SAMPLE GREENHOUSE GAS CALCULATION

Introduction

Typically, greenhouse gas inventories are completed with the support of software or consultants; though this may be the case in many instances, it is important to understand how emissions are calculated. Use this guide as a support for calculating emissions or creating a spreadsheet to reduce outside support for greenhouse gas calculations and inventories.

Greenhouse gas calculations are completed as follows:

- **Step 1:** Gather activity data.
- **Step 2:** Identify emission factors.
- **Step 3:** Refer to global warming potentials.
- **Step 4:** Calculate.

Sample Greenhouse Gas Calculation

Step 1: Gather Activity Data

Collecting raw data on relevant greenhouse gas emitting activities (ex. natural gas and/or electricity consumption, litres of gasoline etc.) is the first key piece required to begin calculating emissions; this information is called Activity Data. If additional data collection support is necessary, refer to Milestone 3 documents "Recommended Key Reporting Areas for a Post-Secondary Greenhouse Gas Inventory" and "Guidance for Completing a Greenhouse Gas Inventory" for further assistance.

Step 2: Identify Emission Factors

Most greenhouse gas emitting activities relevant to the post-secondary sector will release three different gases, each in different amounts: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). This means each emitting activity has three different emission factors, one for each gas. Remember, an emission factor is the amount of a greenhouse gas produced per unit of an emitting activity, for instance, grams of carbon dioxide emitted per litre of gasoline, or grams of methane emitted per cubic metre (m^3) of natural gas etc. For reference, Canadian emission factors can be found within the National Inventory Report that is housed in two locations, the Government of Canada website and the United Nations Climate Change website.

Certain emission factors vary based on geographical location; for instance, electricity emission factors vary within provinces and territories due to different combinations of renewable and non-renewable sources used to generate electricity. Therefore, it is best practice to use emission factors from areas that describe the location of your institution with the highest degree of accuracy. Generally, cities or regions do not have their own emission factors, so provincial or national values are the next options.

The example below will demonstrate how to calculate greenhouse gas emissions for 1,000 L of gasoline. Emission factors are provided in the table below. Refer to "Guidance for Completing a Greenhouse Gas Inventory" for additional information on emission factors.

Greenhouse Gas	Gasoline Emission Factors (g/L)
Carbon dioxide (CO_2)	2,307
Methane (CH_4)	0.14
Nitrous oxide (N_2O)	0.022

Note: The location of the above emission factors are within Part 2 Table A6-12 "Light-duty Gasoline Vehicles: Tier 2" of the 2018 National Inventory Report publication.

Step 3: Refer to Global Warming Potentials (only required if converting to carbon dioxide equivalent)

As a reminder, carbon dioxide equivalent (CO_2e) is a term used to express the impact of each greenhouse gas in terms of the amount of CO_2 that would create the same amount of warming[1]. For instance, driving a vehicle predominantly produces carbon dioxide, but it also creates methane and nitrous oxide, both of which are better at warming than carbon dioxide; these gases also need to be considered in the final calculation. CO_2e converts the amount of gas produced by an activity into one unit and number instead of reporting on each greenhouse gas separately. Global Warming Potentials (GWP) are required to make this calculation and the relevant ones for this example are outlined in the table below. For reference, the GWP of carbon dioxide is one, methane is 25, and nitrous oxide is 298, meaning one tonne of methane has the heating ability of 25 tonnes of carbon dioxide, and one tonne of nitrous oxide has the heating ability of 298 tonnes of carbon dioxide. Find GWPs here. Note, GWP are the same regardless of the emitting activity, unlike emission factors.

Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298

Step 4: Calculate

As an example, the calculation below shows how to determine total emissions in CO_2e from 1,000 L of gasoline. Remember, most greenhouse gas emitting activities release three different gases, so each calculation will have to be completed three times - once for each gas, though the formulas will remain the same.

Calculation

A. Calculate tonnes of emissions for each gas for the chosen emitting activity, in this case it is the combustion of 1,000 L of gasoline. This calculation is completed for each gas.

$$\text{Greenhouse Gas Emissions} = \text{Activity Data} \times \text{Emission Factor}$$

B. Using results from Step A, convert to CO_2e. This calculation is completed for each gas.

$$CO_2e = A \times \text{GWP of gas}$$

C. Add results of Step B together

A. Calculate Emissions for Each Greenhouse Gas Emitted as a Result of the Activity

Gas 1

CO_2 Carbon Dioxide = 1,000 L x 2,307 g/L

= 2,307,000 g CO_2
This equals **2.307 Tonnes of CO_2**

Gas 2

CH_4 Methane = 1,000 L x 0.14 g/L

= 140 g CH_4
This equals **0.00014 Tonnes of CH_4**

Gas 3

N_2O Nitrous Oxide = 1,000 L x 0.022 g/L

= 22 g N_2O
This equals **0.000022 Tonnes of N_2O**

B. Using Results from Step A, Convert to CO_2e for Each Gas

Multiply each gas by their corresponding GWP to convert each gas to their CO_2e value. Use the table above as a reference.

The calculation looks like this:

Gas 1

CO_2 Carbon Dioxide: 2.307 Tonnes of CO_2 X 1 GWP = **2.307 Tonnes of CO_2e**

Gas 2

CH_4 Methane: 0.00014 Tonnes of CH_4 X 25 GWP = **0.0035 Tonnes of CO_2e**

Gas 3

N_2O Nitrous Oxide: 0.000022 Tonnes of N_2O X 25 GWP = **0.006556 Tonnes of CO_2e**

C. Add

With all greenhouse gases now converted to the same unit (CO_2e), simply add together.

Total CO_2e produced by 1,000 L of gasoline = **2.307** **0.0035** **0.006556**

= 2.317 Tonnes of CO_2e

Potential Challenges

- Finding accurate and locally relevant emission factors.
- If calculating without the help of software, finding the required time to organize potentially large data sets and complete manual calculations.

Conclusion

Greenhouse gas inventories are typically contracted out or completed with the assistance of software and may be associated with high or unsustainable costs. In practice, emissions calculations are not overly complex and expand the knowledge base of those taking on the task. Before deciding on the supports required to complete a greenhouse gas inventory, take a moment to consider if it can be completed internally with in-house capacity.

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[1] The Guardian. (2017). What are CO_2e and global warming potential? Accessed from https://www.theguardian.com/environment/2011/apr/27/co2e-global-warming-potential