The Climate Registry

APRIL 2020

The Climate Registry (TCR) is pleased to present its 2020 default emission factors. Each year, we update the default emission factors associated with our program because

(1) The components of energy (electricity, fuel, etc.) change over time, and
(2) Emission factor quantification methods are often refined.

Members that rely on these emission factors to measure and report base year inventories should assess whether changes in emissions factors over time materially impact their base year emissions, and consider adjusting accordingly. The default emission factors are incorporated into the Climate Registry Information System (CRIS) for use in emissions calculations. We publish these default factors to our website to advance best practices, consistency, and transparency in corporate greenhouse gas (GHG) accounting.

Our default emission factors are compiled from publicly available data sources, which are cited at the bottom of each table. TCR is not responsible for the underlying data or methodology used to calculate these default emission factors, or for communicating any changes to the data sources that occur between our annual updates.

As detailed in TCR's General Reporting Protocol, you should apply the most up-to-date emission factor available in CRIS (or otherwise) when calculating emissions. To calculate indirect emissions associated with electricity using grid average emission factors, you should apply the emission factor that corresponds with the year being reported (or the most recent previous year), and may not apply a factor that post-dates the reporting year.

TCR members are encouraged to contact policy@theclimateregistry.org with questions or feedback on these default emission factors or citation information.

Sincerely,

The Climate Registry

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Table 1.1 U.S. Default Factors for Calculating CO_2 Emissions from Combustion of Fossil Fuel and Biomass

Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Coal and Coke	**MMBtu / short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / short ton**
Anthracite	25.09	28.28	1	103.69	2602
Bituminous	24.93	25.44	1	93.28	2325
Subbituminous	17.25	26.50	1	97.17	1676
Lignite	14.21	26.65	1	97.72	1389
Coal Coke	24.80	31.00	1	113.67	2819
Mixed Electric Utility/Electric Power	19.73	26.05	1	95.52	1885
Unspecified Residential/Com*	19.27	25.71	1	94.27	1817
Mixed Commercial Sector	21.39	25.71	1	94.27	2016
Mixed Industrial Coking	26.28	25.61	1	93.90	2468
Mixed Industrial Sector	22.35	25.82	1	94.67	2116
Natural Gas	**Btu / scf**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / scf**
US Weighted Average	1026.00	14.47	1	53.06	0.05444
Greater than 1,000 Btu*	>1000	14.47	1	53.06	varies
975 to 1,000 Btu*	975 – 1,000	14.73	1	54.01	varies
1,000 to 1,025 Btu*	1,000 – 1,025	14.43	1	52.91	varies
1,025 to 1,035 Btu*	1025 – 1035	14.45	1	52.98	varies
1,025 to 1,050 Btu*	1,025 – 1,050	14.47	1	53.06	varies
1,050 to 1,075 Btu*	1,050 – 1,075	14.58	1	53.46	varies

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Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
1,075 to 1,100 Btu*	1,075 – 1,100	14.65	1	53.72	varies
Greater than 1,100 Btu*	>1,100	14.92	1	54.71	varies
(EPA 2010) Full Sample*		14.48	1	53.09	n/a
(EPA 2010) <1.0% CO_2*		14.43	1	52.91	n/a
(EPA 2010) <1.5% CO_2*		14.47	1	53.06	n/a
(EPA 2010) <1.0% CO_2 and <1,050 Btu/scf*	<1,050	14.42	1	52.87	n/a
(EPA 2010) <1.5% CO_2 and <1,050 Btu/scf*	<1,050	14.47	1	53.06	n/a
(EPA 2010) Flare Gas*	>1,100	15.31	1	56.14	n/a
Petroleum Products	**MMBtu / gallon**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / gallon**
Distillate Fuel Oil No. 1	0.139	19.98	1	73.25	10.18
Distillate Fuel Oil No. 2	0.138	20.17	1	73.96	10.21
Distillate Fuel Oil No. 4	0.146	20.47	1	75.04	10.96
Residual Fuel Oil No. 5	0.140	19.89	1	72.93	10.21
Residual Fuel Oil No. 6	0.150	20.48	1	75.10	11.27
Still Gas*	0.143	18.20	1	66.73	9.53
Used Oil	0.138	20.18	1	74.00	10.21
Kerosene	0.135	20.51	1	75.20	10.15
LPG	0.092	16.83	1	61.71	5.68
Propane (Liquid)	0.091	17.15	1	62.87	5.72
Propylene	0.091	18.48	1	67.77	6.17
Ethane	0.068	16.25	1	59.60	4.05

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Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Ethylene	0.058	17.99	1	65.96	3.83
Isobutane	0.099	17.71	1	64.94	6.43
Isobutylene	0.103	18.78	1	68.86	7.09
Butane	0.103	17.66	1	64.77	6.67
Butylene	0.105	18.74	1	68.72	7.22
Naptha (<401 deg F)	0.125	18.55	1	68.02	8.50
Natural Gasoline	0.11	18.24	1	66.88	7.36
Other Oil (>401 deg F)	0.139	20.79	1	76.22	10.59
Pentanes Plus	0.110	19.10	1	70.02	7.70
Petrochemical Feedstocks	0.125	19.37	1	71.02	8.88
Petroleum Coke (Liquid)	0.143	27.93	1	102.41	14.64
Special Naptha	0.125	19.73	1	72.34	9.04
Unfinished Oils	0.139	20.33	1	74.54	10.36
Heavy Gas Oils	0.148	20.43	1	74.92	11.09
Lubricants	0.144	20.26	1	74.27	10.69
Motor Gasoline	0.125	19.15	1	70.22	8.78
Aviation Gasoline	0.120	18.89	1	69.25	8.31
Kerosene Type Jet Fuel	0.135	19.70	1	72.22	9.75
Asphalt and Road Oil	0.158	20.55	1	75.36	11.91
Crude Oil	0.138	20.33	1	74.54	10.29
Petroleum Waxes*	0.132	19.80	1	72.60	9.57

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Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Fossil Fuel-derived Fuels (gaseous)	**MMBtu / scf**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / scf**
Acetylene**	0.00147	19.53	1	71.61	0.11
Blast Furnace Gas	0.000092	74.81	1	274.32	0.02524
Coke Oven Gas	0.000599	12.78	1	46.85	0.02806
Propane (Gas)	0.002516	16.76	1	61.46	0.15463
Fuel Gas	0.001388	16.09	1	59.00	0.08189
Fossil Fuel-derived Fuels (solid)	**MMBtu / short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / short ton**
Municipal Solid Waste	9.95	24.74	1	90.70	902
Tires	28.00	23.45	1	85.97	2407
Plastics	38.00	20.45	1	75.00	2850
Petroleum Coke (Solid)	30.00	27.93	1	102.41	3072
Biomass Fuels-Solid	**MMBtu / short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / short ton**
Wood and Wood Residuals (12% moisture content)	17.48	25.58	1	93.80	1640
Agricultural Byproducts	8.25	32.23	1	118.17	975
Peat	8.00	30.50	1	111.84	895
Solid Byproducts	10.39	28.78	1	105.51	1096
Kraft Black Liquor (NA hardwood)		25.55	1	93.70	n/a
Kraft Black Liquor (NA softwood)		25.75	1	94.40	n/a
Kraft Black Liquor (Bagasse)		26.05	1	95.50	n/a
Kraft Black Liquor (Bamboo)		25.55	1	93.70	n/a
Kraft Black Liquor (Straw)		25.94	1	95.10	n/a
Municipal Solid Waste (Biomass)	9.95	24.74	1	90.70	902

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Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Biomass Fuels-Gaseous	**MMBtu / scf**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / scf**
Biogas (Captured Methane)	0.000655	14.20	1	52.07	0.034106
Landfill Gas (50% CH_4/50%CO_2)	0.000485	14.20	1	52.07	0.025254
Wastewater Treatment Biogas***	varies	14.20	1	52.07	varies
Biomass Fuels - Liquid	**MMBtu / gallon**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / gallon**
Ethanol (100%)	0.084	18.67	1	68.44	5.75
Biodiesel (100%)	0.128	20.14	1	73.84	9.45
Rendered Animal Fat	0.125	19.38	1	71.06	8.88
Vegetable Oil	0.120	22.24	1	81.55	9.79

Source: Heat Content and CO_2 emission factors per unit energy are from EPA Final Mandatory Reporting of Greenhouse Gases Rule Tables C-1 and AA-1. Carbon Content is derived using the heat content and/or default emission factor. Except those marked with * are from US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 2, Tables A- 41, A-46, A-47, A-47, A-50, A-52, A-62, and A-63 (heat content factor for Unspecified Residential/Corn from U.S. Energy Information Administration, Monthly Energy Review (January 2020), Table A-5, and ** derived from the API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry (August 2009), Section 3.6.3, Table 3-8. A fraction oxidized value of 1.00 is from the Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006) and *** EPA Climate Leaders Technical Guidance (2008) Table B-2. n/a = data not available.

Note: Where not provided from the EPA Final Mandatory Reporting of Greenhouse Gases Rule, default CO_2 emission factors (per unit energy) are calculated as: Carbon Content × Fraction Oxidized × 44/12. Default CO_2 emission factors (per unit mass or volume) are calculated using the equation: Heat Content × Carbon Content × Fraction Oxidized × 44/12 × Conversion Factor (if applicable).

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Table 1.2 Canadian Default Factors for Calculating CO_2 Emissions from Combustion of Natural Gas, Petroleum Products, and Biomass

Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Mass or Volume)
Natural Gas	**kg C / GJ**	**GJ / megalitre**		**g CO_2 / m^3**
All Provinces				
Still gas (Upgrading Facilities)	n/a	43.24	1	2140
Still gas (Refineries & Others)	n/a	36.08	1	2183
Newfoundland and Labrador				
Marketable	n/a	39.03	1	1901
NonMarketable	n/a	39.03	1	2494
Nova Scotia				
Marketable	n/a	39.03	1	1901
NonMarketable	n/a	39.03	1	2494
New Brunswick				
Marketable	n/a	39.03	1	1901
NonMarketable	n/a	39.03	1	n/o
Quebec				
Marketable	n/a	39.03	1	1887
NonMarketable	n/a	39.03	1	n/o
Ontario				
Marketable	n/a	39.03	1	1888

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Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Mass or Volume)
NonMarketable	n/a	39.03	1	n/o
Manitoba				
Marketable	n/a	39.03	1	1886
NonMarketable	n/a	39.03	1	2441
Saskatchewan				
Marketable	n/a	39.03	1	1829
NonMarketable	n/a	39.03	1	2441
Alberta				
Marketable	n/a	39.03	1	1928
NonMarketable	n/a	39.03	1	2392
British Columbia				
Marketable	n/a	39.03	1	1926
NonMarketable	n/a	39.03	1	2162
Yukon				
Marketable	n/a	39.03	1	1901
NonMarketable	n/a	39.03	1	2401
Northwest Territories				
Marketable	n/a	39.03	1	1901
NonMarketable	n/a	39.03	1	2466

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Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Mass or Volume)
Natural Gas Liquids	**kg C / GJ**	**GJ / Kilolitre**		**g CO_2 / L**
Propane: Residential Propane	n/a	25.31	1	1515
Propane: Other Uses Propane	n/a	25.31	1	1515
Ethane	n/a	17.22	1	986
Butane	n/a	28.44	1	1747
Refinery LPGs (All Stationary)	n/a	n/a	1	1629
Petroleum Products	**kg C / GJ**	**GJ / Kilolitre**		**g CO_2 / L**
Light Fuel Oil Electric Utilities	n/a	38.80	1	2753
Light Fuel Oil Industrial	n/a	38.80	1	2753
Light Fuel Oil Producer Consumption	n/a	38.80	1	2670
Light Fuel Oil Residential	n/a	38.80	1	2753
Light Fuel Oil Forestry, Construction, Public Administration, Commercial/Institutional	n/a	38.80	1	2753
Heavy Fuel Oil (Electric Utility, Industrial, Forestry, Construction, Public Administration, Commercial/Institutional)	n/a	42.50	1	3156
Heavy Fuel Oil (Residential)	n/a	42.50	1	3156
Heavy Fuel Oil (Producer Consumption)	n/a	42.50	1	3190
Kerosene (Electric Utility, Industrial, Producer Consumption, Residential, Forestry, Construction, Public Administration, Commercial/Institutional)	n/a	37.68	1	2560
Diesel	n/a	38.30	1	2681

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Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Mass or Volume)
Petroleum Coke from Upgrading Facilities	n/a	40.57	1	3494
Petroleum Coke from Refineries & Others	n/a	46.35	1	3814
Motor Gasoline	n/a	35.00	1	2307
Biomass	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Wood Fuel/Wood Waste	n/a	18.00	1	840
Spent Pulping Liquor	n/a	14.00	1	891
Landfill Gas	n/a	n/a	1	2752
Stoves and Fireplaces	n/a	n/a	1	1539
Pellet Stove	n/a	n/a	1	1652
Other Wood-burning Equipment	n/a	n/a	1	1539

Source: Default CO_2 emission factors: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019), Annex 6: Emission Factors, Tables A6-1, A6-3, A6-4, A6-5, A6-56 and A6-57. The CO_2 emission factor for refinery LPGs is from: Environment Canada, National Inventory Report, 1990-2012: Greenhouse Gas Sources and Sinks in Canada (2015), Annex 8: Emission Factors, Table A8-5. Default Heat Content: Statistics Canada, Report on Energy Supply and Demand in Canada, 2016-Revision (April 2019), Energy conversion factors, p. 132; Default Carbon Content: Canada-specific carbon content coefficients are not available. If you cannot obtain measured carbon content values specific to your fuels, you should use the default emission factor; Default Fraction Oxidized: Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006). n/a = data not available. n/o = not occurring.

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Table 1.3 Canadian Default Factors for Calculating CO_2 Emissions from Combustion of Coal

Province and Coal Type	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor
Newfoundland and Labrador	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	28.96	1	2202
Foreign Bituminous	n/a	29.82	1	2540
Foreign Sub-Bituminous	n/a	19.15	1	1865
Lignite	n/a	15.00	1	1459
Prince Edward Island	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	28.96	1	2202
Foreign Bituminous	n/a	29.82	1	2540
Foreign Sub-Bituminous	n/a	19.15	1	1865
Lignite	n/a	15.00	1	1459
Nova Scotia	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	28.96	1	2202
Foreign Bituminous	n/a	29.82	1	2540
Foreign Sub-Bituminous	n/a	19.15	1	1865
Lignite	n/a	15.00	1	1459
New Brunswick	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	26.80	1	2202

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Province and Coal Type	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor
Foreign Bituminous	n/a	29.82	1	2540
Foreign Sub-Bituminous	n/a	19.15	1	1865
Lignite	n/a	15.00	1	1459
Quebec	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	28.96	1	2176
Foreign Bituminous	n/a	29.82	1	2662
Lignite	n/a	15.00	1	1459
Ontario	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	25.43	1	2202
Foreign Bituminous	n/a	29.82	1	2651
Foreign Sub-Bituminous	n/a	19.15	1	1865
Lignite	n/a	15.00	1	1459
Manitoba	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Foreign Sub-Bituminous	n/a	19.15	1	1865
Saskatchewan	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	25.43	1	2202
Canadian Sub-Bituminous	n/a	19.15	1	1769
Lignite	n/a	15.00	1	1455

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Province and Coal Type	Carbon Content	Heat Content	Fraction Oxidized	CO_2 Emission Factor
Alberta	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	25.43	1	2202
Canadian Sub-Bituminous	n/a	19.15	1	1769
Lignite	n/a	15.00	1	1459
British Columbia	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Canadian Bituminous	n/a	26.02	1	2202
Canadian Sub-Bituminous	n/a	19.15	1	1769
Lignite	n/a	15.00	1	1459
All Provinces and Territories	**kg C / GJ**	**GJ / t**		**g CO_2 / kg**
Coke	n/a	28.83	1	3173
Anthracite	n/a	27.70	1	2411
Coke Oven Gas	n/a	19.14	1	687

Source: Default CO_2 Emission Factors: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019), Annex 6: Emission Factors, Tables A6-8 and A6-9; Default Heat Content: Statistics Canada, Report on Energy Supply and Demand in Canada, 2016-Revision (April 2019), Energy conversion factors, p. 132 (value for Foreign Bituminous uses heat content of "Imported bituminous" value, for Foreign Sub-Bituminous uses heat content of "Sub- bituminous"); Default Carbon Content: Canada-specific carbon content coefficients are not available. If you cannot obtain measured carbon content values specific to your fuels, you should use the default emission factor; Default Fraction Oxidized: Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006) and Environment Canada, National Inventory Report, 1990-2015: Greenhouse Gas Sources and Sinks in Canada (April 2017), Annex 4: Reference Approach Energy Conversion and Emission Factors for Canada. n/a = data not available.

Note: CO_2 emission factors from Environment Canada originally included fraction oxidized factors of less than 100% for Solid - Primary Fuels. Values were converted to include a 100% oxidation rate using 98.8% for Anthracite, 98.8% for Bituminous, 99.4% for Subbituminous, and 99.5% for Lignite based on the rates used to calculate the original factors.

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Table 1.4 Canadian Default Factors for Calculating CH_4 and N_2O Emissions from Combustion of Natural Gas, Petroleum Products, Coal, and Biomass

Fuel Type	CH_4 Emission Factor (Per Unit Mass or Volume)	N_2O Emission Factor (Per Unit Mass or Volume)
Natural Gas	**g CH_4 / m^3**	**g N_2O / m^3**
Electric Utilities	0.490	0.049
Industrial	0.037	0.033
Producer Consumption (NonMarketable)	6.4	0.060
Pipelines	1.900	0.050
Cement	0.037	0.034
Manufacturing Industries	0.037	0.033
Residential, Construction, Commercial/Institutional, Agriculture	0.037	0.035
Natural Gas Liquids	**g CH_4 / L**	**g N_2O / L**
Propane (Residential)	0.027	0.108
Propane (All Other Uses)	0.024	0.108
Ethane	0.024	0.108
Butane	0.024	0.108
Refinery LPGs	0.024	0.108
Refined Petroleum Products	**g CH_4 / L**	**g N_2O / L**
Light Fuel Oil (Electric Utilities)	0.18	0.031
Light Fuel Oil (Industrial and Producer Consumption)	0.006	0.031

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Fuel Type	CH_4 Emission Factor (Per Unit Mass or Volume)	N_2O Emission Factor (Per Unit Mass or Volume)
Light Fuel Oil (Residential)	0.026	0.006
Light Fuel Oil (Forestry, Construction, Public Administration, and Commercial/Institutional)	0.026	0.031
Heavy Fuel Oil (Electric Utilities)	0.034	0.064
Heavy Fuel Oil (Industrial and Producer Consumption)	0.12	0.064
Heavy Fuel Oil (Residential, Forestry, Construction, Public Administration, and Commercial/Institutional)	0.057	0.064
Kerosene (Electric Utilities, Industrial, and Producer Consumption)	0.006	0.031
Kerosene (Residential)	0.026	0.006
Kerosene (Forestry, Construction, Public Administration, and Commercial/Institutional)	0.026	0.031
Diesel (Refineries and Others)	0.133	0.400
Diesel (Upgraders)	0.151	1.10
Still Gas (Refineries and Others)	0.031	0.00002
Still Gas (Upgraders)	0.0389	0.00002
Motor Gasoline (Unspecified)	0.100	0.02
Petroleum Coke	**g CH_4 / L**	**g N_2O / L**
Upgrading Facilities	0.12	0.024
Refineries & Others	0.12	0.0275
Coal	**g CH_4 / kg**	**g N_2O / kg**
Coal (Electric Utilities)	0.02	0.03

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Fuel Type	CH_4 Emission Factor (Per Unit Mass or Volume)	N_2O Emission Factor (Per Unit Mass or Volume)
Coal (Industry and Heat & Steam Plants)	0.03	0.02
Coal (Residential, Public Administration)	4.00	0.02
Coke	0.03	0.02
Coal (gas)	**g CH_4 / m^3**	**g N_2O / m^3**
Coke Oven Gas	0.04	0.04
Biomass	**g CH_4 / kg**	**g N_2O / kg**
Wood Fuel/Wood Waste (Industrial Combustion)	0.09	0.06
Spent Pulping Liquor (Industrial Combustion)	0.02	0.02
Stoves and Fireplaces (Advance Technology or Catalytic Control)	5.9	0.12
Stoves and Fireplaces (Conventional, Inserts)	12.9	0.12
Pellet Stove	4.12	0.059
Other Wood-burning Equipment	4.12	0.059
Landfill Gas	**kg CH_4 / t**	**kg N_2O / t**
Landfill Gas (Industrial Combustion)	0.05	0.005

Source: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019), Annex 6: Emission Factors, Tables A6-2, A6-3, A6-4, A6-6, A6-10, A6-56, and A6-57. n/a = data not available.

Note: The CH_4 and the N_2O emission factors for refinery LPGs is from: Environment Canada, National Inventory Report, 1990-2012: Greenhouse Gas Sources and Sinks in Canada (2014), Annex 8: Emission Factors, Table A8-4.

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Table 1.5 Default $CH_4$and N_2O Emission Factors by Technology Type for the Electricity Generation Sector

Fuel Type and Basic Technology	Configuration	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Liquid Fuels			
Residual Fuel Oil/Shale Oil Boilers	Normal Firing	0.8	0.3
Residual Fuel Oil/Shale Oil Boilers	Tangential Firing	0.8	0.3
Gas/Diesel Oil Boilers	Normal Firing	0.9	0.4
Gas/Diesel Oil Boilers	Tangential Firing	0.9	0.4
Large Diesel Oil Engines >600hp (447kW)		4.0	n/a
Solid Fuels			
Pulverized Bituminous Combustion Boilers	Dry Bottom, wall fired	0.7	0.5
Pulverized Bituminous Combustion Boilers	Dry Bottom, tangentially fired	0.7	1.4
Pulverized Bituminous Combustion Boilers	Wet Bottom	0.9	1.4
Bituminous Spreader Stoker Boilers	With and without re-injection	1.0	0.7
Bituminous Fluidized Bed Combustor	Circulating Bed	1.0	61.1
Bituminous Fluidized Bed Combustor	Bubbling Bed	1.0	61.1
Bituminous Cyclone Furnace		0.2	1.6
Lignite Atmospheric Fluidized Bed		n/a	71.2

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Fuel Type and Basic Technology	Configuration	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Natural Gas			
Boilers		0.9	0.9
Gas-Fired Gas Turbines >3MW		3.8	0.9
Large Dual-Fuel Engines		245.0	n/a
Combined Cycle		0.9	2.8
Peat			
Peat Fluidized Bed Combustor	Circulating Bed	3.0	7.0
Peat Fluidized Bed Combustor	Bubbling Bed	3.0	3.0
Biomass			
Wood/Wood Waste Boilers		9.3	5.9
Wood Recovery Boilers		0.8	0.8

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Chapter 2: Stationary Combustion, Table 2.6. Values were converted back from LHV to HHV using IPCC's assumption that LHV are five percent lower than HHV for coal and oil, 10 percent lower for natural gas, and 20 percent lower for dry wood. (The IPCC converted the original factors from units of HHV to LHV, so the same conversion rates used by the IPCC were used here to obtain the original values in units of HHV.) Values were converted from kg/TJ to g/ MMBtu using 1 kg = 1000 g and 1 MMBtu = 0.001055 TJ. n/a = data not available.

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Table 1.6 Default Factors for Calculating CH_4 and N_2O Emission from Kilns, Ovens, and Dryers

Industry	Source	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Cement, Lime	Kilns - Natural Gas	1.04	n/a
Cement, Lime	Kilns – Oil	1.0	n/a
Cement, Lime	Kilns – Coal	1.0	n/a
Coking, Steel	Coke Oven	1.0	n/a
Chemical Processes, Wood, Asphalt, Copper, Phosphate	Dryer - Natural Gas	1.04	n/a
Chemical Processes, Wood, Asphalt, Copper, Phosphate	Dryer – Oil	1.0	n/a
Chemical Processes, Wood, Asphalt, Copper, Phosphate	Dryer – Coal	1.0	n/a

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Chapter 2: Stationary Combustion, Table 2.8. Values were converted back from LHV to HHV using IPCC's assumption that LHV are five percent lower than HHV for coal and oil and 10 percent lower for natural gas. Values were converted from kg/TJ to g/MMBtu using 1 kg = 1000 g and 1 MMBtu = 0.001055 TJ. n/a = data not available.

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Table 1.7 Default Factor for Calculating CH_4 and N_2O Emissions by Technology Type for the Industrial Sector

Fuel Type and Basic Technology	Configuration	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Liquid Fuels			
Residual Fuel Oil Boilers		3.0	0.3
Gas/Diesel Oil Boilers		0.2	0.4
Large Stationary Diesel Oil Engines >600hp (447 kW)		4.0	n/a
Liquefied Petroleum Gases Boilers		0.9	4.0
Solid Fuels			
Other Bituminous/Sub-bit. Overfeed Stoker Boilers		1.0	0.7
Other Bituminous/Sub-bit. Underfeed Stoker Boilers		14.0	0.7
Other Bituminous/Sub-bituminous Pulverized	Dry Bottom, wall fired	0.7	0.5
Other Bituminous/Sub-bituminous Pulverized	Dry Bottom, tangentially fired	0.7	1.4
Other Bituminous/Sub-bituminous Pulverized	Wet Bottom	0.9	1.4
Other Bituminous Spreader Stokers		1.0	0.7
Other Bituminous/Sub-bit. Fluidized Bed Combustor	Circulating Bed	1.0	61.1
Other Bituminous/Sub-bit. Fluidized Bed Combustor	Bubbling Bed	1.0	61.1
Natural Gas			
Boilers		0.9	0.9
Gas-Fired Gas Turbines >3MW		3.8	0.9
Natural Gas-fired Reciprocating Engines	2-Stroke Lean Burn	658.0	n/a
Natural Gas-fired Reciprocating Engines	4-Stroke Lean Burn	566.9	n/a

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Fuel Type and Basic Technology	Configuration	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Natural Gas-fired Reciprocating Engines	4-Stroke Rich Burn	104.4	n/a
Biomass			
Wood/Wood Waste Boilers		9.3	5.9
Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Chapter 2: Stationary Combustion, Table 2.7. Values were converted from LHV to HHV assuming that LHV are five percent lower than HHV for coal and oil, 10 percent lower for natural gas, and 20 percent lower for dry wood. (The IPCC converted the original factors from units of HHV to LHV, so the same conversion rates used by the IPCC were used here to obtain the original values in units of HHV.) Values were converted from kg/TJ to g/MMBtu using 1 kg = 1000 g and 1 MMBtu = 0.001055 TJ. n/a = data not available.			

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Table 1.8 Default Factors for Calculating CH_4 and N_2O Emissions by Technology Type for the Commercial Sector

Fuel Type and Basic Technology	Configuration	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Liquid Fuels			
Residual Fuel Oil Boilers		1.4	0.3
Gas/Diesel Oil Boilers		0.7	0.4
Liquefied Petroleum Gases Boilers		0.9	4.0
Solid Fuels			
Other Bituminous/Sub-bit. Overfeed Stoker Boilers		1.0	0.7
Other Bituminous/Sub-bit. Underfeed Stoker Boilers		14.0	0.7
Other Bituminous/Sub-bit. Hand-fed Units		87.2	0.7
Other Bituminous/Sub-bituminous Pulverized Boilers	Dry Bottom, wall fired	0.7	0.5
Other Bituminous/Sub-bituminous Pulverized Boilers	Dry Bottom, tangentially fired	0.7	1.4
Other Bituminous/Sub-bituminous Pulverized Boilers	Wet Bottom	0.9	1.4
Other Bituminous Spreader Stokers		1.0	0.7
Other Bituminous/Sub-bit. Fluidized Bed Combustor	Circulating Bed	1.0	61.1
Other Bituminous/Sub-bit. Fluidized Bed Combustor	Bubbling Bed	1.0	61.1
Natural Gas			
Boilers		0.9	0.9
Gas-Fired Gas Turbines >3MWa		3.8	1.3
Biomass			
Wood/Wood Waste Boilers		9.3	5.9

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Chapter 2: Stationary Combustion, Table 2.10. Values were converted from LHV to HHV assuming that LHV are five percent lower than HHV for coal and oil, 10 percent lower for natural gas, and 20 percent lower for dry wood. (The IPCC converted the original factors from units of HHV to LHV, so the same conversion rates used by the IPCC were used here to obtain the original values in units of HHV.) Values were converted from kg/TJ to g/MMBtu using 1 kg = 1000 g and 1 MMBtu = 0.001055 TJ.

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Table 1.9 U.S. Default Factors for Calculating CH_4 and N_2O Emissions by Fuel Type for the Industrial and Energy Sectors

Fuel Type / End-Use Sector	CH_4 (kg / MMBtu)	N_2O (kg / MMBtu)
Coal		
Industrial	0.011	1.6E-3
Energy Industry	0.011	1.6E-3
Coke		
Industrial	0.011	1.6E-3
Energy Industry	0.011	1.6E-3
Petroleum Products		
Industrial	3.0E-3	6.0E-4
Energy Industry	3.0E-3	6.0E-4
Natural Gas		
Industrial	1.0E-3	1.0E-4
Energy Industry	1.0E-3	1.0E-4
Municipal Solid Waste		
Industrial	0.032	4.2E-3
Energy Industry	0.032	4.2E-3
Tires		
Industrial	0.032	4.2E-3
Energy Industry	0.032	4.2E-3
Blast Furnace Gas		
Industrial	2.2E-5	1.0E-4
Energy Industry	2.2E-5	1.0E-4
Coke Oven Gas		
Industrial	4.8E-4	1.0E-4
Energy Industry	4.8E-4	1.0E-4
Biomass Fuels Solid (except Wood and Wood Residuals)		
Industrial	0.032	4.2E-3
Energy Industry	0.032	4.2E-3

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Fuel Type / End-Use Sector	CH_4 (kg / MMBtu)	N_2O (kg / MMBtu)
Wood and Wood Residuals		
Industrial	0.0072	3.6E-3
Energy Industry	0.0072	3.6E-3
Biogas		
Industrial	3.2E-3	6.3E-4
Energy Industry	3.2E-3	6.3E-4
Biomass Fuels Liquid		
Industrial	1.1E-3	1.1E-4
Energy Industry	1.1E-3	1.1E-4
Pulping Liquors		
Industrial*	1.9E-3	4.2E-4

Source: CH_4 and N_2O emission factors per unit energy are from EPA Final Mandatory Reporting of Greenhouse Gases Rule Table C-2. Except those marked with * are from Table AA-1.

Note: For coal combustion, organizations who fall within the IPCC "Energy Industry" category can employ a value of 1g of CH_4/MMBtu.

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Table 1.10 Default Factors for Calculating CH_4 and N_2O Emissions by Fuel Type for the Residential and Commercial Sectors

Fuel Type / End-Use Sector	CH_4 (g / MMBtu)	N_2O (g / MMBtu)
Coal		
Residential	300.7	1.5
Commercial	10.0	1.5
Petroleum Products		
Residential	10.0	0.6
Commercial	10.0	0.6
Natural Gas		
Residential	4.7	0.1
Commercial	4.7	0.1
Wood		
Residential	253.2	3.4
Commercial	253.2	3.4

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Chapter 2: Stationary Combustion, Tables 2.4 and 2.5. Values were converted from LHV to HHV assuming that LHV are five percent lower than HHV for coal and oil, 10 percent lower for natural gas, and 20 percent lower for dry wood. (The IPCC converted the original factors from units of HHV to LHV, so the same conversion rates used by the IPCC were used here to obtain the original values in units of HHV.) Values were converted from kg/TJ to g/MMBtu using 1 kg = 1000 g and 1 MMBtu = 0.001055 TJ.

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Table 2.1 U.S. Default Factors for Calculating CO_2 Emissions from Combustion of Transport Fuels

Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Volume)
Fuels Measured in Gallons	**kg C / MMBtu**	**MMBtu / barrel**		**kg CO_2 / gallon**
Gasoline	19.2	5.25	1	8.78
Diesel Fuel	20.2	5.80	1	10.21
Aviation Gasoline	18.9	5.04	1	8.31
Jet Fuel (Jet A or A-1)	19.7	5.67	1	9.75
Kerosene	20.5	5.67	1	10.15
Residual Fuel Oil No. 5	19.9	5.88	1	10.21
Residual Fuel Oil No. 6	20.5	6.30	1	11.27
Crude Oil	20.3	5.80	1	10.29
Biodiesel (B100)	20.1	5.38	1	9.45
Ethanol (E100)	18.7	3.53	1	5.75
Methanol*	n/a	n/a	1	4.10
Liquefied Natural Gas (LNG)	n/a	n/a	1	4.50
Liquefied Petroleum Gas (LPG)	17.2	3.86	1	5.68
Propane (Liquid)	16.8	3.82	1	5.72
Ethane	16.3	2.86	1	4.05
Isobutane	17.7	4.16	1	6.43
Butane	17.7	4.33	1	6.67
Renewable Diesel (R100)**	20.2	5.80	1	10.21
Fuels Measured in Standard Cubic Feet	**kg C / MMBtu**	**Btu / Standard cubic foot**		**kg CO_2 / Standard cubic foot**
Compressed Natural Gas (CNG)	14.5	1026	1	0.05444
Propane (Gas)	16.8	2516	1	0.15463

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Fuel Type	Carbon Content (Per Unit Energy)	Heat Content	Fraction Oxidized	CO_2 Emission Factor (Per Unit Volume)
Renewable Natural Gas***	14.5	1026	1	0.05444

Source: Heat content and default emission factors are from EPA Final Mandatory Reporting of Greenhouse Gases Rule Table C-1. Carbon content derived using the heat content and default emission factor. A fraction oxidized of 1.00 is from the IPCC, Guidelines for National Greenhouse Gas Inventories (2006). CNG and LNG CO_2 factors are from EPA Center for Corporate Climate Leadership GHG Emission Factors Hub (March 2020). *Methanol emission factor is calculated from the properties of the pure compounds. **Renewable Diesel (R100) emission factor assumes that chemical properties of renewable diesel are indistinguishable from petroleum-based diesel according to CalEPA Fuels Guidance Document, Version 2.0, September 2015. ***Renewable Natural Gas (RNG) emission factor assumes that RNG is chemically identical to fossil natural gas, according to U.S. Department of Energy Office of Energy Efficiency and Renewable Energy's Alternative Fuels Data Center information on Natural Gas Vehicle Emissions. n/a = data not available.

Note: Carbon contents are calculated using the following equation: (Emission Factor / (44/12) / Heat Content x Conversion Factor. Heat content factors are based on higher heating values (HHV).

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Table 2.2 Canadian Default Factors for Calculating CO_2 Emissions from Combustion of Transport Fuels

Fuel Type	Carbon Content (kg C / GJ)	Heat Content	Fraction Oxidized	CO_2 Emission Factors
		GJ / kiloliter		g CO_2 / L
Motor Gasoline	n/a	35.00	1	2307
Diesel	n/a	38.30	1	2681
Light Fuel Oil	n/a	38.80	1	2753
Heavy Fuel Oil	n/a	42.50	1	3156
Aviation Gasoline	n/a	33.52	1	2365
Aviation Turbo Fuel	n/a	37.40	1	2560
Propane	n/a	25.31	1	1515
Ethanol	n/a	n/a	1	1508
Biodiesel	n/a	n/a	1	2472
Kerosene	n/a	n/a	1	2560
		GJ / megaliter		g CO_2 / L
Natural Gas	n/a	39.03	1	1.9

Source: Default CO_2 Emission Factors: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019) Annex 6: Emission Factors, Table A6-13; Default Heat Content: Statistics Canada, Report on Energy Supply and Demand in Canada, 2016-Revision (April 2018), Energy conversion factors, p. 132; Default Carbon Content: Not available for Canada. If you cannot obtain measured carbon content values specific to your fuels, you should use the default emission factor. Default Fraction Oxidized: A value of 1.00 is used following the Intergovernmental Panel on Climate Change (IPCC), Guidelines for National Greenhouse Gas Inventories (2006).

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Table 2.3 Canadian Default Factors for Calculating CH_4 and N_2O Emissions from Mobile Combustion

Vehicle Type	CH_4 Emission Factor (g CH_4/L)	N_2O Emission Factor (g N_2O/L)
Light-Duty Gasoline Vehicles (LDGVs)		
Tier 2	0.14	0.022
Tier 1	0.23	0.47
Tier 0	0.32	0.66
Oxidation Catalyst	0.52	0.20
Non-Catalytic Controlled	0.46	0.028
Light-Duty Gasoline Trucks (LDGTs)		
Tier 2	0.14	0.022
Tier 1	0.24	0.58
Tier 0	0.21	0.66
Oxidation Catalyst	0.43	0.20
Non-Catalytic Controlled	0.56	0.028
Heavy-Duty Gasoline Vehicles (HDGVs)		
Three-Way Catalyst	0.068	0.2
Non-Catalytic Controlled	0.29	0.047
Uncontrolled	0.49	0.084
Gasoline Motorcycles		
Non-Catalytic Controlled	0.77	0.041
Uncontrolled	2.3	0.048
Light-Duty Diesel Vehicles (LDDVs)		
Advance Control*	0.051	0.22
Moderate Control	0.068	0.21
Uncontrolled	0.10	0.16
Light-Duty Diesel Trucks (LDDTs)		
Advance Control*	0.068	0.22
Moderate Control	0.068	0.21

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Vehicle Type	CH_4 Emission Factor (g CH_4/L)	N_2O Emission Factor (g N_2O/L)
Uncontrolled	0.085	0.16
Heavy-Duty Diesel Vehicles (HDDVs)		
Advance Control	0.11	0.151
Moderate Control	0.14	0.082
Uncontrolled	0.15	0.075
Gas Fueled Vehicles		
Natural Gas Vehicles	0.009	0.00006
Propane Vehicles	0.64	0.028
Railways		
Diesel Train	0.15	1.0
Marine		
Gasoline Boats	0.22	0.063
Diesel Ships	0.25	0.072
Light Fuel Oil Ships	0.26	0.073
Heavy Fuel Oil Ships	0.29	0.082
Kerosene	0.25	0.071
Aviation		
Aviation Gasoline	2.2	0.23
Aviation Turbo Fuel	0.029	0.071
Renewable Fuels		
Biodiesel	**	**
Ethanol	***	***
Off-Road Vehicles		
Off-road Gasoline 2-stroke	10.61	0.013
Off-road Gasoline 4-stroke	5.08	0.064
Off-road Diesel <19kW	0.073	0.022
Off-road Diesel >=19kW, Tier 1-3	0.073	0.022
Off-road Diesel >= 19kW, Tier 4	0.073	0.227

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Vehicle Type	CH_4 Emission Factor (g CH_4/L)	N_2O Emission Factor (g N_2O/L)
Off-road Natural Gas	0.0088	0.00006
Off-road Propane	0.64	0.087
Source: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019) Annex 6: Emission Factors, Table A6-13. *Advanced control diesel emission factors should be used for Tier 2 diesel vehicles. **Diesel CH_4 and N_2O emission factors (by mode and technology) shall be used to calculate biodiesel emissions. ***Gasoline CH_4 and N_2O emission factors (by mode and technology) shall be used to calculate ethanol emissions.		

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Table 2.4 U.S. Default Factors for Calculating CH_4 and N_2O Emission from Highway Vehicles by Technology Type

Vehicle Type/Control Technology	CH_4 (g / mi)	N_2O (g / mi)
Gasoline Passenger Cars		
EPA Tier 2	0.0078	0.0082
Low Emission Vehicles*	0.0105	0.0150
EPA Tier 1	0.0271	0.0429
EPA Tier 0	0.0704	0.0647
Oxidation Catalyst	0.1355	0.0504
Non-Catalyst Control	0.1696	0.0197
Uncontrolled	0.1780	0.0197
EPA Tier 3 / ARB LEV III	0.0022	0.0067
ARB LEV II	0.0061	0.0082
ARB LEV	0.0100	0.0205
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
EPA Tier 2	0.0080	0.0082
Low Emission Vehicles*	0.0148	0.0157
EPA Tier 1	0.0452	0.0871
EPA Tier 0	0.0776	0.1056
Oxidation Catalyst	0.1516	0.0639
Non-Catalyst Control	0.1908	0.0218
Uncontrolled	0.2024	0.0220
EPA Tier 3 / ARB LEV III	0.0020	0.0067
ARB LEV II	0.0056	0.0082
ARB LEV	0.0148	0.0223
Gasoline Medium and Heavy-Duty Vehicles (Trucks and Buses)		
EPA Tier 2	0.0085	0.0082
Low Emission Vehicles*	0.0303	0.0320
EPA Tier 1	0.0655	0.1750
EPA Tier 0	0.2630	0.2135
Oxidation Catalyst	0.2356	0.1317
Non-Catalyst Control	0.4181	0.0473

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Vehicle Type/Control Technology	CH_4 (g / mi)	N_2O (g / mi)
Uncontrolled	0.4604	0.0497
EPA Tier 3 / ARB LEV III	0.0115	0.0160
ARB LEV II	0.0212	0.0175
ARB LEV	0.0300	0.0466
Diesel Passenger Cars		
Advanced	0.0005	0.0010
Moderate	0.0005	0.0010
Uncontrolled	0.0006	0.0012
Diesel Light-Duty Trucks		
Advanced	0.0010	0.0015
Moderate	0.0009	0.0014
Uncontrolled	0.0011	0.0017
Diesel Medium and Heavy-Duty Vehicles (Trucks and Buses)		
Aftertreatment	0.0051	0.0048
Advanced	0.0051	0.0048
Moderate	0.0051	0.0048
Uncontrolled	0.0051	0.0048
Motorcycles		
Non-Catalyst Control	0.0672	0.0069
Uncontrolled	0.0899	0.0087

Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 3, Table A-111. *The CH_4 and N_2O emissions from Low-Emission Vehicles are from: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2015 (April 2017) Annex 3, Table A-108.

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Table 2.5 U.S. Default Factors for Calculating CH_4 and N_2O Emissions from Highway Vehicles by Model Year

Vehicle Type and Year	CH_4 (g / mi)	N_2O (g / mi)
Gasoline Passenger Cars		
Model Years 1984-1993	0.0704	0.0647
Model Year 1994	0.0617	0.0603
Model Year 1995	0.0531	0.0560
Model Year 1996	0.0434	0.0503
Model Year 1997	0.0337	0.0446
Model Year 1998	0.0247	0.0395
Model Year 1999	0.0222	0.0362
Model Year 2000	0.0175	0.0304
Model Year 2001	0.0105	0.0212
Model Year 2002	0.0102	0.0207
Model Year 2003	0.0098	0.0190
Model Year 2004	0.0083	0.0116
Model Year 2005	0.0076	0.0098
Model Year 2006	0.0076	0.0104
Model Year 2007	0.0072	0.0087
Model Year 2008	0.0071	0.0084
Model Year 2009	0.0072	0.0084
Model Year 2010	0.0071	0.0082
Model Year 2011	0.0071	0.0082
Model Year 2012	0.0071	0.0082
Model Year 2013	0.0071	0.0082
Model Year 2014	0.0071	0.0082
Model Year 2015	0.0066	0.0080
Model Year 2016	0.0064	0.0183
Model Year 2017	0.0058	0.0177
Gasoline Light Trucks (Vans, Pickup Trucks, SUVs)		
Model Years 1987-1993	0.0813	0.1035

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Vehicle Type and Year	CH_4 (g / mi)	N_2O (g / mi)
Model Year 1994	0.0646	0.0982
Model Year 1995	0.0517	0.0908
Model Year 1996	0.0452	0.0871
Model Year 1997	0.0452	0.0871
Model Year 1998	0.0412	0.0787
Model Year 1999	0.0333	0.0618
Model Year 2000	0.0340	0.0631
Model Year 2001	0.0221	0.0379
Model Year 2002	0.0242	0.0424
Model Year 2003	0.0220	0.0337
Model Year 2004	0.0099	0.0127
Model Year 2005	0.0087	0.0106
Model Year 2006	0.0091	0.0116
Model Year 2007	0.0084	0.0102
Model Year 2008	0.0073	0.0084
Model Year 2009	0.0072	0.0082
Model Year 2010	0.0073	0.0082
Model Year 2011	0.0074	0.0082
Model Year 2012	0.0074	0.0082
Model Year 2013	0.0073	0.0082
Model Year 2014	0.0073	0.0082
Model Year 2015	0.0071	0.0081
Model Year 2016	0.0064	0.0079
Model Year 2017	0.0061	0.0078
Gasoline Medium and Heavy-Duty Trucks and Buses		
Model Years 1985-1986	0.4058	0.0515
Model Year 1987	0.3652	0.0849
Model Years 1988-1989	0.3472	0.0933
Model Years 1990-1995	0.3231	0.1142
Model Year 1996	0.1278	0.1680

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Vehicle Type and Year	CH_4 (g / mi)	N_2O (g / mi)
Model Year 1997	0.0924	0.1726
Model Year 1998	0.0655	0.1750
Model Year 1999	0.0648	0.1724
Model Year 2000	0.0630	0.1660
Model Year 2001	0.0577	0.1468
Model Year 2002	0.0634	0.1673
Model Year 2003	0.0600	0.1554
Model Year 2004	0.0156	0.0209
Model Year 2005	0.0117	0.0140
Model Year 2006	0.0193	0.0274
Model Year 2007	0.0119	0.0107
Model Year 2008	0.0143	0.0125
Model Year 2009	0.0085	0.0082
Model Year 2010	0.0085	0.0082
Model Year 2011	0.0085	0.0082
Model Year 2012	0.0085	0.0082
Model Year 2013	0.0085	0.0082
Model Year 2014	0.0085	0.0082
Model Year 2015	0.0085	0.0082
Model Year 2016	0.0135	0.0156
Model Year 2017	0.0133	0.0159
Diesel Passenger Cars		
Model Years 1960-1982	0.0006	0.0012
Model Years 1983-2017	0.0005	0.0010
Diesel Light Duty Trucks		
Model Years 1960-1982	0.0011	0.0017
Model Years 1983-1995	0.0009	0.0014
Model Years 1996-2017	0.0010	0.0015
Diesel Medium and Heavy-Duty Trucks and Buses		
All Model Years 1960-2017	0.0051	0.0048

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Vehicle Type and Year	CH_4 (g / mi)	N_2O (g / mi)
Diesel Motorcycles		
Model Years 1960-1995	0.0899	0.0087
Model Years 1996-2017	0.0069	0.0672
Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 3, Tables A-107 - A-111.		

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Table 2.6 U.S. Default Factors for Calculating CH_4 and N_2O Emissions from Alternative Fuel Vehicles

Vehicle Type	CH_4 (g / mi)	N_2O (g / mi)
Light-Duty Cars		
Methanol-Flex Fuel ICE	0.008	0.007
Ethanol-Flex Fuel ICE	0.008	0.007
CNG ICE	0.083	0.007
CNG Bi-fuel	0.083	0.007
LPG ICE	0.008	0.007
LPG Bi-fuel	0.008	0.007
Biodiesel (BD100)	0.001	0.001
Light-Duty Trucks		
Ethanol-Flex Fuel ICE	0.013	0.012
CNG ICE	0.125	0.012
CNG Bi-fuel	0.125	0.012
LPG ICE	0.013	0.014
LPG Bi-fuel	0.013	0.014
LNG	0.125	0.012
Biodiesel (BD100)	0.001	0.001
Medium Duty Trucks		
CNG ICE	4.200	0.001
CNG Bi-fuel	4.200	0.001
LPG ICE	0.014	0.034
LPG Bi-fuel	0.014	0.034
LNG	4.200	0.001
Biodiesel (BD100)	0.032	0.003
Heavy-Duty Trucks		
Neat Methanol ICE	0.075	0.028
Neat Ethanol ICE	0.075	0.028
CNG ICE	3.700	0.001
LPG ICE	0.013	0.026

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Vehicle Type	CH_4 (g / mi)	N_2O (g / mi)
LPG Bi-fuel	0.013	0.026
LNG	3.700	0.001
Biodiesel (BD100)	0.004	0.002
Buses		
Neat Methanol ICE	0.027	0.032
Neat Ethanol ICE	0.027	0.032
CNG ICE	10.000	0.001
LPG ICE	0.034	0.017
LNG	10.000	0.001
Biodiesel (BD100)	0.002	0.002
Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 3, Tables A-112 - A-113.		

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Table 2.7 U.S. Default Factors for Calculating CH_4 and N_2O Emissions from Non-Highway Vehicles

Vehicle Type / Fuel Type	CH_4 (g / gallon)	N_2O (g / gallon)
Ships and Boats		
Residual Fuel Oil	0.554	0.554
Gasoline 2 Stroke	9.591	0.064
Gasoline 4 Stroke	5.147	0.232
Distillate Fuel Oil (Diesel)	0.287	0.498
Rail		
Diesel Fuel	0.798	0.255
Aircraft		
Jet Fuel	0.000	0.300
Aviation Gasoline	7.063	0.107
Agricultural Equipment		
Gasoline - Equipment 2 Stroke	12.991	0.056
Gasoline - Equipment 4 Stroke	7.556	0.215
Gasoline - Off-road Trucks	7.556	0.215
Diesel - Equipment	0.287	0.485
Diesel - Off-Road Trucks	0.156	0.495
LPG	2.299	0.388
Construction/Mining Equipment		
Gasoline - Equipment 2 Stroke	12.407	0.073
Gasoline - Equipment 4 Stroke	5.683	0.195
Gasoline - Off-Road Trucks	5.683	0.195
Diesel - Equipment	0.227	0.472
Diesel - Off-Road Trucks	0.156	0.495
LPG	1.256	0.404
Lawn and Garden Equipment		
Gasoline - Residential 2 Stroke	16.496	0.053
Gasoline - Residential 4 Stroke	6.721	0.176

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Vehicle Type / Fuel Type	CH_4 (g / gallon)	N_2O (g / gallon)
Gasoline - Commercial 2 Stroke	15.573	0.061
Gasoline - Commercial 4 Stroke	5.901	0.184
Diesel-Commercial	0.335	0.466
LPG	0.400	0.415
Airport Equipment		
Gasoline 4 Stroke	2.618	0.251
Diesel	0.195	0.492
LPG	0.372	0.415
Industrial/Commercial Equipment		
Gasoline 2 Stroke	15.143	0.056
Gasoline 4 Stroke	5.580	0.198
Diesel	0.249	0.469
LPG	0.509	0.413
Logging Equipment		
Gasoline 2 Stroke	12.028	0.075
Gasoline 4 Stroke	6.987	0.184
Diesel	0.124	0.495
Railroad Equipment		
Gasoline 4 Stroke	5.864	0.187
Diesel	0.456	0.418
LPG	1.441	0.404
Recreational Equipment		
Gasoline 2 Stroke	8.164	0.039
Gasoline 4 Stroke	8.633	0.232
Diesel	0.415	0.405
LPG	3.161	0.374

Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 3, Table A-114 - A-115. Original factors converted to g/gallon fuel using fuel density defaults from US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 6.5.

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Table 2.8 Default Factors for Calculating LTO Emissions for Typical Aircraft

Aircraft	CO_2 (kg / LTO)	CH_4 (kg / LTO)	N_2O (kg / LTO)
A300	5450	0.12	0.2
A310	4760	0.63	0.2
A319	2310	0.06	0.1
A320	2440	0.06	0.1
A321	3020	0.14	0.1
A330-200/300	7050	0.13	0.2
A340-200	5890	0.42	0.2
A340-300	6380	0.39	0.2
A340-500/600	10660	0.01	0.3
707	5890	9.75	0.2
717	2140	0.01	0.1
727-100	3970	0.69	0.1
727-200	4610	0.81	0.1
737-100/200	2740	0.45	0.1
737-300/400/500	2480	0.08	0.1
737-600	2280	0.10	0.1
737-700	2460	0.09	0.1
737-800/900	2780	0.07	0.1
747-100	10140	4.84	0.3
747-200	11370	1.82	0.4
747-300	11080	0.27	0.4
747-400	10240	0.22	0.3
757-200	4320	0.02	0.1
757-300	4630	0.01	0.1
767-200	4620	0.33	0.1
767-300	5610	0.12	0.2
767-400	5520	0.10	0.2
777-200/300	8100	0.07	0.3

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Aircraft	CO_2 (kg / LTO)	CH_4 (kg / LTO)	N_2O (kg / LTO)
DC-10	7290	0.24	0.2
DC-8-50/60/70	5360	0.15	0.2
DC-9	2650	0.46	0.1
L-1011	7300	7.40	0.2
MD-11	7290	0.24	0.2
MD-80	3180	0.19	0.1
MD-90	2760	0.01	0.1
TU-134	2930	1.80	0.1
TU-154-M	5960	1.32	0.2
TU-154-B	7030	11.90	0.2
RJ-RJ85	1910	0.13	0.1
BAE 146	1800	0.14	0.1
CRJ-100ER	1060	0.06	0.03
ERJ-145	990	0.06	0.03
Fokker 100/70/28	2390	0.14	0.1
BAC111	2520	0.15	0.1
Dornier 328 Jet	870	0.06	0.03
Gulfstream IV	2160	0.14	0.1
Gulfstream V	1890	0.03	0.1
Yak-42M	2880	0.25	0.1
Cessna 525/560	1070	0.33	0.03
Beech King Air	230	0.06	0.01
DHC8-100	640	0.00	0.02
ATR72-500	620	0.03	0.02

Source: IPCC, Guidelines for National Greenhouse Gas Inventories (2006), Volume 2: Energy, Chapter 3: Mobile Combustion, Table 3.6.9. LTO = landing/take-off.

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Table 2.9 Factors for Estimating CH_4 and N_2O Emissions from Gasoline and Diesel Vehicles (SEM)

GHG	MT GHG per MT of CO_2
CH_4	2.37E-05
N_2O	4.29E-05

Source: Derived from US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019), Table 2-13. Only includes data for passenger cars and light-duty trucks.

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Table 3.1 U.S. Default Factors for Calculating Emissions from Grid Electricity by eGRID Subregion

eGRID 2018 Subregion	eGRID 2018 Subregion Name	2018 Emission Rates		
		(lbs CO_2 / MWh)	(lbs CH_4 / GWh)	(lbs N_2O / GWh)
AKGD	ASCC Alaska Grid	1039.60	82.00	11.00
AKMS	ASCC Miscellaneous	525.10	24.00	4.00
AZNM	WECC Southwest	1022.40	77.00	11.00
CAMX	WECC California	496.50	34.00	4.00
ERCT	ERCOT All	931.70	66.00	9.00
FRCC	FRCC All	931.80	66.00	9.00
HIMS	HICC Miscellaneous	1110.70	118.00	18.00
HIOA	HICC Oahu	1669.90	180.00	27.00
MROE	MRO East	1678.00	169.00	25.00
MROW	MRO West	1239.80	138.00	20.00
NEWE	NPCC New England	522.30	82.00	11.00
NWPP	WECC Northwest	639.00	64.00	9.00
NYCW	NPCC NYC/Westchester	596.40	22.00	3.00
NYLI	NPCC Long Island	1184.20	139.00	18.00
NYUP	NPCC Upstate NY	253.10	18.00	2.00
RFCE	RFC East	716.00	61.00	8.00
RFCM	RFC Michigan	1312.60	129.00	18.00
RFCW	RFC West	1166.10	117.00	17.00
RMPA	WECC Rockies	1273.60	123.00	18.00
SPNO	SPP North	1163.20	124.00	18.00
SPSO	SPP South	1166.60	91.00	13.00

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eGRID 2018 Subregion	eGRID 2018 Subregion Name	2018 Emission Rates		
		(lbs CO_2 / MWh)	(lbs CH_4 / GWh)	(lbs N_2O / GWh)
SRMV	SERC Mississippi Valley	854.60	55.00	8.00
SRMW	SERC Midwest	1664.20	185.00	27.00
SRSO	SERC South	1027.90	81.00	12.00
SRTV	SERC Tennessee Valley	1031.50	97.00	14.00
SRVC	SERC Virginia/Carolina	743.30	67.00	9.00
US Territories (not an eGRID Region)*	n/a	1891.57	75.91	17.13
Source: U.S. EPA Year 2018 eGRID 13th edition (March 2020: eGRID subregion annual total output emission rates). Except * from Department of Energy Guidance on Voluntary Reporting of Greenhouse Gases, Form EIA-1605 (2007), Appendix F, Electricity Emission Factors, Table F-1.				

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Table 3.2 Canadian Default Factors for Calculating Emissions from Grid Electricity by Province

Province	2016 Emission Rates		
	g CO_2 / kWh	g CH_4 / kWh	g N_2O / kWh
Alberta	740	0.04	0.01
British Columbia	11.2	0.003	0.0008
Manitoba	1.9	0.0001	0.0001
New Brunswick	320	0.02	0.005
Newfoundland and Labrador	37	0.0006	0.001
Northwest Territories	190	0.01	0.03
Nova Scotia	700	0.03	0.01
Ontario	36	0.01	0.001
Prince Edward Island	7	0.0002	0.0001
Quebec	1.2	0.0	0.0001
Saskatchewan	650	0.05	0.02
Yukon	43	0.003	0.01
Nunavut	710	0.0	0.0

Source: Environment Canada, National Inventory Report, 1990-2017: Greenhouse Gas Sources and Sinks in Canada (April 2019) Annex 13: Emission Factors, Table A13-2 - A13-14.

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Table 3.3 Mexican Default Factors for Calculating Emissions from Grid Electricity

Year	Emission Rates (kg CO_2e / MWh)
2019	505
2018	527

Source: Gobierno de México, Secretaria de Medio Ambiente y Recursos Naturales, Factores de Emisión del Sistema Eléctrico Nacional para 2018 (Feb 2019) y 2019 (Feb 2020). Factors are a national average of all the power plants operating and delivering electricity to the National Electric System and do not include transmission and distribution losses.

Note: These emission rates are in units of CO_2 equivalent (CO_2e) and include emissions of CO_2, CH_4, and N_2O.

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Table 3.4 Non-North American Default Factors for calculating Emissions from Electricity Generation

Region / Country / Economy	2010 Emission Rates (g CO_2 / kWh)	2011 Emission Rates (g CO_2 / kWh)
Albania	2	7
Algeria	548	556
Angola	440	390
Argentina	367	390
Armenia	92	123
Australia	841	823
Austria	188	215
Azerbaijan	439	455
Bahrain	640	601
Bangladesh	593	564
Belarus	449	441
Belgium	220	196
Benin	720	722
Bolivia	423	433
Bosnia and Herzegovina	723	794
Botswana	2517	1787
Brazil	87	68
Brunei Darussalam	717	717
Bulgaria	535	591
Cambodia	804	793

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Region / Country / Economy	2010 Emission Rates (g CO_2 / kWh)	2011 Emission Rates (g CO_2 / kWh)
Cameroon	207	200
Chile	410	441
Chinese Taipei	624	601
Colombia	176	108
Congo	142	230
Costa Rica	56	64
Côte d'Ivoire	445	437
Croatia	236	334
Cuba	1012	955
Cyprus	697	732
Czech Republic	589	591
Dem. Rep. of Congo	3	3
Denmark	360	315
Dominican Republic	589	743
DPR of Korea	465	475
Ecuador	389	345
Egypt	450	457
El Salvador	223	243
Eritrea	646	849
Estonia	1014	1086
Ethiopia	7	7
Finland	229	191

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Region / Country / Economy	2010 Emission Rates ($g CO_2 / kWh$)	2011 Emission Rates ($g CO_2 / kWh$)
France	79	61
FYR of Macedonia	685	811
Gabon	383	378
Georgia	69	102
Germany	461	477
Ghana	259	215
Gibraltar	762	752
Greece	718	720
Guatemala	286	286
Haiti	538	382
Honduras	332	371
Hong Kong, China	723	768
Hungary	317	317
Iceland	0	n/a
India	912	856
Indonesia	709	755
Iraq	1003	903
Ireland	458	427
Islamic Rep. of Iran	565	578
Israel	689	727
Italy	406	402
Jamaica	711	620

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Region / Country / Economy	2010 Emission Rates (g CO_2 / kWh)	2011 Emission Rates (g CO_2 / kWh)
Japan	416	497
Jordan	566	637
Kazakhstan	403	431
Kenya	274	294
Korea	533	545
Kosovo	1287	1109
Kuwait	842	787
Kyrgyzstan	59	45
Latvia	120	133
Lebanon	709	707
Libya	885	636
Lithuania	337	270
Luxembourg	410	387
Malaysia	727	688
Malta	872	862
Mongolia	949	837
Montenegro	405	653
Morocco	718	729
Mozambique	1	1
Myanmar	262	255
Namibia	197	24
Nepal	1	1

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Region / Country / Economy	2010 Emission Rates ($g\ CO_2$ / kWh)	2011 Emission Rates ($g\ CO_2$ / kWh)
Netherlands	415	404
Netherlands Antilles	707	708
New Zealand	150	141
Nicaragua	460	471
Nigeria	405	433
Norway	17	13
Oman	794	741
Pakistan	425	409
Panama	298	357
Paraguay	n/a	n/a
People's Rep. of China	766	764
Peru	289	297
Philippines	481	492
Poland	781	780
Portugal	255	303
Qatar	494	490
Republic of Moldova	517	486
Romania	413	499
Russian Federation	384	437
Saudi Arabia	737	754
Senegal	637	689
Serbia	718	784

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Region / Country / Economy	2010 Emission Rates ($g CO_2 / kWh$)	2011 Emission Rates ($g CO_2 / kWh$)
Singapore	499	500
Slovak Republic	197	200
Slovenia	325	338
South Africa	927	869
Spain	238	291
Sri Lanka	379	469
Sudan	344	204
Sweden	30	17
Switzerland	27	30
Syrian Arab Republic	594	602
Tajikistan	14	12
Thailand	513	522
Togo	195	206
Trinidad and Tobago	700	506
Tunisia	463	455
Turkey	460	472
Turkmenistan	954	983
Ukraine	392	450
United Arab Emirates	598	600
United Kingdom	457	441
United Rep. of Tanzania	329	288
Uruguay	81	197

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Region / Country / Economy	2010 Emission Rates (g CO_2 / kWh)	2011 Emission Rates (g CO_2 / kWh)
Uzbekistan	550	559
Venezuela	264	234
Vietnam	432	429
Yemen	655	633
Zambia	3	3
Zimbabwe	660	358

Source: 2010 emission rates from *CO_2 Emissions from Fuel Combustion Highlights* (2012) © OECD/IEA, 2012, CO_2 emissions per kWh from electricity and heat generation. 2011 emission rates from *CO_2 Emissions from Fuel Combustion Highlights* (2013) © OECD/IEA, 2013, CO_2 emissions per kWh from electricity and heat generation. Values were converted from tonnes/tWh to g/kWh using 1 tonne = 1,000,000 g and 1 tWh = 1,000,000,000 kWh. n/a = data not available.

Note: Emission rates more recent than 2011 are not publicly available, but are available for purchase from the International Energy Agency.

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Table 3.5 Average Cost per Kilowatt Hour by U.S. State

State	2018 Average Retail Price Residential (¢/kWh)	2018 Average Retail Price Commercial (¢/kWh)	2018 Average Retail Price Industrial (¢/kWh)
AK Total	21.94	18.58	17.10
AL Total	12.18	11.24	6.01
AR Total	9.81	7.75	5.64
AZ Total	12.77	10.64	6.55
CA Total	18.84	16.34	13.20
CO Total	12.15	10.02	7.47
CT Total	21.20	16.76	13.77
DC Total	12.84	11.97	8.30
DE Total	12.53	9.65	7.95
FL Total	11.54	9.19	7.67
GA Total	11.47	9.79	6.00
HI Total	32.47	29.90	26.10
IA Total	12.24	9.68	6.45
ID Total	10.15	7.93	6.47
IL Total	12.77	9.12	6.80
IN Total	12.26	10.60	7.38
KS Total	13.35	10.66	7.60
KY Total	10.60	9.74	5.68
LA Total	9.59	8.85	5.35
MA Total	21.61	17.17	14.89

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State	2018 Average Retail Price Residential (¢/kWh)	2018 Average Retail Price Commercial (¢/kWh)	2018 Average Retail Price Industrial (¢/kWh)
MD Total	13.30	10.43	8.23
ME Total	16.84	12.51	9.32
MI Total	15.45	11.15	7.10
MN Total	13.14	10.38	7.53
MO Total	11.34	9.40	7.22
MS Total	11.12	10.43	6.00
MT Total	10.96	10.11	5.19
NC Total	11.09	8.58	6.33
ND Total	10.25	9.10	7.98
NE Total	10.70	8.83	7.60
NH Total	19.69	15.81	13.42
NJ Total	15.41	12.21	10.07
NM Total	12.68	10.02	5.84
NV Total	11.85	7.74	6.10
NY Total	18.52	14.50	6.02
OH Total	12.56	10.11	7.01
OK Total	10.30	8.07	5.34
OR Total	10.98	8.91	5.86
PA Total	13.89	8.94	6.84
RI Total	20.55	16.58	15.39
SC Total	12.44	10.11	6.10

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State	2018 Average Retail Price Residential (¢/kWh)	2018 Average Retail Price Commercial (¢/kWh)	2018 Average Retail Price Industrial (¢/kWh)
SD Total	11.59	9.62	7.77
TN Total	10.71	10.51	5.68
TX Total	11.20	8.16	5.39
UT Total	10.41	8.23	5.90
VA Total	11.73	8.32	6.86
VT Total	18.02	15.24	10.66
WA Total	9.675	8.72	4.71
WI Total	14.02	10.67	7.33
WV Total	11.18	9.24	6.40
WY Total	11.29	9.58	6.71

Source: Energy Information Administration: Electric Power Annual, Table 2.10: Average Price of Electricity to Ultimate Customers by End-Use Sector, by State, in cents per kilowatt-hour (October 2019).

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Table 3.6 Canadian Energy Intensity by Building Activity

Principal Building Activity	GJ / m^2	Electricity / Natural gas Split (%)
Office building (non-medical)	1.13	58/42
Medical office building	1.28	49/51
Elementary or secondary school	0.88	37/63
Assisted daily or residential care	1.3	45/55
Warehouse	0.82	40/60
Hotel, motel, or lodge	1.24	43/57
Hospital	2.45	32/68
Food or beverage store	1.87	70/30
Non-food retail store	1.12	46/54
Other activity or function*	1.19	43/57

Source: Statistics Canada, Survey of Commercial and Institutional Energy Use, 2014 (September 2016), Tables 2 and 7. Energy intensity values in Canada include both electricity and natural gas consumption (a small subset of other fuel types is included in the natural gas portion). Members should refer to the 3rd column of this table to apportion their consumption totals between activities accordingly.

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Table 3.7 U.S. Electricity and Natural Gas Intensity by Building Activity

Principal Building Activity	Electricity Intensity (kWh / ft^2)	Natural Gas Intensity (ft^3 NG/ft^2)
Education	11.0	29.8
Food Sales	48.7	61.3
Food Service	44.9	159.2
Health Care	25.8	78.5
Inpatient	31.0	101.1
Outpatient	18.7	38.0
Lodging	15.3	43.8
Mercantile	18.3	33.5
Retail (other than mall)	15.2	21.5
Enclosed and strip malls	21.1	41.3
Office	15.9	26.8
Public Assembly	14.5	33.9
Public Order and Safety	14.9	39.5
Religious Worship	5.2	28.1
Service	8.3	42.7
Warehouse and Storage	6.6	19.4
Other	28.3	57.2
Vacant	4.5	13.9
Source: 2012 Commercial Buildings Energy Consumption Survey, Energy Information Administration (http://www.eia.doe.gov/emeu/cbecs), Tables E6 (Electricity) and E8 (Natural Gas).		

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Table 3.8 U.S. Utility-Specific CO_2 Emission Factors for Purchased Electricity

Utility	Factor Type	CO_2 Emission Factor lbs / MWh
2005		
Northern States Power Company (Xcel Energy)	System Average	1236.79
Public Service Company of Colorado (Xcel Energy)	System Average	1847.47
Southwestern Public Service Company (Xcel Energy)	System Average	1693.15
2006		
Northern States Power Company (Xcel Energy)	System Average	1225.77
Public Service Company of Colorado (Xcel Energy)	System Average	1834.24
Southwestern Public Service Company (Xcel Energy)	System Average	1615.99
2007		
Northern States Power Company (Xcel Energy)	System Average	1234.59
Public Service Company of Colorado (Xcel Energy)	System Average	1752.67
Southwestern Public Service Company (Xcel Energy)	System Average	1638.03
2009		
Bonneville Power Administration	System Average	93.17
Modesto Irrigation District	Retail Power	1036.17
	Special Power	0.00
	Wholesale Power	2048.09
Northern States Power Company (Xcel Energy)	System Average	1104.51
Public Service Company of Colorado (Xcel Energy)	System Average	1611.58
Southwestern Public Service Company (Xcel Energy)	System Average	1574.10
Pacific Gas & Electric	System Average	575.38
2010		
Bonneville Power Administration	System Average	134.70
City of Vernon, Light and Power	System Average	775.83
Modesto Irrigation District	Retail Power	942.99
	Special Power	0.00
	Wholesale Power	2026.12
Newmont Nevada Energy Investment	Wholesale Power	2055.79
Northern States Power Company (Xcel Energy)	System Average	1033.97
Public Service Company of Colorado (Xcel Energy)	System Average	1660.08
Southwestern Public Service Company (Xcel Energy)	System Average	1558.67
Sacramento Municipal Utility District	Retail Power	526.47
	Special Power	0.00
	Wholesale Power	828.58

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Utility	Factor Type	CO_2 Emission Factor lbs / MWh
Seattle City Light	Retail Power	45.57
	Special Power	0.00
	Wholesale Power	537.64
Pacific Gas & Electric	System Average	444.64
2011		
Bonneville Power Administration	System Average	47.86
City of Vernon, Light and Power	System Average	731.49
Northern States Power Company (Xcel Energy)	System Average	1071.45
Public Service Company of Colorado (Xcel Energy)	System Average	1618.19
Southwestern Public Service Company (Xcel Energy)	System Average	1472.69
Pacific Gas & Electric	System Average	392.87
Sacramento Municipal Utility District	Retail Power	429.29
	Special Power	0.00
	Wholesale Power	795.14
Seattle City Light	Retail Power	13.77
	Special Power	0.00
	Wholesale Power	218.75
2012		
Bonneville Power Administration	System Average	36.91
City of Vernon, Light and Power	System Average	765.97
Metropolitan Water District of Southern California	Wholesale Power	658.73
	Self-consumed Power	157.87
Northern States Power Company (Xcel Energy)	System Average	930.35
Public Service Company of Colorado (Xcel Energy)	System Average	1547.64
Southwestern Public Service Company (Xcel Energy)	System Average	1558.67
Pacific Gas & Electric	System Average	444.62
Sacramento Municipal Utility District	Retail Power	521.73
	Special Power	0.00
	Wholesale Power	799.77
Seattle City Light	Retail Power	25.62
	Special Power	0.00
	Wholesale Power	362.85
2013		
Bonneville Power Administration	System Average	43.65
City of Palo Alto	System Average	0.00
City of Vernon, Light and Power	System Average	760.86

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Utility	Factor Type	CO_2 Emission Factor lbs / MWh
Metropolitan Water District of Southern California	Wholesale Power	610.82
	Self-consumed Power	239.10
Northern States Power Company (Xcel Energy)	System Average	950.19
Public Service Company of Colorado (Xcel Energy)	System Average	1371.27
Southwestern Public Service Company (Xcel Energy)	System Average	1512.37
Pacific Gas & Electric (Corrected)	System Average	427.27
Sacrameto Municipal Utility District	Retail Power	559.86
	Special Power	0.00
	Wholesale Power	816.02
Seattle City Light	Retail Power	33.23
	Special Power	0.00
	Wholesale Power	491.61
2014		
Bonneville Power Administration	System Average	36.82
City of Palo Alto	System Average	0.00
Metropolitan Water District of Southern California	Wholesale Power	610.82
	Self-consumed Power	458.55
Northern States Power Company (Xcel Energy)	System Average	961.21
Public Service Company of Colorado (Xcel Energy)	System Average	1472.69
Southwestern Public Service Company (Xcel Energy)	System Average	1485.91
Pacific Gas & Electric	System Average	434.92
Sacrameto Municipal Utility District	Retail Power	561.08
	Special Power	0.00
	Wholesale Power	803.58
Seattle City Light	Retail Power	20.08
	Special Power	0.00
	Wholesale Power	376.25
Sonoma Clean Power	Special Power - EverGreen	51.00
	Retail Power - CleanStart	224.38
2015		
Bonneville Power Administration	System Average	36.44
City of Palo Alto	System Average	0.00
Imperial Irrigation District	System Average	1037.52
Metropolitan Water District of Southern California	Wholesale Power	650.32
	Self-consumed Power	358.60
Northern States Power Company (Xcel Energy)	System Average	877.44
Public Service Company of Colorado (Xcel Energy)	System Average	1468.28

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Utility	Factor Type	CO_2 Emission Factor lbs / MWh
Southwestern Public Service Company (Xcel Energy)	System Average	1375.68
Pacific Gas & Electric	System Average	404.51
Sacrameto Municipal Utility District	Retail Power	590.84
	Special Power	0.00
	Wholesale Power	667.34
Seattle City Light	Retail Power	52.44
	Special Power	0.00
	Wholesale Power	319.31
Sonoma Clean Power	Special Power - EverGreen	57.00
	Retail Power - CleanStart	217.57
University of California, Office of the President	System Average	719.06
2016		
Metropolitan Water District of Southern California	Wholesale Power	568.65
	Self-consumed Power	239.56
Northern States Power Company (Xcel Energy)	System Average	817.91
Public Service Company of Colorado (Xcel Energy)	System Average	1342.61
Southwestern Public Service Company (Xcel Energy)	System Average	1287.50
Pacific Gas & Electric	System Average	293.67
Sonoma Clean Power	Special Power - EverGreen	57.00
	Retail Power - CleanStart	97.76
Bonneville Power Administration	System Average	35.76
Seattle City Light	Retail Power	31.12
	Special Power	0.00
	Wholesale Power	216.67
Sacramento Municipal Utility District	Retail Power	492.95
	Special Power	0.00
	Wholesale Power	852.75
University of California, Office of the President	System Average	493.61
CleanPowerSF	Special Power - Green	186.74
	Special Power - SuperGreen	0.00
Hetch Hetchy	Wholesale Power	0.12
	Retail Power	0.00
2017		
Metropolitan Water District of Southern California	Wholesale Power	526.90
	Self-consumed Power	293.21
Sonoma Clean Power	Special Power - EverGreen	53.00
	Retail Power - CleanStart	127.98

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Utility	Factor Type	CO_2 Emission Factor lbs / MWh
University of California, Office of the President	System Average	208.50
Pacific Gas & Electric	System Average	210.44
Sacramento Municipal Utility District	Retail Power	383.60
	Special Power	0.00
	Wholesale Power	645.95
Seattle City Light	Retail Power	46.37
	Special Power	0.00
	Wholesale Power	106.12
Northern States Power Company (Xcel Energy)	System Average	822.32
Public Service Company of Colorado (Xcel Energy)	System Average	1302.93
Southwestern Public Service Company (Xcel Energy)	System Average	1239.00
CleanPowerSF	Special Power - Green	0.00
	Special Power - SuperGreen	0.00
Hetch Hetchy	Wholesale Power	0.12
	Retail Power	0.00
Bonneville Power Administration	System Average	27.21
2018		
East Bay Community Energy	Special Power - Renewable 100	0.00
	Special Power - Brilliant 100	0.00
	Special Power - Bright Choice	100.75
Sonoma Clean Power	Special Power - EverGreen	46.02
	Retail Power - CleanStart	98.81
University of California, Office of the President	System Average	138.17
Sacramento Municipal Utility District	Retail Power	465.17
	Special Power	0.00
	Wholesale Power	590.84
Pacific Gas & Electric	System Average	206.29

Source: These emission factors have been reported by TCR members using the Electric Power Sector (EPS) Protocol and the option to develop utility-specific electricity delivery metrics. TCR members who are customers of these utilities can use these verified emission factors when quantifying market-based Scope 2 emissions. Utility-specific emission factors have been converted from tonnes/MWh to lbs/MWh in order to streamline reporting in CRIS.

Note: The emission factors in this table are updated once per year based on the verified emission factors available at the time of publication. More recent utility-specific emission factors may be available on TCR's website: https://www.theclimateregistry.org/our-members/cris-public-reports/.

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Table 4.1 Default Factors for Calculating Emissions from Refrigeration/Air Conditioning Equipment

Type of Equipment	Refrigerant Capacity (kg)	Installation Emission Factor k (% of capacity)	Operating Emission Factor w (% of capacity/year)	Refrigerant Remaining at Disposal y (% of capacity)	Recovery Efficiency z (% of remaining)
Domestic Refrigeration	0.05 - 0.5	1%	0.50%	80%	70%
Stand-alone Commercial Applications	0.2 - 6	3%	15%	80%	70%
Medium & Large Commercial Refrigeration	50 - 2,000	3%	35%	100%	70%
Transport Refrigeration	3 - 8	1%	50%	50%	70%
Industrial Refrigeration including Food Processing and Cold Storage	10 -10,000	3%	25%	100%	90%
Chillers	10 - 2,000	1%	15%	100%	95%
Residential and Commercial A/C including Heat Pumps	0.5 - 100	1%	10%	80%	80%
Mobile Air Conditioning - Maritime	5.0 - 6,500	0.50%	40%	50%	50%
Mobile Air Conditioning - Railway	10 - 30	0.50%	20%	50%	50%
Mobile Air Conditioning - Buses	4 - 18	0.50%	20%	50%	50%
Mobile Air Conditioning - Other Mobile	0.5 - 2	0.50%	20%	50%	50%

Source: IPCC, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019), Volume 3: Industrial Processes and Product Use, Table 7.9.

Note: Emission factors above are the most conservative of the range provided by the IPCC. The ranges in capacity are provided for reference. You should use the actual capacity of your equipment. If you do not know your actual capacity, you should use the high end of the range provided (e.g., use 2,000 kg for chillers).

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Table 4.2 Default Composition of Refrigerant Blends that Contain HFCs and PFCs

Blend	Constituents	Composition (%)
R-405A	HCFC-22/HFC-152a/HCFC-142b/PFC-318	(45.0/7.0/5.5/42.5)
R-413A	PFC-218/HFC-134a/HC-600a	(9.0/88.0/3.0)
R-508A	HFC-23/PFC-116	(39.0/61.0)
R-508B	HFC-23/PFC-116	(46.0/54.0)
Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Table 7.8, page 7.44.		

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Table 4.3 U.S. Default Factors for Calculating CO_2 Emissions from Geothermal Energy Production

Fuel Type	Carbon Content (Per Unit Energy)	CO_2 Emission Factor (Per Unit Energy)
Geothermal	**kg C / MMBtu**	**kg CO_2 / MMBtu**
Flash Steam	2.18	7.99
Dry Steam	3.22	11.81
Binary	0.00	0.00
Binary/Flash Steam	0.00	0.00
Source: US Inventory of Greenhouse Gas Emissions and Sinks 1990-2017 (April 2019) Annex 2, Table A-41.		

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Table 5.1 Global Warming Potential Factors for Required Greenhouse Gases

Common Name	Formula	Chemical Name	SAR	TAR	AR4	AR5
Carbon dioxide	CO_2		1	1	1	1
Methane	CH_4		21	23	25	28
Nitrous oxide	N_2O		310	296	298	265
Nitrogen trifluoride	NF_3		n/a	10,800	17,200	16,100
Sulfur hexafluoride	SF_6		23,900	22,200	22,800	23,500
Hydrofluorocarbons (HFCs)						
HFC-23 (R-23)	CHF_3	trifluoromethane	11,700	12,000	14,800	12,400
HFC-32 (R-32)	CH_2F_2	difluoromethane	650	550	675	677
HFC-41 (R-41)	CH_3F	fluoromethane	150	97	92	116
HFC-125 (R-125)	C_2HF_5	pentafluoroethane	2,800	3,400	3,500	3,170
HFC-134 (R-134)	$C_2H_2F_4$	1,1,2,2-tetrafluoroethane	1,000	1,100	1,100	1,120
HFC-134a (R-134a)	$C_2H_2F_4$	1,1,1,2-tetrafluoroethane	1,300	1,300	1,430	1,300
HFC-143 (R-143)	$C_2H_3F_3$	1,1,2-trifluoroethane	300	330	353	328
HFC-143a (R-143a)	$C_2H_3F_3$	1,1,1-trifluoroethane	3,800	4,300	4,470	4,800
HFC-152 (R-152)	$C_2H_4F_2$	1,2-difluoroethane	n/a	43	53	16
HFC-152a (R-152a)	$C_2H_4F_2$	1,1-difluoroethane	140	120	124	138
HFC-161 (R-161)	C_2H_5F	fluoroethane	n/a	12	12	4
HFC-227ea (R-227ea)	C_3HF_7	1,1,1,2,3,3,3-heptafluoropropane	2,900	3,500	3,220	3,350

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Common Name	Formula	Chemical Name	SAR	TAR	AR4	AR5
HFC-236cb (R-236cb)	$C_3H_2F_6$	1,1,1,2,2,3-hexafluoropropane	n/a	1,300	1,340	1,210
HFC-236ea (R-236ea)	$C_3H_2F_6$	1,1,1,2,3,3-hexafluoropropane	n/a	1,200	1,370	1,330
HFC-236fa (R-236fa)	$C_3H_2F_6$	1,1,1,3,3,3-hexafluoropropane	6,300	9,400	9,810	8,060
HFC-245ca (R-245ca)	$C_3H_3F_5$	1,1,2,2,3-pentafluoropropane	560	640	693	716
HFC-245fa (R-245fa)	$C_3H_3F_5$	1,1,1,3,3-pentafluoropropane	n/a	950	1,030	858
HFC-365mfc	$C_4H_5F_5$	1,1,1,3,3-pentafluorobutane	n/a	890	794	804
HFC-43-10mee (R- 4310)	$C_5H_2F_{10}$	1,1,1,2,3,4,4,5,5,5-decafluoropentane	1,300	1,500	1,640	1,650
Perfluorocarbons (PFCs)						
PFC-14 (Perfluoromethane)	CF_4	tetrafluoromethane	6,500	5,700	7,390	6,630
PFC-116 (Perfluoroethane)	C_2F_6	hexafluoroethane	9,200	11,900	12,200	11,100
PFC-218 (Perfluoropropane)	C_3F_8	octafluoropropane	7,000	8,600	8,830	8,900
PFC-318 (Perfluorocyclobutane)	c-C_4F_8	octafluorocyclobutane	8,700	10,000	10,300	9,540
PFC-3-1-10 (Perfluorobutane)	C_4F_{10}	decafluorobutane	7,000	8,600	8,860	9,200
PFC-4-1-12 (Perfluoropentane)	C_5F_{12}	dodecafluoropentane	n/a	8,900	9,160	8,550
PFC-5-1-14 (Perfluorohexane)	C_6F_{14}	tetradecafluorohexane	7,400	9,000	9,300	7,910
PFC-9-1-18 (Perfluorodecalin)	$C_{10}F_{18}$		n/a	n/a	>7,500	7,190

Source: Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) published in 1995, Third Assessment Report (TAR) published in 2001, Fourth Assessment Report (AR4) published in 2007, and Fifth Assessment Report published in 2013. All defaults 100-year GWP values. For any defaults provided as a range, use exact value provided for the purpose of reporting to TCR. n/a = data not available.

Note: Complete reporters must include emissions of all Kyoto-defined GHGs (including all HFCs and PFCs) in inventory reports. If HFCs or PFCs are emitted that are not listed above, complete reporters must use industry best practices to calculate CO_2e from those gases.

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Table 5.2 Global Warming Potentials of Refrigerant Blends

Refrigerant Blend	Gas	SAR	TAR	AR4	AR5
R-401A	HFC	18.2	15.6	16.12	17.94
R-401B	HFC	15	13	14	15
R-401C	HFC	21	18	18.6	20.7
R-402A	HFC	1680	2040	2100	1902
R-402B	HFC	1064	1292	1330	1205
R-403A	PFC	1400	1720	1766	1780
R-403B	PFC	2730	3354	3444	3471
R-404A	HFC	3260	3784	3922	3943
R-407A	HFC	1770	1990	2107	1923
R-407B	HFC	2285	2695	2804	2547
R-407C	HFC	1526	1653	1774	1624
R-407D	HFC	1428	1503	1627	1487
R-407E	HFC	1363	1428	1552	1425
R-407F	HFC	1555	1705	1825	1674
R-407G	HFC	1321	1334	1463	1331
R-407H	HFC	1314	1371	1495	1378
R-407I	HFC	1301	1332	1459	1337
R-408A	HFC	1944	2216	2301	2430
R-410A	HFC	1725	1975	2088	1924
R-410B	HFC	1833	2118	2229	2048
R-411A	HFC	15	13	14	15

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Refrigerant Blend	Gas	SAR	TAR	AR4	AR5
R-411B	HFC	4.2	3.6	3.72	4.14
R-412A	PFC	350	430	442	445
R-415A	HFC	25.2	21.6	22.32	24.84
R-415B	HFC	105	90	93	104
R-416A	HFC	767	767	843.7	767
R-417A	HFC	1955	2234	2346	2127
R-417B	HFC	2450	2924	3027	2742
R-417C	HFC	1570	1687	1809	1643
R-418A	HFC	3.5	3	3.1	3.45
R-419A	HFC	2403	2865	2967	2688
R-419B	HFC	1982	2273	2384	2161
R-420A	HFC	1144	1144	1258	1144
R-421A	HFC	2170	2518	2631	2385
R-421B	HFC	2575	3085	3190	2890
R-422A	HFC	2532	3043	3143	2847
R-422B	HFC	2086	2416	2526	2290
R-422C	HFC	2491	2983	3085	2794
R-422D	HFC	2232	2623	2729	2473
R-422E	HFC	2135	2483	2592	2350
R-423A	HFC	2060	2345	2280	2274
R-424A	HFC	2025	2328	2440	2212
R-425A	HFC	1372	1425	1505	1431
R-426A	HFC	1352	1382	1508	1371

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Refrigerant Blend	Gas	SAR	TAR	AR4	AR5
R-427A	HFC	1828	2013	2138	2024
R-428A	HFC	2930	3495	3607	3417
R-429A	HFC	14	12	12	14
R-430A	HFC	106.4	91.2	94.24	104.88
R-431A	HFC	41	35	36	40
R-434A	HFC	2662	3131	3245	3075
R-435A	HFC	28	24	25	28
R-437A	HFC	1567	1684	1805	1639
R-438A	HFC	1890	2151	2264	2059
R-439A	HFC	1641	1873	1983	1828
R-440A	HFC	158	139	144	156
R-442A	HFC	1609	1793	1888	1754
R-444A	HFC	85	72	87	88
R-444B	HFC	284	240	293	295
R-445A	HFC	117	117	128.7	117
R-446A	HFC	442	374	459	460
R-447A	HFC	540	493	582	571
R-447B	HFC	666	646	739	714
R-448A	HFC	1170	1300	1386	1273
R-449A	HFC	1184	1308	1396	1282
R-449B	HFC	1199	1320	1411	1296
R-449C	HFC	1067	1167	1250	1146
R-450A	HFC	546	546	600.6	546

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Refrigerant Blend	Gas	SAR	TAR	AR4	AR5
R-451A	HFC	132.6	132.6	145.86	132.6
R-451B	HFC	145.6	145.6	160.16	145.6
R-452A	HFC	1724	2067	2139	1945
R-452B	HFC	632	607	697	675
R-452C	HFC	1789	2143	2219	2018
R-453A	HFC	1534	1664	1765	1636
R-454A	HFC	228	193	236	237
R-454B	HFC	448	379	465	466
R-454C	HFC	140	118	145	146
R-456A	HFC	624	618	684	626
R-457A	HFC	131	113	136	138
R-458A	HFC	1457	1576	1650	1564
R-460C	HFC	684	697	762	694
R-461A	HFC	2291	2676	2767	2567
R-462A	HFC	1883	2136	2249	2060
R-463A	HFC	1256	1400	1493	1377
R-464A	HFC	1106	1277	1320	1240
R-465A	HFC	137	116	142	142
R-500	HFC	37	31	32	36
R-503	HFC	4692	4812	5935	4972
R-504	HFC	313	265	325	326
R-507 or R-507A	HFC	3300	3850	3985	3985
R-509 or R-509A	PFC	3920	4816	4945	4984

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Refrigerant Blend	Gas	SAR	TAR	AR4	AR5
R-512A	HFC	198	179	189.3	196.1
R-513A	HFC	572	572	629.2	572
R-513B	HFC	540	539.5	593	539.5
R-515A	HFC	348	420	386	402
R-516A	HFC	130	127	139	130

Source: Refrigerant blend GWPs are calculated using a weighted average from the blend composition and the IPCC GWP values. The blend compositions are from ASHRAE Standard 34-2019. The GWP values are 100- year values from the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (SAR) published in 1995, Third Assessment Report (TAR) published in 2001, Fourth Assessment Report (AR4) published in 2007, and Fifth Assessment Report (AR5) published in 2013.

Note: Red text indicates a revised GWP for R-407G. Correct number is approximately 5% lower than previously published.

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Conversion Factors

Mass			
1 pound (lb) =	453.6 grams (g)	0.4536 kilograms (kg)	0.0004536 metric tons
1 kilogram (kg) =	1,000 grams (g)	2.2046 pounds (lb)	0.001 metric tons
1 short ton (ton) =	2,000 pounds (lb)	907.18 kilograms (kg)	0.9072 metric tons
1 metric ton =	2,204.62 pounds (lb)	1,000 kilograms (kg)	1.1023 short tons
Volume			
1 cubic foot (ft^3) =	7.4805 U.S. gallons (gal)	0.1781 barrels (bbl)	
1 cubic foot (ft^3) =	28.32 liters (L)	0.02832 cubic meters (m^3)	
1 U.S. gallon (gal) =	0.0238 barrels (bbl)	3.785 liters (L)	0.003785 cubic meters (m^3)
1 barrel (bbl) =	42 U.S. gallons (gal)	158.99 liters (L)	0.1589 cubic meters (m^3)
1 liter (L) =	0.001 cubic meters (m^3)	0.2642 U.S. gallons (gal)	0.0063 barrels (bbl)
1 cubic meter (m^3) =	6.2897 barrels (bbl)	264.17 U.S. gallons (gal)	1,000 liters (L)
Energy			
1 kilowatt hour (kWh) =	3,412 Btu (Btu)	3,600 kilojoules (KJ)	
1 megajoule (MJ) =	0.001 gigajoules (GJ)		
1 gigajoule (GJ) =	0.9478 million Btu (MMBtu)	277.8 kilowatt hours (kWh)	
1 British thermal unit (Btu) =	1,055 joules (J)	1.055 kilojoules (KJ)	
1 million Btu (MMBtu) =	1.055 gigajoules (GJ)	293 kilowatt hours (kWh)	
1 therm =	100,000 Btu	0.1055 gigajoules (GJ)	29.3 kilowatt hours (kWh)
Other			
kilo =	1,000		
mega =	1,000,000		
giga =	1,000,000,000		
tera =	1,000,000,000,000		
peta =	1,000,000,000,000,000		
1 mile =	1.609 kilometers		
1 metric ton carbon (C) =	$^{44}/_{12}$ metric tons CO_2		

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