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Canada



STRATEGY ON SHORT-LIVED CLIMATE POLLUTANTS – 2017

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Environment and Climate Change Canada
Public Inquiries Centre
7th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-997-2800
Toll Free: 1-800-668-6767 (in Canada only)

Email: ec.enviroinfo.ec@canada.ca

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Stratégie de lutte contre les polluants climatiques de courte durée de vie, 2017.

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CONTEXT

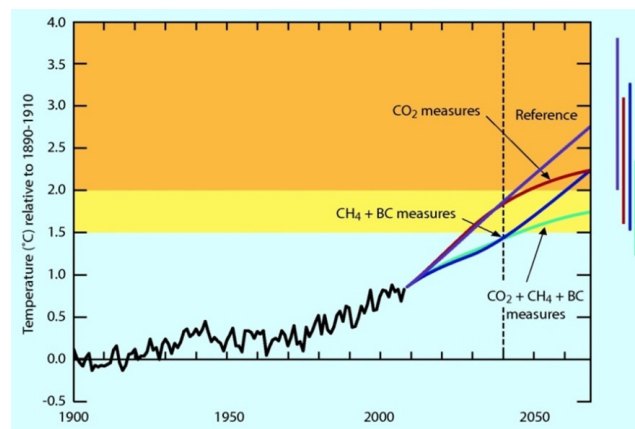
Canadians are experiencing the effects of climate change across the country, particularly in the climate-sensitive North. At the same time, exposure to air pollution is negatively affecting the health of Canadians and degrading the environment. Canada is taking action on climate change through the [Pan-Canadian Framework on Clean Growth and Climate Change](#) (the Pan-Canadian Framework). This Framework is Canada's plan to grow the economy while reducing emissions and building resilience to adapt to a changing climate. It was developed in partnership with provinces and territories, and in close consultation with Indigenous Peoples. Canada is also committed to advancing measures that lead to cleaner air and healthier communities, in partnership with provinces and territories.

Short-lived climate pollutants (SLCPs) are potent greenhouse gases (GHGs) and air pollutants. They have relatively short atmospheric lifetimes compared to longer-lived GHGs such as carbon dioxide (CO₂), and have a warming impact on climate. As such, reducing SLCPs can help achieve our climate and air quality objectives. SLCPs include methane and hydrofluorocarbons (HFCs), black carbon, which is a component of fine particulate matter (PM_{2.5}), and ground-level ozone.

Recent studies indicate that global action on carbon dioxide and SLCPs together is needed to keep average global temperatures to no more than 1.5 to 2°C above pre-industrial levels this century, and to meet the temperature goals in the Paris Agreement. Reducing SLCP emissions can also result in significant air quality benefits. Implementation of black carbon, methane and ozone measures has the potential to reduce global warming in 2050 by approximately 0.5°C and by approximately 0.7°C in the Arctic by 2040, prevent more than two million premature deaths worldwide each year, and avoid global crop losses of more than 30 million tonnes annually by 2030¹.

Air quality benefits would be felt mainly within the countries where measures are implemented. Consequently, SLCP mitigation has garnered significant attention in Canada and internationally.

IMPLEMENTATION OF GLOBAL MEASURES TO MITIGATE SLCPs AS A COMPLEMENT TO CO₂ MITIGATION COULD SLOW THE RATE OF NEAR-TERM GLOBAL WARMING, AND HELP TO KEEP AVERAGE GLOBAL TEMPERATURES FROM RISING BY MORE THAN 2°C ABOVE PRE-INDUSTRIAL LEVELS THIS CENTURY.



Source: UNEP Integrated Assessment of Black Carbon and Tropospheric Ozone, Summary for Policy Makers.

¹ UNEP/WMO. 2011. "Integrated Assessment of Black Carbon and Tropospheric Ozone". Available at: http://www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf

There is a key opportunity to slow the rate of near term warming by reducing emissions of SLCPs, while at the same time advancing national priorities related to air quality and health. The expected benefits of SLCP mitigation are particularly relevant for Canada as an Arctic nation. Our Arctic warmed by 2.2°C between 1948 and 2013 resulting in significant impacts to local populations and sensitive northern ecosystems. Black carbon is of particular significance in the Arctic due to its additional warming effect when deposited onto snow or ice. Therefore, black carbon emissions emitted near or within Arctic nations have a particularly significant impact on Arctic climate.

All levels of government in Canada have implemented policies and measures that address emissions of SLCPs. In the case of black carbon, reductions have occurred largely as a co-benefit of other measures. While progress has been made, knowledge and mitigation gaps remain. The Pan-Canadian Framework advances SLCP mitigation objectives through a wide variety of new actions across all sectors of the economy, including specific actions focused on methane and HFCs, as well as actions to foster innovation that will help catalyze the transition to a clean growth economy (see summary box on page 13). As Canada works to implement the Pan-Canadian

Framework, advance its [Mid-Century Long-Term Low-Greenhouse Gas Development Strategy](#), and develop its next steps to address air quality, there is a key opportunity to better coordinate and expand efforts on SLCPs, and to communicate Canada's priorities and progress in these areas.

This Strategy outlines a holistic Environment and Climate Change Canada (ECCC) approach to addressing SLCPs through five pillars for action: 1) enhancing domestic mitigation efforts; 2) science and communications; 3) engaging in international fora; 4) improving coordination of ECCC and government-wide activities; and 5) collaborating with provincial and territorial governments and other possible partners.

Implementation of this Strategy will: generate reductions from all key SLCP emissions sources; ensure that the Department's work on SLCPs and that of other government departments is mutually reinforcing; leverage policy levers across all levels of governments in Canada to better coordinate mitigation efforts; and continue our work internationally in leadership roles. Implementation of this Strategy will be coordinated with, and complementary to, implementation of the Pan-Canadian Framework.



IMPACTS, EMISSIONS, AND CURRENT MEASURES

BLACK CARBON

Black carbon is a component of $PM_{2.5}$ generated by the incomplete combustion of fossil fuels and biomass. Black carbon emissions are estimated to be the third largest contributor to current warming, after CO_2 and methane. Black carbon influences climate in multiple ways: by directly heating surrounding air when suspended in the atmosphere; by reducing the reflectivity of the earth's surface when deposited, an effect particularly strong over snow and ice; and through additional indirect effects related to interaction with clouds. Black carbon is estimated to be 3,200 (range of 270-6,200) times more potent a warming agent than CO_2 over a 20-year period^{2,3}. Reducing uncertainties related to quantifying the overall warming effects of black carbon represents an active area of scientific research internationally.

Short-term and long-term exposure to $PM_{2.5}$, of which black carbon is a component, is also associated with a broad range of human health impacts, including respiratory and cardiovascular effects as well as premature death. In its 2012 assessment of the health effects of black carbon, the World Health Organization (WHO) noted that black carbon is a “carrier” of other pollutants, delivering them deep into the respiratory system, and further that a reduction in exposure to $PM_{2.5}$ containing black carbon should lead to a reduction in the health effects associated with $PM_{2.5}$ ⁴.

In line with commitments under the Arctic Council, ECCC has published an annual black carbon emissions inventory since 2015. The initial inventory was for the 2013 data year. The black carbon inventory is also submitted annually to the United Nations Economic Commission for Europe (UNECE) and posted on ECCC's website.

It is estimated that 41 kilotonnes (kt) of black carbon were emitted in Canada in 2014. Recognizing the uncertainties related to global warming potentials (GWP) for black carbon and that these should be used with caution, application of the GWP_{20} values above would imply that Canada's 2014 emissions of black carbon are approximately equivalent to 131 megatonnes (Mt) of CO_2 emissions over a 20-year period. On- and off-road diesel vehicles and engines are estimated to be the largest source of black carbon emissions in Canada, accounting for over 40% of Canada's total black carbon emissions in 2014. Residential wood-burning follows as the second largest source, accounting for about one quarter of emissions. Emissions from stationary diesel engines are also regionally significant in the North, where they are commonly used for electricity generation in remote communities and at off-grid mine sites. Marine shipping may also constitute an increasingly significant source in the Arctic, due to projected increases in shipping activity in the region. See figure 1 below for a more detailed breakdown of Canada's black carbon emissions.

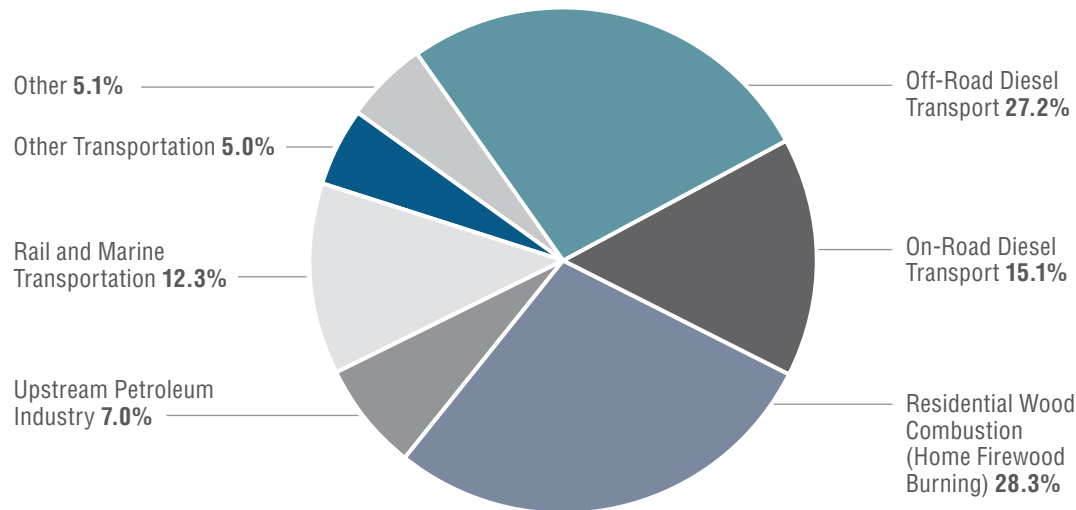
² GWP_{20} from Bond et al. (2013). Bounding the role of black carbon in the climate system: A scientific assessment.

³ The use of the GWP_{20} in this section is to help communicate the potential contribution of black carbon mitigation to reducing near-term warming. Given the very different ways black carbon and CO_2 influence climate and their vastly different lifetimes in the atmosphere, there is not yet scientific consensus on a metric to quantify black carbon relative to CO_2 . Further science work to reduce uncertainties and develop more appropriate metrics is needed.

⁴ World Health Organization, 2012. “Health effects of black carbon”. Available at: <http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2012/health-effects-of-black-carbon-2012>.

FIGURE 1: BLACK CARBON EMISSIONS BY SOURCE (2014)

(Source: Black Carbon Inventory 2017)



A number of federal measures already in place are expected to reduce emissions of black carbon as a co-benefit of other measures including stringent transportation sector air pollutant regulations for new on- and off-road vehicles and engines, ambient air quality standards for $PM_{2.5}$, and GHG regulations for coal-fired electricity generation (expected to generate co-benefit reductions in black carbon as coal power plants are phased-out). The North American Emission Control Area (ECA) for ships requires that ships sailing within 200 nautical miles of the United States (U.S.) and Canadian coasts (Arctic waters not included) burn a fuel with sulphur content no greater than 0.1%. Throughout Canada and the U.S., the ECA is expected to lead to a 74% reduction in $PM_{2.5}$ emissions below levels by 2020. Federal programs such as Natural Resources Canada's SmartWay Transport Partnership also support black carbon emission reductions.

Examples of provincial, territorial or municipal measures expected to result in reduced emissions of black carbon include transportation programs and policies (e.g. motor vehicle inspections, scrappage programs), emission standards for new wood-burning appliances, and wood stove change-out programs in some provinces and territories. For example, British Columbia recently updated its wood-burning regulations, and Ontario included \$4 million in funding for a wood stove change-out program in its recently released Five Year Climate Action Plan. The City of Montreal has put in place stringent standards for wood-burning stoves and fireplaces. Provinces such as Alberta, British Columbia and Saskatchewan have implemented measures to reduce flaring from oil and gas operations.

RECENT FEDERAL ACTIONS AND COMMITMENTS ON BLACK CARBON

- Canada's endorsement of the World Bank's Zero Routine Flaring by 2030 initiative in April 2016 will support reductions in black carbon emissions resulting from routine flaring at oil production facilities.
- New federal investments that support clean technologies in place of those that rely on fossil fuels will reduce emissions of black carbon over the longer term. Examples include:
 - Budget 2017 provided \$220 M over four years to help reduce reliance on diesel and other fossil fuels for electricity generation and heating in Northern, remote and Indigenous communities.
 - The Pan-Canadian Framework includes a number of actions that will help reduce black carbon emissions by reducing fossil fuel consumption. These include actions to improve energy efficiency and reduce emissions in the transportation sector, and to reduce reliance on diesel in northern and remote communities. See summary table on page 13 for more details.
- Canada has committed to develop national actions to reduce black carbon emissions in the Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership in July 2016.
- In May 2017, Canada, alongside other Arctic States, adopted the Expert Group on Black Carbon and Methane summary report which recommends that Arctic States further collectively reduce their black carbon emissions by at least 25 – 33 percent below 2013 levels by 2025.
- Transport Canada published draft emissions regulations for the rail sector in June 2016, including exhaust emission standards for particulate matter.
- ECCC initiated regulatory development for new stationary diesel (compression-ignition) engines in November 2016.

Black carbon gaps

Based on an assessment of current measures related to black carbon emissions, key mitigation gaps for black carbon include existing on- and off-road mobile diesel sources, stationary diesel engines and wood-burning appliances.

In the case of **on- and off- road mobile diesel** sources, current federal regulatory measures focus on fuels as well as new vehicles and engines. These have and will continue to result in black carbon emission reductions as fleets turn over. However, due to the long lifetimes of diesel vehicles, turnover of the in-use fleet is slow, and fleets are still dominated by engines pre-dating the most recent emissions standards. Although some provinces and territories have implemented measures focusing on existing vehicles, on- and off- road diesel vehicles and engines continue to be Canada's largest source of black carbon emissions.

Though emissions from **stationary diesel engines** are not estimated to be a large source of black carbon emissions nationally, they are a source of particular concern in many Northern remote and Indigenous communities, where engines operate 24 hours a day for off-grid electricity generation, often in close proximity to homes and schools, impacting local air quality. These emissions also generate local warming impacts, including through the deposition of black carbon on snow and ice, which accelerates melting. There are currently no federal regulations and few provincial and territorial measures targeting emissions from stationary engines.

Regulatory measures to address **wood-burning appliances** are limited at both federal and provincial/territorial levels. Some provinces regulate the sale of new wood-burning appliances, while some municipalities have by-laws relating to

residential wood combustion, including emission standards, bans on certain types of appliances, or restrictions on the use of wood-burning appliances during smog days. Measures to address emissions from existing sources are limited to wood stove change-out programs or rebates for certain new appliances in some provinces and territories.

A number of non-regulatory initiatives related to wood burning have taken place through the Canadian Council of Ministers of the Environment (CCME). These include development of a guidance document for Canadian jurisdictions on open-air burning (2016); review of municipal, provincial, territorial and federal policies for open-air burning in selected Canadian and international jurisdictions (2016); a Code of Practice for Residential Wood Burning Appliances (2012); and a review of municipal, provincial and federal policies for wood burning appliances in selected Canadian and U.S. jurisdictions (2012).

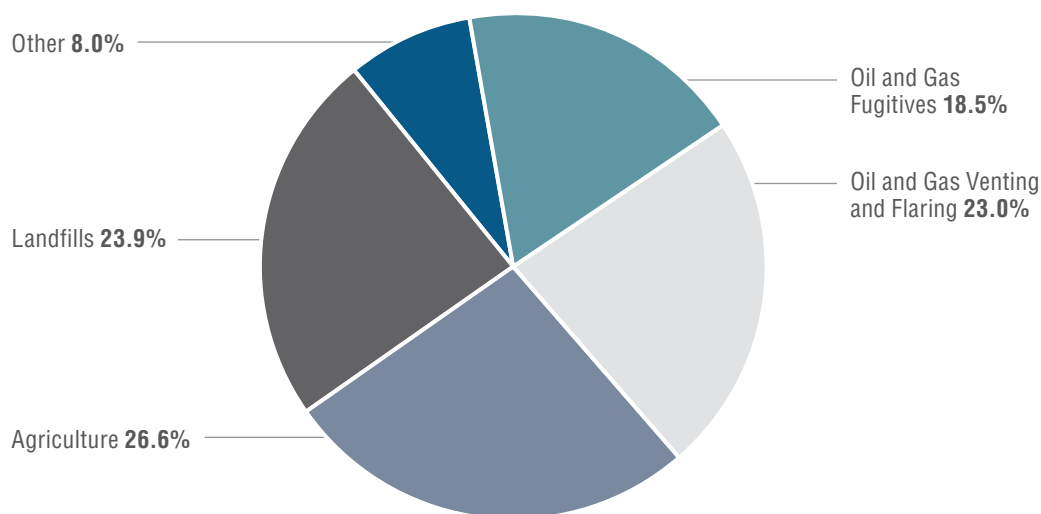
METHANE

Methane is a potent GHG. Methane is estimated to be 86 times more potent a warming agent than CO₂ over a 20-year period, and 34 times more potent than CO₂ over a 100-year period⁵. In addition to its significant climate impacts, methane contributes to the formation of ground-level ozone.

4,300 kt of methane were emitted in Canada in 2014, accounting for 108 Mt CO₂e, or 15%, of Canada's total GHG emissions⁶ (using the most recent GWP for methane, this is equivalent to 361.2 Mt of CO₂ emissions over a 20-year period). The oil and gas sector accounted for 44% of Canada's methane emissions in 2014, largely from oil and natural gas fugitive sources, including venting and flaring (42% of national total). 91% of these emissions are produced in Alberta and Saskatchewan. The remainder of Canada's methane emissions is largely from agriculture and solid waste disposal (e.g. landfills). See figure 2 below for a more detailed breakdown of Canada's methane emissions.

FIGURE 2: METHANE EMISSIONS BY SOURCE (2014)

Source: National Inventory Report 1990-2014 - Part 3)



⁵ Table 8.7 In Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 659–740, doi:10.1017/CBO9781107415324.018. The GWP20 and GWP100 values given here account for climate-carbon feedbacks, which increases the GWP values relative to values without these feedbacks.

⁶ National Inventory Report 1990-2014 – Part 3. Canada's reported GHG emissions for methane are based on a 100-year GWP of 25, per the IPCC's 4th assessment report and UNFCCC reporting guidelines.

Federal measures already in place addressing methane include funding for solid waste projects under selected federal infrastructure programs.

At the provincial and territorial level, British Columbia, Alberta and Saskatchewan have implemented measures to reduce venting and fugitive emissions from oil and gas operations. Alberta recently announced a new goal to cut methane emissions by 45% from oil and gas operations by 2025. Alberta is also proposing the development of specific requirements for new facilities as well as a voluntary initiative aimed at reducing venting and fugitive emissions from existing facilities. In British Columbia's Climate

Leadership Plan released in 2016, the province set a target to reduce methane emissions from oil and gas extraction and processing infrastructure built before January 1, 2015, by 45 percent by 2025. British Columbia will also be offering incentives to reduce emissions from applications built between 2015 and 2018 with a Clean Infrastructure Royalty credit program, as well as a new offset protocol. The province also plans to establish standards for the development of projects after 2018-2020, including mandatory leak detection and repair.

Several provinces have landfill gas capture regulations or incentives. Different approaches have been taken in terms of scope and requirements.

RECENT FEDERAL ACTIONS AND COMMITMENTS ON METHANE

- In the Pan-Canadian Framework, Canada committed to work with provinces and territories to reduce methane emissions from the oil and gas sector by 40-45% below 2012 levels by 2025.
- To achieve this goal, Canada will implement federal methane regulations for the oil and gas sector, which will address Canada's largest source of methane emissions and provide clear and consistent requirements across the country. Canada published proposed regulations in May 2017.
- In the Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership, Canada also committed to developing and implementing a national methane strategy, taking action to reduce emissions from landfills, and implementing voluntary measures to reduce and recover food waste.

Methane gaps

Forthcoming federal, provincial and territorial measures under development to address oil and gas sources will address the largest mitigation gap for this SLCP. The key remaining mitigation gaps for methane are for **municipal solid waste landfills** and agriculture sources (enteric fermentation in particular). Recommendations on mitigation measures for the agriculture sector are not included in this Strategy however could be pursued in collaboration with Agriculture and Agri-Food Canada, taking into consideration efforts under the Pan-Canadian Framework on Clean Growth and Climate Change.

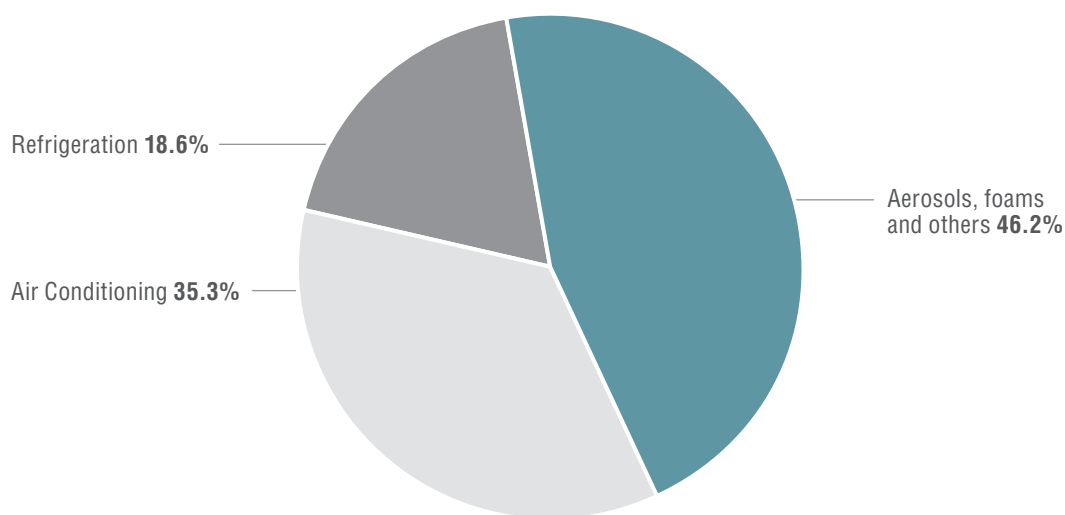
HYDROFLUOROCARBONS (HFCs)

HFCs are potent GHGs. The potency of HFCs varies by species and ranges from <1 to 10,800 times that of CO₂ over a 20-year period, and <1 to 12,400 that of CO₂ over a 100-year period⁷. Although HFC emissions are not currently a significant contributor to total GHG emissions in Canada, they are projected to more than triple between 2013 and 2030 unless additional policy measures are introduced. Most HFC emissions come from aerosols and foams, air-conditioning and refrigeration, where their use has rapidly increased in place of ozone-depleting substances. See figure 3 below for a more detailed breakdown of Canada's HFC emissions.

⁷ Appendix 8: A In Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestad, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 659–740, doi:10.1017/CBO9781107415324.018.

FIGURE 3: HFC EMISSIONS BY SOURCE (2014)

(Source: National Inventory Report 1990-2014)



A suite of existing federal and provincial and territorial regulations control ozone-depleting substances and HFCs once they are in use in refrigeration, air-conditioning and fire-extinguishing systems.

RECENT FEDERAL ACTIONS AND COMMITMENTS ON HFCs

- A federal permitting and reporting system for the import, export and manufacture of HFCs was established in spring 2016.
- A notice published in May 2016 requires the preparation and implementation of pollution prevention plans for the sound management of end-of-life halocarbon refrigerants. The notice, which includes HFCs, will contribute to preventing emissions of HFCs at end-of-life.
- Federal regulations were proposed in November 2016 to phase down the consumption of HFCs and to prohibit the import and manufacture of products containing or designed to contain HFCs. Regulations will avert future HFC releases to the environment and allow Canada to ratify and comply with the Kigali Amendment to phase-down HFCs under the Montreal Protocol.
- Canada committed to update public procurement processes to transition away from high-GWP HFCs whenever feasible in the U.S.-Canada Joint Statement on Climate, Energy and Arctic Leadership.

HFC gaps

There are no measures in place to limit growth of the use of HFCs however new federal measures proposed in 2016 would help control the consumption of HFCs, thereby reducing their use and avoiding future emissions.

OZONE

Ozone is a product of precursors including nitrogen oxides (NO_x), volatile organic compounds (VOCs) and carbon monoxide (CO), which transform into ozone in the atmosphere. Ground-level ozone is a powerful GHG, a significant contributor to current warming, and a key component of smog. It has deleterious effects on human health, damages plants and affects agricultural production. In Canada, the transportation and oil and gas sectors are key sources of ozone precursors. Residential wood combustion is also a significant source of CO emissions.

Measures to address ozone precursors are part of air quality actions, driven primarily by human health concerns. Transportation measures are the most mature, including several significant air pollution measures that address ozone precursors and that as a co-benefit, reduce black carbon. Other federal measures include consumer and commercial sector VOC regulations and new, more stringent Canadian ambient air quality standards (CAAQS) for ozone. The continued implementation of Canada's Air Quality Management System (AQMS) framework provides the basis for future mitigation efforts and air quality improvements. As part of this effort, Base Level Industrial Emission Requirements (BLIERs) instruments were finalized and others proposed in spring 2016. This represents an important step forward in addressing emissions of ozone precursors from industrial sources. Provincial measures to reduce ambient concentrations and prevent the exceedance of the CAAQS for ozone and fine particulate matter would also contribute to future emission reductions.

RECENT FEDERAL ACTIONS AND COMMITMENTS ON OZONE

- Multi-sector Air Pollutants Regulations (MSAPR) finalized in June 2016 will reduce emissions of ozone precursors from industrial boilers and heaters, the cement sector, and natural gas-fired stationary engines.
- Non-regulatory instruments for the aluminium and the iron, steel and ilmenite sectors were finalized in May 2016.
- Draft instruments for 7 other sectors published in May 2016 will also help to address ozone precursors.

Ozone gaps

A gap analysis for ozone has not been undertaken.

A HOLISTIC APPROACH TO ADDRESSING SLCPs

This SLCP Strategy complements the Department's foundational work on climate change and clean air. It will coordinate and enhance work under these programs by focusing on five pillars for action, which are all key for achieving desired outcomes: 1) enhancing domestic mitigation; 2) Enhancing science and communications to broaden understanding; 3) systematically engaging in international fora; 4) improving coordination of ECCC activities; and 5) collaborating with provincial and territorial governments and other possible partners.

Enhancing domestic mitigation

Increased awareness of SLCPs from a policy perspective has only occurred in the last few years. All levels of government have implemented measures that reduce emissions of SLCPs – sometimes targeted, such as in the case of methane and HFCs, or from what would later be understood as a co-benefit of PM_{2.5} actions, in the case of black carbon. However, these measures were not in the context of an integrated approach to climate and air policy.

Enhanced domestic mitigation of SLCPs will provide a cost-effective way to contribute to Canada's international commitments to help limit global warming this century to well below 2°C above pre-industrial temperatures, while striving towards 1.5°C. It will also generate near-term air quality and health benefits. Black carbon measures implemented in or near the North have the potential to realize local Arctic benefits.

Enhanced measures could continue to be undertaken through approaches that address GHGs and air quality. However now that the short-term climate effects and health impacts of SLCP emissions are better understood, there is scope to do so more effectively than has been the case to date, by explicitly considering and quantifying the multiple benefits of SLCP mitigation when making mitigation decisions.

Enhancing science and communications to broaden understanding

ECCC's science work relating to SLCPs includes emissions characterization, atmospheric monitoring, processes studies and modelling. Monitoring provides measurements for determining long-term atmospheric trends, and for setting a baseline against which the success of mitigation efforts can be assessed and climate and air quality models evaluated. Monitoring also allows the relative importance of various sources of pollutants to be assessed by sector and jurisdiction, and assess how their relative contributions to total emissions evolve over time. Processes research and modelling allows improved representation of atmospheric and terrestrial processes in air quality and climate prediction systems in order to quantify the influence of SLCPs on climate and air quality. See Annex II for additional detail on ECCC's current science work relating to SLCPs.

Scientific challenges differ with each pollutant. Enhancing scientific work to increase understanding of the interactions between SLCPs and other pollutants as well as of their climate and air quality impacts will support the quantification of the multiple benefits that can be derived from action on SLCPs.

Though SLCPs are increasingly part of the dialogue on climate change, the importance of SLCP mitigation and the multiple benefits it can achieve is still not always understood by decision-makers. Targeted efforts will be undertaken to communicate how SLCPs contribute to climate change and air pollution and why it is important to include SLCP mitigation as a fundamental component of strategies to mitigate climate change, in parallel with near-term action on CO₂. These efforts will aim to increase understanding of SLCPs more broadly, within policy communities and by the general public.

Systematically engaging in international fora

Canada's recent international engagement on SLCPs reflects the emerging understanding that the best opportunity to slow the rate of near-term warming globally, and in sensitive regions such as the Arctic, is by cutting emissions of SLCPs – both at home, and internationally. Effective action is needed on many fronts, including outside the United Nations Framework Convention on Climate Change (UNFCCC), if commitments to avoid global temperature increase are to be achieved.

Canada's international climate finance and SLCP funding contributions aim to reduce GHG and SLCP emissions internationally, with a focus on developing countries.

ECCC is actively engaged in numerous international fora that seek to advance mitigation and scientific understanding of SLCPs globally (see Annex II for details). A more systematic approach to this engagement will leverage our existing North American partnerships, deepen our multilateral engagement, and seek to showcase our national and subnational activities.

Improving coordination of ECCC and Government of Canada activities

Canada's domestic mitigation, science and international work on SLCPs are increasingly linked. For example, both the Climate and Clean Air Coalition (CCAC) and the Arctic Council are calling for countries to step up domestic actions. Improved coordination of the Department's work on SLCPs will help to better integrate ECCC's science, policy and regulatory activities, and its domestic, North American, and international actions. Effective governance will also facilitate the prioritization and coordination of ECCC activities

and engagement (domestically and internationally) within anticipated resourcing, and ensure that they are mutually reinforcing.

Other Government of Canada departments (OGDs) have the mandate to address SLCP sources such as the marine, rail, aviation and agricultural sectors. Improved coordination with OGDs will enhance the overall effectiveness of Canada's action on SLCPs.

Collaborating with provincial and territorial governments and other partners

Provinces and territories hold many SLCP policy levers and are important actors in SLCP mitigation. Increased collaboration with provincial and territorial partners on SLCPs is needed to coordinate action in order to drive emission reductions across key sources. ECCC could seek to advance coordinated action in priority areas that fall under joint jurisdiction, such as the transportation sector, building on the momentum of the Pan-Canadian Framework on Clean Growth and Climate Change to further advance action on SLCPs. Collaboration among governments is also needed to improve the consistency of emission inventories across jurisdictions, through alignment of reporting requirements or establishing data sharing agreements while minimizing duplication of efforts.

Canadian capabilities on SLCP mitigation extend beyond governments. This Strategy will leverage the knowledge, capacity and engagement of a broad suite of actors in Canada, including cities, municipalities, private sector, academia, government agencies such as the National Research Council, non-government organizations (NGOs), and Indigenous communities.



ACTIONS TO SUPPORT EACH PILLAR

The sections below outline a suite of actions through which ECCC could implement a holistic approach to SLCPs based on the five pillars.

It is recognized that a phased approach will be required for implementation, and that measures addressing the same pollutant from the same source, or that further scientific understanding, could be layered over time. Near-term actions ECCC will take are highlighted. Complementary actions that ECCC could advance in the future are also identified. A graphic of current and potential actions to address SLCP emissions is provided in Annex I.

Enhancing domestic mitigation action

The actions outlined below take into consideration issues related to shared jurisdiction, and

sector-specific barriers to reducing emissions. Additional detail on each of the actions described is provided in Annex II.

A summary of how the Pan-Canadian Framework contributes to domestic SLCP mitigation is also provided in the box below.

OVERARCHING

Inclusion of SLCP mitigation objectives in departmental priorities, requiring consideration of SLCPs in decision-making on air quality and GHG actions, and inclusion of benefits of SLCP mitigation in cost benefit analyses of air pollutant and GHG mitigation measures could help to institutionalize the consideration of SLCP benefits in mitigation approaches.

ADVANCING SLCP MITIGATION UNDER THE PAN-CANADIAN FRAMEWORK

In December 2016, First Ministers adopted the Pan-Canadian Framework on Clean Growth and Climate Change, the country's first-ever pan-Canadian climate plan. The Pan-Canadian Framework aims to grow the economy while reducing emissions and building resilience to the impacts of climate change. It was developed in collaboration with provinces and territories, and in consultation with Indigenous Peoples.

The Pan-Canadian Framework has four main pillars: pricing carbon pollution; complementary measures to further reduce emissions across the economy; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs.

Many of the actions under the Pan-Canadian Framework will help reduce emissions of short-lived climate pollutants across multiple sectors of the economy.

Electricity

- Measures to help reduce reliance on diesel in northern, remote and Indigenous communities

Built environment

- Improving the efficiency of appliances and equipment
- Improving building codes and energy efficiency of housing, which will reduce the energy required to heat buildings

Transportation

- Continuing to improve fuel efficiency of new light-duty and heavy-duty vehicles
- Improving the efficiency of existing heavy-duty vehicles by requiring retrofits
- Increasing the number of zero-emission vehicles on the road
- Developing a clean fuel standard, which can help move away from fuels that contribute to black carbon, such as diesel

Industry

- Reducing methane emissions from the oil and gas sector
- Phasing down the use of HFCs
- Investing in new industrial technologies

Forestry, agriculture and waste

- Generating bioenergy and bioproducts, such as generating renewable fuel from waste

Innovation

- Support new approaches to early-stage technology development to advance research in areas that have the potential to substantially reduce GHG emissions and other pollutants

BLACK CARBON

Black carbon mitigation gaps will be addressed through air pollution measures or programs targeting and/or prioritizing those PM_{2.5} sources known to result in significant black carbon emissions, or that have significant regional impacts, such as in the Arctic, or in densely populated areas. Actions taken to address black carbon gaps will support Canada's commitment to pursue significant national actions to reduce black carbon emissions in North America.

Diesel emissions, which are very high in black carbon, are of particular concern from a human health perspective. In 2012, the World Health Organization (WHO) classified diesel exhaust as carcinogenic to humans. This conclusion is supported by Health Canada's Diesel Exhaust Health Risk Assessment (2016), which links exposure to diesel exhaust from mobile sources alone to 700 premature deaths in Canada annually. Health Canada's risk assessment also found that diesel emissions are associated with significant

numbers of acute respiratory symptom days, restricted activity days, asthma symptom days, hospital admissions, emergency room visits, child acute bronchitis episodes and adult chronic bronchitis cases across Canada.⁸

A combination of regulatory and program approaches, addressing both new and existing sources, could be an effective way to reduce emissions from wood-burning appliances and stationary diesel engines.

Jurisdictional considerations are an important factor in assessing how best to address mitigation gaps for **on- and off- road diesel vehicles and engines**. Once a vehicle is sold at the retail level, provincial and territorial governments have jurisdiction over its environmental performance within their respective boundaries, and along with municipalities have the most policy levers to support action on existing fleets. The Government of Canada could explore opportunities with provinces and territories to further reduce emissions from these sources.

⁸ Health Canada, 2016. "Human Health Risk Assessment for Diesel Exhaust – Summary". Available at: <https://www.canada.ca/en/health-canada/services/publications/healthy-living/human-health-risk-assessment-diesel-exhaust-summary.html>

Stationary diesel engines are used in many applications throughout Canada. They are a source of particular concern in many Northern communities, where engines operate 24 hours a day for off-grid electricity generation, often in close proximity to homes and schools, impacting local air quality. Federal regulations to implement performance standards for new stationary diesel engines, similar to U.S. standards in place since 2006, are being advanced through funding received under Budget 2016. Support for retrofits and replacements in collaboration with provincial and territorial partners would help to reduce emissions from existing units. This would support commitments under the Pan-Canadian Framework to work with Indigenous Peoples and northern and remote communities in reducing their reliance on diesel by improving the energy efficiency of diesel generating units, supporting the demonstration and installation of hybrid or renewable energy systems, and connecting communities to electricity grids.

There are approximately 3.6 million **wood-burning appliances** in Canada. A large fraction of emissions come from older appliances. Federal measures for new residential and commercial/institutional wood-burning appliances would ensure consistent national standards across Canada and ensure new appliances are efficient. Minor amendments to the *Canadian Environmental Protection Act, 1999* (CEPA) would be needed to allow regulation of manufacturers and importers (rather than individual households or businesses). A key challenge is slow rates of turnover due to decades-long lifetimes; replacing an inefficient wood-burning appliance with a modern one can

reduce PM_{2.5} emissions by up to 70% on a per unit basis, with co-benefits for methane and CO₂. In addition to health benefits associated with reduced PM_{2.5} and therefore black carbon emissions, reducing emissions from wood-burning appliances could also generate other co-benefits related to human health. For example, they could also help to reduce emissions of VOCs and other toxics such as polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, and help to reduce wintertime smog.

Enhanced domestic actions could also be targeted to supporting Government of Canada and ECCC objectives to **promote the use of clean technologies**. For example, the Government of Canada operates a number of facilities in the Arctic that rely on diesel fuel for electricity generation, including ECCC's Eureka weather station. Investments in solar or other renewable sources, based on the results of a feasibility study, would reduce fuel-use and lower emissions from diesel combustion and demonstrate the application of renewable technologies in the Arctic. In the Pan-Canadian Framework, the Government of Canada committed to reduce its own GHG emissions to 40 percent below 2005 levels by 2030 or earlier, and also set a goal of using 100 percent clean power by 2025.

There may also be potential to reduce emissions from **marine** sources in partnership with Transport Canada and continued collaboration with members of the International Maritime Organization (IMO). Canada will continue to work with Arctic partners to determine how best to address the risks posed by black carbon emissions from Arctic shipping.

NEW NEAR-TERM ECCC ACTIONS ON BLACK CARBON

- Proposed regulations for new stationary diesel engines will be published in the *Canada Gazette, Part I* for a public comment period. The target date for publication is 2018. The emission standards will contribute to air quality, health and climate benefits.

METHANE

Announced measures to address methane from oil and gas sources at the federal level, in Alberta and in British Columbia will reduce Canada's largest source of methane emissions, with co-benefits reductions of some ozone precursors, and contribute to Canada's GHG emissions reduction targets.

A landfill gas (LFG) recovery initiative could further reduce methane from **municipal solid waste landfills**. Measures identified in consultation with provinces and territories, requiring or incenting the capture of landfill gas are being advanced through new funding received under Budget 2016. There are opportunities to accelerate the capture and utilisation rate of landfill gas and support the implementation of technologies and infrastructure to divert and manage organic waste as a long-term solution.

Furthermore, there is a growing body of evidence that identifies **waste prevention, reuse and recycling** as the largest source of untapped potential for GHG reductions in the waste sector. Measures to reduce GHGs could focus on food waste reduction, organics diversion, and recycling

and material reuse. These would complement actions to reduce emissions from landfills. Food waste is a major part of the organic materials that emit methane from landfills. Under United Nations Sustainable Development goals, and in the recent NALS joint action plan, Canada committed to work towards reducing food waste by 50%. ECCC will collaborate with Agriculture and Agri-Food Canada (AAFC) as they develop a national food policy. The current national waste diversion rate is about 25% of the waste generated, largely due to provincially regulated recycling programs, and provincial and municipal organics diversion regulations and initiatives. Leading countries from the Organization for Economic Co-operation and Development (OECD) divert up to 50-60% of their waste. Additional measures to be identified in collaboration with provinces and territories, and with input from stakeholders, could increase resource utilization and recycling, and move Canada toward a circular economy.

The national methane strategy committed to in the Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership may include additional measures beyond those considered in this Strategy.

NEW NEAR-TERM ECCC ACTIONS ON METHANE

- The federal government will work with provinces and territories to achieve the objective of reducing methane emissions from the oil and gas sector, including offshore activities, by 40-45 percent below 2012 levels by 2025, including through equivalency agreements.
- ECCC will develop measures to address methane from landfills in consultation with provinces and territories.
- Consultations on strategies to reduce avoidable food waste, increase organics diversion, and increase recycling and reuse will begin in 2017.

HYDROFLUOROCARBONS (HFCs)

Building on new federal measures finalized in spring 2016, **comprehensive regulatory measures** proposed in late 2016 would control the consumption of HFCs through a phase-down of the manufacture, import and export of HFCs and prohibit the manufacture and import of HFC-containing products and equipment in certain sectors. These measures could be complemented

by pursuing work with OGDs to ensure energy efficiency programs and regulations are well coordinated, and by engaging and collaborating with other actors to communicate the importance of technology development and implementation related to HFCs.

Additional actions could be taken to **encourage the replacement of HFC systems and products** with more climate-friendly alternatives, where

feasible. For example, the Government of Canada will be “leading by example” by implementing an HFC procurement program to promote the use of climate-friendly low-global warming potential

alternatives whenever feasible, and to gradually transition to equipment that uses more sustainable alternatives to high-global warming potential HFCs.

NEW NEAR-TERM ECCC ACTIONS ON HFCs

- ECCC will work to develop final regulations for the proposed HFC regulatory measures that were published in 2016. These measures will allow Canada to comply with its Montreal Protocol HFC obligations and ratify the Kigali amendment.
- The federal commitment to update public procurement processes to transition away from high-GWP HFCs whenever feasible will further reduce HFC emissions.

OZONE

The publication of the CAAQS for fine particulate matter and ozone should help to drive down ambient concentrations of these two pollutants. Under the AQMS, provinces and territories are expected to develop air quality management action plans for regions (air zones) within their jurisdiction where concentrations of these pollutants are approaching or exceeding the CAAQS. Action plans would look at all sources of these pollutants and management actions could include regulatory and non-regulatory instruments including those under the AQMS and MSAPR.

At the federal level, work will proceed to finalize draft instruments for seven industrial sectors posted in May 2016. Proposed regulations for petroleum and refinery gases, which are VOCs, from the downstream oil and gas sector as part of the Chemicals Management Plan, will also help to address ozone precursors.

There may be scope to set more ambitious ambient air quality standards for PM_{2.5} and ozone, as some aspects of current standards are not as stringent as levels proposed by the World Health Organization (WHO). In addition, consideration could be given to developing additional emissions standards for industrial sectors where emissions and impacts on local air quality can be very significant (e.g. petroleum refining, coal-fired power plants).

NEW NEAR-TERM ECCC ACTIONS ON OZONE

- ECCC will finalize proposed instruments for the aluminum, steel, potash, pulp and paper, iron ore pellets, and base metals smelting sectors and for cross-sectoral turbines.
- ECCC is leading development of more stringent ambient air quality standards and is working to bring forward additional emissions standards for key pollutants and sectors.
- ECCC will seek approval from federal, provincial and territorial Ministers of the Environment for new Canadian ambient air quality standards for NO₂, and lead the review of PM and ozone standards.
- Proposed federal regulations to reduce petroleum and refinery gases will be published in the *Canada Gazette, Part I*, in 2017.

SUMMARY OF APPROACHES

TABLE 1: SUMMARY OF POTENTIAL MEASURES

SOURCES	POTENTIAL MEASURES					
	REGULATIONS	OTHER CONTROL MEASURES	INCENTIVES AND PROGRAMS	TECHNOLOGY DEMONSTRATION AND SUPPORT	JURISDICTION	TIMELINES
BLACK CARBON						
Existing diesel vehicles and engines			✓		Provincial/ territorial and municipal	Medium-longer term
New diesel vehicles and engines	✓				Federal	In place
Existing stationary diesel engines			✓	✓	Federal and/or provincial/ territorial	Medium-longer term
New stationary diesel engines	✓				Federal	Near term
Existing wood-burning appliances		✓	✓		Provincial/ territorial and municipal	Medium-longer term
New wood-burning appliances	✓	✓			Federal and provincial/ territorial	Medium-longer term
METHANE						
Existing oil and gas operations	✓				Federal and provincial/ territorial	Near term
New oil and gas operations	✓				Federal and provincial/ territorial	Near term
Existing solid waste landfills	✓ ¹	✓ ¹	✓ ¹		Federal and provincial/ territorial	Near to medium term
New solid waste landfills	✓ ¹	✓ ¹	✓ ¹		Federal and provincial/ territorial	Near to medium term
HFCs						
Existing and new systems	✓	✓	✓	✓	Federal and provincial/ territorial	Near term: regulations and other control measures Medium term: incentives and programs, technology demonstration and support

SOURCES	POTENTIAL MEASURES					
	REGULATIONS	OTHER CONTROL MEASURES	INCENTIVES AND PROGRAMS	TECHNOLOGY DEMONSTRATION AND SUPPORT	JURISDICTION	TIMELINES
OZONE						
Canadian ambient air quality standards					Federal	Near term: NO _x Medium term: more stringent PM _{2.5} /ozone
Existing industrial sources	✓	✓			Federal and provincial/ territorial	Near term: MSAPR and 7 sectors for which instruments proposed in 2016
New industrial sources	✓	✓			Federal and provincial/ territorial	Near term: MSAPR and 7 sectors for which instruments proposed in 2016

¹ To be determined in consultation with provinces and territories.

Enhancing science and communications to broaden understanding

ECCC's Climate Change and Clean Air science programs provide the foundation to support the effective incorporation of SLCPs into the plan to combat climate change and reduce GHG emissions, as well as support the setting of air quality standards. ECCC is the only agency in Canada making long-term, continuous observations of GHGs and black carbon. ECCC also engages in international research communities to ensure that the climate prediction and SLCP science on which decisions are based remain leading edge and consistent with current scientific understanding.

Implementation of the following actions is critical to addressing SLCP knowledge gaps and improving ECCC's quantification of emissions of SLCPs and supporting the assessment of trends, with a focus on black carbon and methane. It would also provide science-based evidence to support decisions related to climate change mitigation and air quality, and improve dissemination of that knowledge to policy communities and the general public.

Refinement of ECCC's Climate and Air Quality Models

Atmospheric methane and black carbon levels are influenced by both human activities and natural terrestrial systems (e.g. wetlands, wildfires, permafrost releases). The proposed approach is to improve the representation of methane and black carbon in ECCC's earth system-based climate model and regional scale air quality model in order to differentiate contributions related to human activities from contributions related to changes in natural systems. Doing so would then allow analyses to determine the potential impact and efficacy of different mitigation scenarios.

Reconciling estimates of methane and VOC emissions from oil and gas operations

The oil and gas sector is the largest source of both methane and VOC emissions in Canada. Additional scientific work is needed to improve approaches for estimating fugitive emissions of methane and VOC emissions from oil and gas operations. This would begin with a study to reconcile emissions estimates generated by

top-down (based on ambient atmospheric observations, including from field campaign intensive studies and satellite) and bottom-up (detailed equipment count and emissions measurements at the equipment or facility level) quantification approaches. Study findings would be used to improve quantification of fugitive emissions from the sector as a whole. This would improve knowledge of emissions from the oil and gas sector, supporting the development of emissions reduction scenarios in air quality and climate prediction systems, and increasing confidence in sector emissions reported in national emissions inventories. It would also result in improved understanding of climate and air quality impacts of SLCPs from oil and gas operations in Canadian, North American and global contexts. This work would facilitate more realistic simulations of emissions changes and of the specific climate and air quality response to those changes, improving understanding of the range of emissions consistent with meeting global targets, and of the climate change and air quality benefits from actions on SLCPs.

Further refining the black carbon inventory to support the development of priority mitigation measures

The quantification of black carbon emissions can be improved for some regions in Canada (such as the North) and for poorly understood emission sources such as biomass burning, flaring and diesel combustion in stationary and mobile equipment. Priorities identified for improvements in the black carbon emission inventory are based on priorities for domestic action. Historical trends in black carbon emissions will be developed as additional years are added to future inventory editions. These will allow the impact of measures to date to be assessed. Consideration could also be given to possible amendments to National Pollutant Release Inventory (NPRI) reporting requirements to support black carbon inventory refinements.

Communicating SLCP science and the importance of SLCP mitigation

ECCC is assessing climate change science content on the Department's website as part of the web renewal process. Refreshing content on SLCPs will be included in this exercise. The Department will also consider other opportunities to communicate: SLCP science, as feasible within existing capacity; the importance of SLCP mitigation; and Canada's related actions; and bring these forward for consideration as appropriate.

NEW NEAR-TERM ACTIONS

- ECCC will enhance methane and black carbon representation in the Department's earth system-based climate model and air quality models. Climate and air quality model data, scientific reports, and targeted analysis for the regulatory community will be available in 2018-2019.
- ECCC will improve the quantification of black carbon and ozone precursors emitted by residential biomass burning, via direct measurement studies.
- ECCC will update web content on SLCPs.
- ECCC will propose complementary communications products to emphasize the need to act to policy communities and the general public, and communicate Canada's actions to address SLCPs on domestic and international fronts.

Systematically engaging in international fora

ECCC could **build on bilateral and continental partnerships** and relationships to further SLCP objectives through continental actions. For example, Canada and the U.S. have been collaborating on air quality through the Canada-U.S. Air Quality Agreement (AQA), signed in 1991 with the purpose of addressing the transboundary movement of air pollutants that cause acid rain. In 2000, an annex to address ground-level ozone was added. Over the past two years, Canada and the U.S. have been informally exploring possible options for updating and strengthening the Agreement. ECCC officials successfully worked with counterparts in the U.S. and Mexico to include SLCP commitments in the North American Clean Energy and Environmental Partnership called for in the Minister's mandate letter. Opportunities to advance SLCP objectives under the Commission for Environmental Cooperation (CEC) could also be explored.

ECCC could **deepen its multilateral engagement** on SLCPs through new actions to support SLCP objectives in a number of existing fora in which it participates. There is a key opportunity to bring international attention to SLCPs and high-profile visibility to Canada's current and planned SLCP mitigation actions under the **UNFCCC process**, by highlighting efforts to address SLCPs in the revised **Nationally Determined Contribution submission (NDC submission)** to be submitted by Canada following completion of the Pan-Canadian Framework on Clean Growth and Climate Change, as well as in related communications materials. This could be as simple as including narrative to highlight that: Canada recognizes the importance of reducing SLCPs in concert with action on CO₂ in attaining temperature goals; measures on methane and HFCs in the NDC contribute to SLCP reductions; and that Canada is also working to reduce emissions of black carbon. In addition, ECCC could advocate for more SLCP-related projects to be supported through climate finance contributions that aim to mobilize private sector investments at multilateral development banks.

In addition, as part of Canada's \$2.65 billion pledge in international climate financing to help developing countries transition to low-carbon and resilient economies, Canada committed \$35M to reduce SLCP emissions. This investment includes,

amongst other things, a \$10M contribution to the CCAC Trust Fund and \$14 million to support NDC implementation in Mexico and Chile through the deployment of clean technologies to reduce methane emissions (1) in the Mexican oil and gas sector and (2) in the Chilean waste management sector.

Canada's engagement on SLCPs under the **Arctic Council's** Expert Group on Black Carbon and Methane provides an opportunity to influence benchmarking activities on SLCPs and re-invigorate or leverage partnerships with non-Arctic States participating in the group towards broader climate and clean air-related goals. Canada will work to implement recommendations from the Expert Group on Black Carbon and Methane Summary of Progress and Recommendations to contribute to the achievement of the collective goal on black carbon. Canada will also continue to engage constructively in discussions within the Expert Group, including to revisit the collective goal on black carbon during future Arctic Council chairmanships. Canada could also undertake new activities through other Arctic Council working groups. For example, Canada could propose project-based work under the Arctic Council's Arctic Contaminants Action Programme's (ACAP) Short-lived Climate Pollutants Expert Group (SLCP EG), focusing on activities that can reduce emissions of black carbon that are transported to and deposited in the Arctic.

A Canadian project could explore and address data gaps for key sources or focus on achieving real reductions in black carbon emissions in the Canadian Arctic region by working with industry and other stakeholders. The project could be a desktop study or data review, or implement concrete and cost-effective measures to reduce emissions. ECCC could also explore work with the territories to develop and submit a case study on black carbon reduction activities or best practices to ACAP's Black Carbon Case Studies Platform, a web-based interactive map that houses case studies from across Arctic States to help the general public find information on black carbon activities in the Arctic. Canada will continue to engage with the expert science community on SLCPs through representation on the AMAP expert group on black carbon, methane and ozone. Additional opportunities such as reducing the use or carriage of heavy fuel oil in the Arctic could also be explored under the Arctic Council and other multilateral fora such as the IMO.

Canada's **endorsement of the World Bank Zero Routine Flaring by 2030 initiative** is expected to contribute to reduced emissions of black carbon, CO₂ and other pollutants produced by routine flaring from oil production operations. This initiative requires that participating governments provide a legal, regulatory, investment, and operating environment that provides oil companies the confidence and incentive to invest in flare elimination solutions. The federal government has committed to work with provincial and territorial governments to implement consistent requirements across the country. Canada will encourage federal, provincial and territorial oil and gas regulators to continue efforts towards eliminating routine flaring, recognizing that flaring for certain specific circumstances, such as safety or emergency reasons, may still need to occur. Specifically, Canada will encourage federal, provincial and territorial oil and gas regulators in efforts to ensure gas conservation regulatory requirements are robust and achieve no routine flaring. The use of Best Available Technology Economically Achievable (BATEA) is encouraged to eliminate flaring. A number of regulators have already taken such action, such as: existing and proposed legislation and policies for solution gas flaring management in Alberta and British Columbia, as well as efforts under the Frontier and Offshore Regulatory Renewal Initiative between the Canada-Newfoundland and Labrador Offshore Petroleum Board, the Canada-Nova Scotia Offshore Petroleum Board and the National Energy Board.

ECCC has **increased its engagement in the CCAC** by serving as co-chair of the CCAC Working Group, the operational decision-making body of the Coalition, for the 2016-2018 period. In addition, CCAC funding provided by Canada, as well as other CCAC Partners, will help to reduce SLCP emissions from key industrial sectors in developing countries, contributing to Canada's international objectives on climate change and in reducing the rate of near-term warming. It also strengthens Canada's profile in efforts to reduce SLCPs. Canada could also nominate experts to the CCAC's new Solutions Centre and expert roster. Furthermore, the Assistant Deputy Minister of the Environmental Protection Branch (ECCC) is co-chairing the Global Methane Initiative for the 2016-2018 period. Participation in these fora demonstrates Canada's commitment to advancing supplementary and complementary efforts to the UNFCCC.

HFCs are the fastest growing GHGs in developing countries due to rapid growth of the refrigeration and air conditioning sector in these countries and their use as replacements for ozone-depleting substances being phased out under the **Montreal Protocol**. Studies have shown that global HFC emissions could constitute up to 10% of total CO₂e emissions by 2050. The most widely used HFCs have lifetimes ranging from 10-30 years. Immediate action to phase down HFCs can therefore make a significant impact in achieving relatively near-term climate mitigation. International engagement to promote the global phase-down of HFCs through an amendment to the Montreal Protocol has represented a critical component of ECCC's approach to mitigating this SLCP. Canada co-sponsored a North American Proposal to phase down HFCs under the Montreal Protocol in 2009, and undertook unrelenting efforts over the past seven years to promote such a phase-down through to the adoption of the Kigali amendment on October 15, 2016. ECCC will **pursue its leadership role under the Montreal Protocol** by encouraging Parties to ratify the Kigali Amendment as soon as possible and by working with Parties towards the implementation of the amendment.

Ratification of the amended Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution would demonstrate Canada's commitment to addressing SLCPs and air pollutants in an international treaty. Canada's commitments are indicative in nature and would be automatically incorporated into the treaty upon ratification. Moreover, once this treaty comes into force for Canada, it would replace three earlier treaties to which Canada is a party and under which we have reporting and reduction obligations.

Engagement in all these fora could seek to **showcase national and subnational activities**, and Canadian SLCP mitigation technologies. For example, national reports on black carbon and methane submitted to the Arctic Council provide an ongoing opportunity to share progress on Canada's scientific and mitigation activities, best practices or lessons learned, at international, national, and subnational levels. Several Canadian companies and end users have developed and implemented innovative technologies to transition from current HFC technologies. ECCC could demonstrate its support for clean technologies by hosting a side event at an upcoming Montreal Protocol Meeting to showcase emerging Canadian

climate-friendly alternatives to current HFC technologies. Canada could also work to raise the profile of, and advocate for, action to reduce SLCPs in international fora such as the Organisation for Economic Co-operation and Development

(OECD), the United Nations Environment Assembly (UNEA), the G7/G20, as well as non-traditional environmental fora such as the International Maritime Organization (IMO), as appropriate.

NEW NEAR-TERM ACTIONS

- ECCC will develop high-level language regarding the importance of SLCP mitigation to include in the narrative for Canada's **NDC submission**.
- ECCC will work to implement several recommendations from the Expert Group on Black Carbon and Methane Summary of Progress and Recommendations to contribute to the achievement of the **collective goal on black carbon under the Arctic Council**.
- ECCC will support efforts to explore opportunities to reduce the use or carriage of heavy fuel oil in the Arctic under multilateral fora such as the IMO or the Arctic Council.
- ECCC will encourage Parties to ratify the Kigali Amendment to the Montreal Protocol as soon as possible, and will work with Parties towards the implementation of the amendment.
- ECCC will work with provincial/territorial governments to implement consistent requirements for the World Bank Zero Routine Flaring by 2030 initiative across the country.
- Canada will continue to strategically engage in the CCAC, focusing on its role as a catalyst for SLCP emission reductions internationally.
- ECCC will work to ratify the Gothenburg Protocol.

Improving coordination of ECCC and Government of Canada activities

The breadth of actions that could be taken on SLCPs suggests that it would be useful to formalize governance of ECCC's SLCP actions in order to enable prioritization and coordination of activities across ECCC's Environmental Protection, Science and Technology, International Affairs, and Strategic Policy Branches.

An **ECCC-wide SLCP integration committee** will be convened to support the implementation of this Strategy, prioritize and coordinate work plans across ECCC, develop resource allocation options, and track progress to ensure that priorities identified for SLCPs are advanced under agreed upon timelines. Members of the committee will represent and serve as SLCP contact points for their programs. The committee will report to the Assistant Deputy Minister of the Environmental Protection Branch.



In the near term, such coordination will assist in ensuring timely, consistent, and streamlined input and consultation across the Department on SLCP activities. Over the longer term, it will ensure the Department's science, policy and international dimensions are working toward coherent and unified strategic goals, aligned with the Ministerial mandate and the Pan-Canadian Framework.

Collaboration with other government departments will be important in developing a well-rounded federal response to SLCPs. For example, Transport Canada (TC) has the mandate to address emissions from marine, rail and aviation, and Agriculture and Agri-Food Canada has the mandate to address methane emissions from the agricultural sector.

A number of other departments are also actively engaged in activities, have implemented programs relevant to SLCPs, or are planning on doing so, including: Natural Resources Canada's (NRCan) Program of Energy Research and Development (PERD), SmartWay Transport Partnership, FleetSmart and its R2000 Housing Standards; and Infrastructure Canada programs, such as the Green Infrastructure Fund and the Public Transit Infrastructure Fund. Health Canada (HC) has undertaken studies to quantify health impacts related to exposure of diesel exhaust, and analysis of the potential air quality and health benefits of a widespread program to retrofit diesel engines.

Other government departments could be formally engaged through the ECCC SLCP Integration Committee. Creation of a federal working group could also be considered.

NEW NEAR-TERM ACTIONS

- ECCC will launch an SLCP integration committee to improve coordination of ECCC and Government of Canada SLCP activities, including to track the implementation of this Strategy and to identify new priorities.
- ECCC will engage other federal departments regarding opportunities to reduce emissions of SLCPs for key sources falling under their mandates.

Collaborating with provincial and territorial governments and other possible partners

ECCC could seek to advance **SLCP mitigation through collaboration with provincial and territorial partners**, by focusing on priority areas that fall under joint jurisdiction, including:

- Black carbon: in-use on- and off-road diesel vehicles and engines, stationary diesel engines, and wood-burning appliances;
- Methane: venting and fugitives from oil and gas operations, landfill gas reduction and capture;
- Ozone: Continuing to work with provinces and territories under the AQMS to address air pollutants, including ozone precursors such as NOx and VOCs;
- HFCs: Preventing emissions of HFCs through a suite of federal/provincial/territorial controls, including public procurement of equipment with alternatives to high-GWP HFCs; and
- Collaboration on improving the consistency of emission inventories across jurisdictions, through alignment of reporting requirements or establishing data sharing agreements while minimizing duplication of efforts.

The federal government has been working with the provinces and territories on methane, including through the process to develop the Pan-Canadian Framework. The need to consider black carbon as a co-benefit was also included and recognized by the specific mitigation opportunities working group. There is also potential to mobilize existing mechanisms within the CCME for longer term collaboration on priority areas.

Of note are the: Mobile Source Working Group (MSWG) where sharing information on how to reduce emissions from in-use fleets, including high emitting on-road vehicles, is one of the primary objectives (revising this group's mandate to include action could be considered); the Air Management Committee, under which ECCC collaborated with provincial and territorial partners to develop a code of practice for wood-burning appliances and a guidance document for open-air burning; the National Action Plan for the Environmental Control of Ozone-depleting Substances and their Halocarbon Alternatives, which includes HFCs; and the Waste Management Task Group. Collaboration will also continue under the AQMS framework more broadly through the Air Management Committee which oversees the implementation of the AQMS.

Municipalities hold a number of policy levers on SLCPs, including related to waste, transit and wood burning. ECCC could **explore possible partnerships with municipalities**. There may also be opportunities to showcase the strengths of cities internationally and draw municipalities into collaboration with federal, provincial and territorial governments as key partners in addressing SLCPs.

ECCC could also **explore possible partnerships with other actors**. Further analysis could be undertaken to better understand how engagement with arms-length institutions and others outside government could support policy objectives, and where engagement efforts could best be focused. Analysis could include consideration of engagement with: funding institutions such as Sustainable Development Technology Canada; the Federation of Canadian Municipalities (FCM); academia, for example on SLCP science; Indigenous communities; NGOs; and the private sector.

NEW NEAR-TERM ACTIONS

- ECCC will continue to collaborate with provincial and territorial partners to advance SLCP mitigation priorities. Discussions could build on existing collaboration on in-use diesel transportation fleets and wood-burning appliances under the Canadian Council of Ministers of the Environment. Further collaboration on accelerating the turnover of existing wood-burning appliances and in-use stationary engines could be proposed.

CONCLUSION

ECCC is committed to reducing emissions of carbon dioxide and other long-lived GHGs as well as SLCPs as part of its comprehensive approach to climate change mitigation. Reducing emissions of SLCPs supports Canada's commitments under the Paris Agreement, and domestic priorities for cleaner air and healthier communities. Comprehensively addressing SLCPs requires new, coordinated actions at home and abroad.

Ideally, all of the actions identified in this Strategy would be undertaken in the near future. However, many of the actions to enhance domestic action and increase scientific understanding require additional resources. Some would also require collaboration with key partners outside ECCC to deliver. Engaging other federal departments and provincial and territorial partners will be a key next step. A phased approach will be taken to advance remaining actions, taking into consideration jurisdictional authorities.

Implementation of new near-term actions will represent an important step forward in addressing SLCP mitigation and knowledge gaps. It will also help to ensure that the Department's work on SLCPs, as well as that of other departments and levels of government are mutually reinforcing. Implementation will be coordinated with, and complementary to, implementation of the Pan-Canadian Framework.

Sustained efforts will be required to advance the implementation of a holistic approach to SLCPs, and to generate the SLCP emissions reductions required domestically and internationally to achieve climate mitigation and air quality goals.



ANNEX I – SUMMARY OF SCLP ACTIONS

Strategy on Short-Lived Climate Pollutants				
A holistic approach to address SCLPs that includes mitigation, science, communications, international and federal/provincial/territorial engagement dimensions				
Pillar 1: Enhancing domestic mitigation 1. Black carbon ✓ Initiate development of federal regulations for new stationary diesel engines ✓ Reduce reliance on diesel for electricity and heat in Northern, remote and indigenous communities • Initiate development of federal measures for new wood-burning appliances 2. Methane ✓ Advance federal regulations for oil and gas operations ✓ Initiate actions for landfills 3. Ozone ✓ Finalize MSAPR and non-regulatory BLUERS already developed • Approve CAAQS for SO ₂ and NO ₂ 4. HFCs ✓ Finalize permitting and reporting system and Pollution Prevention Notice and advance regulatory measures	Pillar 2: Enhancing science and communications to broaden understanding 1. Enhance methane and black carbon representation in ECCC's earth system-based climate model and air quality models 2. Further refine the black carbon inventory to support the development of priority mitigation measures 3. Update web content on SCLPs 4. Propose communications products to emphasize need to act and to communicate Canada's actions	Pillar 3: Systematically engaging in international fora ✓ Continue to take active role to promote an HFC amendment to the Montreal Protocol ✓ Collaborate with US on methane from oil and gas ✓ Co-chair the Global Methane Initiative and the CCAC Working Group for 2016-2018 ✓ Integrate SCLPs into a North American agreement on energy and the environment ✓ Agree to a quantitative collective goal on black carbon under the Arctic Council 1. Highlight SCLPs in Canada's NDC submission 2. Consider adding PM _{2.5} in the process of refreshing the Canada-US Air Quality Agreement 3. Initiate work to implement consistent national requirements for the World Bank Zero Routine Flaring by 2030 initiative 4. Use a portion of ECCC's Climate Finance envelope to mobilize private sector investments through facilities within multilateral development banks 5. Advocate for support for SCLP-related projects at multilateral development banks that mobilize private sector investments 6. Contribute an additional \$10M contribution to the CCAC Trust Fund over 5 years. 7. Support NDC implementation in Mexico and Chile through technology deployment in the oil and gas and waste sectors. 8. Ratify the amended Gothenburg Protocol to the Convention on Long-range Transboundary Air Pollution	Pillar 4: Improving coordination of ECCC and Government of Canada activities 1. Establish an ECCC SCLP integration committee • Develop 5-year work plan • Refine and elaborate analysis of trade-offs • Work to include SCLP mitigation objectives in departmental priorities 2. Collaborate with OGDs through ECCC SCLP integration Committee to enhance the overall effectiveness of the Government of Canada's action on SCLPs	Pillar 5: Collaborating with provinces/territories and other possible partners 1. Collaborate with provinces/territories on SCLP mitigation priorities including through the CCME (e.g. diesel vehicles and engines, stationary diesel engines, wood-burning appliances, oil and gas operations, landfills, HFC refrigerants)
Pillar 1: Medium-Longer Term 1. Black carbon • Consider options for reducing emissions from in-use vehicles and engines (including stationary engines) • Consider options for reducing emissions from in-use wood-burning appliances • Reduce reliance on diesel generation at Government of Canada Arctic facilities 2. Methane • National methane strategy • Initiative on food waste reduction • Strategy for Recycling and a Circular Economy • Landfill Gas Recovery Initiative including economic incentives and an outreach program 3. Ozone • More stringent CAAQS for PM _{2.5} and ozone • Consider emission standards for ozone precursors for industrial sectors	Pillar 2: Medium-Longer Term 1. Reconcile bottom-up and top-down estimates of fugitive methane and VOC emissions from oil and gas operations 2. Ongoing refinements to the black carbon inventory to support the development of priority mitigation measures	Pillar 3: Medium-Longer Term 1. Advance SCLP objectives under the CEC 2. Host a side event at a Montreal Protocol meeting to profile innovative Canadian technologies that could assist in the transition from current HFC technologies 3. Consider extending North American Emissions Control Area to the Arctic 4. Lead a project or case study under the Arctic Council to help address data gaps or reduce emissions in Canada's North	Pillar 4: Medium-Longer Term 1. Advance SCLP objectives under the CEC 2. Host a side event at a Montreal Protocol meeting to profile innovative Canadian technologies that could assist in the transition from current HFC technologies 3. Consider extending North American Emissions Control Area to the Arctic 4. Lead a project or case study under the Arctic Council to help address data gaps or reduce emissions in Canada's North	Pillar 5: Medium-Longer Term 1. Explore partnerships with municipalities (e.g. waste, transit, wood-burning) 2. Explore partnerships with other actors (private sector, academia, government agencies, NGOs, Indigenous communities)

NOTES

- Near-term: 2017-2018
- Medium-longer term: series of actions that could be taken over time to drive deeper reductions

ANNEX II – CURRENT STATUS OF ECCC SCIENCE AND INTERNATIONAL ENGAGEMENT ON SLCPs

Science

The ongoing ECCC science program delivers targeted science and science advice, throughout the policy chain from the identification of policy needs and air pollutant issues, to the development and implementation of regulatory actions, to the evaluation of their efficacy in reducing atmospheric levels of pollution. This program also supports the quantification of co-benefits that can be derived from specific action on air pollutants and SLCPs (specifically for black carbon) on climate change mitigation.

Science on SLCPs is composed of: 1) identification of emission sources and quantification of emission rates; 2) measurement of ambient levels of SLCPs; 3) study of the atmospheric processes with respect to different SLCPs; 4) development and application of climate and air quality models to assess the impact of changes in SLCP emissions on ambient levels of SLCPs and radiative forcing; and 5) characterization of SLCP emissions from mobile sources.

Identification of SLCP emission sources

Monitoring allows the relative importance of various sources for different pollutants to be assessed, as well as tracking how their relative contributions to total emissions evolve over time.

Emissions of all SLCPs (or their precursors) are quantified annually at the national level and for different sectors. National and provincial/territorial emissions of methane and HFCs are included in Canada's National Inventory of GHG Sources and Sinks (NIR). Ozone precursors are included in Canada's Air Pollutant Emissions Inventory annual report (APEI). Canada's first Black Carbon Inventory was released in 2015 for the 2013 year, and is published annually as part of Arctic Council commitments. All reports are submitted to the UN

(UNFCCC or UNECE), and are also available via the Open Government data portal. The NIR and APEI follow international reporting formats, making them comparable to reports of other countries that use the same reporting formats.

Current scientific work on monitoring emissions includes the development and improvement of black carbon and methane emission estimates and emission factors, as well as targeted projects focused on characterization of transportation and oil and gas emissions. Challenges include quantifying regional and fugitive sources, refining emission rates by technologies and operating conditions, and quantifying emissions from sources with skewed emission distributions.

Monitoring of ambient levels of SLCPs

ECCC operates the long-term measurement networks for atmospheric levels of SLCPs (including methane, black carbon and ozone) to determine long-term trends and the atmospheric response to changes in emissions over time. As these pollutants also undergo long range transport, the monitoring program also contributes to understanding the influence of regional to global sources on air quality and climate. These measurements take place at sentinel sites across Canada, and form the basis for the development of baselines against which to assess atmospheric change and to verify the efficacy of mitigation policies. ECCC's long-term measurements (as well as those of other nations, and combined with satellite observations) are also applied to characterize emissions of SLCPs at a regional-scale, providing a top-down approach (i.e.: observations based) to improving emissions estimates.

The work also includes analysis of the data to understand the impacts of domestic and international sources on the long-term trends. ECCC also undertakes ongoing black carbon method

inter-comparison work with international partners to better integrate results across programs, and between atmospheric and emission source methodologies. ECCC is also working to better understand the contribution of local emission sources (including increased ship traffic) to air pollution in northern communities.

Atmospheric processes research and development and application of air quality and climate models

The processes studies effort focuses on improving our scientific understanding of atmospheric and terrestrial processes affecting SLCPs, and the resulting impact on air quality and climate. This scientific knowledge will subsequently inform model development and parameterization of these processes in ECCC's models, improving our ability to estimate the climate response to these pollutants individually and as a group, and thereby our ability to predict Canadian and global climate change to inform domestic and international mitigation plans. This work also contributes to improved air quality projections to quantify short-term air quality benefits derived from reductions in emissions of SLCPs, informing the development of policy.

Processes research and modelling enables the development of impact assessments of the various sources/types of pollutants. Current work includes: studying the atmospheric transport pathways and chemical transformations related to SLCPs to improve air quality and climate predictions; quantifying the magnitudes of aggregate regional and area sources; daily air quality forecasts and air quality scenario analyses, which can discern the relative contribution of biomass burning versus anthropogenic emissions to black carbon levels; and Canadian Earth System Model (CanESM) simulations to evaluate the climate effects of SLCP emissions from particular sectors and regions globally. Challenges include regional-scale climate influence on air quality and weather and precipitation, as well as the impact of SLCPs on human health and ecosystems.

Characterization of SLCP mobile source emissions

Efforts to characterize black carbon emissions from mobile sources focus on improving understanding of vehicle/engine operational conditions and fuel characteristics that impact quantity and formation of black carbon. This work will subse-

quently inform mitigation decisions related to the reduction of black carbon emissions from on- and non-road mobile source sectors, including marine vessels.

Continental and international engagement

Canada is currently engaged actively in a number of international fora addressing SLCPs. This existing engagement provides a starting point for considering ways in which Canada's international action on SLCPs can be better integrated with domestic science and mitigation priorities.

Arctic Council

The Arctic Council was one of the first fora to recognize the importance of taking action to address SLCPs. Its early work focused on scientific contributions, confirming the substantially disproportionate impact that SLCPs have on the Arctic and concluding that reductions would lead to near-term climate, health and economic benefits in the Arctic, while also contributing to the global effort to limit the increase in the global average temperature.

ECCC scientists actively participate in the Arctic Council Arctic Monitoring and Assessment Program's (AMAP) Expert Group on Short-Lived Climate Forcers. This will enhance targeted science and monitoring regarding Arctic climate responses to SLCPs and builds on ECCC contributions to the 2015 assessments through the participation of climate scientists in the ongoing analysis of observations and application of climate models under AMAP.

Canada's current policy engagement on SLCPs under the Arctic Council builds on the work of the Task Force on Short-lived Climate Forcers (TF SLCF) under Denmark's 2009-2011 and Sweden's 2011-2013 Chairmanships. This Task Force produced two sets of recommendations that have informed the Arctic Council's subsequent SLCP work.

Addressing SLCPs affecting the Arctic was a key priority for Canada's 2013-2015 Chairmanship, during which the Canadian co-chaired Task Force for Action on Black Carbon and Methane (TFBCM) was established. The TFBCM's deliverable for 2013-2015 was *Enhanced Black Carbon and Methane Reductions: An Arctic Council Framework for Action*, adopted by

Arctic Ministers at the April 2015 Ministerial. The *Framework* commits Arctic States and participating Observer States to enhanced, ambitious national (and collective) action plans or mitigation strategies, as well as to improve science and inventories, and to exercise leadership by working with Arctic Council Observer States and others to reduce emissions produced beyond the borders of Arctic States. It also includes commitments to submit biennial national reports on emissions and action, and to submit black carbon inventories to the United Nations Economic Commission for Europe's (UNECE) Convention on Long-range Transboundary Air Pollution (LRTAP). As part of Canada's commitment to addressing SLCPs under the Arctic Council, the federal government submitted its first Black Carbon Inventory to the UNECE in February 2015 and its first *National Black Carbon and Methane Report* to the Arctic Council in December 2015.

An Expert Group was created under the Framework to support the implementation of the Framework, including by reviewing and synthesizing national reports, and delivering a summary of progress and recommendations to Arctic Council Ministers. ECCC represents Canada in the Expert Group on Black Carbon and Methane (EGBCM) and is working with Arctic partners to deliver on these commitments. The EGBCM recently published its first Summary of Progress and Recommendations, which was adopted during the Tenth Ministerial Meeting of the Arctic Council in May 2017. The report is the first Pan-Arctic report on collective progress to reduce black carbon and methane emissions by the Arctic States and several Observer States. The report recommends that Arctic States collectively reduce their black carbon emissions by at least 25 – 33 percent below 2013 levels by 2025. The report also makes 12 recommendations for enhanced policy action focused on four sectors where large near-term gains are possible: diesel-powered mobile sources; methane leakage, venting and flaring in the oil and gas sector; residential biomass combustion; and solid waste disposal.

Other key elements of the Arctic Council Framework include continued monitoring, research and scientific reporting; increasing awareness; and, the carrying out of project and sector-based activities. These are activities ECCC is already actively engaged in, or in some cases leading, in other international fora, including the UNECE, UNFCCC, CCAC and

the WMO. Canada's engagement in the Arctic Council's work on SLCPs could work to enhance the Arctic perspective on climate and air quality discussions in other international fora, and leverage existing expertise and opportunities found in these other fora while avoiding duplicative efforts.

The Arctic Council's Arctic Contaminants Action Program's (ACAP) Short-lived Climate Pollutants Expert Group (SLCP EG) is carrying out ongoing project-based science and mitigation work, including the Black Carbon Case Studies Platform, which showcases work undertaken by Arctic States to improve black carbon science and enhance mitigation. Efforts are underway to achieve a pan-Arctic scope for the Black Carbon Case Studies Platform.

Climate and Clean Air Coalition

Canada is a founding member of the Climate and Clean Air Coalition (CCAC) and work under this forum has been a Canadian priority since 2012.

Canada recently announced funding of \$25M for SLCP mitigation action with key partner countries, including for projects that aim to reduce black carbon emissions to benefit the Arctic. This includes \$10M for the CCAC Trust Fund to support programs and initiatives in developing countries, bringing Canada's total contribution to the CCAC Trust Fund to \$23M. ECCC will work to ensure that these funds align with, and build on domestic and international policy imperatives, science and technical expertise, and Canadian products and services which can help foster reductions in SLCPs.

Through a series of sector-based initiatives, the CCAC seeks to promote near-term reductions of SLCPs worldwide (including across developed and developing contexts). Canada co-leads the implementation of initiatives on black carbon from heavy-duty diesel vehicles and engines, the promotion of HFC alternative technologies and SLCP mitigation from agriculture and municipal solid waste. Canada is also a Partner in the CCAC's Oil and Gas Initiative—chairing the Technology Demonstration Component and acting as lead Partner of the Methane Partnership—which focuses on venting and flaring in the oil and gas sector in Africa, Latin America and Asia.

Canada is the co-chair of the CCAC Working Group for 2016-2018. The Working Group is the operational decision making body of the Coalition

which meets twice a year, as well as for short preparatory meetings in advance of the High Level Assembly of Ministers and Heads of non-state Partner organizations. The Working Group makes decisions on such things as approving new partners, approving new initiatives, funding for new projects, and formulating recommendations to the High Level Assembly. Canada is also a member of the CCAC Steering Committee and Chair of the Communications Working Group.

Global Methane Initiative

The Global Methane Initiative (GMI) is a voluntary international partnership which addresses fugitive emissions of methane through the development, deployment and diffusion of clean technologies. Since 2004, it has mobilized a network of over 1,300 public and private sector organizations, and leveraged nearly \$480 million in investment from private companies and financial institutions. The GMI is active in the five key methane-emitting sectors, which include oil and gas, coal mining, municipal waste, wastewater and agriculture. Its primary activities include building national and regional capacity for technical and policy approaches to methane mitigation, sector-specific assessments of project opportunities, developing and disseminating best practices, and supporting development of methane action plans.

Canada has been an active member of the GMI since 2005. Canada has funded a variety of projects over the years and participated actively in the Steering Committee and subcommittees. Canada is also co-chairing the Global Methane Initiative for the period 2016-2018, and for which new terms of reference were announced in March 2016. As part of this role, Canada is responsible for providing strategic leadership to the Steering Committee and hosting at least one annual meeting.

As both Co-Chair of the CCAC Working Group and the GMI Steering Committee, Canada is well positioned to support the increasing collaboration between the CCAC and the GMI, and create synergy between their complementary mandates.

Gothenburg Protocol

The Gothenburg Protocol to the UNECE's LRTAP Convention was established in 1999 to address acid rain, smog, ozone and the degradation of water bodies. Initially focusing on sulphur dioxide (SO₂), nitrogen oxides (NO_x), ammonia and volatile organic compounds (VOCs), the Protocol was

amended in 2012 to include new commitments for 2020 as well as black carbon as a component of fine particulate matter (PM_{2.5}). Parties are encouraged to prioritize PM_{2.5} measures that will also significantly reduce emissions of black carbon. The LRTAP Convention also developed the initial guidance documents for black carbon emissions inventories.

Current work under the Gothenburg Protocol includes ongoing discussions and negotiations on improving the procedures by which Parties may adjust their emissions reduction targets, and the preparation of the 2016 LRTAP Assessment Report, which assesses the Convention's impacts throughout the UNECE region and will inform subsequent policy discussions under the Convention.

Canada is a signatory to the Gothenburg Protocol, and has ratified other Protocols under the Convention that will be subsumed under the amended Gothenburg Protocol when it comes into force (requires ratification by two thirds of Parties to the original Protocol). The Protocol contains flexibilities to facilitate ratification. Canadian commitments, for example, are to be indicative and automatically incorporated. At present, Canada is working to ratify the Gothenburg Protocol.

Canada and the U.S. regularly work closely within the LRTAP Convention to express North American interests. The U.S. ratified the amended Gothenburg Protocol in January 2017. Sweden was the first to ratify the amended Protocol in November 2015. There is a current initiative by Parties and the LRTAP Convention to accelerate ratification of the amended protocol (both in the Eastern European Caucasus and Central European (EECCA) region and in North America.

Canada-U.S. Air Quality Agreement

The Canada-United States Air Quality Agreement seeks to control and reduce transboundary air pollution between Canada and the US, originally addressing emissions of SO₂ and nitrogen dioxide (NO₂) that cause acid rain. In 2000, the Agreement was amended by adding the Ozone Annex to address emissions of pollutants that lead to the formation of ground-level ozone, namely NO_x and VOCs. The Agreement has led to significant decreases in air pollutant emissions responsible for acid rain and smog on both sides of the border.

Both countries met their respective commitments under the Agreement a number of years ago. Over the past two years, the two countries have been exploring the possibility of updating and strengthening the Agreement, including renewing the commitments and possibly integrating PM_{2.5} into the Agreement.

Commission for Environmental Cooperation

The Commission for Environmental Cooperation (CEC) is a Canada-U.S.-Mexico tri-lateral forum to facilitate environmental protection in an increasingly integrated North America and may achieve a heightened profile following COP21.

In its 2015-2020 Strategic Plan for Climate Change Mitigation, the CEC has prioritized enhancing national efforts to address SLCPs as part of broader approaches to climate change. The Strategic Plan also supports emerging areas of scientific research on SLCPs as well as a focus on indigenous dimensions, enhancing information-sharing, capacity-building and communication among Canada, the U.S. and Mexico.

Recent work on SLCPs under the CEC has focused on documenting and comparing emission estimation methodologies for black carbon and co-pollutants, as well as on climate change modeling and assessment, waste diversion and transportation sector emissions reductions.

Montreal Protocol

The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. The Montreal Protocol has achieved unparalleled success in eliminating these substances worldwide over the past 30 years.

HFCs were developed as replacements for ozone-depleting substances being phased out under the Montreal Protocol. Canada, along with Mexico and the U.S., began promoting the phase-down of HFCs under the Montreal Protocol in 2009. In October 2016, Parties to the Montreal Protocol adopted the Kigali amendment to phase down the consumption and production of HFCs.

Implementation of the Kigali amendment could avoid up to 0.5 degrees Celsius of warming by the end of the century, thus making a significant contribution to the objectives of the Paris Agreement. HFC emissions will continue to be reported and accounted for under the United Nations Framework Convention on Climate Change (UNFCCC).

International Maritime Organization (IMO)

The IMO is the UN agency responsible for setting global standards applicable to international shipping, including environmental standards. Transport Canada leads Canada's delegation at the IMO and is supported by ECCC through the provision of expert technical and policy advice relating to air pollutant and GHG emissions from ships. ECCC is contributing emissions testing expertise to a multi-year IMO work plan, to assess the impacts on the Arctic of black carbon emissions from ships. Other SLCPs being studied by ECCC and under discussion at the IMO include fugitive VOCs from tankers.

ECCC – NOAA collaboration in aerosols and GHG monitoring over North America

The two institutions have a long (multi-decadal) history of coordinated research and monitoring for GHGs and aerosols (including black carbon) which will continue to provide observations and insights regarding source influences, necessary to assess the efficacy of mitigation actions and to support ongoing development and evaluation of climate and air quality models.

Active participation in the international black carbon method development and intercomparison studies for North America and Europe

ECCC's Science and Technology Branch participates in several international fora including the World Meteorological Organization's Global Atmosphere Watch Program, ECCC-NOAA bilateral collaborations, and individual research collaborations, which support the advancement of developing and testing of observational methods and calibration protocols for the monitoring of atmospheric concentrations.

ANNEX III – ENHANCED DOMESTIC MITIGATION

This Annex provides additional detail on potential near and medium-longer term actions described in the main body of the Strategy.

BLACK CARBON

Collaborate with provincial and territorial partners to reduce emissions from in-use diesel fleets

Despite emissions reductions that have resulted from stringent federal regulations since 2004 to address air pollutants from newly manufactured on- and off-road diesel vehicles and engines, and regulatory and program measures focused on existing vehicles in some provinces, the sector continues to be Canada's largest source of black carbon emissions. Turnover of the in-use fleet – still dominated by engines pre-dating the most recent emissions standards – is slow.

Once a vehicle is sold at the retail level, provincial/territorial governments have jurisdiction over its environmental performance within their respective boundaries, and along with municipalities have the most policy levers to support action on existing fleets. The Government of Canada could explore opportunities with provinces and territories to further reduce emissions from these sources.

The U.S. EPA estimates that retrofitting on-road vehicles with diesel particulate filters is one of the most cost-effective ways to reduce diesel emissions. Estimated costs range from US\$8,000-\$20,000 depending on vehicle type, with the potential to reduce black carbon emissions by up to 99%⁹. It has also estimated that for every dollar invested in reducing diesel exhaust, a community may achieve an estimated \$13 in public health benefits. For every dollar the EPA invests in its Clean Diesel Program, as many as \$3 is invested by other government agencies, private organizations, industry and non-profit organizations.

In 2012, the World Health Organization (WHO) classified diesel exhaust as carcinogenic to humans¹⁰. This conclusion was supported by Health Canada's Diesel Exhaust Health Risk Assessment, released in March 2016, which links exposure to diesel exhaust to 700 premature deaths, as well as to annual morbidity outcomes, and notes that mitigation strategies that target diesel engines would significantly reduce health risks to Canadians. Health Canada also completed an analysis of the potential air quality and health benefits of a widespread program to retrofit diesel engines, and released a final report in 2016.

Implement a multi-pronged approach to reduce emissions from wood-burning appliances

Residential wood combustion is the second most significant source of black carbon in Canada, accounting for 28% of estimated emissions in 2014. It is also one of the largest sources of particulate matter, VOCs and other toxics such as polycyclic aromatic hydrocarbons (PAHs), dioxins and furans, and a key contributor to wintertime smog. There are approximately 3.6 million wood-burning appliances in Canada¹¹. A large fraction of emissions come from older appliances. Emissions from this source are also of significance in Canada's North, where use of wood burning appliances is increasing due to biomass strategies that promote the use of wood for space heating as a means of reducing reliance on imported fossil fuels.

Some provinces regulate the sale of new wood-burning appliances, while some municipalities have by-laws relating to residential wood combustion, including bans on certain types of appliances. However, regulations largely require conformity with U.S. EPA (1988) standards or Canadian Standards Association (CSA B415) codes, which have become dated (the EPA released strengthened

⁹ US EPA Report to Congress on Black Carbon (2012).

¹⁰ WHO -IARC press release, IARC: Diesel engine exhaust carcinogenic, 12 June 2012.

¹¹ Environment Canada (2005). Impact of Residential Wood Stove Replacement on Air Emissions in Canada.

wood combustion standards in 2015). Non-certified appliances are still sold in Canada, and there is potential for future growth in sales of imported, lower cost, non-certified models. Measures to address emissions from existing sources are limited to wood stove change-out programs or rebates for certain new appliances in some provinces and territories.

A mix of initiatives targeting both new and existing wood-burning appliances could be effective in reducing emissions from this source. Federal regulations could ensure consistent national standards in Canada. Minor amendments would be needed to CEPA 1999 in order to allow regulating manufacturers and importers (rather than individual households). However, regulatory development could be done concurrently with CEPA amendments. Replacing an inefficient wood-burning appliance with a modern one can reduce PM_{2.5} emissions by up to 70% on a per unit basis¹², with co-benefits for methane and CO₂¹³.

Implement measures to reduce emissions from stationary diesel engines

Stationary diesel engines are used in many applications throughout Canada. Many of Canada's northern communities rely on stationary diesel engines for electricity generation, including all communities in Nunavut, and many remote communities in the Northwest Territories, Quebec, Newfoundland and Labrador, Ontario, British Columbia, and Manitoba. Diesel engine exhaust has been classified as carcinogenic by the World Health Organization (WHO). The prevalent use of diesel engines in these communities is a concern for local air quality, where engines operate 24 hours a day, often in close proximity to homes and schools.

There are no federal regulations and few provincial measures targeting PM_{2.5} emissions from stationary engines. Budget 2016 provided funding to begin development of federal regulations that will implement performance standards for new stationary engines (as is done in the U.S.). Retrofits and replacements to reduce emissions from existing sources could also be considered.

¹² Arctic Council (2014). Reduction of Black Carbon Emissions from Residential Wood Combustion in the Arctic Black Carbon Inventory, Abatement Instruments and Measures.

¹³ US Environmental Protection Agency, Report to Congress on Black Carbon (2012) p. 210.



The federal *Sulphur in Diesel Fuel Regulations* presently limit sulphur in diesel fuel to 15 ppm and 1000 ppm for use in small and large stationary diesel engines, respectively. It is possible that the limit will need to be lowered for large stationary engines to enable tighter emission standards for these engines.

Reduce emissions from flaring during oil and gas production

Endorsement of the World Bank Zero Routine Flaring by 2030 initiative will help to reduce black carbon emissions resulting from routine flaring during oil production operations. This initiative requires that participating governments provide a legal, regulatory, investment, and operating environment that provides oil companies the confidence and incentive for investing in flare elimination solutions. The federal government will work with provincial/territorial governments to implement consistent requirements across the country. Canada will encourage federal, provincial and territorial oil and gas regulators to continue efforts towards eliminating routine flaring, recognizing flaring for certain specific circumstances, such as safety or emergency reasons, may still need to occur. Specifically, Canada will encourage federal, provincial and territorial oil and gas regulators in efforts to ensure gas conservation regulatory requirements are robust and achieve no routine flaring. The use of Best Available Technology Economically Achievable (BATEA) is encouraged to eliminate flaring. A number of regulators have already taken such action, such as: existing and proposed legislation and policies for solution gas flaring management in Alberta and British Columbia, as well as efforts under the Frontier and Offshore Regulatory Renewal Initiative between the Canada-Newfoundland and Labrador Offshore Petroleum Board, the Canada-Nova Scotia Offshore Petroleum Board and the National Energy Board. This measure will reduce routine flaring during oil production and related emissions of black carbon, CO₂ and other pollutants.

Reduce emissions from marine sources

The marine sector accounts for 6.9% of black carbon emissions. Though not a large contributor nationally, recent analysis by ECCC found that, in 2010, ships sailing in the Canadian Arctic contributed up to 10% of local black carbon emissions, and that emissions may increase to as much as 40% locally by 2030 as levels of Arctic shipping traffic increase. The North American Emission Control Area (ECA) implemented domestically under the *Canada Shipping Act* requires that ships sailing within 200 nautical miles of the Canadian shoreline burn a fuel with a sulphur content no greater than 0.1%. Throughout Canada and the United States, the ECA is expected to lead to a 74% reduction in PM_{2.5} emissions below levels in 2020 absent the ECA. The ECA does not extend into Canada's Arctic.

With expertise and support from ECCC, Transport Canada (TC) regulates emissions from the marine sector and ECCC has been working with TC to reduce marine emissions. In collaboration with TC, ECCC plans to continue to advance its multi-year work plan to assess the potential impacts of current and future-forecasted shipping emissions on Arctic air quality, human health and ecosystems. ECCC will also continue to provide expert technical and policy contributions to an international study on marine emissions of black carbon.

Reduce emissions from Government of Canada facilities in the Arctic

The Government of Canada operates a number of facilities in the Arctic that rely on diesel fuel for electricity generation, including the Eureka weather station and Canadian Forces Station Alert on Ellesmere Island, as well as number of other facilities operated by Parks Canada, Fisheries and Oceans Canada and Natural Resources Canada. Diesel generation at these facilities is expensive and a source of black carbon and other emissions.

Some of these facilities are located in northern regions where solar power is feasible due to high amounts of sunlight in the spring and summer months and low levels of annual precipitation and cloud cover. For example, Eureka, Nunavut, with an average of over 2,000 hours of sunshine per year, has an annual solar photovoltaic (PV) potential similar to Victoria, B.C. or St. John's, NL. During the month of May, Eureka, NU has higher solar PV potential than any major city in Canada¹⁴.

Investment in solar power to supplement diesel generation at the Eureka weather station and other Government of Canada facilities in the North would reduce fuel-use and lower emissions from diesel combustion. It would also offer the potential for long term cost savings, while demonstrating technical feasibility and national leadership for the advancement of renewable energy technologies for off-grid and remote applications across Canada.

METHANE

Implement regulations to reduce methane from oil and gas operations

The oil and gas sector accounted for 44% of Canada's methane emissions in 2014, largely from venting and fugitive sources, which accounted for 42% of the national total. Alberta and Saskatchewan produce more than 90% of Canada's oil and gas methane emissions.

In the Pan-Canadian Framework, Canada committed to work with provinces and territories to reduce methane emissions from the oil and gas sector by 40-45 percent below 2012 levels by 2025. In 2016, Canada undertook over 150 hours of consultations with partners and stakeholders, including provinces, on the development of the proposed regulatory approach. In May 2017, Canada announced proposed regulations to reduce methane emissions from Canada's oil and gas sector, which will also reduce air pollutants (volatile organic compounds) as a co-benefit.

British Columbia, Alberta and Saskatchewan have also implemented measures to reduce venting and fugitive emissions from oil and gas operations. Alberta recently announced a new goal to cut

methane emissions from oil and gas by 45% by 2025, and also is proposing the development of specific requirements for new facilities as well as a voluntary initiative aimed at reducing venting and fugitive emissions from existing facilities. In their recently released Climate Leadership Plan, British Columbia set a target to reduce methane emissions from oil and gas extraction and processing infrastructure built before January 1, 2015, by 45 percent by 2025. British Columbia will also be offering incentives to reduce emissions from applications built between 2015 and 2018 with a Clean Infrastructure Royalty credit program, as well as a new offset protocol, and plans to establish standards for the development of projects after 2018-2020 onwards, including mandatory leak detection and repair. All these measures would help to address this mitigation gap, while generating co-benefits for VOCs, which contribute to ground-level ozone and of which many are toxic to humans. Methane and VOCs are released by many of the same sources in the oil and gas sector.

Implement a landfill gas recovery initiative

The waste sector accounts for approximately 26% of national methane emissions, most of which come from solid waste landfills (approximately 24% of national total). There are no federal measures addressing waste, other than eligibility of solid waste projects for funding under some federal infrastructure programs. Though some provincial governments have regulations that require the capture of landfill gases from their largest landfills and others have programs to incent landfill gas recovery, these measures vary significantly in scope, stringency and results.

Methane from municipal waste landfills could be addressed through a landfill gas (LFG) recovery initiative that would involve complementary federal and provincial measures. A number of options were discussed under the Mitigation Working Group, under the Pan-Canadian Framework development process. Budget 2016 also provided funding to begin development of federal regulations or other control measures identified in consultation with provinces and territories to reduce methane from landfills.

¹⁴ Natural Resources Canada, Photovoltaic Potential, <http://pv.rncan.gc.ca>

Actions would aim to increase the 2012 capture rate for LFG from roughly 36% to 51%, in line with the U.S. capture rate (57%), and achieve a reduction of up to 5.5¹⁵ MT CO₂e per year. A focus on utilization of landfill gas could yield approximately 4.4 Mt CO₂e in reductions, with net annual revenues. Further analysis is needed to assess black carbon emissions from landfill gas flaring and to determine best practices to mitigate these emissions and consultations with provinces/territories and other stakeholders to determine the appropriate mix of provincial and federal measures and incentives to deliver reductions.

HYDROFLUOROCARBONS (HFCs)

Implement regulatory measures to control HFC consumption

HFCs are increasingly being used as substitutes to ozone-depleting substances in the refrigeration and air-conditioning sectors, as foam blowing agents and, to a lesser extent, in aerosol products and fire-extinguishing equipment. A suite of federal and provincial/territorial regulations control ozone-depleting substances and HFCs once they are in use in refrigeration, air-conditioning and fire-extinguishing systems. However, there are no measures that limit the use of HFCs in these sectors. In Canada, total HFC emissions are projected to more than triple between 2013 and 2030 in the absence of further action.

Federal measures finalized in spring 2016 establish a **permitting and reporting system** for the import, export and manufacture of HFCs. In addition, a notice requiring the preparation and implementation of **pollution prevention plans** for the sound management of end-of-life halocarbon refrigerants, which include HFCs, will contribute to preventing emissions of HFCs at end-of-life.

Comprehensive regulatory measures proposed in 2016 would avoid emissions of HFCs through a phase-down of the manufacture, import and export of HFCs, allowing Canada to comply with its Montreal Protocol HFC obligations and to ratify

the Kigali amendment. The regulation will also include a prohibition on the manufacture and import of specific products and equipment using HFCs, such as those used in refrigeration, air conditioning, foams and aerosols. These measures could be complemented by pursuing work with other government departments to ensure energy efficiency programs and regulations are well coordinated, and by engaging and collaborating with other actors to communicate the importance of technology development and implementation related to HFCs.

Encourage transitions to climate-friendly alternatives

Additional actions could be taken to encourage the replacement of HFC systems and products with more climate-friendly alternatives, where feasible.

In the U.S.-Canada Joint Statement on Climate, Energy and Arctic Leadership, the Government of Canada committed to “leading by example” by updating public procurement processes to transition away from high global warming potential HFCs, whenever feasible, through government purchase of more sustainable and greener equipment and products. This could include promoting the procurement of refrigeration, air-conditioning and fire-extinguishing systems, as well as of manufactured items such as foam products in office furniture and construction insulation, that are HFC-free or climate-friendly. This initiative also aligns with Canada’s commitments under the CCAC to promote public procurement of climate-friendly low-global warming potential alternatives whenever feasible, and to gradually transition to equipment that uses more sustainable alternatives to high-global warming potential HFCs. ECCC could act as a center of expertise for this initiative.

Implementation of these initiatives would also encourage development of alternative technologies.

¹⁵ With revised Global Warming potential value of 25 from 21 (IPCC 4th Assessment Report), the estimated amount of additional methane emission reduction is 6.5 Mt eCO₂

OZONE

Finalize implementation of proposed instruments for industrial sectors

In the near term, as part of the continued implementation of the Air Quality Management System (AQMS), ECCC will finalize proposed instruments published in May 2016 for the aluminum, steel, iron ore pellets, potash, pulp and paper, and base metals smelters sectors and for cross-sectoral turbines. Under the Air Management Committee, ECCC will continue to collaborate with provinces and territories to develop a new CAAQS for NO₂.

Building on this, there may be scope to set more ambitious ambient air quality standards for PM_{2.5} and ozone, as some aspects of current standards are not as stringent as levels proposed by the World Health Organization (WHO). In addition, ECCC is working to bring forward additional emissions standards for key pollutants and industrial sectors where emissions and impacts on local air quality can be very significant (e.g. petroleum refining, coal-fired power plants).



