Environment and Climate Change Canada
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Canada's Greenhouse Gas and Air Pollutant Emissions Projections 2020

Canada

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Table of Contents

List of Figures

List of Tables

1. Greenhouse Gas Emissions Projections

1.1. Context

At the 21st Conference of Parties meeting in Paris in December 2015, Canada pledged to reduce its greenhouse gas emissions by 30 percent below the 2005 level by 2030, which means a drop from 730 megatonnes of carbon dioxide equivalent (Mt CO_2 eq) in 2005 to 511 Mt by 2030. At the time of the 21st Conference of the Parties (COP21), Canada's greenhouse gas emissions were projected to grow to 815 Mt by 2030.[1] In other words, in 2015, Canada's emissions were projected to increase 12% above 2005 levels by 2030 whereas Canada's target required a 30% decrease.

The Pan-Canadian Framework on Clean Growth and Climate Change (Pan-Canadian Framework) was adopted on December 9, 2016, as Canada's plan to take ambitious action to fight climate change and drive economic growth. The Pan-Canadian Framework included more than 50 concrete actions covering all sectors of the Canadian economy.

Over the past five years, an intensive national effort has advanced these measures. In 2019, Canada submitted its Fourth Biennial Report to the United Nations Framework Convention on Climate Change (UNFCCC). Accounting for all federal, provincial and territorial measures announced up to September 2019, the report projected Canada's greenhouse gas emissions in 2030 would be 588 Mt, 227 Mt lower than the 815 Mt projected before the adoption of the Pan-Canadian Framework.[2]

1.2. A Healthy Environment and a Healthy Economy

Building on the foundation established by the Pan-Canadian Framework, Canada's strengthened climate plan to create jobs and support people, communities and the planet, *A Healthy Environment and a Healthy Economy*[3] focuses on a series of new and strengthened federal climate actions to ensure Canada not only meets, but also exceeds its current 2030 Paris Agreement target of 30% below 2005 levels by 2030.

The plan contains 64 strengthened and new federal policies, programs and investments to cut pollution and build a stronger, cleaner, more resilient and inclusive economy. Some of the investments in this plan will begin immediately, to ensure Canada continues to make rapid progress. Other measures require engagement with provinces and territories, with stakeholders and Indigenous partners and with Canadians.

The proposed actions outlined in this plan will – once fully implemented – enable Canada to exceed its current 2030 target. Environment and Climate Change Canada's analysis indicates that these actions could further reduce emissions by at least 85 million tonnes beyond the reductions that will be driven by the Pan-Canadian Framework. Additional provincial and territorial measures will build on the impacts of

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1 Canada's Second Biennial Report on Climate Change (https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/second-biennial-report.html).

2 Ibid.

3 The contents of the plan can be consulted online at https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview.html.

the federal measures, leading to further emission reductions. As such, in partnership with provinces and territories, Canada can reduce greenhouse gas emissions in the range of 32% to 40% below 2005 levels in 2030 while maintaining strong economic growth.

These emission reduction projections are conservative relative to the significant investments and economic transformation likely to unfold over the coming decade. Certain investments, such as those in clean technology or public transit, are difficult to quantify in advance but can be expected to have a material impact on greenhouse gas emissions. These projections also do not account for the reality that Canada is just starting along the innovation curves associated with some of the most promising decarbonization technologies, such as industrial electrification, carbon capture, utilization and storage (CCUS) and hydrogen.

The 2020 Reference Case, described in greater detail in Section 1.3, serves as a baseline for the assessment of Canada's strengthened climate plan, which was released on December 11, 2020.

Economy wide measures such as increasing the carbon price and the Clean Fuel Standard (CFS) as well as complementary sectoral measures, such as light duty and heavy duty vehicle regulations, net-zero ready building codes, strengthened methane regulations and other measures proposed in the plan are expected to reduce Canada's emissions by 144 Mt by 2030, relative to 674 Mt of greenhouse gas emissions in 2030 under the 2020 Reference Case. The LULUCF accounting contribution, the expected impact of the proposed nature-based solutions and the measures in the plan to reduce emissions from fertilizer use in agriculture are expected to reduce emissions by a further 27 Mt. Combined, these reductions arrive at approximately 503 Mt in 2030, or about 8 Mt below Canada's 2030 target. This represents about a 31% reduction below Canada's 2005 emissions. For further details please refer to *Modelling and Analysis of A Healthy Environment and a Healthy Economy*.[4]

Table 1 below illustrates the expected emission reductions of the measures included in the plan in 2030 and Table 2 shows emission reductions by sector from 2005 levels.

Table 1: Expected Emission Reductions of Canada's Strengthened Climate Plan in 2030 (Mt CO_2 eq)

	Projected Emissions in 2030
2020 Reference Case	674
Sectoral Measures, post-2022 carbon price and CFS (liquid only)	144
LULUCF accounting contribution	17
Nature-Based Solutions and agriculture measures	10
Total Projected Emissions from the Plan	503
Canada's 2030 Target	511

[4] Available online at https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/annex_modelling_analysis_healthy_environment_healthy_economy.pdf.

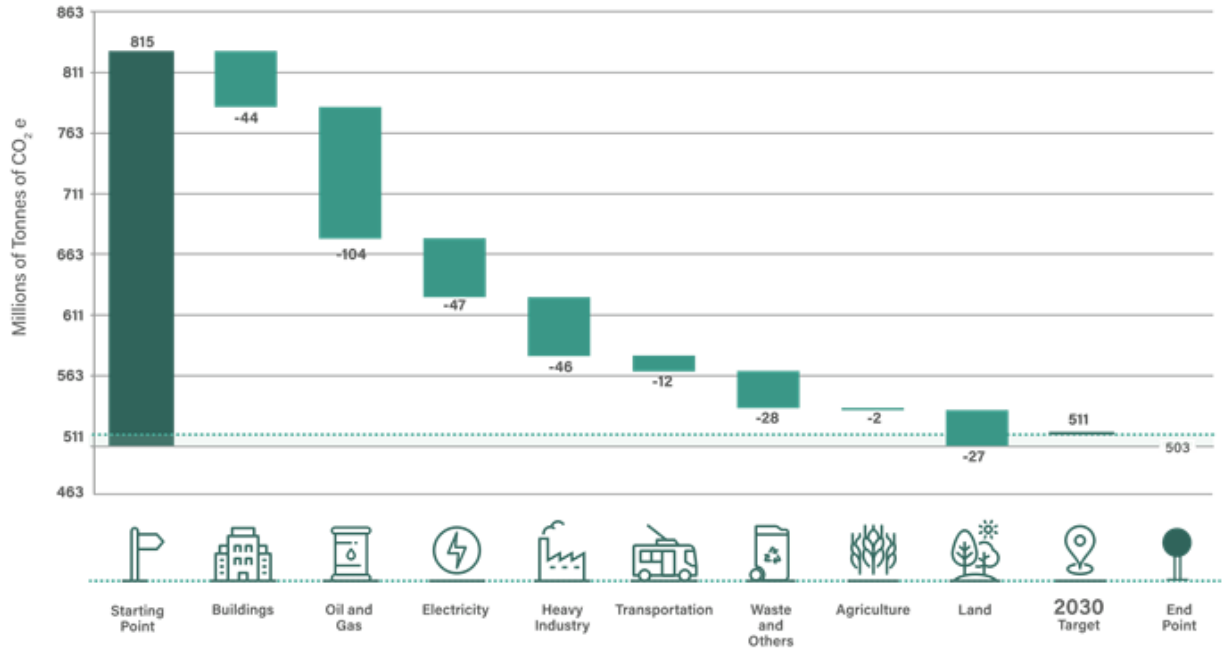
Table 2: Expected Emission Reductions of Canada's Strengthened Climate Plan, by Economic Sector, 2030 (Mt CO_2 eq)

	Historical				Projected Emissions with the Plan		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Oil and Gas	158	159	191	193	177	138	-20
Electricity	119	96	81	64	38	11	-108
Transportation	161	168	172	186	155	151	-10
Heavy Industry	87	75	79	78	65	61	-26
Buildings	86	82	86	92	90	65	-21
Agriculture	72	68	71	73	73	74	2
Waste & Others	46	42	41	42	39	31	-15
LULUCF, NBS and agriculture measures	n.a.	11	-8	-13	-25	-27	-27
Total (incl. LULUCF)	730	702	712	716	612	503	-227

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020, except for LULUCF accounting contribution.

The distribution of projected emission reductions by sector are presented in Figure 1 below, which illustrates the impact of the measures included in the plan, when compared to what Canada's emissions in 2030 were projected to be in 2015 before the adoption of the Pan-Canadian Framework.[5]

Figure 1: Progress to Canada's 2030 Emissions Target



[5] As reported in Canada's Second Biennial Report on Climate Change (https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/second-biennial-report.html).

1.3. Reference Case Projections

Environment and Climate Change Canada (ECCC) updates Canada's GHG emissions projections annually, reflecting the latest historical data and up-to-date future economic and energy market assumptions. As such, projections fluctuate over time as a result of changes in these assumptions.

Canada's GHG projections are derived using the Energy, Emissions and Economy Model for Canada (E3MC) that combines a detailed bottom-up simulation with a top-down macroeconomic model. E3MC is internationally peer reviewed and incorporates external data from consistent sources (for more information on E3MC, please see Annex 2.7 of Canada's Fourth Biennial Report). [6]

In E3MC, energy data is allocated to individual subsectors based on data from Statistics Canada, Natural Resources Canada's Office of Energy Efficiency, Canada's GHG Reporting Program, the Canadian Energy and Emissions Data Centre (CEEDC) and various oil sands reports. These subsectors are then aggregated into the economic sectors presented in this report. Macroeconomic variables such as gross domestic product (GDP), population and relative energy prices from the macroeconomic model are key drivers of energy use and GHG emissions in most sectors. This method of energy and emissions allocation is essential for identifying possible impacts from current and future policies and measures implemented in a particular sector.

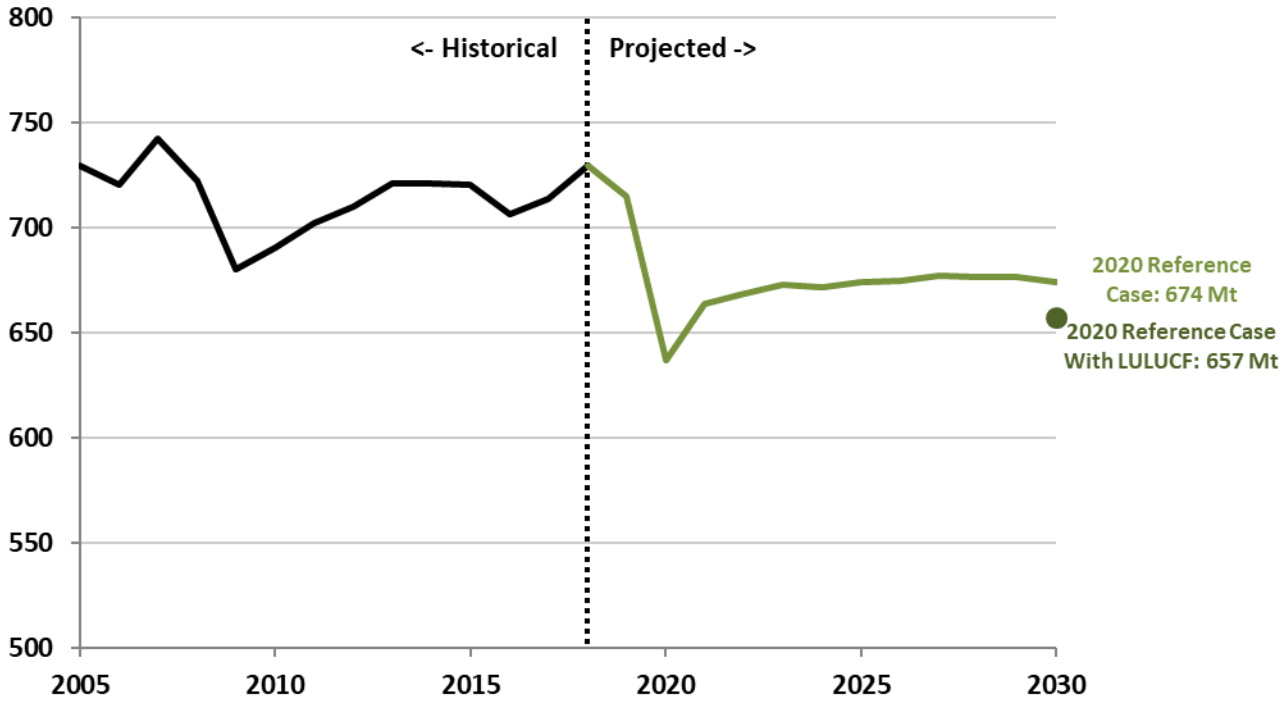
This section presents Canada's Reference Case emissions projections to 2030. Included in the 2020 Reference Case are all policies and measures funded, legislated and implemented by federal, provincial and territorial governments as of September 2020. It is aligned with Canada's historical emissions from 1990 to 2018 as presented in National Inventory Report 1990-2018: Greenhouse Gas Sources and Sinks in Canada (NIR 2020).[7] The Reference Case does not take into account the impact of broader strategies or future measures within existing plans where significant details are still under development. Policies still under development will be included in subsequent reference cases as their details become finalized. For example, the Clean Fuel Standard or post-2025 light duty vehicle regulations are not included in the 2020 Reference Case. The Reference Case also does not include potential net purchases of credits by Quebec's under the Western Climate Initiative. The list of federal, provincial and territorial policies and measures that were included in the Reference Case is provided in Table A.33. For clarity, it should be noted that all results from the Reference Case presented in this Section and in Annexes 1, 2, 3, and 5 do not include the additional measures that have been included in Canada's strengthened climate plan, which was presented in Section 1.2 above.

As shown in Figure 2 and Table 3, total Canadian GHG emissions projections in the Reference Case are expected to reach 674 Mt CO_2 eq in 2030; or 657 Mt when taking into account the accounting contribution from Land Use, Land-Use Change and Forestry (LULUCF).

[6] Canada's Fourth Biennial Report on Climate Change (https://unfccc.int/documents/209928).

[7] For more information about NIR 2020, please consult https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html.

Figure 2: Canada's Domestic Emissions Projections (Mt CO_2 eq): Reference Case



Note: Historical emissions data comes from NIR 2020.

Table 3: GHG emissions by Economic Sector (Mt CO2 eq) under the Reference Case, from 2005 to 2030 (Including Land Use, Land-Use Change and Forestry)

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Oil and Gas	158	159	191	193	177	194	36
Electricity	119	96	81	64	38	21	-98
Transportation	161	168	172	186	155	178	17
Heavy Industry	87	75	79	78	65	82	-5
Buildings	86	82	86	92	90	82	-5
Agriculture	72	68	71	73	73	77	5
Waste & Others	46	42	41	42	39	41	-5
LULUCF [a]	n.a.	11	-8	-13	-25	-17	n.a.
Total (excl. LULUCF)	**730**	**691**	**720**	**729**	**637**	**674**	**-55**
Total (incl. LULUCF)	**730**	**702**	**712**	**716**	**612**	**657**	**-73**

Notes:

[a]: By design, the LULUCF accounting contribution for 2005 is zero. The LULUCF accounting contribution for the historical and projected periods cannot be compared directly, because the scope of available data differs between historical years and projections.

Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020, except for LULUCF accounting contribution.

1.3.1. Comparison of Current and Previous Reference Case Emissions Projections

In 2030, the Reference Case GHG emissions in Canada are projected to reach 674 Mt, 1 Mt above last year's 2019 Reference Case forecast of 673 Mt presented in Canada's Fourth Biennial Report (see Figure 2 and Table 3), if excluding the LULUCF accounting contribution. This reflects a number of revisions made since last year, namely:

- Revisions to historical data from the 2020 National Inventory Report on GHG Sources and Sinks in Canada.
- Revised oil and natural gas production and price assumptions, which are taken from the Canadian Energy Regulator's *Canada's Energy Future 2020* report that was published on November 24, 2020.
- Expected impact of COVID-19 pandemic and economic recession in 2020 and a gradual recovery in the following years. GDP projections to the year 2021 were calibrated to Finance Canada's *Economic and Fiscal Snapshot 2020* tabled on July 8th, 2020 that reflected the impact of COVID-19 on the Canadian economy. The GDP projections between 2022 and 2030 were based on Finance Canada's long-term projections.
- The 2020 Reference Case includes updated projections of fuel consumption in the passenger transportation sector to better reflect typical on-road conditions, driving behaviour and the types of vehicles Canadians are driving. This change, as well as historical data revisions and the impact of the revised United States light duty vehicles standards, led to a substantial increase in projected transportation-related emissions out to 2030 as compared to the 2019 Reference Case.

Table 4 presents comparisons between the historical data and projections presented in previous BRs and the Reference case, while Figure 3 and Table 5 only show differences between the data presented in BR4 and the Reference Case.

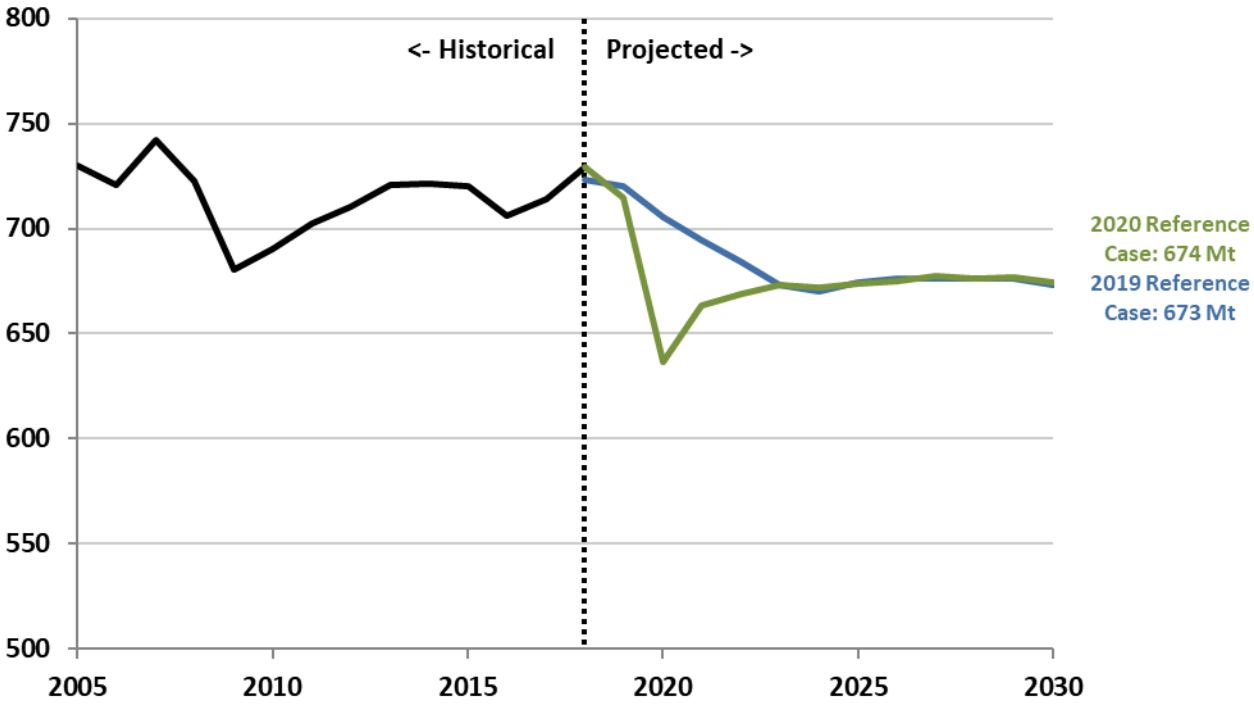
Table 4: Revisions to Canada's Reference Case GHG Emissions (Mt CO_2 eq) since Canada's Second Biennial Report

	Historical		Projected				Target
	2005	2010	2015	2018	2020	2030	2030
2nd Biennial Report (BR2)	749	707	735	760	766	815	524
3rd Biennial Report (BR3)	738	701	722	736	728	722	517
4th Biennial Report (BR4)	730	693	722	723	705	673	511
2020 Reference Case (Ref20)	730	691	720	729	637	674	511
Difference (Ref20-BR2)	**-19**	**-16**	**-14**	**-31**	**-130**	**-141**	**-13**

Notes:
Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2015 (BR2), NIR 2017 (BR3), NIR 2019 (BR4) and NIR 2020 (Ref20).

Shaded cells represent historical values at the time of preparation of each report.

Figure 3: Comparison between the 2020 and 2019 Reference Case Projections (2005 to 2030) (Excluding LULUCF)



Note: Historical emissions data comes from NIR 2020.

Table 5: Comparison of 2020 Reference Case with BR4, by Economic Sector (Mt CO_2 eq)

	2020		2030		Change	
	BR4	**Ref20**	**BR4**	**Ref20**	**2020**	**2030**
Oil and Gas	206	177	213	194	-29	-18
Electricity	52	38	24	21	-14	-3
Transportation	170	155	153	178	-15	24
Heavy Industry	77	65	84	82	-12	-2
Buildings	84	90	77	82	6	4
Agriculture	74	73	76	77	-1	1
Waste & Others	43	39	45	41	-4	-4
Total (excl. LULUCF)	**705**	**637**	**673**	**674**	**-69**	**1**
Total (incl. LULUCF)	**682**	**612**	**658**	**657**	**-71**	**-1**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020, except for LULUCF accounting contribution.

1.3.2. Emissions Intensity

The decline in emissions intensity continues. There has been an average annual decline in Canadian emissions intensity (emissions per unit of GDP) of approximately 1.6% from 1990 to 2018. Emissions intensity is expected to continue to decrease through 2030.

Canadian per capita GHG emissions have been decreasing significantly since 2005 when they were 22.6 tonnes CO_2 eq per person. In 2018, emissions per capita were 19.7 tonnes CO_2 eq per person and projections show that they will continue to decrease through 2030, when they are expected to fall to 15.9 tonnes per person.

Figure 4: Canadian Emissions Intensity per Unit of GDP under Reference Case, 1990 to 2030

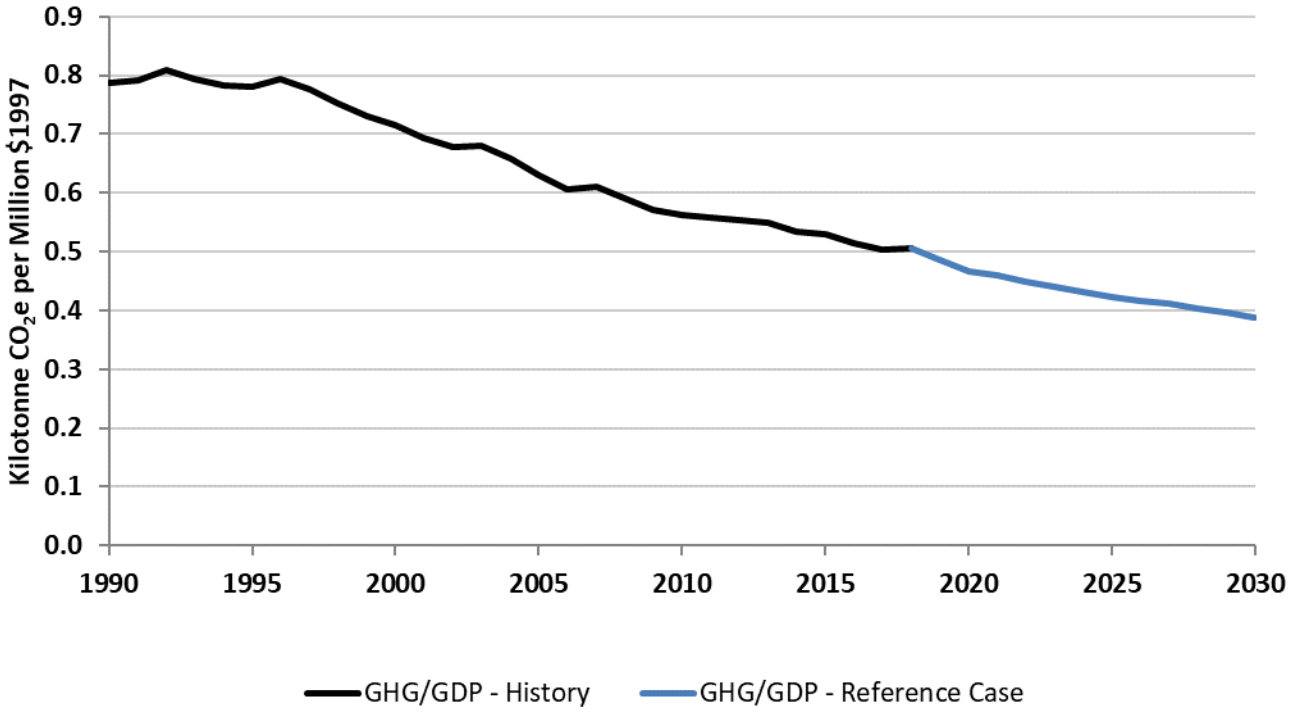
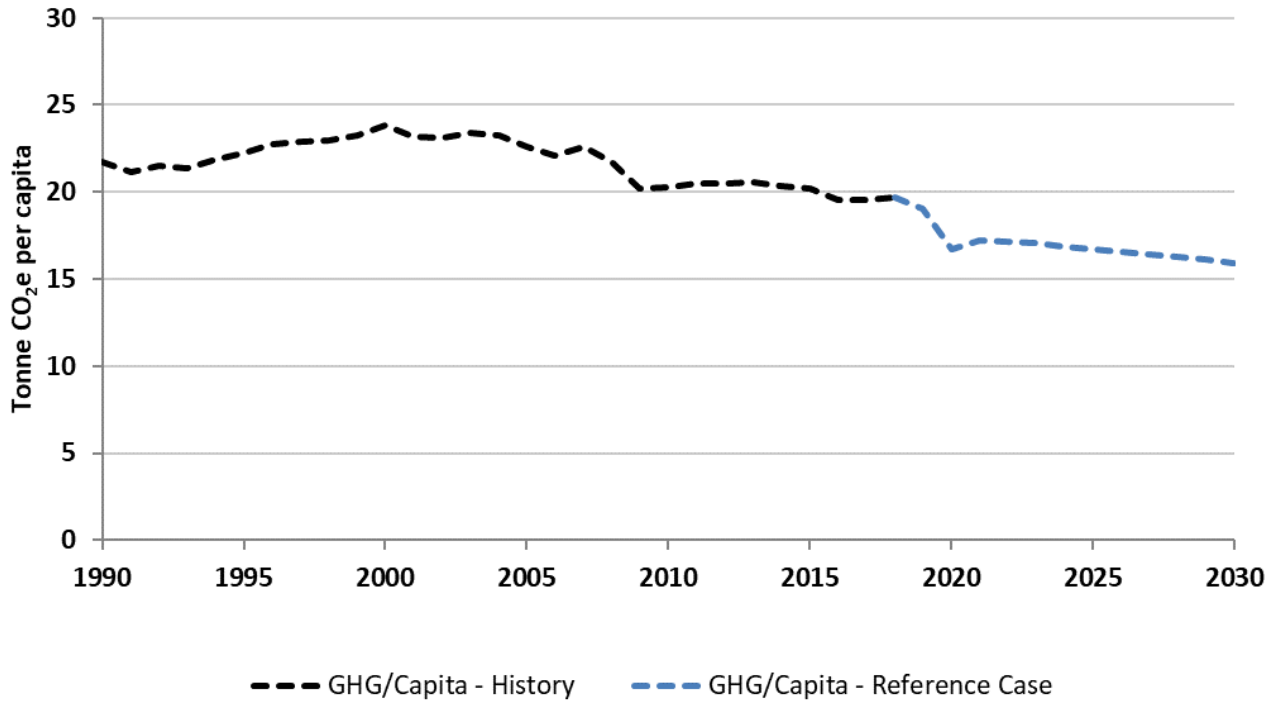


Figure 5: Canadian GHG Emissions per Capita under Reference Case, 1990 to 2030



1.3.3. Emissions by Gas

Detailed emissions projections by gas and economic sectors are provided in Annex 1. Total Canadian GHG emissions over the projection period by gas are presented in Table 6.

Table 6: Total Canadian Emissions Projections under Reference Case by Gas in CO_2 eq, Excluding LULUCF Emissions (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Carbon Dioxide (CO_2)	576	556	576	587	502	546	-30
Methane (CH4)	106	92	96	91	85	78	-28
Nitrous Oxide (N_2O)	37	33	36	38	37	39	2
Hydrofluorocarbon (HFC)	5	8	11	13	13	10	5
Perfluorocarbon (PFC)	4	2	1	1	<1	<1	-3
Sulphur-Hexafluoride (SF_6)	1	<1	<1	<1	<1	<1	-1
Nitrogen Trifluoride (NF_3)	<1	<1	<1	<1	n.a.	n.a.	n.a.
Total	**730**	**691**	**720**	**729**	**637**	**674**	**-55**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

1.3.4. Land Use, Land-use Change and Forestry (LULUCF) Sector

The Land Use, Land-Use Change and Forestry (LULUCF) sector focuses on emissions and removals associated with managed lands. In its Nationally Determined Contribution (NDC) submitted in May 2017, Canada indicated it was examining its approach to accounting for the LULUCF sector towards its

2030 emission reduction target. Canada has since established accounting approaches for each LULUCF sub-sector and has provided LULUCF accounting contributions in 2018 (Canada's 2018 Greenhouse Gas and Air Pollutant Emissions Projections Report)[8] and in 2019 (Canada's Fourth Biennial Report)[9].

Table 7 and Table 8 present LULUCF accounting contributions for historical and projected years, respectively, grouped into five high-level sub-sectors. Results from these two tables cannot be compared directly, because the scope of available data differs between the historical and projected periods for several sub-sectors.

These results do not reflect the impact from planting two billion trees over the next decade, which has been announced after the September 2020 threshold for inclusion in the Reference Case. Other mitigation activities (e.g. British Columbia's Forest Carbon Initiative) may also be included in future projection reports, as appropriate. More details on the LULUCF sector are available in Annex 4.

Table 7: Accounting LULUCF contribution in selected historical years (Mt CO_2 eq)

LULUCF Sub-sectors	2013	2014	2015	2016	2017	2018
Forest Land Remaining Forest Land + associated Harvested Wood Products	-2.1	-7.3	- 11	- 14	- 16	- 18
Land Converted to Forest Land	0.4	0.4	0.5	0.5	0.6	0.6
Cropland Remaining Cropland[1]	1.8	2.7	3.5	4.4	5.2	6.0
Forest Conversion and associated Harvested Wood Products[2]	-1.0	-1.0	-1.5	-1.7	-2.1	-2.5
Others[3]	0.1	0.1	0.3	0.4	0.4	0.2
TOTAL[4]	-0.8	-5.1	-7.9	- 11	- 12	- 13

Notes:
[1] Includes the residual emissions after 20 years following the conversion from Forest Land to Cropland.
[2] Includes all emissions from Forest Conversion, except the residual emissions after 20 years following the conversion from Forest Land to Cropland.
[3] Includes net emissions from Cropland, Grassland, Wetlands and Settlements that do not fall into any of the four lines above.
[4] Totals may not add up due to rounding.

Table 8: Accounting LULUCF contribution projected for 2020 and 2030 (Mt CO_2 eq)

LULUCF Sub-sectors	2020	2030
Forest Land Remaining Forest Land + associated Harvested Wood Products	- 30	- 25
Land Converted to Forest Land	0.7	1.0
Cropland Remaining Cropland[1]	7.8	12
Forest Conversion and associated Harvested Wood Products[2]	-3.0	-4.9
Others[3]		
TOTAL[4]	- 25	- 17

Notes:
[1] Includes the residual emissions after 20 years following the conversion from Forest Land to Cropland.

[8] 2018 Canada's Greenhouse Gas and Air Pollutant Emissions Projections (http://publications.gc.ca/collections/collection_2018/eccc/En1-78-2018-eng.pdf).

[9] Canada's Fourth Biennial Report on Climate Change (https://unfccc.int/documents/209928).

[2] Includes all emissions from Forest Conversion, except the residual emissions after 20 years following the conversion from Forest Land to Cropland.
[3] Includes net emissions from Cropland, Grassland, Wetlands and Settlements that do not fall into any of the four lines above. Projections are not currently available for these elements.
[4] Totals may not add up due to rounding.

1.3.5. Emissions by Province and Territory

Emissions vary considerably by province and territory, driven by diversity in population size, economic activities and resource base, among other factors. For example, provinces and territories where the economy is oriented more toward resource extraction will tend to have higher emissions levels whereas more light manufacturing or service-based economies tend to have lower emissions levels. Electricity generation sources also vary, with provinces that rely on fossil fuels for their electricity generation having higher emissions than provinces and territories that rely more on non-emitting sources of electricity, e.g. hydroelectricity, nuclear and wind.

Table 9 displays projected provincial and territorial GHG emissions from 2005 to 2030. The projected Reference Case emissions reflect a diversity of economic factors and government measures to reduce GHG emissions. These include energy efficiency and renewable electricity programs, carbon pricing, regulatory measures and legislated renewable electricity targets.[10]

Table 9: Provincial and Territorial GHG Emissions (Mt CO_2 eq) from 2005 to 2030 (Excluding LULUCF)

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Newfoundland and Labrador	10	10	11	11	12	11	< 1
Prince Edward Island	2	2	2	2	2	2	-1
Nova Scotia	23	20	17	17	16	11	-12
New Brunswick	20	18	14	13	12	11	-9
Quebec	86	79	79	83	74	79	-7
Ontario	203	172	163	165	145	162	-41
Manitoba	20	19	21	22	20	22	2
Saskatchewan	68	69	77	76	63	66	-2
Alberta	232	240	276	273	231	250	18
British Columbia	62	57	59	66	58	58	-4
Yukon	1	1	<1	1	1	1	< 1
Northwest Territories	2	1	2	1	1	1	> -1
Nunavut	1	1	1	1	1	1	1
Canada	730	691	720	729	637	674	-55

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

[10] Although provincial and territorial governments have announced a diverse range of measures, only measures that could be readily modeled or have an announced regulatory or budgetary dimension were modeled. Aspirational goals and targets that were not supported by measurable, real and verifiable actions were not included in the Reference Case. The policies and measures modeled in this section are listed in Table A.33 in Annex 3 of this report.

1.3.6. Sensitivity Analysis

Canada develops its scenarios of emissions projections using E3MC, a detailed, proven energy, emissions and economy model. Each year, the model is re-calibrated using the most recent data available (see Annex 3) to provide a robust, well-grounded in empirical evidence forecast. Nevertheless, uncertainty is inherent in the projections of any model that looks decades into the future. To address this issue, this section presents results of a sensitivity analysis conducted to attempts to determine the change in model output values that results from modest changes in model input values. Results of alternative scenarios showing the sensitivity of GHG emission projections to projected energy prices and economic growth are presented below. That said, other sources of uncertainty exist and they are discussed in more details in Annex 2.5 of Canada's Fourth Biennial Report.[11]

Given the uncertainty regarding the key drivers of GHG emissions, the scenario presented in the previous section should be seen as one estimate within a set of possible emissions outcomes in the projection period, as events that will shape emissions and energy markets cannot be fully anticipated. In addition, future developments in technologies, demographics and resources cannot be foreseen with certainty. The variation in these complex economic and energy variables implies that modeling results are most appropriately viewed as a range of plausible outcomes. ECCC addresses this uncertainty via modeling and analysis of alternative cases. The sensitivity analysis has been developed to consider uncertainty related to future economic growth and the evolution of world fossil fuel prices. These assumptions are presented in Table 10 through Table 12 and the overall range of emissions is presented in Figure 6.

As illustrated in Table 12, in the scenario with slow GDP, slow population growth and low world oil prices, GHG emissions could be as low as 615 Mt by 2030 on the low end. On the high end, emissions could be 735 Mt in a scenario with fast GDP, high population growth and high world oil prices. This represents a range of 119 Mt.

Table 10: Economic and Population Growth by Scenario – 2018 to 2030 (Percent)

	GDP	Population
Slow GDP, Low Prices	0.6	0.8
Low Prices	1.2	1.1
Slow GDP	1.0	0.8
Reference Case	1.6	1.1
Fast GDP	2.2	1.5
High Prices	2.0	1.1
Fast GDP, High Prices	2.6	1.5

[11] Canada's Fourth Biennial Report on Climate Change (https://unfccc.int/documents/209928).

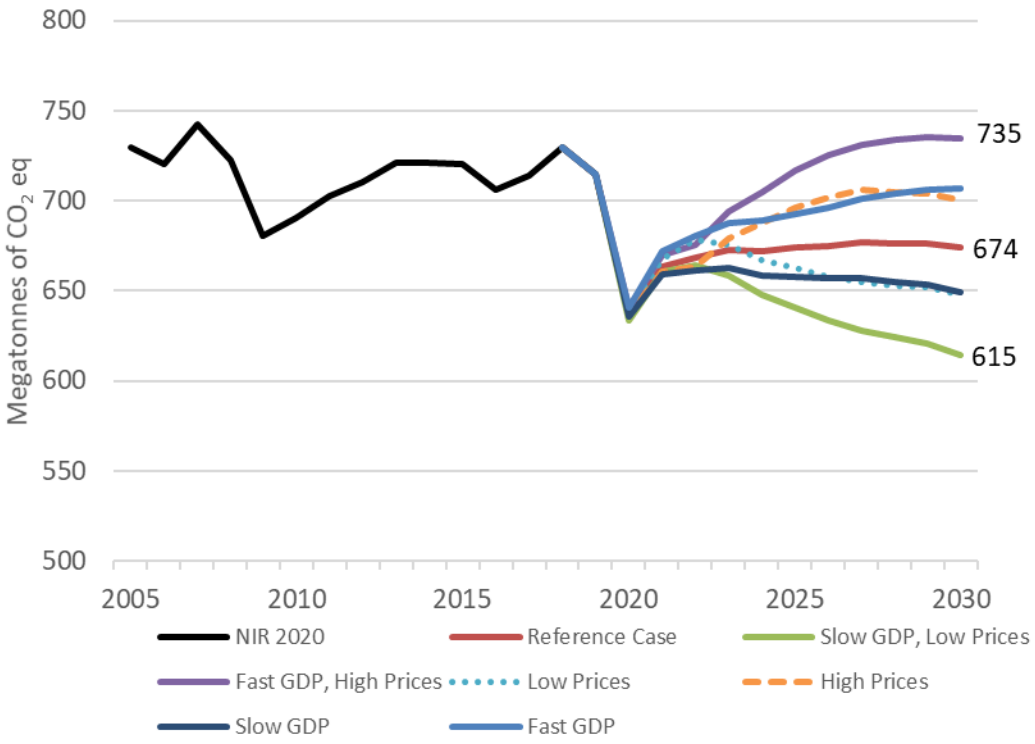
Table 11: Oil and Gas Prices and Production by Scenario – 2030

FUEL	UNITS	Scenarios						
		Slow GDP, Low Prices	Low Prices	Slow GDP	Reference Case	Fast GDP	High Prices	Fast GDP, High Prices
Crude Oil Price (WTI)	2018 US$/bbl	35.62	35.62	69.78	69.78	69.78	113.70	113.70
Heavy Oil Price (WCS)	2018 US$/bbl	24.71	24.71	57.50	57.50	57.50	100.28	100.28
Crude Oil	1000 bbl/day	4 465	4 465	6 239	6 242	6 240	8 047	8 047
Natural Gas Price (Henry Hub)	2018 US$/MMBTU	2.24	2.24	3.44	3.44	3.44	4.40	4.40
Natural Gas	Billion Cubic Feet per year	3 588	3 588	7 708	7 708	7 707	14 261	14 261

Table 12: Sensitivity of GHG Emissions to Changes in GDP and Prices (excluding LULUCF) in Mt CO_2 eq

Scenarios	GHG Emissions in 2030 (Mt)	Difference With Reference Case	
		Mt	%
Fast GDP, High Prices	735	61	9.0
Fast GDP	707	33	4.8
High Prices	700	26	3.9
Reference Case	674	0	0.0
Slow GDP	649	-25	-3.7
Low Prices	648	-26	-3.9
Slow GDP, Low Prices	615	-60	-8.8
Range	**615 to 735**	**-60 to 61**	**-8.8 to 9.0**

Figure 6: Canada's Domestic Emissions Projections (Mt CO_2 eq): Sensitivity Analysis Scenarios



2. Air Pollutant Emissions Projections

Air quality is important for all Canadians, having many impacts, including on human health, the natural environment, buildings and infrastructure, crop production, and the economy. It can also exacerbate climate change. Air pollutant emissions projections inform both domestic and international work related to improving air quality. It is important to understand how emissions of key pollutants are expected to change in the future as new regulatory and non-regulatory instruments are brought in.

In Canada, air quality management is a shared responsibility between federal, provincial and territorial governments, and includes collaborative efforts to manage air quality by implementing the Air Quality Management System (AQMS). The AQMS includes ambient air quality standards, emissions standards for key industrial sources, air zones in provinces and territories and airsheds to manage transboundary air pollution issues, mobile sources, as well as reporting to Canadians.

The Canadian Ambient Air Quality Standards (CAAQS) are health- and environment-based ambient air quality objectives put in place to further protect human health and the environment and to provide the drivers for local air quality improvements across the country.

CAAQS are developed in a collaborative process, and reviewed regularly. Development and periodic reviews of the CAAQS require emissions projections to inform air quality modelling of future expected air quality. Once approved by federal, provincial and territorial ministers of the environment, CAAQS are established by the federal government as ambient air quality objectives under the *Canadian Environmental Protection Act, 1999*.

In 2013, CAAQS for 2015 and 2020 were established for fine particulate matter and ground level ozone, the main components of smog. In 2017, new CAAQS for nitrogen dioxide and sulphur dioxide for 2020 and 2025 were published. Following a review of the 2020 ozone standard, in 2019, a new standard with an effective year of 2025 was put in place and Canada is currently conducting a review of the CAAQS for $PM_{2.5}$,

Many air pollutants travel long distances and across national boundaries. Canada works with other countries in international fora to address air pollution, including from outside its borders, that impacts Canadian air quality. Canada works bilaterally with the United States (U.S.) under the Canada-U.S. Air Quality Agreement to address transboundary air pollution that impacts both countries. A biennial progress report is published under the agreement that tracks progress in each country. Projections of expected air pollution emissions are important indicators of Canada's performance within such frameworks.

As a Party to the United Nations Economic Commission for Europe's (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP or Air Convention), Canada has mandatory air pollutant emissions reporting obligations and regularly submits its annual Air Pollutant Emissions Inventory[12]

[12] Available online at https://www.canada.ca/en/environment-climate-change/services/pollutants/air-emissions-inventory-overview.html.

(APEI) and an accompanying inventory report on 17 air pollutants. Canada has voluntarily submitted its air pollutant emissions projections on six pollutants[13] annually since 2019.[14]

The Gothenburg Protocol is the most recent and most active of the eight protocols under the Air Convention. Canada ratified the Gothenburg Protocol and its amendments in November 2017, and the Protocol entered into force in October 2019. Canada's commitments under the Gothenburg Protocol include:

1. Emissions ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds (VOCs) to be achieved by 2010 and maintained;
2. Indicative emission reduction commitments expressed as a percentage reduction from a base year of 2005 to be met by 2020 for SO_2, NOx, VOCs and fine particulate matter; and
3. Limiting emissions in specific sectors using Canadian air pollution emission reduction measures (included in the Protocol annexes).

The implementation of the Protocol is expected to reduce the transport of pollutants and lower the levels of ambient particulate matter (PM) and ozone. Other benefits include improved human health, and ecosystems, and near-term climate benefits from reductions in black carbon and ozone. Table 13 contains Canada's indicative emission reduction commitments expressed in percentages for each pollutant under the Gothenburg Protocol. The Gothenburg Protocol indicative emission reduction commitments and projected emissions by pollutant are in Annex 5 of this report.

In addition, Canada works with Arctic countries under the Arctic Council to collectively meet a goal to reduce emissions of black carbon, an air pollutant with significant climate warming properties. Canada and other Arctic States have committed to a collective, aspirational goal to reduce emissions of black carbon by 25-33% below 2013 levels by 2025.

Table 13: Gothenburg Protocol Indicative Emission Reduction Commitments

Pollutant	Gothenburg Reduction Commitments	
	2010 to 2019 (absolute emissions [kt])	2020 and Beyond (Reduction from 2005 levels [%])
Nitrogen Oxides	2 250	35
Fine Particulate Matter ($PM_{2.5}$) excluding open sources [a]	N/A	25
Sulphur Dioxides	1 450	55
Volatile Organic Compounds	2 100	20

Note:

[a] For the purposes of the Gothenburg Protocol commitments, open sources are limited to road dust, construction operations, and crop production.

[13] The six pollutants are nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOC), particulate matter 2.5 ($PM_{2.5}$), ammonia (NH_3) and black carbon.

[14] The 2019 submission relied on projections that were published in *Canada's Greenhouse gas and air pollutant emissions projections: 2018*.

Emissions of black carbon are reported in Canada's annual *Black Carbon Inventory* report, and are voluntarily reported to the UNECE. As per the Arctic Council's Framework for Action on Enhanced Black Carbon and Methane Emissions Reductions, Canada also produces a *National Report on Black Carbon and Methane*[15] on a biennial basis. This report summarizes black carbon and methane emissions, as well as projections and actions to reduce emissions of these pollutants.

Table 14: Air Pollutant Emissions by Pollutant, 2005 to 2030 (Kilotonnes, except otherwise specified)

	Historical			Projected		Change from 2005	
	2005	**2010**	**2018**	**2020**	**2030**	**Level**	**%**
Nitrogen Oxides	2 470	2 138	1 853	1 601	1 486	-984	-40
Sulphur Oxides	2 174	1 367	817	629	663	-1 511	-70
Volatile Organic Compounds	2 406	2 059	1 919	1 668	1 844	-563	-23
Total Particulate Matter							
(excl. Open Sources)	702	649	621	598	637	-65	-9
(incl. Open Sources)	19 501	23 295	28 736	26 154	32 164	12 664	65
PM 10							
(excl. Open Sources)	473	421	396	367	368	-105	-22
(incl. Open Sources)	6 278	7 256	8 877	8 106	9 796	3 518	56
PM 2.5							
(excl. Open Sources)	379	323	285	260	241	-139	-37
(incl. Open Sources)	1 338	1 433	1 626	1 480	1 691	352	26
Carbon Monoxide	8 009	6 692	5 765	5 149	5 634	-2 375	-30
Mercury **(Kilograms)**	7 925	5 035	3 112	2 458	2 854	-5 070	-64
Ammonia	498	459	484	467	580	82	16
Black Carbon	n.a.	n.a.	38	32	28	n.a.	n.a.

Notes:

[1] Black carbon emissions begin in 2013. In that year, black carbon emissions were 44 kilotonnes.

[2] Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[16]

According to 2020 Reference Case projections, emissions are expected to stay within the Gothenburg Protocol reduction commitment limits for the air pollutants covered by the Protocol and are expected to have declined considerably in 2020 due to the impact of COVID-19 pandemic. After 2020, air pollutant emissions are expected to continue to decline due to policies and measures that aim to reduce air pollutants and GHG emissions often through reductions in energy consumption. However, there are exceptions to this trend, with emissions of NOx (for the period covering 2020-2025), VOCs (increasing

[15] Available online at https://www.canada.ca/en/environment-climate-change/services/pollutants/black-carbon-methane-summary.html.

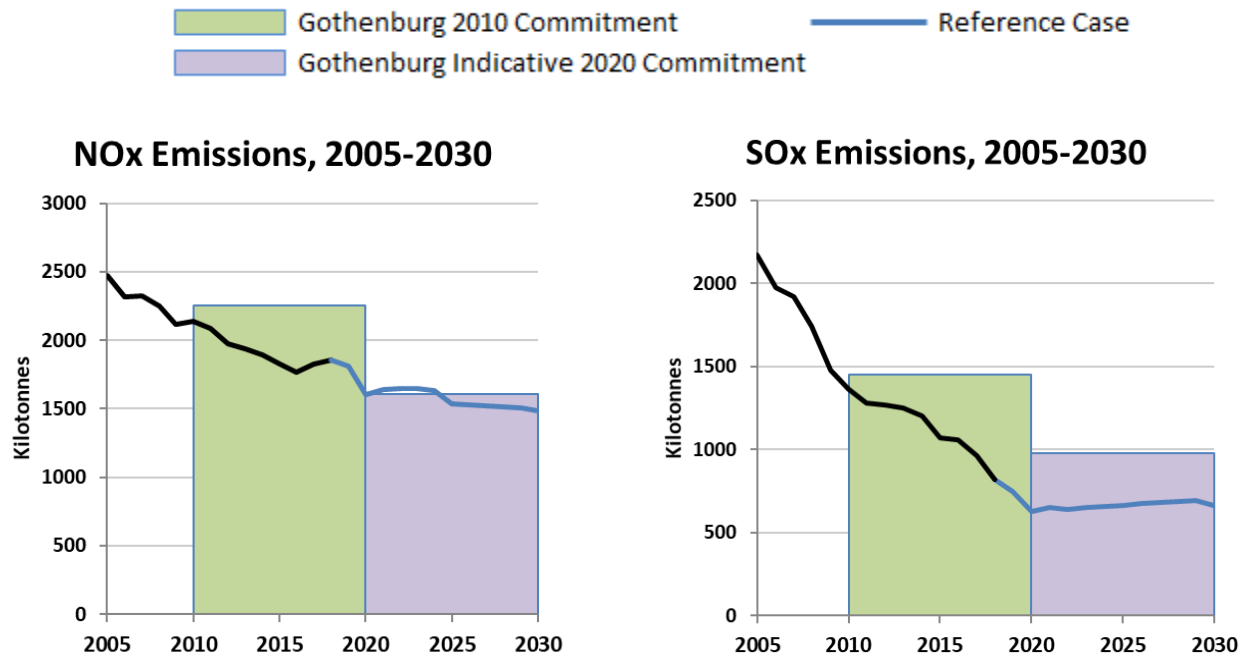
[16] For more information about APEI 2020, please consult https://www.canada.ca/en/environment-climate-change/services/pollutants/air-emissions-inventory-overview.html

between 2025-2030), fine particulate matter from open sources[17] and ammonia being projected to increase due increased use of fertilizer in the agriculture sector and greater activity in the oil and gas and transportation sectors. New measures included in the strengthened climate plan aiming to reduce GHG emissions that are not reflected in the Reference Case may have additional air quality benefits and may help lower these air pollutant emissions.

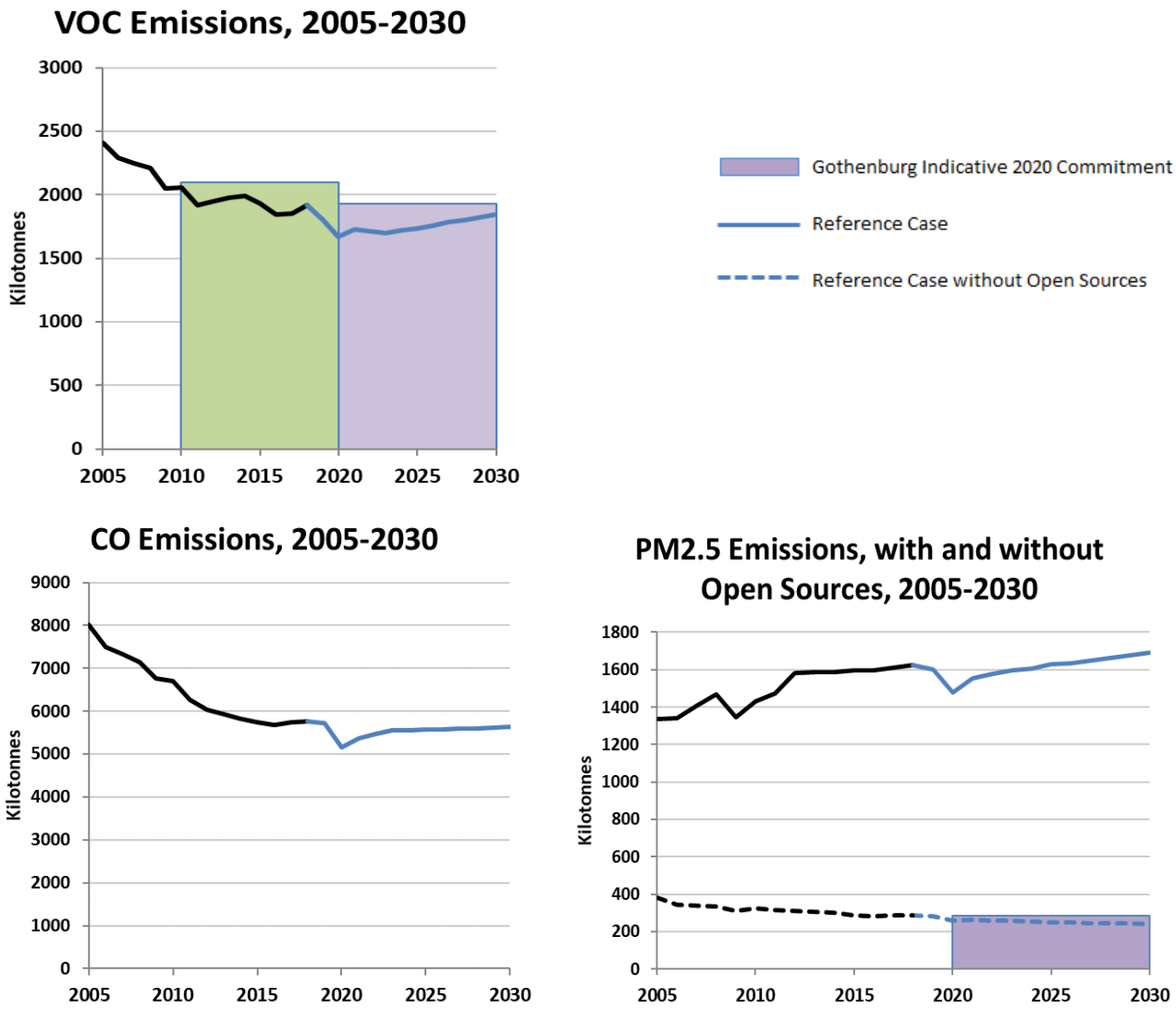
In addition, emissions of black carbon are projected to decrease, meaning that Canada is in alignment with the aspirational goal for Arctic Council countries.

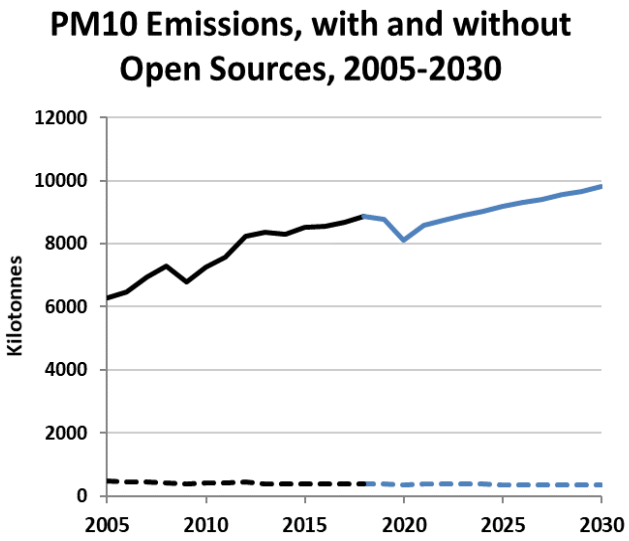
The COVID-19 pandemic has significantly impacted several sectors, including tourism, commercial and industrial sectors as well as demand for on-road and air passenger transportation, resulting in a rapid decline of projected emissions across all air pollutants in 2020. As the economy gradually recovers in the following years, air pollutant projected emissions are expected to return to pre-pandemic trends.

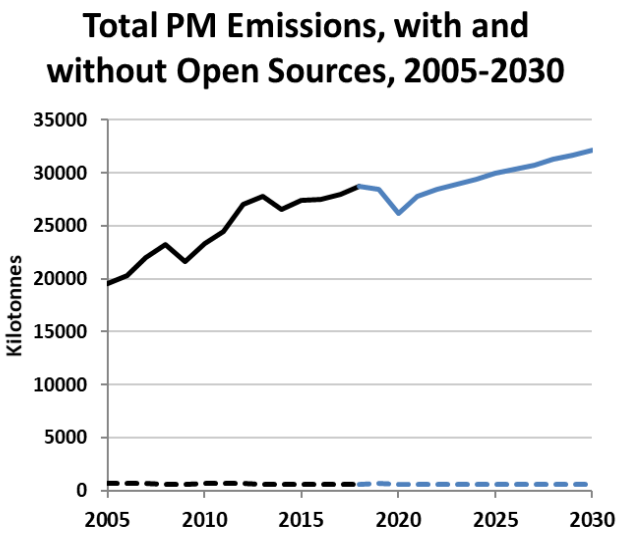
Figure 7: Air Pollutant Emissions by Pollutant, 2005 to 2030

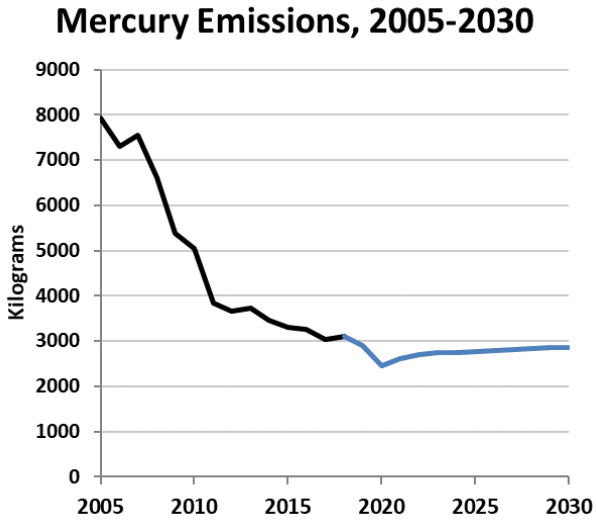


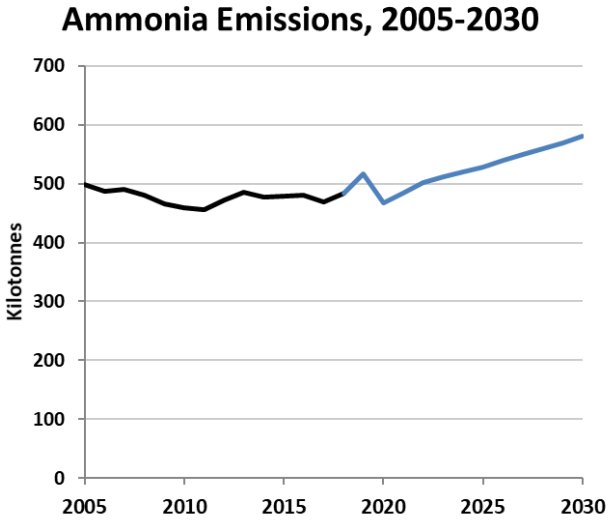
[17] Note that the commitment for fine particulate matter under the Gothenburg Protocol does not include open sources, therefore this projected increasing trend does not impact the reduction commitment made under that Protocol.

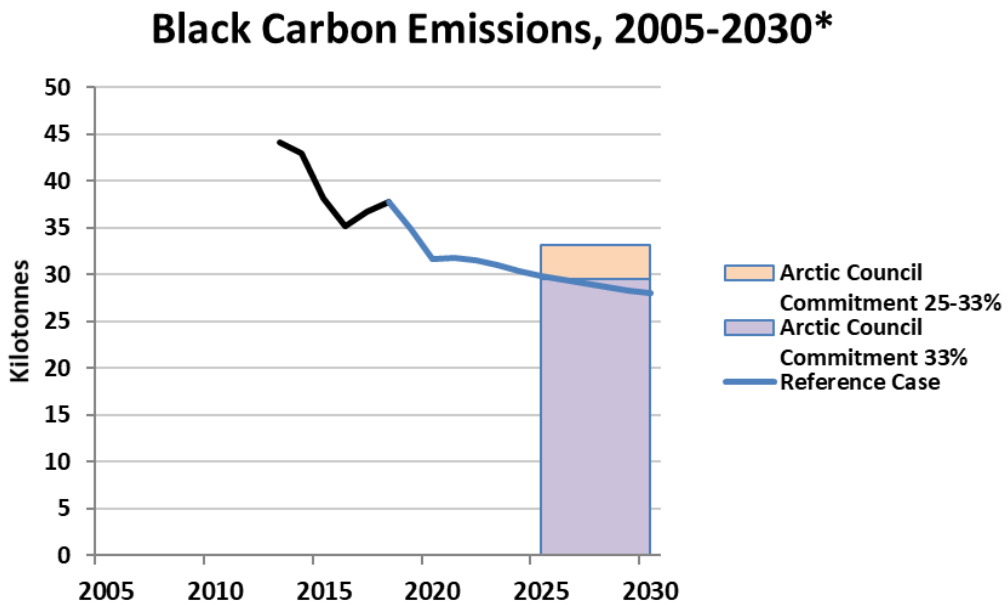

VOC Emissions, 2005-2030
Kilotonnes
3000
2500
2000
1500
1000
500
0
2005
2010
2015
2020
2025
2030
Gothenburg Indicative 2020 Commitment
Reference Case
Reference Case without Open Sources
CO Emissions, 2005-2030
Kilotonnes
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2005
2010
2015
2020
2025
2030
PM2.5 Emissions, with and without Open Sources, 2005-2030
Kilotonnes
1800
1600
1400
1200
1000
800
600
400
200
0
2005
2010
2015
2020
2025
2030


PM10 Emissions, with and without Open Sources, 2005-2030
Kilotonnes
12000
10000
8000
6000
4000
2000
0
2005
2010
2015
2020
2025
2030


Total PM Emissions, with and without Open Sources, 2005-2030
Kilotonnes
35000
30000
25000
20000
15000
10000
5000
0
2005
2010
2015
2020
2025
2030


Mercury Emissions, 2005-2030
Kilograms
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2005
2010
2015
2020
2025
2030


Ammonia Emissions, 2005-2030
Kilotonnes
700
600
500
400
300
200
100
0
2005
2010
2015
2020
2025
2030



* The Black Carbon inventory begins in 2013.

Annex 1. Supplementary Information for 2020 Reference Case Projections

Emissions by IPCC Sectors

Table A.1: GHG emissions by IPCC Sector (Mt CO_2 eq) from 2005 to 2030 (Excluding LULUCF)

	Historical				Projected	
	2005	**2010**	**2015**	**2018**	**2020**	**2030**
Stationary Combustion and Fugitive Sources	403	372	389	379	325	323
Transport	191	195	201	217	185	211
Industrial Processes	57	51	54	56	50	60
Agriculture	60	55	58	59	60	63
Waste	20	17	18	18	17	17
Total	**730**	**691**	**720**	**729**	**637**	**674**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Detailed Economic Sector Tables

Table A.2: Oil and Gas Sector Emissions (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	**2010**	**2015**	**2018**	**2020**	**2030**	
Natural Gas Production and Processing	55	48	50	50	46	39	-16
Conventional Oil Production	30	27	34	29	27	27	-3
Light Oil Production	11	11	17	16	13	14	3
Heavy Oil Production	17	14	16	11	12	11	-6
Frontier Oil Production	2	2	2	2	2	1	0
Oil Sands	37	54	74	84	76	95	58
Bitumen In Situ	11	20	33	41	36	50	39
Bitumen Mining	8	11	16	17	17	20	12
Bitumen Upgrading	17	22	24	24	23	25	9
Oil and Natural Gas Transmission	12	7	10	11	11	10	-2
Downstream Oil and Gas	23	23	22	21	18	21	-3
Petroleum Products	22	22	21	19	16	19	-2
Natural Gas Distribution	1	1	1	1	1	1	0
Liquid Natural Gas Production	0	0	0	0	0	1	1
Total	158	159	191	193	177	194	36

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.3: Upstream Oil and Natural Gas Production: Emissions and Drivers

	Historical				Projected	
	2005	2010	2015	2018	2020	2030
Conventional Oil Production						
Emissions (Mt CO_2 eq)	30	27	34	29	27	27
Production (1000 barrels/day)	1 360	1 227	1 265	1 271	1 246	1 571
Emissions Intensity (kg CO_2 eq /bbl)	60.3	60.0	73.2	63.0	58.4	47.5
Oil Sands (Excluding Upgraders)						
Emissions (Mt CO_2 eq)	21	32	50	59	53	70
Production (1000 barrels/day)	1 065	1 612	2 526	3 125	2 864	3 935
Emissions Intensity (kg CO_2 eq /bbl)	53.2	54.5	54.3	52.0	50.4	48.7
Natural Gas Production and Processing						
Emissions (Mt CO_2 eq)	55	48	50	50	46	39
Production (1000 boe/day)	3 611	3 124	3 160	3 387	3 305	3 598
Emissions Intensity (kg CO_2 eq /boe)	41.7	42.3	43.3	40.1	38.3	30.0

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.4: Petroleum Refining and Upgrading Sector Emissions and Drivers

	Historical				Projected	
	2005	2010	2015	2018	2020	2030
Traditional Refineries						
Emissions (Mt CO_2 eq)	22	22	21	19	16	19
Refined Petroleum Products (1000 barrels/day)	1 992	1 956	1 835	1 893	1 581	1 973
Emissions Intensity (kg CO_2 eq /bbl)	30.2	30.7	31.8	28.2	28.3	27.0
Upgraders						
Emissions (Mt CO_2 eq)	17	22	25	25	23	25
Synthetic Crude Oil Produced (1000 barrels/day)	611	849	1 058	1 219	1 149	1 327
Emissions Intensity (kg CO_2 eq /bbl)	74.6	69.4	63.7	55.3	54.8	52.4

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.5: Liquefied Natural Gas Sector Emissions and Drivers

	Historical			Projected	
	2005	2010	2018	2020	2030
Liquefied Natural Gas Production					
Emissions (Mt CO_2 eq)	-	-	-	-	1.5
Production (1000 boe/day)	-	-	-	-	391
Emissions Intensity (kg CO_2 eq/boe)	-	-	-	-	10.3

Table A.6: Transportation Emissions by Subsector (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Passenger Transport	90	89	91	99	74	91	1
Cars, Light Trucks and Motorcycles	82	82	83	90	70	81	-1
Bus, Rail and Domestic Aviation	8	8	8	9	4	10	2
Freight Transport	60	69	72	78	72	76	16
Heavy Duty Trucks, Rail	54	63	67	73	67	72	17
Domestic Aviation and Marine	6	6	5	5	5	5	-1
Other: Recreational, Commercial and Residential	10	10	9	9	9	10	0
Total	161	168	172	186	155	178	17

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.7: Utility Electricity Sector: Emissions and Drivers

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Emissions (Mt CO_2 eq)	119	96	81	64	38	21	-98
Generation (Terawatt Hours)	554	541	578	582	548	561	7

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.8: Utility Electricity Sector Emissions by Fuel Type (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Coal	98	79	62	44	14	1	-98
Refined Petroleum Products	11	5	6	5	4	1	-11
Natural Gas	10	13	13	15	19	20	10
Biomass	0	0	0	0	0	0	0
Total	119	96	81	64	38	21	-98

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.9: Heavy Industry: Emissions and Drivers

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Emissions (Mt CO_2 eq)	87	75	79	78	65	82	-5
Gross Output of Heavy Industry (1997 $billions)	144	122	150	147	125	167	23

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.10: Heavy Industries' Emissions by Subsector (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Mining	7	8	8	8	7	9	2
Smelting and Refining (Non-ferrous metals)	14	11	10	10	9	11	-4
Pulp and Paper	9	7	6	8	5	5	-4
Iron and Steel	16	14	15	16	11	17	1
Cement	13	10	10	11	10	11	-2
Lime and Gypsum	3	3	2	2	2	2	-1
Chemicals and Fertilizers	25	23	27	24	21	27	2
Total	87	75	79	78	65	82	-5

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.11: Residential Subsector: Emissions and Drivers

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Emissions (Mt CO_2 eq)	46	43	44	47	46	42	-4
Households (millions)	12	13	14	15	15	17	5

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.12: Commercial Subsector: Emissions and Drivers

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Emissions (Mt CO_2 eq)	40	38	41	46	44	40	0
Floor space (millions m^2)	654	714	747	756	759	835	180

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.13: Agriculture Sector Emissions by Subsector (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
On-Farm Fuel Use	12	13	13	14	13	14	1
Crop Production	16	18	23	24	25	25	9
Animal Production	44	37	35	36	35	38	-6
Total	72	68	71	73	73	77	5

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.14: Waste and Others Emissions by Subsector (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Waste	20	17	18	18	17	17	-3
Coal Production	2	3	2	3	2	2	0
Light Manufacturing, Construction & Forest Resources	24	22	21	22	19	22	-2
Total	46	42	41	42	39	41	-5

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Table A.15: Emissions Related to Fuel sold to Ships and Aircrafts Engaged in International Transport by Sub-Sector (Mt CO_2 eq) from 2005 to 2030

	Historical				Projected		Change 2005 to 2030
	2005	2010	2015	2018	2020	2030	
Foreign Freight	8	7	6	7	7	8	1
Foreign Passenger	9	8	11	13	13	15	6
Total	16	15	17	20	19	23	7

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from NIR 2020.

Detailed Emissions by Gas and by Economic Sector

Table A.16: CO_2 Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	1995	2000	2005	2010	2015	2018	2020	2030
Oil and Gas	70	83	102	111	118	145	152	140	165
Electricity	94	97	128	118	95	79	63	37	21
Transportation	116	117	137	152	160	165	178	149	173
Heavy Industry	74	80	84	78	71	76	76	64	81
Buildings	68	74	79	79	73	74	79	76	69
Agriculture	12	15	15	14	14	15	16	16	16
Waste & Others	30	29	27	25	23	22	22	20	22
Total	462	495	572	576	556	576	587	502	546

Note: Numbers may not sum to the total due to rounding.

Table A.17: CH_4 Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	1995	2000	2005	2010	2015	2018	2020	2030
Oil and Gas	36	49	55	47	41	45	41	36	28
Electricity	<0.1	0	0	0	0	0	0	0	0
Transportation	2	2	1	1	1	1	1	1	1
Heavy Industry	0	0	0	0	0	0	0	0	0
Buildings	5	5	4	3	3	3	3	3	2
Agriculture	25	30	31	35	29	28	28	27	29
Waste & Others	23	23	20	20	18	18	18	18	17
Total	91	108	112	106	92	96	91	85	78

Note: Numbers may not sum to the total due to rounding.

Table A.18: N_2O Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	1995	2000	2005	2010	2015	2018	2020	2030
Oil and Gas	0.3	0.4	0.5	0.6	0.6	0.8	0.9	0.9	1.0
Electricity	0.5	0.5	0.7	0.7	0.6	0.5	0.4	0.3	0.2
Transportation	3.8	4.2	5.8	5.8	4.2	3.3	3.6	3.1	3.6
Heavy Industry	11.7	11.7	2.5	4.2	1.5	1.5	1.5	0.6	0.8
Buildings	1.1	1.2	1.4	1.2	1.1	1.2	1.4	1.4	1.2
Agriculture	20.8	22.7	24.1	23.7	24.4	28.0	28.9	30.0	31.1
Waste & Others	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.2	1.3
Total	38.9	41.4	35.9	37.2	33.4	36.5	37.9	37.4	39.2

Note: Numbers may not sum to the total due to rounding.

Table A.19: HFC Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	1995	2000	2005	2010	2015	2018	2020	2030
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.1	1.1	1.9	2.6	2.3	2.4	2.0	0.5
Heavy Industry	1.0	0.0	0.0	0.0	0.6	0.5	0.3	0.2	0.2
Buildings	0.0	0.3	1.5	2.8	4.3	7.5	9.4	9.9	9.3
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste & Others	0.0	0.0	0.1	0.4	0.3	0.8	0.4	0.4	0.4
Total	1.0	0.5	2.8	5.1	7.7	11.0	12.5	12.6	10.3

Note: Numbers may not sum to the total due to rounding.

Table A.20: PFC Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2018**	**2020**	**2030**
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Industry	7.6	6.3	4.9	3.8	1.8	1.0	0.6	0.4	0.4
Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste & Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	7.6	6.3	5.0	3.8	1.9	1.0	0.6	0.4	0.4

Note: Numbers may not sum to the total due to rounding.

Table A.21: SF_6 Emissions Projections by Economic Sector (Mt CO_2 eq)

	Historical							Projected	
	1990	**1995**	**2000**	**2005**	**2010**	**2015**	**2018**	**2020**	**2030**
Oil and Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0
Transportation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Heavy Industry	3.0	2.1	2.7	1.2	0.3	0.3	0.2	0.0	0.0
Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste & Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	3.2	2.3	2.9	1.4	0.4	0.4	0.3	0.1	0.1

Note: Numbers may not sum to the total due to rounding.

Annex 2. Sensitivity Analysis

Table A.22: Sensitivity Analysis

Scenario	GHG Emissions in 2030	Difference Between 2005 and 2030
Fast GDP, High Prices	735	5
Fast GDP	700	-23
High Prices	707	-29
Reference Case	674	-55
Slow GDP	649	-80
Low Prices	648	-82
Slow GDP, Low Prices	615	-115
Range	615 to 735	-115 to 5

Table A.23: Projected GHG Emissions for Sensitivity Analysis Scenarios by Sector (excluding LULUCF) in Mt CO_2 eq in 2030

Sector	Fast GDP, High World Oil Price	High World Oil Prices	Fast GDP	Slow GDP	Low World Oil Prices	Slow GDP, Low World Oil Prices
Oil and Gas	234	233	196	194	154	153
Electricity and Steam	26	22	24	19	20	16
Transportation	184	176	188	171	178	169
Heavy Industry	88	73	96	69	92	77
Buildings	81	80	83	80	83	82
Agriculture	78	76	77	76	78	76
Waste and Others	43	40	43	40	43	41
Grand Total	**735**	**700**	**707**	**649**	**648**	**615**

Annex 3. Baseline Data and Assumptions

Historical data on GDP and disposable personal income are provided from Statistics Canada. Consumer price index and population demographics are also produced by Statistics Canada while historical emissions data are provided by the *National Inventory Report*, 2020 (NIR 2020). GDP projections to the year 2021 were calibrated to Finance Canada's *Economic and Fiscal Snapshot 2020* tabled on July 8th, 2020 that reflected the impact of COVID-19 on the Canadian economy. The GDP projections between 2022 and 2030 were based on Finance Canada's long-term projections.

Forecasts of oil and natural gas price and production are taken from the Canadian Energy Regulator's *Canada's Energy Future 2020* report that was published on November 24, 2020.[18] The CER is an independent federal agency that regulates international and interprovincial aspects of the oil, gas and electric utility industries. The U.S. Energy Information Administration's outlook on key parameters is also taken into account in the development of energy and emissions trends.

Table A.24: Macroeconomic Assumptions, 2005–2030 Average Annual Growth Rates

	Historical	Projected	
	2005 to 2018	2018 to 2020	2020 to 2030
Gross Domestic Product	1.7%	-2.7%	2.4%
Consumer Price Index	1.7%	1.9%	2.0%

Table A.25: Summary of Key Price-Related Assumptions Used in Projection Analysis from 1990 to 2030

	Historical							Projected	
	1990	1995	2000	2005	2010	2015	2018	2020	2030
Oil Price (2018 US$/bbl)	39.16	26.11	39.58	65.27	87.15	51.33	65.25	31.45	69.78
Natural Gas Price (2018 US $/mmbtu)	2.60	2.39	5.62	10.04	4.73	2.76	3.15	2.01	3.44
CPI (1992 = 100)	93.27	104.21	113.53	127.34	138.65	150.66	159.14	165.25	201.68

Table A.26: Summary of Key Economic and Demographic Assumptions Used in Projection Analysis from 1990 to 2030 (average annual percent change)

	Historical					Projected		
	1990 - 1995	1995 - 2000	2000 - 2005	2005 - 2010	2010- 2018	2018 - 2020	2020 - 2025	2025 - 2030
Real GDP	1.7	4.1	2.6	1.2	2.0	-2.7	3.1	1.8
Population	1.1	0.9	1.0	1.1	1.1	1.4	1.2	1.0
Population of driving age (18–75)	1.3	1.2	1.3	1.4	1.1	1.0	0.8	0.7
Labour Force	0.6	1.5	1.8	1.3	0.9	0.8	0.9	1.2

[18] Available online at https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/index.html.

Table A.27: Summary of Key Agriculture Assumptions Used in Projection Analysis from 2010 to 2030 (average annual percent change)

	Historical	Projected		
	2010-18	2018-20	2020-25	2025-30
Total Crops Area	1.58	-0.44	0.18	0.34
Total Cattle	-0.97	-1.35	0.67	1.07
Total Hogs	-0.02	0.94	0.11	-0.19
Total Poultry	3.09	2.52	1.43	1.63

Energy and Electricity Production

Table A.28: Crude Oil Production (thousand barrels per day)

	Historical				Projected	
	2005	2010	2015	2018	2020	2030
Crude and Condensates	**1 533**	**1 373**	**1 492**	**1 723**	**1 733**	**2 307**
Conventional Heavy	526	424	430	458	507	639
Conventional Light	511	512	654	640	601	815
C5 and Condensates	173	146	227	452	487	736
Frontier Light (offshore + northern)	323	291	181	173	138	117
Oil Sands	**1 065**	**1 612**	**2 526**	**3 125**	**2 864**	**3 935**
Oil Sands: Primary	151	194	258	167	155	240
Oil Sands: In Situ	288	562	1 107	1 354	1 259	1 973
Steam - assisted Gravity Drainage	83	318	843	1 141	1 061	1 673
Cyclic Steam Stimulation	205	244	263	213	198	300
Oil Sands Mining	627	857	1 162	1 605	1 451	1 723
Total Production (gross)	**2 598**	**2 985**	**4 018**	**4 848**	**4 597**	**6 242**

Table A.29: Oil Sands Disposition (thousand barrels per day)

	Historical				Projected	
	2005	2010	2015	2018	2020	2030
Oil Sands (gross)	**1 065**	**1 612**	**2 526**	**3 125**	**2 864**	**3 935**
Oil Sands (net)	**980**	**1 504**	**2 413**	**2 998**	**2 747**	**3 807**
Synthetic	611	849	1 058	1 219	1 149	1 327
Non-upgraded Bitumen	369	656	1 356	1 779	1 599	2 480
Own Use	**85**	**108**	**113**	**127**	**117**	**128**

Table A.30: Annual Natural Gas Production (billion cubic feet)

	Historical				Projected	
	2005	**2010**	**2015**	**2018**	**2020**	**2030**
Natural Gas Supply	**6 580**	**6 092**	**6 243**	**6 928**	**6 769**	**7 400**
Marketable Gas	**6 248**	**5 298**	**5 513**	**5 871**	**5 712**	**6 343**
Gross Production	7 736	6 692	6 771	7 257	7 081	7 708
Own-use Consumption	1 489	1 395	1 259	1 387	1 370	1 366
Imports	**332**	**794**	**730**	**1 057**	**1 057**	**1 057**
Liquefied Natural Gas Production	**0**	**0**	**0**	**0**	**0**	**838**

Table A.31: Electricity Supply and Demand (Terawatt hours)

	Historical				Projected	
	2005	**2010**	**2015**	**2018**	**2020**	**2030**
Electricity Required	**602**	**590**	**642**	**644**	**618**	**647**
Total Gross Demand	546	533	548	563	525	584
Purchased from Grid	*496*	*488*	*492*	*506*	*466*	*509*
Own Use	*50*	*45*	*56*	*57*	*59*	*75*
Net Exports	24	25	62	48	62	30
Exports	*44*	*44*	*73*	*61*	*75*	*56*
Imports	*20*	*19*	*11*	*13*	*13*	*26*
Losses	32	32	32	33	31	33
Electricity Produced	**610**	**594**	**652**	**647**	**619**	**649**
Utility Generation	554	541	578	582	548	561
Coal and Petroleum Coke	*102*	*84*	*63*	*52*	*19*	*1*
Refined Petroleum Products	*10*	*3*	*4*	*3*	*3*	*1*
Natural Gas	*21*	*31*	*34*	*39*	*44*	*49*
Nuclear	*87*	*86*	*96*	*95*	*82*	*65*
Hydro	*327*	*321*	*345*	*353*	*352*	*380*
Other Renewables	*7*	*16*	*35*	*40*	*48*	*66*
Industrial Generation	56	53	74	64	70	88
Coal and Petroleum Coke	*0*	*0*	*0*	*0*	*0*	*0*
Refined Petroleum Products	*1*	*1*	*1*	*1*	*1*	*1*
Natural Gas	*18*	*21*	*35*	*28*	*33*	*42*
Hydro	*31*	*27*	*33*	*29*	*30*	*38*
Other Renewables	*6*	*4*	*5*	*6*	*7*	*7*

Emissions Factors for Various Fuels[19]

Table A.32: Mass of CO_2 eq Emissions Emitted per Quantity of Energy for Various Fuels

Fuel	CO_2 eq Emission Factor (g/MJ)
Aviation Gasoline	74.25
Biodiesel	5.41
Biomass	5.62
Coal	91.25
Coke	110.30
Coke Oven Gas	36.72
Diesel	71.46
Ethanol	2.49
Gasoline	71.66
Heavy Fuel Oil	75.31
Jet Fuel	69.40
Kerosene	68.14
Light Fuel Oil	71.16
LPG	38.27
Lubricants	58.09
Naphtha Specialties	17.77
Natural Gas	47.00
Natural Gas Raw	57.17
Other Non-Energy Products	36.41
Petrochemical Feedstocks	14.22
Petroleum Coke	84.57
Renewable Natural Gas	0.38
Still Gas	51.48

[19] The table presents national emission factors by fuel averaged throughout the entire projection period of 1990 to 2030. Emission factors presented in the table calculated by dividing the total fuel-related GHG (CO_2, CH_4 and N_2O) emissions (prior to CCS) by the energy contained in the total amount of fuel used (for energy and non-energy uses) over all years, provinces/territories, sectors, technologies and end-uses. Actual emission factors used for modeling vary by year, province/territory, sector, technology and end-use.

Federal, Provincial and Territorial Measures

Table A.33: GHG Measures Reflected in Reference Case

Provincial/Territorial Measures	Federal and Multi-Jurisdictional Measures
Adoption of the National Energy Code for Buildings of Canada (2010-2012) by all provinces and territories	• Federal Backstop Carbon Pollution Pricing • Amendments accelerating the phase out of coal-fired generation of electricity and performance standards for natural gas electricity generation[20] • Energy Innovation Program • Incentives to Zero Emission Vehicles • Public Transit Investments • Emerging renewables and smart grids • Off-diesel energy systems in remote communities • Federal Budget 2016: Supporting Energy Efficiency and Renewable Energy Development. Increase efficiency of residential and commercial devices (including refrigeration, freezers, ranges, dryers) through regulations and ENERGY STAR certification (Amendment 14) • Equipment Standards (Amendment 13) • Voluntary emission reductions for planes and trains • Light-duty vehicles 1 (LDV-1) GHG emissions standards for the light-duty vehicle model years 2011 to 2016 • Light-duty vehicles 2 (LDV-2) GHG emissions standards increases stringency for model years 2017 to 2025 • Heavy-duty vehicles 1 (HDV) GHG emissions standards for heavy-duty vehicle model years 2014 to 2018 • Heavy-duty vehicles 2 (HDV) GHG emissions standards for heavy-duty vehicle model years 2021 to 2027 and trailers • *Regulations Amending the Ozone-depleting Substances and Halocarbon Alternatives Regulations* • *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas sector)*
Renewable Fuel Content across all jurisdictions (except for Newfoundland and Labrador, Yukon, the Northwest Territories and Nunavut)	
Newfoundland and Labrador • Muskrat Falls hydro project • Waste Management Strategy • Newfoundland's carbon pricing system	
Prince Edward Island • PEI Fuel Charge	
Nova Scotia • Nova Scotia's carbon pricing system • Cap on GHG emissions from the electricity sector • Renewable portfolio standard for electricity generation • Electricity demand-side management policies • *Solid Waste-Resource Management Regulations*	
New Brunswick • Renewable Portfolio Standard • New Brunswick Carbon Levy	
Quebec • Western Climate Initiative cap-and-trade regime[21] • 5% ethanol objective in gasoline distributors fuel sales • Drive electric program • Landfill gas regulation • Eco-performance program for industry • Program to support energy efficiency improvements in marine, air and rail transport (PETMAF) • Program to reduce/avoid GHG emissions by using intermodal transportation (PREGTI) • Program Écocamionnage • Renewable natural gas mandate (5% by 2025) • Quebec policy for the management of residual materials • Residual forest biomass program • Chauffez Vert program	
Ontario • Ethanol in Gasoline Regulation (increasing ethanol content in gasoline to 10% by 2020) • Residential electricity peak savings (time-of-use pricing) • Feed-in tariff program • Landfill gas regulation (O. Reg. 216/08 and 217/08)	

[20] A number of provinces are currently working with the Government of Canada on Equivalency agreements in lieu of the amended coal-fired electricity regulations.

[21] Expected net purchases of the credits by Quebec under the WCI are not included in the Reference Case.

Provincial/Territorial Measures	Federal and Multi-Jurisdictional Measures
• Strategy for a Waste-free Ontario • Independent Electricity System Operator contracted electricity supply • Nuclear refurbishment • Energy Storage Contract with Quebec • Ontario Natural Gas 2015-2020 Conservation Framework • Ontario Electricity 2015-2020 Conservation Framework	• Accelerating Industrial Energy Efficiency Management • Low-Carbon Economy Challenge Fund • Low-Carbon Economy Leadership Fund • Strategic Interconnections in electricity (Manitoba – Saskatchewan, Quebec – New Brunswick)
Manitoba • Biofuel Mandate (ethanol content in gasoline increasing to 10% and biodiesel content in diesel to 5% by 2020) • Manitoba Building Code Section 9.36 (for housing) • Manitoba Composts program • Efficiency Manitoba Act • Waste Reduction and Recycling Support Program	
Saskatchewan • Adoption of the Building Codes • Boundary Dam 3 Carbon Capture Project • *Uniform Building and Accessibility Standards Regulations* (2013) • Solid Waste Management Strategy • Saskatchewan's output-based performance standards system	
Alberta • Alberta's Technology Innovation and Emissions Reduction System (TIER) • 100 Mt cap for oil sands • Quest carbon capture and storage project • Carbon Trunk Line Project – CO_2 capture and use for enhanced oil recovery • Energy efficiency requirements for housing and small buildings, section 9.36 of the 2014 Alberta Building Code edition • Municipal Waste Annual Disposal Targets	

British Columbia
• Carbon tax increasing to $35 in 2018, $40 in 2019 and $50 in 2021
• CleanBC plan:
  ○ ZEV mandate and incentives
  ○ Tailpipe Emissions Standard
  ○ Heat Pump Incentive
  ○ Organic Waste Diversion and Landfill gas
  ○ Industrial Electrification
  ○ Carbon Capture and Storage
  ○ CleanBC for Industry
• British Columbia Cement Low Carbon Fuel Program
• Landfill gas management regulation
• British Columbia *Clean Energy Act*: Clean or renewable electricity requirement – 100% of electricity from clean or renewable sources by 2025
• Revisions for energy efficiency of large residential and	

Provincial/Territorial Measures	Federal and Multi-Jurisdictional Measures
commercial buildings (Part 3) (reg # 167/2013) • Revisions for energy efficiency of housing and small buildings (Part 9) (reg # 173/2013) • City of Vancouver Building Codes • Clean Energy Vehicles Program (Phase 1, 2, Phase 3 and Beyond), a ZEV mandate and support for zero emissions vehicle charging stations in buildings • Step Code: Increased Energy Efficiency Requirements in the Building Code • Municipal Waste disposal target and organic waste disposal restriction • Energy Efficiency Standards Regulation on gas-fired boilers	
Northwest Territories • Biomass Strategy • NWT Carbon tax	

Annex 4. The Contribution of the Land Use, Land-Use Change and Forestry Sector and Modeling Methodologies

The Land Use, Land-Use Change and Forestry (LULUCF) sector focuses on emissions and removals associated with managed lands (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Lands), including those associated with land-use change and emissions from Harvested Wood Products (HWP) derived from these lands. In its May 2017 submission to the UNFCCC regarding its Nationally Determined Contribution (NDC) for 2030, Canada indicated that it intended to account for all IPCC categories. For the LULUCF sector, the NDC stated that Canada would exclude the impacts of natural disturbances and focus on anthropogenic emissions and removals.

Canada has since established accounting approaches for each LULUCF sub-sector and has provided LULUCF accounting contributions in 2018 (through Canada's Greenhouse Gas and Air Pollutant Emissions Projections Report)[22] and in 2019 (through its Fourth Biennial Report on Climate Change released)[23]. This year, Canada continues to estimate the accounting contribution from LULUCF using the same general methodologies as in previous years, but using updated data and some methodological improvements, consistent with NIR 2020.

For almost all LULUCF sub-sectors, the accounting approach compares net emissions in a given year with net emissions in the base year (often referred to as a "net-net" approach), which for Canada is 2005. Given the unique characteristics of forests, Canada uses a reference level (RL) approach for Forest Land remaining Forest Land (FLFL) and the associated HWP. This approach first involves defining the RL, which is a projection of emissions from FLFL and associated HWP that reflects a continuation of recent forest management policies and practices. For any given year, accounting then involves calculating the difference between actual emissions (or projected emissions, when historical data are not yet available) in that year and the pre-defined RL value for the same year. As a result, the accounting contribution reflects the impact of actual management on emissions relative to the impact of the management assumed in the RL. Section A2.6 from Canada's Fourth Biennial Report on Climate Change provides more details on LULUCF in general and on the tables presented below.

Table A.34 provides the net flux estimates for 1990, 2005 and recent historical years for all LULUCF sub-sectors. Values in Table A.34 are consistent with Table 6–1 from NIR 2020.

[22] 2018 Canada's Greenhouse Gas and Air Pollutant Emissions Projections (http://publications.gc.ca/collections/collection_2018/eccc/En1-78-2018-eng.pdf).

[23] Canada's Fourth Biennial Report on Climate Change (https://unfccc.int/documents/209928).

Table A.34: Historical LULUCF sector net GHG flux estimates for selected years

	Net GHG flux (kt CO_2 eq.)[1]							
LULUCF Sub-sectors	**1990**	**2005**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
A. Forest Land	**-200 000**	**-150 000**	**-150 000**	**-150 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**
Forest Land remaining Forest Land (FLFL)[2]	-200 000	-140 000	-150 000	-150 000	-140 000	-140 000	-140 000	-140 000
Land converted to Forest Land (LFL)	-1 100	- 950	- 590	- 540	- 500	- 440	- 390	- 330
B. Cropland[3]	**8 100**	**-11 000**	**-10 000**	**-9 500**	**-8 600**	**-7 700**	**-6 800**	**-6 200**
Cropland remaining Cropland (CLCL)	-1 300	-15 000	-13 000	-12 000	-11 000	-10 000	-9 700	-8 800
Land converted to Cropland (LCL)	9 500	3 900	2 700	2 800	2 700	2 800	2 900	2 700
C. Grassland	**0.6**	**0.9**	**1.9**	**0.8**	**1.2**	**1.2**	**1.2**	**1.2**
Grassland remaining Grassland (GLGL)	0.6	0.9	1.9	0.8	1.2	1.2	1.2	1.2
Land converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	**5 300**	**3 100**	**3 100**	**3 100**	**2 900**	**2 900**	**3 000**	**2 600**
Wetlands remaining Wetlands (WLWL)	1 500	2 600	2 400	2 400	2 500	2 600	2 600	2 400
Land converted to Wetlands (LWL)	3 800	480	670	710	410	330	350	210
E. Settlements	**2 100**	**2 100**	**2 300**	**2 300**	**2 200**	**2 100**	**1 900**	**1 800**
Settlements remaining Settlements (SLSL)	-3 900	-4 100	-4 100	-4 100	-4 100	-4 100	-4 100	-4 100
Land converted to Settlements (LSL)	6 000	6 100	6 400	6 400	6 400	6 200	6 000	5 900
F. Other Land	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**
G. Harvested Wood Products (HWP)[4]	**130 000**	**140 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**
HWP from FLFL	120 000	140 000	130 000	130 000	130 000	130 000	130 000	130 000
HWP from *Forest Conversion*	3 000	3 000	3 000	3 000	2 900	2 800	2 700	2 600
Total LULUCF[5]	**-60 000**	**-13 000**	**-25 000**	**-25 000**	**-18 000**	**-19 000**	**-16 000**	**-13 000**
Forest Conversion[6]	*21 000*	*16 000*	*15 000*	*15 000*	*15 000*	*15 000*	*14 000*	*14 000*

Notes:
NE = Not Estimated, NO = Not Occurring.

[1] Negative sign indicates net removals of CO_2 from the atmosphere.
[2] Wetlands subject to forest management practices are not included in NIR estimates due to a lack of suitable activity data and science to quantify the short, medium and long-term impacts of management on net GHG emissions.
[3] Wetlands converted to Cropland and subject to agricultural management practices are not included in inventory estimates due to a lack of suitable activity data and science to quantify the short, medium and long-term impacts of conversion and management on net GHG emissions.
[4] Emissions are shown separately for HWP from FLFL and HWP from Forest Conversion because their accounting approaches differ.
[5] Totals may not add up to due to rounding.
[6] Shown for information only. Forest Conversion overlaps with the sub-sectors of Cropland remaining Cropland (CLCL), Land converted to Cropland (LCL), Wetlands remaining Wetlands (WLWL), Land converted to Wetlands (LWL), Land converted to Settlements (LSL) and Harvested Wood Products (HWP).

Table A.35 provides the net flux estimates for 1990, 2005 and recent historical years as well as selected projection years (2020 and 2030), but only for the sub-sectors and parts of sub-sectors for which projections are currently available. Table A.35 is provided to show historical information that is consistent with projections in order to facilitate understanding of the accounting projections.

Table A.35: Net GHG flux estimates for selected years from LULUCF sub-sectors for which projections are currently available

Net GHG flux (kt CO_2 eq.)[1]										
LULUCF Sub-sectors	**1990**	**2005**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2020**	**2030**
A. Forest Land	**-200 000**	**-150 000**	**-150 000**	**-150 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**	**-140 000**
Forest Land remaining Forest Land (FLFL)[0]	-200 000	-140 000	-150 000	-150 000	-140 000	-140 000	-140 000	-140 000	-140 000	-140 000
Land converted to Forest Land (LFL)	-1 100	- 950	- 590	- 540	- 500	- 440	- 390	- 330	- 240	0
B. Cropland	**8 300**	**-11 000**	**-10 000**	**-9 200**	**-8 400**	**-7 500**	**-6 600**	**-6 000**	**-4 200**	**- 640**
Cropland remaining Cropland (CLCL)[2]	- 880	-14 000	-13 000	-12 000	-11 000	-10 000	-9 200	-8 400	-6 600	-2 800
Land converted to Cropland (LCL)[3]	9 200	3 800	2 600	2 600	2 500	2 500	2 600	2 400	2 400	2 100
C. Grassland[4]										
Grassland remaining Grassland (GLGL)										
Land converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands[5]	**2 800**	**1 500**	**1 400**	**1 500**	**1 200**	**1 200**	**1 200**	**1 000**	**940**	**540**
Wetlands remaining Wetlands (WLWL)	610	1 100	950	940	940	930	910	890	540	460
Land converted to Wetlands (LWL)	2 200	410	480	530	240	230	250	130	400	79
E. Settlements[6]	**6 000**	**6 100**	**6 400**	**6 400**	**6 300**	**6 200**	**6 000**	**5 900**	**5 600**	**4 500**
Settlements remaining Settlements (SLSL)										
Land converted to Settlements (LSL)	6 000	6 100	6 400	6 400	6 300	6 200	6 000	5 900	5 600	4 500
F. Other Land	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**	**NE, NO**
G. Harvested Wood Products (HWP)	**130 000**	**140 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**	**130 000**
HWP from FLFL	120 000	140 000	130 000	130 000	130 000	130 000	130 000	130 000	130 000	130 000
HWP from *Forest Conversion*	3 000	3 000	3 000	3 000	2 900	2 800	2 700	2 600	2 600	2 400
Total LULUCF[7]	**-58 000**	**-10 000**	**-23 000**	**-23 000**	**-16 000**	**-17 000**	**-15 000**	**-11 000**	**-13 000**	**-9 500**
Forest Conversion[8]	*21 000*	*16 000*	*15 000*	*15 000*	*15 000*	*15 000*	*14 000*	*14 000*	*13 000*	*11 000*

Notes:
NE = Not Estimated, NO = Not Occurring.

[0] Historical estimates and projections do not include net emissions from drainage, as these projections are not yet available.
[1] Negative sign indicates net removals of CO_2 from the atmosphere.
[2] Historical estimates and projections do not include net emissions from agricultural woody biomass, as these projections are not yet available.
[3] Historical estimates and projections are only for Forest Land converted to Cropland.
[4] No projections are available for grasslands.
[5] Historical estimates and projections are only for Forest Land converted to Wetlands.
[6] Historical estimates and projections are only for Forest Land converted to Settlements.
[7] Totals may not add up to due to rounding.
[8] Shown for information only. Forest Conversion overlaps with the sub-sectors of Cropland remaining Cropland (CLCL), Land converted to Cropland (LCL), Wetlands remaining Wetlands (WLWL), Land converted to Wetlands (LWL), Land converted to Settlements (LSL) and Harvested Wood Products (HWP).

Table A.36 presents the contribution from FLFL and associated HWP, showing how it is derived using the RL approach.

Table A.36: Accounting contribution from FLFL and associate HWP in selected years

(kt CO_2 eq.)[1]								
Forest Land Remaining Forest Land + associated Harvested Wood Products	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2020**	**2030**
Reference Level values	-21 000	-16 000	-7 000	-4 500	-1 300	3 800	13 000	8 700
Historical and Projected values	-23 000	-24 000	-18 000	-19 000	-17 000	-14 000	-18 000	-16 000
Accounting contribution[2]	**-2 100**	**-7 300**	**-11 000**	**-14 000**	**-16 000**	**-18 000**	**-30 000**	**-25 000**

Notes:
Projected Years: actual contributions will depend on actual emissions/removals occurring in 2020 and 2030.
[1] Negative values represent progress towards lowering Canada's GHG emissions.
[2] Totals may not add up due to rounding.

Table A.37 presents the contribution from all LULUCF sub-sectors in selected historical years based on estimates shown in Table A.34 for net-net accounting and Table A.36 for RL accounting.

Table A.37: Accounting contribution by LULUCF sub-sector in selected historical years

LULUCF Sub-sectors	(kt CO_2 eq.)[1] 2013	2014	2015	2016	2017	2018	Accounting Approach
A. Forest Land[2]							
Forest Land Remaining Forest Land (FLFL) + associated Harvested Wood Products (HWP)	-2 100	-7 300	-11 000	-14 000	-16 000	-18 000	Reference Level
Land converted to Forest Land (LFL)	360	410	450	510	560	620	Net-Net
B. Cropland	**640**	**1 600**	**2 400**	**3 300**	**4 200**	**4 800**	**Net-Net**
Cropland remaining Cropland (CLCL)	1 800	2 700	3 500	4 400	5 200	6 000	Net-Net
Land converted to Cropland (LCL)	-1 100	-1 100	-1 100	-1 100	-1 000	-1 200	Net-Net
C. Grassland[4]	**1.1**	**0**	**0.3**	**0.4**	**0.4**	**0.4**	**Net-Net**
Grassland remaining Grassland (GLGL)	1.1	0	0.3	0.4	0.4	0.4	Net-Net
Land converted to Grassland (LGL)	NO	NO	NO	NO	NO	NO	Net-Net
D. Wetlands[5]	**- 20**	**20**	**- 170**	**- 130**	**- 110**	**- 440**	**Net-Net**
Wetlands remaining Wetlands (WLWL)	- 210	- 210	- 100	28	28	- 170	Net-Net
Land converted to Wetlands (LWL)	190	230	- 68	- 160	- 130	- 270	Net-Net
E. Settlements[6]	**240**	**230**	**180**	**50**	**- 210**	**- 240**	**Net-Net**
Settlements remaining Settlements (SLSL)	- 60	- 60	- 60	- 60	- 60	- 60	Net-Net
Land converted to Settlements (LSL)	300	290	240	110	- 150	- 180	Net-Net
F. Other Land	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	
G. Harvested Wood Products (HWP)[3]							
HWP from FLFL	IE	IE	IE	IE	IE	IE	Reference Level
HWP from *Forest Conversion*	3.3	- 31	- 140	- 190	- 350	- 430	Net-Net
Total LULUCF[4]	**- 820**	**-5 100**	**-7 900**	**-11 000**	**-12 000**	**-13 000**	
Forest Conversion[5]	*- 820*	*- 880*	*-1 400*	*-1 600*	*-2 000*	*-2 500*	*Net-Net*

Notes:
NE = Not Estimated, NO = Not Occurring, IE = Included Elsewhere.

[1] Negative values represent progress towards lowering Canada's GHG emissions.
[2] The FL contribution is not shown here because two different accounting approaches are used to calculate the FL contribution: FLFL and associated HWP is accounted using the reference level approach, whereas LFL is accounted using the net-net approach.
[3] The HWP contribution is not shown here because two different accounting approaches are used to calculate the HWP contribution. HWP associated with FLFL is included under FLFL and associated HWP. The contribution from HWP from Forest Conversion is shown separately.
[4] Totals may not add up due to rounding.
[5] Shown for information only. Forest Conversion overlaps with the sub-sectors of Cropland remaining Cropland (CLCL), Land converted to Cropland (LCL), Wetlands remaining Wetlands (WLWL), Land converted to Wetlands (LWL), Land converted to Settlements (LSL) and Harvested Wood Products (HWP).

Table A.38 presents the projected contribution in 2020 and 2030 based on estimates shown in Table A.35 for net-net accounting and Table A.36 for RL accounting, for those sub-sectors for which emission projections are available.

Table A.38: Projected accounting contribution by LULUCF sub-sector in 2020 and 2030

LULUCF Sub-sectors	(kt CO_2 eq.)[1] 2020	2030	Accounting Approach[2]
A. Forest Land[3]			
Forest Land Remaining Forest Land (FLFL) + associated Harvested Wood Products (HWP)	-30 000	-25 000	Reference Level
Land converted to Forest Land (LFL)	720	950	Net-Net
B. Cropland[4]	**6 400**	**10 000**	**Net-Net**
Cropland remaining Cropland (CLCL)	7 800	12 000	Net-Net
Land converted to Cropland (LCL)	-1 400	-1 700	Net-Net
C. Grassland[5]			Net-Net
Grassland remaining Grassland (GLGL)			Net-Net
Land converted to Grassland (LGL)	NO	NO	Net-Net
D. Wetlands[6]	**- 580**	**- 980**	**Net-Net**
Wetlands remaining Wetlands (WLWL)	- 570	- 650	Net-Net
Land converted to Wetlands (LWL)	- 10	- 330	Net-Net
E. Settlements[7]	**- 500**	**-1 600**	**Net-Net**
Settlements remaining Settlements (SLSL)			Net-Net
Land converted to Settlements (LSL)	- 500	-1 600	Net-Net
F. Other Land	**NE,NO**	**NE,NO**	
G. Harvested Wood Products (HWP)[8]			
HWP from FLFL	IE	IE	Reference Level
HWP from *Forest Conversion*	- 460	- 660	Net-Net
Total LULUCF[9]	**-25 000**	**-17 000**	
***Forest Conversion*[10]**	*-3 000*	*-5 300*	Net-Net

Notes:
NE = Not Estimated, NO = Not Occurring, IE = Included Elsewhere.

[1] Negative values represent progress towards lowering Canada's GHG emissions.
[2] Projected Years: actual contributions will depend on actual emissions/removals occurring in 2020 and 2030.
[3] The FL contribution is not shown here because two different accounting approaches are used to calculate the FL contribution: FLFL and associated HWP is accounted using the reference level approach, whereas LFL is accounted using the net-net approach.
[4] Projections are available only for Cropland remaining Cropland (CLCL, excluding agricultural woody biomass) and Forest Land converted to Cropland.
[5] No projections are available.
[6] Projections are available only for Forest Land converted to Wetlands.
[7] Projections are available only for Forest Land converted to Settlements.
[8] The HWP contribution is not shown here because two different accounting approaches are used to calculate the HWP contribution. HWP associated with FLFL is included under FLFL and associated HWP. The contribution from HWP from Forest Conversion is shown separately.
[9] Totals may not add up due to rounding.
[10] Shown for information only. Forest Conversion overlaps with the sub-sectors of Cropland remaining Cropland (CLCL), Land converted to Cropland (LCL), Wetlands remaining Wetlands (WLWL), Land converted to Wetlands (LWL), Land converted to Settlements (LSL) and Harvested Wood Products (HWP).

Annex 5. Air Pollutant and Black Carbon Emissions Projections – Supplementary Information

Policies and Measures in the 2020 Reference Case

Canada has a large number of environmental policies and regulations that affect air pollutant emissions projections. Some of these policies are directly aiming to reduce emissions of air pollutants, while others are targeting GHG emissions, but have indirect impacts on air pollution. Major policies and measures aiming to directly reduce air pollution that have been explicitly modeled and included in the 2020 Reference Case are listed below.

- Base-Level Industrial Emission Requirements (BLIERs)
  Environment and Climate Change Canada (ECCC) implemented a diverse set of BLIERs in its ongoing commitment to the Air Quality Management System (AQMS) through regulatory and non-regulatory measures. Since 2016, ECCC has published:
  - Final codes of practice for the aluminium sector and the iron, steel & ilmenite sector
  - Final code of practice for the potash sector
  - Final code of practice for the pulp and paper sector
  - One pollution planning notice for the iron, steel and ilmenite sector
  - One guideline for stationary combustion turbines
  - Three performance agreements for the aluminium sector and the iron ore pellets sector
  - Five company-specific performance agreements for the base metals smelting sector
  - *Multi-Sector Air Pollutants Regulations (MSAPR) – (SOR/2016-151)*
    The MSAPR requires owners and operators of industrial facilities and equipment types to meet strict performance standards across Canada. The purpose of the regulation is to reduce NOx emissions from gaseous fuel-fired boilers and heaters and stationary spark-ignition engines used in several industrial sectors and NOx and SO_2 from cement production.
- *VOC Concentration limits for Architectural Coatings Regulations (SOR/ 2009-264)*
  The purpose of this regulation is to protect the environment and health of Canadians from VOC emissions, generated by architectural coatings.
- *Sulphur in Gasoline Regulations (SOR/99-236)*
  The objective of the Regulation is to reduce sulphur content when using diesel and heavy fuel oils in transportation and utility electric generation.
- *Canada and USA Emission Control Area (ECA) for Ships*
  The purpose of the Regulation is to reduce SOx and NOx emissions in Marine Diesel Engines. This is achieved through the use of lower sulphur fuels and / or use of after treatment technologies such as scrubbers and selective catalytic reduction. The ECA applies to waters south of 60ºN latitude.
- *On-Road and Off-Road Vehicle Regulations*
  Various regulations aimed at reduction air pollutants by imposing requirements for engines imported and manufactured in Canada. The specific regulations are as follows:
  - *On-Road Vehicle and Engine Emission Regulations*. Tier 2 and 3 Emission Standards to reduce NOx, PM, CO, VOC.
  - *Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations* to reduce NOx, PM, VOC.
  - *Off-Road Small Spark-Ignition Engine Emission Regulations* to reduce NOx, PM, VOC, CO.

- *Locomotive Emissions Regulations (SOR/2017-121)*
  Establish emission standards and testing procedures to reduce emissions of NOx, PM, HC, CO and smoking from the operation of locomotives.

Reference Case Emissions by Pollutant

Table A.39: Sulphur Oxides Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	5	8	6	6	6
Buildings	56	18	7	7	6
Electricity and Steam	522	334	220	98	2
Heavy Industry	947	536	291	238	318
Oil and Gas	462	341	267	259	303
Transportation	148	115	16	13	18
Waste and Others	32	16	10	9	9
Total	**2 174**	**1 367**	**817**	**629**	**663**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.40: Nitrogen Oxides Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	129	114	72	52	37
Buildings	99	81	85	80	71
Electricity and Steam	246	229	122	109	71
Heavy Industry	227	164	153	138	158
Oil and Gas	444	472	505	449	317
Transportation	1 181	973	847	723	787
Waste and Others	143	103	67	49	45
Total	**2 470**	**2 138**	**1 853**	**1 601**	**1 486**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

[24] For more information about APEI 2020, please consult https://www.canada.ca/en/environment-climate-change/services/pollutants/air-emissions-inventory-overview.html.

Table A.41: Volatile Organic Compounds Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	164	151	162	159	160
Buildings	471	429	433	404	382
Electricity and Steam	3	2	1	3	3
Heavy Industry	184	118	130	101	134
Oil and Gas	713	685	737	673	791
Transportation	593	473	280	201	219
Waste and Others	251	186	166	126	154
Total	**2 406**	**2 059**	**1 919**	**1 668**	**1 844**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.42: Total Particulate Matter Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	50	47	43	41	40
Buildings	254	253	262	247	215
Electricity and Steam	34	21	15	7	3
Heavy Industry	156	106	94	81	105
Oil and Gas	22	16	25	24	27
Transportation	67	57	39	31	59
Waste and Others	149	183	185	167	189
Total Without Open Sources	**702**	**649**	**621**	**598**	**637**
Total With Open Sources	**19 501**	**23 295**	**28 736**	**26 154**	**32 164**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.43: Particulate Matter 10 Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	24	22	16	14	13
Buildings	209	205	205	191	159
Electricity and Steam	15	9	6	3	2
Heavy Industry	87	62	55	46	60
Oil and Gas	17	13	18	18	20
Transportation	66	56	39	31	45
Waste and Others	61	63	71	64	70
Total Without Open Sources	**473**	**421**	**396**	**367**	**368**
Total With Open Sources	**6 278**	**7 256**	**8 877**	**8 106**	**9 796**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.44: Particulate Matter 2.5 Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	15	13	7	6	4
Buildings	196	192	187	174	142
Electricity and Steam	8	5	3	2	1
Heavy Industry	57	38	32	26	34
Oil and Gas	13	10	13	15	15
Transportation	53	43	26	22	25
Waste and Others	33	20	19	17	19
Total Without Open Sources	**379**	**323**	**285**	**260**	**241**
Total With Open Sources	**1 338**	**1 433**	**1 626**	**1 480**	**1 691**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.45: Black Carbon Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	n.a	n.a	4	3	2
Buildings	n.a	n.a	13	12	10
Electricity and Steam	n.a	n.a	0	0	0
Heavy Industry	n.a	n.a	2	1	1
Oil and Gas	n.a	n.a	2	2	2
Transportation	n.a	n.a	13	12	12
Waste and Others	n.a	n.a	3	2	1
Total	**n.a**	**n.a**	**38**	**32**	**28**

Note:

[1] Black carbon emissions begin in 2013. In that year, black carbon emissions were 44 kilotonnes.

[2] Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.46: Carbon Monoxide Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	101	91	58	57	59
Buildings	1 248	1 251	1 239	1 145	924
Electricity and Steam	47	37	32	79	72
Heavy Industry	697	690	661	605	799
Oil and Gas	497	529	578	572	557
Transportation	4 807	3 767	3 003	2 521	3 033
Waste and Others	609	324	194	170	190
Total	**8 009**	**6 692**	**5 765**	**5 149**	**5 634**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.47: Mercury Emissions in Kilograms

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	10	17	14	14	14
Buildings	850	531	348	340	335
Electricity and Steam	2 161	1 582	580	170	44
Heavy Industry	3 334	1 938	1 477	1 264	1 685
Oil and Gas	193	231	126	109	138
Transportation	102	82	60	53	56
Waste and Others	1 274	653	506	507	581
Total	**7 925**	**5 035**	**3 112**	**2 458**	**2 854**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]

Table A.48: Ammonia Emissions in Kilotonnes

	Historical			Projected	
	2005	**2010**	**2018**	**2020**	**2030**
Agriculture	458	426	453	440	546
Buildings	8	7	7	7	7
Electricity and Steam	1	1	0	0	0
Heavy Industry	14	12	12	11	15
Oil and Gas	2	2	3	2	3
Transportation	11	9	8	7	8
Waste and Others	4	2	2	1	2
Total	**498**	**459**	**484**	**467**	**580**

Note: Numbers may not sum to the total due to rounding. Historical emissions data comes from the Air Pollutant Emissions Inventory 2020 (APEI).[24]