



CANADA'S 2016 GREENHOUSE GAS EMISSIONS REFERENCE CASE

Environment and Climate Change Canada
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CANADA'S GREENHOUSE GAS (GHG) EMISSIONS PROJECTIONS 2016

This report provides a reference case of Canada's greenhouse gas (GHG) emissions through 2030. This Reference Case presents the future impacts of policies and measures taken by federal, provincial and territorial governments as of November 1st, 2016. It is aligned with Canada's historical emissions from 1990 to 2014 as presented in *National Inventory Report 1990-2014: Greenhouse Gas Sources and Sinks in Canada* (NIR). 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. Table 30 gives a full description of measures included into 2016 Reference Case.

Given the uncertainty regarding the key drivers of GHG emissions, alternate scenarios (high and low emissions projections) are also included.

The projections in this report use the same modelling framework as those presented by Environment and Climate Change Canada's Biennial Reports to the United Nations Framework Convention on Climate Change (UNFCCC) in 2014 and 2016.

As shown in Table 1, absent additional actions, total Canadian GHG emissions projections in the Reference Case would be 731 megatonnes of carbon dioxide equivalent (Mt CO₂ eq) in 2020 and 742 Mt in 2030.

Table 1 Reference Case Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical		Projected		Change 2005 to 2030
	2005	2014	2020	2030	
Oil and Gas	159	192	201	233	74
Electricity	118	78	64	34	-84
Transportation	171	171	168	157	-14
Heavy Industry	88	76	85	97	9
Buildings	85	87	89	94	9
Agriculture	70	73	72	74	4
Waste & Others	56	54	51	53	-3
Total	747	732	731	742	-5

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

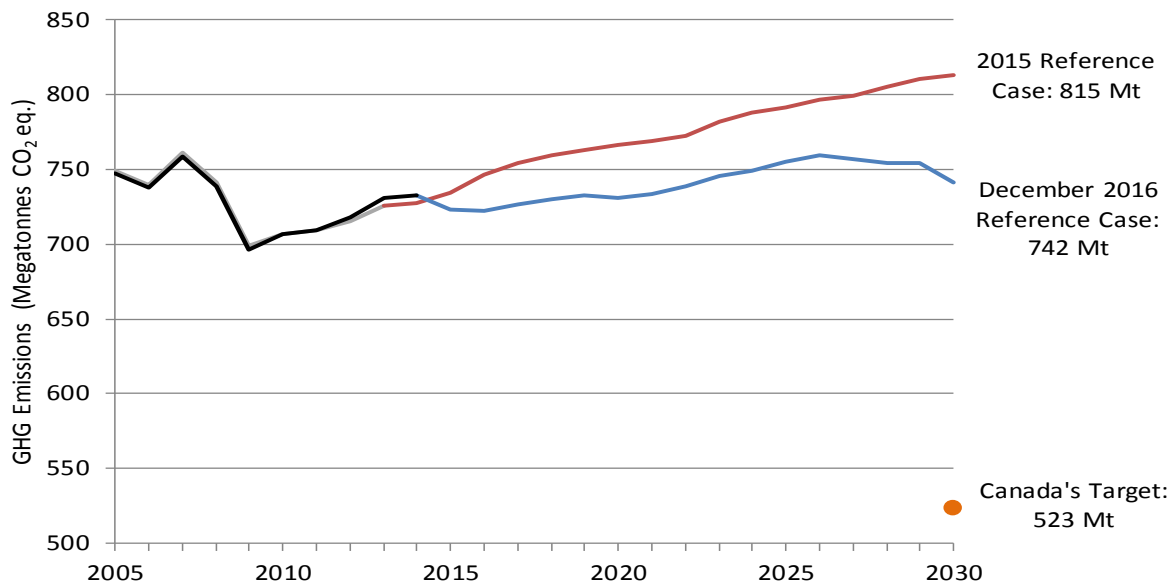
Comparison of 2016 and 2015 Reference Case Emissions Projections¹

In 2030, the Reference Case GHG emissions in Canada are projected to reach 742 Mt, 73 Mt below last year's forecast of 815 Mt presented in Canada's Second Biennial Report (see Figure 1 and Table 2)². This reflects the expected impacts of a number of federal and provincial policies that were put in place over the last year, namely:

- Alberta's Carbon levy, 2030 phase-out of coal-fired electricity, and 100 Mt cap on oil sand emissions;
- Domestic reductions from Ontario joining Quebec and California in the Western Climate Initiative (WCI) cap-and-trade regime in 2017;
- Quebec's regulation for new commercial, institutional and residential high-rise buildings; and,
- Government of Canada measures (announced in Federal Budget 2016) to increase efficiency of residential and commercial equipment and appliances.

In addition to the new policies, the lower Reference Case emissions projections are also driven by a lower GDP growth forecast and lower light oil, oil sands, and natural gas production estimates (see Annex 1 for details). These changes in macroeconomic and energy assumptions, along with modelling improvements and revisions in historical data, result in emissions reductions of approximately 30 Mt in 2030 from last year's projection.

Figure 1 Canada's 2016 and 2015 Reference Case Emissions Projections³



¹ Reference Case emissions projections differences between 2016 Reference Case and 2015 Reference Case by IPCC sector and type of greenhouse gas are presented in Annex 1.

² The projections in this report do not include carbon sequestration or emissions from land use, land-use change and forestry.

³ As part of the Vancouver Declaration on clean growth and climate in March 2016, First Ministers committed to Implement GHG mitigation policies in support of meeting or exceeding Canada's 2030 target of a 30% reduction below 2005 levels of emissions, including specific provincial and territorial targets and objectives (<http://www.scics.gc.ca/english/view.asp?x=1>). Based on the latest NIR's estimates, this means that Canada's target in 2030 is 523 Mt.

Table 2 Comparison of 2016 and 2015 Reference Case Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical	2015 Projection		2016 Projection		Change
	2005	2020	2030	2020	2030	2030
Oil and Gas	159	210	242	201	233	-9
Electricity	118	74	58	64	34	-24
Transportation	171	169	164	168	157	-7
Heavy Industry	88	90	107	85	97	-10
Buildings	85	96	109	89	94	-15
Agriculture	70	74	76	72	74	-2
Waste & Others	56	54	59	51	53	-6
Total	747	768	815	731	742	-73

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

Sensitivity Analysis

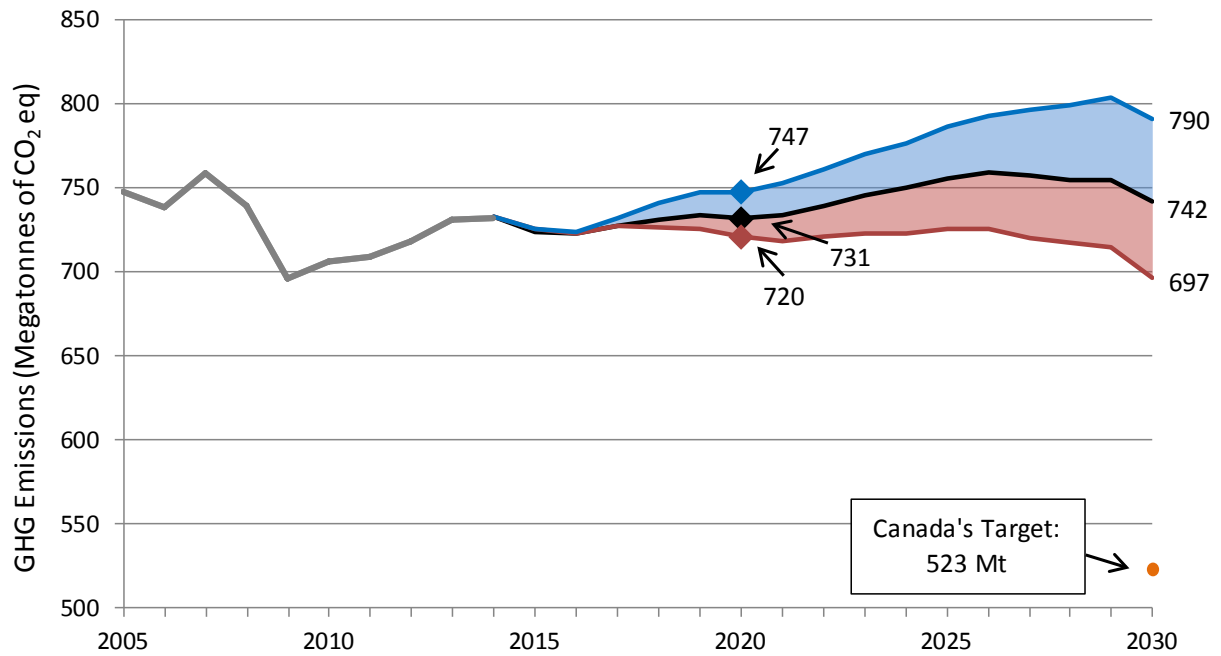
GHG emissions projections depend on a number of economic and energy assumptions and are subject to significant uncertainty, especially in the longer term (see Table 3). In general, GDP growth has a direct and significant impact on GHG emissions. In Canada, oil and natural gas production is also strongly correlated with oil and gas prices which are highly volatile and largely determined by external commodity markets.

Table 3 GDP Growth, Oil and Gas Price Assumptions

Assumptions	Low	Reference	High
Average Annual GDP Growth (2014-2030)	1.0%	1.7%	2.3%
2030 West Texas Intermediate Oil Price (2014 US\$/bbl)	42	81	111
2030 Henry Hub Natural Gas Price (2014 US\$/GJ)	2.89	3.72	4.62
2030 GHG Emissions (Mt CO₂ eq.)	697	742	790

To address these uncertainties, alternate scenarios that reflect different assumptions about oil and natural gas prices and production as well as different rates of economic growth have been developed. As shown in Figure 2 below, these scenarios suggest that the expected emission range of the Reference Case in 2030 could be from 697 Mt in the lowest emissions scenario to 790 Mt in the highest emissions scenario. This 93 Mt range will continue to change over time with further government actions, technological change, economic conditions and developments in energy markets. Furthermore, these estimates do not include contributions for Land Use, Land-Use Change and Forestry (LULUCF).

Figure 2 Canada's Domestic Emissions Projections in 2020 and 2030 (Mt CO₂ eq)



Annex 1: Supplementary Information for Projections

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Emissions Projections by Sector

This section describes projected emissions by sectors defined by the Intergovernmental Panel on Climate Change (IPCC), by type of greenhouse gas, economic sector and subsector.

Table A1 Detailed Emissions Projections by IPCC Sector (Mt CO₂ eq)

Sector	Historical			Projected	
	2005	2010	2014	2020	2030
Stationary Combustion and Fugitive Sources	403	371	391	389	392
Transport	195	199	203	201	192
Industrial Processes	58	50	51	59	74
Agriculture	61	57	59	59	60
Waste	31	29	29	23	23
Total	747	706	732	731	742

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

Table A2 Detailed Emissions by Type of Gas (Mt CO₂ eq)

Sector	Historical			Projected	
	2005	2010	2014	2020	2030
Carbon dioxide (CO ₂)	579	555	574	577	577
Methane (CH ₄)	116	104	108	100	103
Nitrous oxide (N ₂ O)	41	38	39	39	40
Hydrofluorocarbons (HFC)	6	7	9	14	19
Perfluorocarbons (PFC)	4	2	1	1	2
Sulphur hexafluoride (SF ₆)	1	0	0	0	0
Total	747	706	732	731	742

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

Table A3 Comparison of 2016 and 2015 Emissions by Intergovernmental Panel on Climate Change (IPCC) Sector (Mt CO₂ eq)

Sector	Historical	2015 Projection		2016 Projection		Change	
	2005	2020	2030	2020	2030	2020	2030
Stationary Combustion and Fugitive Sources	403	417	450	389	392	-28	-58
Transportation	195	204	198	201	192	-3	-6
Industrial Processes	58	66	84	59	74	-7	-10
Agriculture	61	60	61	59	60	-1	-1
Waste	31	21	22	23	23	2	1
Total	747	768	815	731	742	-37	-73

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

Table A4 Comparison of 2016 and 2015 Emissions by Type of Gas (Mt CO₂ eq)

Sector	Historical	2015 Projection		2016 Projection		Change	
	2005	2020	2030	2020	2030	2020	2030
CO ₂	579	608	643	577	577	-31	-66
CH ₄	116	103	104	100	103	-3	-1
N ₂ O	41	40	42	39	40	-1	-2
HFC	6	14	22	14	19	0	-3
PFC	4	2	2	1	2	-1	0
SF ₆	1	0	0	0	0	0	0
Total	747	768	815	731	742	-37	-73

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

Table A5 Change in GHG Emissions by Economic Sector (Mt CO₂ eq)

Sector	2005	2014	2020	2030	Change	
					2005 to 2020	2005 to 2030
Electricity	118	78	64	34	-53	-84
Transportation	171	171	168	157	-3	-14
Oil and Gas	159	192	201	233	42	73
Heavy Industry	88	76	85	97	-4	9
Buildings	85	87	89	94	4	9
Agriculture	70	73	72	74	2	4
Waste & Others	56	54	51	53	-5	-3
Total	747	732	731	742	-16	-6

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

Detailed Economic Sector Tables

Oil and Gas

Table A6 Oil and Gas Sector: Emissions by Production Type (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Natural Gas Production and Processing	58	57	50	56	-9	-3
Conventional Oil Production	31	36	31	32	0	1
Light Oil Production	12	17	14	16	2	4
Heavy Oil Production	17	17	16	15	-2	-2
Frontier Oil Production	2	2	2	1	0	-1
Oil Sands⁴	34	68	87	108	53	74
Bitumen In Situ	8	30	38	57	30	49
Bitumen Mining	10	18	26	27	17	17
Bitumen Upgrading	16	20	23	25	6	8
Oil and Natural Gas Transmission	12	10	9	10	-3	-3
Downstream Oil and Gas	23	23	23	23	0	0
Petroleum Products	22	21	22	22	0	0
Natural Gas Distribution	1	1	1	1	0	0
Liquid Natural Gas Production	0	0	0	3	0	3
Total	159	192	201	233	42	73

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

Table A7 Selected Upstream Oil and Natural Gas Subsectors: Emissions and Drivers

	2005	2014	2020	2030
Conventional Oil Production				
Emissions (Mt CO ₂ eq)	31	36	31	32
Production (1,000 barrels/day)	1,361	1,401	1,309	1,247
Natural Gas Production and Processing				
Emissions (Mt CO ₂ eq)	58	57	50	56
Gross Production (billion cubic feet)	7,753	6,829	6,319	7,366
Oil Sands⁴				
Emissions (Mt CO ₂ eq)	34	68	87	108
Production (1,000 barrels/day)	1,066	2,306	3,220	3,967

Note: Numbers do not include C5 and condensates.

⁴ Based on the Alberta Government's announcement, Alberta's 100 Mt cap on oil sands emissions excludes emissions from cogeneration of electricity and new upgrading. When taking these into account, total emissions from oil sands is 93 Mt in 2030 under the reference case scenario, below the 100 Mt cap.

Table A8 Petroleum Refining: Emissions and Drivers

	2005	2014	2020	2030
Traditional Refineries				
Emissions (Mt CO ₂ eq)	22	21	22	22
Refined Petroleum Processed (1,000 barrels/day)	2,095	1,952	2,033	2,033

Table A9 Electricity Generation: Emissions by Fuel Type (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Coal	97	62	52	8	-45	-90
Refined Petroleum Products	11	5	3	2	-9	-9
Natural Gas	9	12	9	24	0	15
Biomass	<1	<1	<1	<1	0	0
Total	118	78	64	34	-53	-84

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

Table A10 Electricity Sector: Emissions and Drivers

	2005	2014	2020	2030
Emissions (Mt CO ₂ eq)	118	78	64	34
Generation (Terawatt Hours)	550	580	595	607

Table A11 Transportation: Emissions (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Passenger Transport	97	95	89	73	-8	-24
Cars, Trucks and Motorcycles	88	86	80	64	-8	-25
Bus, Rail and Domestic Aviation	9	9	9	9	0	1
Freight Transport	62	68	70	73	7	11
Heavy Duty Trucks, Rail	55	62	63	66	8	11
Domestic Aviation and Marine	8	6	7	7	-1	0
Other: Recreational, Commercial and Residential	11	9	9	11	-2	-1
Total	171	171	168	157	-3	-14

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

Table A12 Heavy Industry: Emissions by Subsector (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Mining	6	8	9	10	3	4
Smelting and Refining (Non-ferrous metals)	14	10	12	15	-2	1
Pulp and Paper	9	7	8	7	-1	-2
Iron and Steel	19	16	17	21	-2	1
Cement	13	10	10	11	-3	-2
Lime and Gypsum	3	3	2	3	-1	-1
Chemicals and Fertilizers	23	24	27	31	3	7
Total	88	76	85	97	-4	9

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

Table A13 Buildings: Emissions (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Residential	46	46	45	46	-1	0
Commercial	40	41	44	49	5	9
Total	85	87	89	94	4	9

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

Table A14 Buildings: Building Stock (million households and million m² floor space)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Residential: households (millions)	12	14	15	16	3	4
Commercial: floorspace (millions m ²)	654	750	804	920	150	266

Table A15 Agriculture Sector: Emissions (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
On-Farm Fuel Use	9	14	13	14	5	5
Crop Production	17	22	21	21	5	5
Animal Production	45	37	37	39	-8	-6
Total	70	73	72	74	2	4

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

Table A16 Waste and Others: Emissions (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Waste	31	29	23	23	-7	-8
Coal Production	3	4	4	3	1	1
Light Manufacturing, Construction and Forest Resources	23	22	24	27	2	4
Total	56	54	51	53	-5	-3

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

Detailed Emissions by Gas and by Economic Sector

Table A17 Carbon Dioxide Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	70	83	103	112	119	143	156	184
Electricity	94	97	128	117	94	77	64	33
Transportation	124	131	147	161	165	165	162	152
Heavy Industry	72	78	81	78	70	73	80	91
Buildings	68	73	78	78	72	77	75	74
Agriculture	8	10	11	10	12	15	15	15
Waste & Others	27	25	25	23	23	23	26	27
Total	463	497	572	579	555	574	577	577

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

Table A18 Methane Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	36	49	55	47	42	48	44	47
Electricity	0	0	0	0	0	0	0	0
Transportation	1	0	0	0	0	0	0	0
Heavy Industry	0	0	0	0	0	0	0	0
Buildings	4	4	4	3	3	3	3	3
Agriculture	27	31	33	36	30	29	29	30
Waste & Others	27	28	29	30	29	28	23	22
Total	95	113	121	116	104	108	100	103

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

Table A19 Nitrous Oxide Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	0	1	1	1	1	1	2	2
Electricity	1	1	1	1	1	0	0	0
Transportation	5	6	7	7	5	4	4	4
Heavy Industry	12	12	3	4	2	2	2	2
Building	1	1	1	1	1	1	1	1
Agriculture	22	24	25	25	26	29	28	28
Waste & Others	2	2	2	2	2	2	2	2
Total	42	46	40	41	38	39	39	40

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

Table A20 Hydrofluorocarbon Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0
Transportation	0	0	1	2	2	3	2	0
Heavy Industry	1	0	0	0	0	0	1	1
Buildings	0	0	2	3	4	6	10	17
Agriculture	0	0	0	0	0	0	0	0
Waste & Others	0	0	0	0	0	0	1	1
Total	1	1	3	6	7	9	14	19

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

Table A21 Perfluorocarbon Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0
Heavy Industry	8	6	5	4	2	1	1	2
Buildings	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0
Waste & Others	0	0	0	0	0	0	0	0
Total	8	6	5	4	2	1	1	2

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

Table A22 Sulphur Hexafluoride Emissions Projections by Economic Sector (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Oil and Gas	0	0	0	0	0	0	0	0
Electricity	0	0	0	0	0	0	0	0
Transportation	0	0	0	0	0	0	0	0
Heavy Industry	3	2	3	1	0	0	0	0
Buildings	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0
Waste & Others	0	0	0	0	0	0	0	0
Total	3	2	3	1	0	0	0	0

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

The Table below presents the historical and projected emissions from foreign passenger and foreign freight (both aviation and marine). These emissions are not included in the reference scenario.

Table A23 Total GHGs from Foreign Passenger and Freight, Aviation and Marine (Mt CO₂ eq)

Sector	Historical						Projected	
	1990	1995	2000	2005	2010	2014	2020	2030
Foreign Freight	4	5	5	5	4	3	3	3
Foreign Passenger	5	5	8	8	8	10	10	11

Table A24 Provincial and Territorial Reference Case Emissions: 2005 to 2030 (Mt CO₂ eq)

	2005	2014	2020	2030	Change 2005 to 2020	Change 2005 to 2030
Newfoundland	10	11	10	8	0	-2
Prince Edward Island	2	2	2	2	0	0
Nova Scotia	23	17	14	12	-10	-11
New Brunswick	20	15	15	14	-6	-7
Quebec*	90	83	85	86	-5	-3
Ontario*	211	170	168	170	-43	-40
Manitoba	21	21	22	23	2	3
Saskatchewan	70	76	73	69	3	0
Alberta	233	274	276	279	43	46
British Columbia	65	63	65	75	0	10
Territories	2	2	2	2	-1	0
Canada	747	732	731	742	-16	-6

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

* These estimates represent domestic emissions. As such, they do not include potential allowances purchased internationally under the Western Climate Initiative cap-and-trade program. Ontario and Quebec have legislated GHG emissions targets for 2020 and 2030. Both provinces have regulated emissions caps to achieve their 2020 targets, Ontario's target being 15% below 1990 and Quebec being 20% (representing, as of the 2014 Canadian inventory, the equivalent of 155 Mt and 71 Mt, respectively). The provinces will use a combination of new domestic policies and international allowances to meet their legislated targets. The impact of Ontario and Quebec's acquisition of international allowances will be additional to reductions shown in Table A24, and have been included in the measures described on page 45 of the Pan-Canadian Framework on Clean Growth and Climate Change.

Table A25 Macroeconomic Assumptions, 2005-2030 Average Annual Growth Rates

Assumption	2005 - 2014	2014 - 2020	2020-2030
Average Annual GDP Growth Rate	1.6%	1.7%	1.6%
Average Annual Population Growth Rate	1.1%	1.0%	0.9%
Average Annual Labour Force Growth Rate	1.1%	0.7%	0.6%

Oil and natural gas production assumptions for the Reference Case are noted in the tables below. Oil and natural gas price and production forecasts are from the National Energy Board's most recent forecast presented in its *Energy Futures 2016: Update – Energy Supply and Demand Projections to 2040*, October 2016.

Table A26 Crude Oil Production in Thousands of Barrels per Day

	2005	2014	2020	2030
Crude and Condensates	1,533	1,588	1,547	1,513
Conventional Light	511	712	578	652
Conventional Heavy	526	462	442	438
C5 and Condensates	173	186	239	266
Frontier Light (Offshore and Northern)	324	227	289	157
Oil Sands	1,066	2,306	3,220	3,967
Oil Sands: Primary	151	285	329	394
<i>Steam Assisted Gravity Drainage</i>	83	737	1,000	1,566
<i>Cyclic Steam Simulation</i>	205	244	309	405
Oil Sands Mining	627	1,039	1,582	1,602
Total Production (Gross)	2,599	3,893	4,767	5,479

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

Table A27 Oil Sands Disposition in Thousands of Barrels per Day

	2005	2014	2020	2030
Oil Sands (gross)	1,066	2,306	3,220	3,967
Oil Sands (net)	980	2,191	3,084	3,824
<i>Synthetic</i>	611	1,027	1,262	1,381
<i>Non-upgraded Bitumen</i>	369	1,164	1,822	2,443
Own Use	86	115	136	143

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

Table A28 Natural Gas Production and Supply in Billion Cubic Feet

	2005	2014	2020	2030
Natural Gas Supply	6,595	6,115	6,490	7,641
Marketable Gas	6,263	5,342	5,406	6,371
<i>Gross Production</i>	7,753	6,829	6,319	7,366
<i>Own Use Consumption</i>	1,490	1,486	913	995
Imports	332	773	1,083	1,270
Liquid Natural Gas Production	0	0	0	912

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

Table A29 Utility Electricity Generation by Fuel, Terawatt-hours

	2005	2014	2020	2030
Coal and Petroleum Coke	98	67	57	11
Hydro	327	348	374	392
Natural Gas	21	29	23	60
Nuclear	87	102	86	74
Other Renewables	4	30	53	69
Refined Petroleum Products	14	5	2	1
Total Generation	550	580	595	607

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

Table A30 GHG Measures Reflected in Projections (in place as of November 2016)

Provincial/Territorial Measures	
Alberta	<ul style="list-style-type: none"> Climate Leadership Plan: <ul style="list-style-type: none"> - Carbon levy - Coal Phase-Out - Emission performance standards and limits for oil sands - Renewable Electricity Program Renewable fuels standard Microgeneration regulation Bioproducer and public transit programs Quest carbon capture and storage project Carbon Trunk Line Project – CO₂ capture and use for enhanced oil recovery
British Columbia	<ul style="list-style-type: none"> Carbon tax Renewable and low carbon fuel requirements regulation Emissions offsets regulation Landfill gas management regulation British Columbia Clean Energy Act: Clean or renewable electricity requirement – 93% of electricity from clean or renewable sources
Manitoba	<ul style="list-style-type: none"> Ethanol sales mandate Biodiesel mandate Emissions tax on coal
New Brunswick	<ul style="list-style-type: none"> Renewable portfolio standard
Newfoundland and Labrador	<ul style="list-style-type: none"> Muskrat Falls hydro project
Nova Scotia	<ul style="list-style-type: none"> Renewable portfolio standard for electricity generation Electricity demand-side management policies Solid Waste-Resource Management Regulations Cap on GHG emissions from the electricity sector
Ontario	<ul style="list-style-type: none"> Western Climate Initiative cap-and-trade regime Residential electricity peak savings (time-of-use pricing)

Provincial/Territorial Measures

- Feed-in tariff program
- Landfill gas regulation (O. Reg. 216/08 and 217/08)
- Coal phase-out
- Independent Electricity System Operator contracted electricity supply
- Ethanol in gasoline rules
- Nuclear refurbishment

- Quebec
- Western Climate Initiative cap-and-trade regime
 - 5% ethanol objective in gasoline distributors fuel sales
 - Drive electric program
 - Landfill gas regulation
 - Eco-performance program for industry

- Saskatchewan
- Ethanol fuel program
 - Renewable diesel program
 - Boundary Dam 3 Carbon Capture Project

Federal Measures

- Reduction of carbon dioxide emissions from coal-fired generation of electricity regulations announced in 2012
- Residential building code changes to incorporate energy efficiency for adoption by provinces across Canada
- Commercial building code changes to incorporate energy efficiency for adoption by provinces across Canada
- Renewable Fuels Regulations
- 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
- 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 (HDV) GHG emissions standards for heavy-duty vehicle model years 2014 to 2018
- The pulp and paper green transformation program, to improve environmental performance of mills including GHG emissions reductions; the program ended in 2012 but will result in ongoing emission reductions
- Incandescent lighting phase-out
- Voluntary emission reductions for planes and trains

Alternate Emissions Scenarios

Given the uncertainty regarding the key drivers of GHG emissions, the Reference Case 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 modelling results are most appropriately viewed as a range of plausible outcomes. Environment and Climate Change Canada addresses this uncertainty via modelling and analysis of alternate cases that focus on variability in two key factors: future economic growth projections and the evolution of oil and natural gas prices and production as per the National Energy Board's high and low forecast scenarios. These assumptions are presented in Tables 31 and 32, and the overall range of emissions is presented in Table A33.

Table A31 Economic Growth and Population from 2014 to 2030

Assumption	2014 to 2020			2020 to 2030		
	Low	Reference	High	Low	Reference	High
Average Annual GDP Growth Rate	1.4%	1.6%	2.1%	0.8%	1.7%	2.4%
Average Annual Population Growth Rate	0.7%	1.0%	1.2%	0.5%	0.9%	1.2%

Table A32 Oil and Gas Price and Production in 2020 and 2030

Assumption	2020			2030		
	Low	Reference	High	Low	Reference	High
Crude Oil Price: WTI (2014 US\$/bbl)	36	64	85	42	81	111
Crude Oil Price: WCS (2014 US\$/bbl)	17	42	60	28	62	89
Crude Oil Production (1000 bbl/day)	4470	4529	4705	4662	5214	5986
Natural Gas Price: Henry Hub (2014 US\$/GJ)	2.43	3.09	3.92	2.89	3.72	4.62
Natural Gas Production (Billion cubic feet)	5706	6319	7183	6008	7366	9758

* Numbers do not include C5 and condensates.

Table A33 Sensitivity of GHG Emissions to Changes in GDP and Price (excluding LULUCF) in Mt CO₂ eq

Scenario	2020	2030	2020 Projection - 2030 Projection -	
			2005 Emission	2005 Emission
Slow GDP, Low World Oil and Gas Prices	720	697	-27	-51
Fast GDP, High World Oil and Gas Prices	747	790	0	43
Reference Scenario	731	742	-16	-6
Sensitivity Range	720 to 747	697 to 790	-27 to 0	-51 to 43

Methodology and Modelling Assumptions

The approach to developing Canada's GHG emissions projections is in line with generally recognized best practices and involves two main features:

1. Using the most up-to-date statistics on GHG emissions and energy use, and sourcing key assumptions from the best available public and private expert sources; and
2. Developing scenarios of emission projections using a detailed Energy, Emissions and Economy Model for Canada (E3MC). E3MC has two components: Energy 2020, which incorporates Canada's energy supply and demand structure, and the in-house macroeconomic model of the Canadian economy. For more information on the models and methodology, please see [Canada's Emissions Trends 2014](#).

Modelling estimates are subject to consultations with various stakeholders, including provincial and territorial governments, to review modelling assumptions, implemented policies and measures and emission estimates. Modelling assumptions also undergo a periodic external review process.

In addition to annual data updates, improvements to the E3MC modelling methodology are periodically undertaken to provide better estimates of energy and emissions. Some key improvements since Canada's Second Biennial Report are the following:

- Emissions factors associated with LNG production, heavy duty vehicles (HDV) and residential wood waste combustion were revised;
- The natural gas pipeline economic driver was changed from national natural gas production to provincial natural gas demand or provincial natural gas production depending on the region of the country;
- Forecasted British Columbia natural gas processing CO₂ emissions from venting were reduced to account for lower CO₂ content in provincial gas deposits;
- Some additional utility-owned cogeneration emissions were allocated to the economic sectors in which they occur;
- Fuel consumption used in cogeneration was split between heat and electricity production for sectors previously lacking a split;
- Cogeneration from manufacturing sectors was adjusted to grow at the same rate as electricity demand in these sectors;
- Off-grid electricity generation and demand were added to Alberta oil sands and Newfoundland frontier oil production;
- A new 100 MW electric transmission intertie between Saskatchewan and Manitoba was added in 2020;
- Historical data for electricity generation from solar, wind, landfill gas and industrial hydroelectricity was revised upward;
- Projections of Quebec electric vehicle sales out to 2030 were utilized in modeling;
- Phase-outs of hydrofluorocarbons (HFCs) in vehicle air conditioning and electric vehicle uptake were incorporated as compliance mechanisms by vehicle manufacturers in the light duty vehicle regulations;
- Projected HFC growth rates were differentiated between buildings and transportation sectors;
- Endogenous technology change was added to the building sector;
- Historical building device efficiencies were revised;
- Biological treatment of solid waste was added as a new emission source.

Oil Price Assumptions

Although oil prices have declined recently, there is significant uncertainty around how these changes will affect longer-term oil production. The emissions projections for the Reference Case in this report incorporate the National Energy Board's integrated forecasts of oil and other energy prices and production from its report, National Energy Board's most recent forecast presented in *Canada's Energy Future 2016: Update – Energy Supply and Demand Projections to 2040*, October 2016. The National Energy Board's expectation of medium-term recovery of oil prices is consistent with other major price forecasts.

GHG emissions are driven by oil production rather than price. While an expectation of lower oil prices for the foreseeable future does have the effect of reducing oil production forecasts, increases in the productivity of oil production have reduced this impact in the National Energy Board's projections. Furthermore, existing oil sands production will likely continue due to substantial existing investments and the long time horizon of projects.

Finally, lower oil prices will lead to higher emissions as a result of an increase in energy demand from other sectors. Thus, any drop in GHG emissions in the oil-producing sector would be partially offset by a rise in emissions from other sectors.

Key Assumptions

GHG emissions projections depend on a number of economic and energy variables and are subject to significant uncertainty, especially in the longer term. The emissions projections reference case is designed to incorporate the best available information about economic growth as well as energy demand and supply into the future. The projections capture the impacts on GHG emissions of future production of goods and services in Canada.

Historical data on key macroeconomic variables, such as GDP, population, and consumer price indices are obtained from Statistics Canada. Statistics Canada also produces the historical energy data used in the model in the *Report on Energy Supply and Demand*. The latest historical GHG emissions are obtained from the 2016 NIR.

In the forecast, key macroeconomic variables in the model such as GDP, the exchange rate, and inflation are aligned to Finance Canada's projections. The economic projections to the year 2021 are calibrated to Finance Canada's *Fall Economic Statement 2016*. The outer years (2022-2030) are based on Finance Canada's 2014 *Update of Long-Term Economic and Fiscal Projections*. Population growth projections are obtained from Statistics Canada. Forecasts of oil and natural gas price and production are taken from the NEB's *Canada's Energy Future*.