Canada’s Low-carbon Pathway

Where are we?

Canada has taken significant steps to address climate change. Federal, provincial and territorial policies and measures implemented in the last 20-years have contributed to a decoupling of greenhouse gas (GHG) emissions from economic growth with the carbon intensity of GDP declining by about 35 per cent in the 1990 to 2016 period. Actions taken to promote non-emitting electricity generation sources and the phase-out of coal-fired power generation have resulted in Canada having one of the cleanest electricity generating systems in the world with over three quarters of Canada’s electricity supply emitting no GHGs (mostly due to the large hydro-power capacity).

In 2016, Canada adopted a comprehensive plan on climate change, the Pan-Canadian Framework on Clean Growth and Climate Change (PCF). This is the first climate change plan in Canada’s history and includes joint and individual commitments by federal, provincial and territorial governments that have been developed with input from Indigenous Peoples, businesses, civil society, and Canadians. The PCF outlines over fifty joint and individual actions by federal, provincial and territorial governments to reduce carbon pollution, build resilience against climate impacts and generate clean growth and includes putting a price on carbon pollution. The plan sets Canada on a path towards meeting or exceeding its Paris Agreement NDC commitment to reduce GHG emissions by 30 percent below 2005 levels by 2030. Federal, provincial and territorial governments are making strong progress in implementing the Pan-Canadian Framework. Funding has been mobilised, greenhouse gas regulations are being put in place, and new policies and programs are being established and implemented.

In November 2016, Canada submitted its Mid-Century Long-term Low-Greenhouse Gas Development Strategy (MCS) to the United Nations Framework Convention on Climate Change (UNFCCC) making it one of the first countries to articulate such a strategy under the Paris Agreement. The MCS examined various pathways to achieve an illustrative 80% reduction in greenhouse gas (GHG) emissions relative to 2005 levels, consistent with the Paris Agreement’s temperature goal.

Many factors influence the future trends of Canada’s GHG emissions including a unique geographic and demographic structure (e.g., population and household formation), economic growth, energy prices (e.g., world oil price and the price of refined petroleum products, regional natural gas prices, and electricity prices), technological change, and policy decisions. For example, while Canada has a relatively small population, it also has one of the largest landmasses in the world, most of it located in the northern half of the northern hemisphere. These factors contribute to heavier energy and transportation use and thus to higher emissions than in more densely populated countries. The relatively high contribution of its manufacturing, construction, mining, oil and gas, and forestry sectors (i.e., about 30 percent of the economy) is unique among industrialised countries. While Canada experienced strong economic growth, including in its crude oil and natural gas extraction sector, it continues to make progress in decoupling economic growth from GHG emissions. The emission intensity for the entire economy (GHG per unit of GDP) has declined by 16.4 percent since 2005. This was also documented in the OECD’s 2017 Environmental Performance Review of Canada that noted Canada’s progress in decoupling economic growth from GHG emissions.

1 This fact sheet was prepared on behalf of the COMMIT Consortium by Nick Macaluso, Director of Model Development and Quantitative Research at Environment and Climate Change Canada. The views expressed in this paper are those of the author and do not reflect those of Environment Canada or the Government of Canada. The COMMIT project, Climate pOlicy assessment and Mitigation Modeling to Integrate national and global Transition pathways is financed by the European Commission’s Directorate-General for Climate Action (DG CLIMATE). More info on: https://themasites.pbl.nl/commit/
A suite of models is used to exploring how varying any of the assumptions above could have a material impact on long-term energy and emissions trends in Canada (i.e., Global Change Assessment Model (GCAM) and EC-MSMR) and its provinces and territories (EC-Pro). The models are briefly described below:

- Global Change Assessment Model (GCAM), a global recursive-dynamic integrated assessment model with 32 world geo-political regions (including Canada as a region) with technology-rich representations of the economy, energy sector, land use and water linked to a climate model.
- EC-MSMR, an open-economy recursive-dynamic international multi-sector, multi-region computable general equilibrium (CGE) model that captures characteristics of country-specific or regional production and consumption patterns through detailed input-output tables and links countries/regions via endogenous bilateral trade flows. The model has 16 countries/regions and 28 industrial sectors, and endogenously simulates final consumption by households, the federal and provincial governments and investment.
- EC-Pro, a 10 province and 3 territory multi-sector, multi-region computable general equilibrium (CGE) model with 25 industrial sectors, final consumption by households, the federal and provincial governments and investment.

Where do we want to go?

In its 7th National Communication and 3rd Biennial Report to the United Nations Framework Convention on Climate Change, Canada presented projections under two scenarios. A reference scenario (‘with measures’), including actions taken by governments, consumers and businesses put in place up to September 2017, and a ‘with additional measures’ scenario, which accounts for a broader suite of policies under the Pan-Canadian Framework.

In 2017 GHG emissions reporting, Canada saw a significant decline in its GHG projections because of measures/policies being implemented under the PCF. In 2030, the GHG emissions in the ‘with measures’ scenario in Canada are projected at 722 Mt CO₂eq, 92 Mt below what was presented in Canada’s 2nd Biennial Report (BR2), a decline greater than 2015 emissions from Canada’s entire building sector. This reflects the future impacts of a number of federal and provincial policies that had been put in place since September 2016 such as:

- Alberta’s Carbon levy, 2030 phase-out of coal-fired electricity, and 100 Mt CO₂eq cap on oil sand emissions;
- Domestic reductions from Ontario joining Québec and California in the Western Climate Initiative (WCI) cap-and-trade regime in 2017;
- Federal, provincial and territorial regulation for new commercial, institutional and residential high-rise buildings and federal measures to increase efficiency of residential and commercial equipment and appliances;
- Federal regulations to reduce releases of methane in the upstream oil and gas sector and to phase-out the use of hydrofluorocarbons;
- Federal GHG emissions standards for heavy-duty vehicles and trailers in years 2021 to 2027;
- Increasing carbon tax in British Columbia to $50/tCO₂eq by 2022 onwards.

The ‘with additional measures’ projections include additional policies and measures which are planned under the Pan-Canadian Framework. Taking into consideration all these climate change mitigation policies and measures, Canada’s emissions are projected to amount to 583 MtCO₂eq in 2030, a 232 MtCO₂eq decline from projections included in the BR2. These additional measures include:

- Federal Carbon Pricing Backstop
- Accelerated Coal-Fired Electricity Phase-Out
- Clean Fuel Standard
- Strategic Interconnections, Smart Grid and Renewables
- Saskatchewan’s renewable target
- BC’s increase in Low Carbon Fuel Standard
- Post-2025 Light Duty Vehicles Regulations
- Accelerating Industrial Management
- Large Scale Technology Demonstration
- Building Codes for new buildings
- Building Retrofits – labelling and codes
- Appliance Standards
- Increased use of wood in construction
- Reduced diesel use in remote communities
- Off-road Vehicles Regulations

Under the ‘Reference scenario’ (i.e., the 2015 GHG projection used to inform Canada’s NDC), emissions are projected to increase from 722 MtCO₂eq in 2015 to 815 MtCO₂eq in 2030. Since announcing Canada’s NDC, implemented and planned policies and measures are expected to achieve emissions levels of 583 Mt by 2030. Other measures under consideration will help achieve Canada’s NDC target of 517 (Figure 1).

Figure 1: Evolution of GHG Emissions to Canada’s NDC target by 2030

The Government of Canada releases annual GHG emissions projections, which take into account evolving policy and economic circumstances; for example, Ontario has recently announced its intention to repeal cap-and-trade legislation. Canada’s 2018 emissions projections are expected to be released at the end of the year.

Canada’s Mid-Century low-carbon scenario presented here is considered to be in line with the objective to limit global warming to well-below 2°C, as cumulative CO₂ emissions are 15.8 Gt in the 2010-2050 period; this is well within the range projected by a number of global models² for cost-optimal scenarios assuming a global carbon budget of 1000 Gt CO₂ considered equivalent to likely below 2°C. Under the Mid-Century low-carbon scenario,

emissions are projected to decrease from 722 MtCO$_2$eq in 2015 to 517 MtCO$_2$eq in 2030 (i.e., to meet Canada’s Nationally Determined Contribution of 30% below 2005 levels) and further decreasing to 149 MtCO$_2$eq by 2050 (i.e., 80% below 2005 levels). Figure 2 below depicts how key sectors could help Canada achieve its mid-century low-emission target. As depicted below, industry (i.e., manufacturing and production of crude oil and natural gas) is projected to generate reductions in the range of 225 MtCO$_2$eq relative to the reference case in 2050, followed by non-CO$_2$ GHG emissions with reductions of about 110 MtCO$_2$eq. Energy supply (i.e., electricity generation and refining/upgrading) and transportation are projected to generate reductions of about 95 MtCO$_2$eq each. Overall, the modelled mid-century low-emission scenario is expected to generate emissions reductions of some 590 MtCO$_2$eq relative to the reference case in 2050.

Figure 2: Greenhouse gas emissions in 2015 and by 2050 in the reference scenario, emission reductions between the reference and low-carbon scenarios by sector (energy supply, industry, residential and commercial buildings, transport, non-energy CO$_2$), and 2050 emissions in the low-carbon scenario (consistent with 1000 GtCO$_2$, i.e. 2 °C).

A cross model comparison of the cost of achieving Canada’s NDC and MCS pathway suggests that with current technologies a market clearing carbon charge in the range of $85 to $150 per ton (in real 2011 dollars Canadian) in 2030 increasing to $300 to $1,800 per ton by 2050 is needed for Canada to achieve its MCS pathway.

How do we get there?

Canada’s Mid-Century Strategy (MCS) is consistent with work underway to implement the Pan-Canadian Framework of policies and measures to help meet Canada’s 2030 NDC emissions reduction objective. The Mid-Century Strategy will inform longer term planning and investment and sets the course towards a low-carbon economy.

Canada’s MCS is not policy prescriptive and highlights the key role of the Pan-Canadian Framework on Clean Growth and Climate Change in contributing to the Paris Agreement goal to hold the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C. Canada’s MCS presents a series of pathways aimed at achieving a net 80% reduction by 2050 relative to 2005. The pathways explored include: i) electrification of service demands coupled with decarbonised electric generation (i.e., high hydro, high nuclear and high renewables); ii) improving energy efficiency in buildings, vehicles and industry; iii) moving to zero emission transport fuels; iv) decarbonise industrial processes; and v) introduction of advanced technologies in energy supply and demand sectors.
For analytical purposes, the Mid-Century Scenario was based on a pathway that includes:

- Electrification of final energy uses in combination with non-emitting electricity generation (including high hydro contribution) to meeting energy demands in the transportation, building and some industrial sectors
- Accelerated Energy efficiency improvements in all demand sectors and demand side management
- Increased use of renewable fuels is prominent across decarbonisation scenarios
- Deployment of innovative and clean technology in industrial sectors, including oil sands production
- Sequestration technologies, such as bioenergy with carbon capture, use, and storage

From a federal perspective, in January 2018, Canada launched its Greening Government strategy, aimed at reducing GHG emissions from federal government operations by 80% by 2050, relative to 2005 levels, a target selected based on the illustrative one in Canada’s MCS.

The implementation of Canada’s NDC and the long-term low-carbon pathway (as envisaged by Canada’s Mid-Century Strategy) implies significant changes in investment requirements for Canada’s energy system both in demand and supply sectors. For example, under the modelled scenario, investment expenditures associated with the expansion of Canada’s electricity system is projected to grow from $30 billion in 2015, to $45 billion in 2030 and further increasing to $105 billion by 2050. The direct policy related cost would represent an additional investment of $0.35 billion in 2020, increasing to $4.8 billion in 2030 and further increasing to more than $14.5 billion by 2050. These investments associated with implementation of Canada’s NDC and Mid-Century pathway will help to accelerate the transformation of Canada’s energy system towards low-carbon options.

Canada’s electricity generation has a low carbon intensity, albeit with significant regional differences. The least carbon intensive electricity generation is in Quebec, Manitoba and British Columbia, while the most carbon intensive is in Alberta, Saskatchewan and Nova Scotia. Ontario and New Brunswick have a modest carbon-intensive electricity system. The current focus on North-South electricity flows presents a challenge to greater exchanges between low and high carbon intensive electricity generating systems. In 2015, the carbon intensity of Canada’s electricity generation system was 120 gCO₂/kWh. By 2030, carbon intensity is projected to decrease to 60 gCO₂/kWh and further decreasing to 3 gCO₂/kWh by 2050.

Over the 2015 to 2050 period, Canada’s projected emissions suggest improvements in (Figure 3):

- Carbon intensity of GDP declining by 92.4 per cent.
- Final energy demand intensity declining by 55.7 per cent.
- Share of electricity in final energy demand is projected to increase by 58.1 percentage points.
- Renewable share in primary energy is projected to increase by 45.5 percentage points.
Oil sands in the low-carbon transition context

The oil sands industry is both an important source of GHG emissions in Canada, while being of vital importance to the economic growth of Alberta’s, and Canada’s, economies. The deployment of innovative and more environmentally sustainable oil sands production technologies could make an important contribution to mitigating the growth in Canada’s GHG emissions, while promoting the competitiveness of Alberta’s oil sands industry and the Canadian economy in general. The 100 MtCO$_2$e emissions per year cap imposed on the oil sands industry is projected to be reached by 2028. This means that the industry has about 10 years to act in order to continue oil sands production growth by reducing its emissions intensity. On the other hand, high bitumen supply cost is another important factor that reduces the competitiveness of oil sands production relative to other competing world crude oil resources.

The technology configurations currently being explored which meet the minimum costs and emissions objective criteria can achieve potential reductions of bitumen supply cost by 34-40 percent, and reduce fuel-derived emissions from in situ oil sands production by more than 80 percent. There are also promising technologies for upgrading bitumen, which could further reduce the life cycle emissions profile of refined petroleum products produced from oil sands.
Realising the benefits from these innovative technologies will require further research and development work in order to reduce the risks of these promising technologies and thereby ensuring their commercialisation and massive market deployment that will contribute to reducing GHG emissions in line with the Canada Mid-Century low-carbon pathway.