably developed energy resources.

Canada's energy assets are a story of regional diversity. Each region has different energy import and export characteristics and thus has different interests when it comes to developing Canada's energy assets. Natural resources dominate the conversation in the west and electricity is the focus in the east, along with the energy security associated with energy imports.

Canada's largest trading partners — the U.S. China, and the EU — have a growing need for low carbon energy imports. Canada, with its extensive low-carbon electricity, natural gas, and oil resources, good reputation, and favorable geographic position, is well-placed to serve their energy needs. Canada's resources can help address the primary concerns of these markets: (1) growing energy demand; (2) the need to decarbonize; and, (3) energy security. By increasing exports of its energy resources, Canada can hit above its weight on global emission reductions.

Many proposals have been put forward to develop energy assets that can increase Canadian exports to the markets, but more often than not, they have run into challenges. Recent years have seen several oil and gas pipelines, major hydroelectricity projects, and electricity transmission proposals put forward. In many of these cases, differing views among Indigenous communities; provincial, municipal, and national governments; public interest groups; and other stakeholders have hindered success and common benefit. These barriers must be unlocked for Canada to realize its potential.

Closing

This report has laid out the realm of the possible for the development of Canada's energy resources. The results present a call to action for Canada's stakeholders to collaborate and ensure the full and broad interests of Canadians are addressed in growing Canada's economy, addressing climate change, and ensuring the well-being and prosperity of future generations. If these diverse stakeholders can work together, then Canada can achieve its energy and related economic potential and hit above its weight in the global fight against climate change.

In recent months, post COVID-19 pandemic discussions have included proposals from various stakeholders for how Canada's energy resources should be developed for the greater good. Climate policy objectives are focusing on fuel switching, including greater electrification of key economic sectors like transportation, buildings, and industry. Climate change is also raising the public profile of other environmental externalities such as air pollutants, waste management, and water quality and availability. In turn, under influence by their stakeholders investors are adopting investment taxonomies that recognize these important environmental considerations in related financial spending.

Achieving a collaboration-based consensus on a National Energy Pact from such myriad interests will require an extraordinary nationwide consultation process. Principles of inclusiveness, comprehensiveness, transparency, disclosure, and fact-based decision making should underpin the outreach, engagement, information sharing, and discussions moving forward. Developing this process is fundamental to successfully enabling a Canada-wide energy investment program. It is equally clear that the significant economic, environmental, and social benefits of Canada's energy resources will not be realized without fundamentally changing the way these critical investment decisions are made.

This renewed interest in energy policy presents an opportunity to gather the various stakeholders and present a common energy strategy for the country. There may be no better time to start a national conversation on the energy policy issues facing Canada.

Acknowledgements

This study was inspired by the pan-Canadian dialogue on how best to develop Canada's energy assets and increase energy exports that was initiated by the Canadian Council for Clean and Reliable Energy at their Energy Leaders Roundtable held in Penticton, B.C. in 2019. The study was conceived of and proposed by Strategic Policy Economics as a way to further this national conversation.

Overview of Strategic Policy Economics

Founded by Marc Brouillette in 2012, Strategic Policy Economics helps clients understand the implications of Ontario's energy and climate policy. The firm specializes in characterizing multi-stakeholder issues stemming from technology-based innovations in policy-driven regulated environments such as energy. Reports on Ontario's climate and energy policy have spanned all major energy and climate issues including the implications of long-term energy planning, emissions reduction, the integration of renewables and imports from Quebec, the economic benefits of extending the life of the Pickering nuclear generating station, the challenges of integrating DER, and the pitfalls of cap and trade.

Production of this report

The Strategic Policy Economics team deployed to develop this report included Marc Brouillette, Qasim Naqvi, Anthony Milton, and Daniel Holman.

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The Strategic Policy Economics team hopes this report will contribute to the new national conversation on energy development in Canada.

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Appendix B - Acronyms

AECL – Atomic Energy Canada Limited
AFN – Assembly of First Nations
Bcm – Billion cubic meters
Bcm/y – Billion cubic meters per year
BP – Bruce Power
CANDU – Canada Deuterium Uranium
CEM – Clean Energy Ministerial
CER – Canada Energy Regulator
CHPE – Chaplain Hudson Power Express
CNL – Canada's Nuclear Laboratories
CNSC – Canadian Nuclear Safety Commission
CO_2 - Carbon dioxide
CO_2 eq – Carbon dioxide equivalent
CPP – Clean Power Plan
DER – Distributed energy resources
DGR – Deep Geological Repository
EIA – Energy Information Agency
EU – European Union
FPIC – Free, prior, and informed consent
G – Grams
GDP – Gross Domestic Product
Gt – Gigatonne
GW – Gigawatt
GWh – Gigawatt hours
IEA – International Energy Agency
IESO – Independent Electricity System Operator
ISO – Independent System Operator
ITUM – Takuaikan Uashat mak Mani-Utenam
KHLP – Keeyask Hydropower Limited Partnership
Kt – Kilotonne
LCOE – Levelized cost of energy
LNG – Liquified natural gas
LTEP – Long-term Energy Plan
MISO – Midcontinent Independent System Operator
MJ – Megajoules
MMb – Million barrels
MMb/d – Million barrels per day
Mt – Megatonne
MW – Megawatt
NECEC – New England Clean Energy Connect

NEI – National Energy Institute
NWMO – Nuclear Waste Management Organization
OPG – Ontario Power Generation
P2G – Power-to-gas
PJ – Petajoules
PJM – Pennsylvania New Jersey Maryland Interconnection
PWU – Power Workers' Union
RCMP – Royal Canadian Mounted Police
SAGD – Steam-assisted gravity drainage
SCO – Synthetic crude oil
SMR – Small modular reactor
SON – Saugeen Ojibway Nation
Strapolec – Strategic Policy Economics
Tcm – Trillion cubic meters
TRC – Truth and Reconciliation Committee
tU – Tonnes elemental uranium
TWh – Terawatt hours
UN – United Nations
UNDRIP – United Nations Declaration on the Rights of Indigenous Peoples
WCSB – Western Canadian sedimentary basin