Environment and Climate Change Canada
Environnement et Changement climatique Canada

Evaluation of the Core Climate Change Mitigation Program

December 2022

Canada

Cat. No.: En4-532/2023E-PDF
ISBN: 978-0-660-47353-6
EC 22072.10

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-938-3860
Toll Free: 1-800-668-6767 (in Canada only)
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

Acknowledgements

The Evaluation Division would like to thank the individuals who contributed to this project. In particular, we would like to acknowledge the contribution of program representatives, partners and interested parties who provided input and comments to inform the findings and recommendations of this evaluation.

This report was prepared by the Evaluation Division of the Audit and Evaluation Branch, Environment and Climate Change Canada.

This report was approved by the Deputy Ministers on December 20, 2022.

Table of contents

List of figures

List of tables

List of acronyms and abbreviations

Coal regulations	Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations
CCCMP	Core Climate Change Mitigation Program
CEPA	*Canadian Environmental Protection Act, 1999*
ECCC	Environment and Climate Change Canada
ENGO	Environmental non-governmental organization
GBA Plus	Gender-based analysis plus
GHG	Greenhouse gas
HDV	Heavy-duty vehicle
HDV regulations	Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LDV	Light-duty vehicle
LDV regulations	Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations
Methane regulations	Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)
Natural Gas regulations	Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity Regulations
Pan-Canadian Framework	Pan-Canadian Framework on Clean Growth and Climate Change
P/T	Provincial/territorial
SLCP	Short-lived climate pollutant
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
WMO	World Meteorological Organization
ZEV	Zero-emission vehicle

Executive summary

This report presents the findings from the evaluation of the Core Climate Change Mitigation Program (CCCMP). Under the CCCMP, Environment and Climate Change Canada (ECCC) delivers sector-specific regulatory actions to reduce emissions of greenhouse gases (GHG) and short-lived climate pollutants (SLCP), pursuant to Canada's commitments under the Paris Agreement. The evaluation covers the period from fiscal year 2016 to 2017, when the CCCMP was first funded, to the first quarter of fiscal year 2021 to 2022 (April 1, 2016 to June 30, 2021), spanning 5 years and 3 months.

The evaluation focussed on ECCC's role in leading and implementing activities under the program. The scope of the evaluation included the program's 3 core activity areas: science and reporting, policy and analysis and mitigation actions. All program activities, with the exception of activities related to the Clean Fuel Regulations, were within the scope of the evaluation. The evaluation examined questions related to efficiency and effectiveness. Lines of evidence included a document, data and literature review, comparative analysis of mitigation measures in other jurisdictions, interviews and case studies.

Findings and conclusions

Efficiency

Overall, implementation of the CCCMP has gone well. All major commitments have been implemented, including key planned mitigation measures for the transportation, oil and gas and electricity sectors.

The design of the CCCMP is sound. The program logic is coherent, and measures are complementary to other federal and provincial and territorial measures, with little evidence of overlap and duplication. The transportation, oil and gas and electricity sectors remain appropriate targets for mitigation. However, an increased pace, stringency and/or scope of measures are needed for these sectors to be able to meet recent federal commitments and targets. Similarly, action beyond measures currently in place is needed to achieve Canada's commitment to reduce methane emissions under the Global Methane Pledge. Although certain sectors and sources of emissions emerged as gaps that are currently not addressed by the CCCMP but require mitigation, most notably, emissions from agriculture, buildings, and heavy industry, the extent to which ECCC has a role to play in addressing these gaps through the CCCMP is unclear.

The evaluation identified a number of areas for improved scientific and technical knowledge. Some examples include understanding of emission sources, carbon sinks and nature-based solutions to climate change mitigation; leveraging top-down approaches to estimating GHG emissions, to increase the validity of these estimates; and considering beneficial and adverse impacts of mitigation measures on population groups across relevant identity factors.

Existing and future mitigation measures, either individually or collectively, may have different social, economic or other impacts on various population groups. For example, some measures

may have a disproportionate impact on lower-income Canadians, if they lead to increased energy or vehicle costs. Similarly, large-scale infrastructure projects such as transmission lines may impact Indigenous Rights. While gender-based analysis plus (GBA Plus) was conducted during the design of the CCCMP and some mitigation measures, it will be important to ensure that GBA Plus continues to be considered in the development and implementation of all CCCMP mitigation measures to comply with the new requirements of the Directive on Regulation.

CCCMP resources were generally considered sufficient to deliver planned activities. Science activities required reallocations from other sources, despite the fact that one quarter of planned CCCMP funds for science and reporting were not spent. Existing resources are, however, viewed as insufficient to advance the federal government's increased commitments, given the growing volume of measures (including the possibility of additional equivalency agreements), the technical complexity of the work and the need to ensure the long-term sustainability of science and monitoring activities. The various efficiency measures already introduced help to balance workload with available resources. These additional measures could include further automating regulatory reporting processes and increasing grants and contributions with external partners to expand analysis capacity.

CCCMP partners engage extensively with interested parties within and outside of the federal government in a variety of ways and through various formal and informal mechanisms. These include other federal departments, provincial and territorial governments, industry, environmental non-governmental organizations and researchers and academia, as well as international regulatory agencies and organizations. These efforts are generally viewed as positive and constructive. There are opportunities to enhance collaboration with the provinces and territories by, for example, engaging with them prior to making policy announcements and commitments; considering additional provincial and territorial data; and formally articulating federal, provincial and territorial roles and responsibilities, as well as equivalency requirements, at the outset of equivalency negotiations. In addition, a need to enhance engagement with Indigenous Peoples was identified, as this, to date, has been limited. Over the timeframe of this evaluation, program representatives reported that there has been increasing awareness and acknowledgement of the need to engage Indigenous Peoples.

With regard to other federal departments, engagement and collaboration could be enhanced through formalizing an information-sharing process to ensure timely communication, particularly given the rapidly evolving policy context. In addition, it could be helpful to continue to collaborate closely to ensure complementarity of regulatory and market-based mitigation measures.

The CCCMP is one of many activities reported under the inventory program Clean Growth and Climate Change Mitigation, which is part of the Departmental Framework Program. The performance measurement for the CCCMP is therefore occurring through the Performance Information Profile for the Clean Growth and Climate Change Mitigation Program and performance measurement strategies for individual mitigation measures.

The program is lacking a formal governance structure, as well as a formal mechanism for integrating science activities and policy and regulatory development activities. Establishing such structures or leveraging existing structures could enhance program oversight, coordination, accountability and effectiveness, including the ability of science activities to inform policy and regulatory development.

Effectiveness

There is evidence of progress toward the immediate and intermediate outcomes of the CCCMP pertaining to information and awareness and compliance. There is, however, more limited evidence to date of reduced emissions in the 3 main sectors targeted by the program.

- **Information and awareness.** The information produced by ECCC is used extensively by external interested parties and meets their needs. Regulatees are generally aware of regulatory requirements and understand their obligations for coming into compliance. Areas for improvement include use of "plain language" in regulations, guidance documents and responses to questions, more data pertaining to the Arctic and the inclusion of Indigenous perspectives and information in reporting.
- **Compliance.** Compliance data for longer-standing regulations indicates that target audiences are generally in compliance with regulatory requirements. For recently introduced measures, compliance information will become available in the coming years.
- **Reduced emissions.** Emission reduction performance has been variable across the 3 main sectors targeted by the CCCMP. Emissions from road transportation have increased, despite increasingly stringent emission standards, as a result of overall sector growth, increased distance travelled and consumer preference for sports-utility vehicles, pick-up trucks and minivans for personal transportation. Conversely, overall emissions from the electricity generation sector have declined. In particular,emissions from coal-fired electricity generation have declined, driven primarily by the phase-out of coal-fired electricity generation in Ontario prior to 2019. Nevertheless, emissions from natural gas-fired electricity have been increasing. Total methane emissions have declined, primarily as a result of declining emissions from the oil and gas sector and livestock production. The impact of measures implemented since the CCCMP was established is not yet evident in emissions trend data.

While numerous factors influence the extent to which emissions reductions are achieved, evidence from this evaluation indicates that federal action is important. It sets out an overarching policy context, as well as prompting and providing a backstop for provincial and territorial measures.

Recommendations

The following recommendations are directed to ECCC's Assistant Deputy Minister of the Environmental Protection Branch, as the senior departmental official responsible for the Core Climate Change Mitigation Program.

Recommendation 1: Assess the program's evolving needs for scientific and technical information and analysis, and identify and implement measures to strengthen the program capacity where required.

Recommendation 2: Consider opportunities to improve engagement and collaboration with external interested parties that have responsibilities for climate change mitigation, in particular, provincial and territorial governments, other federal government departments and Indigenous Peoples.

Recommendation 3: Review the existing program's governance structure to ensure that it continues to support effective decision-making process, coordination and accountability.

1. Introduction

This report presents the findings from an evaluation of the Core Climate Change Mitigation Program (CCCMP). Under the CCCMP, Environment and Climate Change Canada (ECCC) delivers sector-specific regulatory actions to reduce emissions of greenhouse gases (GHG) and short-lived climate pollutants (SLCP), pursuant to Canada's commitments under the Paris Agreement. The evaluation covers the period from fiscal year (FY) 2016 to 2017, when the CCCMP was first funded, to the first quarter of FY 2021 to 2022.

Context

Canada played an active role in the international negotiations that led to the adoption of the Paris Agreement in 2015. Parties to the Agreement committed to accelerate and intensify the actions and investments needed for a sustainable low-carbon future, to limit global average temperature rise to below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C. As part of its first Nationally Determined Contribution submitted to the United Nations Framework Convention on Climate Change (UNFCCC), pursuant to the Paris Agreement, Canada committed to reducing GHG emissions by 30% below 2005 levels by 2030.

In 2016, the Pan-Canadian Framework for Clean Growth and Climate Change (the Pan-Canadian Framework) was established as Canada's first national plan for reducing emissions, building resilience to the impacts of climate change and enabling clean growth and jobs. An initiative of federal and provincial/territorial (P/T) governments and National Indigenous Organizations, the Pan-Canadian Framework drives collaboration toward meeting Canada's 2030 target under the Paris Agreement. It includes more than 50 actions covering all sectors of the Canadian economy and consists of 4 pillars:

- pricing carbon pollution
- complementary actions to reduce emissions across the economy
- adaptation and climate resilience
- clean technology, innovation and jobs

The CCCMP falls under the pillar 2: complementary actions to reduce emissions across the country.

Evolving policy context

Since 2016, the global policy context has evolved rapidly. Numerous international scientific and policy bodies, including the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO) and the International Energy Agency (IEA), have concluded in recent years that:

- efforts to date have been insufficient to stabilize global warming

- more ambitious action, including far-reaching economic and atmospheric decarbonization, is needed to reduce GHG emissions in order to meet goals under the Paris Agreement and avoid catastrophic impacts.

Many countries, including Canada, have enhanced their emissions reduction targets for 2030, committed to net-zero emissions by 2050 and announced new measures designed to help achieve these targets.

The Government of Canada built on the federal initiatives underway as part of the Pan-Canadian Framework by introducing A Healthy Environment and a Healthy Economy, also known as the Strengthened Climate Plan, in December 2020. The new plan announced measures to enable Canada to exceed its target of 30% reduction in GHG emissions below 2005 levels by 2030. It consists of over 64 additional measures under 5 pillars to accelerate the decarbonization of the Canadian economy, including pollution pricing, sector-specific and cross-sectoral complementary GHG emission reduction activities, support for clean innovation and jobs and climate change adaptation activities.

In April 2021, the Government of Canada committed to accelerating GHG emission reductions, announcing a new target of 40 to 45% reduction below 2005 levels by 2030. Canada formally committed to this target when it submitted its enhanced Nationally Determined Contribution the UNFCCC in July 2021. The 2021 Federal Budget included a number of additional measures intended to help Canada achieve this new target.

In June 2021, the *Canadian Net-Zero Emissions Accountability Act* was passed into law. This legislation enshrines Canada's commitment to set national targets for the reduction of GHG emissions in Canada, with the objective of attaining net-zero emissions by 2050; establishes Canada's 2030 GHG target, under the Act, as being Canada's Nationally Determined Contribution under the Paris Agreement (currently 40 to 45% below 2005 levels by 2030); and requires the Minister of Environment and Climate Change to set the subsequent 2035, 2040, and 2045 targets at least 10 years in advance. The legislation also contains various provisions for accountability and transparency.

What is not included in the evaluation

Since June 2021, the Government of Canada has announced a variety of new commitments for the transportation, oil and gas and electricity sectors, including:

- committing to all new light-duty vehicles (LDV) sold in Canada must be zero-emission vehicles (ZEV) by 2035, to be achieved through a combination of investments and regulations, including possible additional mandatory measures beyond the current Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations
- committing to develop emissions standards for heavy-duty vehicles (HDV) that are aligned with the most ambitious standards in North America, and a requirement that 100% of selected categories of medium-duty and HDVs be zero emission by 2040

- announcing Canada's support for the Global Methane Pledge, which calls on countries to commit to a collective goal of reducing global methane emissions across all key methane emitting sectors by at least 30% from 2020 levels by 2030
- setting a target to reduce methane emissions from the oil and gas sector by at least 75% below 2012 levels by 2030
- committing to cap oil and gas sector GHG emissions and ensure that emissions decline at a pace and scale needed to achieve net zero by 2050
- committing to achieve a net-zero electricity grid by 2035

In March 2022, the Government of Canada released the first 2030 Emissions Reduction Plan under the *Canadian Net-Zero Accountability Act*, setting out its plan for achieving emissions that are 40% lower than 2005 levels by 2030.

Profile of the Core Climate Change Mitigation Program

The CCCMP focusses primarily on the transportation, electricity and oil and gas sectors, which are responsible for 60% of Canada's GHG emissions (2019 data). It also addresses SLCP emissions from certain sources, including landfills and wood-burning appliances. Core CCCMP activities include:

- **Science and reporting.** This activity provides the foundational science and reporting to support evidence-based decisions for effective and efficient action on climate change mitigation. It includes conducting scientific activities to monitor GHG and SLCP levels and establish baseline trends, and providing new and independent scientific information to meet domestic and international reporting obligations on GHG emissions.
- **Policy and analysis.** This activity provides the foundational information and analysis required to support evidence-based decisions for effective and efficient action on climate change mitigation. It includes, but is not limited to, intelligence gathering; technical and economic modelling of policy options and specific mitigation measures; provision of technical, economic and legal expertise to support regulatory activities, such as the development of Triage and Regulatory Impact Analysis Statements related to regulatory initiatives and equivalency agreements; representing the Government of Canada internationally; and interdepartmental collaboration on cross-cutting policy issues.
- **Mitigation actions.** This activity supports the development, implementation, administration, review and amendment of GHG regulations and other mitigation measures, with a primary focus on the transportation and oil and gas sectors. It includes provision of core sectoral technical expertise; development of pre-gazette regulatory policies; regulatory consultations and engagement with interested parties, including engagement with Indigenous groups, to support regulatory development; development and publication of proposed regulations; publication, administration and implementation of final regulations, including compliance promotion, verification and enforcement activities; and regulatory review and amendment of existing regulations. This activity also includes negotiating equivalency agreements with provinces and territories under

section 10 of the *Canadian Environmental Protection Act, 1999* (CEPA) as well as monitoring the progress of these agreements. A list of CCCMP mitigation measures is in Appendix A.

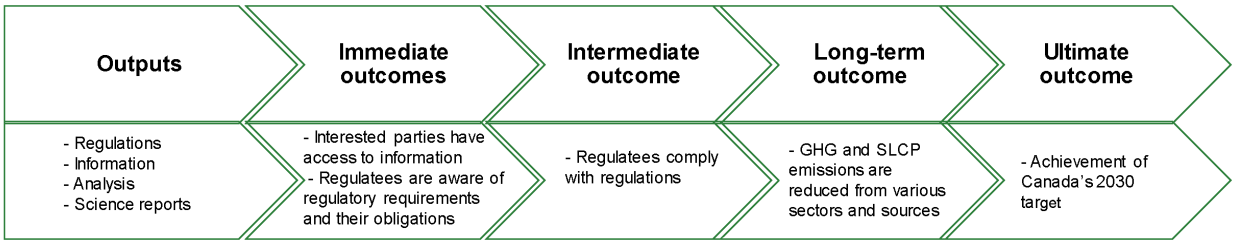
Expected results

CCCMP activities are expected to produce 4 main results:

- **Information and awareness**. Program activities are intended, in part, to ensure that internal and external interested parties have access to needed information and analysis, and that regulated entities are aware of regulatory requirements and of their obligations for coming into compliance.
- **Compliance.** Once regulations are in force and those working under them are aware of their obligations, it is expected that they will comply with regulatory requirements. In turn, compliance becomes a prerequisite for long-term outcome achievement in the form of emission reductions.
- **Reduced emissions.** GHG and SLCP emissions from regulated sectors and sources are expected to be reduced as regulatees comply with regulated requirements. In particular, the CCCMP aimed to achieve emission reductions from LDV, HDV, coal-fired and natural gas-fired electricity generation and methane emissions in the oil and gas sector, among others.
- **Achievement of 2030 target**. Originally, CCCMP measures were expected to contribute to the achievement of Canada's 2030 target of a 30% reduction below 2005 levels of GHG emissions and to reduce SLCP emissions. While there was originally no overall goal to reduce SLCPs to a certain level per se, methane (both an SLCP and a GHG) was included in the 2030 target. In addition, Canada has committed to the Arctic Council goal for Arctic States to collectively reduce emissions of black carbon by 25 to 33% below 2013 levels by 2025.

Since the CCCMP was established, the federal government has announced more ambitious targets for GHGs and SLCPs (in particular methane), as described in Section 1.2. Although this evaluation does not assess the performance of the CCCMP against the new targets, it does consider whether the program design is appropriate for achieving them. Figure 1 presents the results logic model for the CCCMP.

Figure 1: Results logic model for the Core Climate Change Mitigation Program



Resources

The CCCMP received funding in Budget 2016 and Budget 2017, totalling $494.6 million over 12 years, starting in FY 2016 to 2017, and $36.2 million in subsequent years. Of these funds, the majority went to ECCC. From FY 2016 to 2017 to FY 2021 to 2022, ECCC received a total of $225 million, of which $98 million was allocated to the Environmental Protection Branch, $53 million to the Science and Technology Branch, $24 million to the Strategic Policy Branch, $27 million to other ECCC branches and $23 million to Employee Benefit Plan. Of the total amount allocated to ECCC, $97 million was allocated to mitigation actions, $51 million to science and reporting, $37 million to policy and analysis, $17 million to corporate support services and $23 million for Employee Benefit Plan. Complete financial information is provided in Annex B.

About the evaluation

The evaluation focussed on the period from FY 2016 to 2017 until the first quarter of FY 2021 to 2022 (from April 1, 2016 to June 30, 2021), spanning 5 years and 3 months. A timeframe beginning with FY 2016 to 2017 aligns with the CCCMP funding profile. Given the rapidly changing policy context, to optimize the relevance of the findings, the evaluation took into account developments that occurred after the official evaluation end date.

The evaluation focussed on ECCC's role in leading and implementing activities under the program. The objectives of the evaluation were to examine issues of relevance and performance (effectiveness and efficiency) as per the 2016 Treasury Board Policy on Results and to put forward recommendations for possible improvements. Lines of evidence included a document, data and literature review, comparative analysis of mitigation measures in other jurisdictions, interviews and case studies.

Appendix C provides a detailed description of the evaluation approach and lines of evidence.

2. Findings

2.1. Implementation

Findings: Overall, implementation of the CCCMP has gone well. Despite some delays and challenges, all major commitments have been implemented, including key mitigation measures for the transportation, oil and gas and electricity sectors.

Key program accomplishments include:

- Publication and implementation of amendments to the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations, establishing new and more stringent GHG emission standards and test procedures aligned with the United States Environmental Protection Agency's (U.S. EPA) HDV Phase 2 equivalent standards. ECCC also continued to administer the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, which establish progressively more stringent GHG emission standards for new on-road LDVs manufactured or imported into Canada for the purpose of sale.
- Publication and implementation of Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector). These regulations, which apply to oil and gas facilities for the extraction, production, processing and transportation of crude oil and natural gas, are intended to control and reduce methane emissions from upstream oil and gas sources by 40 to 45% by 2025 from 2012 levels. Equivalency agreements were established with British Columbia, Alberta and Saskatchewan in 2020.
- Publication and implementation of amendments to the Reduction of Carbon Dioxide Emission from Coal-fired Generation of Electricity Regulations to phase out conventional coal-fired electricity by no later than 2030. Under the amended regulations, new units built after July 1, 2015 have to meet the performance standard of 420 tonnes of carbon dioxide per gigawatt-hour of electricity produced when they start operating. As for existing units, they must meet the performance standard at their end of useful life (generally 50 years) or by 2030, whichever comes first.. ECCC also renewed an existing equivalency agreement with Nova Scotia related to coal-fired electricity generation (first published in 2014) and finalized an equivalency agreement with Saskatchewan.
- Publication and implementation of Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity, which set performance emission standards for natural gas-fired electricity generation, including for coal-fired boilers converted to run on natural gas. The intent of these regulations is to support a transition to a lower-emitting electricity sector, given the anticipated increased demand for natural gas-fired electricity.

- Publication and implementation of Off-road Compression-Ignition Regulations (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations, which establish and implement air pollutant emission standards, in alignment with U.S. EPA standards.[1] ECCC also engaged internationally on SLCPs through the Arctic Council, the Global Methane Initiative and the Climate and Clean Air Coalition.

Various factors and challenges have led to delays or partial implementation of some activities:

- **Canada-U.S. regulatory harmonization.** Canada's LDV and HDV regulations are aligned with U.S. EPA standards and test procedures to take into account the integrated North American auto market. Some provisions set out in the LDV and HDV regulations were affected by regulatory action taken to maintain alignment of the integrated North American market (see text box).
- **New regulated community.** Compliance promotion activities for the Methane Regulations were affected by uncertainties stemming from this new area of federal regulation. In the absence of a comprehensive regulated parties list, the first compliance year focussed on assessing the regulated audience and determining what compliance promotion activities would be effective. This work was complicated by ongoing negotiations with respect to equivalency with British Columbia, Alberta and Saskatchewan, which together account for 98% of the potential regulated community. The establishment of equivalency agreements with these provinces substantially reduced the size of the federally regulated community. Beginning in FY 2020 to 2021, the Multi-Sector Air Pollutants Regulations Working Group is providing compliance promotion support for the Methane Regulations on an ad hoc basis.

Impact of Canada-U.S. regulatory harmonization

Canada's emission standards for LDVs are aligned with U.S. standards. They became less stringent in 2020 following the publication of a U.S. Final Rule, reducing the annual increase in stringency from about 5% to about 1.5% for the 2021 to 2026 model years. In December 2021, the U.S. EPA published a Final Rule, which increased the annual increases in the stringency of emission standards for model years 2023 to 2026 to 5% to 10% per year. Since the US standards are incorporated by reference in the Canadian regulations, these new more stringent standards automatically apply in Canada.

In response to legal challenges and petitions filed by the U.S. trailer industry against the U.S. EPA, as well as concerns about the economic impact that ECCC heard from the Canadian trailer manufacturing and trucking industry and the results of a Canadian trailer market analysis conducted by ECCC, HDV trailer standards were temporarily suspended in Canada.

[1] Although these regulations primarily target air pollutants and were included as part of the recent Evaluation of the Addressing Air Pollution Horizontal Initiative, they were included as part of the CCCMP because they also indirectly address short-lived climate pollutants due to the air pollutant standards implemented for stationary diesel engines.

- **COVID-19**. Due to the COVID-19 pandemic, compliance promotion activities for the Methane Regulations were delivered online. The pandemic also led the industry to experience labour shortages, delays in installation of equipment and challenges in carrying out some leak detection and repairs requirements. Due to concerns regarding risks to human health and safety, regulatees were given more time to comply with regulatory leak detection and repair requirements, as allowed by the regulations.

A few measures have progressed differently than originally planned:

- New regulations for the off-road transportation sector were planned to be published in Canada Gazette II in 2021. To date, a considerable amount of technical analysis has been completed to support more informed decisions on policy development.
- More time than expected was needed to secure necessary expertise and develop a sound dataset to inform foundational analysis and engagement on potential measures to reduce methane emissions from landfills. This analysis has now been completed.
- Development of options to reduce black carbon emissions from wood-burning appliances was put on hold following initial policy analysis. The analysis identified a need for an amendment to CEPA to enable development and implementation of a national standard for wood-burning appliances.

A detailed description of the implementation status of planned CCCMP activities is in Appendix D.

2.2. Program design

Findings: While the design of the CCCMP is sound, an increased pace, stringency and/or scope of measures are needed for the transportation, oil and gas and electricity sectors to be able to meet recent federal commitments and targets. There is a need for improved scientific and technical knowledge in a range of areas, to inform effective policy and regulatory development.

The evaluation assessed the appropriateness of program design in terms of program logic and coherence, complementarity, sectoral focus, pace and stringency of measures and gaps.

Program logic and coherence

The program logic, or theory of change, underpinning the CCCMP is sound. The core CCCMP activities, namely science and reporting, policy and analysis and mitigation actions, are consistent with those of other federal regulatory programs. This is also the case for the program's expected outcomes: information and awareness, compliance and mitigated risk—in this case, reduced emissions. CCCMP activities are coherent to the extent that they share the common objective of reducing GHG and SLCP emissions, although evidence indicates that linkages and interactions among CCCMP activities and partners could be improved. This point is discussed in Section 2.6.

Complementarity, overlap and duplication

CCCMP measures are complementary to other federal and P/T measures with the same objective of reducing GHG and SLCP emissions. Federal climate change mitigation initiatives within the Pan-Canadian Framework, the Strengthened Climate Plan and Budget 2021 encompass a range of complementary actions and strategies across economic sectors. CCCMP mitigation actions were designed to complement carbon pricing and other federal initiatives.

Despite shared federal and P/T jurisdiction, there is little overlap and duplication among CCCMP and P/T measures due to a federal requirement to consider P/T measures in regulatory design and the provision for equivalency in CEPA. The latter allows GHG or air pollutant regulations to be stood down if a province or territory has an enforceable regulation providing for an equivalent or better environmental outcome. However, a few caveats were identified. When equivalency agreements are established, there is a temporary period of "duplicate regulations" before the federal regulations are no longer in effect. In addition, since equivalency agreements are established for 5-year time periods, they create uncertainty for the industry with respect to which regulations will apply and when. However, these issues do not appear to be major concerns for the parties involved.

Coverage, pace and stringency of measures

The oil and gas, transportation and electricity sectors continue to be appropriate targets for mitigation measures. Together, these sectors accounted for 60% of Canada's total GHG emissions in 2019, with the oil and gas and transportation sectors combined being responsible for over half the total (26% and 25%, respectively). An increased pace, stringency and/or scope of measures are needed for these sectors to able to meet new federal commitments and reduction targets. Similarly, further action on methane is needed to achieve Canada's commitment to reduce methane emissions under the Global Methane Pledge.

Transportation

Within the transportation sector, the on-road subsector has been the main focus of CCCMP mitigation measures to date. Emissions from LDVs and HDVs have been increasing since 2005 despite increasingly stringent emissions standards, indicating that current regulations are insufficient to reduce emissions from this sub-sector. Indeed, in its February 2021 midterm evaluation of the LDV Regulations, ECCC concluded that the standards increasing in stringency by only 1.5% per year were not rigorous enough to allow Canada to meet its emissions reduction objectives. There are significantly more stringent standards now in place for the 2023 to 2026 model years and commitments made for the post-2026 model years aiming to drive deeper reductions.

In December 2020, the federal government announced its commitment to align LDV and HDV emissions standards with the most stringent North American standards, to require all new LDVs to be zero-emission by 2035 and to continue working toward decarbonization of the HDV sector. Achieving these strengthened commitments will likely require, among other things, measures to encourage production and uptake of zero-emission LDVs and HDVs. One example is the adoption of regulated ZEV sale targets for new cars, a key component of the IEA's Roadmap to Net-Zero by 2050 (see text box).

Additional measures to support transportation system decarbonisation – ZEV sales mandates

A ZEV sales mandate requires manufacturers to offer for sale an increasing proportion of ZEVs. The IEA recommends adopting a 60% ZEV sales mandate for new cars by 2030 and 100% by 2035, as well as a 50% ZEV mandate for HDVs by 2035.

Several jurisdictions have already introduced ZEV sales mandates. In 2018, Quebec's ZEV standard came into force, and in May 2019, British Columbia became the first jurisdiction in the world to legislate a 100% ZEV sales target for LDVs. California has had a ZEV sales mandate in place for LDVs since 1990, and in June 2020, became the first jurisdiction in the world to adopt legally binding targets for manufacturers to gradually increase their sales share of zero-emission trucks.

Canada's Emissions Reduction Plan included commitments to:

- Develop light-duty vehicle (LDV) ZEV regulated sale targets, which will require that at least 20% of all new LDVs offered for sale by 2026 are ZEVs, at least 60% by 2030 and 100% by 2035;
- Launch an integrated strategy to reduce emissions from medium-and heavy-duty vehicles (MHDVs) with the aim of reaching 35% of total MHDV sales being ZEVs by 2030. In addition, the Government will develop a MHDV ZEV regulated sale targets to require 100% MHDVs offered for sale to be ZEVs by 2040 for a subset of vehicle types based on feasibility.

For the HDV sector, where the durability and longevity of the existing diesel fleet pose particular challenges for GHG abatement, measures will also be required to incentivize fleet turnover and to reduce emissions in the existing fleet through technological innovations. For both LDVs and HDVs, a range of financial and tax incentives, along with significant investment

in public infrastructure (for example, charging stations) will also be required. Such measures, however, are outside of ECCC's scope of authority to develop and implement.

Additional measures to reduce methane emissions from the oil and gas sector – examples from other jurisdictions

Pneumatic requirements: British Columbia, California and Colorado require most pneumatic equipment, including controllers and pumps, to be zero emitting.

Venting: While Canada's regulations establish a facility-wide venting limit, other jurisdictions have taken steps to ban venting under certain circumstances. California prohibits venting from wells; Colorado bans venting and flaring at oil and gas sites; and British Columbia's Flaring and Reduction Guidelines aim to eliminate venting from oil and gas well sites, facilities and pipelines.

Flaring: The U.S, Colorado and British Columbia have established specific rules around flaring and prohibit flaring under certain circumstances.

Abandoned oil and gas wells: California requires abandoned wells to be capped, to prevent release of natural gas.

Although on-road transportation has been the primary focus of the CCCMP to date, a need was also identified for measures to address GHG emissions from large industrial off-road transportation, such as construction vehicles.

Oil and gas

Recent ECCC analysis indicates that the Methane Regulations and provincial equivalents, along with complementary measures, are on track to meet the 2025 target the department set for methane reductions from the oil and gas sector.

However, enhanced commitments for this sector were announced in 2021, including a commitment to achieve at least a 75% reduction in methane emissions from oil and gas by 2030. Additional measures will be needed to achieve this target. Key interviewees noted that the Methane Regulations could be updated by strengthening the stringency of standards or requirements, such as banning venting in some circumstances or requiring pneumatic equipment to be zero-emitting, and expanding coverage to include more upstream sources, such as flaring and abandoned wells. Examples of such requirements exist elsewhere (see text box). Initiatives led by other federal departments, such as Natural Resources Canada's Emissions Reduction Fund, are also expected to contribute to achieving the enhanced target.

Some key interviewees identified a need for measures to mitigate non-methane GHG emissions from the oil and gas sector. These are currently addressed by the Output-Based Pricing System Regulations (or provincial systems that meet the federal benchmark criteria). While the federal government has announced a commitment to cap and cut oil and gas sector GHG emissions in line with meeting net-zero commitments by 2050, it has not yet published a plan for achieving this commitment.

Electricity

The electricity sector accounted for only 8% of Canada's total emissions in 2019. Emissions from this sector have decreased by 48% since 2005 (despite increased demand), as a result of transitioning from high- to low-GHG emitting sources of electricity. Nevertheless, ongoing attention to this sector is warranted, given increased expected demand for electricity as a result of transitioning to a net-zero economy, as well as Canada's recent commitment to achieving a net-zero electricity grid by 2035. Currently, the Natural Gas regulations set best in class emission standards for natural gas generation but more action is required to reach the goal of a net-zero electricity system by 2035.

The federal government recently announced its intention to develop and implement a Clean Electricity Regulation (CER), formerly known as the Clean Electricity Standard. The final form of the CER's scope and design will be influenced by consultations and the consideration of the full set of changes needed to transition the electricity sector to net zero while providing an increased supply of electricity to support electrification in all other sectors.

Other methane emissions

According to evidence provided by the Global Methane Assessment, taking rapid measures to reduce methane emissions across a range of sectors, including not only oil and gas, but also waste and agriculture, could significantly slow the rate of warming in the near term. Moreover, mitigation actions for each major methane-emitting sector are available, affordable and cost-effective.

To date, the CCCMP has addressed methane emissions by focussing primarily on mitigation measures for the oil and gas sector. The program is also taking action on methane emissions from waste, as described in Section 2.1, and work is underway on a National Methane Strategy to reduce methane emissions across the broader Canadian economy. Further action on methane beyond measures currently in place is needed to carry out Canada's support for the Global Methane Pledge, which aims to reduce global methane emissions by 30 percent below 2020 levels by 2030. In this context, it is important to note that, although ECCC has responsibilities in relation to monitoring and reporting on emissions from agriculture, Agriculture and Agri-food Canada has the mandate to reduce GHG emissions from the sector.

Other sectors and sources of emissions

In 2019, approximately one quarter of Canada's total GHG emissions were from buildings (12.5%) and heavy industry (10.5%). Some CCCMP mitigation measures apply to certain activities or equipment types used within these sectors. In addition, other measures within the Pan-Canadian Framework or Strengthened Climate Plan apply to these sectors. It is unclear whether current measures are sufficient to address emissions from these sectors, and whether ECCC has a role to play in addressing any outstanding gaps.

Scientific and technical knowledge and understanding

Two areas of scientific and technical knowledge and understanding could be strengthened to further support decision making. In addition, technological change is occurring rapidly in 2 sectors and is expected to continue to require sustained attention.

Evidence shows that knowledge and understanding of emission sources and sinks could be strengthened. We found that emissions from certain sources are not well characterized, notably methane emissions from abandoned wells, downstream emissions of exported fossil fuels and emissions from forest fires. Scientific understanding of carbon sinks and the role of nature-based solutions in climate change mitigation is nascent and is key to understanding future carbon levels, making climate predictions and estimating the expected outcomes of mitigation efforts (Kaushik et al., 2020).

The information collected also demonstrates that emissions estimation and mitigation measure modelling could be strengthened. There is evidence that the use of top-down approaches to estimating GHG emissions is limited, although these approaches are recognized to increase estimates validity and accuracy when used in addition to traditional bottom-up methods (see text box). There is no evidence that the combined and cumulative impacts of mitigation measures on affected industrial sectors are being measured or estimated through modelling. Finally, there is no evidence that beneficial and adverse economic and social impacts of mitigation measures are being measured or estimated for population groups across relevant identity factors.

Evolving approaches to estimating GHG emissions

There are 2 main approaches to estimating GHG emissions.

- The "bottom-up" approach uses statistical parameters called "emissions factors", combined with sector activity data, to determine the sum of emissions from each combination of source and sector.
- The "top-down" approach uses atmospheric measurements of GHG concentrations in the air at a given time, collected through observation towers, aircraft and satellites. Modelling is used to probabilistically attribute emissions to their sources (referred to as "inverse modelling"). According to the IPCC, top-down methods provide significant value and utility over bottom-up methods when used effectively (IPCC, 2019).

Several studies using atmospheric measurement and inverse modelling, including some by ECCC scientists, have produced emission estimates for methane and carbon dioxide from oil sands that are significantly higher than those reported in Canada's national GHG inventory (Chan et al., 2020; Liggio et al., 2019; MacKay et al., 2021).

This research drove the development of a revised methodology for estimating methane emissions from fugitive sources, which has been applied in the 2022 edition of Canada's National Inventory Report. The revised methodology will focus on improving source and location data to strengthen estimates of fugitive emissions. Challenges in building a national surface network for gathering atmospheric GHG observations are a constraint to adopting top-down approaches in Canada.

Program representatives and external interviewees are of the view that understanding and keeping abreast of rapid technological change is key to the design and administration of effective instruments. Among the multiple relevant domains of technological change, 2 stand out as continuing to require sustained attention. First, is the set of technological developments for reducing emissions from HDVs. Given the durability and longevity of the existing HDV fleet, a mix of technologies, including battery-electric trucks, hydrogen-electric fuel cell trucks, biofuels, natural gas, renewable natural gas and high-efficiency diesel engines, is likely to be required to provide long-term emissions reductions for this sector (Cunanan et al., 2021). Second, is the set of technologies required for the industry to reach net zero, such as geothermal, small modular nuclear reactors, carbon capture and storage, direct air capture and hydrogen.

In light of these knowledge gaps and opportunities for improvement, this report recommends that the program assess its evolving needs for scientific and technical information and analysis, and identify and implement measures to strengthen the program capacity where required (see Recommendations section).

2.3. Consideration of GBA Plus

Findings: GBA Plus was conducted during the design of the CCCMP and some mitigation measures. Given that the transition to a net-zero economy may have a different social, economic and other impact on various population groups, it will be important to ensure that a GBA Plus continues to be an integral part of the development and implementation of all CCCMP mitigation measures.

The Cabinet Directive on Regulation sets out the Government of Canada's expectations and requirements in the development, management, and review of federal regulations. In addition, the Directive also outline new requirements with respect to GBA Plus and Modern Treaty Implications. Other tools are available to assess potential adverse impacts on Indigenous Rights.

A gender-based analysis plus (GBA Plus) was conducted during the design of the overall CCCMP and is mentioned in foundational documents, such as the funding submission and the Performance Information Profile for Clean Growth and Climate Change. It was also conducted during the design of some mitigation measures. For example, flexibilities were put in place under the Off-Road Compression-Ignition and Large Spark-Ignition Engine Emission Regulations to avoid remote communities having to pay more to purchase new stationary compression-ignition engines for use in remote locations, where communities rely on them as a source of power. Some earlier Regulatory Impact Analysis Statements include discussion of the impact on population groups or regions, but they do not explicitly refer to GBA Plus.

Key interviewees observed that existing and future mitigation measures, either individually or collectively, as well as the transition to a net-zero economy, may have a different social, economic or other impact on population groups. For example:

- If they lead to increased energy or vehicle costs, some mitigation actions may have a disproportionate impact on lower-income Canadians.
- It is likely that a sizeable workforce will need to transition out of the oil and gas sector.
- Indigenous communities may be at risk if the social impact is not considered or embedded in policy.

Given the scope and pace of change, understanding the impact on population groups and regions will be important. As noted previously, the evaluation identified a need to advance modelling to perform this type of analysis.

2.4. Engagement and collaboration

Findings: While ECCC's engagement and collaboration activities are viewed as positive and constructive, several opportunities for improvement were identified. These include improving the formal consultation processes, improving engagement with Indigenous Peoples and formalizing an information-sharing process with federal partners.

Interested parties external to the federal government

In a variety of ways and through various formal and informal mechanisms, CCCMP partners engage extensively with interested parties outside the federal government, including P/T governments, industry, environmental non-governmental organizations (ENGO) and researchers and academia, as well as international regulatory agencies and organizations. Examples include:

- participating in the established Canada Gazette process, including the public comment period, as well as various other consultations, engagement activities, and technical working groups on proposed mitigation measures
- sharing policy analyses and recommendations
- negotiating and managing equivalency agreements
- developing industrial climate policy and offset programs (provinces and territories)
- conducting scientific and policy research, acting in a scientific advisory capacity to ECCC (for example, on quality of emission estimates) and collaborating with ECCC scientists in international initiatives such as the WMO's Integrated Global Greenhouse Gas Information System (researchers and academia)
- collaborating with international regulatory agencies, such as the U.S. EPA, with respect to work planning and priority setting in relation to the transportation and oil and gas sectors

external key interviewees generally described their engagement with ECCC as positive. They indicated that they value the sharing of insights and diverse perspectives, appreciate being included in policy and regulatory consultations and engagement and consider their working relationships with ECCC to be effective. International researchers singled out the high quality

and innovation of the work of ECCC scientists in the area of atmospheric measurement of GHG emissions, as well as their contributions to international initiatives.

The evaluation identified several opportunities to improve engagement and collaboration with interested parties outside the federal government.

- **Enhance engagement and collaboration with provinces and territories.** Given shared jurisdiction, advancing climate change mitigation relies on effective federal, provincial and territorial engagement and collaboration. Perceived areas for improvement include:
  - engaging provinces and territories prior to making policy announcements and commitments
  - involving provinces and territories in setting GHG reduction targets
  - considering P/T data and research in emissions modelling and projections, target setting and policy and regulatory development and in establishing the expected outcomes of specific mitigation measures

  In addition, establishing a Memorandum of Understanding at an early stage in the negotiations could help to improve the negotiation process for equivalency agreements (see text box). The document could outline expectations and clarify roles, responsibilities and equivalency requirements, thus enhancing collaboration and transparency to address issues with the technical assessment of equivalency.

Enhancing collaboration: Lessons learned from the implementation of methane equivalency agreements

In the absence of an explicit definition of equivalency in CEPA, equivalency is interpreted as equivalent in effect. There is a lack of clarity around equivalency requirements and how effects from distinct regulations are determined to be equivalent (Péloffy et al., 2019; Plumptre & Flanagan, 2017; Schulte, 2017). Establishing a Memorandum of Understanding between the federal government and the provincial government concerned at an early stage in the negotiation process, which sets out the roles, responsibilities and expectations with regard to the demonstration of equivalency (for example, expected outcomes, monitoring, reporting and penalties), would help to address these uncertainties.

Issues with the technical assessment of equivalency, including measurement and modelling techniques and the data used in equivalency determinations, create reputational and delivery risks. According to some interviewees, these risks could be addressed through increased data-sharing between provinces and the federal government; use of jurisdiction-specific data in modelling; and collaboration on the approach to modelling that is to be used to support the assessment of equivalency, including adjusting modelling assumptions over time as new methodologies and data emerge.

- **Greater effort on engaging Indigenous Peoples.** Internal key interviewees reported that engagement with Indigenous Peoples has been limited to date, and Indigenous Peoples have not always been considered as key interested parties during policy and

regulatory development (for example, vehicle and engine regulations). Although there has been increasing awareness and acknowledgement of the need to engage Indigenous People, program representatives identified the need for greater effort. The time required for this engagement was identified as a challenge, given the pace of mitigation work.

- **Improve formal consultation and engagement processes.** A variety of specific suggestions were made, primarily by regulatees and ENGOs, to improve formal consultation and engagement processes. These included suggestions for engagement at an earlier stage in the process, advance publication of the upcoming policy and regulatory consultation and engagement calendar, earlier distribution of supporting material, extending the comment period for proposed regulations and demonstrating how stakeholder input is taken into consideration in policy and regulatory development. Regulatees expressed a desire for sector-specific and in-person (as opposed to virtual) consultations and engagement, where possible.

Other federal departments and agencies

In addition to interested parties external to the federal government, CCCMP partners engage and collaborate with several federal departments and agencies through formal and informal mechanisms: Transport Canada, Natural Resources Canada, Crown-Indigenous Relations Canada, Innovation, Science and Economic Development Canada, Infrastructure Canada, Finance Canada, Agriculture and Agri-food Canada, Canada Border Services Agency, Statistics Canada and the National Research Council.

Examples include various cross-departmental senior management committees and collaborative working groups, such as:

- the Energy and Transportation sector-wide table, established to develop policy recommendations to support the Strengthened Climate Plan
- the ZEV Task Team, which consists of representatives from the Environmental Protection Branch at ECCC, Natural Resources Canada, Transport Canada, Innovation, Science and Economic Development Canada and Procurement and Public Services Canada, and which is responsible for issue resolution and planning program elements to be presented to Cabinet

A variety of bilateral mechanisms also exists. Examples are data-sharing agreements between the Science and Technology Branch and Statistics Canada and a Memorandum of Understanding outlining the roles and responsibilities of ECCC and the Canada Border Services Agency with regard to the importation of regulated vehicles and engines.

The program representatives and representatives of other federal departments and agencies who were interviewed generally view interdepartmental collaboration as positive and constructive. They did, however, mention the following opportunities for improvement.

- **Formalizing an information-sharing process** to ensure timely communication of information among branches and departments, particularly given the rapidly evolving policy context.
- **Collaborating more closely to ensure complementarity of regulatory and market-based mitigation measures.** As a specific example, key interviewees noted that any future updates to the Methane Regulations should be informed by evidence from Natural Resources Canada's Emissions Reduction Fund. The Fund supports private investment in methane emission reductions, helping drive market and technological change. In doing so, it generates substantial intelligence which in turn could provide additional data points useful to regulatory design review.

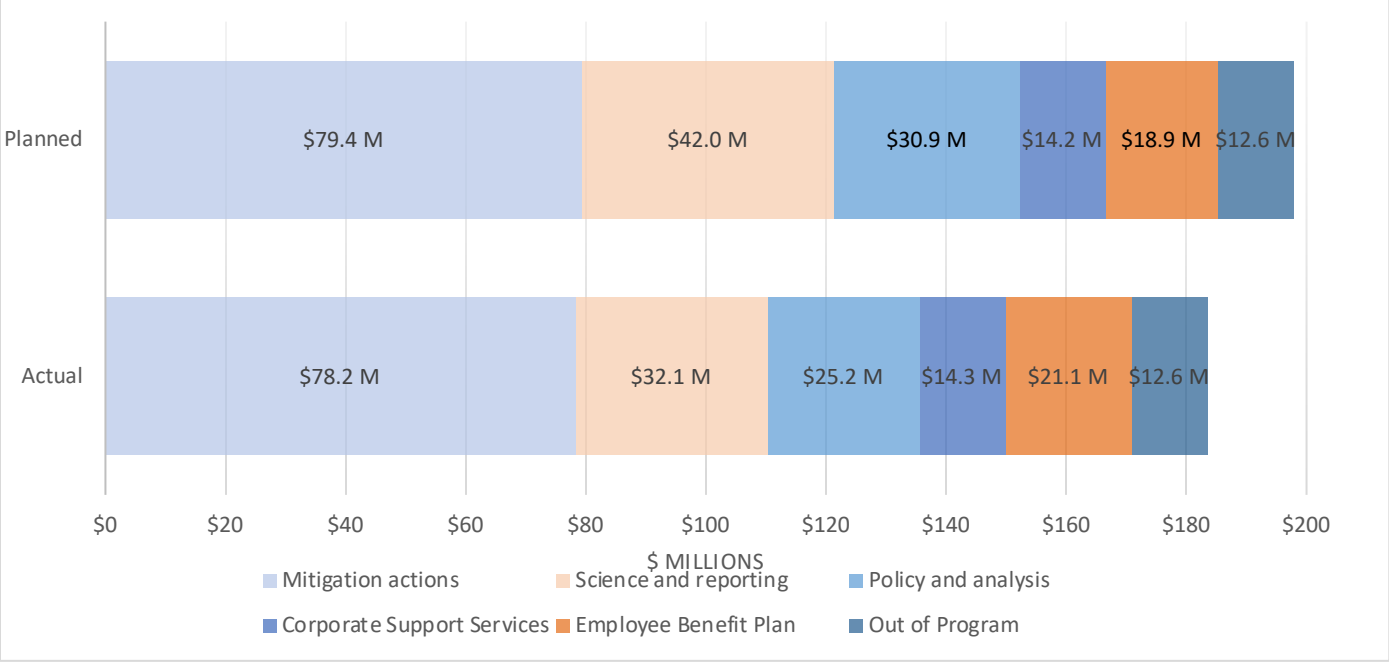
2.5. Resource use and alignment to mandate

Findings: Overall, ECCC underspent slightly on CCCMP activities between FY 2016 to 2017 and FY 2020 to 2021. Resources were generally considered sufficient to deliver planned activities. However, science activities required reallocations from other sources, despite the fact that one quarter of planned CCCMP funds for science and reporting were not expended. Existing resources are viewed as insufficient to advance the federal government's increased commitments. Further efficiency measures were identified to help to balance workload with available resources.

Between FY 2016 to 2017 and FY 2020 to 2021, ECCC spent 92% of the planned CCCMP resources.

- Actual spending by the Strategic Policy Branch was close to what was planned (97%), while the Environmental Protection Branch and the Science and Technology Branch both underspent relative to plans (88% and 83%, respectively).
- Actual spending on mitigation actions almost exactly matched planned spending (99%). However, as Figure 2 shows, ECCC underspent on policy and analysis (83%) and science and reporting (76%) activities.

Figure 2: Comparison of planned and actual spending by core activity, fiscal year 2016 to 2017 to fiscal year 2020 to 2021



Source: Corporate Services and Finance Branch, ECCC.

- We understand that various factors influenced the program spending overtime. For example, position vacancies, delayed staffing, shifting priorities, delay in IT projects and procurement as well as issues due to COVID-19 affected the pace of spending from FY 2018 to 2019 to FY 2020 to 2021.

Complete financial information is provided in Appendix B.

Most internal key interviewees indicated that CCCMP resources were sufficient to deliver planned activities. However, Science and Technology Branch representatives involved in science activities reported that CCCMP funding was intended to augment the existing GHG monitoring and climate modelling program to include SLCPs, but was insufficient to undertake any substantive science work. Consequently, implementation of planned SLCP monitoring activities reportedly required reallocating operational funding (A-base) and climate change adaptation funds, creating pressures on work in other areas. The evaluation was unable to reconcile the apparent discrepancy between unspent CCCMP funds for science and reporting activities and the need reported by internal key interviewees to supplement CCCMP funding for science activities with funding from other sources.

Almost all internal key interviewees agree that resource constraints are an ongoing challenge and that additional resources are required to continue advancing climate change mitigation in the context of the federal government's increased commitments, citing:

- the technical complexity of the work, requiring specialized, higher-cost expertise for policy, analysis and regulatory development activities and specialized training (for example, training of enforcement officers)
- the growing volume of mitigation measures
- the potential for negotiation of new equivalency agreements, along with renewal of existing ones; given the complexity and time-consuming nature of the negotiation process, there are concerns that ECCC will not have sufficient resources to deal with all 5 renewals at the same time
- the long-term sustainability of science and monitoring activities; current resources are insufficient to analyze all of the data collected, account for GHG and SLCP emissions and the impact of mitigation efforts and support lifecycle management of the monitoring system (upgrading or replacing monitoring technology and infrastructure)

Internal key interviewees reported that various measures have been taken to help address resource pressures and balance workload with available resources, including:

- shifting resources internally
- investing in databases that can support processing large amounts of data
- when developing multiple equivalency agreements on same regulation, conducting a full cost-benefit analysis for the first agreement and a simplified analysis for remaining ones
- developing biannual work plans with the U.S. to coordinate priorities and share resources (transportation sector)
- partnering with academics and researchers to support data analysis, including placing key collaborators on retainer
- using a risk-based approach to enforcement

Suggestions for further measures to enhance efficiency include:

- **Further automating data collection systems.** While automating reporting processes is expensive and can be difficult to implement, relieving staff of this cumbersome process would help balance resources with workload and improve public spending efficiency. Currently, for example, methane data is collected through emails and entered into spreadsheets, taking up a considerable amount of staff time.
- **Increasing collaborations with others to expand analysis capability.** Increasing partnership through grants and contributions with other organizations would allow the Science and Technology Branch to expand its analytic capabilities to better align with identified analysis needs.

2.6. Governance

Findings: There is currently no formal governance structure for the CCCMP, nor is there a formal mechanism for integrating science activities with policy and regulatory development activities. Establishing such structures or leveraging existing structures could enhance program coordination and effectiveness, including the ability of CCCMP science activities to inform policy and regulatory development.

ECCC's Energy and Transportation Directorate within the Environmental Protection Branch is the lead for the CCCMP within ECCC. CCCMP activities are managed through existing ECCC oversight structures such as the Climate Change Working Group, regulatory management systems, senior management meetings and departmental reporting.

There is no dedicated formal governance structure for the CCCMP. Most internal key interviewees indicated that, at an operational level, ECCC branches directly involved in the CCCMP collaborate well together, which they attributed to a strong foundation of longstanding working relationships between branches. On the other hand, the existence of a functional governance structure is generally accepted to be an essential component of sound program management within government and necessary for effective decision making, coordination and accountability.

Related to program governance, some internal key interviewees indicated that there is no formal committee or other mechanism for linking CCCMP partners involved in science and policy and regulatory development. They viewed this as a significant shortcoming for the following reasons:

- the information needs of regulators are not known in advance, which is problematic because the turnaround time for generating scientific data can be lengthy (3 to 7 years)
- there is limited opportunity to advise on how scientific research could support policy and regulatory priorities and to strategically evolve the science to meet policy and regulatory needs

To help address this gap, informal biweekly information-sharing teleconferences, open to all those involved in the climate program, were initiated 2 years ago. Those who noted the existence of this venue see it as inadequate to support program planning, coordination, and communication of results.

The recently revived Short-lived Climate Pollutants Integration Committee was identified by several internal key interviewees as a positive example of a formal mechanism for integration and collaboration between science and policy/regulatory development within ECCC (see text box).

The Short-Lived Climate Pollutants Integration Committee – an example of coordination of science and policy and regulatory activities

The Short-Lived Climate Pollutants Integration Committee was established to ensure coordination and integration of ECCC's policy, science and regulatory activities related to SLCPs at the domestic and international levels. The committee is charged with:

- supporting the implementation of the SLCP Strategy by prioritizing and coordinating SLCP-related initiatives across ECCC
- tracking and reporting on progress on the implementation of the Strategy on SLCPs
- establishing consistent positions and messaging in domestic and international forums
- supporting updates of the SLCP Strategy, including the identification of new SLCP priorities, as needed

The Committee consists of director-level representatives or their delegates from ECCC's Environmental Protection Branch, International Affairs Branch, Climate Change Branch, Science and Technology Branch, Strategic Policy Branch, and the Public Affairs and Communications Branch, as well as representatives from the Meteorological Service of Canada and from Transport Canada, Natural Resources Canada and Health Canada. The Air Emissions Priorities Division convenes and chairs the committee and provides secretariat support.

2.7. Performance measurement

Findings: Performance measurement for the program is occurring through the Performance Information Profile for the Clean Growth and Climate Change Mitigation Program and performance measurement strategies for individual mitigation measures. Data for many indicators are not yet available due to regulatory implementation, reporting and data validation timelines. Challenges to performance measurement include accuracy in estimating emissions, attributing outcomes to activities and communicating results.

CCCMP does not have a separate or stand-alone logic model or performance measurement framework. However, a Performance Information Profile (PIP), including a logic model, has been developed for the Clean Growth and Climate Change Mitigation Program, of which the CCCMP is a part. Most of the main regulations that are within the scope of the CCCMP, with the exception of the Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Electricity Generation, contribute outcome indicators to the Performance Information Profile. Corporate Management Directorate maintains an Excel spreadsheet that serves as a centralized location for compiling this performance data.

In addition, logic models and performance measurement strategies have been developed for the following CCCMP regulations:

- Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations
- Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations
- Reduction of Carbon Dioxide Emissions from Coal-fired Electricity Regulations
- Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Electricity Generation
- Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)
- Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations

Performance measurement is occurring, although data for many indicators are not yet available due to regulatory implementation, reporting and data validation timelines. As a result, performance data for many indicators are expected to become available only in the coming years.

Other challenges to performance measurement include:

- **Accuracy in estimating emissions.** Performance measurement and an analysis of effectiveness require accuracy in baseline emission estimates and ongoing monitoring of data. Demonstrating whether regulations are contributing to expected reductions is affected by the methodology used to measure and backcast or forecast emissions. Incorporating or leveraging top-down approaches to estimating emissions may in some instances help to

validate estimates and increase accuracy. As was described in Section 2.2, ECCC has recently leveraged information from top-down approaches to revise its methodology for estimating methane emissions from the oil and gas sector.

- **Attributing results.** Given the wide range of factors that may influence GHG emissions (see Section 2.9), it is difficult to attribute observed emissions reductions to specific regulations. Some interviewees advocated focusing instead on measuring the combined impact of mitigation measures.
- **Communicating results.** At the performance reporting stage, given the highly technical nature of many indicators (for example, the GHG emission performance of LDVs), results achieved are difficult to communicate in a language that is accessible to the general public. This challenge is common to many science-based regulatory programs.

2.8. Achievement of expected results

Information and awareness

Findings: Overall, the information produced by ECCC is used extensively by external interested parties and meets their needs. Regulatees are generally aware of regulatory requirements and understand their obligations for coming into compliance. Areas for improvement include more data pertaining to the Arctic, inclusion of Indigenous perspectives and information in reporting and use of "plain language" in regulations, guidance documents and responses to questions.

As a direct outcome of CCCMP activities, ECCC aims to provide internal and external interested parties with access to the information and analysis that they need to inform their decision making.

Senior managers and decision makers

In the immediate term, program partners aim to provide senior management and decision makers with access to information and analyses on GHG and SLCP emissions, clean growth and climate change policy. A considerable volume of information and analyses is being produced and delivered on request to senior managers. However, internal key interviewees noted that they are sometimes uncertain how this information is used to inform decision making.[2] Furthermore, they indicated that the information provided may, in some cases, be incomplete because resource limitations have resulted in large amounts of collected data remaining unanalyzed. On a positive note, they indicated that scientific data is being presented earlier in the policy discussion process compared to what was done prior to 2016.

[2] Internal reporting indicates that 100% of requested information products were delivered to senior management and decision makers in FY 2018 to 2019 and FY 2019 to 2020. However, the number and nature of these requests are not reported, nor is information on how these products were perceived and used by senior managers and decision makers.

External interested parties

External key interviewees reported that they use extensively the information and analyses produced by ECCC, most frequently:

- Regulatory Impact Analysis Statements, which are used to explain the rationale for proposed regulations, as well as the expected costs and benefits
- National Greenhouse Gas Inventory Reports, which are used to assess P/T climate plans and incorporate data into policy and research
- Canada's Strengthened Climate Plan, which is used to inform policy development and provide policy direction

External key interviewees reported that the available information generally meets their needs. However, timeliness is perceived as an issue, particularly with respect to national GHG inventory data.[3] Perceived gaps include data pertaining to northern latitudes and the Arctic and Indigenous information and perspectives in reporting.

Regulated entities

Regulated individuals and organizations are generally aware of regulatory requirements and their obligations, with most segments of the target audiences having participated in consultations and engagement activities during regulatory development. Furthermore, regulatees generally believe that ECCC has provided adequate and timely information to facilitate compliance and has been open to feedback and available for follow-up questions and discussion.

In general, regulatees who were interviewed believe regulated entities understand what they need to do to come into compliance. Available performance data indicates that 100% of known regulatees subject to longer-standing regulations (namely the LDV, HDV and Renewable Fuels Regulations) submitted an annual report, as required, in both FY 2018 to 2019 and FY 2019 to 2020. This information is not yet available for regulations that were recently implemented.

That said, both regulatees and ECCC noted that limited technical expertise or limited resources to address technical requirements among small and medium-sized companies is a potential barrier to achieving compliance, especially for the HDV and Methane Regulations. ECCC planned to carry out targeted compliance promotion activities to reach small and medium-sized operators to address this issue.

Regulatees identified a specific need for greater use of "plain language" in regulations, guidance documents and ECCC's response to questions from regulatees, given the highly technical nature of the subject matter. For example, the vehicle and engine emission regulations were identified as difficult to understand for some regulated parties.

[3] Canada reports its national GHG inventory by April 15 each year, with data for the latest year being published 14.5 months following the year in question. This is consistent with international reporting deadlines.

Compliance

Findings: Compliance data for longer-standing regulations indicates that target audiences are generally in compliance with regulatory requirements.

Information on compliance with CCCMP regulations and associated equivalency agreements was limited at the time that the evaluation was conducted, due primarily to the relatively recent implementation of many of the measures within the scope of the program and the evaluation. Compliance reporting for the amended Coal, Natural Gas and Methane Regulations is expected in FY 2021 to 2022.

For longer-standing regulations, available information indicates that regulated communities are generally in compliance.

- **LDV regulations.** Compliance reports indicate that companies were in compliance throughout the 2011 to 2019 model years. The emission performance of 2017 and 2018 model year LDVs improved relative to the 2011 year, but was slightly below the targets, a result ECCC attributed to the expiration of the flex fuel vehicle credit, which negatively impacted the performance of several manufacturers, and the ongoing shift in consumer choice away from passenger cars and toward light-duty trucks and vehicles with slightly larger footprints within segments. For the 2019 model year, GHG emissions per vehicle of all new passenger automobiles and light-duty trucks were 23.2% and 16.9% lower, respectively, than 2011 model year vehicles.
- **HDV regulations.** For the 2018 model year, emission performance exceeded the target for both combination tractors and vocational vehicles, but was short of the target for heavy-duty pick-up trucks and vans. This result was attributed to a shift in consumer choice, coupled with various flexibility provisions such as the credit mechanisms that might not directly translate into an emission reduction for a particular model year. Emission performance met or exceeded the target for all categories of HDVs for the 2019 model year.
- **Renewable fuel regulations.** For the 2016 to 2018 compliance periods, all primary suppliers reported achieving the minimum renewable fuel content in their gasoline and distillate pools. Some submissions were suspected to contain errors or deviations from requirements and were subject to compliance verification. Suspected violations were referred to the Enforcement Branch for follow-up.

Reduced emissions

Findings: Emission reduction performance has been variable across the 3 main sectors targeted by the CCCMP, namely transportation, oil and gas and electricity. The impact of measures implemented since the CCCMP was established is not yet evident in emissions trend data due to offsetting factors.

Since 2005, Canada's total GHG emissions have remained essentially unchanged. According to ECCC's National Inventory Report 1990-2020, Canada's total GHG emissions in 2019 were 738 megatonnes of carbon dioxide equivalent, a 0.3% decrease from the previous year and a net reduction of 0.4% from 2005 total emissions.

Over this period, emission reduction performance has been variable across the main sectors targeted by the CCCMP, namely transportation, oil and gas and electricity. It is important to note that the impact of new regulations or regulatory amendments that came into force since the establishment of the CCCMP are not expected to be evident yet in trend data, since such changes only become evident over a longer term.

GHG emissions from light-duty and heavy-duty vehicles

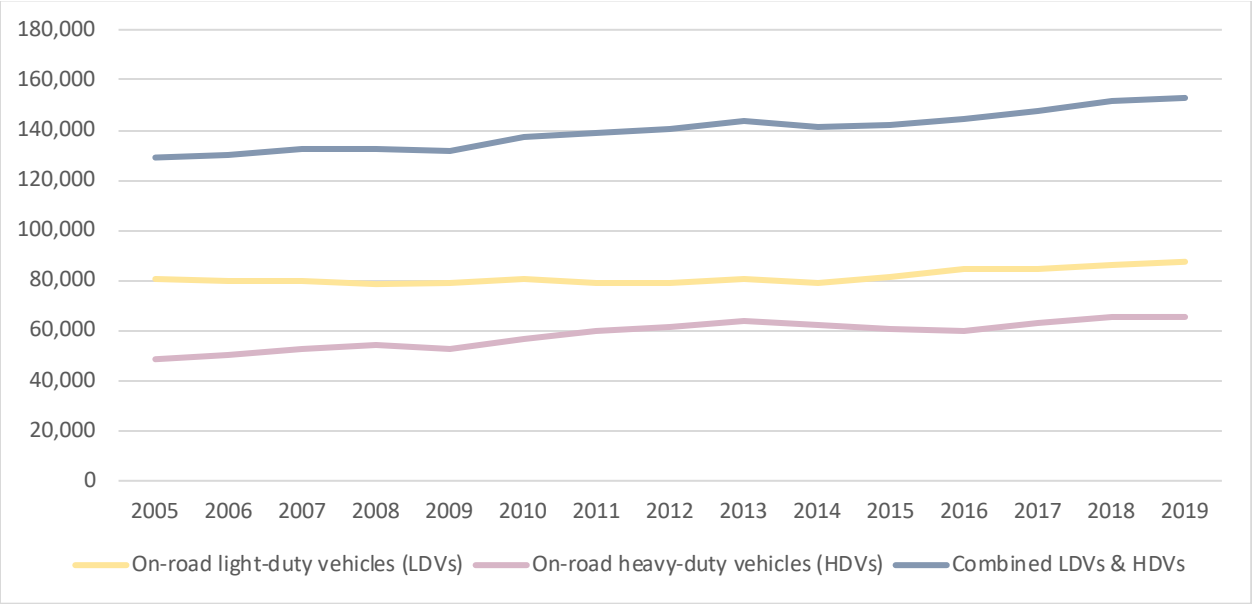
The LDV and HDV Regulations are expected to lead to reduced GHG emissions from LDVs and HDVs. ECCC's midterm evaluation of the LDV Regulations, published in February 2021, concluded that since 2011, the regulations have reduced GHG emissions in new passenger automobiles by 19.2% per vehicle and in light-duty trucks by 15.5% per vehicle.

However, as shown in, data from Canada's National Greenhouse Gas Inventory shows that overall emissions from LDVs and HDVs increased by 18% between 2005 and 2019. Emissions from LDVs increased by about 9%, while emissions from HDVs increased by about 35%. Furthermore, emissions continued an overall upward trajectory despite the introduction of increasingly stringent emission standards, beginning in 2011 for LDVs and in 2014 for HDVs.

ECCC attributes the growth in road transport emissions to growth of the vehicle fleet and in the total number of kilometres travelled for both light-duty and heavy-duty vehicles. For LDVs, the growth in emissions is also attributable to the increasing use of sport-utility vehicles, pick-up trucks and minivans for personal transportation.

Lastly, according to Canada's Fourth Biennial Report on Climate Change (2020), transportation emissions are projected to drop significantly by 2030, due primarily to the projected increases in fuel-efficiency of on-road vehicles and the growth of ZEVs. This change from historical trends is being driven by the federal LDV regulations, the impact of carbon pricing, and the new ZEV mandates, all of which are expected to more than offset the impact of a growing population and economy. Emissions are projected to decrease by 16 Mt between 2020 and 2030 as the stock of existing vehicles is gradually turned over with more efficient gasoline and diesel vehicles as well as with an increasing share of ZEV. The federal HDV GHG emissions standards parts 1 and 2 will also contribute to increased fuel-efficiency of on-road freight vehicles and a decline in emissions. The projections also include the impact of public transit investments.

Figure 3: Canada's greenhouse gas emissions from on-road light-duty and heavy-duty vehicles, from 2005 to 2019 (kilotonnes of carbon dioxide equivalent)

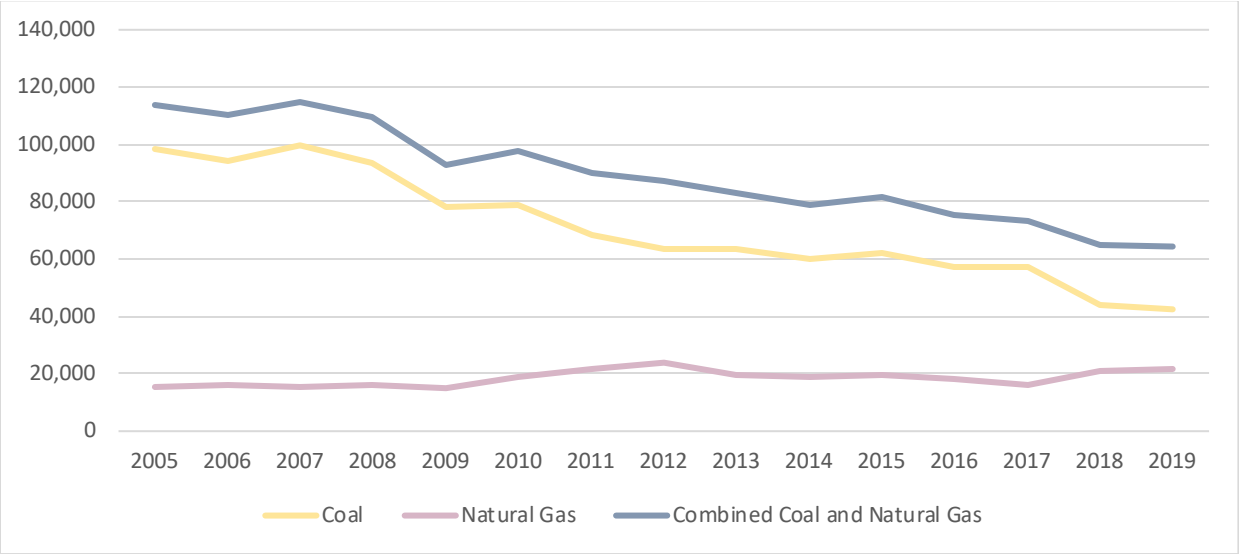


Source: Canada's Official GHG Inventory, Table A9-2 - Canada's 1990-2019 GHG Emissions by IPCC Sector.

GHG emissions from coal-fired and natural gas-fired electricity generation

The Coal-fired Electricity regulations are expected to result in the majority of coal units shutting down or converting to natural gas fuel by 2030, thereby reducing GHG emission from coal-fired generation. The Natural Gas-fired Electricity regulations set standards to ensure efficient performance from natural gas-fired electricity generation units. Inventory data shows that emissions from electricity generation have decreased by 48% since 2005 (despite increased demand), as a result of transitioning from high- to low-GHG emitting sources of electricity. Over this period, emissions from coal-fired electricity generation have declined by 57%, a trend attributable primarily to Ontario's phase-out of coal prior to 2019, while emissions from natural gas-fired electricity generation have increased by 42%, as shown in Figure 4. This data does not yet reflect the impact of the 2018 amendments to the Coal-fired Electricity regulations or the 2018 implementation of the Natural Gas-fired Electricity regulations.

Figure 4: Canada's greenhouse gas emissions from combustion of coal and natural gas for electricity generation, from 2005 to 2019 (kilotonnes of carbon dioxide equivalent)



Source: Canada's Official GHG Inventory, Table A13-1 - Electricity Generation and GHG Emission Details for Canada.

Methane emissions from the oil and gas sector

The Methane regulations are expected to lead to reduced methane emissions from the oil and gas sector. While the trend data for methane emissions from the oil and gas sector is not readily available, methane emissions from all sources decreased by 12% between 2005 and 2017, primarily as a result of declining emissions from livestock and the oil and gas sector. This data does not yet reflect the impact of the Methane regulations, which were implemented in 2018. interviewees noted that tracking emission reductions for methane is complicated by changing measurement methodology, as was described in Section 2.2.

Black carbon emissions

CCCMP mitigation actions targeting SLCPs are expected to lead to reduced black carbon emissions. Canada has committed to the Arctic Council goal for Arctic States of collectively reducing black carbon emissions (an SLCP) by 25 to 33% below 2013 levels by 2025. Data from Canada's 2020 Black Carbon Inventory Report shows that black carbon emissions declined by 16% between 2013 and 2019, although emissions increased between 2016 and 2018 before stabilizing in 2019 at 31,000 tonnes.

2.9. Influencing factors

Findings: While several factors influence the extent to which emission reductions are achieved, federal action is important because it provides an overarching policy context, as well as prompting, and providing a backstop for provincial/territorial measures.

Numerous factors are likely to influence the extent to which emission reductions will be achieved in the sectors and sources targeted by CCCMP mitigation measures. For example, jurisdictional authorities for climate change mitigation are shared among various orders of government. The Pan-Canadian Framework explicitly takes a collaborative approach. Consequently, actions by other governments will invariably impact program implementation and achievement of CCCMP's expected outcomes. Other relevant factors include market trends, consumer choices and behaviour, changing industry practice and scientific and technological developments.

Two examples examined in this evaluation illustrate the role of external factors in influencing outcome achievement.

- Although the LDV Regulations have been successful in reducing GHG emissions in new passenger automobiles and light-duty trucks, overall emissions from the LDV sector have increased, due to overall sector growth, increased distance travelled and consumer preferences for sport-utility vehicles, pick-up trucks and minivans for personal transportation. This evidence suggests that achieving emission reductions in a context of overall sector growth and prevailing consumer preferences may also require measures to incentivize the production and uptake of ZEVs.
- Alberta's successful and rapid phase-out of coal-fired electricity generation is seen by observers as the outcome of a provincial policy to eliminate coal-fired power generation by 2030, combined with carbon pricing and the federal Coal Regulations (Thibault et al., 2021; Vriens, 2018). In this context, the province's carbon pricing scheme, based on a technology-neutral performance standard, was a key factor in the industry's decision to switch from coal to natural gas, while support programs mitigated the impact of the transition for affected communities and workers. The federal Coal regulations set the overarching policy context, influenced Alberta's approach and provided a backstop against possible policy reversals on the part of the provincial government. As a result of this combination of policies, by the end of 2023, all of Alberta's 18 coal units will be either retired or converted to natural gas. This is 7 years earlier than required under Alberta's coal phase-out policy and 6 years earlier than mandated by federal regulations. GHG emissions from electricity generation in Alberta are expected to decline from 47.4 megatonnes per year in 2015 to 9.4 megatonnes per year by 2030, an 80% reduction in annual emissions (Thibault et al., 2021).

While the Alberta experience provides a particularly compelling example, many key interviewees emphasized the importance and effectiveness of federal policy and regulations more generally in setting an overall national policy context and providing a backstop (or insurance) for provincial policy or reversals of course.

3. Conclusions, recommendations and management response

3.1 Conclusions

Efficiency

Overall, implementation of the CCCMP has gone well. All major commitments have been implemented, including key planned mitigation measures for the transportation, oil and gas and electricity sectors.

The design of the CCCMP is sound. The program logic is coherent, and measures are complementary to other federal and P/T measures, with little evidence of overlap and duplication. The transportation, oil and gas, and electricity sectors remain appropriate targets for mitigation. However, an increased pace, stringency and/or scope of measures are needed for these sectors to be able to meet recent federal commitments and targets. Similarly, further action on methane is needed to achieve Canada's commitment to reduce methane emissions under the Global Methane Pledge. Although certain sectors and sources of emissions emerged as gaps that are currently not addressed by the CCCMP but require mitigation — most notably, emissions from agriculture, buildings, and heavy industry — the extent to which ECCC has a role to play in addressing these gaps through the CCCMP is unclear.

The evaluation identified a number of areas for improved scientific and technical knowledge. Some examples include improved understanding of emission sources, carbon sinks and nature-based solutions to climate change mitigation; leveraging top-down approaches to estimating GHG emissions, to increase the validity of these estimates; improved understanding of technologies for reducing emissions from HDVs and for industry to reach net zero; and advancing modelling in order to understand the potential and actual impacts of mitigation measures.

Modelling is particularly important because existing and future mitigation measures, either individually or collectively, may have different social, economic or other impacts on various population groups. For example, some measures may have a disproportionate impact on lower-income Canadians, if they lead to increased energy or vehicle costs. Similarly, large-scale infrastructure projects such as transmission lines may impact Indigenous Rights. While GBA Plus was conducted during the design of the CCCMP and some mitigation measures, it will be important to ensure that GBA Plus continues to be considered in the development and implementation of all CCCMP mitigation measures to comply with the new requirements of the Cabinet Directive on Regulation.

CCCMP resources were generally considered sufficient to deliver planned activities. Science activities required reallocations from other sources, despite the fact that one quarter of planned CCCMP funds for science and reporting were not spent. Existing resources are, however, viewed as insufficient to advance the federal government's increased commitments, given the growing volume of measures (including the possibility of additional equivalency agreements),

the technical complexity of the work, and the need to ensure the long-term sustainability of science and monitoring activities. The various efficiency measures already introduced could help to balance workload with available resources. These additional measures could include further automating regulatory reporting processes and increasing grants and contributions with external researchers and academics to expand analysis capacity,

CCCMP partners engage extensively with interested parties within and outside of the federal government in a variety of ways and through various formal and informal mechanisms. These include other federal departments, P/T governments, industry, ENGOs and researchers and academia, as well as international regulatory agencies and organizations. These efforts are generally viewed as positive and constructive. There are opportunities to enhance collaboration with the provinces and territories by, for example, engaging with them prior to making policy announcements and commitments; considering P/T data; and formally articulating federal and P/T roles and responsibilities, as well as equivalency requirements, at the outset of equivalency negotiations. In addition, a need to enhance engagement with Indigenous Peoples was identified, as this, to date, has been limited.

With regard to other federal departments, engagement and collaboration could be enhanced through formalizing an information-sharing process to ensure timely communication, particularly given the rapidly evolving policy context. In addition, it could be helpful to clarify the respective roles and responsibilities of ECCC and Transport Canada with regard to mitigating GHG emissions from the transportation sector and to collaborate closely to ensure complementarity of regulatory and market-based mitigation measures.

Performance measurement for the CCCMP is occurring through the Performance Information Profile for the Clean Growth and Climate Change Mitigation program and performance measurement strategies for individual mitigation measures.

Furthermore, the program is lacking a formal governance structure, as well as a formal mechanism for integrating science activities and internal partners with policy and regulatory development activities and partners. Establishing such structures or leveraging existing structures could enhance program oversight, coordination, accountability, and effectiveness, including the ability of science activities to inform policy and regulatory development.

Effectiveness

There is evidence of progress toward the immediate and intermediate outcomes of the CCCMP pertaining to information and awareness and compliance. There is, however, more limited evidence to date of reduced emissions in the 3 main sectors targeted by the program.

- **Information and awareness:** The information produced by ECCC is used extensively by external interested parties and meets their needs. Regulatees are generally aware of regulatory requirements and understand their obligations for coming into compliance. Areas for improvement include use of “plain language” in regulations, guidance

documents and responses to questions, more data pertaining to the Arctic and the inclusion of Indigenous perspectives and information in reporting.

- **Compliance:** Compliance data for longer-standing regulations indicates that target audiences are generally in compliance with regulatory requirements. For recently introduced measures, compliance information will become available in the coming years.
- **Reduced emissions:** Emission reduction performance has been variable across the 3 main sectors targeted by the CCCMP. Emissions from road transportation have increased, despite increasingly stringent emission standards, as a result of overall sector growth, increased distance travelled, and consumer preference for sport-utility vehicles, pick-up trucks, and minivans for personal transportation. Conversely, overall emissions from the electricity generation sector have declined. In particular, emissions from coal-fired electricity generation have declined, driven primarily by the phase-out of coal-fired electricity generation in Ontario prior to 2019. Nevertheless, emissions from natural gas-fired electricity have been increasing. Total methane emissions have declined, primarily as a result of declining emissions from the oil and gas sector and livestock production. The impact of measures implemented since the CCCMP was established is not yet evident in emissions trend data.

While numerous factors influence the extent to which emissions reductions are achieved, evidence from this evaluation indicates that federal action is important to setting an overarching policy context, as well as prompting, and providing a backstop for, P/T measures.

3.2 Recommendations and management response

The following recommendations are addressed to ECCC's Assistant Deputy Minister of the Environmental Protection Branch (EPB), as the senior departmental official responsible for the Core Climate Change Mitigation Program.

Recommendation 1

Recommendation 1: Assess the program's evolving needs for scientific and technical information and analysis, and identify and implement measures to strengthen the program capacity where required.
Given enhanced federal commitments and emission reduction targets, program partners and external interested parties anticipate increased demands for scientific and technical information and analysis. A number of opportunities were identified for improved knowledge and understanding to support decision making. More extensive use of grants and contributions funding could expand ECCC's analytic capabilities in support of these increased commitments.
Statement of agreement or disagreement
The Assistant Deputy Minister of the Environmental Protection Branch agrees with the recommendation.

Management response

ECCC agrees that good decision making requires a robust knowledge base.

The Department is committed to the continuous improvement of scientific information related to climate change. ECCC's Science and Technology Branch is currently leading the development of the Climate Science 2050: Canada's Climate Change Science and Knowledge Plan. This plan will identify Canadian climate change science and knowledge priorities and inform future planning and investments by science and knowledge producers, holders and funders as they advance the collaborative and interdisciplinary efforts needed to inform climate action. Effective progress on these science activities will require improved coordination of collaborative government-academic research partnerships, enabled by ECCC working closely with the granting councils to build and guide this capacity.

ECCC's Science and Technology Branch is also leading the development of a whole-of-government plan to reduce methane emissions across the broader Canadian economy consistent with the Global Methane Pledge. Enhancing scientific knowledge and continuous improvement in emissions measurement and quantification is essential to inform policy decisions and is a key part of this plan. The Government of Canada will continue to work with academics, scientific experts, industry, and clean technology companies to better understand methane emission sources and improve quantification to mitigate emissions.

ECCC has some of the most advanced modelling measures in the country. It has also implemented a variety of initiatives such as the Department's Academic Engagement Strategy, the Net-Zero Advisory Body and the Climate Change Institute. In addition, the Department has also recently received funding related to Nature-based Climate Solutions. Although these initiatives are being funded separately from Clean Growth Climate Change programming, the Department will continue to seek opportunities to leverage these initiatives to improve its capacity to respond to demands for accurate economic and emissions modelling.

ECCC uses Grants and Contributions agreements to support technological developments to support transition to net-zero emissions, and will continue to identify experts to carry out appropriate activities under Grants and Contributions agreements.

Deliverables	Timeline	Responsible party
Climate Science 2050: Canada's Climate Change Science and Knowledge Plan	December 31, 2022	Science and Technology Branch
Canada's Methane Reduction Plan	December 31, 2022	Science and Technology Branch
Continue engaging with industry and academia, using grants and contribution agreements to further shared objectives	October 31, 2024	Environmental Protection Branch and Science and Technology Branch

and stimulate the development of new GHG mitigation technologies.		

Recommendation 2

Recommendation 2: Consider opportunities to improve engagement and collaboration with external interested parties that have responsibilities for climate change mitigation, in particular, provincial and territorial governments, other federal government departments and Indigenous Peoples.
ECCC's engagement and collaboration efforts are generally seen as positive and constructive. In some cases, collaboration with provincial and territorial governments could be improved by engaging with them prior to making policy announcements and commitments; considering additional provincial and territorial data; and formally articulating roles, responsibilities, and equivalency requirements at the outset of equivalency negotiations. In addition, engagement with Indigenous Peoples has been limited to date and a need for greater effort was identified. For other federal departments, collaboration could be enhanced through formalizing an information-sharing process and collaborating closely to ensure complementarity of regulatory and market-based mitigation measures.
Statement of agreement or disagreement
The Assistant Deputy Minister of the Environmental Protection Branch agrees with the recommendation.
Management response
Coordination and engagement on overlapping initiatives is essential to the development and implementation of well informed, robust GHG policies and measures. While engagement with interested parties is a standard practice, the department is committed to continuous improvement. This is particularly the case in support of Indigenous reconciliation. Departmental programs will continue to collaborate to adopt best practices regarding their various activities. ECCC's engagement and collaboration with provinces and territories, non-governmental organizations and experts has been substantive and valuable. ECCC recognizes the importance of these actions and will continue to engage and collaborate with interested parties, including with provinces and territories, in advance of policy announcements, to the extent that is within the Department's control.

Deliverables	Timeline	Responsible party
ECCC will continue to collaborate through existing and new interdepartmental coordination mechanisms with other	December 31, 2025	Environmental Protection Branch

government departments on the development of GHG emission reduction regulations.		

Recommendation 3

Recommendation 3: Review the existing program's governance structure to ensure that it continues to support effective decision-making process, coordination and accountability.
Rather than having program-specific governance, logic model and performance measurement, the CCCMP currently leverages existing departmental mechanisms, including at the Departmental Result Framework program inventory level and for specific regulations. Beyond the Short-lived Climate Pollutants Integration Committee, the program does not have a formal mechanism to link climate change mitigation science, policy, and regulatory development. Instead, it leverages existing departmental structures and relationships, for example through informal biweekly information-sharing teleconferences. Establishing formal and program-specific governance structures, logic model and performance measurement could enhance program oversight, coordination, accountability and effectiveness.
Statement of agreement or disagreement
The Assistant Deputy Minister of the Environmental Protection Branch partially agrees with the recommendation.
Management response
The Core Climate Change Mitigation Program, the subject of this evaluation, is a part of the Clean Growth and Climate Change Mitigation Program. The Clean Growth and Climate Change Mitigation Program is included in the Departmental Results Framework, and includes 7 Core Climate Change Mitigation Program-specific indicators, 5 of which are also Departmental Results Indicators. The program currently has a number of horizontal collaborative mechanisms in place for governance and coordination of climate change mitigation science, policy, and regulatory development. These include the Deputy Minister Climate Plan Implementation, the Assistant Deputy Minister Climate Plan Implementation and the Director General Climate Plan Implementation committees. The program will continue to leverage existing committees and working groups to ensure coherence among activities, and identify areas for improvement. As required by the Treasury Board Secretariat's Policy on Results, ECCC has established a Performance Information Profile for each program in the Departmental Results Framework Program Inventory. Each Performance Information Profile contains a logic model and an indicator table. As Canada's climate plans continue to evolve, a review and update of the Clean Growth and Climate Change Mitigation Program Performance Information Profile is recommended. The

current Performance Information Profile is mostly based on the Pan-Canadian Framework on Clean Growth and Climate Change and lacks information related to measures subsequently announced in the Emissions Reduction Plan. These concerns have been raised by Corporate Services and Finances Branch and by the Climate Change Branch.

The program is also scheduled to present the results and progress of the Clean Growth and Climate Change Mitigation Program to the Performance Measurement, Evaluation and Results Committee in early 2023.

Deliverables	**Timeline**	**Responsible party**
Present an updated Clean Growth and Climate Change Mitigation Program Performance Information Profile and logic model to the Performance Measurement, Evaluation and Results Committee	December 31, 2023	Environmental Protection Branch, supported by the Climate Change Branch and other branches with items in the Performance Information Profile

Appendix A: Program mitigation measures

Table 1: Regulatory instruments targeting greenhouse gas and short-lived climate pollutant emissions under the Core Climate Change Mitigation Program

Status	Instrument	Sector	Emissions targeted	SOR Number or Canada Gazette I (CGI) publication date	Implementation date	Year last amended
Early Stage of Implementation (implemented under the CCCMP)	Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations[4]	Cross-sectoral	SLCP	SOR/2020-258	2020	n/a
Early Stage of Implementation (implemented under the CCCMP)	Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)	Oil and Gas	GHG	SOR/2018-66	2018	n/a
Early Stage of Implementation (implemented under the CCCMP)	Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity	Electricity	GHG	SOR/2018-261	2018	n/a
Implemented prior to the CCCMP	Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations	Transportation	GHG	SOR/2013-24	2013	2018
Implemented prior to the CCCMP	Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations	Electricity	GHG	SOR/2012-167	2012	2018
Implemented prior to the CCCMP	Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations	Transportation	GHG	SOR/2010-201	2010	2014
Implemented prior to the CCCMP	Renewable Fuels Regulations	Oil and Gas	SLCP	SOR/2010-189	2010	2011
Equivalency Agreements	Canada-Nova Scotia equivalency agreement regarding greenhouse gas emissions from electricity producers	Electricity	GHG SLCP	n/a	2014	Renewed in 2020
Equivalency Agreements	Canada-Saskatchewan equivalency agreement	Electricity	GHG SLCP	n/a	2016	Renewed in 2020

[4] Although these regulations primarily target air pollutants and were included as part of the recent Evaluation of the Addressing Air Pollution Horizontal Initiative, they were included as part of the CCCMP because they also indirectly address short-lived climate pollutants due to the air pollutant standards implemented for stationary diesel engines.

Status	Instrument	Sector	Emissions targeted	SOR Number or Canada Gazette I (CGI) publication date	Implementation date	Year last amended
	regarding greenhouse gas emissions from electricity producers					
Equivalency Agreements	Canada-Alberta equivalency agreement respecting the release of methane from the oil and gas sector	Oil and Gas	GHG SLCP	n/a	2020	n/a
Equivalency Agreements	Canada-British Columbia equivalency agreement respecting the release of methane from the oil and gas sector	Oil and Gas	GHG SLCP	n/a	2020	n/a
Equivalency Agreements	Canada-Saskatchewan equivalency agreement respecting the release of methane from the oil and gas sector	Oil and Gas	GHG SLCP	n/a	2020	n/a

Appendix B: Financial information from ECCC Departmental Results Reports

Table 2: Planned Core Climate Change Mitigation Program expenditures, by branch, fiscal year 2016 to 2017 to fiscal year 2021 to 2022

ECCC Branch	FY 2016 to 2017	FY 2017 to 2018	FY 2018 to 2019	FY 2019 to 2020	FY 2020 to 2021	FY 2021 to 2022*	Total
Environmental Protection Branch	$12,243,848	$14,232,047	$17,990,116	1$7,750,124	$17,625,542	$17,675,538	$97,517,215
Science and Technology Branch	$8,535,186	$8,984,491	$8,950,287	$8,991,382	$8,991,382	$8,998,313	$53,451,041
Strategic Policy Branch	$3,584,949	$3,828,892	$4,336,988	$4,236,989	$4,236,989	$4,236,989	$24,461,796
Other branches	$3,859,679	$3,991,760	$4,601,132	$4,800,437	$4,702,698	$4,578,872	$26,534,578
Employee Benefit Plan	$3,111,846	$3,460,820	$4,109,700	$4,109,700	$4,109,700	$4,109,700	$23,011,466
Total ECCC	**$31,335,508**	**$34,498,010**	**$39,988,223**	**$39,888,632**	**$39,666,311**	**$39,599,412**	**$224,976,096**
Out of Program	$2,039,262	$2,295,070	$2,758,525	$2,758,135	$2,757,277	$2,757,004	$15,365,273

Source: Corporate Services and Finance Branch, ECCC
Other ECCC Branches include: Audit and Evaluation, Corporate Services and Finance, Meteorological Service of Canada, Legal Services, Enforcement Branch and Public and Indigenous Affairs, Ministerial Services Branch and Corporate Support Services.
Out of Program includes: Procurement and Public Services Canada and Shared Services Canada.
*This evaluation covers only the first quarter of FY 2021 to 2022 (to June 30, 2022).

Table 3: Planned Core Climate Change Mitigation program expenditures, by core activity, fiscal year 2016 to 2017 to fiscal year 2020 to 2021

Activity	FY 2016 to 2017	FY 2017 to 2018	FY 2018 to 2019	FY 2019 to 2020	FY 2020 to 2021	FY 2021 to 2022*	Total
Mitigation actions	$11,599,378	$13,644,099	$18,154,062	$18,119,076	$17,909,494	$17,839,494	$97,265,603
Science and reporting	$8,263,914	$8,434,279	$8,402,638	$8,443,732	$8,443,732	$8,450,661	$50,438,956
Policy and analysis	$5,977,237	$6,331,241	$6,262,187	$6,162,187	$6,162,187	$6,162,187	$37,057,226
Corporate Support Services	$2,383,133	$2,627,571	$3,059,636	$3,053,937	$3,041,198	$3,037,370	$17,202,845
Employee Benefit Plan	$3,111,846	$3,460,820	$4,109,700	$4,109,700	$4,109,700	$4,109,700	$23,011,466
Total ECCC	**$31,335,508**	**$34,498,010**	**$39,988,223**	**$39,888,632**	**$39,666,311**	**$39,599,412**	**$224,976,096**
Out of Program	$2,039,262	$2,295,070	$2,758,525	$2,758,135	$2,757,277	$2,757,004	$15,365,273
Grand Total	**$33,374,770**	**$36,793,080**	**$42,746,748**	**$42,646,767**	**$42,423,588**	**$42,356,416**	**$240,341,369**

Source: Corporate Services and Finance Branch, ECCC
*This evaluation covers only the first quarter of FY 2021 to 2022 (to June 30, 2022).

Table 4: Core Climate Change Mitigation Program planned versus actual expenditures, by branch, fiscal year 2016 to 2017 to fiscal year 2020 to 2021

ECCC Branch	Planned	Actual	Variance	Actual/planned
Environmental Protection Branch	$79,841,677	$70,475,598	$-9,366,079	88%
Science and Technology Branch	$44,452,728	$37,092,136	$-7,360,592	83%
Strategic Policy Branch	$20,224,807	$19,642,684	$-582,123	97%
Other branches	$21,955,706	$22,635,768	$680,062	103%
Employee Benefit Plan	$18,901,766	$21,082,786	$2,181,020	112%
Total ECCC	**$185,376,684**	**$170,928,972**	**$-14,447,712**	**92%**
Out of Program	$12,608,269	$12,608,269	$0	100%
Grand Total	**$197,984,953**	**$183,537,241**	**$-14,447,712**	**93%**

Source: Corporate Services and Finance Branch, ECCC.
Other ECCC Branches include: Audit and Evaluation, Corporate Services and Finance, Meteorological Service of Canada, Legal Services, Enforcement Branch, and Public and Indigenous Affairs, Ministerial Services Branch, and Corporate Support Services..
Out of Program includes: Procurement and Public Services Canada, and Shared Services Canada.
This evaluation covers only the first quarter of FY 2021-2022 (to June 30, 2022).

Table 5: Core Climate Change Mitigation Program planned versus actual expenditures, by core activity, fiscal year 2016 to 2017 to fiscal year 2020 to 2021

Activity	Planned	Actual	Variance	Actual/planned
Mitigation actions	$79,426,109	$78,242,933	$-1,183,176	99%
Science and reporting	$41,988,295	$32,075,893	$-9,912,402	76%
Policy and analysis	$30,895,039	$25,196,083	$-5,698,956	82%
Corporate Support Services	$14,165,475	$14,331,313	$165,838	101%
Employee Benefit Plan	$18,901,766	$21,082,786	$2,181,020	112%
Total ECCC	**$185,376,684**	**$170,929,008**	**$-14,447,676**	**92%**
Out of Program	$12,608,269	$12,608,269	$0	100%
Grand Total	**$197,984,953**	**$183,537,277**	**$-14,447,676**	**93%**

Source: Corporate Services and Finance Branch, ECCC.
Out of Program includes: Procurement and Public Services Canada, and Shared Services Canada.
This evaluation covers only the first quarter of FY 2021 to 2022 (to June 30, 2022).

Appendix C: Evaluation approach

Evaluation issues and questions

The following questions were examined in the evaluation.

Efficiency

- Have activities been implemented as planned? What, if any, challenges have been encountered and how have these been addressed?
- Is the program responsive to emerging issues, challenges, and developments?
- Is the design of the program appropriate in the context of Canada's Strengthened Climate Plan?
- To what extent has GBA Plus been considered in the design of the program?
- To what extent is there complementarity, duplication, and/or overlap with other initiatives (federal, P/T) that aim to reduce GHG emissions?
- What new challenges are equivalency agreements posing for ECCC? How is ECCC responding to these challenges?
- Has the program used resources as planned? To what extent do the program resources and capacity align with its mandate?
- Are there alternative approaches that would be more efficient or effective at achieving the expected results?
- Does the governance structure support participation and decision making?
- To what extent is performance data and information available, usable, and of quality to support decision making and evaluation?

Effectiveness

- To what extent has the program made progress in achieving expected outcomes?

  Immediate outcome: Information and awareness

  - To what extent has the program provided internal and external interested parties with access to needed information and analysis for decision making?

  Intermediate outcome: compliance

  - To what extent are regulated entities in compliance with regulations implemented to limit or reduce GHG and SLCP emissions?

  Long-term/ultimate outcomes: reduced emissions/achievement of targets

  - To what extent have emissions been reduced in the targeted sectors?
  - To what extent is the CCCMP on track to achieving targeted reductions in GHG and SLCP emissions by 2030, and net zero by 2050?
- Have there been other effects from program activities, including group-specific impacts?
- What other factors (external and internal to the program) are influencing program delivery or the achievement of expected outcomes?

Evaluation approach and methodology

Several data collection methodologies were used to address the evaluation issues and questions. Evidence drawn from these methods informed the findings and conclusions.

Document, literature and data review

The document, literature, and data review served to develop a thorough understanding of the CCCMP and to contribute as a line of evidence to address all evaluation questions. Examples of the types of materials reviewed included key policy-setting documents, program planning and operational documents, departmental plans and results reports, previous evaluation and audit reports, relevant legislation and regulations, relevant publicly available data (for example, Canada's Official Greenhouse Gas Inventory), financial information, performance measurement data, information on governance, peer-reviewed scientific literature, grey literature, reports by key international bodies such as the IPCC and the WMO and other materials.

Comparative analysis

The jurisdictional comparison examined approaches to mitigating climate change in other jurisdictions, both in Canada and internationally, with the primary objective of uncovering lessons learned from experiences elsewhere, as well as information on possible alternatives that ECCC may wish to consider. The jurisdictional comparison examined approaches taken in select jurisdictions, identified through scoping interviews with senior management, in relation to the 3 main sectors targeted by the CCCMP: transportation, oil and gas and electricity generation. Relevant information was located through online searches.

Key informant interviews

Interviews were used to solicit informed opinions and observations on the evaluation questions from various interested parties involved in or familiar with the CCCMP. A total of 68 key interviewees were interviewed, including:

- 30 program representatives, including representatives of the Environmental Protection Branch, Science and Technology Branch, Strategic Policy Branch, Enforcement Branch, Climate Change Branch and Corporate Management Directorate.
- 38 external key interviewees, including representatives of other federal government departments, provincial and territorial governments, researchers and academia, regulatees, ENGOs and Indigenous organizations.

Case studies

Four detailed case studies were completed, focussing on the following topics:

- phase-out of coal-fired electricity generation in Alberta
- implementation of methane equivalency agreements
- reducing GHG emissions from heavy-duty freight vehicles
- evolving approaches to estimating GHG emissions

Each case study consisted of a document, data and literature review as well as interviews. Interview questions relating to the case studies were integrated into the interview guides, and all interviewees were given the option of addressing these questions.

Appendix D: Detailed description of Core Climate Change Mitigation Program implementation

Science and reporting

In the area of science, ECCC continued long-term atmospheric modelling and monitoring of GHGs, SLCPs and aerosols, and augmented existing monitoring and climate modelling programs to understand the role of SLCPs in warming the climate and the potential for reductions in SLCP emissions to mitigate climate change. ECCC also conducted research focussing on measuring anthropogenic GHGs at the sub-national scale (from urban to facility level) to identify new qualification methods and support further mitigation potential. Internal key interviewees reported that implementation of planned SLCP monitoring activities required reallocating A-base and climate change adaptation funds, creating pressures on work in other areas.

With regard to reporting, ECCC continued to operate the Greenhouse Gas Reporting Program, which collects information on GHG emissions annually from facilities across Canada, and produced annual reports on facility-level GHG emissions. ECCC also continued regular reporting on GHGs and SLCPs, producing Canada's National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, Canada's Black Carbon Inventory Report and Canada's Greenhouse Gas and Air Pollutant Emissions Projections Report. ECCC also made submissions to meet Canada's international reporting obligations, including GHG and black carbon inventory submissions to the UNFCCC and the United Nations Economic Commission for Europe, as well as data submissions to the World Meteorological Organisation.

Policy and analysis

ECCC conducted intelligence gathering and completed technical analyses and modelling to support policy options and mitigation measures. ECCC also conducted economic analysis and cost-benefit analysis, including the development of Regulatory Impact Analysis Statements, for proposed CCCMP regulations. ECCC followed the established regulatory process for developing and implementing CCCMP regulations, including publishing proposed regulations and Regulatory Impact Analysis Statements in Canada Gazette I, holding mandatory public consultations on proposed regulations, and publishing final regulations in Canada Gazette II.

ECCC produced national GHG and air pollution emission projections and targets, and reported annually on progress towards these targets. ECCC also met its international reporting obligations and participated in various international fora.

Mitigation actions

ECCC proposed and implemented key planned mitigation measures to reduce GHG emissions, with a primary focus on the transportation, electricity and oil and gas sectors.

Transportation

ECCC continued to administer the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations, which establish progressively more stringent GHG emission standards for new on-road LDVs manufactured or imported into Canada for the purpose of sale. The regulations took effect with model year 2011 and were amended in 2014 to establish GHG standards for the 2017 to 2025 model years. In 2018, the U.S. EPA rolled back its existing emission standards for LDVs for the 2020 to 2025 model years. In December 2021, the US EPA published a revised LDV standard which increased the stringency for model years 2023 to 2026. Since the U.S. EPA standards are incorporated by reference into the Canadian regulations, these changes were automatically applied in Canada to align with those in the U.S.

ECCC published final Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations in 2018. The amendments establish new and more stringent GHG emission standards and test procedures aligned with the U.S. EPA HDV Phase 2 equivalent standards for the 2021 to 2027 model years. In addition, the amendments introduce emissions standards for trailers that are pulled by on-road combination tractors. The application of the trailer provisions in Canada has been suspended pending the outcome of litigation concerning the equivalent provisions in the U.S. (Government of Canada, 2021a).

The Transportation Division of ECCC continued to administer the LDV and HDV Regulations through activities such as (but not limited to) compliance promotion; development of new testing methodologies and a new implementation approach for Enhanced Compliance of Vehicles and Engines, delivery of the Enhanced Vehicle Compliance Verification Program, updating and administering the Vehicle and Engine Emissions Reporting Registry (the online reporting tool that is used by automakers to submit their regulatory reports) and processing and analyzing regulatory submissions.

ECCC commissioned various technical analyses related to reducing GHG emissions from the off-road transportation sector to inform policy options.

Electricity

In 2018, ECCC published the final Amended Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations (Coal-fired Electricity Regulations) to phase out conventional coal-fired electricity by no later than 2030. Under the amended regulations, new units built after July 1, 2015 have to meet the performance standard of 420 tonnes of carbon dioxide per gigawatt-hour of electricity produced when they start operating. As for existing units, they must meet the performance standard at their end of useful life (generally 50 years) or by 2030, whichever comes first.

Also in 2018, ECCC published the Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity Regulations (Natural Gas-fired Electricity Regulations), which set performance emission standards for the natural gas-fired electricity generation, including for coal-fired boilers converted to run on natural gas. The intent of these regulations is to support a transition to a lower-emitting electricity sector, given anticipated increased demand for natural gas-fired electricity, and to provide regulatory certainty to industry.

In 2019, ECCC renewed an existing equivalency agreement with Nova Scotia related to coal-fired electricity generation and finalized an equivalency agreement with Saskatchewan.

Oil and gas

ECCC published the Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector) in 2018. These regulations, which apply to oil and gas facilities for the extraction, production and processing, and transportation of crude oil and natural gas, are intended to control and reduce methane emissions from upstream oil and gas sources by 40-45% by 2025 from 2012 levels. The regulations have a staged implementation: leak detection and repair, compressors, and well completion rules came into force in 2020, while pneumatic devices and venting rules will come into force in 2023.

Implementation of the Methane Regulations was challenged by the fact that the upstream oil and gas sector is a relatively new area of federal regulation, which meant that the regulated community was not known to ECCC in advance. Consequently, in 2020 (the first year of compliance), ECCC's compliance promotion activities focussed primarily on assessing the regulated audience and determining what compliance promotion activities would be most effective.

This work was complicated by ongoing negotiations with respect to equivalency with British Columbia, Alberta and Saskatchewan, which resulted in equivalency agreements being established with all 3 provinces by the end of 2020. Since these jurisdictions account for 98% of the potential regulated community, the agreements substantially reduced the size of the federally regulated community. Beginning in FY 2020 to 2021, the Multi-sector Air Pollutant Regulations Working Group is providing compliance promotion support for the Methane Regulations on an ad hoc basis.

Due to the COVID-19 pandemic, compliance promotion activities were delivered online in FY 2020 to 2021, rather than in person. The pandemic also led industry to experience labour shortages, delays in installation of equipment, and challenges in carrying out some leak detection and repairs requirements. Due to concerns regarding risks to human health and safety, regulatees were given more time to comply with regulatory leak detection and repair requirements, as allowed by the regulations.

ECCC continued to administer the Renewable Fuels Regulations by carrying out compliance promotion, compliance verification, and enforcement activities. Planned collaborations with the United States and Mexico with respect to reducing GHG emissions from the oil and gas sector

did not take place, which program representatives attributed to the change in the U.S. administration.

Short-lived climate pollutants

The specific mitigation activities for SLCPs that were included in the CCCMP are near-term measures identified in ECCC's 2017 Strategy on Short-lived Climate Pollutants, one of which was federal regulations for methane from upstream oil and gas operations (already described). In addition, in 2020, ECCC published the Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations, which establish and implement air pollutant emission standards in alignment with U.S. EPA standards.[5]

A planned discussion paper and engagement strategy on potential measures to reduce methane from landfills were somewhat delayed, as time was needed to secure the necessary expertise and develop a sound dataset. The paper had been drafted as of July 2021, with consultation and engagement undertaken in fall 2021 and pre-publication in Canada Gazette I expected in fall 2022. Initial analysis of regulatory options to reduce black carbon from new wood-burning appliances, completed in 2017, indicated that development of a national standard for new woodstoves will require an amendment to CEPA. Further work in this area is on hold. [6]

Canada engaged internationally on SLCPs as the current chair of the Global Methane Initiative, and as a member of the Arctic Council, which in 2017 committed to the aspirational goal of reducing collective emissions of black carbon by 25 to 33% of 2013 levels by 2025. In 2018, Canada hosted the Global Methane Forum, an outcome of which was to launch the Global Methane Challenge in 2019 to accelerate and showcase methane mitigation.

Marine and industrial sectors

ECCC completed research and technical analysis to better understand emissions from the Canadian domestic marine sector, and in particular to better understand the impact of black carbon emissions from ships in the Arctic. With regard to industrial sectors, ECCC designed and implemented output-based performance standards for the mining and processing sectors, the electricity sector, and the oil and gas sector.

[5] Although these regulations primarily target air pollutants and were included as part of the recent Evaluation of the Addressing Air Pollution Horizontal Initiative, they were included as part of the CCCMP because they also indirectly address SLCPs due to the air pollutant standards implemented for stationary diesel engines.
[6] In April 2021, the Government of Canada introduced Bill C-28, the Strengthening Environmental Protection for a Healthier Canada Act. Bill C-28 proposed amendments to CEPA that would have enabled regulations to be made governing the design of products that may release toxic substances during their use (such as wood-burning appliances). However, Bill C-28 died on the Order Paper when the 2021 federal election was called.

Appendix E: Reference list

CCAC & UNEP. (2021). Global Methane Assessment: Summary for Decision Makers.

Center for Climate and Energy Solutions. (2019). Clean energy standards: State and federal policy options and considerations. Center for Climate and Energy Solutions.

Chan, E., Worthy, D. E. J., Chan, D., Ishizawa, M., Moran, M. D., Delcloo, A., & Vogel, F. (2020). Eight-Year Estimates of Methane Emissions from Oil and Gas Operations in Western Canada Are Nearly Twice Those Reported in Inventories. *Environmental Science & Technology*, *54*(23), 14899–14909.

Cunanan, C., Tran, M.-K., Lee, Y., Kwok, S., Leung, V., & Fowler, M. (2021). A Review of Heavy-Duty Vehicle Powertrain Technologies: Diesel Engine Vehicles, Battery Electric Vehicles, and Hydrogen Fuel Cell Electric Vehicles. *Clean Technologies*, *3*(2), 474–489.

Department of Finance Canada. (2021, April 19). Budget 2021 A Healthy Environment for a Healthy Economy [Backgrounders].

ECCC. (2020a). *A Healthy Environment and a Healthy Economy: Canada's strengthened climate plan to create jobs and support people, communities and the planet.*

ECCC. (2020b). *Canada's national report on black carbon and methane: Canada's third biennial report to the Arctic Council.*

ECCC. (2021a). *Canada's Black Carbon Inventory Report 2013-2019.*

ECCC. (2021b). *Final decision document on the midterm evaluation of the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations.*

ECCC. (2021c). *National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada. Executive Summary.*

ECCC. (2021d). *National Inventory Report 1990-2019: Greenhouse Gas Sources and Sinks in Canada. Part 1.*

ECCC. (2021e, July 30). *Greenhouse gas emissions performance for the 2019 model year light-duty vehicle fleet* [Acts].

ECCC. (2021f). *Review of Canada's methane regulations for the upstream oil and gas sector* [Regulations].

ECCC. (2022). *2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy.*

Government of Canada. (1999). *Canadian Environmental Protection Act, 1999.*

Government of Canada. (2018a). *Pan-Canadian Framework on Clean Growth and Climate Change.*

Government of Canada. (2018b). *Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity (SOR/2018-261).*

Government of Canada. (2018c, November 16). *Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations (SOR/2013-24).* https://laws-lois.justice.gc.ca/eng/regulations/sor-2013-24/FullText.html

Government of Canada. (2018d, November 16). *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (SOR/2010-201).*

Government of Canada. (2018e, November 30). *Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations (SOR/2012-167).*

Government of Canada. (2020a, January 1). *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector) (SOR/2018-66).*

Government of Canada. (2020b, December 4). *Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations (SOR/2020-258).*

Government of Canada. (2021a, May 29). *Canada Gazette, Part 1, Volume 155, Number 22: ORDERS IN COUNCIL*. Government of Canada, Public Works and Government Services Canada, Integrated Services Branch, Canada Gazette.

Government of Canada. (2021b, June 29). *Canadian Net-Zero Emissions Accountability Act.*

IEA. (2020). *Methane Tracker 2020* [Fuel Report]. International Energy Agency.

IEA. (2021). *Net Zero by 2050: A Roadmap for the Global Energy Sector.*

IPCC. (2019). *2019 Refinement to the 2006 IPCC Guidelines of National Greenhouse Gas Inventories* (E. Calvo Buendia, K. Tanabe, A. Kranjc, J. Baasansuren, M. Fukuda, S. Ngarize, A. Osako, Y. Pyrozhenko, P. Shermanau, & S. Federici, Eds.).

IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Summary for Policymakers. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.*

Kaushik, A., Graham, J., Dorheim, K., Kramer, R., Wang, J., and Byrne, B. (2020, February 20). *The Future of the Carbon Cycle in a Changing Climate*. Eos.

Liggio, J., Li, S.-M., Staebler, R. M., Hayden, K., Darlington, A., Mittermeier, R. L., O'Brien, J., McLaren, R., Wolde, M., Worthy, D., & Vogel, F. (2019). Measured Canadian oil sands

CO_2 emissions are higher than estimates made using internationally recommended methods. *Nature Communications*, *10*(1), 1863.

MacKay, K., Lavoie, M., Bourlon, E., Atherton, E., O'Connell, E., Baillie, J., Fougère, C., & Risk, D. (2021). Methane emissions from upstream oil and gas production in Canada are underestimated. *Scientific Reports*, *11*(1), 1–8.

Ocko, I. B., Sun, T., Shindell, D., Oppenheimer, M., Hristov, A. N., Pacala, S. W., Mauzerall, D. L., Xu, Y., & Hamburg, S. P. (2021). Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming. *Environmental Research Letters*, *16*(5), 054042.

Péloffy, K., Thomas, S., Marshall, D., & Abreu, C. (2019). *Setting Expectations for Robust Equivalency Agreements in Canada*.

Plumptre, B., & Flanagan, E. (2017). *Using equivalency agreements to advance Canadian climate policy* [Data set]. Pembina Institute.

Schulte, D. (2017). *Healthy Environment, Healthy Canadians, Healthy Economy: Strengthening the Canadian Environmental Protection Act, 1999. Report of the Standing Committee on Environment and Sustainable Development*. Committee Report No. 8—ENVI (42-1).

Thibault, B., Jeyakumar, B., Brown, G., & Olmsted, K. (2021). *From Coal to Clean: Canada's progress toward phasing out coal power*. Pembina Institute.

UNEP. (2020). *Emissions Gap Report 2020*.

Vriens, L. (2018). *The End of Coal: Alberta's Coal Phase-Out*. International Institute for Sustainable Development.

WMO. (2021). *State of the Global Climate 2020*.