

Methodology for Establishing Fuel-Specific Carbon Levies:

- The following steps outline the calculation methodology for fuel-specific carbon levies:
 - Obtain fuel specific emission factors from Environment and Climate Change Canada’s National Inventory Report (NIR), from stoichiometric equation or other source.
 - Obtain any necessary factors for volume/energy conversions.
 - Calculate the fuel-specific carbon levy using Equation 1.
- Equation 1 and its variables are defined below. Emission factors and conversion factors are summarized in Table 1. Final calculated carbon levies are summarized in Table 2.

Equation 1:

$$\text{Levy for Fuel A} = (\text{CO2EF}_{\text{Fuel A}} \cdot \text{CO2GWP} + \text{CH4EF}_{\text{Fuel A}} \cdot \text{CH4GWP} + \text{N2OEF}_{\text{Fuel A}} \cdot \text{N2OGWP}) \cdot \text{Price of Carbon} \cdot \text{Conversion Factor}$$

Where:

- $\text{CO2EF}_{\text{Fuel A}}$ is the CO2 emission factor for Fuel A.
 CO2GWP is the 100-year global warming potential for CO2, equivalent to 1 tonnes CO2e.
 $\text{CH4EF}_{\text{Fuel A}}$ is the CH4 emission factor for Fuel A.
 CH4GWP is the 100-year global warming potential for CH4, equivalent to 25 tonnes CO2e.
 $\text{N2OEF}_{\text{Fuel A}}$ is the N2O emission factor for Fuel A.
 N2OGWP is the 100-year global warming potential for N2O, equivalent to 298 tonnes CO2e.
 Price of Carbon is the price of carbon specified by the Government of Alberta in \$ per tonne CO2e.
 Conversion Factor is a fuel-specific energy-volume conversion factor.

Table 1: Summary of Emission Factors and Conversion Factors

Fuel	Variable	Value	Units	Reference / Comment
Aviation (Jet) Fuel	CO2EF	2560	g/L	NIR 2015 Part 2 Table A6-11
	CH4EF	0.029	g/L	
	N2OEF	0.071	g/L	
	Conversion Factor	N/A	N/A	
Aviation Gas	CO2EF	2365	g/L	NIR 2015 Part 2 Table A6-11
	CH4EF	2.2	g/L	
	N2OEF	0.23	g/L	
	Conversion Factor	N/A	N/A	
Bunker fuel	CO2EF	3156	g/L	NIR 2015 Part 2 Table A6-11 (Heavy Fuel Oil Ships)
	CH4EF	0.28	g/L	
	N2OEF	0.079	g/L	
	Conversion Factor	N/A	N/A	
Butane	CO2EF	1747	g/L	NIR 2015 Part 2 Table A6-3
	CH4EF	0.024	g/L	
	N2OEF	0.108	g/L	

	Conversion Factor	N/A	N/A	N/A
Coal Coke	CO2EF	3173	kg/tonne	NIR 2015 Part 2 Table A6-8
	CH4EF	0.03	kg/tonne	NIR 2015 Part 2 Table A6-9
	N2OEF	0.02	kg/tonne	
	Conversion Factor	N/A	N/A	N/A
Coke Oven Gas	CO2EF	687	g/m3	NIR 2015 Part 2 Table A6-8
	CH4EF	0.04	g/m3	NIR 2015 Part 2 Table A6-9
	N2OEF	0.04	g/m3	
	Conversion Factor	N/A	N/A	N/A
Diesel	CO2EF	2636	g/L	NIR 2015 Part 2 Table A6-11: A discount of 2% is applied to account for the Renewable Fuels Standard mandated blend rate.
	CH4EF	0.08586	g/L	NIR 2015 Part 3: calculated a weighted average Alberta fleet EF by dividing total CH4 emissions from diesel vehicles by litres of fuel (fuel quantity calculated based on total CO2 divided by CO2 emission factor).
	N2OEF	0.13027	g/L	NIR 2015 Part 3: calculated a weighted average Alberta fleet EF by dividing total N2O emissions from diesel vehicles by litres of fuel (fuel quantity calculated based on total CO2 divided by CO2 emission factor).
	Conversion Factor	N/A	N/A	N/A
Ethane	CO2EF	986	g/L	NIR 2015 Part 2 Table A6-3
	CH4EF	0.024	g/L	
	N2OEF	0.108	g/L	
	Conversion Factor	N/A	N/A	N/A
Gas Liquids	CO2EF	1631	g/L	Average of propane and butane: NIR 2015 Part 2 Table A6-3 and Table A6-11
	CH4EF	0.024	g/L	Average of propane and butane: NIR 2015 Part 2 Table A6-3 and Table A5-11
	N2OEF	0.108	g/L	Average of propane and butane: NIR 2015 Part 2 Table A6-3 and Table A6-11
	Conversion Factor	N/A	N/A	N/A
Gasoline	CO2EF	2200	g/L	2015 NIR Part 2 Table A6-11: A discount of 5% is applied to account for the Renewable Fuels Standard mandated blend rate.
	CH4EF	0.20370	g/L	NIR 2015 Part 3: calculated a weighted average Alberta fleet EF by dividing total CH4 emissions from gasoline vehicles by litres of fuel (fuel quantity calculated based on total CO2 divided by CO2 emission factor).
	N2OEF	0.12806	g/L	NIR 2015 Part 3: calculated a weighted average Alberta fleet EF by dividing total N2O emissions from gasoline vehicles by litres of fuel (fuel quantity calculated based on total CO2 divided by CO2 emission factor).
	Conversion Factor	N/A	N/A	N/A
Heating Distillate Oil	CO2EF	2753	g/L	NIR 2015 Part 2 Table A6-4
	CH4EF	0.026	g/L	
	N2OEF	0.006	g/L	

	Conversion Factor	N/A	N/A	N/A
Heavy Fuel Oil	CO2EF	3156	g/L	NIR 2015 Part 2 Table A6-4
	CH4EF	0.057	g/L	
	N2OEF	0.064	g/L	
	Conversion Factor	N/A	N/A	
High Heat Value Coal	CO2EF	2212	Kg/tonne	NIR 2015 Part 2 Table A-7
	CH4EF	0.03	Kg/tonne	NIR 2015 Part 2 Table A6-9
	N2OEF	0.02	Kg/tonne	
	Conversion Factor	N/A	N/A	N/A
Kerosene	CO2EF	2560	g/L	NIR 2015 Part 2 Table A6-4
	CH4EF	0.026	g/L	
	N2OEF	0.031	g/L	
	Conversion Factor	N/A	N/A	
Locomotive diesel	CO2EF	2636	g/L	NIR 2015 Part 2 Table A6-11: A discount of 2% is applied to account for the Federal Renewable Fuels Regulations mandated blend rate. 2015 NIR Part 2 Table A6-11
	CH4EF	0.15	g/L	
	N2OEF	1.1	g/L	
	Conversion Factor	N/A	N/A	
Low Heat Value Coal	CO2EF	1763	Kg/tonne	NIR 2015 Part 2 Table A-7
	CH4EF	0.03	Kg/tonne	NIR 2015 Part 2 Table A6-9
	N2OEF	0.02	Kg/tonne	
	Conversion Factor	N/A	N/A	N/A
Methanol	CO2EF	1087	g/L	From reaction stoichiometry assuming 100% combustion efficiency
	CH4EF	N/A	N/A	
	N2OEF	N/A	N/A	
	Conversion Factor	N/A	N/A	
Naphtha	CO2EF	2245	g/L	EPA Emission Factors for Greenhouse Gas Inventories Table 1 ¹
	CH4EF	0.1	g/L	
	N2OEF	0.02	g/L	
	Conversion Factor	3.78541	L/gallon	
Natural Gas	CO2EF	1928	g/m3	2015 NIR Part 2 Table A6-1
	CH4EF	0.037	g/m3	2015 NIR Part 2 Table A6-2
	N2OEF	0.035	g/m3	2015 NIR Part 2 Table A6-2
	Conversion Factor	38.34	GJ/e3m3	McCann (2000)

¹ http://www.epa.gov/sites/production/files/2015-12/documents/emission-factors_nov_2015.pdf

Raw Gas	CO2EF	2392	g/m3	2015 NIR Part 2 Table A6-1
	CH4EF	6.4	g/m3	2015 NIR Part 2 Table A6-2
	N2OEF	0.06	g/m3	2015 NIR Part 2 Table A6-2
	Conversion Factor	44.83	GJ/e3m3	McCann (2000)
Pentanes Plus/Condensate	CO2EF	1913	g/L	From reaction stoichiometry assuming pentane with 100% combustion efficiency
	CH4EF	N/A	g/L	
	N2OEF	N/A	g/L	
	Conversion Factor	N/A	N/A	N/A
Propane	CO2EF	1515	g/L	NIR 2015 Part 2 Table A6-11
	CH4EF	0.64	g/L	NIR 2015 Part 2 Table A5-11
	N2OEF	0.028	g/L	NIR 2015 Part 2 Table A6-11
	Conversion Factor	N/A	N/A	N/A
Refinery Gas	CO2EF	1883	g/m3	NIR 2015 Part 2 Table A6-5
	CH4EF	N/A	g/m3	NIR 2015 Part 2 Table A6-4
	N2OEF	0.00002	g/m3	NIR 2015 Part 2 Table A6-4
	Conversion Factor	N/A	N/A	N/A
Refinery Petroleum Coke	CO2EF	3814	g/L	NIR 2015 Part 2 Table A6-5 refineries and others
	CH4EF	0.12	g/L	NIR 2015 Part 2 Table A6-4
	N2OEF	27.5	g/m3	NIR 2015 Part 2 Table A6-6 refineries and others
	Conversion Factor	835	t/l	Canadian Industrial Energy End-Use Data Analysis Centre. 2014. Energy Use and CO2 Emissions in Canadian Oil Refineries 1990, 1994 to 2012.
Upgrader Petroleum Coke	CO2EF	3494	g/L	NIR 2015 Part 2 Table A6-5 Upgrading Facilities
	CH4EF	0.12	g/L	NIR 2015 Part 2 Table A6-4
	N2OEF	24	g/m3	NIR 2015 Part 2 Table A6-6 Upgrading Facilities
	Conversion Factor	835	t/l	Canadian Industrial Energy End-Use Data Analysis Centre. 2003. A Review of Energy Consumption in Canadian Oil Sands Operations, Heavy Oil Upgrading 1990, 1994 to 2001.

Table 2: Summary of Fuel-Specific Carbon Levies

Type of Fuel	January 1, 2017 Rate (\$20/tonne)	January 1, 2018 Rate (\$30/tonne)
Aviation (Jet) Fuel	5.17 ¢/L	7.75 ¢/L
Aviation Gas	4.98 ¢/L	7.47 ¢/L
Bunker fuel	6.36 ¢/L	9.55 ¢/L
Butane	3.56 ¢/L	5.3400 ¢/L
Coal Coke	\$63.59 /tonne	\$95.39 /tonne
Coke Oven Gas	1.40 ¢/m3	2.1 ¢/m3

Diesel	5.35 ¢/L	8.0300 ¢/L
Ethane	2.04 ¢/L	3.0600 ¢/L
Gas Liquids	3.33 ¢/L	4.99 ¢/L
Gasoline	4.49 ¢/L	6.7300 ¢/L
Heating Distillate Oil	5.51 ¢/L	8.27 ¢/L
Heavy Fuel Oil	6.35 ¢/L	9.53 ¢/L
High Heat Value Coal	\$44.37 /tonne	\$66.56 /tonne
Kerosene	5.14 ¢/L	7.7100 ¢/L
Locomotive diesel	5.94 ¢/L	8.9 ¢/L
Low Heat Value Coal	\$35.39 /tonne	\$53.09 /tonne
Methanol	2.18 ¢/L	3.2600 ¢/L
Naphtha	4.49 ¢/L	6.7300 ¢/L
Natural Gas	\$1.01 /GJ	\$1.52 /GJ
Raw Gas	\$1.15 /GJ	\$1.72 /GJ
Pentanes Plus	3.82 ¢/L	5.73 ¢/L
Propane	3.08 ¢/L	4.6200 ¢/L
Refinery Gas	3.77 ¢/m3	5.65 ¢/m3
Refinery Petroleum Coke	\$63.86 /tonne	\$95.79 /tonne
Upgrader Petroleum Coke	\$58.50 /tonne	\$87.75 /tonne