

Guide to calculating GHG emissions by hand

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Calculating Greenhouse Gas Emissions by Hand

Introduction

This document provides a step-by-step guide to calculating your greenhouse gas (GHG) emissions, expressed in kilograms of carbon equivalents (kg CO₂e). The calculations for each emissions factor are indicated to allow for long-hand conversions to determine total GHG emissions.

What are Carbon equivalents (CO₂e)?

Carbon equivalents provide a universal measure by which to compare all greenhouse gases and to express them in common units. Because carbon dioxide is the most prevalent greenhouse gas, other greenhouse gases have been given a carbon equivalent values. For example, methane gas is 25 times more potent than carbon dioxide as a greenhouse gas. In other words, it takes 25 carbon dioxide molecules to equal the global warming potential (GWP) of one molecule of methane. The GWP provides a method for converting emissions of various gases into a common measure, indicated as carbon or carbon dioxide equivalents (CO₂e). Greenhouse gas emissions tend to be listed as CO₂e.

Human-generated GHGs generally come from the following four sources:

1. Travel (airplane, bus, train, car, ferry)
2. Electricity consumption
3. Heating consumption
4. Waste production

To calculate your GHG emissions, you will need to gather the following information:

- **Travel:** Kilometres (km) traveled by each transportation type: this can be determined by tracking kilometers traveled for trips taken over time.
- **Electricity:** Kilo-watt hours (kWh) of electricity consumed: this can be collected from electricity bills.
- **Heating:** Cubic metres (m³) of natural gas, litres (L) of heating oil or propane (these can be found on your heating bills), or cords of wood consumed.
- **Waste:** Kilograms (kg) of waste produced: this can be estimated through gathering a typical week's worth of waste, weighing it and multiplying it by the number of weeks in your evaluation period.

I. Travel

Airplane

Separate airplane travel to those trips under 500 km and longer than 500 km. This is important because flights over 500 km have a greater impact due to emissions released at a higher altitude, and are therefore calculated differently.¹

Calculations:

- For short trips (under 500km), multiply the kilometres traveled by 0.15
(Ex. 1,000 km x 0.15 = 150 kg CO₂e)
- For long trips (over 500km), multiply the kilometres traveled by 0.11 and 2.7.²
(Ex. 1,000 km x 0.11 x 2.7 = 297 kg CO₂e)

Detailed examples:

In 2007, you traveled 3000 km in short distance flights (i.e. from Montreal to Toronto) and

45,000 km in long distance flights (i.e. Calgary to Sydney, Australia)
 Short distance: $3000\text{km} \times 0.15 = 450$ kg of carbon dioxide equivalents (CO₂e)
 Long distance: $45,000\text{km} \times 0.11 \times 2.7 = 13,365$ kg CO₂e

Bus

Separate bus travel to local city travel buses and inter-urban trips i.e. on Coach Canada or Greyhound.

Calculation:

- For travel on local travel (city bus), multiply the kilometers traveled by 0.079.
(Ex. $1,000 \text{ km} \times 0.079 = 79$ kg CO₂e)
- For interurban travel (Coach Canada, Greyhound), multiply the kilometers traveled by 0.041.³ (Ex. $1,000 \text{ km} \times 0.041 = 41$ kg CO₂e)

Train

Train travel refers to travel on Via Rail.

Calculation:

- For emissions produced by train travel, multiply the kilometers traveled by 0.105.⁴
(Ex. $1,000 \text{ km} \times 0.105 = 105$ kg CO₂e)

Subway/Light Rail

People in Calgary, Montreal, Toronto and Vancouver can also calculate the GHG emissions from their use of subways or light rail. You will need to determine the distance you've traveled and multiply it by the factor below to calculate your amount of GHG emissions.

Calgary (C-Train): 0.08

Montreal (Metro): 0.01

Toronto (Subway): 0.077

Vancouver (Skytrain): 0.06

Sample Calculation, based on 100 km:

- For Calgary, multiply the kilometres traveled by 0.08.
(e.g. $100 \text{ km} \times 0.08 = 8$ CO₂e)
- For Montreal, multiply the kilometres traveled by 0.01.
(e.g. $100 \text{ km} \times 0.01 = 1$ CO₂e)
- For Toronto, multiply the kilometres traveled by 0.077.
(e.g. $100 \text{ km} \times 0.077 = 7.7$ CO₂e)
- For Vancouver, multiply the kilometres traveled by 0.06.
(e.g. $100 \text{ km} \times 0.06 = 6$ CO₂e)

Car

It is important to know the type of car when calculating vehicle GHG emissions, because cars that are less fuel-efficient produce more emissions.

Table 1 below notes the type of car, and the number you multiply by to calculate the carbon dioxide equivalents produced per car type.

Table 1: Car type and emissions factor

Type of Car	Multiply kilometres traveled by:
Hybrid car (i.e. a Prius)	0.1262
Sub-compact (i.e. small car, like a Civic)	0.183
Compact (i.e. larger car, like an	0.2162

Accord)	
Minivan	0.2964
Truck or SUV	0.3103

Source: Foundation Paper on Climate Change and Guidelines to Defra's GHG conversion factors for company reporting.

Ferry

When gathering the data on travel by ferry, be sure to know which trips were taken with a car and those as a foot passenger, as these are calculated differently.⁵

Calculations:

- Ferry trip by car: multiply the distance traveled (kms) by 0.757.
(Ex. 1,000 km x 0.757 = 757 kg CO₂e)
- Ferry foot passenger: multiply the distance traveled by 0.037.⁶
(Ex. 1,000 km x 0.037 = 37 CO₂e)

II. Electricity

The impact of electricity consumption differs by province due to the different sources of energy that feed the regional grids. For example, British Columbia and Quebec use mostly hydro-electricity, while Alberta uses primarily oil.

You can calculate your electricity-related GHGs by multiplying your consumption (in kilowatt hours: KWh) by the emissions factor depending on your province location.

Calculation:

- KWh multiplied by your province's emissions factor = kg eCO₂.
(Ex. 1,000 kWh x 0.924 for Alberta = 924 kg Co₂e)

Table 2 provides the emissions factor per province.

Table 2: Electricity emission factor by province

Province	Electricity Emission Factor
Alberta	0.924
British Columbia	0.031
Manitoba	0.028
New Brunswick	0.455
Newfoundland & Labrador	0.033
NWT / Nunavut / Yukon	0.249
Nova Scotia	0.763
Ontario	0.241
Prince Edward Island	0.449
Quebec	0.009
Saskatchewan	0.914

Source: Canadian Standards Association GHG Registry⁷

III. Heating

The greenhouse gas emissions created from heating depend upon the source used to create the energy. Depending on your heating energy source, follow the indications in the Table 3 below to determine your heating-related GHGs.

Calculation:

- Cubic metres/litres/cords multiplied by their respective emissions factors = CO₂e.
(Ex. 1,000 litres of heating oil x 2.8 = 2800 kg CO₂e)

Table 3: Emissions factors for various heating sources

If you use:	Find your consumption in:	Multiply it by:
Natural gas	Cubic metres (m ³)	1.9
Heating oil	Litres (L)	2.8
Propane	Litres (L)	1.53
Wood	Cords*	18 x 1.576 ⁸

*A cord is 8 ft by 8ft by 8ft (standard measurement of wood pile; wood is sold in cords).

IV. Solid waste

Greenhouse gas emissions from waste are produced when organic matter decomposes while compressed in a landfill with no air. This is referred to as anaerobic decomposition, and the result is a greenhouse gas called methane, which is 25 times more potent than carbon. Similar to greenhouse gases generated from electricity production, those created by solid waste depend upon the province where you are located due to soil conditions.⁹

Calculation:

- Kg of waste multiplied by the emissions factor of your province = CO₂e.
(Ex. 1,000 kg x 0.06 in Alberta = 60 kg CO₂e)

Table 4: Calculating carbon equivalents by province for solid waste-related GHGs

Province	Multiply your kg of solid waste by:
Alberta	0.06
British Columbia	0.13
Manitoba	0.06
New Brunswick	0.13
Newfoundland & Labrador	0.13
NWT / Nunavut / Yukon	0.05
Nova Scotia	0.13
Ontario	0.08
Prince Edward Island	0.13
Quebec	0.13
Saskatchewan	0.06

Source: All figures from National Inventory Report: Natural Resources Canada.

Endnotes

¹ Long flights change in radiation energy at high levels in the atmosphere (the troposphere) and therefore have a larger impact. Learn more at: http://www.atmosfair.de/fileadmin/user_upload/image4/atmosfair_calculator_04.pdf

² Emissions factor information came from the Guidelines to Defra's GHG conversion factors for company reporting (<http://www.defra.gov.uk/environment/business/envrp/pdf/conversion-factors.pdf>).

³ These emissions factors came from the Foundation Paper on Climate Change: Transportation Sector. http://www.tc.gc.ca/programs/environment/climatechange/english/climatechange/prog_reports/trans_found.pdf

⁴ Emissions factor information came from the Foundation Paper on Climate Change.

⁵ Ferry foot passengers are responsible for 5 percent of total emissions on a ferry trip, and cars contribute 95 percent (based on proportions by weight on BC Ferries).

⁶ Emissions factor information came from the Foundation Paper on Climate Change.

⁷ This information is found on http://www.ghgregistries.ca/emission_estimation_resources_e.cfm or http://www.ghgregistries.ca/challenge/emission_estimation_resources_e.cfm. The Canadian Standards Association GHG registries are widely recognized as being the most accurate emissions factors for electricity, insofar as one fixed emission factor can ever be considered accurate (challenging due to ever-changing energy sources that feed regional grids).

⁸ There are two conversion factors for wood because it is first converted from cords to giga-joules (GJ), then GJ eCO₂.

⁹ Emissions factors for solid waste are expressed as L₀ values, which is the methane generation potential. Methane is a highly potent greenhouse gas, with 25 times the warming potential of one unit of carbon dioxide. The k value is the generation rate constant coefficient. Multiplying L₀ * k gives the amount of methane produced. This result is multiplied by 25 to determine global warming potential, and divided by 1000 to convert it to kilograms.