RESEARCH REPORT

Pursuing Clean Growth in Atlantic Canada: Progress, Challenges and Policy Priorities

July 2018

ATLANTIC PROVINCES ECONOMIC COUNCIL | CONSEIL ÉCONOMIQUE DES PROVINCES DE L'ATLANTIQUE

About the Atlantic Provinces Economic Council

The Atlantic Provinces Economic Council (APEC) is a policy research organization whose mandate is to further economic progress in Atlantic Canada and build synergies among its stakeholders to strengthen the region's position in a rapidly changing world. APEC is an independent, non-government, charitable organization supported by its members and guided by a board of directors from across the Atlantic region. It accomplishes its mandate by monitoring and analysing current and emerging economic trends and policies; consulting widely on research findings and building consensus around policy solutions; communicating its research and policy analysis to business, government and the community at large; and advocating the appropriate public and private sector policy responses. APEC's revenue is derived primarily from membership, funded research, events and sponsorships. Our membership includes individuals, small and large companies, labour groups, academic institutions, municipalities and government agencies.

For more information about APEC visit www.apec-econ.ca.

Statement of Independence

APEC does not accept any research funding or other contributions that specify a particular result or policy position or that inhibits its independence in pursuing its research and dissemination activities. All APEC research reports and other publications are subject to review and APEC staff are responsible for the final content and wording of all publications and releases.

Pursuing Clean Growth in Atlantic Canada: Progress, Challenges and Policy Priorities

By David Chaundy, Fred Bergman and Patrick Brannon with research assistance from Thomas Hindle

Acknowledgements

APEC would like to thank the individuals who took the time to be interviewed for this research, and those who provided valuable information, insights and feedback on this report. This project received financial support from the Atlantic Canada Opportunities Agency (ACOA) under the Atlantic Policy Research Initiative, which provides a vehicle for the analysis of key socio-economic policy issues in Atlantic Canada. The opinions expressed in this report are not necessarily those of APEC's directors, members, ACOA or the Government of Canada. APEC staff are responsible for the accuracy and reliability of the information presented. Information in this report is current up to 31 March 2018. The greenhouse gas data used in this report are from Environment and Climate Change Canada's *National Inventory Report 1990-2015: Greenhouse Gas Source and Sinks in Canada* and its 2015 facility-reported greenhouse gas data, along with Natural Resources Canada's comprehensive energy use database.

Pursuing Clean Growth in Atlantic Canada: Progress, Challenges and Policy Priorities

Table of Contents

Abbreviations

CO_2: Carbon dioxide

CO_2e: Carbon dioxide equivalent units

DSM: Demand-side management

EV: Electric vehicles

GDP: Gross domestic product (a standard measure of the size of an economy)

GHG: Greenhouse gas

GWh: Gigawatt hour

IOC: Iron Ore Company of Canada

kWh: Kilowatt hour

LEED: Leadership in Energy and Environmental Design

LNG: Liquefied natural gas

MPI: APEC's Major Projects Inventory

Mt: Megatonnes

MW: Megawatts

TWh: Terawatt hour

Executive Summary

This report assesses Atlantic Canada's progress towards clean growth, highlights some of the challenges, and identifies key policy priorities. APEC's companion report, *Growing Atlantic Canada's Clean Technology Firms*, released in February 2018, focused on how to facilitate the growth of Atlantic Canada's clean technology firms.

For this report, an economy (industry or firm) may be viewed as **transitioning to clean growth,** or experiencing **cleaner growth,** if economic growth is occurring with a smaller negative environmental impact or a more sustainable use of resources, relative to some historical level or predetermined standard. **Clean growth** is therefore used in the sense of a transition to stronger economic outcomes with improved environmental performance.

Chapter 2 Highlights

Transportation (31%) and electricity generation (28%) were the largest source of Atlantic Canada's GHG emissions in 2015. Transportation and agriculture were relatively more important in Prince Edward Island. Oil and gas (13%) and buildings (12%) are also important sources of Atlantic GHG emissions.

In the 1990s, Atlantic Canada's GHG emissions increased in line with economic growth, but a wedge between the two has developed since. However, while GHGs have declined since 2005, regional GDP has barely advanced. Declining emissions partly reflect the closure of industrial plants and sites as well as increased use of renewable energy and greater energy efficiency.

While greenhouse gas (GHG) emissions often receive prime attention, with carbon dioxide (CO_2) being the biggest contributor, environmental impacts include all forms of pollution and environmental degradation as well as sustainable use of natural resources. There is no single indicator for environmental performance and there are relatively few indicators for the Atlantic provinces. However, available data do point to improved air quality since at least 2000.

Over the next 15 years, GHG emissions are currently projected to decline further below 1990 levels in the three Maritime provinces, with the steepest drop in Nova Scotia. Emissions in Newfoundland and Labrador are projected to contract back to 1990 levels. However, the closure of existing thermal electricity generating stations or industrial facilities, or new resource developments and manufacturing plants, can have a sizeable impact on provincial GHG emissions in Atlantic Canada.

The New England Governors-Eastern Canadian Premiers' targets to reduce regional emissions by 35-45% below 1990 levels by 2030 is more aggressive than the 30% reduction from 2005 levels in the Pan-Canadian Clean Growth and Climate Change Framework targets, if applied to the Atlantic provinces individually. GHG emissions in Nova Scotia and New Brunswick are already 30% below 2005 levels.

Chapter 3 Highlights

Electricity generation accounts for 41% of provincial GHG emissions in Nova Scotia, 27% in New Brunswick and 13% in Newfoundland and Labrador.

Emissions from generation have fallen sharply in New Brunswick and Nova Scotia since 2005. This partly reflects the closure of large industrial facilities and the associated reduction in fossil-fuel generation; demand-side management policies to reduce demand through energy efficiency programs; and provincial policies to significantly increase renewable energy generation.

Approximately two-thirds of electricity generating capacity in Atlantic Canada in 2015 was from non-emitting (e.g., nuclear) or renewable energy (including biomass). Between 2009 and 2015, Atlantic Canada's wind generation capacity increased by 75%; the region accounted for 11% of Canada's installed wind generation capacity in 2015.

The completion of the Maritime Link and the PEI-NB Interconnection Upgrade projects in 2017 have improved transmission capacity between the Atlantic provinces. A regionally integrated approach to electricity resources planning offers potential to generate cost savings.

Chapter 4 Highlights

Atlantic firms spent $514 million on environmental protection in 2014 although spending has declined since 2008. Data from APEC's Major Projects Inventory suggest environmental capital spending is rising again and will reach a new high in 2020.

Only 4.5% of Atlantic manufacturers used an advanced green technology in 2012, below the 6.2% national rate. High costs are a big barrier to adoption.

Buildings account for 12% of Atlantic GHG emissions. A growing number of new buildings have a Leadership in Energy and Environmental Design (LEED) certification, which is credited with reducing emissions, energy and water needs.

Transportation accounts for almost one-third of Atlantic GHG emissions with almost three-quarters arising from passenger and freight road transportation. Rising vehicle

ownership is contributing to higher emissions, offset by better fuel efficiency, emissions controls and biofuel requirements. Electric vehicles will grow in importance but have limited short-term impacts on Atlantic emissions.

APEC estimates that spending on clean infrastructure in the Atlantic region peaked at $539 million in 2017 but will remain elevated in 2018 and 2019.

Chapter 5 Highlights

A reduction in mining activity has contributed to a decline in Atlantic GHG emissions from mining since 2010; proposed new mines would add to existing emissions. Improvements in technology, enhanced management techniques and stringent monitoring are important to mitigate environmental effects of mining.

Offshore oil projects are large sources of provincial GHG emissions although there has been no clear trend in emissions since 2005. Onshore production and collection of scientific data are limited as hydraulic fracturing (fracking) is not currently permitted in three Atlantic provinces.

Agriculture accounted for less than 4% of Atlantic Canada's GHG emissions in 2015. Free software enables farmers to estimate their emissions and examine the impact of alternative farming practices, but greater use could be made of environmental farm management plans.

Atlantic Canada's aquaculture industry continues to grow. Mitigating environmental risks, obtaining eco-labelling and ensuring community support are increasingly important.

Atlantic GHG emissions from fishing and seafood processing have declined since 2000. Government and industry investment in science and research, combined with co-management of the fisheries, can help support the sustainability of fish stocks.

Pulp and paper mills are typically large emitters of GHGs, although forest industry emissions have fallen along with mill closures. Energy efficiency remains paramount for this industry.

Competitive pressures are a key challenge for the region's two refineries, which are important contributors to provincial GHG emissions.

Chapter 6 Highlights

The federal government is currently in the processing of replacing the Canadian Environmental Assessment Act 2012 with the Impact Assessment Act, based upon recommendations of an Expert Panel.

Environmental assessments are an important planning and decision-making tool designed to minimize or avoid adverse environmental effects before they occur and to incorporate environmental factors into decision-making. They are used by federal and provincial governments.

Carbon pricing is being introduced in the Atlantic provinces in 2019 although only two provinces had announced their plans, as of March 2018. (Prince Edward Island announced their plan in May after this report was complete.) Addressing equity and competitiveness concerns need to be top priorities for these carbon pricing regimes. There is scope for greater collaboration in provincial approaches to carbon pricing in the Atlantic region.

If the Atlantic provinces are going to track their environmental performance beyond the current focus on GHG emissions, investments need to be made in data collection and assessment.

Carbon pricing should increase the incentives to invest in clean technologies, but solutions to help de-risk the adoption of large-scale, new clean technologies should also be considered.

APEC advocates early planning and engagement by project developers, along with greater reliance on science and evidence and political leadership, to help find a better balance between economic growth and the environment in the Atlantic region.

Chapter 1

Introduction: What is Clean Growth?

This chapter provides the context and key definitions for this report, explaining what is meant by clean growth. It provides an overview of the rest of the report which assesses Atlantic Canada's clean growth performance and identifies the key policy priorities to achieve clean growth.

1.1 Introduction and Context

Interest in environment and climate change policies has waxed and waned in recent decades. The Paris Agreement, negotiated as part of the United Nations Framework Convention on Climate Change in December 2015, is viewed as a "landmark agreement" that "charts a new course" to combat global climate change.[1] It brings almost 200 countries together with national commitments designed to limit the rise in global temperatures.

The Canadian government, along with the provinces and territories, issued the Vancouver Declaration on Clean Growth and Climate Change in March 2016, reaffirming Canada's commitment to the Paris Agreement, and outlining a "vision and principles" that will guide the transition towards "sustainable and clean economic growth."[2] This commitment resulted in the release of the *Pan-Canadian Framework on Clean Growth and Climate Change* in December 2016, which represents a "collective plan to grow our economy while reducing emissions and building resilience to adapt to a changing climate."[3]

The Pan-Canadian Framework has four main pillars: pricing carbon pollution, as an efficient way to reduce emissions, drive innovation, and encourage people and businesses to pollute less; complementary measures to further reduce emissions across the economy, such as energy efficiency standards and codes for vehicles and buildings; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs.

[1] United Nations Framework Convention on Climate Change (2016). *Paris Agreement*. Accessed at http://unfccc.int/paris_agreement/items/9485.php
[2] Canada's First Ministers (2016, March 3). Communiqué of Canada's First Ministers. [News Release]. Accessed at http://pm.gc.ca/eng/news/2016/03/03/communique-canadas-first-ministers.
[3] Canadian Council of Ministers of the Environment (2016). *Pan-Canadian Framework on Clean Growth and Climate Change*. Ottawa: Government of Canada.

This report assesses Atlantic Canada's progress towards clean growth, highlights some of the challenges, and identifies key policy priorities. APEC's companion report, *Growing Atlantic Canada's Clean Technology Firms*, which was released in February 2018, focused on the fourth pillar of the Pan-Canadian Framework: how to grow the economy by facilitating the growth of Atlantic Canada's clean technology firms. Neither report assesses measures to adapt to or build resilience to climate change, although the costs of climate change, or inaction to mitigate its effects, could be substantial.[4]

1.2 Defining Clean Growth

For this report, an economy (industry or firm) may be viewed as **transitioning to clean growth,** or experiencing **cleaner growth,** if economic growth is occurring with a smaller negative environmental impact or a more sustainable use of resources, relative to some historical level or predetermined standard. **Clean growth** is therefore used in the sense of a transition to stronger economic outcomes with improved environmental performance.[5]

While greenhouse gas (GHG) emissions often receive prime attention, with carbon dioxide (CO_2) being the biggest contributor, environmental impacts include all forms of pollution and environmental degradation as well as sustainable use of natural resources. This report discusses both GHG emissions and other environmental effects at both the aggregate level (Chapter 2) and at the industry level (Chapters 3 and 5).

Clean growth is essentially another name for the term "green growth" which is largely focused on economic growth while preserving natural or environmental assets.[6] Green growth may be viewed as a subset of "sustainable development" which includes a focus on the economy, environment and equality (or the social dimension of growth).[7] This report focuses only on the interaction between the economy and the environment.

---

[4] The Pan-Canadian Framework states that "The cost of inaction is greater than the cost of action: climate change could cost Canada $21-$43 billion per year by 2050, according to 2011 estimates from the National Round Table on the Environment and the Economy." Canadian Council of Ministers of the Environment (2016), pp. 1.

[5] This definition is consistent with that implied in the Forward to *the Pan-Canadian Framework on Clean Growth and Climate Change*, which is a "plan to grow our economy while reducing emissions and building resilience to a changing climate." It represents a "step in the transition to a clean growth and resilient economy." It is also consistent with the Federal Sustainable Development Strategy which states that, "A growing clean technology industry in Canada contributes to clean growth and the transition to a low-carbon economy." Government of Canada (2016). *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2016–2019.* Ottawa: Environment and Climate Change Canada, p. 26.

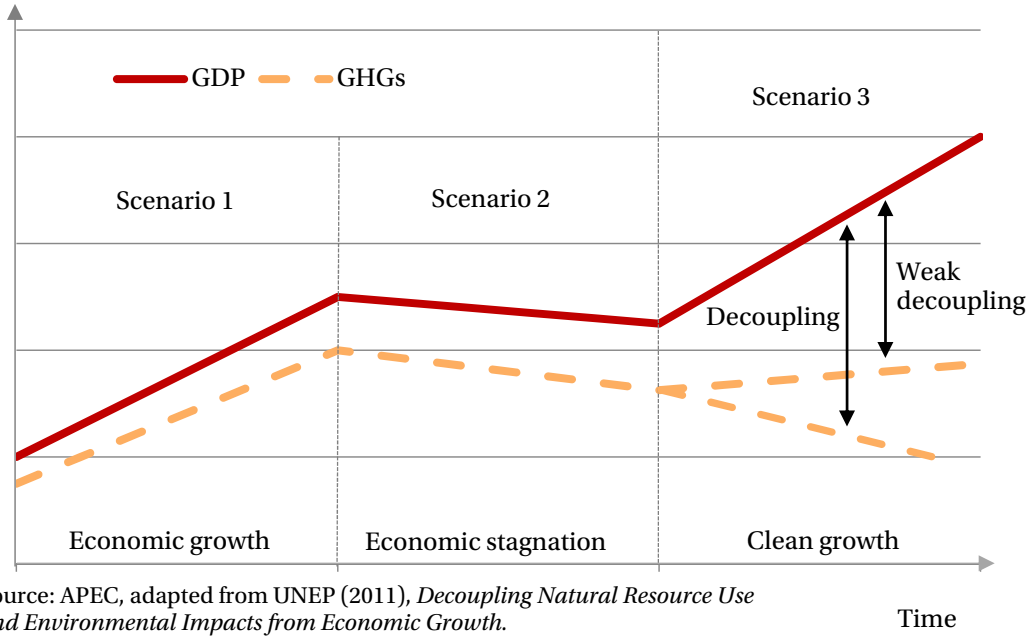
[6] "Green growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies." Organization for Economic Cooperation and Development (2011). *Towards Green Growth: A Summary for Policy Makers.* Paris: OECD, p. 4.

[7] Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (International Institute for Sustainable Development, accessed at http://www.iisd.org/topic/sustainable-development). This definition was crafted by the UN World Commission on Environment and Development in the 1987 report, *Our Common Future* (also known as the Brundtland report), and appears to be the most commonly adopted definition of sustainable development. "Green growth has not been conceived as a replacement for sustainable development, but rather should be considered a subset of it. It is narrower in scope, entailing an operational policy agenda that can help achieve concrete, measurable progress at the interface of the economy and the environment" (Organization for Economic Cooperation and Development, 2011, p. 5)

The essential concept is illustrated in Figure 1.1, using GDP as a proxy for the economy, and GHG emissions as a proxy for the environment.

Figure 1.1 Atlantic Canada Needs to Decouple Environmental Impacts from Economic Growth

Real GDP and GHG emissions (Index)



Source: APEC, adapted from UNEP (2011), *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth.*

In scenario 1, the economy is experiencing economic growth, but GHG emissions, or adverse environmental impacts, are also increasing. As shown in Chapter 2, this is reflective of Atlantic Canada's experience from 1990 to 2000. While economic growth is occurring, so are adverse environmental impacts.

In scenario 2, GHG emissions are declining and other environmental impacts are diminishing, but economic growth has also stalled or even declined. This is reflective of Atlantic Canada's experience between 2007 and 2015. Environmental performance has improved, but the economy is not doing well. Economic decline can cause a decrease in GHGs if, for example, a large pulp and paper plant closes. Similarly, if policies improve environmental performance but also reduce economic activity, this is not clean growth.

In scenario 3, the economy is growing and GHG emissions are declining, or at least increasing at a slower rate. This is reflective of Atlantic Canada's experience from 2000 to 2007. This is illustrative of what the pursuit of, or transition to, clean growth is all about. There is a decoupling of economic activity from negative environmental effects - the economy is growing (or at least not decreasing) while the negative environmental

intensity of this economic activity is improving.[8] Weak decoupling is where negative environmental effects are increasing, but at a much slower rate than economic growth, such that the environmental intensity of economic activity declines. (Strong) decoupling occurs when there is an absolute decline in negative environmental impacts along with continued or improved economic growth.

The transition to clean growth implies the adoption of clean technologies to reduce negative environmental impacts, helping to decouple economic activity from environmental effects. These clean technologies, as discussed in APEC's companion report, help reduce pollution, for example, while improving business performance.

There are two basic ways to facilitate this decoupling. Regulations, such as motor vehicle emissions regulations, fuel efficiency standards, building codes, and provincial renewable energy standards, which define acceptable, or at least improved, environmental performance. What is unknown, however, is the cost of meeting these standards, and what impact it may have on the economy. This regulatory approach, however, will likely spur innovation to find ways to minimize the cost of meeting the new standard.

The second approach is to put a price on pollution, either through a cap-and-trade system or a carbon tax.[9] The advantage of this approach is that it uses the power of the market to achieve the reduction in emissions at the lowest cost, rather than forcing every firm or household to meet a certain standard when some firms or households some can do so more cheaply than others.

The carbon price increases the cost to firms and households of producing GHGs, and therefore provides an inducement to find cheaper and cleaner alternatives. Again, it should spur innovation as there is an incentive to find ways to avoid paying the carbon price, by using technologies with lower emissions.

What is unknown, however, is how big of a reduction in emissions will be achieved if a carbon tax is implemented, or the price of carbon under a cap-and-trade system. Given the time required to develop and adopt clean technology, any reduction in emissions will usually increase over time, for example, as households replace aging motor vehicles, appliances and heating systems with cleaner alternatives.

[8] The GHG emissions intensity of economic activity, for example, can be measured by the volume of GHG emissions per dollar of GDP. Clean growth requires a non-negative change in economic growth with an improvement in environmental performance which implies, for example, that the GHG intensity of economic activity is decreasing.
[9] Ragan, Chris (2017). Pricing Carbon: Advice for the Atlantic Provinces. *Atlantic Report*, Summer. Halifax: APEC, pp. 2.

Governments in Canada are using both approaches. The federal government is requiring all provinces to implement a carbon price in 2019 that meets certain requirements, as discussed in Chapter 6.2. This means the four Atlantic provinces must implement a carbon price in 2019, or use the federal carbon pricing system; Ontario, Quebec, Alberta and British Columbia have already implemented carbon pricing policies. Regulatory standards are also being used, such as renewable energy standards (discussed in Chapter 3); building standards (discussed in Chapter 4.3); and clean fuel standards (discussed in Chapter 4.4). Regulatory standards are also an implicit part of environmental impact assessments, which are designed to assess the environmental impact of new projects, as discussed in Chapter 6.1.

1.3 Report Overview

The remainder of this report is organized as follows.

Chapter 2 assesses Atlantic Canada's clean growth performance in terms of economic growth (measured by real GDP) and GHG emissions. It explains the key contributors to these trends. It discusses other environmental indicators, but there are few indicators with time series data at the provincial level. It concludes by looking at the prospects for clean growth and progress towards regional and national GHG targets.

Chapter 3 focuses on electricity generation as this is a large contributor to GHG emissions, particularly in Nova Scotia and New Brunswick. Reductions in emissions from electricity generation have made sizeable contributions to the aggregate change in Atlantic GHG emissions. The chapter explains the contributions of demand-side management and increased use of renewables, along with the policies that have been used to help reduce emissions.

Chapter 4 focuses on clean technology adoption, using Statistics Canada data to track spending on environmental protection and investment in and adoption of clean technology. It explains the trend in emissions from buildings and the growing importance of a Leadership in Energy and Environmental Design (LEED) certification. It analyses the trends in transportation emissions and the degree of spending on clean infrastructure.

Chapter 5 focuses on a select number of industries to explore what clean growth looks like in mining, oil and gas, agriculture, aquaculture, the fishing and seafood processing industry, and the forest industry. It highlights the economic contributions of these industries, the key environmental issues they face, and options to facilitate clean economic growth.

Chapter 6 discusses two key federal policies to facilitate clean growth – the use of environmental impact assessments and carbon pricing. It highlights key priorities for Atlantic Canada, namely: the need for better provincial data on non-GHG environmental indicators; the need to do carbon pricing well while also developing policies to help de-risk the adoption of newly developed clean technologies. Finally, APEC provides its recommendations on how to improve the assessment of new projects, echoing the findings of a recent expert panel.

Chapter 2

Atlantic Canada's Clean Growth Performance

Chapter Summary

- **Transportation (31%) and electricity generation (28%) were the largest source of Atlantic Canada's GHG emissions in 2015. Transportation and agriculture were relatively more important in Prince Edward Island. Oil and gas (13%) and buildings (12%) are also important sources of Atlantic GHG emissions.**
- **In the 1990s, Atlantic Canada's GHG emissions increased in line with economic growth, but a wedge between the two has developed since. However, while GHGs have declined since 2005, regional GDP has barely advanced.**
- **Declining emissions partly reflect the closure of industrial plants and sites as well as increased use of renewable energy and greater energy efficiency.**
- **There is no single indicator for environmental performance and there are relatively few indicators for the Atlantic provinces. However, available data do point to improved air quality since at least 2000.**
- **Over the next 15 years, GHG emissions are currently projected to decline further below 1990 levels in the three Maritime provinces, with the steepest drop in Nova Scotia. Emissions in Newfoundland and Labrador are projected to contract back to 1990 levels. However, the closure of existing thermal electricity generating stations or industrial facilities, or new resource developments and manufacturing plants, can have a sizeable impact on provincial GHG emissions in Atlantic Canada.**
- **The New England Governors-Eastern Canadian Premiers' targets to reduce regional emissions by 35-45% below 1990 levels by 2030 is more aggressive than the 30% reduction from 2005 levels in the Pan-Canadian Clean Growth and Climate Change Framework targets, if applied to the Atlantic provinces individually. GHG emissions in Nova Scotia and New Brunswick are already 30% below 2005 levels.**

This chapter assesses Atlantic Canada's clean growth performance by first looking at trends in GHG emissions relative to economic growth, identifying the key reasons for declining Atlantic GHG emissions. It then briefly looks at non-GHG indicators. This analysis is challenging because there is no single, composite indicator of environmental performance and there are relatively few indicators with provincial data. The final

section looks ahead to assess the prospects for clean economic growth in Atlantic Canada and progress towards various regional and national GHG reduction targets.

2.1 Economic Growth and Greenhouse Gas Emissions

In 2015, Atlantic Canada's GHG emissions accounted for 5.9% of Canada's GHG emissions, below its population share (6.6%), but marginally higher than its share of GDP (5.4%).[10] This means that Atlantic Canada's contribution to Canada's target to reduce national emissions by 30% below 2005 levels by 2030 will be quite small: even if the region's emissions fell a further 35% below 2015 levels, it would reduce national emissions by only 2%.

Transportation (31%) and electricity (28%) are the two largest sources of Atlantic Canada's GHG emissions (Table 2.1). Transportation is a key contributor in all four provinces. Electricity is a particularly large contributor in Nova Scotia and New Brunswick, due to their greater reliance on fossil fuels for generation. Nationally, oil and gas accounts for 26% of emissions, in large part due to Alberta's oil and gas industry; regionally, this industry is only a sizeable source of emissions in Newfoundland and Labrador (20%) because of its offshore oil industry, and in New Brunswick (19%), due to the oil refinery in Saint John.

Buildings account for 12% of emissions in the Atlantic region, similar to the national share. Agriculture is a large contributor to emissions in Prince Edward Island (23%), while Newfoundland and Labrador's mining industry adds to its industrial emissions.

From 1990 to the early 2000s, Atlantic Canada's GHG emissions increased, largely tracking growth in the economy, as measured by real GDP (Figure 2.1). Since then, there has been some decoupling of economic growth and emissions in the region as emissions stalled while the economy continued to expand. However, since about 2007, the story has been less positive. While emissions have declined, down 24% since 2005, regional GDP has barely grown.

[10] Most of the greenhouse gas data used throughout this report come from Environment and Climate Change Canada (2017), *National Inventory Report 1990-2015: Greenhouse Gas Source and Sinks.* Data for 2016, contained in the 2018 edition of the *National Inventory Report,* were released after the March 31 cut-off date for this report. Environment and Climate Change Canada's facility reported data and Natural Resources Canada's comprehensive energy use database are also used.

Table 2.1 Electricity and Transportation are Large Sources of GHG Emissions in Atlantic Canada

Volume of emissions, 2015 (Mt CO_2e)

	CA	ATL	NL	PE	NS	NB
Oil and gas	189.5	5.4	2.1	0.0	0.6	2.6
Electricity	78.7	11.9	1.3	0.0	6.7	3.8
Transportation	173.0	13.1	3.7	0.8	4.6	4.0
Industrial	97.5	3.3	1.3	0.1	0.8	1.1
Buildings	85.6	4.9	1.1	0.3	2.3	1.2
Agriculture	72.8	1.6	0.1	0.4	0.5	0.6
Waste	24.7	2.2	0.8	0.1	0.6	0.7
Total	721.8	42.4	10.3	1.8	16.2	14.1

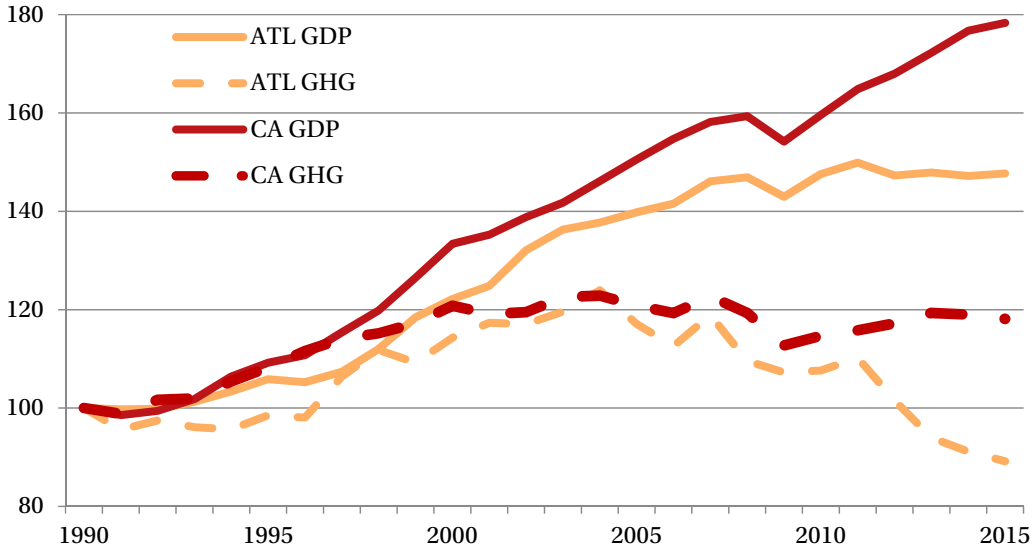
Share of emissions, 2015 (%)

Oil and gas	26	13	20	0	4	19
Electricity	11	28	13	1	41	27
Transportation	24	31	36	46	28	28
Industrial	14	8	12	5	5	8
Buildings	12	12	11	18	14	9
Agriculture	10	4	1	23	3	4
Waste	3	5	8	7	4	5
Total	100	100	100	100	100	100

Source: Environment and Climate Change Canada

Figure 2.1 Atlantic Canada's GHG Emissions Intensity is Declining

Real GDP (chained 2007 dollars) and GHG emissions (metric tonnes), (Index, 1990=100)



Source: Statistics Canada, Environment and Climate Change Canada

Still, there has been a substantial improvement in the overall GHG intensity of the region's economy. GHG emissions per unit of output have been decreasing across the region since 1990 (Table 2.2), with the GHG emissions intensity of economic activity falling 24-36% in the three Maritime provinces between 2005 and 2015.

Table 2.2 Emissions Intensity is Falling Across Atlantic Canada

Emissions intensity (Kg CO_2e/$ real GDP)

	CA	ATL	NL	PE	NS	NB
1990	0.61	0.75	0.59	0.66	0.78	0.84
2005	0.49	0.62	0.40	0.45	0.70	0.74
2015	0.41	0.43	0.38	0.34	0.45	0.49
Change in emissions intensity (%)						
1990-2004	-16	-11	-26	-25	-7	-4
2005-2015	-17	-30	-6	-24	-36	-34

Source: Statistics Canada. Environment and Climate Change Canada

Emissions intensity in Nova Scotia and New Brunswick remains above the national average due to a dependence on fossil fuels for electricity generation. Prince Edward Island currently has the lowest emissions intensity in the region, due to wind generation and imported electricity from New Brunswick. Newfoundland and Labrador is below the national average due to its large resources of hydroelectricity.

Nationally, there is also a growing wedge between GDP and emissions: total emissions in 2015 were almost the same as in 2000, although this implies Canada has significant work to do to grow its economy and reduce its emissions by 30% below 2005 levels. This partly reflects diverging trends across the country (Figure 2.2). GHG emissions have increased in Alberta and Saskatchewan since 2004, while the Maritime provinces have seen the greatest reductions over this time period.

What contributed to the decline in emissions in Atlantic Canada since 2005?

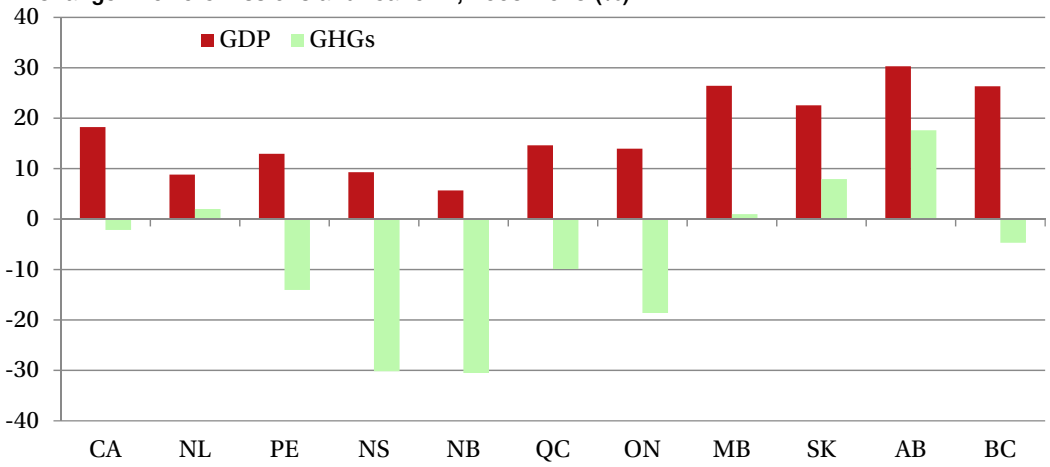
Reductions in emissions from electricity generation made the largest contributions to the reduction in GHGs in New Brunswick and Nova Scotia, accounting for two-thirds and one-half of the emissions reductions in their provinces respectively (Table 2.3). Transportation (14-15%) and industrial activity (10%) represented another one-quarter of the drop in GHG emissions in these two provinces over this period.

The reduction in emissions from electricity generation partly reflects a reduction in output. For example, industry restructuring reduced electricity demand in New Brunswick by 11% between 2005 and 2015. This allowed the closure of two thermal

generation stations in New Brunswick, which accounted for 70% of the reduction in New Brunswick's GHG emissions from thermal generation between 2007 and 2014.[11]

Figure 2.2 GHG Emissions Have Fallen Sharply in the Maritime Provinces

Change in GHG emissions and real GDP, 2005-2015 (%)



Source: Statistics Canada, Environment and Climate Change Canada

Renewable energy policies also played a role in reducing electricity emissions, most notably in Nova Scotia. APEC estimates that climate change policies, including both renewable energy and energy efficiency programs, accounted for about half of the reduction in Nova Scotia's thermal generation over the period 2008 to 2014, and for almost one-third of the reduction in thermal generation in New Brunswick between 2007 and 2014.

While Newfoundland and Labrador's overall emissions were little changed between 2005 and 2015, emissions from offshore oil production declined. Emissions from transportation increased, largely it seems due to increased road transportation.[12] The opening of the Voisey's Bay mine in 2005 and the associated Long Harbour hydromet processing facility in 2014, added to Newfoundland and Labrador's emissions, while the closure of two iron ore mines in 2014 (Wabush Mines and Labrador Iron Mines) provided some offset.

A reduction in emissions from buildings and agriculture accounted for about 85% of Prince Edward Island's drop in emissions since 2005.

[11] The coal-fired Grand Lake generating station closed in 2010 and the oil-fired Dalhousie generating station closed in 2012.

[12] Between 2005 and 2015, the distance travelled for goods transported by truck to and from Newfoundland and Labrador increased by 20%; the 32% increase in the distance travelled to the province likely reflects, in part, transportation of supplies and equipment for major project developments in the province.

Table 2.3 Industry Contributions to Atlantic GHG Reduction Vary by Province

	CA	ATL	NL	PE	NS	NB
Change in emissions, 2005-2015 (Mt CO_2)						
Oil and gas	31.6	-1.3	-0.5	0.0	-0.9	0.1
Electricity	-38.1	-7.6	0.5	0.0	-3.8	-4.3
Transportation	9.8	-1.8	0.5	0.0	-1.2	-1.1
Industrial	-15.4	-1.4	-0.5	-0.1	-0.3	-0.6
Buildings	0.2	-0.7	0.2	-0.1	-0.4	-0.3
Agriculture	-1.1	-0.3	0.0	-0.1	-0.1	-0.0
Waste	-2.9	-0.2	-0.0	-0.0	-0.1	-0.1
Total	-16.5	-13.3	0.2	-0.3	-7.0	-6.2
Change in emissions, 2005-2015 (%)						
Oil and gas	20%	-19%	-20%	0%	-60%	5%
Electricity	-33%	-39%	61%	247%	-36%	-53%
Transportation	6%	-12%	14%	3%	-21%	-22%
Industrial	-14%	-30%	-26%	-50%	-29%	-33%
Buildings	0%	-12%	22%	-27%	-16%	-20%
Agriculture	-2%	-14%	43%	-23%	-20%	-7%
Waste	-10%	-7%	-1%	-4%	-15%	-7%
Total	-2%	-24%	2%	-14%	-30%	-31%
Contribution to change in total emissions, 2005-2015 (percentage points)						
Oil and gas	-192%	10%	-243%	0%	13%	-2%
Electricity	231%	57%	238%	-4%	55%	69%
Transportation	-60%	14%	218%	-8%	17%	18%
Industrial	94%	11%	-214%	28%	5%	9%
Buildings	-1%	5%	92%	41%	6%	5%
Agriculture	7%	2%	14%	42%	2%	1%
Waste	18%	1%	-5%	2%	2%	1%
Total	100%	100%	100%	100%	100%	100%

Source: Environment and Climate Change Canada

2.2 Other Measures of Environmental Performance

GHGs are a big focus for Canada's climate change policy, but they are not the only relevant indicator of environmental performance.[13] While there are fewer provincial indicators of sustainability available than nationally, this section highlights a few key measures, to complement the analysis of GHGs in Section 2.1.

[13] The UN's 2030 Agenda for Sustainable Development is based on 17 sustainable development goals and 169 targets (https://sustainabledevelopment.un.org/post2015/transformingourworld); the federal government tracks numerous indicators to support the Federal Sustainable Development Strategy (https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/federal-sustainable-development-strategy.html); and the OECD has 26 Green Growth Indicators. Organization for Economic Cooperation and Development (2017*). Green Growth Indicators 2017*. Paris: OECD.

Various measures of air quality and pollution point to improving environmental performance in Atlantic Canada. For example, Atlantic emissions of sulphur oxide gases (SO_x),[14] nitrogen oxide (NO_x),[15] ammonia,[16] carbon monoxide[17] and volatile organic compounds,[18] have all declined since 1990 with the exception of NO_x emissions in Newfoundland and Labrador. As a result, emissions have declined sharply relative to GDP (see, for example, Figures 2.3 and 2.4). In Canada, NO_x and SO_x have declined due to a combination of tighter emissions regulations on the transportation and electric power generation sectors; the closure of coal-fired electricity generation units; and changes in industrial processes, including smelting.[19]

The challenge is that there is no single indicator of air quality. Atlantic Canada has a lower concentration of NO_2 in the air than elsewhere in Canada; its SO_2 concentration is lower than everywhere except the Prairies; but its concentration of volatile organic compounds is higher than everywhere except the Prairies. There may be scope for further gains, but industrial structure also plays a role: Prince Edward Island has a much higher rate of ammonia emissions per dollar of GDP than Canada or the other Atlantic provinces, due to its greater dependence on agriculture.

[14] Sulphur dioxide, or SO_2, belongs to a family of sulphur oxide gases (SO_x). It is formed from the sulphur contained in raw materials such as coal, oil and metal-containing ores during combustion and refining processes. SO_2 dissolves in water vapour in the air to form acids, and interacts with other gases and particles in the air to form particles known as sulphates and other products that can be harmful to people and their environment. For example, SO_2 can cause adverse effects on respiratory systems of humans and animals, and damage to vegetation. https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/sulphur-oxides.html.

[15] Nitrogen oxides include the gases nitrogen oxide (NO) and nitrogen dioxide (NO_2). NO_x is formed primarily from the liberation of nitrogen contained in fuel and nitrogen contained in combustion air during combustion processes. NO emitted during combustion quickly oxidizes to NO_2 in the atmosphere. NO_2 dissolves in water vapour in the air to form acids, and interacts with other gases and particles in the air to form particles known as nitrates and other products that may be harmful to people and their environment. For example, NO_2 can cause adverse effects on respiratory systems of humans and animals, and damage to vegetation. https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/nitrogen-oxides.html.

[16] Ammonia (NH_3) is a colourless gas with a pungent odor. Most of the NH_3 emitted is generated from livestock waste management and fertilizer production. NH_3 is poisonous if inhaled in great quantities and is irritating to the eyes, nose, and throat in lesser amounts. https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/ammonia.html.

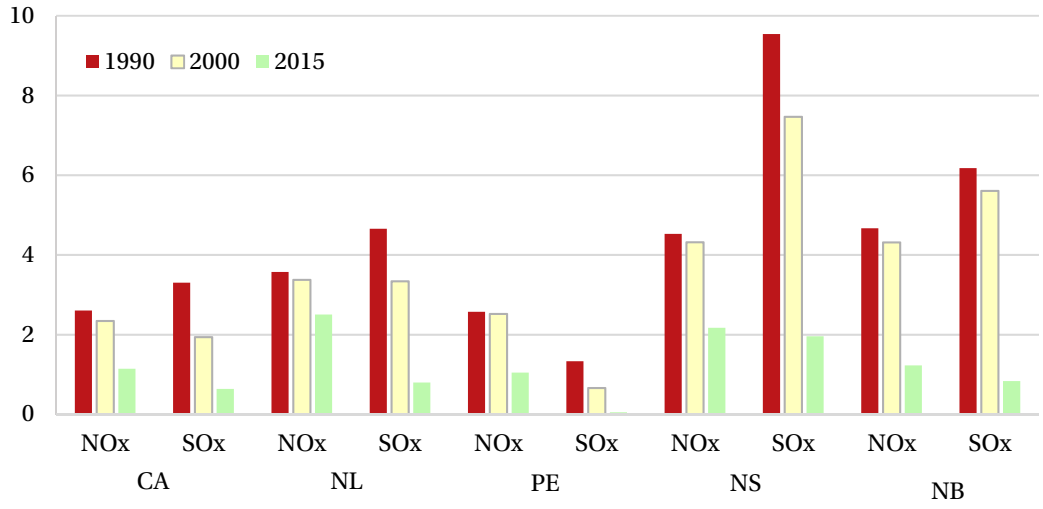
[17] Carbon monoxide (CO) is a colourless, odourless, tasteless and poisonous gas. It is a product of incomplete combustion of hydrocarbon-based fuels and is emitted directly from automobile tailpipes. Other lesser but significant sources are the wood industry, residential wood heating and forest fires. CO can have a significant impact on human health. It enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart disease are especially sensitive to CO poisoning. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive. CO can affect healthy individuals, impairing exercise capacity, visual perception, manual dexterity, learning functions, and ability to perform complex tasks. https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/carbon-monoxide.html.

[18] Volatile organic compounds (VOCs) are carbon-containing gases and vapors such as gasoline fumes and solvents. Many individual VOCs are known or suspected of having direct toxic effects on humans, ranging from carcinogenesis to neurotoxicity. https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/volatile-organic-compounds.html

[19] Environment and Climate Change Canada. *Canadian Smog Science Assessment Highlights and Key Messages: Sources of Smog Pollutants*. Accessed at http://www.ec.gc.ca/air/default.asp?lang=En&n=72F82C27-1&offset=7

Figure 2.3 Reductions in Air Pollution

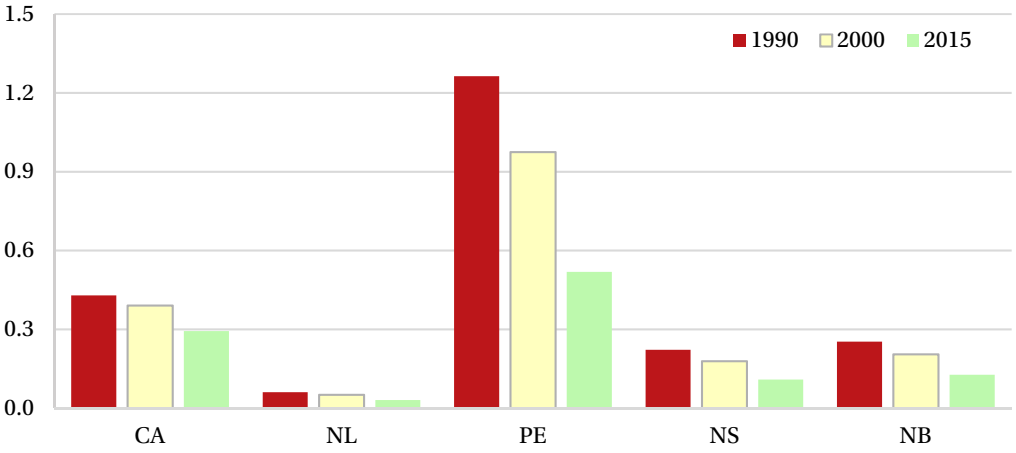
Tonnes of nitrous oxide (NO_x) and sulphur oxide (SO_x) gases emitted per million dollars of real GDP



Source: Environment and Climate Change Canada, Statistics Canada

Figure 2.4 Agriculture Explains PEI's Higher Ammonia Emissions Intensity

Tonnes of ammonia per million dollars of real GDP



Source: Environment and Climate Change Canada, Statistics Canada

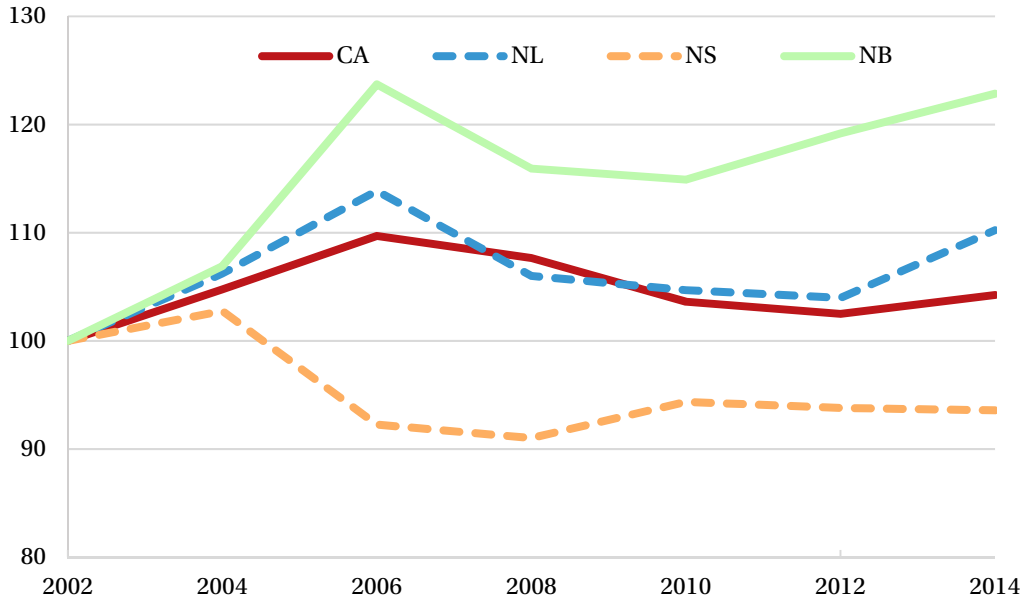
There are fewer indicators for water quality. Data on the proportion of households that treat their water before consuming it suggests which communities suffer from poorer water quality. In 2015, 65% of households in Newfoundland and Labrador treated their water prior to consumption; by contrast only 47% of New Brunswick households did so, below the national average of 51%. Since 2007, there have been no clear trends in these proportion of households treating their water.

The volume of household and other waste provides another measure of environmental performance. For example, increased recycling can reduce the amount of waste that

needs to be disposed of. Nova Scotia is the only Atlantic province that has seen a sustained reduction in its total waste disposed of.[20] Nationally, the proportion of waste being recycled or composted increased from 21% to 25% between 2000 and 2012.

Figure 2.5 Nova Scotia is Leading the Way in Reducing Waste

Waste disposal from all sources (Tonnes, index, 2002=100)



Note: Data for Prince Edward Island are not available.
Source: Statistics Canada

2.3 The Outlook for Clean Growth in Atlantic Canada

Atlantic Canada is facing a "slower for longer" long-term economic outlook as an aging population combines with minimal population growth at best (see Table 2.4), to lead to slower growth in both labour supply and consumer spending.[21] For example, the economies of Nova Scotia and New Brunswick are expected to grow at about 1% per year between 2016 and 2040.[22] With an aging population, average household size and dwelling size will likely decline, reducing energy demand.

The Auditor General of Canada recently provided projections of Canada's GHG emissions through 2030 and the impacts on GHG emissions of related policies put in place as of September 2017.[23] Nova Scotia is forecasted to see the steepest decline in emissions in the Atlantic region (Figure 2.6). Nova Scotia has an equivalency agreement

[20] Data is not available for Prince Edward Island.
[21] APEC (2015). Atlantic Canada Economic Outlook 2016: (S)lower for Longer. *Atlantic Report,* Fall. Halifax: APEC.
[22] Conference Board of Canada (2017). *Provincial Outlook Long-Term Economic Forecast,* Summer. Ottawa: Conference Board of Canada.
[23] Office of the Auditor General of Canada (2018). *Perspectives on Climate Change Action in Canada—A Collaborative Report from Auditors General—March 2018.* Accessed at http://www.oag-bvg.gc.ca/internet/English/parl_otp_201803_e_42883.html. This collaborative report built on individual reports conducted by the provincial offices of the auditor general. The cut-off dates for the Atlantic provinces range from June 2016 to April 2017.

with the federal government, which ensures an equivalent reduction in GHG emissions as if it had closed its coal-fired power plants by 2030. Prince Edward Island and New Brunswick will also see declines while emissions in Newfoundland and Labrador will eventually return to 1990 levels.

Table 2.4 Population Decline Forecast in Three Atlantic Provinces

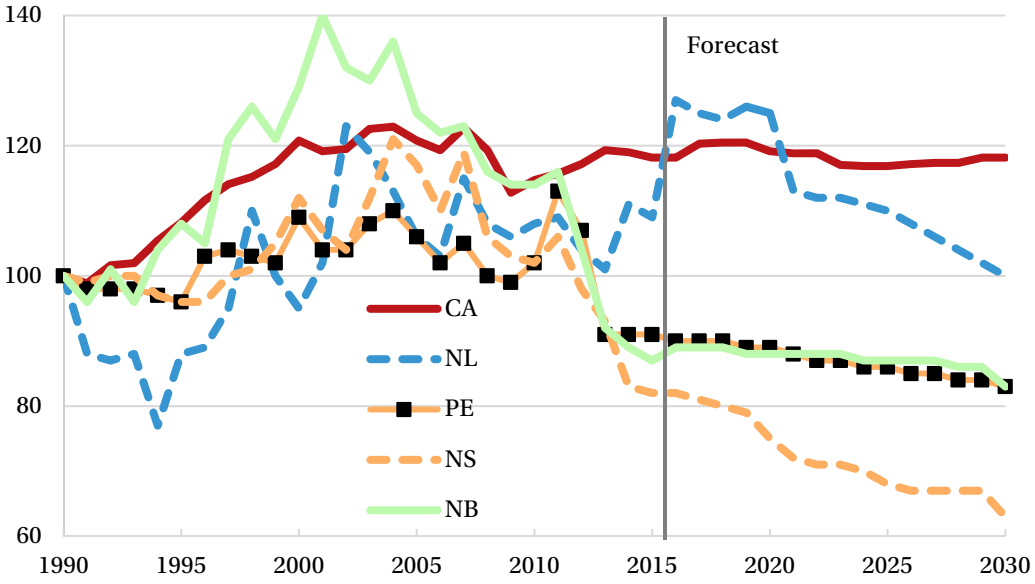
Compound annual population growth rate (%)

	1990-2016	2016-2030
Canada	1.05%	0.88%
Atlantic Canada	0.04%	-0.07%
Newfoundland and Labrador	-0.33%	-0.13%
Prince Edward Island	0.50%	0.49%
Nova Scotia	0.16%	-0.08%
New Brunswick	0.09%	-0.13%

Source: Statistics Canada, provincial Departments of Finance, Office of the Parliamentary Budget Officer

Figure 2.6 Further GHG Reductions Projected in the Maritime Provinces

GHG emissions (Index, 1990=100)



Note: 2016 data is a forecast, not actuals.
Source: Environment and Climate Change Canada, Office of the Auditor General of Canada

The closure of existing larger GHG emitters, or the developments of new operations, can have a significant impact on provincial GHG emissions, and are likely not all captured in the federal government's projections. For example, GHG emissions from large facilities represented 48% of Newfoundland and Labrador's total GHG emissions in 2015. Its largest emitter, the Holyrood thermal generating station, accounts for 24% of total large facility emissions, or 11% of total GHG emissions from all sources (Table 2.5). It will be

decommissioned after Muskrat Falls comes on-line.[24] The Hebron project, which started production in late 2017 and will ramp up output over the next few years, will add to GHG emissions. Proposed mine developments, while generating new economic activity, will also increase GHG emissions, if they proceed.

Table 2.5 Potential Changes to Large GHG Emitters in Newfoundland & Labrador

Select large emitters	City	GHG (Mt of CO_2e)	As share of large emitters, 2015 (%)
All large emitters, 2015		**4,925**	100
Holyrood thermal generating station	Holyrood	- 1,183	24
Hebron oil project	Offshore	+ 600	12
Kami iron ore mine	Labrador Trough	+ 309	6
Fluorspar mine reactivation	St. Lawrence	+ 29	< 1
Total		**4,676**	

Note: The table only shows large emitters for which there is expected to be a change in emissions due to a large increase (start) or decrease (end) in operations.
Source: Canadian Environmental Assessment Agency, Newfoundland and Labrador Department of Municipal Affairs and Environment, Environment and Climate Change Canada, APEC

In Nova Scotia, large facilities account for 47% of Nova Scotia's total GHG emissions. The top five emitters in Nova Scotia are electricity generating stations, which comprise over 91% of emissions from large facilities. Three natural gas related facilities are expected to cease operation over the next few years as the two offshore projects are decommissioned. Two proposed liquefied natural gas (LNG) projects would have a large impact on Nova Scotia's overall GHG emissions.

Table 2.6 Potential Changes to Large GHG Emitters in Nova Scotia

Select large emitters	City	GHG (Mt of CO_2e)	As share of large emitters, 2015 (%)
All large emitters, 2015		**7,637**	100
Thebaud production platform (Sable gas project)	Offshore	- 187	2.4
Deep Panuke production platform	Offshore	- 130	1.7
Goldboro gas plant	Goldboro	- 79	1.0
Goldboro LNG	Goldboro	+ 3,778	49.5
Bear Head LNG	Bear Head	+ 1,954	25.6
Total		**12,974**	

Note: The table only shows large emitters for which there is expected to be a change in emissions due to a large increase (start) or decrease (end) in operations.
Source: Canadian Environmental Assessment Agency, Nova Scotia Department of Environment, Environment and Climate Change Canada, APEC

[24] Government of Newfoundland and Labrador. (2011). *Charting Our Course: Climate Change Action Plan 2011*. Accessed at http://www.exec.gov.nl.ca/exec/ccee/publications/climate_change.pdf.

Large emitters account for over one-half of New Brunswick's GHG emissions. The Irving Oil refinery is the largest emitter, at 41% of the large facility emissions, and one-fifth of total provincial GHG emissions. Over 40% of large facility emissions come from the Belldune and Coleson Cove electricity generating stations in New Brunswick.

Table 2.7 Potential Changes to Large GHG Emitters in New Brunswick

Facility	City	GHG (Mt of CO_2e)	As share of larger emitters, 2015 (%)
All large emitters, 2015		**7,219**	**100**
Sisson tungsten-molybdenum mine	Fredericton	48	1
Total		**7,267**	

Note: The table only shows large emitters for which there is expected to be a change in emissions due to a large increase (start) or decrease (end) in operations.
Source: Canadian Environmental Assessment Agency, New Brunswick Department of Environment and Local Government, Environment and Climate Change Canada, APEC

In August 2015, the New England Governors and Eastern Canadian Premiers (NEG-ECP) set a target to reduce the region's GHG emissions by 35-45% below 1990 levels by 2030, extending an earlier target to reduce emissions by 10% below 1990 levels by 2020.[25] By comparison, the target in the Pan-Canadian Framework (PCF), agreed to in May 2016, are for Canada's emissions to be 30% below 2005 levels by 2030.

Assuming the targeted reductions apply to each province individually, the 2030 NEG-ECP target is more aggressive than the Pan-Canadian Framework (Table 2.8). The Pan-Canadian Framework, if achieved by the four Atlantic provinces individually, would reduce the region's emissions to 39 Mt or less by 2030, while the NEG-ECP target would reduce emissions to 26-31 Mt by 2030.

Table 2.8 GHG Emissions Targets Across Atlantic Canada

GHG emissions (kt CO_2e)

	1990	2005	2015	PCF (-30% below 2005), 2030	NEG-ECP (-35% below 1990), 2030	NEG-ECP (-45% below 1990), 2030
NL	9,500	10,100	10,300	7,080	6,180	5,230
PE	1,940	2,060	1,760	1,440	1,260	1,070
NS	19,800	23,200	16,200	16,200	12,900	10,900
NB	16,300	20,300	14,100	14,200	10,600	8,960
ATL	47,600	55,700	42,400	39,000	30,900	26,200
CA	611,000	738,000	721,000	517,000	n.a.	n.a.

Source: Environment and Climate Change Canada, Pan-Canadian Framework on Clean Growth and Climate Change, New England Governors-Eastern Canadian Premiers.

[25] The four Atlantic provinces have not officially endorsed these targets at a provincial level, with the exception of New Brunswick, whose Climate Change Action Plan endorses a 10% reduction below 1990 levels by 2020.

Chapter 3

Clean Electricity

Chapter Summary

- **Electricity generation accounts for 41% of provincial GHG emissions in Nova Scotia, 27% in New Brunswick and 13% in Newfoundland and Labrador.**
- **Emissions from generation have fallen sharply in New Brunswick and Nova Scotia since 2005. This partly reflects the closure of large industrial facilities and the associated reduction in fossil-fuel generation; demand-side management policies to reduce demand through energy efficiency programs; and provincial policies to significantly increase renewable energy generation.**
- **Approximately two-thirds of electricity generating capacity in Atlantic Canada in 2015 was from non-emitting (e.g., nuclear) or renewable energy (including biomass). Between 2009 and 2015, Atlantic Canada's wind generation capacity increased by 75%; the region accounted for 11% of Canada's installed wind generation capacity in 2015.**
- **The completion of the Maritime Link and the PEI-NB Interconnection Upgrade projects in 2017 have improved transmission capacity between the Atlantic provinces. A regionally integrated approach to electricity resources planning offers potential to generate cost savings.**
- **Governments have used various policies to encourage or require greater renewable energy production. Carbon pricing will also be introduced in 2019 although, at present, the four Atlantic provinces are pursuing their own individual approaches.**
- **Governments need to be mindful of the incremental impact of their policies on electricity rates to ensure that cleaner electricity does not undermine the pursuit of economic growth.**

As described in Chapter 2, electricity accounts for a large portion of Atlantic GHG emissions and has contributed to significant reductions in total emissions. This chapter explains the factors that have led to lower emissions from electricity generation in Atlantic Canada and what the prospects are for further shifts to clean electricity generation.

3.1 Recent Trends in Generation and Emissions

Electricity generation accounts for 41% of all GHG emissions in Nova Scotia and 27% in New Brunswick (down from 40% in 2005), due to a reliance on fossil fuels (Table 3.1). Electricity accounts for 13% of emissions in Newfoundland and Labrador because of its abundant sources of hydroelectricity; some of this power is exported to Quebec.

Since 2005, emissions from electricity generation have fallen sharply in New Brunswick (53%) and Nova Scotia (36%), accounting for over half of the drop in total emissions in those provinces over that period. GHG emissions from electricity generation have increased in Newfoundland and Labrador and Prince Edward Island over the last decade but still only account for 1% of all emissions in Prince Edward Island.

Table 3.1 Electricity Sector Has Played Big Role in Change in Total GHG Emissions

Electricity GHG emissions

Jurisdiction	GHGs, 2005 (Kt CO_2e)	GHGs, 2015 (Kt CO_2e)	Share of total emissions, 2005 (%)	Share of total emissions, 2015 (%)	Change in electricity emissions, 2005-2015 (%)	Change in total emissions, 2005-2015 (%)	Contribution to change in total emissions 2005-2015, (%)
NL	819	1,319	8	13	61	2	237
PE	4.8	16.5	0	1	244	-14	-4
NS	10,566	6,716	46	41	-36	-30	55
NB	8,063	3,776	40	27	-53	-31	69
ATL	19,453	11,828	35	28	-39	-24	57
CA	121,732	83,703	16	11	-31	1	-435

Source: Environment and Climate Change Canada

The contribution of electricity generation to GHG emissions depends on two broad factors: the volume of electricity produced, which depends on factors such as industry and household demand; and GHG emissions intensity (grams of CO_2e emissions per kWh), which reflects in large part the relative importance of renewables and non-emitting fuel sources.

Between 2005 and 2015, electricity generation fell by 34% in New Brunswick and a more modest 18% in Nova Scotia (Table 3.2). In large part this reflects the impact of industrial restructuring. There were 13 forest industry closures in Atlantic Canada between 2004 and 2012, displacing 4,200 people. As a result, NB Power's industrial electricity sales volumes declined by 24% between 2006/2007 and 2015/2016, while NS Power's industrial

electricity sales decreased 41% between 2005 and 2015.[26] Across Atlantic Canada, electricity sales to mining and manufacturing fell 32% between 2005 and 2015, compared with a 20% decline nationally.

Table 3.2 Emissions Intensity Has Fallen in Maritime Electricity Industry

Jurisdiction	Generation, 2005 (GWh)	Generation, 2015 (GWh)	Change, 2005-2015 (%)	Emissions intensity, 2005 (g CO_2e/kWh)	Emissions intensity, 2015 (g CO_2e/kWh)	Change, 2005-2015 (%)
NL	42,136	41,753	1	19	32	63
PE	46.4	614	1,223	103	27	-74
NS	12,477	10,220	-18	850	658	-23
NB	21,063	13,940	-34	383	271	-29
ATL	75,723	66,527	-12	257	178	-31
CA	604,370	642,690	6	202	130	-35

Note: Generation includes electric utilities generation and industry generation.
Source: Statistics Canada, Environment and Climate Change Canada, APEC

Emissions intensity fell by about 30% in Nova Scotia and New Brunswick between 2005 and 2015. Nova Scotia still relies on coal for just under half of its generation and Nova Scotia Power's four coal-fired and petroleum coke electricity generating stations accounted for 36% of the province's total GHG emissions in 2015. However, the province has reduced its reliance on oil with greater use of natural gas, which is less emissions-intensive, and wind power (Table 3.3).

Table 3.3 Nova Scotia's Shifts From Coal Towards Wind Generation

Share of electricity generation by source, Nova Scotia Power (%)

Source	kg CO_2 per mmbtu	2005 (%)	2015 (%)
Coal	93 - 114	63	46
Natural gas	53 - 54	12	12
Petroleum coke	102 - 114	11	10
Oil	72 - 79	2	1
Other fossil fuels	59 - 75	0	0
Biomass	93 - 118	0	3
Wind	0	1	14
Hydro & tidal	0	9	10
Imports	n.a.	2	4
Total	n.a.	100	100

Note: Biomass stores CO_2 making it carbon neutral even though CO_2 is released during combustion.
Source: Environmental Protection Agency, Nova Scotia Power

[26] NB Power. *Annual Reports, 2010/2011 and 2014/2015*. Accessed at https://www.nbpower.com/en/about-us/accountability-reports/annual-and-quarterly-reports and Emera. *Annual Reports, 2005 and 2014*. Accessed at http://investors.emera.com/GenPage.aspx?IID=4072693&GKP=205804

New Brunswick reduced its reliance on oil from 35% of electricity generation in 2005 to 9% in 2015, in part by closing its Dalhousie oil-fired electricity generation station in 2013 in the face of declining demand. NB Power also closed the Grand Lake coal-fired generating station in 2010, although the Belledune coal-fired electricity generation facility still accounted for 15% of total provincial GHG emissions in 2015. Greater use of nuclear power from the refurbished Point Lepreau station (up to 30% of generation in 2015), wind and natural gas complemented the switch from oil.

Prince Edward Island relies heavily on imported electricity from New Brunswick, which accounted for 75% of its electricity sales in 2014.[27] Renewable energy accounted for 99% of Prince Edward Island's own electricity generation in 2015, thanks to the addition of wind capacity. It also reduced the amount of oil burned, lowering the emissions intensity of its generation.

Newfoundland and Labrador's electricity generation has the second lowest GHG intensity in the Atlantic region because 95% of its generation is sourced from hydro. The remainder is oil burned at the Holyrood generating station, natural gas burned at offshore oil facilities, and some wind energy.

Overall, renewables, including hydro, wind, biomass and tidal, increased their share of Atlantic generation from 62% to 70% between 2005 and 2015. Rising oil prices helped improve the relative affordability of renewable energy prior to 2014, encouraging a shift away from oil.

3.2 Demand-Side Management (DSM)

As discussed in Chapter 1, clean growth is about growing the economy while reducing adverse environmental impacts. The closure of a large mine or manufacturing plant allows for cleaner economic activity by reducing emissions and other negative environmental effects from direct industrial activity, and by reducing the indirect demand for electricity generated from fossil fuels. However, there is also a substantial economic loss, observed in exports revenues, employment and personal incomes and tax revenues.

Is there a way to reduce electricity demand without harming economic activity? Demand-side management (DSM) includes planning, implementing, and monitoring electric utilities' activities to influence consumers' level and pattern of electricity usage.[28] DSM programs are typically focused on reducing electricity demand in the residential,

[27] Prince Edward Island Energy Corporation (2017). *Provincial Energy Strategy 2016/2017*, p. 8.
[28] Energy Information Administration. *Electric Utility Demand Side Management*. Accessed at https://www.eia.gov/electricity/data/eia861/dsm/

commercial, institutional and industrial sectors through a combination of energy efficiency, fuel substitution (e.g., electricity for heating oil), co-generation (e.g., combined heat and power), and distribution (e.g., net metering and smart grids).

Until a few years ago, DSM and energy efficiency programs were the policy response of choice to address energy supply shortages and avoid the need for capital investment in expensive generation capacity. This is due to the fact that DSM is often the least cost option.[29] Program spending on DSM has fallen, or is falling, in all four Atlantic provinces although it is still important in the region.[30] Industry restructuring has reduced peak load demand and climate change has shifted the focus towards reliability, because of increased storm intensity and longer or more widespread power outages.

Still, DSM initiatives have produced energy savings and therefore helped to reduce GHG emissions. APEC estimates cumulative Atlantic energy savings from DSM up to 2015 were approximately 1,557 GWh, which is about 2% of total generation in the Atlantic region in 2015 or 5% of electricity demand in the Atlantic provinces.[31] However, these savings in electricity use from DSM equate to about 20% of the reduction in the region's electricity demand between 2005 and 2015. Atlantic savings are fairly evenly split between residential and business users.

Table 3.4 Atlantic DSM Programs Reducing Electricity Demand by 1% Annually

	Program costs ($millions)		Annual energy savings (GWh)		DSM saving (% of sales)		Annual cost (cents/kWh)	
Jurisdiction	2009	2015	2009	2015	2009	2015	2009	2015
NL	1.5	6.6	3	103	0.03	1.1`	56	6
PE	0.6	n.a.	1	n.a.	0.1	n.a.	41	n.a.
NS	9.4	32	64	138	0.6	1.3	15	23
NB	5.9	7.0	55	31	1.6	0.8	11	22
ATL	17	45	122	272	0.4	1.2	14	17

Note: Program costs exclude general costs such as education, support, planning and evaluation.
Source: Statistics Canada, regulatory filings with provincial utilities boards, Maritime Electric, APEC

[29] Synapse Energy Economics (2018). *Nova Scotia Power Inc. Thermal Generation Utilization and Optimization: Economic Analysis of Retention of Fossil-Fueled Thermal Fleet To and Beyond 2030.* (This report for the Nova Scotia Utility and Review Board was released after the March 31 cut-off date for this report.)
[30] Energy efficiency grants from the PEI Office of Energy Efficiency fell from $5 million annually in 2009/2010 to about $1 million annually in 2014/2015. In New Brunswick, grants and contributions from Efficiency New Brunswick fell from almost $16 million in 2012 to $6 million in 2016. In Nova Scotia, DSM costs have fallen to about $30-35 million annually since 2015, compared with $40-45 million in 2012/2013. Energy conservation spending in Newfoundland and Labrador increased to over $8 million per year in 2016/2017 but is projected to decline to almost $4 million by 2020.
[31] These numbers all exclude Prince Edward Island. Newfoundland and Labrador's electricity generation is considerably higher than its electricity demand because it exports a considerable amount of electricity. This results in DSM savings in the region being a higher percentage share of electricity demand than as a share of electricity generation.

In 2015, first year general and program DSM costs amounted to about 25-32 cents/kWh in the Atlantic provinces.[32] However, most jurisdictions calculate a total resource cost (TRC) to evaluate energy conservation programs. The TRC compares the lifetime benefits, based on the net present value of the avoided costs, such as energy and capacity over the life of the program, relative to the up-front investment costs, which can include DSM program costs and household or business participant costs. For example, Efficiency One estimated a TRC benefit/cost ratio of 2.3 for 2016, although this ratio does not include any decreased environmental impact or positive effect on property values.[33]

The lifetime unit cost of DSM in Nova Scotia is currently estimated to be 1.9 cents/kWh.[34] By comparison, residential electricity rates in 2016 were about 16 cents/kWh in Halifax and Charlottetown, 12.5 cents/kWh in Moncton and about 12 cents/kWh in St. John's.[35]

Most provinces pass along the costs of DSM programs to customers via rate increases. For example, Newfoundland Power defers and amortizes its conservation program costs over a seven-year period. Through the annual rate stabilization adjustment, customer rates are adjusted based on the difference between the conservation program costs included in the most recent test year and actual costs incurred.

Most Atlantic provinces also have non-electrical energy conservation programs aimed at reducing use of fossil fuels, such as energy audits and assessments which recommend energy efficiency measures to reduce energy use (such as new windows and doors or more insulation). In 2015, Efficiency One's non-electrical energy programs were exclusively for the residential sector and resulted in annual energy savings of 40 GWh, compared with 138 GWh in savings from their electrical DSM programs.[36] Program costs for non-electrical energy programs were also higher at 37 cents/kWh, compared with 23 cents/kWh for its electrical energy programs in 2015.

Provinces and power utilities continue to implement DSM. Over the period 2015-2020, Newfoundland and Labrador Hydro and Newfoundland Power are projected to spend $33 million on energy efficiency programs, resulting in cumulative energy savings of 883 GWh.[37]

[32] ICF International (2015). *Review of Nova Scotia's Energy Savings Portfolio*. Vancouver: ICF International. Submitted to Nova Scotia Power.
[33] Efficiency One (2016). *2016-2018 Demand-Side Management (DSM) Resource Plan.* Halifax: Efficiency One.
[34] Efficiency One (2018). *Efficiency One 2017 Annual Report*. Accessed at https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170125-en.pdf
[35] Hydro Quebec (2016). *Comparison of Electricity Rates in Major North American Cities*, Rates in effect April 1, 2016.
[36] Electricity accounted for 41% of Nova Scotia's GHG emissions in 2015, compared with 20% from non-electricity stationary combustion of fossil fuels.
[37] Newfoundland and Labrador Hydro and Newfoundland Power (2015). *Five-Year Energy Conservation Plan: 2016-2020.*

Prince Edward Island's energy strategy includes the use of energy efficiency programs to reduce the electricity load by 0.4% per year starting in 2017, until it reaches 2% by 2020. The energy strategy is also focused on improving energy efficiency by reducing use of oil heat, while encouraging increased use of heat pumps, electricity, and wood and pellet stove heat. The energy efficiency programs are forecast to reduce GHG emissions by 40 kt by 2021 and 138 kt by 2031.

Nova Scotia Power filed an application for investments in advanced metering infrastructure and smart grid that total $133 million over the 2018-2019 period. The capital investment plan will provide access to smart meters for new builds and existing buildings that opt to have them installed.[38]

NB Power's Reduce and Shift Demand program has been replaced by the Energy Smart program, which includes three components. Smart habits include incentives for energy efficiency and conservation, such as a rebate for installation of a heat pump and updating insulation. Smart grid includes a grid modernization partnership with Siemens Canada and UNB while smart meters could be installed in households by the end of 2018. Smart solutions include smartphone applications for monitoring energy use and providing access to data analytics, although this will require time-of day rates.

3.3 Renewable Energy and Transmission

Approximately two-thirds of electricity generating capacity in Atlantic Canada was from non-emitting or renewable energy in 2015, if nuclear power and biomass are included (Table 3.5). Biomass is considered carbon-neutral because it stores carbon prior to being burned and comes from sustainable forests products when possible.[39] Compared with Canada as a whole, the three Maritime provinces have a greater reliance on fossil fuel generation and modest hydro capacity while Newfoundland and Labrador is almost all hydro.

A significant increase in non-renewable energy prices prior to the 2008/2009 recession helped make renewable energy more affordable. Between 2003 and 2008, energy prices increased at a rapid pace; for example, in US dollars Brent crude oil prices increased by 236%. Over the last decade, the depletion of non-renewable energy resources also placed an increased emphasis on energy security, while climate change commitments required governments to implement GHG emission reduction and renewable energy targets to reduce their respective jurisdiction's environmental footprint. Natural Resources Canada

[38] Nova Scotia Power (2017b). *2018 Annual Capital Expenditure Plan*. Halifax: Nova Scotia Power. Filed with Nova Scotia Utility and Review Board on November 22, 2017.
[39] Biomass stores CO_2 making it carbon neutral even though CO_2 is released during combustion.

reported that Canadian businesses invested $273 million in renewable and clean energy supply in 2013, while Canadian governments invested $341 million in 2013/2014.[40]

The Atlantic provinces invested in more renewable energy over the last seven years, especially wind energy due to its lower cost relative to other renewables. Onshore wind energy technology is relatively mature and less expensive than large-scale hydro or nuclear energy, and is cheaper than developmental tidal energy or biomass energy.

Table 3.5 Fossil Fuels Still Large Part of Maritime Generating Capacity

Share of electricity generation capacity, 2015 (%)

Source	NL	PE	NS	NB	ATL	CA
Hydro	91.3	0.0	13.9	21.1	54.2	58.6
Wind	0.7	55.9	11.3	6.5	5.7	5.6
Tidal	0.0	0.0	0.8	0.0	0.1	0.0
Solar	0.0	0.0	0.0	0.0	0.0	0.1
Biomass	0.0	0.3	4.2	3.5	1.8	1.8
Nuclear	0.0	0.0	0.0	15.6	4.7	5.7
Fossil fuel	8.0	43.8	69.8	53.2	33.4	28.2
Total	100	100	100	100	100	100

Note: Table 3.5 (generation capacity) is not directly comparable to Table 3.3 (actual generation).[41] Electricity generation capacity is the maximum electric output an electricity generator can produce under specific conditions. Electricity generation is the amount of electricity a generator produces over a specific period of time. Many generators do not operate at their full capacity all the time.
Source: Statistics Canada, National Energy Board, Government of New Brunswick, Maritime Electric

Between 2009 and 2015, Atlantic Canada's wind generation capacity increased by 75% and the region accounted for 11% of Canada's installed wind generation capacity in 2015. According to APEC's Major Projects Inventory, $13 billion was invested in major renewable energy projects in Atlantic Canada between 2009 and 2017, or $2.9 billion excluding the Muskrat Falls hydro project and related electricity transmission projects. Between 2018 and 2022, APEC forecasts a further $3.7 billion will be invested in major renewable energy projects, or $1.8 billion excluding the Muskrat Falls hydro project and electricity transmission projects.

While investment in renewable energies is important from an environmental perspective, the cost of electricity generated from renewables is more expensive; fossil fuels is cheaper than its counterparts.[42] However, there are forecasts that electricity from renewables will fall into the price range of fossil fuels by 2020.[43] Certain renewable energy

[40] Natural Resources Canada (2015b). *Energy Fact Book*. 2015-2016. Ottawa: Natural Resources Canada.
[41] United States Energy Information Administration. *What is the difference between electricity generation capacity and electricity generation?* Accessed at https://www.eia.gov/tools/faqs/faq.php?id=101&t=3
[42] This is why carbon pricing is so important as the cost of fossil fuel generation does not currently include any costs associated with climate change.
[43] International Renewable Energy Agency (2018). *Renewable Power Generation Costs in 2017*. Accessed at http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017

sources, such as wind and solar, are also intermittent. This increases the difficulty of reaching 100% renewable energy without large scale energy storage capability or large amounts of hydroelectricity to balance intermittent renewable sources.

Table 3.6 Renewable Energy Spending is Expected to Increase in Atlantic Canada

Major renewable energy projects ($millions)

Jurisdiction	2009-2015	2016-2022	2009-2022
NL	4,670	7,213	11,883
PE	128	203	331
NS	1,716	1,566	3,282
NB	289	2,916	3,205
ATL	6,803	11,898	18,701

Source: APEC Major Projects Inventory

Newfoundland and Labrador

Newfoundland and Labrador added 27 MW of wind energy at Fermeuse in 2009, in addition to the 27 MW wind farm at St. Lawrence that came on-line in 2008 but this new capacity is tiny compared with the province's 6,759 MW of installed hydro capacity. Beothuk Energy has proposed to build a 180 MW offshore wind farm in St. George's Bay.

The Muskrat Falls hydro project will add another 824 MW of capacity when it comes on-line, currently estimated to be in 2020. The latest capital cost estimate for the Muskrat Falls project is $12.7 billion, including financing costs.[44] The expected combined residential rate for customers in 2022, after Muskrat Falls hydro is completed, is estimated to be 23 cents/kWh, compared with current residential rates of about 12 cents/kWh.[45]

The Holyrood oil-fired generating station accounted for about 11% of the province's GHG emissions in 2015. When the Muskrat Falls hydro project comes on-line, it could allow for the decommissioning of the Holyrood generation station, reducing emissions by 1 Mt annually, which is equivalent to taking 300,000 cars off the road.[46]

There are 22 isolated systems in Newfoundland and Labrador that serve rural communities which are not connected to the electricity grid and that receive power from diesel generators. Wind studies are being conducted near some of these communities to see if there is potential for renewable energy.[47]

[44] The federal government loan guarantee for the Muskrat Fall project resulted in approximately $1 billion in interest cost savings.
[45] Nalcor Energy (2017). *Muskrat Falls Project Update.* (Presentation).
[46] Department of Natural Resources (2012). *Environmental Benefits of Closing the Holyrood Thermal Generating Station*. St. John's: Government of Newfoundland and Labrador.
[47] Nalcor Energy's Ramea project uses a combination of wind-hydrogen- diesel to provide power for that isolated community in southern Newfoundland and is in the early stages of developing phase 2, which will include hydrogen fuel cells to store excess wind energy.

Newfoundland and Labrador Hydro has been approved to accept applications for net metering, which will allow customers who own renewable energy generators up to 100 kW to generate power for their own use and supply surplus energy to the distribution system. Province-wide, there is a 5 MW cap on net metering, which limits its potential contribution to renewables.[48]

Prince Edward Island

Since 2009, Prince Edward Island has added 133 MW of wind power, bringing it to 204 MW of installed wind capacity. Including storage capacity, the WEI Canada wind farm added 12 MW of wind capacity in 2013, while the Hermanville-Clearsprings wind farm added another 30 MW in 2014. The City of Summerside's 12 MW wind farm was commissioned in 2009, while GDF Suez's 79 MW wind farm began exporting power to NB Power in 2009. The PEI energy strategy proposes the development of two additional wind farms: 30 MW in 2019 and 40 MW in 2025.[49]

The existing wind capacity is still relatively small in terms of the Island's electricity needs. Maritime Electric purchases 92 MW of wind energy from the PEI Energy Corporation. However, with an effective load carrying capability of 23%, this represents less than 10% of the Island's peak demand.[50] The recent installation of two, 180 MW electricity transmission cables between the Island and New Brunswick will increase the potential for further wind energy exports.

Nova Scotia

Nova Scotia Power estimated 28% of its electricity was sourced from renewables in 2016, exceeding a target of 25% set for 2015. Most of this increase was due to wind power, along with a 60 MW biomass facility in Port Hawkesbury. This target was achieved through Nova Scotia Power's investments in renewable energy, along with investments by independent power producers and uptake of the community feed-in tariff (COMFIT).[51]

---

[48] Government of Newfoundland and Labrador (2017, May 19). Minister Coady Supports Public Utilities Board's Approval of Net Metering Program. [News release].

[49] Prince Edward Island Energy Corporation (2017).

[50] Effective load carrying capability (ELCC) is an output of probabilistic modeling, which assesses likely system needs and the potential for wind and solar resources to contribute to these needs. The ELCC expresses how well the facility is able to meet reliability conditions and reduce expected reliability problems or outage events caused by capacity shortfalls as compared to a perfect generator (considering availability and use limitations).
California Public Utilities Commission – Energy Division (2014). *Effective Load Carrying Capacity and Qualifying Capacity Calculation Methodology for Wind and Solar Resources*.

[51] The COMFIT program set feed-in tariff rates for wind, biomass, run of the river hydro and tidal power. By the end of 2015, Nova Scotia's COMFIT program was projected to add 205 MW in renewable generation capacity with an investment of approximately $35 million. The COMFIT program and the recent Nova Scotia Power-IPP projects will add 4% and 2% to electricity rates, respectively. Nova Scotia Department of Energy (2015). *COMFIT Review: January to July 2015*. Halifax: Government of Nova Scotia.

Nova Scotia's 2009 renewable energy policy also set a target to increase renewable energy to 40% of electricity demand by 2020. The Maritime Link is now commissioned but is waiting for the completion of the delayed Muskrat Falls project to import hydro power from Newfoundland and Labrador, which should enable Nova Scotia to achieve this 40% renewable target. Beothuk Energy also proposes to build a 1,000 MW offshore wind farm near Yarmouth.

Nova Scotia Power's latest *10 Year System Outlook* includes 21 MW in new firm capacity sourced from renewable electricity generation, including 19 MW in COMFIT and 2 MW in small-scale tidal projects. It forecasts the Lingan 2 coal-fired generation unit will be decommissioned in 2020/2021 with energy from Muskrat Falls to replace it.[52] However, this will have a limited impact on GHG emissions because of rising peak demand and the necessity to balance increasing wind generation, which will require additional coal-fired generation from units still in operation.

Looking further ahead, Nova Scotia has five developmental tidal projects planned over the medium-term in the Bay of Fundy, for a total of 24 MW. Nova Scotia's long-run target for tidal energy is 300 MW.

New Brunswick

In 2014, the Electricity Act was amended to include the establishment of the Renewable Portfolio Standard of 40% by 2020.[53] The province is on track for 2020: In 2016/2017, renewables provided 36% of its NB Power's in-province electricity (or 42% including imports).[54]

Since 2010, New Brunswick added phase 2 of the Kent Hills wind farm (54 MW), along with wind farms at Lameque (45 MW) and Caribou Mountain (99 MW). NB Power has reached an agreement with TransAlta to add 17.25 MW at Kent Hills 3 by late 2018 and has a community renewable energy program in place to develop 40 MW of renewable energy from aboriginal businesses and another 40 MW from local entities by 2020. New Brunswick may also be able to import clean energy from Quebec or Newfoundland and Labrador when Muskrat Falls is completed, although the latter option could require increased transmission capacity between the Maritime provinces.

[52] Nova Scotia Power (2017a). *10 Year System Outlook*. Halifax: Nova Scotia Power. Filed with Nova Scotia and Utility and Review Board on June 30, 2017.
[53] Government of New Brunswick. *Renewable Portfolio Standard.* Accessed at http://www2.gnb.ca/content/gnb/en/departments/erd/energy/content/energy_blueprint/content/renewable_portfolio.html
[54] NB Power (2017). *Annual Report 2016/2017.*

Closing the Belledune coal-fired electricity generating station would help the province reduce its GHG emissions, as this facility accounted for 2.1 Mt, or 15%, of the province's GHG emissions in 2015. However, this would mean a reduction of 467 MW, or 10% of New Brunswick's current generation capacity.[55] NB Power is therefore analyzing alternative fuel sources, such as hydrogen fuel, biomass and natural gas.[56] If an alternative fuel source cannot be found, the province could pursue an equivalency agreement with the federal government to keep the plant operating beyond the national requirement to eliminate coal generation by 2030. A 2017 Senate report, quoting a NB Power official, suggested that early closure of the Belledune generating station in 2030 could result in a 39% rate increase and have a devastating impact on electricity customers and the provincial economy.[57]

While the Coleson Cove plant has the potential to be converted to natural gas, which would reduce GHG emissions, this facility is not used year-round. The project economics of its conversion partially depends on access to reasonably-priced natural gas. A dwindling domestic natural gas supply in the region will increase transportation (tolling) costs for imported natural gas.

NB Power is undertaking environmental, geo-technical and site testing studies related to a proposal to add 100 MW of capacity at the Grand Falls hydro generating station. This proposed project is not required to meet the 2020 target of 40% renewables, suggesting it will not proceed until post-2020. NB Power is also proposing a project to ensure the Mactaquac Generating Station can operate to its intended lifespan of 2068 (100 years).[58] This run of the river hydro facility has an installed generation capacity of 660 MW, supplying about 12% of New Brunswick's power. Most of the work, once approved, will take place between 2020 and 2036.

Transmission

The Maritime Link project was completed in 2017 and allows power to transfer from Newfoundland and Labrador to Nova Scotia, and vice versa, which will allow power from Muskrat Falls, when it comes on line, to reach Nova Scotia. Last year, Prince Edward Island also completed installation of two new 180 MW transmission cables between the Island and New Brunswick, which will provide the ability to export wind power and

[55] Energy generation and capacity are not directly comparable.
[56] NB Power (2017, December 13). NB Power seeks new fuel source for Belledune Generating Station. [News Release]. Accessed at https://www.nbpower.com/en/about-us/news-media-centre/news/2017/nb-power-seeks-new-fuel-source-for-belledune-generating-station/
[57] Government of Canada (2017b). *Report of the Standing Senate Committee on Energy, the Environment and Natural Resources: Positioning Canada's Electricity Sector in a Carbon Constrained Future*, p. 17.
[58] NB Power (2018). *Mactaquac Life Achievement Project*. Accessed at https://www.nbpower.com/en/about-us/projects/mactaquac-project.

potentially import power from Muskrat Falls. The project is in addition to the two existing 100MW submarine cables.

NS Power plans to add 345 kV of additional transmission capacity between Nova Scotia and New Brunswick according to their latest *10 Year System Outlook*.[59] A 2012 study estimated that increasing the transmission intertie capacity between Nova Scotia and New Brunswick to 800 MW, from 300-350 MW, would cost approximately $454 million in 2015 dollars.[60]

A 2012 Atlantic Energy Gateway study estimated the net present value savings over the period 2015-2040 from regional integrated resource planning, as opposed to stand-alone provincial plans, in conjunction with increased transmission interties between the Maritime provinces. In a high renewables scenario, including a mix of additional hydro, wind, tidal and natural gas generation, the savings would total $772 million.[61] These savings would be sufficient to cover the $600 million cost of the increased transmission infrastructure, leaving a net benefit of $175 million in savings for rate payers.[62]

By comparison, a recent Canadian study estimated that the cost of complete decarbonization of Canada's electricity system by 2025 would add $8.2 to $12.6 billion in annual costs. The higher estimate assumes additional inter-provincial transmission is not allowed; the lower estimate reflects the $4.2 billion in annual cost savings resulting from increased inter-provincial transmission.[63] The substantial cost of building a national East-West supergrid across Canada, along with additional renewable energy generation, suggests an alternative approach is to build it in piecemeal fashion regionally, and integrate it with American grids where possible.[64] This could minimize the impact on electricity rates, while enhancing reliability and access to broader electricity markets, and helping more jurisdictions achieve renewable energy and GHG emission targets.

Under the Regional Electricity Cooperation and Strategic Infrastructure Initiative, in partnership with Natural Resources Canada and the Atlantic provincial governments, the Atlantic region's electric utilities are identifying, attaining consensus and studying options related to the best regional electricity infrastructure projects to reduce GHG

[59] Nova Scotia Power (2017a).
[60] AEG Transmission Planning Committee (2012). *Atlantic Energy Gateway Transmission Modeling Study Report.*
[61] AEG Resource Development Modelling Committee (2012). *Atlantic Energy Gateway Resource Development Modelling Study*.
[62] The other two scenarios in the study – a nuclear and a natural gas scenario – had higher estimated savings at the time.
[63] Dolter, Brett and Nicholas Rivers (2017). *The Cost of Decarbonizing the Canadian Electricity System*. Working paper. Accessed at https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/energy-resources/The_Cost_of_Decarbonizing_the_Canadian_Electricity_System_Manuscript_with_images_Sept_25_2017.pdf
[64] Carlson, Richard (2017). *Connecting Canadians through a renewable energy supergrid*. Mowat Centre. Accessed at https://mowatcentre.ca/connecting-canadians-through-a-renewable-energy-supergrid/

emissions. This initiative is building upon the dialogue from the previous Atlantic Energy Gateway. An RFP was issued under this initiative in December 2016 for a study to achieving consensus on the best electricity infrastructure projects to help transition to lower GHG emissions while replacing coal-fired generation to meet electricity demand from the electrification of buildings and transportation over the period 2030 to 2041. The study is expected in the second quarter of 2018.

3.4 Policy Considerations

Governments and electric utilities in Atlantic Canada have used a number of policies to increase generation of renewable power, including:[65] renewable energy standards; offering contracts for renewables, such as through power purchase agreements (PPAs), request for proposals (RFPs), and feed-in tariff (FIT) rates;[66] incentives to reduce the cost of renewable energy, such as accelerated cost allowances, tax credits or loan guarantees;[67] implementing or enhancing net metering programs;[68] and offering renewable energy credit (RECs), which are tradeable certificates based on certified production from qualifying renewable sources.[69] The federal and provincial governments in the region are now adding a new policy, namely carbon pricing, beginning in 2019.

Based on details of the federal government's carbon pricing backstop, the cost of using various fossil fuels will increase, beginning in 2019 (Table 3.7). However, exact price impacts in the Atlantic provinces will depend upon the details of the provincial schemes, which must be equivalent to the standard specified by the federal government. As of March 2018, the federal government was still working out the details of how electricity generation will be treated under the federal carbon pricing backstop.[70]

In terms of carbon-pricing, each of the Atlantic provinces seems to be pursuing a different and independent option. Nova Scotia is moving forward with a cap and trade system, which will include electricity generation.[71] New Brunswick is using the federal carbon pricing backstop for its ten current large emitters, including electricity generating

[65] National Energy Board (2016). *Canada's Renewable Power Landscape: Energy Market Analysis 2016*, p. 6.
[66] Nova Scotia has relied more on FITs than other Atlantic provinces.
[67] For example, the federal corporate income tax system provides accelerated capital cost allowance rates for investments in capital assets that produce renewable energy, fuels from waste, or conserve energy by using fuel more efficiently, including electrical energy storage. The federal government provided a loan guarantee for the Muskrat Falls and the Maritime Link projects, saving Newfoundland and Labrador $2.7 billion and Nova Scotia $325 million in interest charges. Government of Newfoundland and Labrador (2016, November 3). Provincial Government Secures Enhanced Federal Loan Guarantee. [News release]. Nalcor Energy (2017). Emera (2014, April 23). Emera Demonstrates Benefit of Federal Loan Guarantee for Nova Scotia Electricity Customers. [New release].
[68] All four Atlantic provinces now offer net metering, up to 100 kW.
[69] Prince Edward Island provides RECs which can be sold outside the province.
[70] Moffet, John (2018). Presentation to APEC Webinar on Carbon Pricing in the Atlantic Provinces: Implications for Business and Competitiveness, March 27.
[71] Climate Change Nova Scotia. *Nova Scotia's Proposed Cap and Trade Program*. Accessed at https://climatechange.novascotia.ca/proposed-cap-and-trade-program.

stations.[72] As of March 2018, Newfoundland and Labrador and Prince Edward Island had not announced their plans. The federal government will decide later in 2018 if provincial policies meet its requirements for carbon pricing. Regional co-operation would be of benefit for carbon pricing, by increasing the pool of companies looking to trade emissions credits, for example. The federal government has indicated its support for a regional approach.[73]

Table 3.7 Carbon Prices Rising on Fossil Fuels for Electricity Generation

Fossil Fuel	Unit	2018 ($10/tonne)	2019 ($20/tonne)	2020 ($30/tonne)	2021 ($40/tonne)	2022 ($50/tonne)
Bituminous coal	$/tonne	22.52	45.03	67.55	90.07	112.58
Sub-bituminous coal	$/tonne	17.72	35.45	53.17	70.90	88.62
Coking coal	$/tonne	31.80	63.59	95.39	127.19	158.99
Light fuel oil	cents/litre	2.74	5.48	8.21	10.95	13.69
Heavy fuel oil	cents/litre	3.19	6.37	9.56	12.75	15.93
Diesel fuel	cents/litre	2.74	5.48	8.21	10.95	13.69
Natural gas	cents/m^3	1.96	3.91	5.87	7.83	9.79

Source: Environment and Climate Change Canada

Since electricity generation accounts for a large share of Nova Scotia's and New Brunswick's GHG emissions, achieving emission targets will likely require a combination of policy measures, including the above suite of policies to reduce the use of fossil fuels to generate electricity and increase the availability of renewable energy. Policies to reduce electricity demand by improving energy efficiency and investing in clean energy infrastructure and smart grid technology can also play a supporting role.

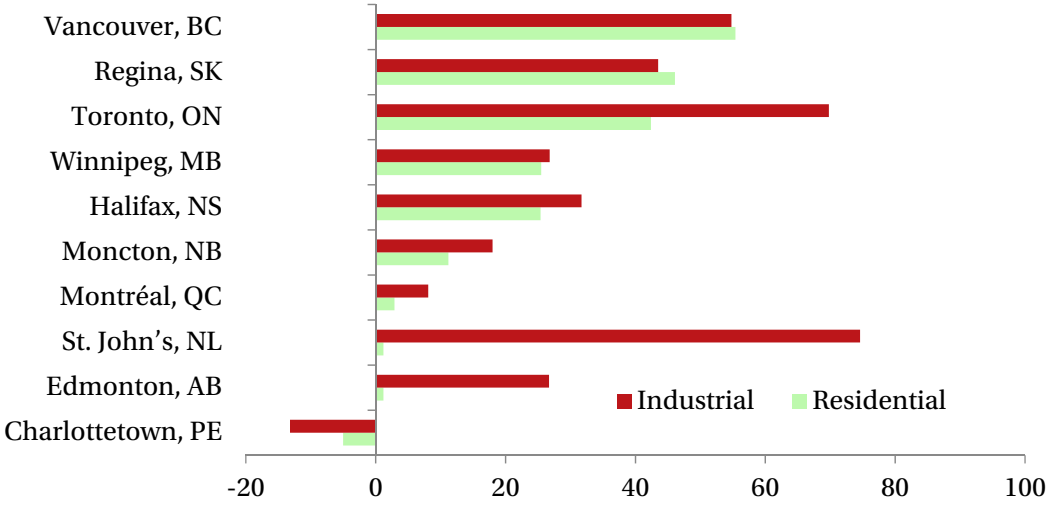
Climate change has global and regional costs, but governments and electric utility regulators also need to be mindful of the incremental impact on regional electricity rates when implementing policies used to promote renewable energy generation and reduce emissions from electricity generation. The design of policy can determine the eventual impact on electricity rates. For example, a recent report noted that green energy policies in Ontario increased on-peak electricity rates from 9.3 cents/kWh in November 2009 to 18 cents/kWh in November 2016.[74] That same report also suggested higher electricity rates resulted in job losses, negating some of the benefits from the 30,000 jobs created by renewable power. British Columbia's carbon tax also increased electricity rates. Most

[72] Government of New Brunswick (2017, December 14). Climate Change Legislation Introduced. [News Release]. Accessed at http://www2.gnb.ca/content/gnb/en/departments/elg/news/news_release.2017.12.1601.html.
[73] Moffet, John (2018).
[74] Trebilcock, Michael (2017). Ontario's Green Energy Experience: Sobering Lessons for Sustainable Climate Change Policies. C.*D. Howe Institute, E-Brief*. Toronto: C.D. Howe Institute.

Atlantic provinces have not seen the same scale of increases in electricity rates (Figure 3.1).[75] Newfoundland and Labrador residents will face further rate hikes when Muskrat Falls comes on line.

Figure 3.1 Electricity Rate Increases Higher in Ontario and British Columbia

Change in electricity rates, 2009-2017 (%)



Source: Hydro Quebec

While carbon pricing is expected to have some impact on electricity prices, government can offset the impact on low-income households and electricity intensive producers through revenue recycling (see Chapter 6.2).

[75] PEI's energy accord reduced electricity rates by 14% in 2011/2012 and froze rates for two years.

Chapter 4

Clean Technology Adoption

Chapter Summary

- **Atlantic firms spent $514 million on environmental protection in 2014 although spending has declined since 2008. Data from APEC's Major Projects Inventory suggest environmental capital spending is rising again and will reach a new high in 2020.**
- **Only 4.5% of Atlantic manufacturers used an advanced green technology in 2012, below the 6.2% national rate. High costs are a big barrier to adoption.**
- **It is estimated that about 106,000 employees in Atlantic Canada have some environmental responsibilities, including 44,000 environmental professionals.**
- **Buildings account for 12% of Atlantic GHG emissions. A growing number of new buildings have a Leadership in Energy and Environmental Design (LEED) certification, which is credited with reducing emissions, energy and water needs.**
- **Transportation accounts for almost one-third of Atlantic GHG emissions with almost three-quarters arising from passenger and freight road transportation. Rising vehicle ownership is contributing to higher emissions, offset by better fuel efficiency, emissions controls and biofuel requirements. Electric vehicles will grow in importance but will have limited short-term impacts on Atlantic emissions.**
- **APEC estimates that spending on clean infrastructure in the Atlantic region peaked at $539 million in 2017 but will remain elevated in 2018 and 2019.**

This chapter explores several different components of Atlantic Canada's transition to clean economic growth including the extent to which firms are investing in environmental protection and adopting clean technology to improve environmental outcomes; the shift to clean buildings, as most economic activity takes place in factories, offices or stores, and workers live in single or multi-unit dwellings; clean transportation, as inputs, intermediate goods and final goods are moved to and from production facilities, business professionals travel to conduct business, and workers commute to and from their place of work; and clean infrastructure, which is important for clean water. The chapter also discusses measurement of Atlantic Canada's clean workforce – those individuals who are employed to help support and maintain the region's transition to cleaner economic growth.

4.1 Clean Firms[76]

Data on spending by firms on environmental activities and adoption of clean technology are currently quite limited, especially at the provincial level. Statistics Canada's *Survey of Environmental Protection Expenditures* provides data on environmental protection spending by primary resource extractive, electricity generation and distribution, and manufacturing industries, in response to current or anticipated regulations, conventions or voluntary agreements. These data are useful to both assess trends in spending on environmental protection and for firms looking to identify opportunities to provide clean technology solutions to Canadian companies.

Total business spending on environmental protection in Canada amounted to $11.8 billion in 2014, the most recent year for data, evenly split between capital and operating expenditures although this is largely due to relatively high capital spending in Alberta's oil and gas industry. In Atlantic Canada, $514 million was spent on environmental protection in 2014, about 4.4% of the national total, with three quarters of Atlantic spending on operating expenses.

Total business spending, both capital and operating expenditure, on environmental protection in Canada has increased by 35% since 2008, but this is almost exclusively due to higher spending in Alberta. Spending by Atlantic firms has declined by 15%, similar to the drop in Ontario.

Nationally, about 56% of capital spending on environmental protection was on pollution abatement and control (Table 4.1) – minimizing the impact of pollution – rather than on pollution prevention, which accounted for 15% of capital spending. This is relevant for Atlantic firms looking for opportunities to provide clean technology solutions in Canada. Three-quarters of the capital expenditure on pollution abatement and control was in the oil and gas extraction industry.

In terms of national operating expenditure on environmental protection, the largest portion is spent on waste management and sewerage services, closely followed by pollution abatement and control. In Atlantic Canada, the largest amount of operating spending is on pollution prevention.

In terms of pollution abatement, the largest portion of capital spending nationally is typically on air pollution (43% in 2012), followed by surface water (38%) and then solid

[76] This section focuses on how Atlantic businesses are adopting clean technology and spending money on environmental protection. APEC's companion report focused on Atlantic firms who specialize in creating and selling clean technologies for other firms to adopt (Chaundy and Ripley, 2018).

and liquid waste (19%).[77] In terms of pollution prevention, the largest portion of capital spending nationally is usually directed to air pollution (44% in 2014), followed by on-site contained solid and liquid waste (26%), and then surface water (20%).[78] These statistics are important as only two of Atlantic Canada's clean technology firms are currently focused on air pollution, the biggest area for Canadian business spending on pollution abatement and prevention.[79] About ten Atlantic firms are focused on clean water and wastewater treatment with four addressing waste management and remediation issues.

Table 4.1 Pollution Abatement Accounts for the Largest Portion of Environmental Spending

Environmental protection spending, 2014

	Canada				Atlantic Canada			
	Capital spending		Operating expenditure		Capital spending		Operating expenditure	
	$m	%	$m	%	$m	%	$m	%
Pollution abatement & control processes (end-of-pipe)	3,172	56	1,725	28	n.a.	n.a.	91	24
Waste management & sewerage services	770	14	1,843	30	n.a.	n.a.	100	26
Pollution prevention processes	853	15	646	10	38	29	128	33
Reclamation & decommissioning	520	9	898	15	6	5	n.a.	n.a.
Environmental monitoring	63	1	344	6	1	1	20	5
Environmental assessments & audits	79	1	160	3	1	1	6	2
Wildlife & habitat protection	40	1	84	1	1	1	n.a.	n.a.
Fees, fines & licences	n.a.	n.a.	214	3	n.a.	n.a.	n.a.	n.a.
Other types of environmental protection	137	2	244	4	n.a.	n.a.	6	2
Total	5,634	100	6,159	100	132	100	382	100

Note: Totals may not sum due to rounding.
Source: Statistics Canada

In terms of the industries that spend the most on environmental protection, oil and gas extraction is the largest, accounting for 55% of total Canadian spending in 2015 (Table 4.2). Other larger spenders include mining, electric power generation, paper manufacturing, petroleum refining, chemical manufacturing and food manufacturing.[80] Chapter 5 provides further discussion of most of these industries and their environmental impacts in Atlantic Canada; electricity generation is discussed in Chapter 3.

[77] In 2014, operating expenditure on pollution abatement in Canada was focused on air (59%), surface water (28%) and solid and liquid waste (13%). Atlantic firms are more focused on surface water (62%) and air (37%).
[78] In 2014, operating expenditure on pollution prevention in Canada was focused on air (43%), surface water (26%) and solid and liquid waste (24%). Atlantic firms are more focused on surface water (67%) and air (28%).
[79] Chaundy, David and Alex Ripley (2018). *Growing Atlantic Canada's Clean Technology Firms*. Halifax: APEC, p. 7.
[80] These industries are also the most likely to have a sustainable development strategy or environmental stewardship plan in place. According to national data for 2014, the industries with higher proportions of firms with such strategies or plans included: electricity generation (23%), pipeline transportation (19%), pulp and paper manufacturing (19%), oil and gas extraction (18%), forestry and logging (17%), natural gas distribution (15%) and mining (14%).

Table 4.2 Oil and Gas Is the Biggest Spender on Environmental Protection

Environmental protection capital and operational expenditure, 2014

	Expenditure ($ millions)	Share of total (%)	Spending as share of revenues (%)
Oil & gas extraction	6,470	55	3.8
Mining & quarrying	1,060	9.0	2.6
Electric power generation, transmission & distribution	775	6.6	1.7
Primary metal manufacturing	766	6.5	1.6
Paper manufacturing	488	4.1	2.0
Petroleum & coal product manufacturing	486	4.1	0.6
Chemical manufacturing	373	3.2	0.7
Food manufacturing	327	2.8	0.4
Other manufacturing industries	270	2.3	n.a.
Transportation equipment manufacturing	200	1.7	0.2
Wood product manufacturing	156	1.3	0.6
Natural gas distribution	133	1.1	n.a.
Non-metallic mineral product manufacturing	115	1.0	0.9
Fabricated metal product manufacturing	97	0.8	0.3
Beverage & tobacco product manufacturing	61	0.5	0.5
Total	11,800	100	1.3

Source: Statistics Canada

Most spending on environmental protection is undertaken by the country's largest firms. In 2014, about 85% of total expenditure on environmental protection was made by firms with over 100 employees, with just over half (52%) made by firms with over 500 employees.[81] In general, larger firms are more likely to invest in pollution prevention: 82% of Canadian firms with 500-999 employers used at least one pollution prevention method in 2014, compared with 43% for firms with less than 100 employees. Similarly, 40% of firms with fewer than 100 employees used at least one environmental management practice, compared with 89% of firms with 500-999 employees.

These data suggest costs of identifying and implementing environmental management practices are a barrier for smaller firms. According to Statistic's Canada's *Survey of Advanced Technology,* about 12% of Canadian firms with 250+ employees had a

[81] Spending per employee also generally increases with firm size.

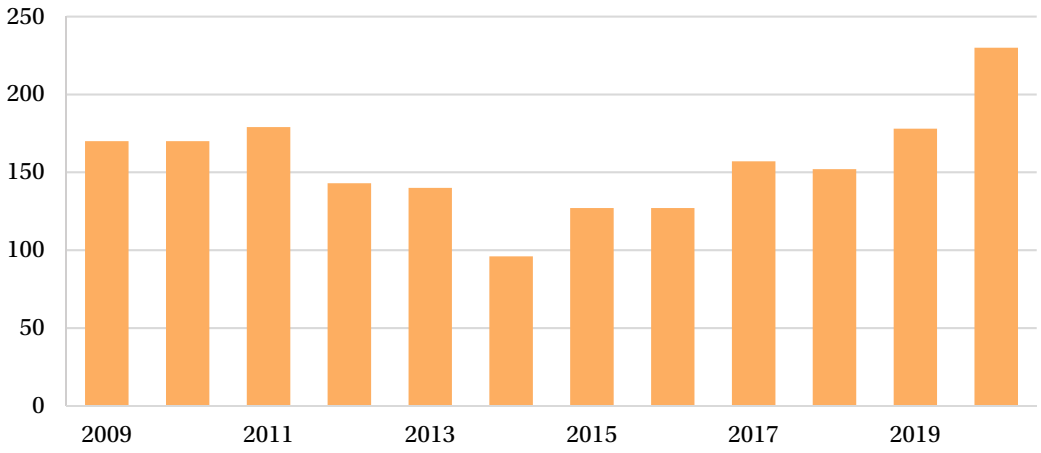
sustainable development strategy or environmental stewardship plan in place in 2014, compared with 2% for firms with 10-99 employees.

Atlantic Environmental Spending from APEC's Major Projects Inventory

APEC's Major Projects Inventory (MPI) provides detail on capital investments over $25 million and can be used to provide an indicator of trends in capital spending on environmental protection.[82] Two components are identified: investments by manufacturing firms, utilities or others to reduce their impact on the environment and spending on environmental remediation to improve a site that has been damaged by previous industrial activity.

Figure 4.1 Environmental Protection Spending on the Rise in Atlantic Canada

Environmental protection capital spending, Atlantic Canada ($ millions)



Source: APEC Major Projects Inventory

According to APEC's MPI, about $1.4 billion was spent on environmental protection in Atlantic Canada over the last decade. Over the period 2009-2017, the public sector has accounted for about 70% of this investment. Atlantic environmental protection capital investment fell from $179 million in 2011 to a low of a $96 million in 2014 but has been rebounding since then. Spending is expected to reach a new high in 2020, led by a $100 million project at CFB Halifax that would improve energy efficiency at Stadacona and the Dockyards and a $90-$100 million investment in a new effluent plant at the Northern Pulp mill.

[82] APEC's MPI data on environmental protection seems to capture a large portion of the capital spending reported in Atlantic Canada from Statistics Canada *Survey of Environmental Protection Expenditures* (79% in 2010, 82% in 2012 and 56% in 2014). While the MPI data serves as a useful indicator of trends in environmental protection capital spending in the Atlantic region, it includes data from firms and public-sector entities and is therefore not directly comparable to the Statistics Canada data on business spending.

Manufacturing firms are among the largest emitters of pollution and users of electricity and water in Atlantic Canada. Several large manufacturers have invested in new technology that reduces the impact of their emissions or effluents from their operations or improves the energy efficiency of their facilities.

A large share of the environmental protection spending is at the region's pulp and paper mills. J. D. Irving's modernization program at its pulp mill in Saint John includes components that will improve energy efficiency and reduce emissions (see box). The company is also installing a new effluent treatment system at its Lake Utopia paper mill. The Northern Pulp mill near Pictou will be building a new effluent plant by 2020. The region's power utility companies have performed several upgrades to generation to reduce emissions and improve energy efficiency. Several other energy efficiency upgrades were recently completed or are planned at the Halifax Airport, the Sydney Coast Guard College, Dalhousie University and at CFB Halifax as part of broader capital programs.

Lake Utopia Paper Mill Upgrade, New Brunswick

J.D. Irving recently spent $30 million to upgrade its Lake Utopia Paper mill near St. George. The mill produces 510 air dry metric tonnes of corrugated medium per day. The corrugated medium is used in cardboard boxes and other consumer products. The project includes the installation of a new process water storage tank, a low rate anaerobic effluent treatment digester and pumping equipment. The project will allow the company to produce a higher grade corrugated medium. The project received its provincial environmental approval in December 2016.

Methane gas will be used to reduce fossil fuel use at the plant by up to 66% and reduce greenhouse gas emissions by 5,568 tonnes per year. The reduction in fossil fuel energy is equal to heating 4,200 homes in New Brunswick every year. The digester will provide a more consistent effluent flow and quality. The project will require fewer outdoor storage ponds which will reduce methane gas odours in the area.

Environmental remediation projects include the Petitcodiac River restoration and environmental remediation projects, the Tar Ponds in Sydney (see box), the Naval Base in Argentia, and a clean-up underway at the Goose Bay Air Force base.

Sydney Tar Ponds Cleanup, Nova Scotia

Steel making operations in Sydney lasted for 100 years until 2001. A by-product of the production were toxic wastes from the coke ovens which included benzene, kerosene, and naphthalene, which were going into a nearby brook and slowly collecting into what was called the Sydney Tar Ponds, and eventually leeching into Sydney Harbour. The lobster fishery in Sydney harbour was closed in 1982 because of the contamination.

In January 2007, the federal and provincial governments committed to a $400 million cost share agreement to clean up the contaminated lands of the Coke Ovens and Tar Ponds sites. Contaminated soil was solidified and stabilized at the Tar Ponds and Cooling Pond sites. An engineered cap was added at the Tar Ponds site to further prevent contaminants from spilling into the local environment. Parks and green spaces were built on the former site.

Contaminant levels on the site were reduced and contained and contaminant flows were largely eliminated in the ground water and in surface water flowing through it. This has led to improved marine water quality in Sydney harbour. The air quality has also been improved with reduced odours that were caused by the contaminants.

Clean Technology Adoption

Statistics Canada's *Survey of Innovation and Business Strategy* shows which firms are using advanced green technologies.[83] In 2012, the most recent year for data, 2.6% of all Canadian firms and 6.2% of manufacturers were using advanced green technologies. In Atlantic Canada, the number of firms using advanced green technologies was lower at 1.1% and 4.5% for manufacturers specifically. The rates of use declined between 2009 and 2012 nationally and in the Atlantic region.

Nationally, the electric power generation industry had the highest proportion of firms that are using advanced green technologies, at 28%. Other industries, relevant to the Atlantic region, with above average shares, included water and sewage (18%), natural gas distribution (15%), mining (13%), oil and gas extraction (12%), pipeline transportation (12%), firms providing scientific and research services (11%), wired telecommunications carriers (11%), and paper manufacturing (9%). As for spending on environmental protection, larger firms with 250+ employees are more likely to adopt advanced green technologies (8.5% of such firms) than small firms with 20-99 employees (2%).

[83] Advanced technologies are defined as new technologies (equipment or software) that perform a new function or improve some function significantly better than commonly used technologies in the industry or by competitors. The 2017 survey asks more specifically about clean technology, using the same definition as used for APEC's companion report on clean technology firms (Chaundy and Ripley, 2018).

Federal Government Funding for Clean Technology Adoption

Federal government funding to support clean technology adoption is available through several programs at ACOA including the Atlantic Innovation Fund (AIF), the Business Development Program (BDP) and the Innovative Communities Fund (ICF).

ACOA has funded several projects that will improve energy efficiency or minimize the environmental impact of manufacturing firms. For example, Cabot Manufacturing received $500,000 towards a $1.2 million project at its Point Tupper facility that will improve clean technology processes. Northsyde Processing of North Sydney received about $300,000 for a $600,000 project to implement a wastewater management program at its operations. Pioneer Enterprises of St. John's was given $400,000 toward a $1.3 million project to improve water treatment systems.

A new Low Carbon Economy Challenge, launched in 2018, will provide $500 million in federal government funding for projects that reduce GHG emissions. Businesses can receive federal funding of $1-50 million, up to 25% of project costs. The Smart Cities Challenge has also been launched with 29 Atlantic communities vying for prizes ranging between $5 and $50 million. Five of these Atlantic communities are focusing on environmental quality.

According to a recent survey, the largest barrier to adoption of clean technology solutions is their high cost, noted by 74% of respondents.[84] Firms found it difficult to justify high cost solutions that had longer payoffs when these projects must compete with other investments in the company that target the reduction of costs. Other barriers included lack of relevance to their business (33%), perceived lack of regulatory pressure for adoption (31%) and a lack of knowledge about potential solutions (29%). As indicated in APEC's companion report, finding ways to de-risk adoption of clean technology, and strengthen the regulatory environment, are critical to the transition to clean economic growth.[85]

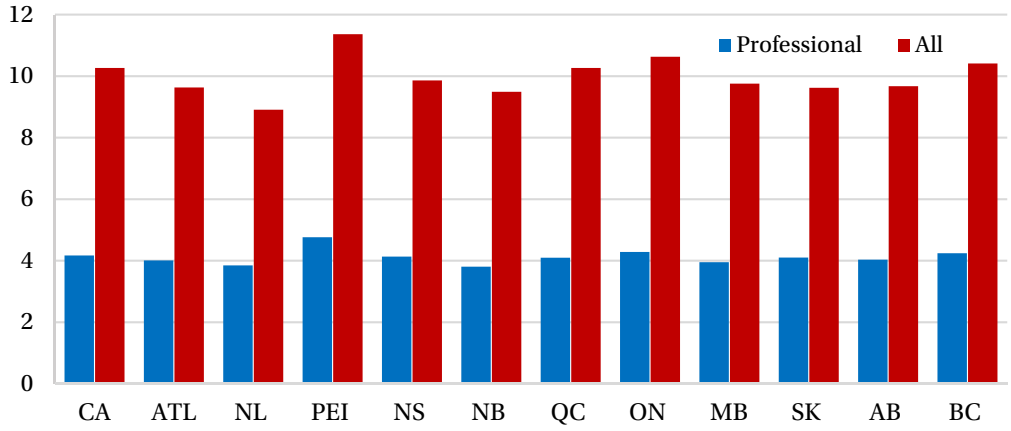
For those firms that did invest in clean technology, the biggest challenge to implementing a solution was that costs were higher than expected (39%). Other challenges included difficulty integrating into existing business processes (26%) and a lack of in-house skills (22%), pointing to the need for skills training and adapting business processes to maximize the effectiveness of capital investments in clean technology.

[84] Williams, Anthony (2016). *Accelerating Canada's Clean Growth Economy: Cleantech Adoption Strategies for a Low Carbon World*. Waterloo: The Centre for Digital Entrepreneurship and Economic Performance (DEEP Centre).
[85] Chaundy and Ripley (2018).

4.2 Clean Workforce

Given the need for skilled workers to support clean technology adoption, it is important to measure the environmental skills capacity of the workforce. Such data are not currently available, but the Environmental Careers Organization (ECO Canada) estimates that there were over 730,000 environmental professionals in Canada in 2013, where over 50% of their role was focused on environmental activities, representing 4.2% of total employment in the country.[86] They estimate there were a total of 1.8 million environmental employees that have some environmental responsibilities within their occupation, which accounted for 10.3% of total employment. In the Atlantic provinces there were about 44,000 environmental professionals and 106,000 employees with some environmental responsibilities.[87] Prince Edward Island has the highest rate of environmental employees at 11.4% with Newfoundland and Labrador having the lowest rate at 8.5%.

Figure 4.2 Prince Edward Island Leads in Environmental Employment
Environmental employees as share of total employment, 2013 (%)



Source: ECO Canada

The number of environmental professionals grew by 46% between 2007 and 2010 in Atlantic Canada compared to 29% nationally. However, employment fell 6% between 2010 and 2013 in Atlantic Canada while it increased 7% in Canada.

The administrative, waste management and remediation services industry has the highest proportion of environmental professionals in Canada at 13.3%, reflecting the role of waste management firms. Professional services also has a relatively high proportion (12%), as this will include environmental engineers in engineering and consulting firms.

[86] ECO Canada (2013). *Profile of Canadian Environmental Employment*. Calgary: ECO Canada.
[87] ECO Canada (2016). *Environmental Employment by Province*. Calgary: ECO Canada.

The primary sectors, including agriculture, fishing, forestry and mining, have about 5.6% of employment held by environmental professionals.

Several demographic trends are apparent based on the broader environmental employee category. Environmental employees tend to be slightly younger – about 62% are under 45 years, compared with 57% for the entire employed population. Females are underrepresented with 35% of employees, compared to 48% for all employees.

Environmental employees are highly educated with nearly 37% having a university degree, compared with 27% for the overall employed workforce. Over half of employees in carbon and climate change mitigation (53%) have at least a bachelor's degree.

There are a growing number of programs in Atlantic universities and colleges that provide environmental focused training with degrees in fields such as environmental sciences, earth and marine sciences, environmental management, sustainable resources, environmental engineering and energy sustainability. However, the curriculum in many other disciplines seems slow to offer detailed courses in environmental or clean technology topics.

4.3 Clean Buildings

As shown in Chapter 2, buildings accounted for about 5 Mt of CO_2 in Atlantic Canada in 2015, about 12% all emissions, with a range of 9% in New Brunswick to 18% in Prince Edward Island.[88] These emissions largely arise from burning fossil fuels for heat in homes and institutional and commercial facilities, which is in addition to fossil fuels burned to produce electricity for these buildings. Atlantic emissions from buildings have declined by 24% between 2004 and 2015, compared with a decline of 9% nationally.

Many new building construction projects in Atlantic Canada are targeting a Leadership in Energy and Environmental Design (LEED) designation, a voluntary third-party certification program and an internationally accepted benchmark for the design, construction and operation of high performance green buildings.[89] The LEED program began in Canada in 2002 and is monitored by the Canada Green Building Council (CaGBC). There are four LEED ratings, Platinum, Gold, Silver and Certified which identifies the level of sustainability in building design, construction and operation.[90]

[88] These building emissions exclude manufacturing and industrial activity.
[89] As of 2014, LEED buildings accounted for 30% of newly constructed institutional buildings and 22% of newly constructed commercial buildings in Canada. US Green Building Council (2017). *LEED in Motion: Canada, 2017*. Washington DC: US Green Building Council, p. 3.
[90] In 2017, the CaGBC also introduced a zero-carbon building standard. A zero carbon building is defined as one that is highly energy-efficient and produces onsite, or procures, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations.

The goal of LEED is to help minimize the impact of buildings on the environment, such as reducing the GHG emissions from heating, cooling, lighting and building materials. The CaGBG estimates that up to 70% of municipal water is consumed in and around buildings.

Nationally, over 3,000 projects have been given the LEED designation. Since 2005, LEED is estimated to have contributed to: energy savings, sufficient to power 221,000 homes for a year; a reduction of 1.3 million tonnes of GHG emissions, equivalent to taking 238,000 cars off the road for a year; saved 13 billion litres of water equivalent to 5,100 Olympic sized swimming pools; and recycled over 1.6 million tonnes of construction waste and debris.[91]

The first LEED project registered in Atlantic Canada was an officer's residential facility at CFB Halifax in January 2007. As of March 2018, 147 projects of varying sizes have been LEED certified in Atlantic Canada; APEC estimates their construction value at $3.3 billion. These include the $58 million Halifax Central Library (Gold), the $90 million Labrador West Health Centre (Silver) and the $157 million Restigouche Hospital (Silver). APEC estimates there is an additional $2.2 billion of LEED targeted projects under construction as of March 2018, including the $325 million science building at Memorial University (Silver).[92]

Most of the LEED construction has taken place in Nova Scotia with 93 projects registered with a value of $1.9 billion. The first LEED platinum project in Atlantic Canada was the Nova Scotia Power Headquarters that was completed in 2011 and received its certification in 2013. There have only been three LEED Platinum projects in Atlantic Canada, out of 250 nationally.[93]

Health care, including hospitals and long-term care facilities, account for the largest share of LEED project value in Atlantic Canada at 24% (Figure 4.3). Recent hospital projects in Truro, Campbellton and Waterville and long-term care homes in St. John's, Corner Brook and Bedford were built to LEED standards. Schools (15%) and universities (9%) accounted for almost one-quarter of LEED construction. Office buildings accounted for 14% of the value and residential buildings 8%. The remaining projects are largely municipal buildings such as recreation, public safety or federal buildings including those built for the Department of National Defence.

[91] US Green Building Council (2017), p. 6.
[92] APEC's Major Projects Inventory.
[93] The other two projects were Efficiency One's headquarters and a single-family concept home in Halifax.

Table 4.3 Nova Scotia Has the Majority of LEED Projects

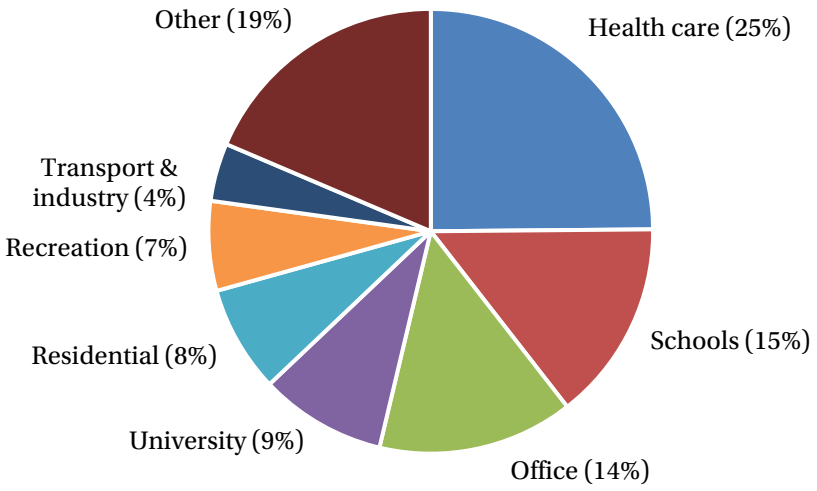
Completed LEED construction projects by province, as of March 2018

	Number of projects	Estimated value ($ million)
Nova Scotia	93	1,850
New Brunswick	27	600
Newfoundland and Labrador	21	850
Prince Edward Island	5	50
Atlantic Canada	146	3,350

Source: Canada Green Building Council, APEC

Figure 4.3 Health Care Accounts for Largest Portion of Atlantic LEED Projects

Share of LEED construction value, Atlantic Canada (%)



Source: Canada Green Building Council, APEC

Governments in Canada have been leaders in setting LEED standards for new building construction. The federal government requires all new federal buildings be constructed to a LEED Gold standard. Each of the provinces in Canada requires a LEED Silver standard, although there are exclusions in some provinces. The Halifax Regional Municipality requires a LEED Silver designation for new construction and Moncton requires buildings to be LEED Certified. All new schools, hospitals, offices and other public buildings have minimum LEED thresholds that must be met during construction. Nearly $2.3 billion of the $3.3 billion LEED projects in Atlantic Canada have been led or financed by the public sector.

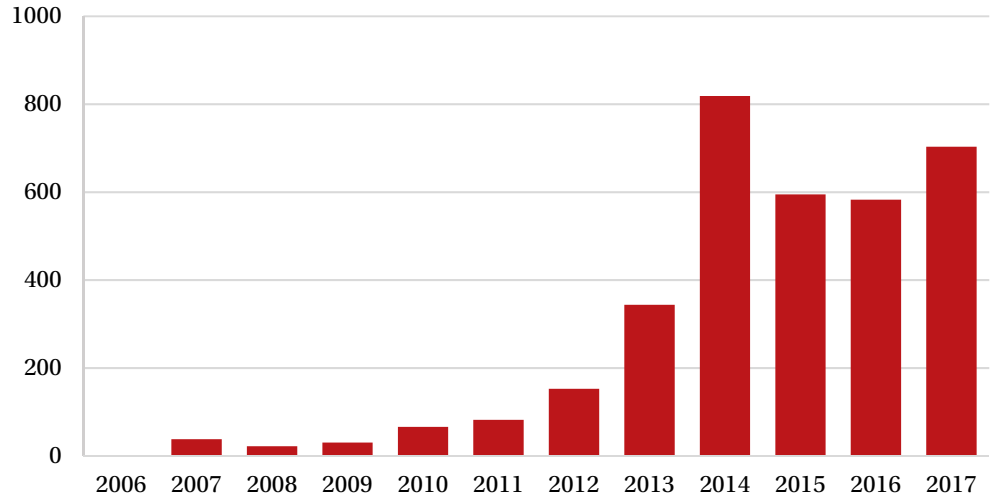
A LEED designation is also growing in importance in new commercial construction. Many tenants, especially international firms, require a LEED designation for their office

space to help reduce their environmental footprint and meet the goals of corporate social responsibility programs. This is a factor behind continued growth in office space in many Canadian cities despite vacancy rates above historical norms. Older office space is typically less efficient and can be costly to refurbish to meet LEED standards. The industrial market is also starting to see more LEED-rated buildings for similar reasons.

A study by the World Green Building Council estimates the cost of green commercial and industrial building projects can range from 0-10% higher than traditional buildings.[94] The same study suggested that the price premium for green certified buildings ranged from 0-30% higher. The higher lease rates, combined with lower operating cost and higher occupancy rates, show the potential value of green buildings. However, the biggest driver of green building development continues to be demand from potential clients.

Figure 4.4 LEED Construction Peaked in 2014

Value of LEED building construction, Atlantic Canada ($ million)



Note: Year represents date project was certified LEED
Source: Canada Green Building Council, APEC

Governments are also looking to tighten building codes. The Pan-Canadian Framework "calls for improving the energy efficiency of new construction through the development and adoption of increasingly stringent model building codes, starting in 2020, with the goal that provinces and territories adopt a 'net zero energy ready' building code by 2030."[95] Federal, provincial and territorial governments are also working to develop a model code for existing buildings by 2022.

[94] World Green Building Council (2013). *The Business Case for Green Buildings: A Review of the Costs and Benefits for Developers, Investors and Occupants.* Accessed at http://www.worldgbc.org/sites/default/files/Business_Case_For_Green_Building_Report_WEB_2013-04-11-2.pdf
[95] Natural Resources Canada. *The National Building Code of Canada*. Accessed at http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/19845.

4.4 Clean Transportation

Transportation is key to the functioning of Atlantic Canada's economy, moving both people and freight. People commute to and from their place work; business people travel to conduct business within and outside the region; non-resident tourists visit the region while on vacation; and residents travel for leisure and other non-work activities such as education. Goods are moved to and from production facilities.

The Atlantic region is a gateway to the rest of Canada and the world, and sees vast quantities of goods moved by air, rail, road, and sea each year. In 2017, Atlantic Canada exported $30 billion of international merchandise.[96] The Atlantic region's total trade (i.e., exports plus imports) with the US was valued at $15 billion in 2016, with 56% shipped via marine and 34% via road. Marine shipments are even more important for non-US trade: in 2011, Atlantic ports loaded and unloaded 84 million tonnes of goods.[97] There are also substantial truck movements within as well as to and from the Atlantic region. In 2016, the total weight of goods transported by truck within and through the Atlantic region was 25 million tonnes.

As a result, the transportation industry is an important contributor to employment and economic activity, sustaining about 52,000 jobs in Atlantic Canada in 2016 (Table 4.4). Trucking (43%), support activities (16%), water (11%) and air (9%) represent the largest segments of the Atlantic region's transportation production value in 2014.

Table 4.4: Economic Impact of Atlantic Canada's Transportation Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	0.8	0.1	1.2	1.4	3.5	9.9	3.8
Production value ($ billion)	1.7	0.3	2.6	3.6	8.2	18.7	n.a.
Exports ($ billion)	0.3	0.1	0.5	1.1	2.0	28.3	6.0
Employment (000s)	9.7	2.5	20.3	19.1	51.6	-1.9	4.7

Note: All data for 2016 except production value and exports which are for 2014. Transportation includes warehousing and storage for the purposes of this report. Exports are international exports.
Source: Statistics Canada

Moving these goods and people requires burning a significant amount of fuel, resulting in GHG emissions. Atlantic transportation GHG emissions were 13.5 Mt in 2015, almost one-third of all emissions.

[96] Innovation, Science and Economic Development Canada. Trade Data Online.
[97] Government of Canada (2015). *Transportation in Canada 2016*. Overview report and Addendum 2016.

Motor vehicles (cars, trucks and off-road vehicles) account for the vast majority (87%) of these transportation-related emissions, largely due to the heavy reliance on motor vehicles for passenger and freight transportation within the region, despite the fact that passenger vehicles have a lower emissions intensity (tonnes per terajoule) relative to rail, air and marine transportation.[98] Passenger transportation accounts for just over half (approximately 60%) of these emissions, reflecting the larger number of kilometers travelled. Rail accounts for a minuscule portion of Atlantic GHG emissions with a limited rail network in Nova Scotia and New Brunswick while air is mainly used for long-distance transportation.

Table 4.5 Road Transport Dominates Atlantic Transportation Emissions

Transportation GHG emissions, Atlantic Canada

	Emissions 2015 (Mt CO_2e)	Change in emissions 2010-2015 (%)	Share of emissions 2015 (%)
By mode			
Road	9.7	- 2	72
Off-road	2.0	-17	15
Marine	0.9	- 50	6
Air	0.6	13	4
Rail	0.3	- 35	2
By type			
Passengers	7.2	- 3	55
Freight	5.1	- 18	39
Off-road	0.8	10	6
Road, by vehicle type			
Light-duty	5.6	- 3	42
Heavy-duty	4.1	- 0.4	30

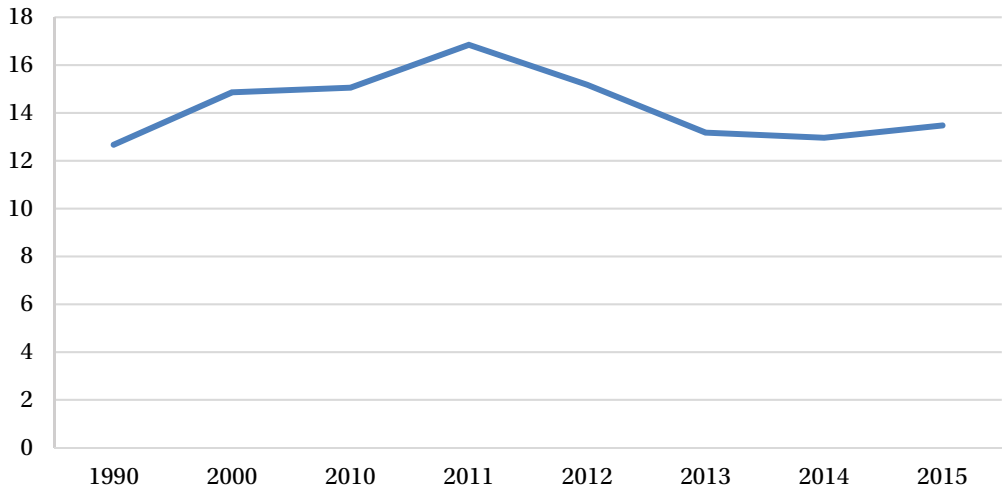
Note: Emissions by type allocates off-road other transport emissions to passengers and freight, whereas emissions by mode includes off-road other transport emissions under off-road. Thus, the two estimates of off-road emissions are not directly comparable.
Source: Environment and Climate Change Canada, APEC

Atlantic transportation GHG emissions increased 19% between 1990 and 2010, reflecting increased economic activity. For example, there was a 34% increase in the number of tonne-kilometers of freight moved by road with little change in energy efficiency of freight movements. While the number of passenger-kilometers increased by 20% over this period, reduced energy requirements helped keep passenger GHG emissions at the same level. Atlantic emissions declined after 2011, partly due to fewer tonne-kilometres of freight and a drop in passenger-kilometers.

[98] Natural Resources Canada, Office of Energy Efficiency. Comprehensive Energy Use Database: Transportation Sector. For Atlantic passenger transportation in 2015, GHG emissions tonnes per terajoule by mode of transport were: road (67.5), air (69.0), rail (78.1), and marine (71.4).
http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_tran_atl.cfm

Figure 4.5 Atlantic Transportation Emissions Declined After 2011

Transportation emissions, Atlantic Canada, (Mt CO_2e)



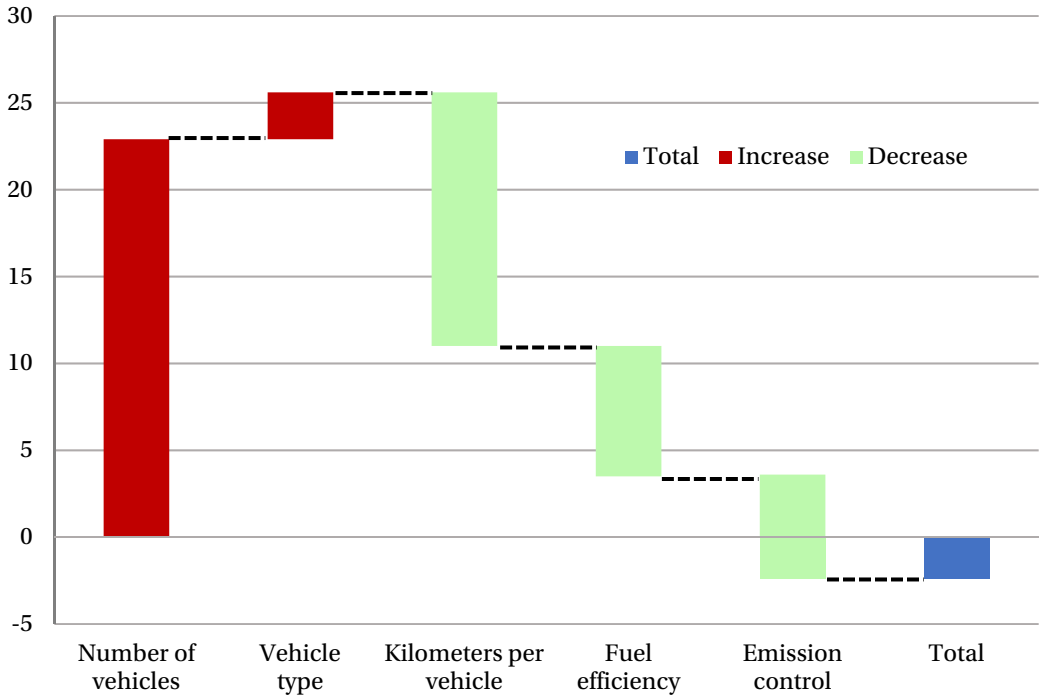
Source: Environment and Climate Change Canada

Nationally, GHG emissions from light-duty vehicles decreased by 2.4% between 2005 and 2015 reflecting the net effect of a number of competing factors (Figure 4.6).[99] The number of light-duty vehicles on the road in Canada increased 23% between 2005 and 2015, due to a combination of a 14% increase in the population aged 16 and over and higher vehicle ownership, amidst rising average incomes and low interest rates. Moreover, more Canadians purchased larger vehicles, such as SUVs, which added 2.7% to emissions over this period. Despite the increase in vehicles, the annual number of kilometers per vehicle fell almost 15%, reflecting an aging population as seniors drive less or not at all. Improvements in vehicle fuel efficiency contributed to a 7.5% reduction in emissions during this decade with a further 6% gain from greater use of emissions control technology and biofuels. For example, federal Renewable Fuel Regulations, require average renewable content of at least 5% for gasoline, beginning December 2010, and at least 2% for diesel fuel, commencing July 2011.

[99] Government of Canada (2017a). *National Inventory Report 1990-2015*, p. 62.

Figure 4.6 Transportation Emission Down Despite More Vehicles

Contribution to change in light-duty vehicle GHGs, Canada, 2005-2015 (%)



Source: Environment and Climate Change Canada, APEC

It is not possible to replicate this exact analysis for Atlantic Canada although many of the same factors will be at work in contributing to the 7% reduction in GHG emissions from light-duty vehicles between 2005 and 2015. For example, the number of registered light vehicles increased by 19%, despite only a 4% increase in the population aged 16 and over.[100] A similar shift to larger vehicles would also have increased emissions. In 2005, trucks (which include minivans, sport-utility vehicles, light and heavy trucks, vans and buses) accounted for 48% of all new motor vehicles purchased in Atlantic Canada; by 2015, this share had increased to 62% as consumers shifted away from passenger cars. Atlantic emissions per registered vehicle fell 21% over this decade, likely reflecting a drop in kilometers travelled per vehicle, due to Atlantic Canada's more rapidly aging population, along with the vehicle and fuel efficiency improvements apparent nationally.

[100] By contrast, the number of light-duty vehicle registrations in Newfoundland and Labrador increased by 40% over this period due to robust economic growth and incomes from high-wage sectors such as mining and oil.

In terms of medium and heavy vehicles, there was a marginal increase (6%) in medium vehicle GHG emissions and a 20% decline in heavy vehicle GHG emissions in Atlantic Canada over the period 2005 to 2015. Despite a 45% increase in medium and heavy vehicle registrations, emissions per vehicle fell by 40%. This partly reflects lower emissions from diesel engines, more than offsetting higher emissions from gasoline vehicles. For example, diesel motor fuel accounted for 67% of freight road emissions in 2015, down from 75% in 2005.

Atlantic Marine GHG Emissions

Marine activity generated 0.88 Mt in GHG emissions in 2015, about 7% of Atlantic transportation GHG emissions and 2% of total Atlantic emissions. Marine emissions arise from the international movement of goods, both container and bulk; short-sea shipping, such as freight transportation between Nova Scotia and Newfoundland; cruise activity; and passenger (and freight) ferries.

Atlantic marine emissions fell 56% between 2005 and 2015, largely due to reduced marine traffic, although increases in the volume of marine trade since 2014 point to upward pressure on marine GHG emissions. The GHG intensity of marine fuel has only slightly improved over this time frame.

Ship manufacturers, shipping companies, and ports are all taking steps to reduce their environmental footprint. Ship manufacturers and designers are pursuing fuel efficiency, while shipping companies are using alternative fuels (natural gas and biofuels) and incorporating renewables (solar and wind). Some of the region's shippers (including Atlantic Towing Ltd., Marine Atlantic and Oceanex Inc.) and ports (including Halifax Port Authority, Port of Saint John and St. John's Port Authority) have Green Marine certification. The Port of Halifax also has ISO 14001 certification. The Port of Halifax's South End Container Terminal Lighting Project will reduce GHG emissions by 500 tonnes annually by using less electricity.

Economic growth, including demographics, personal income and demand for freight movements, will continue to play an important role in determining Atlantic Canada's GHG emissions from passenger and freight transportation. What factors will help further reduce the GHG emissions intensity of transportation?[101]

Carbon pricing will be introduced in the Atlantic provinces in 2019 beginning at $20/tonne. This is expected to increase gasoline prices by 4 cents/litre, or 4% of the average price in 2017.[102] Empirical estimates suggest each 1% increase in gasoline prices

[101] For a more detailed discussion of reducing emissions from freight transportation, see Plumptre, Bora, Eli Angen and Dianne Zimmerman (2017*). The State of Freight: Understanding greenhouse gas emissions from goods movement in Canada*. Calgary: The Pembina Foundation.
[102] APEC calculations based on using the United States Environmental Protection Agency: GHG Energy Calculator; and Statistics Canada.

due to a carbon tax will reduce demand by 1.3%.[103] This suggests that even at $50/tonne, there will be a modest short-term effect on GHG emissions from road transportation.

Greater shifts to public transportation are likely to play only a minor role in Atlantic Canada. For example, in Halifax, the region's largest urban centre, only 12% of workers use public transport with a further 9% walking or biking to work.[104] By contrast, in Toronto with its greater size and density, 24% use public transportation. Nationally, the numbers of commuters using public transport is growing faster than the number using a car, with the proportion using public transport increasing from 10.1% in 1996 to 12.4% in 2016.

Federal regulations will also have an impact, although researchers view carbon pricing as the most cost-effective way of reducing emissions.[105] A new clean fuel standard aims to achieve a 30 Mt reduction in GHG emissions by 2030, which is about 15% of current transportation-related GHG emissions in Canada, and equivalent to taking more than seven million cars off the road.[106] This standard will further increase the use of renewable fuel additives. At present, gasoline uses about 7% renewables and diesel 2% renewables. The proposed fuel standard also includes reducing life-cycle carbon emissions from fuels by 10-15% by 2030, but these standards will not be implemented until 2019.

There will be policy flexibility in how these reductions are achieved, including a market-based approach, such as a crediting and trading system. The interaction of the proposed clean fuel standard policy with provincial carbon pricing policies will create higher business costs in those provinces with a carbon tax. In those provinces with a cap and trade system, there may not be a net reduction in emissions. A low carbon fuel standard combined with an emissions trading system could displace transportation emissions to other sectors.[107]

Electric vehicles (EV) will likely play an increasing role, with one report forecasting EVs will account for 20% of light-duty vehicle sales in Canada by 2025.[108] However, their contribution will be limited in the next decade for several reasons. As of mid-2017, there

[103] Antweiler, Werner and Gulati, Sumeet (2016). *Frugal Cars or Frugal Drivers? How Carbon and Fuel Taxes Influence the Choice and Use of Cars*. Accessed at https://ssrn.com/abstract=2778868
[104] The proportion of commuters using public transport is even lower in other Atlantic cities such as Saint John (4.1%), Moncton (3.4%) and St. John's (3.1%) with the proportion biking or walking in the 5-6% range. However, carpooling is more prevalent in the Atlantic provinces. Statistics Canada (2017a). Journey to work: Key results from the 2016 Census, *The Daily*, November 29.
[105] Dachis, Benjamin (2018). Keep Clean Fuel Standard in Low Gear. *Intelligence Memos*, January 18. Toronto: C.D. Howe Institute.
[106] Government of Canada. *Clean Fuel Standard*. Accessed at https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html
[107] Smart Prosperity Institute (2017): Low Carbon Fuel Standards in Canada. *Policy Brief,* p. 8.
[108] MARCON (2016). *Business Case for Investing in Electric Vehicle Direct Current Fast Charge Station Infrastructure.* Report prepared for Canadian Council for Ministers of the Environment (CCME). Accessed at https://www.ccme.ca/files/Resources/air/mobile_sources/Final%20DCFC%20Report.pdf

were only 233 EV sold in the Atlantic region,[109] or 0.6% of the 37,000 being driven in Canada, and representing 0.01% of light-duty vehicle registrations in Atlantic Canada.

EVs are more expensive to purchase than fossil-fuelled vehicles although costs should decline as the technology improves along with greater market penetration. For example, a 2018 Ford Focus electric vehicle in Bangor, Maine costs US$30,100 compared with US$22,600 for a 2018 Ford Focus SEL gas-powered vehicle.[110] Battery costs are expected to decline to $100 per kWh by 2020, approximately one-tenth of what they were in 2010.[111] Annual fuel savings are estimated at $1,500 for an EV In Nova Scotia and 75% of fuel costs in New Brunswick.[112]

Increased use of EVs will require a network of charging stations, which is slowly being developed (see box). The EV driving range is shorter in cold weather: the EV effective range in -7 ° C is one-quarter less than in 20 ° C.[113]

Just as important is the extent to which EV's are charged by renewable energy or fossil fuel sources.[114] For example, one study estimated the electricity required to power a Nissan Leaf EV for 100 km would generate 13 kg CO_2e in Nova Scotia versus 0.04 kg CO_2e in Quebec because of Nova Scotia's higher current dependence upon fossil fuels.[115] However, Nova Scotia Power estimates that each EV will reduce GHG emissions by as much as 50%, while NB Power estimates reductions of 80%, relative to a gas or diesel-powered vehicle.[116] As provinces increase their share of renewables, the GHGs required to fuel electric vehicles will fall.

Canada's Ecofiscal Commission estimates the cost of reducing GHG emissions in Quebec by providing an $8,000 subsidy for buying EVs is approximately $400 per tonne, compared with a projected national carbon price of $50/tonne by 2022, which suggests

[109] As of the end of 2017 there were 206 EVs in Nova Scotia.
[110] Kelley Blue Book. Accessed at https://www.kbb.com/electric-car/
[111] Frankel, David and Amy Wagner (2017). *Battery storage: The next disruptive technology in the power sector*. Los Angeles: McKinsey & Company. Accessed at https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/battery-storage-the-next-disruptive-technology-in-the-power-sector
[112] Nova Scotia Power. *Electric vehicles: FAQs.* Accessed at https://www.nspower.ca/en/home/for-my-home/heating-solutions/electric-vehicles/FAQ.aspx
NB Power. *Electric vehicles: FAQs.* Accessed at https://www.nbpower.com/en/products-services/electric-vehicles/faqs/
[113] Hughes, Larry (2016). *Electric vehicles in Nova Scotia: An examination of availability, affordability, and acceptability issues.* Halifax: Dalhousie University, p. 9.
[114] EVs may also have a role in terms of renewable energy storage. The Applied Energy Research Lab at the Nova Scotia Community College is conducting research on vehicle to grid technology (V2G). V2G allows the electricity grid to use the EV battery as a storage device and draw down that power during peak demand, while the EV is connected to the grid and not in use.
[115] Hughes, Larry (2016), p. 27.
[116] Nova Scotia Power. *Electric vehicles: FAQs.* and NB Power. *Electric vehicles: FAQs.*

subsidizing the purchase of EVs is an expensive policy option to reduce emissions.[117] Moreover, one researcher finds that EV subsidies have zero or negative GHG benefits because each EV sold allows manufacturers to sell fossil fuel vehicles with higher GHG emissions under current attribute-based regulations on car manufacturers.[118]

Building the Infrastructure for Electric Vehicles (EV)

The Canadian Automobile Association (CAA) shows 147 EV charging stations located in Atlantic Canada as of March 2018 including 22 EV fast charging stations (level-3), located in Nova Scotia and New Brunswick. An EV can typically travel about 200 km on a full charge, about the distance from Halifax, NS to Sackville, NB. EV fast chargers currently cost about $3.75 per 15 minute session.

Nova Scotia has 42 charging stations, including three fast-charging stations, as of April 2018. Nova Scotia Power will install a further 12 EV fast charging stations (level-3) across the province by spring 2018, all within 1 km of 100 series (TransCanada) highways. It will cost approximately $2.50 per 15-minute session to charge an EV and these fast charge stations will be able to fully charge an EV within 15-30 minutes. The provincial government will install 12 EV level-2 charging locations at the Nova Scotia Power locations. Tesla Canada also plans to add two charging stations, one in Halifax and one near Truro.

New Brunswick currently has 78 charging stations, including 19 fast-charging stations, as of April 2018.* Natural Resources Canada has provided $0.95 million towards the installation of 19 fast charging EV stations along the TransCanada Highway network, while the provincial government will cost-share installing 5 charging stations along highways in northern New Brunswick. Tesla Canada also plans to add 5 charging stations in New Brunswick, including one each in Saint John, Fredericton, Moncton, Woodstock and St. Stephen.

* Each charging station can have multiple charging ports. For example, in New Brunswick there are 107 charging ports in NB Power's eCharge Network, which is a smart charging program for electric vehicles.

4.5 Clean Infrastructure

Modern economies depend on infrastructure with many of these assets now critical to supporting improved environmental performance. This can include transmission lines to support renewable electricity generation; investments in clean water and wastewater

[117] Canada's Ecofiscal Commission (2017). *Can subsidies for electric vehicles "boost the signal" from carbon pricing?* Accessed at https://ecofiscal.ca/2017/06/28/can-subsidies-for-electric-vehicles-boost-the-signal-from-carbon-pricing/. Similarly, a study for Quebec estimates that its $8,000 rebate on the purchase of an EV plus the $600 rebate on a home charging station will cost $288 per tonne of reduced GHG emissions if it achieves the target of 1 million EVs on the road by 2030. Belzile, Germain and Mark Milke (2017). *Are Electric Vehicle Subsidies Efficient?* Montreal: Montreal Economic Institute.

[118] Irvine, Ian (2017). Electric Vehicle Subsidies in the Era of Attribute-Based Regulations. *Canadian Public Policy*, vol., 43, no. 1, March, pp. 50-60.

treatment facilities; development of a network of electrical vehicle charging stations; and clean-up of former industrial sites.

Investments in municipal water, wastewater and other environmental projects have become an increasingly important priority over the last decade. This began with the stimulus spending announced during the 2008/2009 global recession, which included a heavy focus on infrastructure. It has continued with a new federal infrastructure plan that is significantly increasing spending on clean infrastructure beginning in 2016/2017.

In the 2009 federal budget the Canadian government increased infrastructure spending well above normal levels to help the economy rebound from the global recession. This funding was typically matched by provincial and municipal funds and included a large portion directed to water and wastewater projects and other green infrastructure. Other infrastructure, including transportation, education, health and recreation projects, also received funding.

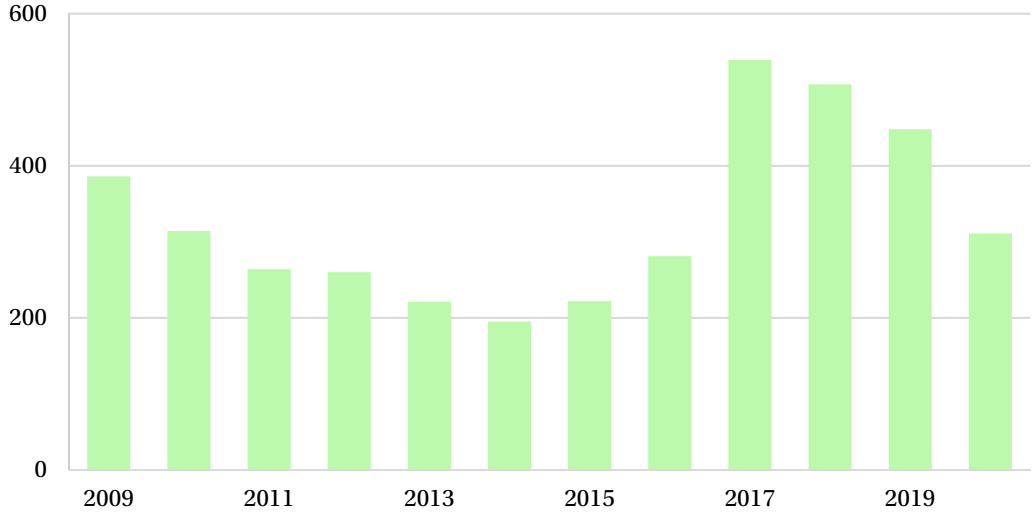
APEC estimates that clean infrastructure spending totalled over $400 million in Atlantic Canada in 2009, during the peak of the stimulus activity.[119] The amount of clean infrastructure spending subsequently fell back to more traditional levels of $200-300 million per year (Figure 4.7). Ongoing infrastructure spending is focused on water and wastewater projects and supported by federal infrastructure plans, such as the Building Canada Fund and the Gas Tax Fund for Municipalities, as well as through provincial and municipal capital budgets.

In the 2016 federal budget a new infrastructure plan was introduced to help boost the economy in light of lower oil prices. A major component of this plan is the Clean Water and Wastewater Fund which will see nearly $300 million of federal money invested in environmental projects in Atlantic Canada on top of other funding programs over five years. The federal government will provide about half of the funding with provincial and municipal governments contribute the remainder. Longer-term funding for green projects was announced in the 2017 federal budget that will see $1.3 billion in federal funding invested over the next 10 years in Atlantic Canada through the Green Infrastructure stream. This will be matched by other levels of government.

[119] For this report, clean infrastructure is defined as projects that improve water and wastewater infrastructure across Atlantic Canada. It is driven by increasing concerns for water quality and the impact of wastewater and storm water on the environment. The funding is driven by federal, provincial and municipal funding for water and wastewater projects. These data are compiled from APEC's Major Projects Inventory which tracks all capital projects in Atlantic Canada valued at $25 million or over ($10 million in Prince Edward Island).

Figure 4.7 Current Clean Infrastructure Spending Exceeds 2009 Stimulus

Clean infrastructure spending, Atlantic Canada ($ millions)



Note: Clean infrastuture is defined as projects that improve water and wastewater infrastructure
Source: APEC Major Projects Inventory

In addition, several large water and wastewater projects are currently underway in the Atlantic region, with the support of the Building Canada Fund.[120] The $90 million Moncton wastewater project began in 2017 and will be complete in 2021; the $58 million Sydney Harbour Wastewater Project will start in 2019 and be complete in 2024 and a $35 million wastewater upgrade in Gander started in 2017 and will be complete in 2019. Charlottetown recently spent $16 million for the new Miltonvale water supply project that was completed this year (see box).

Miltonvale Water Supply Project – Charlottetown

The Miltonvale Water Supply project in Charlottetown was valued at $15.7 million and was completed in 2018. The project includes new supply wells, a new reservoir, piping to connect the water into the existing city network, and other mechanical and electrical work to treat and pump the water. The federal government picked up about half of the project cost through the Clean Water and Wastewater Fund; the remainder was split between the province and the city.

The project will provide the city of Charlottetown with a fourth wellfield as a source of water for its residents. The project is expected to have a positive environmental impact as it will also reduce the amount of water the city draws from the Winter River watershed.

The $229 million Saint John Safe Clean Drinking Water Project, which was funded by the P3 Canada Fund, began in 2016 and is scheduled for completion in 2018. APEC estimates

[120] For further details on these projects see APEC's annual Major Projects Inventory.

that clean infrastructure spending in the region peaked at $539 million in 2017 and will remain elevated in 2018 and 2019.

Table 4.6 Major Federal Programs Supporting Clean Infrastructure in Canada

Fund	Total funding ($)	Timeframe	Key focus and parameters	Project example (Project value)
Building Canada Fund - Provincial-Territorial Infrastructure Component	$10 billion	2014-2024	• Projects that contribute to economic growth, a clean environment, and stronger communities • Matched by provincial and municipal funds	Sydney Harbour Wastewater ($58 million)
Gas Tax Fund for Municipalities	$2 billion per year (ongoing)	2014-2023	• Distributed by province to municipalities • Includes clean and other infrastructure	Used to fund various projects within municipal capital budgets
P3 Canada Fund	$1.3 billion	2010-2017	• Public funding to provide better value, timeliness and accountability for infrastructure through P3 projects	Saint John Safe Clean Drinking Water Project ($216 million)
Clean Water and Wastewater Fund	$2 billion	2016-2020	• Only water and wastewater projects • Small and mid-sized projects • Dispersed widely • Matched by provincial and municipal funds	Corner Brook Sewer Separation Project ($9 million)
Green Infrastructure Stream	$9.2 billion	2018-2028	• For GHG mitigation (e.g., smart grids, renewables, energy efficiency and transportation), resistance and disaster mitigation projects and water and wastewater • Matched by provincial and municipal funds	n.a.
Canada Infrastructure Bank – Green Projects	$5 billion	2018-2028	• Infrastructure that reduces emissions, delivers clean air and safe water, and promotes renewable power • Seeks to attract investment from private sector and institutional investors	n.a.

Source: APEC

Federal government funding for clean infrastructure programs typically account for one-third or one-half of the total project cost. In some instances, the project will be shared by all three levels of government or matched by one other level of government. In the case of the Gas Tax Fund for Municipalities the funding is provided by the federal government, distributed by the province and spent largely be municipalities.

According to the Federation of Canadian Municipalities, municipal governments own nearly 60% of the infrastructure in Canada but rely on federal and provincial funding to

support their repair and maintenance.[121] The 2016 Canadian Infrastructure Report Card estimates that about 11% of the water, wastewater and storm water infrastructure in Canada was in poor or very poor condition. The replacement value of these assets is about $61 billion. The replacement value of those in fair condition is $112 billion. The Atlantic provinces may have greater needs to update some of their clean infrastructure although recent data are not available.[122]

In 2009, Canadian Ministers for the Environment released a 30-year Canada-wide Strategy for the Management of Municipal Wastewater Effluent, which sets out National Performance Standards and site-specific Effluent Discharge Objectives.[123] The strategy was estimated to cost $10 to $30 billion to implement, with significant expenditures required in the Atlantic region to meet these standards. For example, in 2012, Halifax Water's 30-year Integrated Resource Plan estimated the cost of the Halifax Harbour Solutions Project secondary upgrade at $287 million, plus $173 million for enhanced overflow control (see box). Similar upgrades for the Cape Breton Regional Municipality could reach $454 million. The Riverhead Wastewater Treatment Plant in St. John's needs to add a $200-million secondary-treatment facility to meet these national environmental standards.

Halifax Harbour Solutions Project

This $333 million project, constructed between 2003 and 2010, provided the Halifax Regional Municipality with three primary level treatment plants around the harbour, together with a new collection system component to divert sewage from the existing outfalls to the plants. The project also included a biosolids processing facility at the AeroTech Park.

After the project was completed the water quality of Halifax harbour improved considerably and is now safe for swimming and other water-based activities. Shellfish harvesting near the harbour resumed after the project was completed and the levels of contaminated sediment and pollution in the harbour fell significantly.

Announcements by the federal government in the 2016 and 2017 budgets, including $22 billion over 11 years for green infrastructure, will begin to address the conditions of these assets, but other funding sources will need to be examined, including public-private partnerships (P3s) and funding through the new Canada Infrastructure Bank (CIB). At least $5 billion is targeted to Green Projects in Canada from the new CIB.

[121] Canadian Infrastructure Report Card (2016). *Informing the Future*. Accessed at http://www.canadainfrastructure.ca/downloads/Canadian_Infrastructure_Report_2016.pdf
[122] Statistics Canada data on the average age of public infrastructure by province in 2007 indicates that water supply systems are older than the Canadian average in Nova Scotia and New Brunswick; wastewater treatment facilities are older than the national average in Prince Edward Island and New Brunswick; and sewer systems are older than the Canadian average in all four Atlantic provinces. http://www.statcan.gc.ca/pub/11-621-m/2008067/tables/5002061-eng.htm.
[123] The strategy was not endorsed by Newfoundland and Labrador, Quebec or Nunavut.

The private sector currently has a limited role in financing new or upgraded water and wastewater projects. One exception is the deal that the City of Saint John made with a private sector consortium to design, build and operate its new water project (see box). Other cities should examine the possibility of P3's to help move forward on new projects to sustain their water and wastewater infrastructure.[124] Planned federal funding will help but will only make modest inroads to the existing clean infrastructure deficit.

Saint John Safe Clean Drinking Water Project (SCDW)

The City of Saint John is building a new 75 million litre per day drinking water treatment plant, three 11 million litre storage reservoirs, 26 km of piping and other associated infrastructure. Port City Water Partners, a private sector consortium, signed a $216 million contract to design, build and operate the water treatment plant and transmission infrastructure for 30 years. Construction will be complete by the end of 2018. The federal and provincial governments are each providing $57 million to the SCDW project under a private-public partnership agreement announced in November 2013. This is the only Atlantic Canadian project to receive funding to date under the federal P3 Canada Fund.

Once complete the city of Saint John will have a safer and more reliable source of drinking water. Over the last decade there have been several boil advisories in Saint John as aging infrastructure led to water main breaks. With the SCDW the city will have better quality water that meets current and future water standards and be able to correct reliability issues in the current water distribution system.

The $22 billion federal funding for green infrastructure over the next decade by the federal government also includes inter-provincial transmission lines that reduce reliance on coal-fired power generation; the development of new low-carbon/renewable power projects; the expansion of smart grids to make more efficient use of existing power supplies; water treatment projects on reserve; and the construction of infrastructure to help manage the risk associated with floods and wildfires.

[124] Poschmann, Finn (2016). A 17th Century Solution to a 21st Century Challenge. *From the Desk of Finn Poschmann*, November 23. Halifax: APEC. https://www.apec-econ.ca/publications/view/?download=1&publication.id=323&site.page.id=51003

Chapter 5

Pursuing Clean Growth in Major Atlantic Industries

Chapter Summary

- **A reduction in mining activity has contributed to a decline in Atlantic GHG emissions from mining since 2010; proposed new mines would add to existing emissions. Improvements in technology, enhanced management techniques and stringent monitoring are important to mitigate environmental effects of mining.**
- **Offshore oil projects are large sources of provincial GHG emissions although there has been no clear trend in emissions since 2005. Onshore production and collection of scientific data are limited as hydraulic fracturing (fracking) is not currently permitted in three Atlantic provinces.**
- **Agriculture accounted for less than 4% of Atlantic Canada's GHG emissions in 2015. Free software enables farmers to estimate their emissions and examine the impact of alternative farming practices, but greater use could be made of environmental farm management plans.**
- **Atlantic Canada's aquaculture industry continues to grow. Mitigating environmental risks, obtaining eco-labelling and ensuring community support are increasingly important.**
- **Atlantic GHG emissions from fishing and seafood processing have declined since 2000. Government and industry investment in science and research, combined with co-management of the fisheries, can help support the sustainability of fish stocks.**
- **Pulp and paper mills are typically large emitters of GHGs, although forest industry emissions have fallen along with mill closures. Energy efficiency remains paramount for this industry.**
- **Competitive pressures are a key challenge for the region's two refineries, which are important contributors to provincial GHG emissions.**

This chapter provides an overview of several key industries in Atlantic Canada's economy, the environmental challenges they face, and their prospects for clean growth.

5.1 Mining

There were 21 active mines across Atlantic Canada as of 2016. Iron ore, nickel and copper are the highest value products mined in the region, all coming from Labrador. Other metals such as gold, zinc, lead, silver and cobalt are also extracted from mines in Atlantic Canada. Several non-metal products are also mined in the region including gypsum, coal, limestone, and until recently, potash. Glencore Canada operates a lead-zinc smelter in Belledune that processes ore from other markets and Vale finished construction of a $4 billion facility in 2016 at Long Harbour that processes ore from the Voisey's Bay nickel mine.

There are several other deposits with potential for future mining activity including expansions in iron ore, gold, zinc and copper as well as new minerals such as fluorspar, uranium, tin and tungsten. Much of the future growth will depend on commodity prices with iron ore in Labrador having the greatest potential for substantial growth.

The mining sector is important to Atlantic Canada's economy, accounting for 3.9% of GDP and 9.1% of international exports. This is especially true in Newfoundland and Labrador where it accounts for 10% of GDP. Due to the capital-intensive nature of the industry, mining accounts for just under 1% of the region's employment. However, with 2,350 employees, the Iron Ore Company of Canada (IOC) is the largest private employer in Newfoundland and Labrador. Mining activity is also concentrated in rural communities and is an important driver of activity in remote areas of the region.

Table 5.1: Economic Impact of Atlantic Canada's Mining Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	2.8	0.0	0.2	0.6	3.5	-7.7	3.9
Production value ($ billion)	2.7	0.0	0.2	0.3	3.2	-51	n.a.
Exports ($ billion)	1.9	0.0	0.1	0.3	2.3	-39	9.1
Employment (000s)	4.2	0.0	2.7	2.9	9.9	2.1	0.9

Note: All data for 2016, unless noted. Exports are international exports.
Source: Statistics Canada, Natural Resources Canada, Trade Data Online

Recent Trends and Outlook

There has been a significant shakeup in the mining sector in Atlantic Canada over the last five years: a few major mines have closed and planned projects have stalled. Weaker commodity prices led to the closure of the Potash Corp. of Saskatchewan mine near Sussex in 2016 and the Wabush iron ore mine in 2014. In addition, Xstrata closed its lead-

zinc mine near Bathurst in 2013 due to the end of reserves. Gypsum mining in Nova Scotia contracted after the crash of housing markets in the US at the end of the 2000s.

As a result, the overall impact of the mining industry has declined. While production values and exports have fallen by about 50%, volumes have fallen by a smaller amount. For example, the value of iron ore production fell by 36% over the last five years, but production levels have remained stable.

Aside from the closures, several planned iron ore projects in Labrador have ground to a halt and plans for an $2.4 billion underground nickel mine at Voisey's Bay by Vale have been put on hold until prices improve.

There have been a few new mine projects that have moved ahead recently including a $150 million investment by Atlantic Gold in a mine in Moose River; the restart of the Donkin coal mine in Cape Breton; and IOC is spending $79 million to expand iron ore production from 18 million to 23 million tonnes per year.

Atlantic mining exploration peaked in 2012 at $243 million, with about $200 million in Newfoundland and Labrador. Exploration spending fell to $44 million in the region in 2016 but is starting to pick up again: $74 million was expected to be spent in 2018.

Looking ahead, there are several projects in various stages of development in Atlantic Canada. ScoZinc Mining plans to reopen a lead-zinc mine in Nova Scotia in 2018. Tacora Resources has purchased the Wabush iron ore mine with plans to reopen in 2018. Alderon Resources continues to advance the $1 billion Kami iron ore project in Labrador that would see 8 million tonnes of production starting as early as 2020. Northcliff Resources hopes to begin work on the $579 million Sisson Brook tungsten mine in 2018.

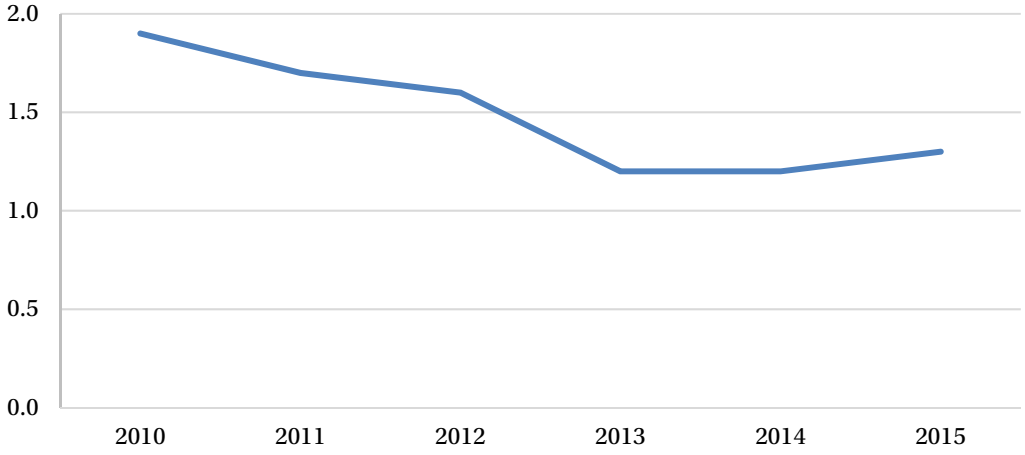
Environmental Impact

There are several environmental concerns that the mining industry has to address in its operations. These environmental and resource impacts from mining can include: soil erosion from drilling and blasting operations and its impact on the surrounding ecosystem; GHG emissions from heavy equipment during extraction and transportation as well as from concentrator or pelletizing operations; soil and water contamination; electricity used for conveyer, crusher and concentration operations; and water use from concentrator or pelletizing operations. Tailings from the concentration process are distributed into specified tailings ponds that could have a large negative impact on the environment if not maintained properly. Mining companies provide sustainable development reports that include a discussion on environmental initiatives, while others have specific environmental focused reports.

GHG emissions of the mining sector have fallen from a peak of 1.9 Mt of CO_2e in 2010 to 1.3 Mt in 2015. This is due to a reduction in mining production over that period.

Figure 5.1 GHG Emissions from Atlantic Canada's Mining Sector Dropped with the Downsizing of the Industry

Mining emissions, Atlantic Canada (Mt CO_2e)



Source: Environment and Climate Change Canada

In 2015 there were five mining operations in the top 30 GHG emitters in Atlantic Canada with the largest being IOC's Carol Project, which accounts for almost 10% of Newfoundland and Labrador's emissions. IOC also requires a great deal of electricity for mining operations. In 2016, the company used 5.2 TWh of electricity which was about 13% of all the electricity produced by Newfoundland and Labrador in that year. Overall, the mining sector accounted for 3.1% of all CO_2 emissions in Atlantic Canada.

Table 5.2 Top GHG Emitters, Mining, Atlantic Canada, 2015

Rank	Company and project	Prov	GHG emissions, 2010 (Mt CO_2e)	GHG emissions, 2015 (Mt CO_2e)	Share of prov. emissions, 2015 (%)
8	IOC Carol Project mine (iron ore)	NL	1.12	0.99	9.6
16	Xstrata Brunswick Smelter (zinc)	NB	0.21	0.19	1.4
22	Vale Voisey's Bay mine (nickel)	NL	0.06	0.09	0.8
26	Potash Corp. mine (potash)	NB	n.a.	0.06	0.4
28	Vale Long Harbour Processing Facility (nickel)	NL	n.a.	0.05	0.5

Note: Project level data is from facility-reported database while the provincial totals used are from the National Inventory Report. Since this data was produced the Potash Corp. closed its mine.
Source: Environment and Climate Change Canada

Regulatory Environment

The federal and provincial government provides guidance and regulation on several environmental areas that impact the mining sector. Any new mine or major mine expansion must undergo a federal and provincial environmental impact and assessment. This is time consuming and costly for proponents but a necessary process for new developments. According to the Mining Association of Canada, the Canadian Environmental Assessment Act of 2012 has led to a deterioration in federal and provincial coordination which has created duplication, delays and uncertainty.[125] The proposed Impact Assessment Act, tabled in Parliament in February 2018, will replace the 2012 Environmental Assessment Act (see Chapter 6.1 for further discussion) and is expected to reduce some of the duplication between federal and provincial environmental assessments. However, there are concerns from the mining industry relating to timelines and costs that could negatively impact the sector depending on how they are implemented.

There are several other government regulations that will have an impact on the mining sector in the coming years. The Multi-Sector Air Pollutants Regulations were announced in 2016 as part of the Canadian Environmental Protection Act. This will set air pollutant emission standards for nitrogen oxides (NO_x) and sulphur oxides (SO_x) from boilers, heaters and stationary engines that are used in several industrial sectors, including mining. All engines must meet a first phase of emissions standards by 2021 and a second more stringent phase by 2026. Amendments to the Metal Mining Effluent Regulations were implemented in 2017 that will strengthen effluent quality standards and improve the efficiency of environmental effects monitoring.

The Federal government's proposed carbon pricing plan will be implemented by the Atlantic provinces in 2019. The mining industry in Canada supports a carbon price for emissions if it meets the following conditions:[126] it is applicable to all sectors of the Canadian economy; is revenue neutral; it ensures a level playing field for trade-exposed emission intensive industries; it addresses competitiveness to prevent declines in output; it is predictable, flexible and sensitive to changing economic conditions; it works in tandem with existing provincial schemes, and is simple to understand and administer; it supports capital investments in technologies that lower emissions and recognizes early action made by companies to reduce emissions.

[125] Mining Association of Canada (2016). *Facts and Figures of the Canadian Mining Industry*. Accessed at http://mining.ca/sites/default/files/documents/Facts-and-Figures-2016.pdf
[126] Mining Association of Canada (2016, April 13). Mining Industry Supports Carbon Price to Address Climate Change. [News Release]. Accessed at http://mining.ca/news-events/press-releases/mining-industry-supports-carbon-price-address-climate-change

Options for Cleaner Growth

Improvements in technology, enhanced management techniques and more stringent monitoring have reduced many of the potential environmental risks associated with mining. To ensure the protection of the surrounding ecosystem the mining sector spends significant resources ensuring that it is minimizing its impact. Companies are researching ways to limit water and energy consumption, minimize soil disturbance and waste production, and limit the amount of soil, water, and air pollution during operations. When the commercial quantities of ore are extracted from an area the company is required to complete the necessary mine remediation and reclamation.

However, for the mining industry to be successful it has to be competitive globally. Strict regulations on mining sector GHG emissions would require investments that would have a negative impact on competitiveness. For example, the mining industry could reduce its GHG emissions if it were to spend hundreds of millions of dollars for new technologies but that is unlikely to be done without some government support.

Over the past few years there has been a decline in GHG emissions but only because of the closure of several mining operations in the region. There are several projects planned that could increase output in the mining sector in Atlantic Canada such as the re-opening of the Wabush iron ore mine, the plans for the new Kami iron ore project and the Sisson Brook mine in New Brunswick.

If the industry does expand over the next few years it will increase the level of GHG emissions through plant emissions and power usage. For example, the Kami iron ore project, proposed by Alderon Resources in Labrador, would add about 309,000 tonnes of CO_2e per year which would boost the total emissions from Newfoundland and Labrador by 3% over 2015 levels. The impact on emissions from electricity generation in Newfoundland and Labrador is muted because most of the new power requirements will come from hydro power.

The mining companies that are active in Atlantic Canada have varying levels of measurement and sustainability initiatives. IOC for example produces an annual sustainability report which includes environmental targets and updates. Along with energy use and GHG emissions the company tracks land rehabilitated and emissions intensity (i.e., emissions per tonne of saleable product). The company also participates in the Mining Association of Canada's *Towards Sustainable Mining* program, which measures societal and environmental performance. In 2016 IOC had top scores in tailings management practices, average scores on energy and GHG emissions management and poor scores on biodiversity practices.

Examples of specific environmental initiatives by IOC include: the Air Quality Improvement Program; the Community Air Monitoring Network, which included the setup of air monitoring stations around the city; the Greenhouse Gas Quantification by Product, which measure GHG emissions of different products; soil and groundwater clean-up from historical contamination; and over 600 hectares have been rehabilitated through the Land Rehabilitation Program.

5.2 Oil and Gas

There are currently four producing oil and gas projects offshore Newfoundland and Labrador with crude oil exports accounting for 38% of provincial merchandise exports in 2017. There are two projects currently producing natural gas offshore Nova Scotia, but these projects will stop producing over the next few years. New Brunswick is currently the only province with onshore natural gas production although there are also onshore oil and gas reserves in Newfoundland and Labrador and Nova Scotia.

Recent Trends and Outlook

Offshore oil output has been trending down since 2007 although expansions at existing fields have helped moderate the natural decline from older wells. Prices dropped considerably after 2014 and averaged US$54/barrel for Brent crude in 2017; the USEIA expects prices of US$62/barrel in 2018 and 2019.

Table 5.3: Economic Impact of Atlantic Canada's Oil and Gas Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	6.0	0.0	0.6	0.0	6.6	-19	7
Production value ($ billion)	n.a.	n.a.	n.a.	n.a.	4.6	-59	n.a.
Exports ($ billion)	3.9	0.0	0.1	0.3	4.2	-39	16
Employment (000s)	7.0	0.0	2.7	3.0	13	6	1

Note: All data for 2016, unless noted. Excludes refined petroleum products. Production value is only for offshore oil and gas. Exports are international exports.
Source: Statistics Canada, Natural Resouces Canada, Trade Data Online, Canadian Association of Petroleum Producers

Newfoundland and Labrador's most recent field, the Hebron Project, saw first oil in late November 2017. It is expected to have a 30-year lifespan and will contribute to increased oil output in 2018 as it ramps up production.[127] Husky Energy is also moving ahead to develop the West White Rose field, with first oil expected in 2020.[128]

[127] Hebron Project (2017, November 28). Hebron Project Produces First Oil. [News Release]. Accessed at http://www.hebronproject.com/mediacentre/2017/firstoil.aspx
[128] Husky Energy (2017). *West White Rose Project*. Accessed at http://wwrp.huskyenergy.com/Project_overview

Exploration actively remains robust with 28 current exploration licences as of February 2018.[129] Statoil continues to evaluate its Bay du Nord discoveries in the undeveloped Flemish Pass basin.[130]

The government of Newfoundland and Labrador recently released their *Advance 2030* plan to grow the province's oil and gas industry. This includes creating commercially viable natural gas production; shorten the time from prospect to production; and turn the province into an energy cluster, including oil and gas as well as renewable energy.[131]

Offshore natural gas production is coming to an end in Nova Scotia. Production has been decreasing since 2014 when Deep Panuke first entered production. Decommissioning has begun at the Sable project and is due to be completed by 2021.[132] Planning for decommissioning has also begun at Deep Panuke.[133] Only one offshore exploration drilling license is currently issued in Nova Scotia, given to BP Oil, who plans to start drilling an exploration well in the second quarter of 2018.[134]

Environmental Impact

The environmental impact of the oil and gas industry depends on the phase of a project, the extraction method and if the project is offshore or onshore. The key challenges are GHG emissions; impacts on marine life during exploration; potential oil spills; and water use and water contamination.

During offshore exploration, seismic activity can have different impacts based on the species affected, with behavioural changes being most common.[135] During drilling and production, the main potential impact are spills of crude oil or drilling muds. Spills can also happen during transportation through either an underwater pipeline to an onshore facility or a shuttle tanker. Spill response plans are required for all Atlantic offshore projects and all spills are monitored by the respective regulatory bodies. At the end of a

[129] CNLOPB (2018). *Licence Information Tables*. Accessed at http://www.cnlopb.ca/exploration/tables.php
[130] Statoil (2018). *Offshore licenses in Canada*. Accessed at https://www.statoil.com/no/hvor-vi-er/canada.html
[131] Newfoundland and Labrador Department of Natural Resources (2018). *The Way Forward on Oil and Gas: Advance 2030*. Accessed at http://www.nr.gov.nl.ca/nr/advance30/pdf/Oil_Gas_Sector_FINAL_online.pdf
[132] ExxonMobil (2017). *Sable Offshore Energy Project Decommissioning Phase Activities*. Accessed at http://soep.com/wp-content/uploads/2017/11/WP02353_SableOpenHouseDisplays.pdf
[133] Encana Corporation (2017). Expression of Interest (EOI). *Integrated Wellbore Plug and Abandonment (P&A) Equipment and Services*. Access at https://www.encana.com/pdf/communities/canada/atlantic/eoi/dc02.pdf
[134] CNSOPB (2017). *Scotian Basin Exploration Drilling Project*. Accessed at https://www.cnsopb.ns.ca/offshore-activity/offshore-projects/scotian-basin-exploration-drilling-project
[135] Department of Fisheries and Oceans Canada (2018b). *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment.* Accessed at http://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html

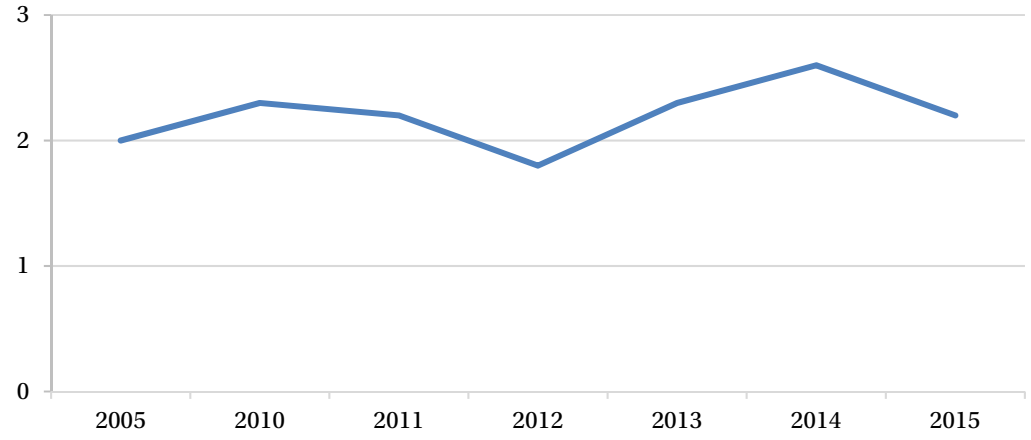
project's life cycle, decommissioning is required which can disturb the marine ecosystem. Gas leaks from the drill sites are also possible once production has ended.[136]

Unconventional onshore extraction methods such as hydraulic fracturing, commonly known as fracking, have their own unique environmental impacts. Fracking involves horizontal drilling and injecting high pressure fluids to fracture an oil or natural gas rich rock. Potential contamination with groundwater is a concern but rare.[137] There is also a large amount of water used and wastewater treatment concerns. However, fracking done by Corridor Resources in New Brunswick used liquefied petroleum gas, which reduces water consumption and the need for water treatment.[138] Potential leaks of natural gas or methane are another concern as they are major GHGs.[139] Recent studies have linked increased volumes of fracking fluids to minor earthquakes, but the effect is highly dependent on the regional geology.[140] There has been no link found in New Brunswick.

The amount of GHGs produced by the oil and gas sector, and its share of total regional emissions, has remained relatively constant in Atlantic Canada. In 2015 there were five oil and gas operations in the top 30 GHG emitters in Atlantic Canada. Newfoundland and Labrador's three oil fields accounted for 15% of its provincial GHGs in 2015 (Table 5.4).

Figure 5.2 Atlantic Canada Upstream Oil & Gas Emissions Have Remained Constant

Upstream oil and gas industry emissions, Atlantic Canada (Mt CO_2e)



Source: Environment and Climate Change Canada

[136] Canadian Association of Petroleum Producers (2017a). *The Atlantic Canadian Offshore. Offshore Oil and Natural Gas Life Cycle.* Accessed at http://atlanticcanadaoffshore.ca/offshore-oil-gas-lifecycle/
[137] Vidic, R.D., S.L. Brantley, J.M. Vandenbossche, D. Yoxtheimer, and J.D. Abad (2013). Impact of Shale Gas Development on Regional Water Quality. *Science,* vol. 340. Accessed at http://science.sciencemag.org/content/340/6134/1235009
[138] Frac Focus (2014). Accessed at http://fracfocus.ca/find_well/NB
[139] Saillant, Richard and David Campbell (2014). *Shale Gas in New Brunswick: Towards a Better Understanding.* Moncton: Canadian Institute for Research on Public Policy and Public Administration.
[140] Schultz, R., G. Atkinson, D. W. Eaton, Y.J. Gu, and H. Kao (2018). Hydraulic fracturing volume is associated with induced earthquake productivity in the Duvernay play. *Science,* vol. *359* (6373), pp. 304-308.

Table 5.4 Top GHG Emitters, Oil and Gas, Atlantic Canada, 2015

Rank	Company and project	Prov	GHG emissions, 2010 (Mt CO_2e)	GHG emissions, 2015 (Mt CO_2e)	Share of prov. emissions, 2015 (%)
13	Suncor Energy (Terra Nova)	NL	0.61	0.55	5.3
14	Husky Oil Sea Rose (White Rose)	NL	0.44	0.54	5.2
15	ExxonMobil - the largest stakeholder (Hibernia)	NL	0.53	0.52	5.0
17	ExxonMobil Thebaud Platform (Sable Offshore Energy Project)	NS	0.16	0.19	1.2
19	Encana (Deep Panuke)	NS	na	0.13	0.8

Note: Project level data is from facility-reported database while the provincial totals used are from the National Inventory Report. Source: Environment and Climate Change Canada

Regulatory Environment

The Canada-Newfoundland and Labrador Offshore Petroleum Board and the Canada-Nova Scotia Offshore Petroleum Board oversee the Atlantic offshore industry. Every offshore exploration or producing project must gain authorization from the board in their jurisdiction. The offshore Boards assess various issues including safety plans, environment protection plans, contingency plans and socio-economic benefits plans.[141]

New Brunswick's onshore resources are regulated by the provincial Department of Energy and Mines (DEM) and the Department of Environment and Local Government (DELG). The DEM oversees exploration of all oil and gas resources through the provincial Oil and Natural Gas Act. The DELG oversees environmental protection with respect to exploration and requires that the New Brunswick Clean Air Act, Clean Water Act and Clean Environment Act are followed.[142]

In Nova Scotia all onshore activities fall under the provincial Petroleum Resources Act which is under the management of the Nova Scotia Department of Energy. The Act regulates all exploration and production within Nova Scotia.[143]

The Newfoundland and Labrador Minister of Natural Resources regulates onshore oil and gas activities through the provincial Petroleum and Natural Gas Act. The province's Minister of Environment and Conservation also regulates and approves any activities

[141] Canadian Association of Petroleum Producers (2017b). *The Atlantic Canadian Offshore: Regulation*. Accessed at http://atlanticcanadaoffshore.ca/regulation/.
[142] Natural Resources Canada (2017b). *New Brunswick's Shale and Tight Resources*. Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17698
[143] Natural Resources Canada (2017c). *Nova Scotia's Shale and Tight Resources*. Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17702

that can harm the environment under the Environmental Protection Act and the Water Resources Act.[144]

Prince Edward Island's onshore and offshore oil and gas activities are governed by the provincial Oil and Natural Gas Act. However, there is no oil and gas development in the province at this time.[145]

Hydraulic fracturing, commonly known as fracking, is not currently permitted in New Brunswick,[146] Nova Scotia[147] or Newfoundland and Labrador.[148] These policies have prevented further development of Atlantic Canada's onshore oil and gas resources. Corridor Resources has used fracking in its production and still produces natural gas in New Brunswick; however, it will not drill a new well or perform any exploration in the province until the ban is lifted.[149] Nova Scotia has stated they are not interested in lifting the hydrological fracturing ban, which is required to access the majority of natural gas in the province, unless there is community support.[150]

Options for Cleaner Growth

The reduction of its emissions intensity is one of the main goals of Suncor Energy, one of Canada's leading integrated energy companies and an operator and producer of offshore oil in Newfoundland and Labrador.[151] Its climate report also notes that "with diligent management of produced methane, offshore crude oil is generally among the lowest carbon intensity sources of crude globally.[152]

The offshore oil and gas industry is also improving its leak detection, spill treatment and ice management to minimize the environmental impact. The use of renewable energy on offshore platforms is being studied, using solar panels or wind turbines on a drilling rig.[153] Floating offshore wind projects, the first of which was produced by Statoil, are

[144] Natural Resources Canada (2017d). *Newfoundland and Labrador's Shale and Tight Resources*. Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17700
[145] Natural Resources Canada (2017e). *Prince Edward Island's Shale and Tight Resources.* Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17712
[146] *Prohibition Against Hydraulic Fracturing Regulation - Oil and Natural Gas Act.* (O.C. 2015-138)
[147] Nova Scotia Department of Energy (2014, September 30). Amendments Introduced for Moratorium on High-volume Hydraulic Fracturing. [News Release]. Accessed at https://novascotia.ca/news/release/?id=20140930002
[148] Newfoundland and Labrador Department of Natural Resources (2013, November 4). Minister Provides Position on Hydraulic Fracturing. [News Release]. Accessed at http://www.releases.gov.nl.ca/releases/2013/nr/1104n06.htm
[149] Corridor Resources Inc (2016, June 3). Corridor Comments of New Brunswick Government's Decision to Continue Hydraulic Fracturing Moratorium. [News Release]. Accessed at https://www.corridor.ca/corridor-comments-on-new-brunswick-governments-decision-to-continue-hydraulic-fracturing-moratorium/
[150] Doucette, Keith (2018). Nova Scotia fracking ban to remain despite gas potential, premier says. *Financial Post*, January 11.
[151] Suncor Energy (2016). *Suncor's Climate Report: Resilience Through Strategy*. Accessed at https://sustainability.suncor.com/2017/pdf/Climate-Report-EN.pdf
[152] Suncor Energy (2016), p. 13.
[153] Tiong, Y K, *et al.* (2015). The Feasibility of Wind and Solar Energy Application for Oil and Gas Offshore Platform. *IOP Conference Series: Materials Science and Engineering*, vol. 78, pp. 012-042.

another option to provide offshore oil and gas operations with renewable energy.[154] However, the harsh and remote location of Newfoundland and Labrador's reserves make this option less likely in the Atlantic region.

Despite Nova Scotia having between $4 and $71 billion in onshore natural gas reserves, there will be very little development under the current regulations.[155] At this time there is a lack of data on Atlantic Canada's onshore oil and gas resources, increasing the need for geological, environmental and health studies to fully understand fracking in Atlantic Canada. The New Brunswick Commission on Hydraulic Fracturing recommended an independent regulator to monitor fracking along with baseline monitoring of the environmental and seismic landscape, among other recommendations. The Newfoundland and Labrador Hydraulic Fracturing Review Panel stated government will need to be the leader to gain the necessary scientific research. A similar sentiment was echoed by the Nova Scotia review panel.

5.3 Agriculture

Primary agriculture (farming) and agri-food processing are an important driver of economic activity in Atlantic Canada, particularly in rural areas, comprising over 2% of GDP and almost 5% of exports in 2016. There were almost 7,500 active farms across Atlantic Canada in 2016, employing almost 12,000 farm employees, with a similar number in agri-food processing. Cattle and dairy (23%), fruit (20%), other crop (17%), other animal production (11%) and vegetable farms (10%) account for over 90% of all farm types in the Atlantic region. Fruit and vegetable ($1,100 million), meat ($620 million), animal food ($430 million) and bakery ($320 million) represented over 70% of Atlantic agri-food manufacturing revenues in 2016.

Table 5.5: Economic Impact of Atlantic Agriculture and Agri-Food Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	0.2	0.4	0.6	0.8	2.0	15	2.2
Production value ($ billion)	0.4	1.3	1.8	2.1	5.6	14	n.a.
Exports ($ billion)	0.01	0.4	0.3	0.5	1.2	21	4.8
Employment (000s)	1.6	4.5	8.1	9.3	23.5	-8	2.1

Note: All data for 2016, unless noted. For the purposes of this report, agriculture excludes aquaculture and agri-food is food manufacturing, excluding seafood, beverage and tobacco manufacturing. Exports are international exports.
Source: Statistics Canada, Trade Data Online

[154] Statoil (2017, October 17). World's first floating wind farm has started production. [News Release]. Accessed at https://www.statoil.com/en/news/worlds-first-floating-wind-farm-started-production.html
[155] These estimates are based on the range for low and high recoverable natural gas reserves in Nova Scotia's Onshore Petroleum Atlas when valued at US$3/mmBTU and assuming an exchange rate of 1CAD$=0.77 US$.

Recent Trends and Outlook

The number of farms in the Atlantic region declined by 12% between 2011 and 2016 while farm acreage decreased by 9%. Average farm size increased marginally due to consolidation – a consistent trend since 1951.

Since global population is forecast to increase by 10% by 2025, global food demand should continue to rise and benefit exports in the longer run. However, Canada's supply management system is at risk in the re-negotiations of the North American Free Trade Agreement (NAFTA). A recent BMO study ranked food products as having a high vulnerability if NAFTA ends and trade reverts to World Trade Organization (WTO) tariffs; crop production had a moderate vulnerability.[156]

Environmental Impact

GHG emissions from primary agriculture accounted for about 4% of Atlantic emissions in 2015. Agriculture and agri-food industry GHG emissions come from various sources, including: methane (CH_4) from ruminant animals and livestock manure; nitrous oxide (N_2O) from decaying crop materials, livestock manure and inorganic fertilizer; and emissions from energy use.

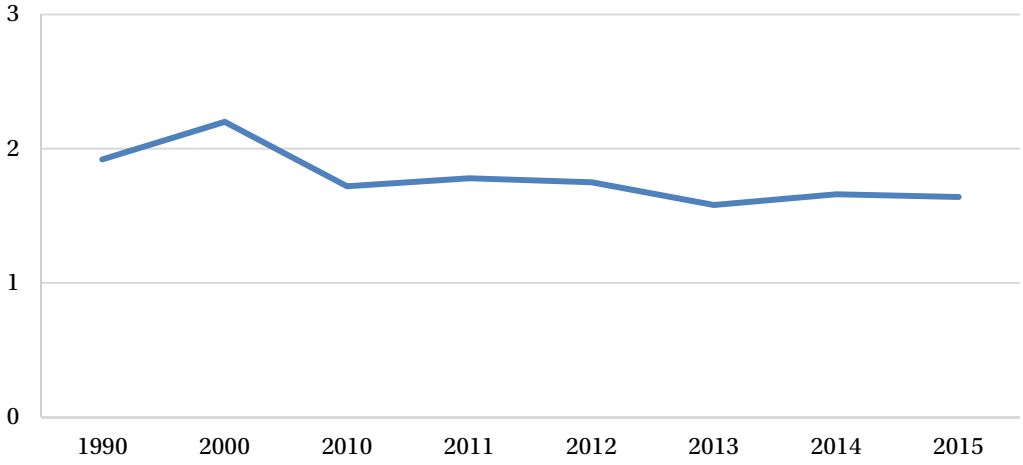
Other environmental issues related to primary agriculture include: soil management, such as potential for erosion and loss of nutrients; water management, including the use of water for irrigation and livestock watering, water quality and watershed protection (i.e., protecting a lake, river, or stream by managing the entire watershed that drains into it); and biodiversity of wildlife habitat. For example, water quality is negatively impacted by increased use of insecticides and fungicides.

Atlantic GHG emissions from the primary agriculture sector decreased from a peak of 2.2 Mt of CO_2e in 2000 to 1.7 Mt in 2010, but have been relatively stable since then. Between 1990 and 2015, Atlantic agriculture methane emissions declined by 19%, largely due to a reduction in animal farming. Increased use of organic farming and renewable energy helped reduce agriculture emissions from other sources. Meanwhile, nitrous oxide emissions rose 7%, reflecting increased crop production. Efficient use of animal feed and fertilizers helps reduce methane and nitrous oxide emissions, while use of biofuels, biomass and renewable energy systems reduces GHG emissions from energy (fossil fuel) use.

[156] Porter, Douglas (2017). *The Day After NAFTA: Economic Impact Analysis*. Toronto: BMO Bank of Montreal.

Figure 5.3 Atlantic Agriculture Emissions Are Stable

Agriculture emissions (Mt CO_2e), Atlantic Canada



Source: Environment and Climate Change Canada

While agriculture's share of GHG emissions may be small, it is emissions intensive. Nationally, crop and animal production, meat manufacturing and dairy manufacturing are in the top 10 industries in terms of direct and indirect energy GHG intensity (i.e., GHG emissions per value of production).[157]

Regulatory Environment

There is a large array of federal and provincial legislation that apply to the agriculture sector, such as the Canadian Environmental Protection Act, which regulates issues such as pollution prevention and dangerous chemical substances. In addition, the Pest Control Products Act regulates the use of pesticides by registering and evaluating pest control products and sets maximum residue limits under the Food and Drugs Act.

All four Atlantic provinces have a voluntary environmental farm plan initiative. In Nova Scotia, for example, the plan specifies standards for water use, farm waste, manure storage and handling, fertilizer use and livestock production, pest management, pesticide storage and application.[158] Farmers who complete a plan may be eligible for various provincial programs under Growing Forward 2, the federal-provincial framework for the agriculture and agri-food sector.[159]

In some instances, agriculture and agri-food projects also undergo provincial environmental assessments. For example, one-half of all projects receiving an

[157] Statistics Canada.
[158] Nova Scotia Department of Agriculture and Fisheries (2004). *Environmental Regulations Handbook for Nova Scotia Agriculture,* p. 8.
[159] The Growing Forward 2 program ends in 2018.

environmental approval in Prince Edward Island in 2016 were in the agriculture and agri-food sector (i.e., farm expansion, feedlot operation, manure storage). In New Brunswick, some cranberry farms underwent environmental impact assessments.

Options for Cleaner Growth

As a result of better farming practices and increased use of technology, the agriculture and agri-food sector has been able to increase production with fewer farms and lower employment. For example, some dairy farms are using milking robotics, maple syrup farms are applying reverse osmosis, and greenhouses are utilizing automated technologies.[160] Ownership transitions can provide an opportunity to adopt best farming practices. As the average age of farm operators in the region was 55 years in 2016, succession planning is an important issue; yet only 5% of Nova Scotia farm operators had a succession plan in 2016.[161]

Atlantic farms are undertaking efforts to reduce their environmental impact. Newfoundland and Labrador farmers rely more on direct marketing of their products with over one-third of their farm operators selling direct to consumers versus almost one-quarter in Nova Scotia.[162] Direct marketing reduces energy used to transport goods to market. Just under 3% of farms on Prince Edward Island were certified organic in 2016, almost one percentage point higher than Canada's share.[163]

The Atlantic agri-food industry is investing in renewables and less emissions intensive fuels. Approximately 275 Atlantic farms, or 3.7% of all farms in the region, reported using one or more renewable energy sources in 2016, with two-thirds of these farms reporting use of solar panels and 23% using wind.[164] Nearly 6% of farms in Prince Edward Island report using some form of renewable energy system.

Oxford Frozen Foods invested in the South Canoe wind project (78 MW) in 2014/2015 and converted to natural gas in 2012, which reduced its GHG emissions. McCain Foods converted its New Brunswick plants to natural gas in 2013.

Only one agri-food manufacturer in the Atlantic region reports GHG emissions: Cavendish Farms in Prince Edward Island emits approximately 50 kt of CO_2e annually. However, Cavendish Farms began producing biogas in 2009 and using compressed

[160] Statistics Canada (2017b). *2016 Census of Agriculture: Leveraging technology and market opportunities in a diverse horticulture industry* (June 7, 2017); and Statistics Canada (2017c). *Production efficiency and prices drive trends in livestock* (May 24, 2017). Accessed at http://www.statcan.gc.ca/pub/95-640-x/95-640-x2016001-eng.htm
[161] Statistics Canada.
[162] Statistics Canada (2017d). *Newfoundland and Labrador farms have the highest rate of direct marketing.* Accessed at http://www.statcan.gc.ca/pub/95-640-x/2016001/article/14800-eng.htm.
[163] Statistics Canada (2017e). *Prince Edward Island has the largest potato crop in Canada*. Accessed at http://www.statcan.gc.ca/pub/95-640-x/2016001/article/14801-eng.htm.
[164] Statistics Canada.

natural gas (CNG) in 2012 to reduce emissions from energy use. Switching to biogas reduced Cavendish Farms' use of heavy oil by 22 million litres annually. Cavendish Farm's GHG emissions declined by almost 50% between 2008 and 2015.

Canadian farmers have access to a useful tool for estimating their GHG emissions. Agriculture and Agri-Food Canada's website provides free access to software for estimating carbon dioxide, nitrous oxide and methane emissions. The software allows farmers to select scenarios and farm management practices that best define their operations. They can also estimate the potential impact on their emissions from changes to their farming practices.[165]

The impending legalization of recreational cannabis will result in an increase in greenhouse farming. However, if cannabis is grown indoors in greenhouses, it will increase electricity demand and GHG emissions in provinces that rely on fossil fuels to generate electricity.

A consultant recommended Prince Edward Island reduce its agriculture GHG emissions by 89 kt by 2031 through a variety of measures, but to exempt agriculture from a potential carbon levy.[166] New Brunswick's climate change strategy includes updating its Environmental Farm Plans to adopt best management practices and take advantage of government funding to reduce emissions. For example, a nutrient management plan and subsurface drainage can reduce nitrous oxide emissions, while beef cattle genetic selection can improve feed efficiency and reduce methane.[167] Since Nova Scotia is developing a cap and trade system, agriculture has an opportunity to provide offset credits.[168]

Under the federal AgriRisk program, the Nova Scotia Federation of Agriculture received $1 million in 2017 to develop a pilot risk assessment model to assess the impact of climate change on the grape and wine industry, including dykes along the Bay of Fundy. Climate change (e.g., a warmer, wetter climate) may provide new crop opportunities, further stimulating the change from animal to crop production. However, climate change risks that impact agriculture include erosion and flooding.

---

[165] Agriculture and Agri-Food Canada (2018b). *Holos software program*. Accessed at http://www.agr.gc.ca/eng/science-and-innovation/results-of-agricultural-research/holos-software-program/?id=1349181297838

[166] Dunsky Energy Consulting (2017). *Recommendations for the Development of a Climate Change Mitigation Strategy*. Prince Edward Island Department of Communities, Land and Environment.

[167] Government of New Brunswick (2016). *Transitioning to a Low-Carbon Economy: New Brunswick's Climate Change Action Plan*, p. 14.

[168] Nova Scotia Federation of Agriculture (2017). *Cap and Trade and Agriculture*. Accessed at http://nsfa-fane.ca/2017/03/17/cap-and-trade-and-agriculture/.

Policy options to reduce the environmental footprint of agriculture and agri-food include dedicating more federal-provincial program funding for the development of mandatory environmental farm plans. For example, these plans could include reforestation of unused agriculture land to create a carbon sink and buffer zones between agricultural land and water courses to reduce soil erosion. Rotating crops benefits the environment by balancing utilization of soil nutrients and reducing pests, thereby limiting the need for chemical fertilizers and pesticides.[169]

However, there can be trade-offs in farming methods. For example, delaying fall plowing until spring can help reduce soil erosion but it also results in the need for more fertilizer because crop residue is not fully decomposed. Many farming techniques aimed at protecting the environment also require specialized equipment or more resources (e.g., labour, farm land) resulting in higher costs.[170] Increased program funding could mitigate these costs. Agri-food also benefits from the application of new equipment, which can improve efficiency and reduce energy use. ACOA recently provided $840,000 in total to Apple Valley Foods for a large oven and Nova Agri Inc. for computerized weighing and filling technology.[171]

Atlantic universities and private companies are investigating various green innovations. For example, Cavendish Farms acquired the rights to the Prospect potato variety, which requires less fertilizer and no soil fumigation. Dalhousie University received $1.7 million in 2017 from the federal Agricultural Greenhouse Gases Program to assess cropping systems for soil health, carbon storage capacity, and soil nitrogen supply in support of mitigation of GHG emissions.[172] In July 2017, ACOA announced $3 million in Atlantic Innovation Funding (AIF) for Acadia University and other research organizations across the Atlantic region to conduct research on alternative green solutions to pest management in the agriculture and forestry sectors.[173] In 2017, Nautilus BioSciences Canada received funding from ACOA and PEI's labour rebate to invest in research related to developing an environmental-friendly, marine-based fungicide to reduce crop loss.[174] More research could help improve agricultural environmental outcomes.

[169] Food and Agriculture Organization of the United Nations (2018). *What is Integrated Plant Nutrient Management?* Accessed at http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/integrated-plant-nutrient-management/ipnm-what/en/.
[170] Agriculture and Agri-Food Canada (2005). *Issues, management problems and solutions for maintaining a zero tillage system and other beneficial soil management practices*, Section II Atlantic Canada.
[171] Atlantic Canada Opportunities Agency (2017, November 15). Positioning Annapolis Valley Food Processing Companies for Greater Export Success. [News release].
[172] Dalhousie University (2017, April 24). Dal research to help farmers adopt clean technologies and practices receives $1.7M. [New release].
[173] Atlantic Canada Opportunities Agency (2017, July 7). Investments in Green Insect Management Help Protect Environment. 2017. [News release].
[174] Atlantic Canada Opportunities Agency (2017, September 20**).** Canadian Farmers to Benefit from Marine-Based Research. [News release].

Farmers and the agri-food industry have a new source of funding for investments in agriculture innovation. Under the Canadian Agriculture Partnership, the federal government will allocate $690 million over the next five years towards agriculture innovation and sustainability, including helping farmers to adapt to climate change, conserve water and soil resources, and grow their businesses sustainably to meet increasing global food demand.[175] This innovation and sustainability funding includes the AgriInnovate Program, which will provide $128 million over the next five years for clean technology adoption, automation and new agricultural products, as well as demonstrate or commercialize new products, processes or technologies that increase agri-food sector competitiveness and sustainability.[176]

5.4 Aquaculture

There were 508 aquaculture establishments across Atlantic Canada in 2016, with a total production value of almost $475 million. In 2016, salmon (37%) and mussels (27%) represented almost two-thirds of the volume of Atlantic aquaculture production. APEC estimates New Brunswick accounted for 40% of the region's aquaculture production value and 78% of its exports in 2016. Aquaculture accounted for 1.5% of the region's total exports. This does not include seafood processing which is part of Chapter 5.5.

Table 5.6: Economic Impact of Atlantic Aquaculture Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ million)	70	40	40	66	216	20	0.2
Production value ($ million)	167	46	69	192	474	38	n.a.
Exports ($ million)	20	42	24	306	392	126	1.5
Employment (000s)	0.24	0.46	0.2	0.59	1.48	7	0.1

Note: All data for 2016, unless noted. Excludes aquaculture processing, which is part of seafood processing. The Atlantic Canada Fish Farmers Association estimates direct employment is over 3,000 persons, but this includes aquaculture farms, processing and feed mills. Exports are international exports.
Source: Statistics Canada, Trade Data Online

Aquaculture is an important economic driver in rural areas. For example, aquaculture accounted for 23% of all employment income in Charlotte County, New Brunswick in 2010.[177]

[175] Agriculture and Agri-Food Canada (2018, February 13). Canadian Agricultural Partnership: Building a Strong Agriculture and Agri-Food Sector. [New release].
[176] Agriculture and Agri-Food Canada (2018a). *Canadian Agricultural Partnership: Federal activities and programs*. Accessed at http://www.agr.gc.ca/eng/about-us/key-departmental-initiatives/canadian-agricultural-partnership/canadian-agricultural-partnership-federal-activities-and-programs/?id=1511361680577.
[177] Gardner-Pinfold (2013). *Socio-economic Impact of Aquaculture in Canada*: Prepared for Department of Fisheries and Oceans Canada, p. 7-8. Accessed at http://www.dfo-mpo.gc.ca/aquaculture/sector-secteur/socio/aqua-es-2013-eng.pdf

Recent Trends and Outlook

The region's aquaculture industry continues to expand. The number of aquaculture establishments in the Atlantic region increased 40% between 2011 and 2016. The volume of aquaculture production increased by 25% between 2011 and 2016, with product prices increasing in-line with inflation. However, export values more than doubled, with 82% of the export gains linked to trade with the US and another 15% of the export growth destined for China. While the volume of Atlantic finfish production expanded 41%, total shellfish production only increased 2% over the last five years.

To help meet growing consumer demand, the OECD-FAO projects global aquaculture production will increase by 2.3% per annum over the period 2017 to 2026, three percentage points slower than during the 2000-2016 period. Global aquaculture production volumes are expected to surpass 100 Mt by 2025.[178]

Cooke Seafood is an important industry player in the region and continues to expand globally, employing approximately 6,000 people world-wide. Marine Harvest, a global company with operations in British Columbia, has announced plans to acquired Northern Harvest's operations in New Brunswick and Newfoundland and Labrador. Grieg Seafood, another global player that also has operations in British Columbia, has plans to set-up farming operations in Newfoundland and Labrador.

Newfoundland and Labrador's Way Forward strategy includes a target to more than double salmon aquaculture output, as well as employment. In 2015, the provincial government announced a MOU with Grieg NL that includes an equity investment of $45 million, which will leverage a total investment of $251 million and upwards of 33,000 tonnes of annual Atlantic salmon production once fully implemented.[179] Until the latest strategy, over 50 aquaculture-related license applications in the province had been awaiting approval for up to four years.

Environmental Impact

Besides GHG emissions, the environmental impact of aquaculture can include: organic waste (i.e., fish waste and fish feed waste); use of pharmaceuticals (antibiotics) and pesticides; the proportion of wild fish used in fish feed; and risk of disease transfer (spread) between farmed and wild fish. For example, fish waste is produced by farmed

[178] Organization for Economic Cooperation and Development - Food and Agriculture Organization of the United Nations (2017). *OECD-FAO Agricultural Outlook 2017-2026*. Paris: OECD.
[179] Government of Newfoundland and Labrador (2015). *Memorandum of Understanding between Newfoundland and Labrador and Grieg Newfoundland AS*. Accessed online on February 6, 2018 http://www.fishaq.gov.nl.ca/pdf/mou_grieg.pdf

fish after they consume fish feed, as well as from uneaten fish feed.[180] Overfeeding results in an accumulation of fish feed waste, which increases nutrient levels in the water allowing for the proliferation of marine fauna, such as algae, that deplete oxygen levels available for fish; in extreme cases, resulting in fish kill(s).[181] However, this is very uncommon in Canada. The possibility of invasion of non-native species (escaped farmed fish) is also a concern but in Atlantic Canada most farmed fish are native to the region.

In some aquaculture projects the negative impact on the wild fishery from the use of acoustic equipment used to deter predatory fish are concerns but this approach is not used in Atlantic Canada. There is also a potential impact on marine transport and navigation (i.e., vessels circumnavigate buoys and pens to avoid entanglement or collision) but Transportation Canada regulations minimize this impact.

The Canadian Science Advisory Secretariat coordinates the peer review of scientific issues facing the aquaculture industry. Some of their research has focused on biological impacts of sea lice, sulfide concentration around aquaculture sites, environmental interaction of finfish cages, potential technologies for closed-containment systems, and impact of finfish on wild fisheries.

Some companies in Atlantic Canada have received the Best Aquaculture Practices (BAP) certification, which ensures healthy foods are produced through environmentally and socially responsible means. For example, Northern Harvest Sea Farms Ltd., Cooke Seafood and PEI Mussel King Inc. are BAP certified. A four-star BAP rating for seafood processing plants, farms, hatcheries and feed mills is the highest standard. There are also Certified Organic mussel operations in Newfoundland and Labrador and Prince Edward Island.

Food safety is also important with many businesses seeking third-party certification. For example, Cooke Seafood and PEI Mussel King Inc. are certified by the British Retail Consortium. The Aquaculture Stewardship Council promotes environmental sustainability and social responsibility.[182] Marine Harvest Canada Ltd.'s operations in British Columbia are certified by the Aquaculture Stewardship Council.

In terms of carbon footprint, aquaculture typically has a lower carbon footprint than animal production and is more efficient in terms of converting animal and fish feed into

[180] Science for Environment Policy (2015). *Sustainable Aquaculture. Future Brief 11*. Brief produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol.
[181] White, Patrick (2013). Environmental consequences of poor feed quality and feed management. In M.R. Hasan and M.B. New, eds. On-farm feeding and feed management in aquaculture. FAO Fisheries and Aquaculture Technical Paper No. 583. Rome, FAO. p. 553–564.
[182] Aquaculture Stewardship Council (2018). *About the ASC*. Accessed at https://www.asc-aqua.org/about-us/about-the-asc/

high quality food protein. Farmed fish have lower nitrogen and phosphorus emissions than beef or pork, but higher emissions than chicken; bivalves (e.g., oysters, clams, scallops and mussels) actually absorb nitrogen and phosphorus.[183]

Other environmental issues related to fish and seafood manufacturing include using less wild fish and fish oil in fish feed for the aquaculture sector. Cooke Seafood's fish feed plant in Nova Scotia only uses approximately 15% fish and fish oil in the manufacture of fish feed.[184]

Regulatory Environment

In the Atlantic region, aquaculture sites undergo a provincial environmental assessment before they are approved for aquaculture production. Once approved, the sites are subject to annual environmental monitoring to assess the effect of organic waste on the marine environment. Some aquaculture projects also undergo a federal environmental assessment by the Canadian Environmental Assessment Agency (CEAA), for example, if a site receives funding from a federal government department or uses (or diverts) a significant amount of water.

Provincial governments issue site licenses, while multiple federal departments and agencies have regulatory responsibilities. Department of Fisheries and Oceans (DFO) Canada regulates the introduction and transfer of fish species to and from farm sites, hatcheries and brooding facilities, as well as protects species at risk. The Canadian Food Inspection Agency (CFIA) regulates the fish and fish feed industry. The CFIA works with DFO to reduce disease in fish through the National Aquatic Animal Health Program. Health Canada oversees drugs approved for pest management. The CFIA approves aquaculture products for export and oversees compliance with food safety and quality rules in federally-licensed processing plants, including tests for the presence of therapeutants in fish to ensure they do not exceed the levels set by Health Canada. Environment Canada, DFO and the CFIA also do water quality testing to ensure food safety and quality is maintained.

The aquaculture regulatory framework developed in the Atlantic region is partially a response to the environmental issues the industry has encountered over the last twenty-five years. New Brunswick and Newfoundland and Labrador use Bay Management Areas (BMA). The New Brunswick provincial government and DFO introduced BMA to address a fish disease called Infectious Salmon Anaemia (ISA). BMA's require farms to hold fish of the same year-class (only one generation of fish on a site at any time) and to operate

[183] Christophe Béné, Manuel Barange, Rohana Subasinghe, Per Pinstrup-Andersen, Gorka Merino, Gro-Ingunn Hemre, and Meryl Williams (2015). Feeding 9 billion by 2050 – Putting fish back on the menu. *Food Security*, vol. 7, no. 2, April, pp. 261-274.
[184] Cooke Seafood (2017). *Cooke Family of Companies Newsletter*. Summer. pp. 41. Accessed at http://www.cookeseafood.com/cms/wp-content/uploads/2017/09/Cooke-Summer-2017-English-LR3.pdf

on a crop rotation (fallow period which is three years in New Brunswick). In response to the outbreak of sea lice, the New Brunswick government and DFO developed the Integrated Pest Management program in 2011, including prevention and control measures, monitoring, and data collection and analysis. This program incorporates the BMA policy, plus the use of sea lice traps, well boats and therapeutants.[185]

In June 2015, the Aquaculture Activities Regulations (AAR) under the federal Fisheries Act came into force. The AAR permits fish health treatments, such as therapeutants for sea lice, and the deposit of organic matter (i.e., fish waste and unconsumed fish feed) within certain restrictions to avoid, minimize and mitigate any potential harm to fish and to fish habitat. The AAR incorporates industry reporting requirements, including environmental monitoring and sampling.[186]

The federal Fisheries Act does not define or include aquaculture, with the industry facing a patchwork of regulations, including federal and provincial legislation and MOU's. However, a 2015 Senate Committee report recommended separate federal legislation for the aquaculture industry. Norway's aquaculture industry is only subject to federal oversight. Streamlined regulation paves the way for economic growth: between 2002 and 2015, the volume of aquaculture production in Norway increased by 52%, while in Canada it increased 9%.[187]

In 2008, the Atlantic provinces signed a Memorandum of Understanding (MOU) for the development of the aquaculture sector, which promoted harmonization of regulation and the policy environment in areas such as: leasing and licensing; environmental monitoring; introductions and transfers of fish species; aquaculture statistics; and aquatic animal health.[188] An example of regional collaboration is the use of Bay Management Area policies in the region.

Options for Cleaner Growth

The Canadian Council of Fisheries and Aquaculture Ministers' 2016-2019 Aquaculture Development Strategy has three main areas of focus: improved regulatory environment; improved fish health; and improved regional economic growth.[189] Aquaculture research and clean technology adoption can help lead to improved outcomes. DFO's Aquaculture

[185] Standing Senate Committee on Fisheries and Oceans (2015). Volume 1 – Aquaculture Industry and Governance in Canada.
[186] Department of Fisheries and Oceans Canada (2015). *Backgrounder: Aquaculture Activities Regulations and guidance document*. Accessed at http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-bck-eng.htm
[187] Organization for Economic Cooperation and Development (2018). *Aquaculture Production*. Accessed at https://stats.oecd.org/Index.aspx?DataSetCode=FISH_AQUA#
[188] The Council of Atlantic Premiers (2008). *Atlantic Province's Memorandum of Understanding for the Development of Aquaculture Sector*. Accessed at https://www.cap-cpma.ca/images/CAP/Aquaculture%20MOU%20English.pdf
[189] Canadian Council of Fisheries and Aquaculture Ministers (2016). Aquaculture Development Strategy 2016-2019. Accessed at http://waves-vagues.dfo-mpo.gc.ca/Library/365376.pdf

Collaborative Research and Development Program, which promotes collaborative research and development activities between the aquaculture industry and DFO's researchers has two goals: optimal fish health and environmental performance. This program is focused on three priority areas in 2018/2019: mitigation of pest and pathogen management; ecosystem interactions; and sustainability and species diversity.

DFO's Program for Aquaculture Regulatory Research (PARR) funds research projects that study the environmental and biological interactions between aquaculture and the aquatic environment. It is part of the Sustainable Aquaculture Program, which has funding of $54 million over the period 2013-2018. One PARR funded project is investigating the interactions between lobster and farmed fish sites, since lobster feed on farm site waste. The federal Fisheries and Aquaculture Clean Technology Adoption Program will provide $20 million over the next 4 years to help industry improve their environmental performance. For example, fish harvesters can convert their vessels to clean alternative fuels or reduce energy use on aquaculture sites.

Aquaculture typically uses less energy to harvest farmed fish than the wild fishery. However, since transportation GHG emissions from shipping aquaculture feed and fish products often represent a small share of industry GHG emissions, the potential for reducing GHG emissions by undertaking aquaculture locally are limited. Many aquaculture certifications do not explicitly include GHG emissions in their measures of sustainability, although they do include measures of carbon and nitrogen discharges in sediment from fish feed. However, as of 2013, companies can have a life cycle assessment of GHG emissions done on their products to achieve ISO 14067 (carbon footprint) certification. This applies to any product, including aquaculture.

Compared to Norway, Canada has higher relative use of feed and energy for fish farm and feed mills and higher emissions of nitrogen and phosphate for salmon farming, suggesting there is room to improve productivity and energy use.[190] Improving energy efficiency can reduce costs and increase competitiveness.

Some aquaculture research projects are focused on mitigating environmental impacts. For example, a potential solution to the fish waste issue is the application of Integrated Multi-Trophic Aquaculture (IMTA), whereby finfish, algae and shellfish are raised in unison and the algae and shellfish consume the waste nutrients from finfish. This can result in additional value-added, while mitigating the environmental consequences of finfish aquaculture. Cooke Seafood, Grieg Seafood BC and Marine Harvest Canada Ltd. are three of the four industry funding partners of the Canadian IMTA Network, along

[190] Organization for Economic Cooperation and Development (2015). OECD Green Growth in Fisheries and Aquaculture. OECD Green Growth Studies. Paris: OECD.

with the Natural Sciences and Engineering Research Council (NSERC), University of New Brunswick, and the Department of Fisheries and Oceans Canada.

Fish crop rotation and regular fallowing can limit the impact of bio-waste on sediment and the environment around aquaculture sites. Preventative farming practises like fish husbandry, fallowing and low stocking densities can reduce the necessity to use Health Canada approved treatments to manage sea lice, for example.[191]

Aquaculture management is key to sustainable aquaculture. A few EU member states, such as Spain, the Netherlands and Austria, are pursuing best practices in sustainability, quality and social responsibility in their aquaculture plans, including ISO 14067.[192]

Obtaining industry certifications and using eco-labelling can raise industry standards and improve public perception of the industry. Consumer and retailer market demand for sustainability and specific eco-labels will influence which suite of certification standards are adopted – although third-party certifiers are increasing collaboration on standards. Aquaculture producers adopt the certifications that the retailers and consumers of their products prefer. For instance, Loblaws began selling farmed fish with the Aquaculture Stewardship Council (ASC) eco-label in central Canada in 2014. Marine Harvest is awaiting approval of its recent acquisition of Northern Harvest Sea Farms Ltd. in the Atlantic region; and it acquired Gray Aqua Foods' assets in Atlantic Canada in 2017. Marine Harvest's west coast salmon operations are ASC and Best Aquaculture Practices (BAP) certified, so its Atlantic region acquisitions could result in the adoption of the ASC eco-label in this region.

The necessity for local support in aquaculture is increasing. Proper site selection, utilizing integrated coastal zone management, can garner stakeholder buy-in, while addressing environmental concerns and stimulating investment. For example, the Nova Scotia Aquaculture Review Board's approval process includes holding public hearings. From an industry perspective, regulatory certainty and transparency are paramount because of the risks and rewards associated with investing in aquaculture.

5.5 Fish and Seafood

Fish and seafood exports accounted for 17% of total Atlantic exports in 2016. There were 15,276 registered fishing vessels across Atlantic Canada in 2016. The total value of fish landings (excluding aquaculture) was approximately $2.7 billion in 2016. Shellfish accounted for 88% of the landed value from all fish species. Shellfish landed value was

[191] Standing Senate Committee on Fisheries and Oceans (2015), p. 32.
[192] European Commission (2016). *Summary of the 27 Multiannual National Aquaculture Plans*. Prepared for Directorate-General for Maritime Affairs and Fisheries.

led by lobster (52%), queen crab (20%) and shrimp (16%); groundfish (8%) and pelagic (4%), such as herring, tuna and mackerel, made up the residual value from all fish species. Atlantic seafood manufacturing was valued at $4.4 billion in 2016. Almost 8,500 people are employed in the primary fishery with over 15,000 in seafood processing, with most jobs in rural, coastal communities.

Table 5.7: Economic Impact of Atlantic Fish and Seafood Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	0.4	0.1	0.6	0.4	1.6	1	1.8
Production value ($ billion)	2.1	0.6	2.5	1.8	7.0	56	n.a.
Exports ($ billion)	1.0	0.3	1.8	1.3	4.3	65	16.8
Employment (000s)	3.7	1.8	10.0	7.9	23.4	24	2.1

Note: All data for 2016, unless noted. Fish and seafood excludes aquaculture for the purposes of this report. Exports are international exports.
Source: Statistics Canada, Department of Fisheries and Oceans Canada, Trade Data Online

Recent Trends and Outlook

The industry continues to consolidate with the number of registered fishing vessels in the region declining by 11% between 2011 and 2016, while the volume of landings only fell 7%. Higher prices boosted landed values by 56% and manufacturing revenues by 52%. Exports grew even faster, especially to the US, Asia and the EU. The Canada-EU Comprehensive Economic and Trade Agreement (CETA), which came into force in September 2017, may lead to further increased sales in the EU as suppliers seek to benefit from lower tariffs.[193]

The OECD-FAO projects global per capita fish consumption will grow 0.4% per annum between 2017 and 2026. However, global wild fish production is expected to contract 0.1% annually, with increased demand met by aquaculture. Average nominal fish prices are forecast to grow 0.8% per year over the same period.[194]

Environmental Impact

The potential environmental effects of the fishing industry include environmental degradation and habitat destruction and overfishing. The wild fishery can also be affected by climate change, as warmer temperatures impact fish migratory and breeding patterns, as well as invasion of non-native species. There is also the risk of disease transfer and inter-breeding between wild fish and escaped aquaculture fish, which could

[193] Chaundy, David (2015). *Opportunities for Atlantic Manufacturers in the EU*. Halifax: APEC, Chapter 2.
[194] Organization for Economic Cooperation and Development - Food and Agriculture Organization of the United Nations (2017).

impact wild fish health; some fish escapes may be caused by increased storm activity due to climate change. However, this is less of a concern in the Atlantic provinces as the fish used in aquaculture practices are local species.

Over a decade ago, the credibility of the scientific management approach to sustainability was challenged because fish stocks were estimated in isolation and industry knowledge was not included in decision-making. Meanwhile, fish stocks continued to decline, providing further evidence that a stand-alone, scientific approach to fisheries management was not generating positive results.[195]

An integrated fisheries management plan adopts a best practices approach, relying on a combination of industry data related to harvesting capacity and fishing methods; and scientific evidence related to the health of the relevant fish stocks. It also incorporates ecosystem-based fisheries management (i.e., recognizes the interaction between fish species and the environment) and shared stewardship (i.e., industry and government jointly make certain fishery management decisions, such as setting total allowable catch).[196] This broader approach to fisheries management also considers other activities that impact fisheries and oceans, such as offshore oil and gas exploration, development and production, including seismic testing, as well as pollution's impact on fish health.

The Department of Fisheries and Oceans Canada's (DFO) Sustainability Survey for Fisheries assesses the current stock status of 73 fisheries in the Atlantic region. In 2016, however, only 25 Atlantic fisheries were rated as healthy, with the rest classified as cautious, critical or uncertain. Fisheries not subject to a scientific peer review process are classified as uncertain, while 19 Atlantic fisheries do not have an integrated fisheries management plan. However, 66% of Canadian wild fisheries by volume and 80% by value are certified by the Marine Stewardship Council (MSC), which promotes sustainable fishing practices, while only 12% of global fishery production is certified.[197]

APEC estimates fish and seafood sector GHG emissions decreased from a peak of 3.9 Mt of CO_2e in 2000 to 2.5 Mt in 2014 or 6% of total Atlantic emissions. The collapse of groundfish stocks almost a quarter of a century ago, followed by industry restructuring post-2000 partially explains lower GHG emissions from the fish and seafood processing sector. While the volume of Atlantic fish landings declined between 1990 and 1995 due to

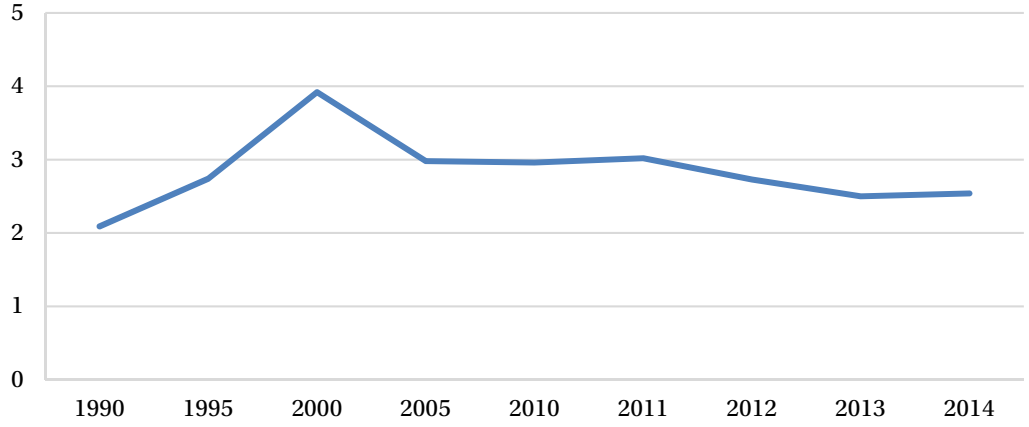
[195] Sheldon, Peter (2007). The weakening role of science in the management of groundfish off the east coast of Canada. *ICES Journal of Marine Science*, vol. 64, pp. 723–729.
[196] Department of Fisheries and Oceans Canada (2013). *Preparing an Integrated Fisheries Management Plan.* Accessed at http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/guidance-guide/preparing-ifmp-pgip-elaboration-eng.htm#toc-n8
[197] SeaChoice (2017). *A Decade of Marine Stewardship Council (MSC) Certification in Canada: Technical Report.* Accessed at http://www.livingoceans.org/sites/default/files/A-Decade-of-MSC-Certification-in-Canada-Technical-Report-SeaChoice-September-2017.pdf

the groundfish collapse, fishing effort in other species increased and total landings for all fish species rose between 1995 and 2004 - after which fish landings began to decline.

The volume of fish landings and the fishing method impacts fuel use in multiple ways – not just based upon the gross weight to transport. For example, as fish stocks get depleted, fishing effort intensifies and vessels travel further and burn more fuel to maximize catch. As seen with the region's groundfish, as fishing pressure intensifies, fish stocks get depleted, eventually to the point where quotas are drastically cut along with fishery access, which automatically reduces fuel use as there is limited quota to catch. In addition to fuel use, GHG emissions intensity (i.e., GHG emissions per volume of production) also impact emissions. The GHG emissions intensity for fishing peaked in 1997 and began to track downwards afterwards, levelled-off between 2005 and 2010, before trending down marginally since then.

Figure 5.4 Atlantic Fish and Seafood Emissions Almost at 1990 Levels

Fish and seafood emissions, Atlantic Canada (Mt CO_2e)



Note: Includes direct and indirect GHGs. Uses national emissions intensity for fish and seafood and Atlantic production values for the same categories to obtain emission estimates.
Source: Statistics Canada, APEC

Despite the recent downward trend, fish (and seafood processing) direct and indirect energy GHG intensity, at 0.44 tonnes (and 0.49 tonnes, respectively) per thousand dollars of production, are both above the all industry average of 0.38. Energy use per tonne of fish caught differs by type of vessel/gear used, but other factors like the age of the vessel and the value of the fish species have an impact on energy efficiency. Energy efficiency is not as relevant for fishers seeking to catch higher-valued fish species, while older vessels may not have fuel-efficient engines or hull design.

Regulatory Environment

Both federal and provincial regulations apply to fish harvesting while the provinces regulate the fish and seafood processing sector. DFO sets policies on quota management

system for wild fisheries and how these quotas are allocated. The fishing season and the types of fishing gear that can be used are set by regulations under the Oceans Act or the Fisheries Act. DFO also used science-based evidence that helps measure the size of the fish stock and their migration patterns which helps them set the policies and make new regulations. However, other factors can impact fish stocks, such as predators, climate change, pollution and foreign-based fishing activity for transboundary stocks. Even with a management framework, wild fishing stocks can be depleted, as evidenced by the drastic reduction in the northern shrimp quota over the last two years, partially due to higher water temperatures and the recovery of the cod stock. Poorly managed fisheries or depleted stocks increase fuel consumption, as fishing vessels travel further to catch their quota.

In February 2018, proposed amendments to the federal Fisheries Act were announced, including: better management and a new permitting framework to protect fish and fish habitat, sustainability and marine refuge biodiversity; increased Indigenous participation in project reviews, monitoring and policy development; modernization of enforcement powers; and enshrinement of inshore fisheries policies in legislation to ensure licence holders and coastal communities continue to receive economic benefits from fishing.[198]

Most of the proposed amendments have a focus on clean growth, including sustainability, improved environmental performance and protection of fish habitat and marine areas. The federal government is also enhancing the protection of marine habitat and species at risk. Under the Oceans Act and the Fisheries Act, the goal is to have 10% of marine and coastal habitats protected by 2020, as promised in 2010 under the United Nations Convention on Biological Diversity.[199]

Amendments to the Canada Petroleum Resources Act allow for the provision of compensation to oil and gas companies that are impacted by marine protected areas (MPAs), thereby mitigating the impact of environmental protection on economic interests. At present, there are no active offshore oil and gas exploration licenses in proposed MPAs in the Atlantic region. However, there are other effective area-based conservation measures, also known as marine refuges, that restrict certain fishing operations and overlap with offshore oil and gas licenses. It is important to balance different industry and environmental interests and to ensure clarity and certainty in these conservation areas so that offshore oil and gas developments are not restricted and investment is not discouraged in marine refuges where such activity is permitted.

[198] Department of Fisheries and Oceans Canada (2018, February 6). Government of Canada introduces new protections for fish and their habitat. [News release].
[199] Department of Fisheries and Oceans Canada (2018a). *Meeting Canada's Marine Conservation Targets*. Accessed at http://www.dfo-mpo.gc.ca/oceans/conservation/plan-eng.html

Under the Species at Risk Act, DFO issued multiple Critical Habitat Orders in 2017 – including additional measures to protect North Atlantic right whales. For example, in July 2017 the Gulf snow crab fishery was closed early.

The Canadian Food Inspection Agency (CFIA) approves fish and seafood for export and oversees compliance with food safety and quality rules applicable to federally-licensed processing plants. In recent years, certification and traceability have also become increasingly important for the fish and seafood sector – but some of the certifications are carried-out by non-government organizations (i.e., Marine Stewardship Council) and are voluntary.

Other regulations that have a bearing on the fishing industry include sulphur content rules for marine fuel. For example, effective August 1, 2012, sulphur content in marine fuels was limited to 1% and reduced further to 0.1% in 2015. However, these regulations only apply to larger vessels weighing 400 gross tonnes or more.[200] The Federal Wastewater Systems Effluent Regulations announced in 2012 under the Fisheries Act will improve effluent quality by requiring all wastewater treatment plants to have secondary treatment by 2040.

Options for Cleaner Growth

Fisheries management is key to a sustainable fishery. With only one-third of Atlantic fisheries in a healthy state, it would be beneficial to increase the number of fisheries subject to a scientific peer review process and an integrated fisheries management plan.

In terms of government-based fisheries management, there are options for addressing issues related to overfishing or overcapacity, such as licence buyback programs, fleet management policy, altering fishing gear used or increasing the size of fish caught. For example, the introduction of the aboriginal fishery and the buyback of licenses, fishing vessels and gear from non-aboriginal fishers helped limit the pressure on fishing stocks.

In terms of resource-stock assessment, government and industry are making investments in science and research. For example, Clearwater, DFO and others are partnering with Nova Scotia Community College's Applied Oceans Research team to study integrated ocean mapping technologies using a suite of subsea camera systems, multi-beam echo sounders and autonomous platforms to help promote sustainable environmental management and assessment processes.[201] This research project received $1 million in funding from the Natural Sciences and Engineering Research Council of Canada

[200] Transport Canada (2013). *Regulations amending the Vessel Pollution and Dangerous Chemicals Regulations*. Accessed at https://www.tc.gc.ca/eng/mediaroom/infosheets-menu-7681.html.
[201] Nova Scotia Community College (2018). *Ocean Research*. Accessed at https://www.nscc.ca/about_nscc/applied_research/areas-of-research/oceans-research/index.asp

(NSERC). Federal budget 2016 allocated $197 million to DFO for ocean and freshwater science over 5 years and created 135 new science positions.

In September 2016, further alignment on oceans research was achieved via the creation of the Oceans Frontier Institute – a collaboration between Dalhousie University, Memorial University and UPEI and eight international research organizations with a funding envelope of approximately $220 million, including $94 million from the Canada First Research Excellence Fund, as well as funding from the provincial governments in Nova Scotia and Newfoundland and Labrador, Clearwater and Ocean Choice International.

The federal government's $325 million Atlantic Fisheries Fund will leverage additional investments from provincial governments in the region and the private sector. Eligible projects include investments in innovation, research and development that contributes to sustainability; adoption of new technologies or equipment that improves effectiveness and sustainability; and partnerships with academia and institutions to enhance understanding of the impacts of changing oceanographic conditions and sustainable harvesting technology. An Atlantic private sector partnership, including among others Ulnooweg, Clearwater and Ocean Choice International, has received matching federal funding to develop an ocean supercluster. This supercluster will leverage approximately $250 million in private-public funding. Some of the ocean supercluster research and innovation will focus on ocean bottom mapping to help the industry fish smarter, while protecting ecosystems.

Fishery certifications do not explicitly include carbon footprint in their measures of sustainability. If the voluntary certification programs did include carbon footprint measures, then industry participants would have an incentive to reduce their carbon footprint to maintain their certifications.

However, some fishing companies are already investing in energy efficiency, which reduces fuel use and GHG emissions. Clearwater's state-of-the-art clam dredging technology has increased catch rates and improved productivity, thereby reducing the size of the fleet from 4 to 3 vessels and lowered the company's carbon footprint. In addition, Clearwater's fleet modernization (introduced 2 new vessels in the last 3 years) has also improved efficiency and productivity.[202]

Increased use of renewables may also be applicable to the fishing industry, but on a smaller scale than in the marine shipping industry. Fuels used in fishing vessels are often exempt from provincial fuel taxes. Many provinces also exempt fuel used in the

[202] Clearwater Seafoods (2017). *2016 Annual Report*. Halifax: Clearwater.

manufacture of a good for sale (i.e., seafood processing) from provincial fuel tax. These fuel tax exemptions will limit the impact of carbon pricing on fuel used in the fish and seafood processing sector. However, a Nordic study concluded that a greater reduction in CO_2 emissions could be achieved by optimizing fish stock recovery and reducing fleet capacity, rather than eliminating fuel tax exemptions.[203]

Finding alternative uses for fish waste or limiting fish waste can help improve clean growth. For example, chitin can be manufactured from crustacean shells. Fish waste can be used as an input to fish feed, pet and animal food; or to produce fish oils and nutraceuticals (e.g., DSM Nutritional Products).

Canada is a leader in having Marine Stewardship Council (MSC) certification, which include the Maritime lobster industry attaining a MSC certification in 2014/2015, Clearwater Seafoods Inc. being 100% MSC certified and Ocean Choice International having over 90% of their fisheries MSC certified. However, having MSC certification does not guarantee fish stocks will remain at high levels – as evidenced by recent reductions in northern shrimp quotas, a MSC-certified fishery. In some circumstances, a MSC certification can be suspended. For example, the southern Gulf crab fishery had its MSC certification suspended due to right whale deaths in 2017 linked to crab fishing methods. It was determined this fishery no longer met the MSC standard for endangered, threatened and protected species.[204] The crab fishery will pilot-test using rope-less traps to see if that reduces right whale entanglement, while still providing optimal catch rates of crab. In addition, DFO recently announced the 2018 crab fishery will open and close earlier, along with a number of other measures, to protect right whales.

The Sustainable Fisheries Partnership is a non-government organization that has a mission to rebuild depleted fish stocks and reduce the environmental impacts of fishing and fish farming. The Partnership has a target to make 75% of global seafood (based on volume) sustainable by 2020; and includes industry partners across the fisheries and aquaculture supply chain (i.e., High Liner Foods, Sobeys and Walmart Canada).
More emphasis should be placed on private, third-party certifications to promote clean growth. These certifications, including eco-labelling, provide a market-based approach to growing global trade and result in improved fisheries management and higher consumer demand for sustainable fish products. Industry subsidization can have a negative impact on sustainability, often resulting in overfishing and depleted fish stocks.[205] Given certification and recertification have on-going costs, including

[203] Nordon (2014). *Reducing Climate Impact from Fisheries: A Study of Fisheries Management and Fuel Tax Concessions in the Nordic Countries*. Denmark: Nordic Council of Ministers.
[204] Marine Stewardship Council (2018, March 20). MSC certificate suspended for Southern Gulf of St. Lawrence snow crab fishery. [News release].
[205] United Nations Environment Programme (2009). *Certification and Sustainable Fisheries*. Accessed at https://unep.ch/etb/publications/FS%20certification%20study%202009/UNEP%20Certification.pdf

application fees, audits, logo usage fees and associated packaging costs, government supports could offset some of these costs for small and medium-sized fishing enterprises.

Climate change's impact on the fishery is complex and broad, potentially influencing fish migration and breeding patterns, fish health and stocks. However, it can also influence ice conditions in the winter and storm activity year-round. In June 2017, the federal government allocated $5 million to the Ice Assistance Emergency Program for Newfoundland and Labrador fishers impacted by ice conditions whose employment insurance was depleted. Since climate change will have a negative impact on coastal communities (e.g., rising sea levels, more intense storms), clean growth policy choices should not magnify the negative impact on these communities. As part of the federal Oceans Protection Plan, the federal government is investing $75 million in the Coastal Restoration Fund.

5.6 Forest Industry

The forest industry, including logging, lumber and other wood products as well as pulp and paper, is an important part of the Atlantic economy, contributing 10% of Atlantic Canada's merchandise exports. Regionally it accounts for 2% of employment with New Brunswick being most reliant on forestry at 4% of total employment. There are currently ten pulp and paper mills in Atlantic Canada: seven in New Brunswick, two in Nova Scotia, and one in Newfoundland and Labrador.

Table 5.8: Economic Impact of Atlantic Canada's Forestry Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ billion)	0.1	0.0	0.4	1.1	1.6	13	2
Production value ($ billion)	n.a.	n.a.	n.a.	n.a.	4.5	-16	14
Exports ($ billion)	01	0.0	0.6	1.7	2.5	3	10
Employment (000s)	1.7	0.5	5.5	13	21	-12	2

Note: All data for 2016 except production value which is 2015. Change is 2012-2015 for production value. Exports are international exports.
Source: Statistics Canada, Natural Resouces Canada, Trade Data Online

Recent Trends and Outlook

Demand for newsprint and other paper products have been declining since at least the early 2000s, in part due to the increased use of digital media. Competitive pressures, including the factors such as a higher exchange rate, high energy costs and increased competition also contributed to the closure of several Atlantic pulp and paper mills starting in 2005. Trade disputes with the US, including both supercalendered paper and softwood lumber, have also created a challenge for regional producers.

As a result, employment in the Atlantic forestry industry has decreased from a peak of 36,300 in 2004 to 21,000 in 2017, with the largest declines in Nova Scotia and New Brunswick. In 2001, 73 communities in Atlantic Canada relied on the forest sector for 20% or more of their wages, while in 2016 that number had dropped to 12 and these were only in New Brunswick.[206] The industry has seen growth in GDP and exports since 2011, aided by higher commodity prices.

According to McKinsey & Company, the global paper and forest-products industry is growing with demand for tissue papers and pulp for hygiene products helping to fill the gap left by shrinking demand for newsprint, coated and uncoated papers.[207] However, demand growth is faster in Asia, Latin America and Eastern Europe. In addition, there is a "broad search for new applications and uses for wood and its components."[208]

Environmental Impact

The key environmental issues in the forestry industry are GHG emissions, sustainable harvesting, and the treatment of wastewater and solid waste. [209]

Pulp and paper mills are the main source of GHG emissions in the forestry industry. Carbon dioxide is by far the main GHG emitted and the leading source of global warming. Sulphur dioxide is another air pollutant that can have negative effects on air quality and can damage vegetation. Nitrogen oxides are also emitted which contributes to acid rain and damage to the ecosystems surrounding pulp and paper mills.[210]

GHG emissions of the Atlantic forest sector fell dramatically from 2.1 Mt CO_2e in 1990 to 0.7 Mt CO_2e in 2010, with a similar decline in the industry's share of total Atlantic emissions. This decline is due in part to a decrease in the number of Atlantic pulp and paper mills. The closure of the UPM Miramichi mill alone accounts for 13% of the drop in forest sector emissions. Energy efficiency also helped thanks in part to the Pulp and Paper Green Transformation Program that provided $1 billion between 2009 and 2012 to improve the environmental performance of pulp and paper mills across Canada. It helped plants increase their renewable electricity capacity and save enough to heat 135,000 homes on an ongoing basis. [211]

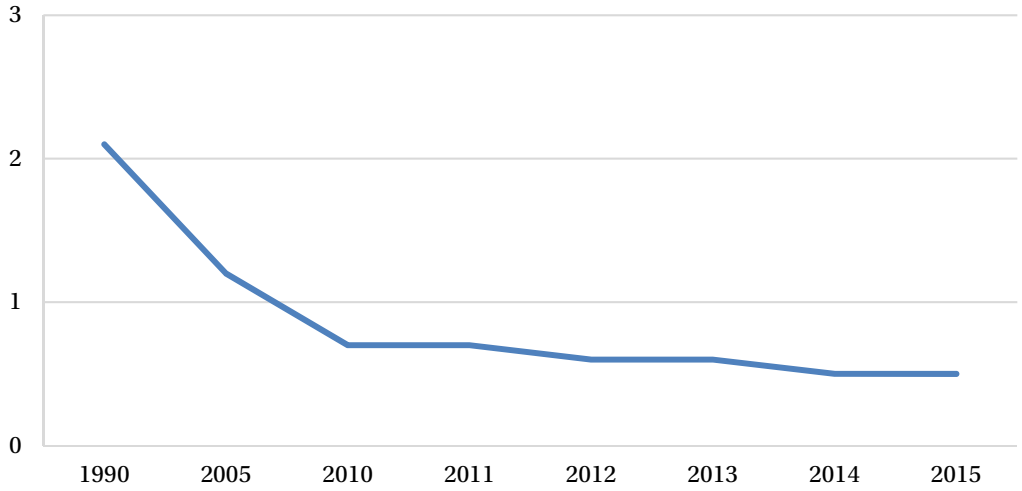
[206] Statistics Canada (2018). Human Activity and the Environment: Forests in Canada. *The Daily*, March 14.
[207] Berg, Peter and Oskar Lingqvist (2017). *Pulp, paper, and packaging in the next decade: Transformational change.* McKinsey & Company.
[208] Berg, Peter and Oskar Lingqvist (2017), p. 2
[209] Gavrilescu, Dan, Adrian Puitel, Gheorghe Dutuc, and Grigore Craciun (2012). Environmental impact of pulp and paper mills. *Environmental Engineering and Management Journal*, vol. 11, no. 1, pp. 81-86.
[210] Environment and Climate Change Canada (2017). *Canadian Environmental Sustainability Indicators. Air Pollutant emissions.* Accessed at https://www.canada.ca/content/dam/eccc/migration/main/indicateurs-indicators/402a9845-2efe-4f98-8427-bebf5c02a664/air_pollutant_en.pdf
[211] Natural Resources Canada (2012). *Pulp and Paper Green Transformation Program. Report on Results*. Accessed at http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/34045.pdf

In 2015 five Atlantic pulp and paper operations were in the top 30 GHG emitters in Atlantic Canada. The four largest forest industry emitters in New Brunswick accounted for 5.2% of the province's GHGs in 2015.

However, work examining the lifecycle of forestry products in J.D. Irving, which has operations in New Brunswick, Nova Scotia and Maine, have shown that the company's forests and forest products currently absorb more carbon than they emit and are projected to remain this way over the next 40 years.[212]

Figure 5.5 Atlantic Canada Forestry GHG Emissions Have Reduced Dramtically

Forest industry emissions, Atlantic Canada (Mt CO_2e)



Source: Environment and Climate Change Canada

Table 5.9 Top GHG Emitters, Pulp and Paper, Atlantic Canada, 2015

Rank	Company and project	Prov	GHG emissions, 2010 (Mt CO_2e)	GHG emissions, 2015 (Mt CO_2e)	Share of prov. emissions, 2015 (%)
20	Irving Pulp & Paper	NB	0.08	0.12	0.8
21	AV Nackawic	NB	0.13	0.11	0.8
22	Irving Paper	NB	0.11	0.10	0.7
25	Northern Pulp Nova Scotia Corporation	NS	0.06	0.07	0.4
28	Twin Rivers Paper Company Inc (Edmundston Pulp Mill)	NB	0.03	0.06	0.4

Note: Project level data is from facility-reported database while the provincial totals used are from the National Inventory Report. Source: Environment and Climate Change Canada

[212] Cameron, Ryan, Chris Hennigar, David MacLean, Greg Adams, and Thom Erdle (2013). A comprehensive Greenhouse Gas Balance for a Forest Company Operation in Northeast North America. *Journal of Forestry*, vol. 111, no. 3, pp. 194–205.

Overharvesting and deforestation have long-term impacts including soil erosion, reduced biodiversity, decreasing the amount of carbon absorbed naturally, and can affect how water is stored, increasing the risk of flooding.[213] However, deforestation only occurs when the trees are permanently removed. This important issue needs to be constantly monitored, but Canada has some of the lowest rates of deforestation in the world at 0.02%.[214]

Clearcutting is the most popular method of harvesting forests in Canada as it accounted for 85% of timber harvesting in 2015. Each province calculates its annual allowable cuts (AAC) which is the amount each province can harvest at a sustainable level. In 2015, Nova Scotia (45%), Newfoundland and Labrador (48%) and Prince Edward Island (81%) were all harvesting at sustainable levels; only New Brunswick exceeded its AAC with harvesting 103% of its AAC.[215]

Wastewater is also a major issue for pulp and paper mills, particularly with the potential impacts on the fishing industry. Water released from the mills have high amounts of suspended solids and potential chemical contamination. Solid waste, including bark, sawdust and wood fragments, are other issues that needs to be properly managed.[216]

Regulatory Environment

Private lands account for 51% of the forests in the three Maritime provinces while in Newfoundland and Labrador 94% of forested lands are publicly owned. Each province has control over the regulations on top of the requirements of relevant federal legislation, such as the Species at Risk Act, and international agreements, which include the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

In New Brunswick, forest operations on crown lands must follow the New Brunswick Crown Lands and Forest Act and the provincial Forest Fires Act. Those who harvest on crown lands must have a timber license. Private woodlot owners must follow the Clean Water Act but are free to manage their forests otherwise. Companies who own private forested land must conform to the Clean Water Act and have their forests certified by a third-party sustainable forestry management program.[217]

[213] Natural Resources Canada (2015a). *Educational Resources: Forestry*. Accessed at http://www.nrcan.gc.ca/node/9321
[214] Natural Resources Canada (2017a). *Deforestation in Canada: Key myths and facts*. Accessed at http://www.nrcan.gc.ca/forests/fire-insects-disturbances/deforestation/13419
[215] See National Forestry Database.
[216] Gavrilescu et al. (2012).
[217] Sustainable Forest Management in Canada (2017a). *Province of New Brunswick Fact Sheet*. Accessed at https://www.sfmcanada.org/images/Publications/EN/New_Brunswick_info_Provinces_and_territories_EN.pdf

Nova Scotia requires that all lands follow the provincial Forests Act, the Nova Scotia Wildlife Habitat and Watercourses Protection Regulations, and the federal Endangered Species Act. Timber harvesting on crown land must also follow the Crown Lands Act while private projects must receive Department of Natural Resources approval and buyers who acquire more than 5,000 cubic meters per year must provide silviculture treatments. Northern Pulp's operation is regulated under separate legislation, the Scott Maritimes Pulp Limited Agreement (1965) Act.[218]

Most of Prince Edward Island's forests are privately owned with the management and harvesting decisions left with the owners. Public forest lands on the island are regulated by the provincial Forest Management Act and forest products from these lands are sold by an open bidding process.[219]

Newfoundland and Labrador's Department of Natural Resources issues licences for its forestry operations and those who use public lands must follow the Newfoundland and Labrador Forestry Act. Private landowners must follow civic and commercial laws.[220]

Options for Cleaner Growth

A continuation of investment in reforestation practices and a focus on sustainability will help the industry going forward. The industry already has some of the lowest GHG emissions of any industry but pulp and paper plants in particular must continue to focus on energy efficiency. Irving Pulp and Paper already uses or recycles 98% of its solid waste and 90% of the mill runs on renewable energy sources. A recent investment at the Irving Pulp Mill reduced nitrogen oxide emissions by 8%.[221] The forestry industry must remain competitive abroad while maintaining sustainability. This is an important consideration for provincial carbon pricing systems (see Chapter 6).

Northern Pulp's Boat Harbour wastewater treatment plant is due to be replaced by January 2020 due to a leak of untreated effluent. The clean-up process is expected to cost around $130 million, up from an estimated liability of $12 million in 2013.[222] The current plan for the new effluent treatment facility currently has the treated effluent being sent directly into the Northumberland Strait.[223]

---

[218] Sustainable Forest Management in Canada (2017b). *Province of Nova Scotia Fact Sheet*. Accessed at https://www.sfmcanada.org/images/Publications/EN/Nova_Scotia_info_Provinces_and_territories_EN.pdf
[219] Sustainable Forest Management in Canada (2017c). *Province of Prince Edward Island Fact Sheet*. Accessed at https://www.sfmcanada.org/images/Publications/EN/PEI_info_Provinces_and_territories_EN.pdf
[220] Sustainable Forest Management in Canada (2017d). *Province of Newfoundland and Labrador Fact Sheet*. Accessed at https://www.sfmcanada.org/images/Publications/EN/NL_info_Provinces_and_territories_EN.pdf
[221] Irving Pulp and Paper (2016). *Celebrating the Completion of Phase 2 Mill Modernization Project*. Accessed at https://www.jdirving.com/uploadedFiles/Products_and_Services/Forestry_and_Forest_Products/Irving_Pulp_and_Paper/IrvingPulpPaper.pdf
[222] Office of the Auditor General Nova Scotia (2017). *Chapter 1: Account for Contaminated Sites.* Report of the Auditor General to the Nova Scotia House of Assembly.
[223] Northern Pulp (2018). *Recommended Approach: Replacement Effluent Treatment Facility Design*. Accessed at https://sites.google.com/dillon.ca/northernpulpetf/effluent-treatment-facility

5.7 Oil Refining

Atlantic Canada currently has two oil refineries producing products for local and export markets. The largest refinery is the Irving Oil-owned facility in Saint John which has a capacity of 320,000 barrels and opened in 1960. The Irving refinery is the largest in Canada. The North Atlantic Refinery in Come-by-Chance, Newfoundland and Labrador began operations in 1973, producing 130,000 barrels per day and is currently owned by Silverpeak Strategic Partners of the US. The two refineries account for about 23% of the refinery capacity in Canada.

The refineries produce gasoline, diesel, heating oil, kerosene, jet fuel, bunker fuel and asphalt products. They import crude oil from various sources including the Middle East, the North Sea, Africa and South America. The Irving refinery also imports crude oil by rail from the western US. Crude imports from the US peaked at $4 billion in 2014 but have dropped to $710 million in 2016 due to both lower prices and shipments. Canadian crude production is also a source for the region's refineries, mainly from the Newfoundland offshore. The strong reliance on international crude is an issue for the sector due to geopolitical concerns and declining reserves in friendlier markets like the UK and Norway. The recently cancelled Energy East pipeline would have diversified the import portfolio, but no other project is currently proposed to improve the flow of oil from western Canada.

While there are only two operating facilities, the oil refining sector is important to the region's economy, accounting for 27% of exports. This is especially true in New Brunswick where it accounts for 2.6% of GDP and 52% of exports. Exports from the Irving refinery totalled $5.2 billion in 2016 with nearly all of that total going to US markets. The North Atlantic refinery exported $1.3 billion in 2016 with the US the dominant market. Due to the capital-intensive nature of the industry, oil refining accounts for only 0.2% of the region's employment.

Table 5.10: Economic Impact of Atlantic Canada's Refined Petroleum Industry, 2016

	NL	PE	NS	NB	Atlantic	Change, 2011-2016 (%) Atlantic	Share of economy (%) Atlantic
Real GDP ($ million)	276	0.0	0.0	707	983	-23	1.1
Exports ($ billion)	1.3	0.0	0.0	5.6	6.9	-45	26.8
Employment (000s)	0.4	0.0	0.1	1.6	2.1	-5	0.2

Note: All data for 2016, unless noted. Exports are international exports.
Source: Statistics Canada, Trade Data Online

Recent Trends and Outlook

Imperial Oil operated a refinery in Dartmouth, Nova Scotia until 2013. That facility has been converted into a storage terminal for refined oil products that are largely distributed in regional markets. The closure of the Imperial Oil refinery, and the decline in oil prices globally, has had a significant impact on the size and impact of the refinery sector in Atlantic Canada. Exports have fallen by 45% between 2011 and 2016 and real GDP has fallen by 23% over the same period.

Both the Saint John and Come-by-Chance refineries planned expansions over the last decade but both were shelved during the 2008 recession. Older and smaller refineries, like the Imperial Oil refinery in Dartmouth and a slightly larger facility near Montreal, were shut down due to the significant upgrades needed to compete in the global market. Newer refineries built in China, Saudi Arabia, South Korea and the US are producing well over 500,000 barrels per day.

Environmental Impact

The oil refining industry has several environmental impacts including GHG and other emissions, soil pollution, power and water usage and the risks associated with transport crude petroleum products. The Irving Oil refinery has the highest level of GHG emissions in the Atlantic region and the North Atlantic refinery is the 8th largest emitter.

GHG emissions from Atlantic refineries have decreased by 20% since 2005. While some of this reduction is due to the closure of the Imperial Oil refinery in Nova Scotia in 2013, sulphur levels in gasoline and diesel have also been reduced by 98% since 2000.

Table 5.11 Top GHG Emitters, Oil Refining, Atlantic Canada, 2015

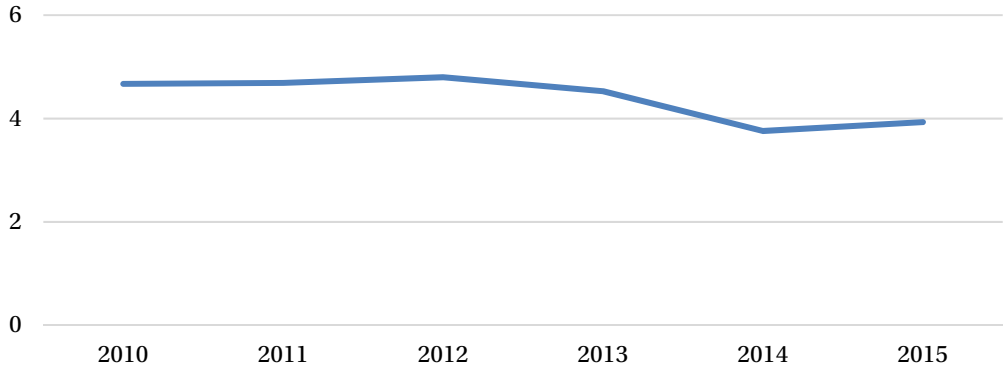
Rank	Company and project	Prov	GHG emissions, 2010 (Mt CO_2e)	GHG emissions, 2015 (Mt CO_2e)	Share of prov. emissions, 2015 (%)
1	Irving Oil Refinery	NB	2.92	2.97	21
8	North Atlantic Refinery	NL	1.02	1.01	10

Note: : Project level data is from facility-reported database while the provincial totals used are from the National Inventory Report.

Source: Environment Canada

Figure 5.6 Oil Refinery GHG Emissions Fell in Atlantic Canada Due to the Closure of the Dartmouth Refinery

Oil refining emissions, Atlantic Canada (Mt CO_2e)



Source: Environment and Climate Change Canada

Regulatory Environment

The federal and provincial government provides guidance and regulation on several environmental areas that impact the refining sector. Refinery upgrades must undergo a federal and provincial environmental impact and assessment.

Options for Cleaner Growth

Carbon pricing plan will be implemented by the Atlantic provinces in 2019. The Canadian Fuels Association believes that carbon pricing should rely on three key principles: preserving industry competitiveness; transparency, so consumers can see the cost of a carbon levy; and a system that is balanced, stable and fair, so different energy sources are treated equitably.[224] The cost competitiveness of the two Atlantic refineries could be eroded as US refineries do not have to pay a price on carbon. Over half of total production from Irving Oil's refinery is exported to the US Northeast. The federal carbon pricing backstop has features to address this concern (see Chapter 6).

A recent study for the Canadian Fuels Association examined the cumulative effect of regulations and policies on Canada's refineries through 2030, including carbon pricing.[225] Two cases were examined which assume a 20% (Case 1) and 40% (Case 2) reduction in petroleum fuel consumption relative to 2005 levels due to climate change initiatives. The reductions in fuel consumption and other regulatory changes are expected to have "a significant negative impact on the Canadian refining industry."

[224] Canadian Fuel Association (2016). *Three principles should guide Canada's carbon pricing.* Accessed at http://www.canadianfuels.ca/Blog/November-2016/Three-principles-should-guide-Canada-s-carbon-pricing/

[225] Tamm, David and Kevin Milburn (2017). *Cumulative Impacts of Climate Change and Other Policy Scenarios Facing the Canadian Downstream Petroleum Sector*. Prepared for the Canadian Fuels Association. Houston: Baker & O'Brien.

In Case 1, 2 of 15 refineries in Canada are shut down, with others operating at reduced capacity; in Case 2, 5 of 15 refineries are shut down, with 8 others negatively affected. There are 8 refineries in Eastern Canada and these are most at risk of shutdown, due to the competitive pressures they face in the Atlantic basin and because of the changes in regional product balances due to reduced consumption. Western refineries operate in more isolated product markets.

In both cases, surviving refineries have to make significant investments to meet fuel and emissions regulations in additional to climate change costs associated with their own GHG emissions. APEC estimates that the capital cost of regulatory compliance for the two Atlantic refineries is $230 to $290 million, assuming they both remain open.

Several investments have been made over the last few years to improve the overall efficiency and environmental performance of the facilities. Irving performs an annual turnaround at its refinery in Saint John of about $60 million but has had larger investments in 2015 ($200 million) and 2016 ($135 million). North Atlantic's capital program at the refinery has averaged about $60 million over the last few years.

Irving Oil has been marketing cleaner fuels ahead of US regulation which has led to recognition by industry peers and Canadian and U.S. governments, including being the first oil company ever to receive the US Environmental Protection Agency Clean Air Excellence Award for low sulphur gasoline. A recent upgrade to environmental performance was accomplished through the installation of a Dehexanizer Unit to reduce the benzene content in gasoline, in order to meet USEPA fuel standards.

Irving Oil has a stated goal of reducing carbon dioxide emissions 17% from 2005 levels by 2020. The company is reducing its carbon footprint through achieving greater energy efficiency and producing less carbon dioxide. There is a carbon capture partnership between the refinery and Praxair, a company that processes carbon dioxide for food-grade use, and recycles it into products like carbonated beverages.

Chapter 6

Policy Priorities for Clean Growth

Chapter Summary

- **Environmental assessments are an important planning and decision-making tool designed to minimize or avoid adverse environmental effects before they occur and to incorporate environmental factors into decision-making. They are used by federal and provincial governments. The federal government is currently in the process of replacing the Canadian Environmental Assessment Act 2012 with the Impact Assessment Act, based upon recommendations of an Expert Panel.**
- **To meet federal requirement, carbon pricing is being introduced in the Atlantic provinces in 2019 although only two provinces had announced their plans, as of March 2018. Addressing equity and competitiveness concerns need to be top priorities for these carbon pricing regimes.**
- **If the Atlantic provinces are going to track their environmental performance beyond the current focus on GHG emissions, investments need to be made in data collection and assessment.**
- **Carbon pricing should increase the incentives to invest in clean technologies, but solutions to help de-risk the adoption of large-scale, new clean technologies should also be considered.**
- **APEC advocates early planning and engagement by project developers, along with greater reliance on science and evidence and political leadership, to help find a better balance between economic growth and the environment in the region.**

This chapter discusses the role that environmental assessments play in achieving clean growth. It then explains how carbon pricing can facilitate clean growth in regard to GHG emissions. It concludes by highlighting some key policy priorities arising from the analysis in this report.

6.1 Environmental Assessments

Development of a new mine or manufacturing plant, exploration and production of onshore or offshore oil and gas, construction and operation of a new electricity generating station, can all have significant effects on the environment. In the language of

economics, these adverse environmental impacts or "externalities" are not priced and therefore are not fully considered in the decision making of the project developer. Putting a pricing on pollution (the polluter pays principle) is one way to address this issue, but it may not always be possible to do so, requiring governments to rely on other policies such as regulation.

> Before the 1970s, little consideration was given to the environmental consequences of large-scale natural resource developments. ... However, as public concerns about environmental matters grew, governments increasingly recognized the need to improve development through appropriate planning.[226]

This eventually led to a federal law in 1992 which was superseded by the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012). All four Atlantic provinces have also legislated environmental protection acts with their accompanying environmental impact assessment processes.

> Canada's constitution does not grant one particular level of government exclusive authority to deal with the environment *per se*. ...
>
> Although the constitution does not assign legislative authority over the environment to either the federal or provincial governments, both levels of government have legislative authority relevant to environmental matters. The environment is a matter of overlapping and concurrent legislative authority. In addition to authority to make laws, both the federal and provincial governments have ownership over a variety of natural resources which confers a measure of control in environmental matters.[227]

This jurisdictional overlap in regulating environmental matters can have important consequences for the cost and efficiency of environmental impact processes. The federal and provincial processes may also lead to different decisions.[228]

An environmental assessment is a planning and decision-making tool. The objectives of an environmental assessment are to minimize or avoid adverse environmental effects before they occur and to incorporate environmental factors into decision making. The International Association for Impact Assessment defines environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major

[226] Pecklumb, Penny and Tim Williams (2012). Canada's New Federal Environmental Process. *Background Paper*, 2012-36-E. Ottawa: Library of Parliament, p. 1.
[227] Heelan Powell, Brenda (2012). *Environmental Assessment & the Canadian Constitution: Substitution and Equivalency*. Edmonton: Environmental Law Centre, pp. 10-11.
[228] Haddock, Mark (2011). *Comparison of the British Columbia and Federal Environmental Assessments for the Prosperity Mine*. Smithers, BC: Northwest Institute for Bioregional Research.

decisions being taken and commitments made."[229] It also outlines objectives and best practices for environment impact assessments.

Many different types of projects require an environmental assessment including most mining, energy and industrial projects but environmental assessments are also required for water management projects, food processing and other manufacturing facilities, transportation projects, and projects in environmental sensitive areas or wetlands.[230]

Normally the design engineer for a project will determine if an environmental assessment is needed, which will depend upon the scope and type of work being proposed and relevant legislation and regulations. In other instances, the federal government can also require an environmental assessment to be in compliance with local or federal laws and regulations.

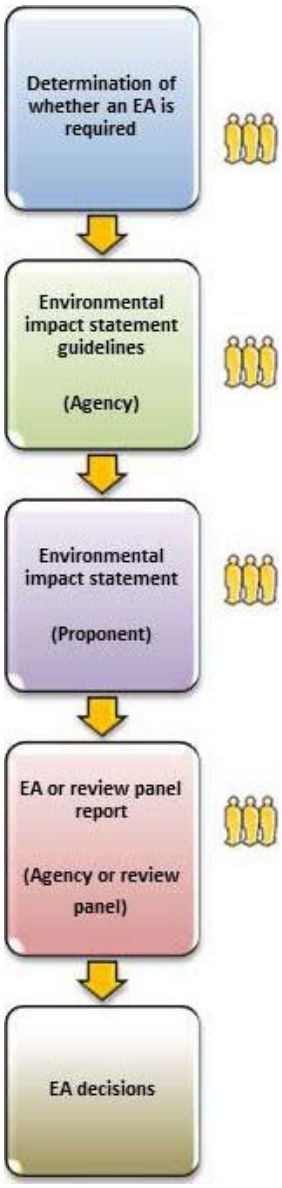
The issues that must be considered during an environmental review process include: purpose of the project; environmental effects and their significance; mitigation measures and alternative means of carrying out the project; socio-economic benefits; changes to the project caused by the environment; public comments and the results of any relevant regional study or any other relevant matter.[231]

There are two types of federal reviews: an environmental assessment by a responsible authority, such as the National Energy Board, and an environmental assessment by a review panel appointed by the Minister of Environment and Climate Change. Both types of assessments can be conducted by the federal government alone or in cooperation with another jurisdiction, such as a province.

Upon acceptance of a complete project description, the designated agency has 45 calendar days to determine whether a federal environmental assessment is required. An environmental assessment conducted by the agency must be completed within 365 days and a review by a panel must be done within 2 years. The key steps in the process are shown in Figure 6.1.

[229] International Association for Impact Assessment (1999). *Principles of Environmental Impact Assessment Best Practice.* Fargo, ND: International Association For Impact Assessment.
[230] For a list of activities that may require a federal environmental assessment, see: http://www.gazette.gc.ca/rp-pr/p2/2012/2012-07-18/html/sor-dors147-eng.html.
[231] Canadian Environmental Assessment Agency

Figure 6.1 Key Milestones in the Current Federal Environmental Assessment (EA) Process



Source: Canadian Environmental Assessment Agency

Review of the CEAA 2012

In 2016 the federal government established a four-person expert panel to review the CEAA 2012. After consultation, the review panel came to the conclusion that:

> we need to improve the way we plan for development in our country.
>
> … assessment processes must move beyond the bio-physical environment to encompass all impacts likely to result from a project, both positive and negative.

> Therefore, what is now "environmental assessment" should become "impact assessment" (IA). …
>
> IA processes must be transparent, inclusive, informed, and meaningful.[232]

The proposed new Impact Assessment (IA):

> aims to identify and address potential issues and concerns early in the design of projects, plans and policies. In so doing, it can contribute to the creation of positive relationships among various interest groups, including reconciliation between Indigenous Peoples and non-Indigenous peoples. IA also aims to contribute to the protection of the bio-physical environment and the long-term well-being of Canadians by gathering proper information to inform decision-making. At a project scale, IA should improve project design and ensure appropriate mitigation measures and monitoring programs are implemented. In sum, IA processes should give Canadians confidence that projects, plans and policies have been adequately assessed.[233]

This new IA will shift away from decisions based largely on the significance of effects on the environment and focus instead on whether the adverse effects in areas of federal jurisdiction are in the broader public interest including addressing impacts on Indigenous and other stakeholders.

The proposed IA "creates challenges for Canada's system of government … with no government having full authority to regulate all impacts." However, the Expert Panel emphasized that the principle of "one project, one assessment" is central to implementing IA. It recommends that "co-operation be the primary mechanism for co-ordination where multiple IA processes apply" and that substitution of one IA process for another be available only if the highest standard of IA applies.[234]

The Expert Panel also recommended that Indigenous Peoples be included in the decision-making at all stages of an IA, that Indigenous knowledge be integrated into all phases of an IA, and that steps be taking to ensure meaningful engagement. The Panel also recognized that:

> there are broader discussions that need to occur between the Government of Canada and Indigenous Peoples with respect to nation-to-nation relationships, overlapping and unresolved claims to Aboriginal rights and title, reconciliation, treaty implementation and the broader implementation of [the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)] [235]

[232] Expert Panel Review of Environmental Impact Assessment Processes (2017). *Building Common Ground: A New Vision for Impact Assessment in Canada*. Ottawa: Canadian Environmental Assessment Agency, p. 2
[233] Expert Panel Review of Environmental Impact Assessment Processes (2017), p. 2.
[234] Expert Panel Review of Environmental Impact Assessment Processes (2017), p. 3.
[235] Expert Panel Review of Environmental Impact Assessment Processes (2017), p. 3.

The Panel indicated that "many of these discussions will be necessary prerequisites to the full and effective implementation of" its recommendations.[236]

On February 8, 2018, Bill C-69 was introduced for first reading, which includes the draft Impact Assessment Act (IAA) to replace the Canadian Environmental Assessment Act, 2012.[237] The new IAA is expected to streamline certain aspects of the process but will also have a greater scope to include not only environmental aspects within federal jurisdiction, but also health, social and economic issues.

The IAA will give more responsibility to the Offshore Petroleum Boards in Nova Scotia and Newfoundland and Labrador, but not as much as was being considered during the review process. The IAA mandates the inclusion of Offshore Board expertise on impact assessment review panels where in the past they were not included. There was discussion of having the Offshore Boards lead the review process but the new IAA will see the ultimate lead be the new Impact Assessment Agency. Under the old system the Minister had the discretion to allow a more streamlined approach to permit offshore oil and gas projects rather than the lengthier review panel process. The Offshore Board currently make decisions on small projects that are not on the designated project list. That is expected to continue but the types of projects that will be on that list is under review. The offshore oil and gas industry would like to keep activities like exploration off the project list.

According to the Mining Association of Canada, the Canadian Environmental Assessment Act of 2012 has led to a deterioration in federal and provincial coordination which has created duplication, delays and uncertainty. The proposed Impact Assessment Act is expected to reduce some of the duplication between federal and provincial environmental assessments. However, there are concerns from the mining industry relating to timelines and costs that could negatively impact the sector depending on how they are implemented.

APEC's research on Atlantic Canada's regulatory environment emphasized that Atlantic Canada's firms want clarity, consistency, certainty and that costs of compliance are minimized for businesses, and hence their consumers and clients.[238] These principles apply to both environmental and non-environmental regulations and it is important to ensure that the new IA and existing provincial environmental assessment processes are consistent with them.

[236] Expert Panel (2017), p. 3.
[237] For a comparison of the old and proposed environmental impact assessments systems see https://www.canada.ca/en/services/environment/conservation/assessments/environmental-reviews/environmental-assessment-processes/current-new-system.html.
[238] Chaundy, David (2016). *Trade Barriers in Atlantic Canada: Opportunities for Regulatory Reform*. Halifax: APEC.

It is also appears that economic development in Atlantic Canada has become more challenging. Whether it's a new mine, aquaculture site, wind farm, tidal or hydroelectricity project; fracking to allow exploration and potential onshore oil and gas development; or the clean-up of existing sites, there seems to be a more fractured debate with the result that while the environment may be protected, it often seems to be at the expense of any economic development.

APEC therefore encourages project proponents, whether required under the new IA or not, to take seriously the Expert Panel's recommendation for early planning and engagement, to identify and discuss issues early, leading to better project design. Similarly, there is a need for discussions and decisions to be based on science and relevant evidence and data. Hopefully, with stronger leadership in these two areas on the part of project proponents and governments and regulators, there will be a higher likelihood of regulatory approval and community support or acceptance, facilitating both economic development while mitigating or managing risks to the environment.

6.2 Carbon Pricing

Carbon pricing can be a useful tool to "reduce GHG emissions at a lower economic cost than regulatory approaches" because it relies on the market to incent firms to identify and adopt the lowest cost ways to reduce emissions.[239]

Carbon pricing can be implemented through a cap-and-trade system or a carbon tax or levy. While the design of either system is important, the main difference is that a cap-and-trade provides certainty on the quantity of emissions, but not the price; a carbon tax provides certainty on the price, but not the amount of emissions reductions, although the tax can be increased over time to achieve a desired emissions target. In both systems, consumers and other businesses will experience an increase in gasoline and other fuel prices.

The Atlantic provinces are required to have a carbon price system in place, equivalent to a $20/tonne carbon price in 2019, or the federal government will impose its carbon pricing backstop. As of March 2018, only Nova Scotia and New Brunswick had announced their plans.[240] Any revenues received by the federal government will be returned to the province in which they arose.

[239] Ragan, Chris (2017), p. 2.
[240] Prince Edward Island announced their plans in May 2018. Government of Prince Edward Island (2018). *Climate Change Action Plan 2018-2023*. Accessed at https://www.princeedwardisland.ca/en/information/communities-land-and-environment/climate-change-action-plan-2018-2023

The Atlantic governments are encouraged to be transparent in the choices they use to recycle any revenues from carbon pricing.[241] Addressing equity concerns should be paramount as a carbon price will probably be regressive, accounting for a larger portion of spending of low-income households.[242] However, research suggest that this can be addressed with a relatively small portion of any carbon tax revenues.[243] There is also evidence that British Columbia's carbon tax was progressive even without revenue recycling.[244]

Provincial governments have a number of choices for any remaining revenues.[245] APEC recommends that priority be given to addressing fiscal competitiveness concerns, i.e., reducing other taxes to encourage economic growth. Any investments in infrastructure or other incentives to facilitate a transition to cleaner growth should be made cautiously, and with strong evidence on the benefits of such investments.

A key concern for any carbon price regime is the competitiveness impact on a large emitter that is heavily reliant on export markets, and facing competitors who are not subject to a carbon price. This is particularly relevant in Atlantic Canada. As explained in Chapters 2 and 5, the region has seen emissions reductions due to the closure of mines and manufacturing mills, which reflects in large part the consequence of competitive pressures,[246] with some electricity generating stations being closed due to the resulting decline in demand. There are ways to address this, through output-based pricing, which provides cash value to the firm,[247] while still charging a marginal price on GHG emissions.[248] The federal carbon pricing backstop, for example, includes this feature to address this concern.[249] Governments should monitor this feature carefully to ensure carbon pricing does not have any unintended adverse effects on the region's economy, including managing any risk of countervailing duties to counter perceived business subsidies. [250]

[241] Ragan, Chris (2017), p. 4.
[242] Ragan, Chris (2017), p. 5.
[243] Beugin, Dale, Richard Lipsey, Christopher Ragan, France St-Hilaire, and Vincent Thivierge (2016). *Provincial Carbon Pricing And Household Fairness*. Montreal: Canada's Ecofiscal Commission.
[244] Beck, Marisa, Nicholas Rivers, Randall Wigle, and Hidemichi Yonezawa (2015). Carbon Tax and Revenue Recycling: Impacts on Households in British Columbia. *Resource and Energy Economics*, vol. 49, pp. 40-69.
[245] Canada's Ecofiscal Commission (2016). *Choose Wisely: Options and Trade-offs in Recycling Carbon Pricing Revenues.* Montreal: Canada's Ecofiscal Commission.
[246] APEC (2007). *Competing in the Global Economy: Atlantic Canada's Recent Export Performance and Trade Policy Issues*. Halifax: APEC.
[247] In the federal carbon pricing backstop, a firm can receive a credit for emissions below the set threshold, which has a cash value as it is tradeable.
[248] Ragan, Chris (2017), p. 5 and Beugin, Dale (2018). *Carbon Pricing and Competitiveness in the Atlantic Provinces*. Presentation for APEC-Ecofiscal Commission webinar, March 27. https://www.apec-econ.ca/events/view/?event.id=125&site.page.id=60001.
[249] Moffet, John (2018). Pan-Canadian approach to pricing carbon pollution. Remarks as part of APEC-Ecofiscal Commission webinar, March 27. https://www.apec-econ.ca/events/view/?event.id=125&site.page.id=60001.
[250] Ragan, Chris (2017), p. 4.

There is value in the four provinces cooperating and adopting a common regime for carbon pricing. With few large emitters in each province, a pooled market for cap and trade would provide greater opportunities to trade permits, hence lowering the cost for firms and ultimately, regional consumers.[251] Similarly, common carbon levies and regulatory regimes would simplify the business environment for firms that operate in multiple provinces, rather than adding another dimension to differences in provincial regulations among the Atlantic provinces;[252] such multi-province firms account for 43% of business sector employment in Atlantic Canada.[253] The federal government has also indicated its support for a regional approach to carbon pricing among the four Atlantic provinces.[254]

It should also be emphasized that carbon pricing is a long-term strategy for combatting climate change: "We are not talking about a policy for the next one to three years; we are talking about designing policy for the next 40 years or so."[255] Our cities, including homes and places of work, and economies have been built on the availability of fossil fuels. It will take time for new technologies to be developed and for them to become cost effective alternatives. Given Atlantic Canada's small market, these technologies will not be developed just for this region. This means the ability of firms and households in Atlantic Canada to have new technologies to choose from, whether low carbon products or processes, is going to depend upon the climate change policies adopted in much larger jurisdictions. Moving too fast on carbon pricing, relative to competitors or the availability of new low-carbon technologies, could have serious economic consequences. Yet going too slow could also have serious economic consequences as a result of climate change.[256]

6.3 Policy Priorities for Clean Growth

There is no single metric to measure environmental performance, unlike economic performance where GDP (or related concepts) is widely used as such an aggregate, though not perfect, indicator. Moreover, aside from GHG emissions, there are limited provincial data currently available to track key indicators of pollution or the sustainable use of resources, as noted in Chapter 2. Investments need to be made to develop and assess environmental indicators at the provincial level if the Atlantic provinces are going to assess their progress towards clean economic growth.

[251] Ragan, Chris (2017, p. 2) and comments by other panelists in the same report (p.1).
[252] Chaundy, David (2016), p. 46.
[253] Chaundy, David (2016), p. 11.
[254] Moffet, John (2018).
[255] Ragan, Chris (2017), p. 3.
[256] The Pan-Canadian Framework states that "The cost of inaction is greater than the cost of action: climate change could cost Canada $21-$43 billion per year by 2050, according to 2011 estimates from the National Round Table on the Environment and the Economy." Canadian Council of Ministers of the Environment (2016), pp. 1.

Atlantic Canada has seen progress in terms of lower GHGs, as explained in Chapter 2. This has been achieved in part by lower emissions in the electricity sector as governments required or encouraged greater use of renewable energy, particularly wind, as explained in Chapter 3. However, emissions have also fallen because of economic decline and the closure of mines and manufacturing plants, as shown in Chapters 2 and 5. Similarly, GHGs from transportation seem to have decreased with trends in freight and passenger traffic, as shown in Chapter 4. Proposed new mines, offshore oil projects and LNG plants will add to economic activity, but also increase provincial GHG emissions.

There are some signs of progress towards cleaner growth including greater use of environmental and energy standards (LEED) in building construction, and greater municipal investments in clean water and wastewater, as discussed in Chapter 4.

However, Atlantic business spending on environmental protection and use of advanced green technologies has declined since 2008, as shown in Chapter 4. This may partly reflect the reduced incentive to make such investments following the large drop in oil prices at that time.

Clean technology adoption is key to the decoupling discussed in Chapter 1 – breaking the link between economic growth and GHG emissions and other environmental impacts, thereby allowing the region to grow while improving environmental performance. The high cost of some clean technology solutions is a key barrier, as discussed in Chapter 4. If sustained, carbon pricing will help to increase the incentives for adoption over time, although the initial price may not be large enough to induce major changes. As emphasized in APEC's companion report on growing Atlantic Canada's clean technology firms, finding innovative ways to help de-risk adoption of clean technologies, would help grow the region's clean technology firms and assist the region's transition to cleaner economic growth. Encouraging further research into environmental innovation can also be of value.

For large industrial operations, there may be a tension between cleaning up production and maintaining the economic benefits of this activity. This seems most evident at this time at the Northern Pulp mill in Nova Scotia. For other existing industries, there may be tensions between federal and provincial jurisdictions in the application of environmental goals and standards; and tensions between existing economic activity and environmental goals. This is apparent in the current proposed implementation of marine protected areas and measures to protect the North Atlantic right whale. In other instances, there may be tensions between industries, such as concerns of the fishing industry around tidal turbines; the tourism industry over placement of wind farms; and the fishing industry over offshore exploration and development. Measuring and clarifying economic and environmental values can help. Where genuine trade-offs exist and technological

solutions are not readily available, dialogue and negotiation is key to finding solutions that can work for parties with diverse interests.

For new economic activity where there are significant potential environmental considerations, a new approach is needed, in the spirit of the Expert Panel discussed in Chapter 6.1. Early planning and engagement by project developers, along with greater reliance on science and evidence, and political leadership to help find a better balance between economic growth and the environment. This will take time and trust will need to be rebuilt. But sharing successes, highlighting role models and developing best practices can help project developers, communities and provinces move towards cleaner economic growth.

References

AEG Resource Development Modelling Committee (2012). *Atlantic Energy Gateway Resource Development Modelling Study*.

AEG Transmission Planning Committee (2012). *Atlantic Energy Gateway Transmission Modeling Study Report.*

Agriculture and Agri-Food Canada (2005). *Issues, management problems and solutions for maintaining a zero tillage system and other beneficial soil management practices*, Section II Atlantic Canada.

Agriculture and Agri-Food Canada (2018, February 13). Canadian Agricultural Partnership: Building a Strong Agriculture and Agri-Food Sector. [New release].

Agriculture and Agri-Food Canada (2018a). *Canadian Agricultural Partnership: Federal activities and programs*. Accessed at http://www.agr.gc.ca/eng/about-us/key-departmental-initiatives/canadian-agricultural-partnership/canadian-agricultural-partnership-federal-activities-and-programs/?id=1511361680577.

Agriculture and Agri-Food Canada (2018b). *Holos software program*. Accessed at http://www.agr.gc.ca/eng/science-and-innovation/results-of-agricultural-research/holos-software-program/?id=1349181297838

Antweiler, Werner and Gulati, Sumeet (2016). *Frugal Cars or Frugal Drivers? How Carbon and Fuel Taxes Influence the Choice and Use of Cars*. Accessed at https://ssrn.com/abstract=2778868

APEC (2007). *Competing in the Global Economy: Atlantic Canada's Recent Export Performance and Trade Policy Issues*. Halifax: APEC.

APEC (2015). Atlantic Canada Economic Outlook 2016: (S)lower for Longer. *Atlantic Report,* Fall. Halifax: APEC.

Aquaculture Stewardship Council (2018). *About the ASC*. Accessed at https://www.asc-aqua.org/about-us/about-the-asc/

Atlantic Canada Opportunities Agency (2017, July 7). Investments in Green Insect Management Help Protect Environment. 2017. [News release].

Atlantic Canada Opportunities Agency (2017, September 20**).** Canadian Farmers to Benefit from Marine-Based Research. [News release].

Atlantic Canada Opportunities Agency (2017, November 15). Positioning Annapolis Valley Food Processing Companies for Greater Export Success. [News release].

Beck, Marisa, Nicholas Rivers, Randall Wigle, and Hidemichi Yonezawa (2015). Carbon Tax and Revenue Recycling: Impacts on Households in British Columbia. *Resource and Energy Economics*, vol. 49, pp. 40-69.

Belzile, Germain and Mark Milke (2017). *Are Electric Vehicle Subsidies Efficient?* Montreal: Montreal Economic Institute.

Berg, Peter and Oskar Lingqvist (2017). *Pulp, paper, and packaging in the next decade: Transformational change.* McKinsey & Company.

Beugin, Dale (2018). *Carbon Pricing and Competitiveness in the Atlantic Provinces*. Presentation for APEC-Ecofiscal Commission webinar, March 27. https://www.apec-econ.ca/events/view/?event.id=125&site.page.id=60001.

Beugin, Dale, Richard Lipsey, Christopher Ragan, France St-Hilaire, and Vincent Thivierge (2016). *Provincial Carbon Pricing And Household Fairness*. Montreal: Canada's Ecofiscal Commission.

California Public Utilities Commission – Energy Division (2014). *Effective Load Carrying Capacity and Qualifying Capacity Calculation Methodology for Wind and Solar Resources.*

Cameron, Ryan, Chris Hennigar, David MacLean, Greg Adams, and Thom Erdle (2013). A comprehensive Greenhouse Gas Balance for a Forest Company Operation in Northeast North America. *Journal of Forestry*, vol. 111, no. 3, pp. 194–205.

Canada's Ecofiscal Commission (2016). *Choose Wisely: Options and Trade-offs in Recycling Carbon Pricing Revenues.* Montreal: Canada's Ecofiscal Commission.

Canada's Ecofiscal Commission (2017). *Can subsidies for electric vehicles "boost the signal" from carbon pricing?* Accessed at https://ecofiscal.ca/2017/06/28/can-subsidies-for-electric-vehicles-boost-the-signal-from-carbon-pricing/

Canada's First Ministers (2016, March 3). Communiqué of Canada's First Ministers. [News Release]. Accessed at http://pm.gc.ca/eng/news/2016/03/03/communique-canadas-first-ministers.

Canadian Infrastructure Report Card (2016). *Informing the Future*. Accessed at http://www.canadainfrastructure.ca/downloads/Canadian_Infrastructure_Report_2016.pdf

Canadian Association of Petroleum Producers (2017a). *The Atlantic Canadian Offshore. Offshore Oil and Natural Gas Life Cycle*. Accessed at http://atlanticcanadaoffshore.ca/offshore-oil-gas-lifecycle/

Canadian Association of Petroleum Producers (2017b). *The Atlantic Canadian Offshore: Regulation*. Accessed at http://atlanticcanadaoffshore.ca/regulation/.

Canadian Council of Fisheries and Aquaculture Ministers (2016). *Aquaculture Development Strategy 2016-2019*. Accessed at http://waves-vagues.dfo-mpo.gc.ca/Library/365376.pdf

Canadian Council of Ministers of the Environment (2016). *Pan-Canadian Framework on Clean Growth and Climate Change*. Ottawa: Government of Canada.

Canadian Fuel Association (2016). *Three principles should guide Canada's carbon pricing*. November 29. Accessed at http://www.canadianfuels.ca/Blog/November-2016/Three-principles-should-guide-Canada-s-carbon-pricing/

Carlson, Richard (2017). *Connecting Canadians through a renewable energy supergrid*. Mowat Centre. Accessed at https://mowatcentre.ca/connecting-canadians-through-a-renewable-energy-supergrid/

Chaundy, David (2015). *Opportunities for Atlantic Manufacturers in the EU*. Halifax: APEC, Chapter 2.

Chaundy, David (2016). *Trade Barriers in Atlantic Canada: Opportunities for Regulatory Reform*. Halifax: APEC.

Chaundy, David and Alex Ripley (2018). *Growing Atlantic Canada's Clean Technology Firms*. Halifax: APEC.

Christophe Béné, Manuel Barange, Rohana Subasinghe, Per Pinstrup-Andersen, Gorka Merino, Gro-Ingunn Hemre, and Meryl Williams (2015). Feeding 9 billion by 2050 – Putting fish back on the menu. *Food Security*, vol. 7, no. 2, April, pp. 261-274.

Clearwater Seafoods (2017). *2016 Annual Report*. Halifax: Clearwater.

Climate Change Nova Scotia. *Nova Scotia's Proposed Cap and Trade Program*. Accessed at https://climatechange.novascotia.ca/proposed-cap-and-trade-program.

CNSOPB (2017). *Scotian Basin Exploration Drilling Project*. Accessed at https://www.cnsopb.ns.ca/offshore-activity/offshore-projects/scotian-basin-exploration-drilling-project

CNLOPB (2018). *Licence Information Tables*. Accessed at http://www.cnlopb.ca/exploration/tables.php

Conference Board of Canada (2017). *Provincial Outlook Long-Term Economic Forecast,* Summer. Ottawa: Conference Board of Canada.

Cooke Seafood (2017). *Cooke Family of Companies Newsletter*. Summer. Accessed at http://www.cookeseafood.com/cms/wp-content/uploads/2017/09/Cooke-Summer-2017-English-LR3.pdf

Corridor Resources Inc (2016, June 3). Corridor Comments of New Brunswick Government's Decision to Continue Hydraulic Fracturing Moratorium. [News Release]. Accessed at https://www.corridor.ca/corridor-comments-on-new-brunswick-governments-decision-to-continue-hydraulic-fracturing-moratorium/

Dachis, Benjamin (2018). Keep Clean Fuel Standard in Low Gear. *Intelligence Memos,* January 18. Toronto: C.D. Howe Institute.

Dalhousie University (2017, April 24). Dal research to help farmers adopt clean technologies and practices receives $1.7M. [New release].

Department of Fisheries and Oceans Canada (2013). *Preparing an Integrated Fisheries Management Plan*. Accessed at http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/guidance-guide/preparing-ifmp-pgip-elaboration-eng.htm#toc-n8

Department of Fisheries and Oceans Canada (2015). *Backgrounder: Aquaculture Activities Regulations and guidance document*. Accessed at http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/aar-raa-bck-eng.htm

Department of Fisheries and Oceans Canada (2018, February 6). Government of Canada introduces new protections for fish and their habitat. [News release].

Department of Fisheries and Oceans Canada (2018a). *Meeting Canada's Marine Conservation Targets.* Accessed at http://www.dfo-mpo.gc.ca/oceans/conservation/plan-eng.html

Department of Fisheries and Oceans Canada (2018b). *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment.* Accessed at http://www.dfo-mpo.gc.ca/oceans/publications/seismic-sismique/index-eng.html

Department of Natural Resources (2012). *Environmental Benefits of Closing the Holyrood Thermal Generating Station.* St. John's: Government of Newfoundland and Labrador.

Dolter, Brett and Nicholas Rivers (2017). *The Cost of Decarbonizing the Canadian Electricity System*. Working paper. Accessed at https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/energy-resources/The_Cost_of_Decarbonizing_the_Canadian_Electricity_System_Manuscript_with_images_Sept_25_2017.pdf

Doucette, Keith (2018). Nova Scotia fracking ban to remain despite gas potential, premier says. *Financial Post,* January 11.

Dunsky Energy Consulting (2017). *Recommendations for the Development of a Climate Change Mitigation Strategy.* Prince Edward Island Department of Communities, Land and Environment.

ECO Canada (2013). *Profile of Canadian Environmental Employment.* Calgary: ECO Canada.

ECO Canada (2016). *Environmental Employment by Province.* Calgary: ECO Canada.

Efficiency One (2016). *2016-2018 Demand-Side Management (DSM) Resource Plan.* Halifax: Efficiency One.

Efficiency One (2018). *Efficiency One 2017 Annual Report.* Accessed at https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170125-en.pdf

Emera (2014, April 23). Emera Demonstrates Benefit of Federal Loan Guarantee for Nova Scotia Electricity Customers. [New release].

Emera. *Annual Reports, 2005 and 2014.* Accessed at http://investors.emera.com/GenPage.aspx?IID=4072693&GKP=205804

Encana Corporation (2017). Expression of Interest (EOI). *Integrated Wellbore Plug and Abandonment (P&A) Equipment and Services*. Access at https://www.encana.com/pdf/communities/canada/atlantic/eoi/dc02.pdf

Energy Information Administration. *Electric Utility Demand Side Management*. Accessed at https://www.eia.gov/electricity/data/eia861/dsm/

Environment and Climate Change Canada (2017). *Canadian Environmental Sustainability Indicators. Air Pollutant emissions.* Accessed at https://www.canada.ca/content/dam/eccc/migration/main/indicateurs-indicators/402a9845-2efe-4f98-8427-bebf5c02a664/air_pollutant_en.pdf

Environment and Climate Change Canada. *Canadian Smog Science Assessment Highlights and Key Messages: Sources of Smog Pollutants*. Accessed at http://www.ec.gc.ca/air/default.asp?lang=En&n=72F82C27-1&offset=7

European Commission (2016). *Summary of the 27 Multiannual National Aquaculture Plans*. Prepared for Directorate-General for Maritime Affairs and Fisheries.

Expert Panel Review of Environmental Impact Assessment Processes (2017). *Building Common Ground: A New Vision for Impact Assessment in Canada*. Ottawa: Canadian Environmental Assessment Agency.

ExxonMobil (2017). *Sable Offshore Energy Project Decommissioning Phase Activities*. Accessed at http://soep.com/wp-content/uploads/2017/11/WP02353_SableOpenHouseDisplays.pdf

Food and Agriculture Organization of the United Nations (2018). *What is Integrated Plant Nutrient Management?* Accessed at http://www.fao.org/agriculture/crops/thematic-sitemap/theme/spi/scpi-home/managing-ecosystems/integrated-plant-nutrient-management/ipnm-what/en/.

Frac Focus (2014). Accessed at http://fracfocus.ca/find_well/NB

Frankel, David and Amy Wagner (2017). *Battery storage: The next disruptive technology in the power sector*. Los Angeles: McKinsey & Company. Accessed at https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/battery-storage-the-next-disruptive-technology-in-the-power-sector

Gardner-Pinfold (2013). *Socio-economic Impact of Aquaculture in Canada*: Prepared for Department of Fisheries and Oceans Canada. Accessed at http://www.dfo-mpo.gc.ca/aquaculture/sector-secteur/socio/aqua-es-2013-eng.pdf

Gavrilescu, Dan, Adrian Puitel, Gheorghe Dutuc, and Grigore Craciun (2012). Environmental impact of pulp and paper mills. *Environmental Engineering and Management Journal*, vol. 11, no. 1, pp. 81-86.

Government of Canada (2015). *Transportation in Canada 2016*. Overview report and Addendum 2016.

Government of Canada (2016). *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada 2016–2019.* Ottawa: Environment and Climate Change Canada.

Government of Canada (2017a). *National Inventory Report 1990-2015*. Ottawa: Environment and Climate Change Canada.

Government of Canada (2017b). *Report of the Standing Senate Committee on Energy, the Environment and Natural Resources: Positioning Canada's Electricity Sector in a Carbon Constrained Future*.

Government of Canada. *Clean Fuel Standard*. Accessed at https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

Government of New Brunswick (2016). *Transitioning to a Low-Carbon Economy: New Brunswick's Climate Change Action Plan*.

Government of New Brunswick (2017, December 14). Climate Change Legislation Introduced. [News Release]. Accessed at http://www2.gnb.ca/content/gnb/en/departments/elg/news/news_release.2017.12.1601.html.

Government of New Brunswick. *Renewable Portfolio Standard.* Accessed at http://www2.gnb.ca/content/gnb/en/departments/erd/energy/content/energy_blueprint/content/renewable_portfolio.html

Government of Newfoundland and Labrador. (2011). *Charting Our Course: Climate Change Action Plan 2011*. Accessed at http://www.exec.gov.nl.ca/exec/ccee/publications/climate_change.pdf

Government of Newfoundland and Labrador (2015). *Memorandum of Understanding between Newfoundland and Labrador and Grieg Newfoundland AS*. Accessed at http://www.fishaq.gov.nl.ca/pdf/mou_grieg.pdf

Government of Newfoundland and Labrador (2016, November 3). Provincial Government Secures Enhanced Federal Loan Guarantee. [News release].

Government of Newfoundland and Labrador (2017, May 19). Minister Coady Supports Public Utilities Board's Approval of Net Metering Program. [News release].

Government of Prince Edward Island (2018). *Climate Change Action Plan 2018-2023*. Accessed at https://www.princeedwardisland.ca/en/information/communities-land-and-environment/climate-change-action-plan-2018-2023

Haddock, Mark (2011). *Comparison of the British Columbia and Federal Environmental Assessments for the Prosperity Mine*. Smithers, BC: Northwest Institute for Bioregional Research.

Hebron Project (2017, November 28). Hebron Project Produces First Oil. [News release]. Accessed at http://www.hebronproject.com/mediacentre/2017/firstoil.aspx

Heelan Powell, Brenda (2012). *Environmental Assessment & the Canadian Constitution: Substitution and Equivalency.* Edmonton: Environmental Law Centre.

Hughes, Larry (2016). *Electric vehicles in Nova Scotia: An examination of availability, affordability, and acceptability issues*. Halifax: Dalhousie University.

Husky Energy (2017). *West White Rose Project*. Accessed at http://wwrp.huskyenergy.com/Project_overview

Hydro Quebec (2016). *Comparison of Electricity Rates in Major North American Cities*, Rates in effect April 1, 2016.

ICF International (2015). *Review of Nova Scotia's Energy Savings Portfolio*. Vancouver: ICF International. Submitted to Nova Scotia Power.

International Association for Impact Assessment (1999). *Principles of Environmental Impact Assessment Best Practice.* Fargo, ND: International Association For Impact Assessment.

International Renewable Energy Agency (2018). *Renewable Power Generation Costs in 2017*. Accessed at http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017

Irvine, Ian (2017). Electric Vehicle Subsidies in the Era of Attribute-Based Regulations. *Canadian Public Policy*, vol., 43, no. 1, March, pp. 50-60.

Irving Pulp and Paper (2016). *Celebrating the Completion of Phase 2 Mill Modernization Project*. Accessed at https://www.jdirving.com/uploadedFiles/Products_and_Services/Forestry_and_Forest_Products/Irving_Pulp_and_Paper/IrvingPulpPaper.pdf

Kelley Blue Book. Accessed at https://www.kbb.com/electric-car/

MARCON (2016). *Business Case for Investing in Electric Vehicle Direct Current Fast Charge Station Infrastructure.* Report prepared for Canadian Council for Ministers of the Environment (CCME). Accessed at https://www.ccme.ca/files/Resources/air/mobile_sources/Final%20DCFC%20Report.pdf

Marine Stewardship Council (2018, March 20). MSC certificate suspended for Southern Gulf of St. Lawrence snow crab fishery. [News release].

Mining Association of Canada (2016, April 13). Mining Industry Supports Carbon Price to Address Climate Change. [News Release]. Accessed at http://mining.ca/news-events/press-releases/mining-industry-supports-carbon-price-address-climate-change

Mining Association of Canada (2016). *Facts and Figures of the Canadian Mining Industry*. Accessed at http://mining.ca/sites/default/files/documents/Facts-and-Figures-2016.pdf

Moffet, John (2018). Pan-Canadian approach to pricing carbon pollution. Remarks as part of APEC-Ecofiscal Commission webinar, March 27. https://www.apec-econ.ca/events/view/?event.id=125&site.page.id=60001.

Nalcor Energy (2017). *Muskrat Falls Project Update*. (Presentation).

National Energy Board (2016). *Canada's Renewable Power Landscape: Energy Market Analysis 2016*.

Natural Resources Canada (2012). *Pulp and Paper Green Transformation Program. Report on Results*. Accessed at http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/34045.pdf

Natural Resources Canada (2015a). *Educational Resources: Forestry*. Accessed at http://www.nrcan.gc.ca/node/9321

Natural Resources Canada (2015b). *Energy Fact Book*. 2015-2016. Ottawa: Natural Resources Canada.

Natural Resources Canada (2017a). *Deforestation in Canada: Key myths and facts*. Accessed at http://www.nrcan.gc.ca/forests/fire-insects-disturbances/deforestation/13419

Natural Resources Canada (2017b). *New Brunswick's Shale and Tight Resources.* Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17698

Natural Resources Canada (2017c). *Nova Scotia's Shale and Tight Resources*. Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17702

Natural Resources Canada (2017d). *Newfoundland and Labrador's Shale and Tight Resources*. Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17700

Natural Resources Canada (2017e). *Prince Edward Island's Shale and Tight Resources.* Accessed at http://www.nrcan.gc.ca/energy/sources/shale-tight-resources/17712

Natural Resources Canada. *The National Building Code of Canada*. Accessed at http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/19845.

NB Power (2017, December 13). NB Power seeks new fuel source for Belledune Generating Station. [News Release]. Accessed at https://www.nbpower.com/en/about-us/news-media-centre/news/2017/nb-power-seeks-new-fuel-source-for-belledune-generating-station/

NB Power. *Annual Reports, 2010/2011, 2014/2015 and 2016/2017.* Accessed at https://www.nbpower.com/en/about-us/accountability-reports/annual-and-quarterly-reports

NB Power. *Electric vehicles: FAQs*. Accessed at https://www.nbpower.com/en/products-services/electric-vehicles/faqs/

NB Power. *Mactaquac Life Achievement Project*. Accessed at https://www.nbpower.com/en/about-us/projects/mactaquac-project.

New Brunswick Department of Energy (2011). *The New Brunswick Energy Blueprint.* Fredericton*:* Government of New Brunswick.

Newfoundland and Labrador Department of Natural Resources (2013, November 4). Minister Provides Position on Hydraulic Fracturing. [News Release]. Accessed at http://www.releases.gov.nl.ca/releases/2013/nr/1104n06.htm

Newfoundland and Labrador Department of Natural Resources (2018). *The Way Forward on Oil and Gas: Advance 2030*. Accessed at http://www.nr.gov.nl.ca/nr/advance30/pdf/Oil_Gas_Sector_FINAL_online.pdf

Newfoundland and Labrador Hydro and Newfoundland Power (2015). *Five-Year Energy Conservation Plan: 2016-2020.*

Nordon (2014). *Reducing Climate Impact from Fisheries: A Study of Fisheries Management and Fuel Tax Concessions in the Nordic Countries*. Denmark: Nordic Council of Ministers.

Northern Pulp (2018). *Recommended Approach: Replacement Effluent Treatment Facility Design*. Accessed at https://sites.google.com/dillon.ca/northernpulpetf/effluent-treatment-facility

Nova Scotia Community College (2018). *Ocean Research*. Accessed at https://www.nscc.ca/about_nscc/applied_research/areas-of-research/oceans-research/index.asp

Nova Scotia Department of Energy (2014, September 30). Amendments Introduced for Moratorium on High-volume Hydraulic Fracturing. [News Release]. Accessed at https://novascotia.ca/news/release/?id=20140930002

Nova Scotia Department of Energy (2015). *COMFIT Review: January to July 2015*. Halifax: Government of Nova Scotia.
Nova Scotia Federation of Agriculture (2017). *Cap and Trade and Agriculture*. Accessed at http://nsfa-fane.ca/2017/03/17/cap-and-trade-and-agriculture/.

Nova Scotia Department of Agriculture and Fisheries (2004). *Environmental Regulations Handbook for Nova Scotia Agriculture*

Nova Scotia Power (2017a). *10 Year System Outlook*. Halifax: Nova Scotia Power. Filed with Nova Scotia and Utility and Review Board on June 30, 2017.

Nova Scotia Power (2017b). *2018 Annual Capital Expenditure Plan*. Halifax: Nova Scotia Power. Filed with Nova Scotia Utility and Review Board on November 22, 2017.

Nova Scotia Power. *Electric vehicles: FAQs*. Accessed at https://www.nspower.ca/en/home/for-my-home/heating-solutions/electric-vehicles/FAQ.aspx

Office of the Auditor General Nova Scotia (2017). *Chapter 1: Account for Contaminated Sites.* Report of the Auditor General to the Nova Scotia House of Assembly.

Office of the Auditor General of Canada (2018). *Perspectives on Climate Change Action in Canada—A Collaborative Report from Auditors General—March 2018.* Accessed at http://www.oag-bvg.gc.ca/internet/English/parl_otp_201803_e_42883.html

Organization for Economic Cooperation and Development - Food and Agriculture Organization of the United Nations (2017). *OECD-FAO Agricultural Outlook 2017-2026*. Paris: OECD.

Organization for Economic Cooperation and Development (2011). *Towards Green Growth: A Summary for Policy Makers*. Paris: OECD.

Organization for Economic Cooperation and Development (2015). *OECD Green Growth in Fisheries and Aquaculture.* OECD Green Growth Studies. Paris: OECD.

Organization for Economic Cooperation and Development (2017). *Green Growth Indicators 2017*. Paris: OECD.

Organization for Economic Cooperation and Development (2018). *Aquaculture Production*. Accessed at https://stats.oecd.org/Index.aspx?DataSetCode=FISH_AQUA#

Pecklumb, Penny and Tim Williams (2012). Canada's New Federal Environmental Process. *Background Paper*, 2012-36-E. Ottawa: Library of Parliament.

Plumptre, Bora, Eli Angen and Dianne Zimmerman (2017). *The State of Freight: Understanding greenhouse gas emissions from goods movement in Canada*. Calgary: The Pembina Foundation.

Porter, Douglas (2017). *The Day After NAFTA: Economic Impact Analysis*. Toronto: BMO Bank of Montreal.

Poschmann, Finn (2016). A 17th Century Solution to a 21st Century Challenge. *From the Desk of Finn Poschmann*, November 23. Halifax: APEC. https://www.apec-econ.ca/publications/view/?do-load=1&publication.id=323&site.page.id=51003

Prince Edward Island Energy Corporation (2017). *Provincial Energy Strategy 2016/2017*.

Prohibition Against Hydraulic Fracturing Regulation - Oil and Natural Gas Act. (O.C. 2015-138)

Ragan, Chris (2017). Pricing Carbon: Advice for the Atlantic Provinces. *Atlantic Report*, Summer. Halifax: APEC, pp. 1-6.

Saillant, Richard and David Campbell (2014). *Shale Gas in New Brunswick: Towards a Better Understanding*. Moncton: Canadian Institute for Research on Public Policy and Public Administration.

Schultz, R., G. Atkinson, D. W. Eaton, Y.J. Gu, and H. Kao (2018). Hydraulic fracturing volume is associated with induced earthquake productivity in the Duvernay play. *Science*, vol. 359 (6373), pp. 304-308.

Science for Environment Policy (2015). *Sustainable Aquaculture. Future Brief 11*. Brief produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol.

SeaChoice (2017). *A Decade of Marine Stewardship Council (MSC) Certification in Canada: Technical Report*. Accessed at http://www.livingoceans.org/sites/default/files/A-Decade-of-MSC-Certification-in-Canada-Technical-Report-SeaChoice-September-2017.pdf

Sheldon, Peter (2007). The weakening role of science in the management of groundfish off the east coast of Canada. *ICES Journal of Marine Science*, vol. 64, pp. 723–729.

Smart Prosperity Institute (2017): Low Carbon Fuel Standards in Canada. *Policy Brief,* p. 8.

Standing Senate Committee on Fisheries and Oceans (2015). *Volume 1 – Aquaculture Industry and Governance in Canada*.

Statistics Canada (2017a). Journey to work: Key results from the 2016 Census, *The Daily*, November 29.

Statistics Canada (2017b). *2016 Census of Agriculture: Leveraging technology and market opportunities in a diverse horticulture industry.*

Statistics Canada (2017c). *Production efficiency and prices drive trends in livestock.*

Statistics Canada (2017d). *Newfoundland and Labrador farms have the highest rate of direct marketing.* Accessed at http://www.statcan.gc.ca/pub/95-640-x/2016001/article/14800-eng.htm.

Statistics Canada (2017e). *Prince Edward Island has the largest potato crop in Canada*. Accessed at http://www.statcan.gc.ca/pub/95-640-x/2016001/article/14801-eng.htm.

Statistics Canada (2018). Human Activity and the Environment: Forests in Canada. *The Daily*, March 14.

Statoil (2017, October 17). World's first floating wind farm has started production. [News Release]. Accessed at https://www.statoil.com/en/news/worlds-first-floating-wind-farm-started-production.html

Statoil (2018). *Offshore licenses in Canada*. Accessed at https://www.statoil.com/no/hvor-vi-er/canada.html

Suncor Energy (2016). *Suncor's Climate Report: Resilience Through Strategy*. Accessed at https://sustainability.suncor.com/2017/pdf/Climate-Report-EN.pdf

Sustainable Forest Management in Canada (2017a). *Province of New Brunswick Fact Sheet.* Accessed at https://www.sfmcanada.org/images/Publications/EN/New_Brunswick_info_Provinces_and_territories_EN.pdf

Sustainable Forest Management in Canada (2017b). *Province of Nova Scotia Fact Sheet.* Accessed at https://www.sfmcanada.org/images/Publications/EN/Nova_Scotia_info_Provinces_and_territories_EN.pdf

Sustainable Forest Management in Canada (2017c). *Province of Prince Edward Island Fact Sheet.* Accessed at https://www.sfmcanada.org/images/Publications/EN/PEI_info_Provinces_and_territories_EN.pdf

Sustainable Forest Management in Canada (2017d). *Province of Newfoundland and Labrador Fact Sheet*. Accessed at https://www.sfmcanada.org/images/Publications/EN/NL_info_Provinces_and_territories_EN.pdf

Synapse Energy Economics (2018). *Nova Scotia Power Inc. Thermal Generation Utilization and Optimization: Economic Analysis of Retention of Fossil-Fueled Thermal Fleet To and Beyond 2030*.

Tamm, David and Kevin Milburn (2017). *Cumulative Impacts of Climate Change and Other Policy Scenarios Facing the Canadian Downstream Petroleum Sector*. Prepared for the Canadian Fuels Association. Houston: Baker & O'Brien.

The Council of Atlantic Premiers (2008). *Atlantic Province's Memorandum of Understanding for the Development of Aquaculture Sector*. Accessed at https://www.cap-cpma.ca/images/CAP/Aquaculture%20MOU%20English.pdf

Tiong, Y K, *et al.* (2015). The Feasibility of Wind and Solar Energy Application for Oil and Gas Offshore Platform. *IOP Conference Series: Materials Science and Engineering*, vol. 78, pp. 012-042.

Transport Canada (2013). *Regulations amending the Vessel Pollution and Dangerous Chemicals Regulations*. Accessed at https://www.tc.gc.ca/eng/mediaroom/infosheets-menu-7681.html.

Trebilcock, Michael (2017). Ontario's Green Energy Experience: Sobering Lessons for Sustainable Climate Change Policies. C.*D. Howe Institute, E-Brief*.

United Nations Environment Programme (2009). *Certification and Sustainable Fisheries.* Accessed at https://unep.ch/etb/publications/FS%20certification%20study%202009/UNEP%20Certification.pdf

United Nations Framework Convention on Climate Change (2016). *Paris Agreement*. Accessed at http://unfccc.int/paris_agreement/items/9485.php

United States Energy Information Administration. *What is the difference between electricity generation capacity and electricity generation?* Accessed at https://www.eia.gov/tools/faqs/faq.php?id=101&t=3

US Green Building Council (2017). *LEED in Motion: Canada, 2017*. Washington DC: US Green Building Council.

Vidic, R.D., S.L. Brantley, J.M. Vandenbossche, D. Yoxtheimer, and J.D. Abad (2013). Impact of Shale Gas Development on Regional Water Quality. *Science,* vol. 340. Accessed at http://science.sciencemag.org/content/340/6134/1235009

White, Patrick (2013). Environmental consequences of poor feed quality and feed management. In M.R. Hasan and M.B. New, eds. On-farm feeding and feed management in aquaculture. *FAO Fisheries and Aquaculture Technical Paper* No. 583. Rome, FAO. p. 553–564.

Williams, Anthony (2016). *Accelerating Canada's Clean Growth Economy: Cleantech Adoption Strategies For a Low Carbon World*. Waterloo: The Centre for Digital Entrepreneurship and Economic Performance (DEEP Centre).

World Green Building Council (2013). *The Business Case for Green Buildings: A Review of the Costs and Benefits for Developers, Investors and Occupants.* Accessed at http://www.worldgbc.org/sites/default/files/Business_Case_For_Green_Building_Report_WEB_2013-04-11-2.pdf