Scope 3 GHG Emissions Accounting for Universities

METHODOLOGICAL GUIDE

Réseau universitaire québécois
EN DÉVELOPPEMENT DURABLE

Title: Trouverons-nous le point de rassemblement [Will we find common ground?]

Medium: Oil on canvas

Dimensions: 91.4 x 76.2 cm (36 x 30 in)

Date: 2025

Artist: Sarah Cloutier

DESCRIPTION

This painting illustrates the concept of studying and quantifying an environment and the emergence of new pathways revealed by the data collected. The data appears in the form of dense rectangles, volumes and textures, like an abstract quantification of GHG emissions from a diversified urban environment. The hot, acidic sky, evoking a climate crisis that is already here, expresses an urgent call to action. The geometric forms are punctuated by plant-like shapes that invite us to think about nature's role in the decisions that will have to be made. All the lines converge on a single focal point, representing collective effort toward change.

Produced for the **Réseau universitaire québécois en développement durable**

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LIST OF ACRONYMS

CAUBO
Canadian Association of University Business Officers

CIRAIG
International Reference Center for Life Cycle Assessment and Sustainable Transition

EF
Emission factor

GHG
Greenhouse gas

GWP
Global warming potential

IPCC
Intergovernmental Panel on Climate Change

ISO
International Organization for Standardization

NIR
National inventory report

RNG
Renewable natural gas

RUQDD
Réseau universitaire québécois en développement durable

t CO_2e
tonnes of CO_2 equivalent

GLOSSARY

Activity data
Quantitative measurement of an activity that generates GHG emissions

Calculation method
Approch for calculating GHG emissions in an inventory

Quantification approch
Method for combining data consistently and clearly

Emission factor
Factor allowing emissions to be estimated from a unit of available activity data

Global warming potential
Factor based on the radiative properties of GHGs

Primary data
Data directly measured or calculated from direct measurements

Radiative forcing
Warming effect of a system (e.g. the atmosphere)

Secondary data
Data from other sources

Scope 3 GHG emissions
An organization's indirect value chain emissions

Specific activity data
Data from specific activities within the organizational boundary

INTRODUCTION

1. WHY A COMMON METHODOLOGICAL GUIDE?

This methodological guide for quantifying Scope 3 GHG emissions is intended as a shared reference tool to help all Quebec universities share reliable data adapted to their specific context. It is the fruit of many months of collaborative efforts by the Réseau universitaire québécois en développement durable (RUQDD). Its purpose is to improve and harmonize emission accounting methodology by facilitating the transfer of collective knowledge and expertise. It is not intended as a substitute for international standards.

In this guide you will find the emission sources to be included, depending on their relevance, in order to ensure a complete inventory. A calculation method is proposed for each Scope 3 category, along with the related emission factors (EFs). The guide also aims to ensure that inventories are coherent, accurate and transparent, and that they can be used by the University to benchmark against itself and peer institutions over time.

2. IMPORTANCE OF SCOPE 3 GHG EMISSIONS

According to the Canadian Association of University Business Officers (CAUBO), Scope 3 emissions may account for as mush as 87% of the GHG emissions from a higher education institution. To fully understand the impact of GHG emissions on the climate, a proper estimation of the sum of scopes 1, 2 and 3 is essential.

Scope 3 GHG emissions are generated by indirect sources linked to the University's activities and operations, that is, sources that are not necessarily owned or controlled by the University. Although the University does not have a regulatory requirement to track and report Scope 3 emissions, estimating them can provide a more complete picture of its total emissions. An inventory can help pinpoint the biggest emission sources, set reduction targets, identify reduction opportunities and monitor performance. Furthermore, given their influential role among the province's stakeholders, universities seek to lead by example, in particular by quantifying their GHG emissions.

BASIC CONCEPTS

1. METHODOLOGICAL REFERENTS

The principles used to produce GHG inventories and reports are based on the following methodological referents:

› GHG Protocol. (2011). *A Corporate Accounting and Reporting Standard (revised edition), including Accounting and Reporting Standard Amendment* (February 2013);

› International Organization for Standardization (ISO) (2018). ISO 14064-1: *Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals;*

› Urban, K., Michayluk, C. and MacCormack, C. [Footprint]. (June 2022). *Scope 3 Greenhouse Gas Emissions Estimation Guidance*. CAUBO.

2. GREENHOUSE GASES TO INCLUDE

In accordance with ISO 14064-1 and the GHG Protocol, the GHGs to include are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3) and any other relevant GHG.

ISO 14064-1 recommends reporting biogenic CO_2 emissions separately. The approach taken in this guide is to exclude biogenic CO_2 from Scope 3 emissions reporting. For example, biogenic CO_2 emissions are not included in the waste treatment EFs proposed in this guide, but they can nevertheless be calculated and reported separately.

Similarly, do not choose EFs that include activities related to carbon capture, such as food products. Carbon capture can be reported separately.

3. REPORTING AND MONITORING OVER TIME

It is good practice to share the emissions accounting results with the university community. This is typically done by producing a GHG emissions inventory or assessment, but the results can also be published on the Web.

The GHG emissions inventory covers a one-year period and should ideally be produced each year. The reporting period is typically the University's fiscal year. The reference year is usually the year in which a GHG inventory was conducted for the first time, and it will vary from one University to the next.

Once the reference year is set, the same calculation method should be used to quantify emissions for that year and all subsequent years. If there is a substantial change (such as a change in EF or adoption of a new consolidation approach), the reference year inventory should be redone using the same activity data so that the inventories will be comparable.

4. ORGANIZATIONAL BOUNDARY

To clearly identify which emission sources to include and which to exclude from the inventory, it is important to set the organizational boundaries.

> The organizational boundary is the grouping of activities or facilities in which an organization exercises operational or financial control or has an equity share. (ISO, 2018)

5. CONSOLIDATION METHOD

The consolidation approach used in this guide is based on operational control. The University reports 100% of the GHG emissions and removals from facilities over which it has operational control. According to ISO 14064-1:2018, "An organization has operational control over an operation if it, or one of its subsidiaries, has the full authority to introduce and implement its operating policies at the operational level."

In other words, an organization has operational control over a GHG-emitting activity if it can make decisions about that activity. In the case of buildings,[1] where GHG emissions are mainly the result of energy consumption, the organization has operational control if it can make choices about the energy source or quantity used. For other types of activity, such as procurement, the organization exercises operational control through its purchasing choices; for example, it can opt for a product with a lower carbon footprint.

Organizations do not have full operational control over Scope 3 emissions. However, this cannot justify excluding emissions from the Scope 3 inventory, since organizations can have agency and influence over the choices and activities resulting in the emissions. In any case, any exclusion must be justified when reporting GHG emissions.

For example, the University can exert its influence through contract clauses or regulations. If there is no power of influence, excluding an emission source from the inventory may be justified. There may be other reasons for exclusion such as data unavailability or low materiality.

1. For more information about reporting GHG emissions from buildings, see the sections on categories 3.8 and 3.13.

6. MATERIALITY

Materiality refers to the relative weight of a GHG emission source or category in an organization's inventory. A source or category is said to be material if it accounts for more than 1% of the Scope 3 inventory. The materiality of an activity is evaluated by analyzing its expected relative weight compared with the average sector data at an appropriate scale. For example, if a university with a similar-sized campus or student population has quantified a source or category, its results may be used to assess the materiality of that source or category.

If an emission source or category is not material, it can be excluded from the inventory. All exclusions, for whatever reason, must be explained clearly. The sum of all exclusions must not exceed 5% of total Scope 3 GHG emissions.

7. DOUBLE COUNTING

The purpose of an inventory is to guide emissions reduction efforts by identifying sources and determining their order of magnitude in order to know the impact of the organization's activities. All GHG emissions across the University's value chain must therefore be included, even if they have already been quantified by another university or organization.

Of course, one organization's Scope 3 emissions are the Scope 1, 2 or 3 emissions of another organization. Looked at from this angle, quantifying Scope 3 emissions can result in the same emissions being reported twice. Quantifying them is nevertheless good practice because it enables the organization to consider the full impact of its activities and to see how that impact is influenced by each actor in the value chain.

As a result, the same GHG emission source can be reported by more than one organization, since they each have the power to influence the activities causing the emissions (Baglia, 2024). In the case of a university delegation, for instance, the travel emissions would be inventoried by the host University as well as the visiting University, given that they both have the ability to reduce emissions by limiting the number of delegates or by other means.

While double counting is justified in the situation above, the same GHG emissions should not appear twice in one organization's inventory. For example, stationary combustion emissions from a building owned by the University and leased out should be inventoried under Scope 1 or Scope 3 (category 3.13), but not both.

8. DATA QUALITY ANALYSIS

The quality of the data that goes into an emissions inventory—including activity data and other information needed for accounting, such as EFs and GWPs (global warming potentials)—is key to producing reliable results.

Data quality depends on its source and its proximity to the University's economic or geographic reality. Primary data and specific data are produced by or obtained from suppliers within the reporting organization's organizational boundaries. The quality of secondary data depends on the level of confidence in the source and how strict it is in its methods.

Data uncertainty can be quite high, especially for Scope 3 emissions. It must be taken into account, reported and, ideally, estimated. Data quality should also be the subject of improvement efforts.

9. QUANTIFICATION APPROCH

A quantification approach is the choice made regarding how GHG emissions are accounted for in an inventory. It is important to select the most appropriate method to minimize the uncertainty inherent in the accounting exercise. There are two methods: activity-based and spend-based. The first, considered more reliable and closer to reality, requires access to physical activity data (e.g. fuel volume, number of kilometres). The second can be useful if expenses are the only activity data available, but it creates more uncertainty and often gives an inaccurate picture of the actual emissions (GHG Protocol, 2011). Moreover, the spend-based method makes it difficult to monitor improvements, for example in responsible procurement. Another reason for choosing the financial approach is the lack of credible or relevant physical emission factors.

10. CALCULATION METHOD

Both activity-based and spend-based methods require multiplying the activity data by the EF.

GHG emissions = activity data x emission factor

Activity data is a quantitative measure of an activity that results in GHG emission or removal: for example, the amount of energy, fuel or electricity consumed, material produced, service provided, or area of land affected (ISO, 2018, 3.2.1).

The EFs are coefficients relating activity data to GHG emissions (ISO, 2018) and are defined as follows:

> Emission factors are based on samples of measurement data and are representative rates of emissions for a given activity level under a given set of operating conditions. It is the estimated average emission rate of a given pollutant for a given source, relative to units of activity. (Government of Canada, 2023)

EFs are produced and updated periodically by various sources and are generally valid for a specific period. The inventory should therefore use the EFs for the period in which the activity took place. This guide uses EFs for 2023 but also has an appendix with EFs for the years 2020 to 2025.

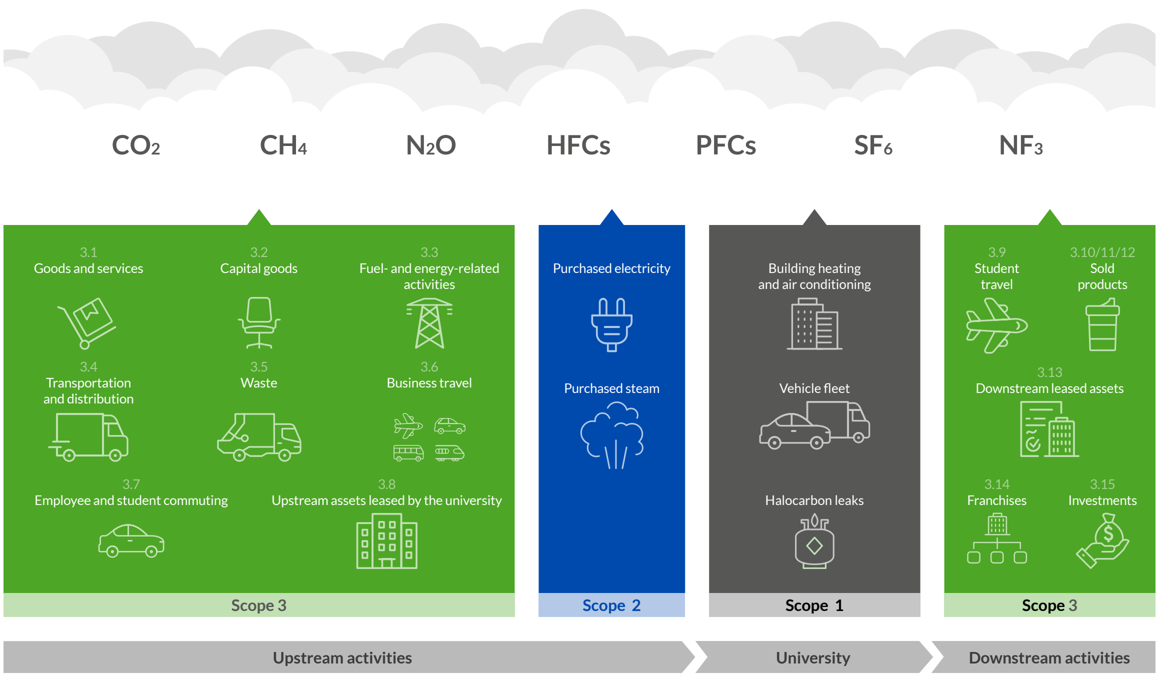
The EFs shown are expressed in tonnes of CO_2 equivalent (t CO_2e). Carbon dioxide equivalents are determined using the EF for each gas emitted and the GWP of that gas. The emission quantities for each GHG are multiplied by its GWP and are then added up and expressed in CO_2 equivalent (CO_2e), which is the common unit of measure.

$$\text{GHG emissions in } CO_2e = \sum \text{GHG emissions}_i \times \text{GWP}_i$$

The GWP of a greenhouse gas is an index based on its radiative properties. Greenhouse gases differ in their ability to absorb heat due to their differing chemical properties and atmospheric lifetimes. The GWP expresses a GHG's potential to trap heat in the atmosphere, compared with that of CO_2. For example, on a 100-year time horizon, methane's heat-trapping potential is 29.8 times greater than that of carbon dioxide. Methane is therefore considered to have a GWP of 29.8 (IPCC, 2021). The GWP values used in this guide are presented in an appendix.

SCOPE 3 GHG EMISSIONS

GREENHOUSE GAS EMISSIONS FROM AN EDUCATIONAL INSTITUTION



Scope 3 emissions are divided into upstream and downstream emissions. The distinction is based on the financial transactions of the reporting organization, where:

- upstream emissions are indirect GHG emissions related to purchased or acquired goods and services (or their transportation); and
- downstream emissions are indirect GHG emissions related to sold goods and services (or their transportation).

The GHG Protocol divides Scope 3 emissions into 15 standardized categories developed to meet the needs of various reporting entities. Not all the categories apply to the University, and some are less important than others. In other words, not all the categories are relevant or have significant emissions.

Table 1 shows the recommended method and EF sources for each category.

Section D of this guide is organized around these 15 categories. For each one, it lists what items to include, the recommended quantification approch, and the source of the proposed EF.

TABLE 1: SUMMARY OF SCOPE 3 EMISSION CATEGORIES

CATEGORY	SUBCATEGORIES	RECOMMENDED METHOD	SOURCE OF PROPOSED EF	DETAILS
3.1 Purchased goods and services	› Purchased goods and services › Food	› Spend-based › Activity-based	› Open IO – Canada database, on Climatiq › Ecoinvent database	
3.2 Capital goods	› Current assets	› Spend-based	› Open IO – Canada database, on Climatiq	› Not depreciated
3.3 Fuel- and energy-related activities	› Fuel › Electricity	› Activity-based	› Environment Canada database › Levasseur et al., 2021	› Life cycle emissions (-) reported scope 1 and 2 emissions
3.4 Upstream transportation and distribution	› Goods	› Exclusion	› N/A	› Materiality, inaccessible data, and methodological limitations
3.5 Waste generated in operations	› Waste transport › Waste treatment › Wastewater treatment	› Activity-based	› GHGenius 5.02c › Varies by type of waste › IPCC, 2019	
3.6 Business travel	› Paid by the university › Delegations › Sports teams	› Activity-based where possible, otherwise spend-based	› EPA GHG Emission Factors Hub › Aviation multiplier: Lee et al., 2021 › Open IO – Canada database, on Climatiq	› Land and air travel

TABLE 1: SUMMARY OF SCOPE 3 EMISSION CATEGORIES — SUITE

CATEGORY	SUBCATEGORIES	RECOMMENDED METHOD	SOURCE OF PROPOSED EF	DETAILS
3.7 Employee and student commuting	› Car › Public transportation	› Activity-based	› EPA GHG Emission Factors Hub	
3.8 Upstream assets leased by the university	› Buildings › Other (boats, cars)	› Activity-based	› National Inventory Report	› University is tenant
3.9 Student travel (downstream transportation and distribution in the GHG Protocol)	› International students › Exchange students	› Activity-based	› EPA GHG Emission Factors Hub › Aviation multiplier: Lee et al., 2021	› One round trip per person
3.10-11-12 Sold products	› Processing, use and treatment	› Exclusion	› N/A	
3.13 Downstream leased assets	› Fuel › Electricity	› Activity-based (or in scopes 1 and 2)	› National Inventory Report	› University is owner and lessor
3.14 Franchises		› N/A	› N/A	
3.15 Investments		› Inclusion	› N/A	› Weighted average carbon intensity (WACI) or Absolute emissions

METHODOLOGICAL GUIDE

3.1. PURCHASED GOODS AND SERVICES

This category covers goods and services purchased by the University recorded as expenditures in the financial statements. They include but are not limited to the following:

- Renovation: material and labour (e.g. general contractors, plumbing and electrical) for the renovation and redevelopment of buildings and spaces;
- Maintenance and repairs: landscaping, extermination and janitorial services, and computer, machinery, vehicle and equipment maintenance;
- Specialized equipment: laboratory equipment, medical/dental equipment, sporting goods, clothing, animal care, chemicals and biological products;
- Accommodation and hosting expenses: caterers, hotels, restaurants;
- Office expenses and equipment: advertising, commercial printing, insurance, office supplies, packaging services, external couriers;
- Professional fees: outsourced legal, architectural, engineering, consulting, security and courier services;
- Digital: audio-video equipment, computers, peripherals, software, online subscriptions, telecommunications;
- Food: food sold on campus by the University or a separate operator, including product purchase, processing (if not included in Scope 1 or 2) and packaging.

i. Recommended method and data sources

For quantifying GHG emissions from purchased goods and services, the activity-based approach is closest to reality. However, given the University context, the complexity of the activity-based approach and the availability of procurement data, it is more practical to use the spend-based method, since one simply needs to obtain the financial statements from the finance department. It is suggested to group goods and services by type and adding up the amounts disbursed for each group.

Not all expenses in the financial statements are to be included in the emissions inventory for purchased goods and services. Some are paid to individuals rather than being linked to a sector of the economy. For example, customs duties, bursaries, employer contributions, carbon credit purchases, chargebacks, bad debts and currency exchange gains or losses would be excluded. Other expenses are excluded because they are covered by another category (e.g. business travel).

For food, the activity-based method should be used. Most food services can provide velocity reports, i.e. detailed lists of food items and packages purchased, including volumes, weights or numbers of units. However, activity-based EFs are not included in this guide. Some sources do produce them, such as the ecoinvent life cycle inventory database. Before adopting the activity-based method, you can estimate the materiality of this subcategory using the spend-based method and EFs found in the appendix (see the next section).

ii. Emission factors

OpenIO – Canada is an open-source model for estimating the life cycle impacts of products and services. Its EFs are available on the Climatiq platform. It uses the Leontief input-output economic model and data specific to Canada.

The user can select EFs by province for a high degree of geographic precision. The EFs are based on average emissions for each activity in the Quebec market, taking imports into account. For this reason, the use of the EF specific to the University's province rather than one for the location where the purchased product was made is recommended.

However, *OpenIO – Canada* shows EFs for very broad categories, and this makes it challenging to match specific expenses with their own distinct factors. Because they are so broad, they represent average emissions for an entire sector or category of goods or services. Not all types of expenditures in the financial statements can be linked to a specific EF. Consequently, the University must make the links manually and be alert to the level of uncertainty in the calculation method.

The appendix contains a non-exhaustive list of EFs considered pertinent for the University. They apply to the purchase price including taxes, retailer margins and distribution costs but do not include endogenization. Endogenization would mean that the EF includes emissions generated in the production of inputs needed to produce the goods purchased by the University. It is recommended to use EFs without endogenization to ensure consistency with other emissions categories in this guide that do not take this part of the life cycle into account.

These EFs were published in 2024 but are based on 2020 as the reference year. To quantify GHG emissions from goods and services purchased in 2023, they have been adjusted for inflation using discount rates from Statistics Canada. To apply spend-based quantification to Category 3.1 GHG emissions for years other than 2023, the EFs listed in the appendix must be adjusted for inflation.[2] In addition, if you are using a database other than *OpenIO – Canada* (e.g. the EPA's GHG Emission Factors Hub), you must also convert the amounts to Canadian dollars.[3]

If you are applying the activity-based method to food services emissions, you can find the EFs in the ecoinvent database. This is a subscription database, but many universities have licences.

2. Calculate the discount rate by dividing the consumer price index (CPI) for the EF year by the CPI for the activity data year, then multiply the EF by the resulting discount rate. CPIs are published by Statistics Canada

3. Multiply the EF by the currency's exchange rate for the period in question. Exchange rates are published by the Bank of Canada.

3.2. CAPITAL GOODS

This category covers purchased goods and services with a long lifespan. They usually appear in the financial statements under long-term assets and are generally used to produce other goods and services. Here is a non-exhaustive list grouped into suggested subcategories:

- Office furniture;
- Computer equipment: audiovisual, hardware, software, wireless telecommunications;
- Specialized equipment: laboratory and analysis instruments, industrial supplies, medical, dental and hospital equipment;
- Books and publications: books, publications, subscriptions to publishing and distribution portals;
- Vehicles: trucks and utility vehicles;
- Construction, major renovations, purchases of new buildings and spaces.

i. i. Recommended method and data sources

For the same reasons as Category 3.1, the activity-based method would be more appropriate for calculating emissions quantification, but this guide covers only the spend-based method since procurement data can simply be obtained from the financial statements.

Amortizing GHG emissions from the production and construction of capital goods is not recommended. All emissions from the assets should be quantified at the time of purchase.. Some items in the financial statements are depreciation expenses, which should not be included (only the initial outlay is considered).

ii. Emission factors

The EFs in OpenIO-Canada are recommended for this category as well. The appendix contains a non-exhaustive list of EFs considered pertinent for the University.

3.3. FUEL- AND ENERGY-RELATED ACTIVITIES

This category covers GHG emissions from the production, transportation and distribution of energy purchased by the University. In the case of fossil fuels, it covers GHGs emitted prior to consumption. In the case of electricity, it covers GHGs emitted upstream of generation, since combustion emissions from the generating station are reported in Scope 2.

i. Recommended method and data sources

The activity-based method is recommended. The activity data is the data used to quantify the Scope 1 and Scope 2 emissions, i.e., electricity consumption and stationary combustion. It is specific data taken from energy providers' invoices and usually compiled in an energy report delivered annually to the Quebec Minister of Higher Education (EnerUNIV file).

Because the recommended EFs cover the entire life cycles of the fuels and electricity purchased, the emissions reported under scopes 1 and 2 must be subtracted from the results so that only the portion belonging to Scope 3 remains.

ii. Emission factors

EFs from the Government of Canada are recommended for fuels (Fuel Life Cycle Assessment Model, 2023). Since they are expressed in t CO_2e/GJ, the fuel volumes must be converted into energy (Conversion chart, Transition énergétique Québec).

TABLE 2: FUEL PRODUCTION AND DISTRIBUTION

ACTIVITY DATA	UNIT	GJ CONVERSION	EMISSION FACTOR (t CO_2e/GJ)	SOURCE
No. 6 fuel oil	liters	0.0425 GJ/L	0.092522690	Fuel Life Cycle Assessment Model, 2023 (ECCC)
Natural gas	m^3	0.03789 GJ/m^3	0.067681332	
RNG	m^3	0.03789 GJ/m^3	0.000412800	
No. 2 fuel oil	liters	0.0385 GJ/L	0.092605124	
Propane	liters	0.02531 GJ/L	0.075450605	
Diesel	liters	0.0385 GJ/L	0.092276543	

For electricity, the most recent life cycle assessment is Levasseur et al., 2021.

TABLE 3: ELECTRICITY PRODUCTION AND DISTRIBUTION

ACTIVITY DATA	UNIT	EMISSION FACTOR (t CO_2e/kWh)	SOURCE
Electricity	kWh	0.0000345	Levasseur *et al.*, 2021

Important: Since these EFs assess GHG emissions for the entire life cycle, the emissions reported under scopes 1 and 2 must be subtracted.

3.4. TRANSPORTATION AND DISTRIBUTION

This category covers GHG emissions from the transportation and distribution of purchased products in vehicles not owned by the University. It also includes transportation and delivery between the University's facilities. In cases where the vehicles do belong to the University, the GHG emissions will be included in Scope 1.

i. Recommended exclusion

It is recommended to exclude this category from Scope 3 inventories for reasons of data accessibility, methodological limitations and materiality, as explained below. It should nevertheless be mentioned in the inventory, and its exclusion from the data should be justified and explained clearly.

On an operational level, the University can make choices about the transportation and distribution of the products it purchases. It can make responsible procurement choices by opting for local products or environmentally friendly sources, or by centralizing its orders.

Data accessibility

- The spend-based method would require knowing the amounts charged to the University for merchandise transportation and distribution. However, these amounts are usually included in the invoices and are impossible to isolate. This also means that a portion of those emissions is included in Category 3.1.
- The activity-based method would require knowing the weight of the merchandise purchased by the University in order to isolate its transportation emissions from those of other products transported by the same carrier. Since the information is not available to the University, this approach is not realistic and would be based solely on assumptions.

Methodological limitations

- The available emission factors related to freight transport were deemed irrelevant for the specific quantification needs of universities.
  - EF per km: overestimation of GHG emissions by attributing all emissions from a trip
  - EF per t-km: see the section on data accessibility

Materiality

- Emissions for this category are generally considered negligible in relation to total Scope 3 emissions.

3.5. WASTE GENERATED IN OPERATIONS

This category covers emissions from waste produced by the University's operations on property it owns, including:

- Transportation of waste (garbage, organic waste, recyclables, hazardous waste, chemicals, biohazards) to disposal and treatment sites;
- Incineration without energy recovery;
- Disposal in a landfill;
- Composting;
- Wastewater treatment.

For recyclable and reclaimable materials, we advise using the cut-off method as recommended by CIRAIG and the GHG Protocol. With this method, emissions from the processing of recyclables are outside the University's reporting boundary. Instead, they are reported by whoever purchased the recycled or reclaimed by-product.

The cut-off method draws a line in the life cycle of a recyclable or reclaimable product. The entity generating the recyclable waste must report the impacts of processes above the line, while the one procuring the by-product (i.e. the recycled waste) has to report the impacts below the line. The line is located after waste collection and transportation, so the University should take transportation into account but should exclude subsequent stages. This approach should be used for waste that will be recycled, biomethanized or incinerated with energy recovery. It should not be used for composting, since compost does not have a high enough value and there is not enough demand.

Hazardous waste, chemicals and biohazards are usually transported and treated separately from ordinary residuals. The type of treatment should be taken into account in calculating their GHG emissions.

i. Recommended method and data sources

The activity-based method is recommended. Accordingly, the waste mass and wastewater volume are needed to quantify the GHG emissions from disposal and treatment. In addition, the distances travelled between the collection site and the treatment site are needed to quantify the emissions from transportation. The University's waste management department should be compiling this data. If not, this category can be quantified using estimates based on, for example, waste container volume.

For waste treatment:

- Obtain the waste mass by type.

For wastewater treatment:

- Obtain the volume of wastewater.

For waste transportation:

- Obtain the value per tonne-kilometer (t-km) of each waste type by multiplying its mass by the distance between the University facility and the treatment site.

One t-km is 1 tonne transported over 1 km. The most accurate way to calculate the t-km value is to multiply the mass by the distance for each transportation segment (e.g. each waste pickup) and add up the resulting values.

Alternatively, several transportation segments can be aggregated, for example if the only information the University has is the annual mass of waste generated. In that case, calculate the t-km value by multiplying the total waste mass by the average transportation distance, which is simply the distance between the University facility and the treatment site. Do not use the total annual transportation distance (i.e. the sum of all transportation segments), since the t-km value would be overestimated. If the waste is collected from several different facilities, use a weighted average for the distance.

Transportation distances should not include return trips, since the EFs (expressed in t-km) are based on the average payload utilization of vehicles, which already takes empty trips into account.

ii. Emission factors

TABLE 4: WASTE PRODUCED BY OPERATIONS

ACTIVITY DATA	UNIT	Emission factor[a] (t CO_2e/unit)	SOURCE
Landfill	tonnes	0.6594	Calculated based on GHG Protocol, 2021, and MELCCFP, 2025
Incineration with energy recovery	tonnes	N/A	–
Incineration without energy recovery	tonnes	0.499	MELCCFP, 2025
Composting	tonnes	0.094138	NIR 1990-2023
Biomethanization	tonnes	N/A	–
Recycling	tonnes	N/A	–
Transportation	tonne-km	0.0001816	RNC, 2022
Wastewater	m^3	0.0007447	IPCC, 2019[b]

a. The EFs for waste treatment (landfill, incineration, composting and wastewater), expressed in t CO_2e, include NO_2 and biogenic CH_4. Since the CO_2 emitted in waste treatment is biogenic, it should not be included in the inventory. If the University wants to report biogenic CO_2 emissions, use a different EF and present the results separately. Biogenic CH_4 is included, with a GWP of 27 rather than 29.8.

b. Where available, use the city's EFs for wastewater treatment emissions.

3.6. BUSINESS TRAVEL

This category covers university community travel paid by the University, sports teams' travel, whether paid by the University or not, and travel by delegations and visitors to the University.

Business travel means trips by University staff as part of their duties, for example to attend conferences and symposia or to collect data. Also included is University-paid travel by conference speakers and guests. This category can also cover travel by students for their fieldword, for their thesis defence and other activities. Although student travel should ideally be in Category 3.9, it cannot always be isolated because of the data source.

Category 3.6 also includes emissions from travel by sports teams, whether paid by the University or not. Even when the University does not pay for such trips, it still has influence over its sports teams' activities.

The same is true of delegations and visitors to the University. Delegations have varying numbers of participants, most of whom attend on their own initiative. However, their travel emissions are included in Category 3.6 because the University has the power to influence their travel. Although including such travel is not common practice and the data can be difficult to obtain, CIRAIG considers it to be good practice, and that is why it is recommended here.

i. Recommended method and data sources

Expenses for University-paid travel should be found in the expense reports compiled by the finance department. For other travel, specific data will have to be obtained from the appropriate departments (whoever is in charge of sports teams and international delegations).

The activity-based method should be used wherever possible, especially for air travel, which emits large quantities of GHGs. For car travel, the activity-based method is recommended if the data is available; if not, the spend-based method can be used. For travel by bus, metro, train and taxi, the activity-based method is also preferable; however, this often involves many assumptions due to lack of data, so the spend-based method is also acceptable.

It is recommended to present the results separately by trip purpose (business, sports, delegations) and mode of transportation.

For air travel (activity-based method):

- Assign the IATA codes for the departure and arrival airports to each trip, then use *R Studio and the airportr* package to calculate the distance travelled (see appendix).

For travel by bus, metro, train and taxi (spend-based method) and by air or car (if using the spend-based method):

- Obtain the total expenses for each transportation mode.

For sports team travel by bus (activity-based method):

- Assign the minimum theoretical distance between the campus and the destination, calculated by Google Maps or a similar tool, to each trip to obtain the distance travelled.

For travel by car (activity-based method):

- Convert the gasoline expense reimbursements to volume of gasoline (using an average gasoline price of $1.71/liter (Régie de l'énergie, 2023)) or convert the per-kilometre reimbursement for personal vehicle use (using the University's reimbursement rate) to distance travelled.

ii. Emission factors

TABLE 5: AIR TRAVEL

ACTIVITY DATA	UNIT	EMISSION FACTOR WITH MULTIPLIER[c] (t CO_2e/unit)	EMISSION FACTOR WITHOUT MULTIPLIER (t CO_2e/unit)	SOURCE
Spend-based method				
Aircraft	CAD	–	0,00093950	OpenIO – Canada, for 2023
Activity-based method				
Short haul (< 482 km)	km	0.000219899	0,000129862	Calculated based on the EPA GHG Emission Factors Hub, 2023
Medium haul (≥ 482 km and ≤ 3,701 km)	km	0.000136973	0,00008086	
Long haul (>3,701 km)	km	0.000173075	0,000102177	

c. A multiplier of 1.7 is applied to the EF for CO_2 to take into account the effects of radiative forcing caused by airplane condensation streams. Although this multiplier is optional, it is recommended by CIRAIG, the IPCC and others, since using it is good practice and is common in the literature (Lee et al., 2021).

TABLE 6: GROUND TRANSPORTATION

ACTIVITY DATA	UNIT	EMISSION FACTOR ($t\ CO_2e$/unit)	SOURCE
Activity-based method			
Gasoline	liters	0.002317478	NIR 1990-2023
Diesel	liters	0.00274208	
Bus	km	0.0000345	EPA GHG Emission Factors Hub, 2023
Gasoline-powered car	km	0.000195825	
Train	km	0,00008454	
Intercity bus	km	0,0000345	
Spend-based method			
Intercity bus	CAD	0.000199602	Calculated based on OpenIO – Canada, for 2023
Public transportation services	CAD	0.00034924	
Train	CAD	0.000235361	
Taxi	CAD	0.000210714	
Gasoline	CAD	0.759889941	
Car	CAD	0.017545562	

3.7. EMPLOYEE AND STUDENT COMMUTING

This category covers daily travel by employees and students between their home and their place of work or study. The modes of transportation included are cars, motorcycles and public transit. Active mobility such as walking and cycling is excluded, since its emissions are considered negligible in relation to the other transportation modes.

Emissions for employee travel can be presented separately from student travel, or they can be presented together.

i. Recommended method and data sources

To quantify emissions in this category, the activity-based method is recommended. Data on car travel is usually provided by the department in charge of transportation and parking. Public transit travel is estimated based on the mode share of public transit as a percentage of overall travel.

For car travel:

- The average distance between the main campus and the employee's or student's home is taken as the travel distance for each daily trip.
  - The department in charge of parking can, for example, provide a list of postal codes for all parking stickers purchased, and a tool like *Google Cloud API* (see appendix) can be used to find the distance between the campus and each postal code.
- The number of daily trips is estimated using parking data (time stamps, free periods, parking tickets, stickers, etc.) or through surveys.

For public transit:

- The average distance is the same as for car travel, unless a survey is conducted specifically for those who use public transit.
- The number of trips is estimated based on the modal share of employees and students using public transit combined with the frequency of use, estimated by survey or by assumption.

ii. Emission factors

TABLE 7: EMPLOYEE AND STUDENT COMMUTING

ACTIVITY DATA	UNIT	EMISSION FACTOR (t CO_2e/unit)	SOURCE
Gasoline-powered car[d]	km	0.000195825	EPA GHG Emission Factors Hub, 2023
Motorcycle	km	0.000115882	
Bus	km	0.0000345	
Subway	Passenger-km	0.000000763	Bombardier-Alstom Consortium Inc., 2015

d. The EF applies to the distance travelled by a vehicle, irrespective of the number of people in the vehicle. If there is information about carpooling, it should be used to adjust the number of trips.

3.8. UPSTREAM ASSETS LEASED BY THE UNIVERSITY

This category covers GHG emissions from the operation of assets that the University leases (for which the University is the leesee) and over which it does not not have operational control. Examples include buildings, rooms, co-owned properties in which the University holds less than 50% of voting rights, leased vehicles, and research infrastructure such as ships and greenhouses. Emissions from the entire life cycle of fuels (natural gas, oil, gasoline, diesel, etc.) and electricity should be included.

A leased asset is usually the subject of a lease, contract or agreement. Shorter-term rentals such as rooms for events or vehicles for occasional trips are covered in Category 3.1 (services). Emissions from assets owned by the University but leased out are covered under Scopes 1 and 2 or Category 3.13.

According to the GHG Protocol, it is the lessee, i.e. the organization conducting the activities linked to the asset, who has operational control of it by default. This means that, in principle, upstream leased assets always fall under Scopes 1 and 2. In some cases, however, it may be the lessor (the asset owner) who has operational control. The emissions from asset operation would then fall under Category 3.8. An example would be a situation where the University leases only one room in a building and has no say in decisions about energy consumption. In a case where the University can make decisions about the use of the asset, for example a vehicle under long-term lease, the emissions would then fall under Scopes 1 and 2.

i. Recommended method and data sources

For this category, the activity-based method is recommended. The facilities management or finance department can usually provide a list of leased assets. To the extent possible, try to obtain specific activity data for each leased asset.

Activity data for leased buildings and spaces can be obtained from:

- Energy providers' invoices (Energir, Hydro-Québec, etc.), some of which may be compiled in the energy report to the Quebec Minister of Higher Education (EnerUNIV file);
- The asset owner's manual compilation of energy consumption;
- Estimates based on total building energy consumption and the area used (occupancy rate);
- Energy use intensity, institutional sector (1.18 GJ/m²; convert to volume of fuel).

Special case: shared research assets

- Participation or occupancy rate * total activity data

ii. Emission factors

TABLE 8 : UPSTREAM ASSETS LEASED BY THE UNIVERSITY

ACTIVITY DATA	UNIT	EMISSION FACTOR (t CO_2e/unit)	SOURCE
Leased buildings and spaces			
Natural gas	GJ	0.067681332	Fuel Life Cycle Assessment Model, 2023 (ECCC)
RNG		0.000412800	
No. 2 fuel oil		0.092605124	
Electricity	kWh	0.0000345	Levasseur et al., 2021
Special cases			
Marine diesel	liters	0.002707658	NIR 1990-2023

3.9. STUDENT TRAVEL

(DOWNSTREAM TRANSPORTATION AND DISTRIBUTION IN THE GHG PROTOCOL)

The CAUBO guide and the GHG Protocol refer to this category as downstream transportation and distribution. CAUBO specifies that it includes emissions from student commuting. However, these are covered under Category 3.7, as explained earlier.

This category therefore covers travel by international students enrolled at the University and students of the University studying abroad (exchange students). Given the nature of this category, all travel is presumed to be by air. In addition, only one round trip per person for their entire stay is to be assumed.

i. Recommended method and data sources

For this category, the activity-based method is recommended. Activity data—that is, origin-destination information for international and exchange students—can be obtained from the department in charge of student mobility. Ideally, use the city or region from which the admission application was made, rather than the international student's country of origin. International students, especially at the graduate and postgraduate levels, have often studied in another country for several years before coming to Quebec and may therefore have flown in from somewhere other than their country of origin.

Obtain the number of kilometres travelled by assigning the IATA codes for the departure and arrival airports to each trip, then use R Studio and the airportr package to calculate the distance travelled (see appendix).

ii. Emission factors

TABLE 9: STUDENT TRAVEL

ACTIVITY DATA	UNIT	EMISSION FACTOR WITH MULTIPLIER[c] (t CO_2e/km)	EMISSION FACTOR WITHOUT MULTIPLIER (t CO_2e/km)	SOURCE
Activity-based method				
Short haul (< 482 km)	km	0.000219899	0.000208993	EPA GHG Emission Factors Hub, 2023
Medium haul (≥ 482 km and ≤ 3,701 km)	km	0.000136973	0.000130137	
Long haul (> 3,701 km)	km	0.000173075	0.000164437	

c. A multiplier of 1.7 is applied to the EF for CO_2 to take into account the effects of radiative forcing caused by airplane condensation streams. Although this multiplier is optional, it is recommended by CIRAIG, the IPCC and others, since using it is good practice and is common in the literature.

3.10/3.11/3.12 PROCESSING, USE AND END-OF-LIFE TREATMENT OF SOLD PRODUCTS

These three categories cover emissions from the processing, use and end-of-life treatment of products sold by the University (products bearing the University logo, food products, etc.).

Food products are processed, consumed and disposed of on campus. Emissions from their processing and use are therefore included in scopes 1 and 2, while their end-of-life treatment belongs to Category 3.5.

As for non-food products, emissions from their processing, use and end-of-life treatment are covered by Categories 3.10, 3.11 and 3.12. According to CAUBO, category 3.10 does not apply, given the nature of the University's activities, which do not include manufacturing the products it sells.

As for 3.11 and 3.12, their exclusion is recommended from the Scope 3 inventory, since the lack of data would make them very difficult to quantify. Many assumptions would have to be used, and this would lower the reliability of results. Moreover, these three categories are generally acknowledged to be insignificant in relation to total Scope 3 emissions.

3.13. DOWNSTREAM LEASED ASSETS

This category covers emissions from assets that the University owns but leases out to other parties. Emissions from the entire life cycle of fuels (natural gas, oil, gasoline, diesel, etc.) and electricity should be included.

Since the University owns those assets, the emissions can be reported under scopes 1 and 2 even though the activities taking place there are not the University's. Alternatively, they can be reported in Category 3.13. In other words, these emissions can be quantified under Scopes 1 and 2 or under Category 3.13, depending on the University's operational control over the asset.

According to the GHG Protocol, it is the lessee, i.e. the organization conducting the activities linked to the asset, who has operational control of it by default. This means that, in principle, downstream leased assets always fall under this category. In some cases, however, it may be the lessor (the asset owner) who has operational control. Example: the asset is a leased room in a building that the University uses part of, and the University makes decisions about energy use for the leased room. According to the "operational control" approach, that asset should be included under scopes 1 and 2, since it is within the organizational boundary.

Emissions from downstream leased assets belong in Category 3.13 in cases where the lessee has operational control. For example, if the University leases out one of its vehicles, it is the user (lessee) who has operational control of the vehicle.

i. Recommended method and data sources

If the University decides to include its downstream leased assets in Category 3.13, the activity-based method is recommended. The facilities management department or finance department can usually provide a list of assets leased out.

Activity data for leased buildings and spaces can be obtained from:

- Energy providers' invoices (Energir, Hydro-Québec, etc.), often compiled in the energy report to the Quebec Minister of Higher Education (EnerUNIV file);
- Estimates based on total building energy consumption and the area used (occupancy rate);

For leased vehicles:

- Quantity of fuel used
  - Amount (convert to volume using average prices for gasoline (Régie de l'énergie))
- Distance travelled
- Estimates
  - Distance: number of days/week x average distance per trip x number of weeks/year
  - Average annual distance travelled by institutional vehicles: 13,880 km (Gouvernement du Québec, 2025)

Special case: shared research assets

- Participation or occupancy rate x total activity data

ii. Emission factors

TABLE 10 : DOWNSTREAM LEASED ASSETS

ACTIVITY DATA	UNIT	EMISSION FACTOR (t CO_2e/unit)	SOURCE
Leased buildings and spaces			
Natural gas	m³	0.001936658	NIR 1990-2023
RNG	m³	0.000010658	
No. 2 fuel oil	liters	0.002762238	
Electricity	kWh	0.0000019	
Véhicules et autres			
Gasoline	liters	0.002317478	NIR 1990-2023
Diesel	liters	0.00274208	
Passenger car	km	0.000195825	EPA GHG Emission Factors Hub, 2023

3.14. FRANCHISES

This category covers emissions generated by franchise operations. It does not apply, since the University does not have franchises. Satellite buildings are treated either as properties (Scopes 1 and 2) or as leased assets (Category 3.8).

3.15. INVESTMENTS

This category covers emissions generated by investments, shares, bonds, pension funds, etc. CAUBO has produced a report explaining these emissions and how to report them.

Two of the most common metrics are weighted average carbon intensity (WACI) and absolute emissions. The CAUBO report describes the pros and cons of each.

WACI (t CO_2e/$M) is derived by adding up the carbon intensities of each portfolio company (emissions per million dollars of revenue), and then computing the weighted average based on portfolio weights.

$$\text{WACI (t } CO_2\text{e/\$M)} = \sum \text{emissions/\$M x weight in portfolio (\%)}$$

Absolute emissions (t CO_2e/$M) are the sum of total financed emissions (t CO_2e) divided by the portfolio's market capitalization in $M. Total financed emissions are the sum of the emissions generated by each company in the portfolio multiplied by the ownership stake, i.e. the stake in proportion to the Enterprise Value Including Cash (EVIC).

$$\text{Total financed emissions (t } CO_2\text{e)} = \sum \text{emissions (t } CO_2\text{e) x amount invested (\$M) / EVIC (\$M)}$$

$$\text{Absolute emissions (t } CO_2\text{e/\$M)} = \text{total financed emissions (t } CO_2\text{e) / portfolio's market capitalization (\$M)}$$

Both metrics are expressed in t CO_2e/$M, and since they are ratios[4], the emissions in this category cannot be added to the Scope 3 inventory. They can be used to measure impact, compare the University's performance against other organizations, and set reduction targets. The ratio in t CO_2e/$M should be reported annually in the University's GHG emissions inventory. Either metric can be produced or obtained by the University's portfolio managers.

Because the intensities are calculated and disclosed differently by each portfolio manager, it is not recommended to multiply the t CO_2e/$M by the amounts invested, since this would make it impossible to compare results.

4. WACI indicates the emissions intensity for a given sales revenue, whereas the dollar amounts in the University's financial statements are investments, not sales revenue. For absolute emissions, the denominator is the share value; however, it is highly improbable that a University would have only shares in its portfolio.

REFERENCES

Baglia, J. (2024). Why Double Counting is so Misunderstood. Persefoni.

Ecomatters. (n.d.). Approaches to recycled content allocation in LCA.

Government of Canada. (2023). Greenhouse gas emissions: Data sources and methods.

Greenhouse Gas Protocol (GHG Protocol). (2011). Corporate Value Chain (Scope 3) Accounting and Reporting Standard: Supplement to the GHG Protocol Corporate Accounting and Reporting Standard.

Intergovernmental Panel on Climate Change. (2018). "Summary for Policymakers". In Global Warming of 1.5°C. [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press.

International Organization for Standardization (ISO). (2018). ISO 14064-1: Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals

Régie de l'Énergie du Québec. (2023). Par région administrative du Québec.

Statistics Canada. (2022). Average energy use intensity by activity type. Government of Canada.

Statistics Canada. (2025). Consumer Price Index. Government of Canada.

Transition énergétique Québec. (2019). Facteurs d'émission et de conversion. Gouvernement du Québec.

Urban, K., Michayluk, C. and MacCornack, C. [Footprint]. (June 2022). *Scope 3 Greenhouse Gas Emissions Estimation Guidance*. CAUBO.

Vitrine statistique sur le développement durable. (2025). GES des véhicules gouvernementaux. Gouvernement du Québec.

SOURCES FOR EMISSION FACTORS

Bombardier-Alstom Consortium Inc. (2015). Environmental Product Declaration – AZUR.

Climatiq. (n.d.). Data explorer.

Environment and Climate Change Canada (2021). Fuel Life Cycle Assessment Model.

Environment and Climate Change Canada (2025). National inventory report 1990–2023: Greenhouse Gas Sources and Sinks in Canada. (NIR)

Fong, W., Sotos, M., Doust, M., Schultz, S., Marques, A. and Deng-Beck, C. (2021). Global Protocol for Community-Scale Greenhouse Gas Inventories. Greenhouse Gas Protocol (GHG Protocol).

[IPCC, 2019] Bartram, D., Short, M., Ebie, Y., Farkaš, J., Gueguen, C., Peters, G., Zanzottera, N. and Karthik, M. (2019). Chapter 6: "Wastewater Treatment and Discharge." In 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[IPCC, 2021] Smith, C., Nicholls, Z., Armour, K., Collins, W., Forster, P., Meinshausen, M., Palmer, M. and Watanabe, M. (2021). "The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Supplementary Material." Chapter 7 in Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

Lee, D.S., Fahey, D.W., Skowron, A., Allen, M.R., Burkhardt, U., Chen, Q., Doherty, S.J., Freeman, S., Forster, P.M., Fuglestvedt, J., Gettelman, A., De León, R.R., Lim, L.L., Lund, M.T., Millar, R.J., Owen, B., Penner, J.E., Pitari, G., Prather, M.J., Sausen, R. and Wilcox, L.J. (2021). "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018." Atmospheric Environment.

Levasseur, A., Mercier-Blais, S., Prairie, Y.T., Tremblay, A. and Turpin, A. (2021). Amélioration de la précision de l'empreinte carbone de l'électricité : estimation des émissions de gaz à effet de serre des réservoirs hydroélectriques.

MELCCFP. (2025). Guide de quantification des émissions de gaz à effet de serre. Gouvernement du Québec.

Natural Resources Canada (2022). GHGenius – A Model for Lifecycle Assessment of Transportation Fuels (version 5.02c).

United States Environmental Protection Agency (EPA). (2023). GHG Emission Factors Hub.

APPENDIX 1: GHG GLOBAL WARMING POTENTIAL

GREENHOUSE GAS	CHEMICAL FORMULA	GWP[e]
Carbon dioxide	CO_2	1
Fossil methane	CH_4 – fossil	29.8
Non-fossil methane[f]	CH_4 – non-fossil	27
Nitrous oxide	N_2O	273
Sulphur hexafluoride	SF_6	24,300
Nitrogen trifluoride	NF_3	17,400
Hydrofluorocarbons (HFC)		
HFC-23	CHF_3	14,600
HFC-32	CH_2F_2	771
HFC-125	CHF_2CF_3	3,740
HFC-134a	CH_2FCF_3	1,530
HFC-143a	CH_3CF_3	5,810
HFC-152a	CH_3CHF_2	164
Perfluorocarbons (PFC)		
Perfluoroethane	C_2F_6	12,400
Perfluoropropane	C_3F_8	9,290

[e] GWP values, taken from the 6th IPCC assessment report, are for 100-year cumulative radiative forcing.

[f] EFs (t CO_2e) of waste treatment and RNG are constructed using the GWP of non-fossil methane.

APPENDIX 2: MONETARY EMISSION FACTORS OF GOODS AND SERVICES

OpenIO-Canada's EFs, published on the Climatiq platform in 2024, are applicable to 2020 and the Quebec market. The EFs listed below have been adjusted for inflation and are applicable for 2020–2024.

They apply to the purchase price including taxes, retailer margins and distribution costs but do not include endogenization. They therefore cover the whole life cycle (cradle to gate) of the goods and services.

IOCC CODE	EXPENSE TYPE	EMISSION FACTORS (kg CO_2e/CAD)					
		2020	2021	2022	2023	2024	2025
MPG311901	Snack food products	0.3411	0.3326	0.3045	0.2813	0.2758	0,2674
MPG311109	Other animal feed	0.639	0.6199	0.5926	0.5672	0.5525	0,5010
MPG337203	Office furniture	0.2525	0.2449	0.2342	0.2241	0.2183	0,2125
MPG339902	Sporting and athletic goods	0.2124	0.2060	0.1970	0.1885	0.1836	0,1787
MPG339909	Other miscellaneous goods	0.2373	0.2302	0.2201	0.2106	0.2052	0,1997
MPG311909	Other miscellaneous food products	0.3615	0.3525	0.3227	0.2981	0.2923	0,0714
MPS541909	Other professional, scientific and technical services	0.0848	0.0823	0.0786	0.0753	0.0733	0,2213
MPS722002	Alcoholic beverages for immediate consumption	0.263	0.2551	0.2439	0.2334	0.2274	0,0161
MPG336112	Light-duty trucks, vans and SUV	0.0191	0.0185	0.0177	0.0170	0.0165	0,0470
MPS541503	Computer systems design and related services (except software development)	0.0559	0.0542	0.0518	0.0496	0.0483	0,0470
MPS524200	Brokerage and other insurance related services	0.05588	0.0542	0.0518	0.0496	0.0483	0,1812
MPG339904	Office supplies (except paper)	0.2153	0.2089	0.1997	0.1911	0.1861	0,1567
MPG339100	Medical, dental and personal safety supplies, instruments and equipment	0.1862	0.1806	0.1727	0.1653	0.1610	0,1237
MPG334A06	Measuring, control, and scientific instruments	0.147	0.1426	0.1363	0.1305	0.1271	0,1207
MPG334A02	Navigational and guidance instruments	0.1434	0.1391	0.1330	0.1273	0.1240	0,1305
MPG5111A2	Books, print and electronic	0.1551	0.1505	0.1438	0.1377	0.1341	0,0578
MPS511200	General purpose software	0.0687	0.0666	0.0637	0.0610	0.0594	0,1157
MPG334A01	Televisions and other audio and video equipment	0.1375	0.1334	0.1275	0.1221	0.1189	0,1676
MPG334100	Computers and computer peripheral equipment including parts	0.1992	0.1932	0.1847	0.1768	0.1722	0,1160

IOCC CODE	EXPENSE TYPE	EMISSION FACTORS (kg CO_2e/CA$)					
		2020	2021	2022	2023	2024	2025
MPG23C300	Electric power engineering construction	0.1378	0.1337	0.1278	0.1223	0.1191	0,1295
MPG5111A1	Periodicals, print and electronic	0.1539	0.1493	0.1427	0.1366	0.1331	0,4379
MPG325900	Chemical products not elsewhere classified	0.5204	0.5048	0.4826	0.4619	0.4499	0,2653
MPG332A08	Forged and stamped metal products	0.3152	0.3058	0.2923	0.2798	0.2725	0,1685
MPG325400	Pharmaceutical and medicinal products	0.2002	0.1942	0.1857	0.1777	0.1731	0,0766
MPS541800	Advertising, public relations and related services	0.091	0.0883	0.0844	0.0808	0.0787	0,2881
MPS323003	Contract printing services for publishers	0.3424	0.3322	0.3175	0.3039	0.2960	0,0628
MPS541300	Architectural, engineering and related services	0.0746	0.0724	0.0692	0.0662	0.0645	0,1707
MPS812300	Laundry and dry-cleaning services	0.2029	0.1968	0.1882	0.1801	0.1754	0,0508
MPS541200	Accounting, tax preparation, bookkeeping and payroll services	0.0604	0.0586	0.0560	0.0536	0.0522	0,0729
MPS541600	Management, scientific and technical consulting services	0.0866	0.0840	0.0803	0.0769	0.0749	0,0926
MPS713A00	Amusement and recreation services	0.11	0.1067	0.1020	0.0976	0.0951	0,1641
MPS562000	Waste management and remediation services	0.195	0.1892	0.1808	0.1731	0.1686	0,1114
MPS484001	Moving services	0,5754	0,5581	0,5336	0,5107	0,4974	0,1034
MPS532A09	Other goods rental and leasing services	0.1324	0.1284	0.1228	0.1175	0.1145	0,1034
MPS532100	Motor vehicle rental and leasing services	0.1229	0.1192	0.1140	0.1091	0.1063	0,0872
MPS561500	Travel arrangement and reservation services	0.1036	0.1005	0.0961	0.0920	0.0896	0,0636
MPS541701	Research and development services	0.0756	0.0733	0.0701	0.0671	0.0654	0,2161
MPS23D000	Repair construction services	0.2568	0.2491	0.2381	0.2279	0.2220	0,1429
MPS811A00	Repair and maintenance services (except for buildings and transportation equipment)	0.1698	0.1647	0.1575	0.1507	0.1468	0,9181
MPS115A02	Support services for animal production, hunting and fishing	1.091	1.0583	1.0118	0.9684	0.9432	0,0853
MPS561400	Business support services	0.1014	0.0984	0.0940	0.0900	0.0877	0,0732

IOCC CODE	EXPENSE TYPE	EMISSION FACTORS (kg CO_2e/CA$)					
		2020	2021	2022	2023	2024	2025
MPS517002	Wireless telephone services	0.087	0.0844	0.0807	0.0772	0.0752	0,1101
MPS561600	Investigation and security services	0.0746	0.0724	0.0692	0.0662	0.0645	0,2149
MPS811100	Motor vehicle repair and maintenance services	0.1308	0.1269	0.1213	0.1161	0.1131	0,0523
MPS488006	Freight transportation arrangement and customs brokering services	0.2554	0.2478	0.2368	0.2267	0.2208	0,0499
MPS622000	Hospital services	0.0621	0.0602	0.0576	0.0551	0.0537	0,1554
MPS541100	Legal services	0.0593	0.0575	0.0550	0.0526	0.0513	0,1444
MPS491000	Postal services	0.1847	0.1792	0.1713	0.1639	0.1597	0,0636
MPS561700	Services to buildings and dwellings	0.1716	0.1665	0.1591	0.1523	0.1484	0,0718
MPS541902	Veterinary services	0.0756	0.0733	0.0701	0.0671	0.0654	0,1506
MPS518000	Data processing, hosting, and related services (except cloud software as a service)	0.0853	0.0827	0.0791	0.0757	0.0737	0,2134
MPG31B001	Men's, women's, boys' and girls' clothing	0.179	0.1736	0.1660	0.1589	0.1548	0,4842

APPENDIX 3: EMISSION FACTORS, 2020 TO 2025

ACTIVITY DATA	SOURCE	UNIT	EMISSION FACTORS RELATED TO TRAVEL (t CO_2e/unit)					
			2020	2021	2022	2023	2024	2025
Activity-based method								
Gasoline	NIR	liters	0.00231736	0.00231736	0.002317478	0.002317478	N/A	N/A
Diesel			0.002747335	0.002747335	0.00274208	0.00274208		
Marine diesel			0.002708248	0.002708248	0.002707658	0.002707658		
Bus	EPA	km	0.0000334	0.0000340	0.0000353	0.0000345	0.00004457	0.00004142
Car			0.00020978	0.00021351	0.00020761	0.0001958	0.000191324	0.000185556
Motorcycle			0.000116716	0.000119823	0.000116195	0.000114356	0.000238544	0.000233498
Train			0,00009271	0,00008958	0,00008705	0,00008454	0,00008503	0,00008503
Air - Short haul (with RF[g])			0.0002285	0.0002189	0.0002199	0.0002199	0.000219899	0.000219899
Air - Medium haul (with RF)			0.0001413	0.0001392	0.000137	0.000137	0.00013697	0.00013697
Air - Long haul (with RF)			0.000175082	0.000171023	0.000173075	0.000173075	0.000173075	0.000173075
Air - Short haul (without RF)			0.000134974	0.000129316	0.000129862	0.000129862	0.000129862	0.000129862
Air - Medium haul (without RF)			0.00008343	0.00008219	0.00008086	0.00008086	0.00008086	0.00008086
Air - Long haul (without RF)			0.00010331	0.000100994	0.000102177	0.000102177	0.000102177	0.000102177
Subway	Bombardier-Alstom Consortium Inc., 2015	passenger-km	0.000000763	0.000000763	0.000000763	0.000000763	0.000000763	0.000000763
Spend-based method								
Intercity bus	Open-IO Canada	CAD	0.00023890	0.00022281	0.00020139	0.00019960	0.00019715	0,00019601
Public transportation services			0.00041800	0.00038984	0.00035237	0.00034924	0.00034495	0,00034295
Train			0.00028170	0.00026272	0.00023747	0.00023536	0.00023247	0,00023112
Taxi			0.00025220	0.00023521	0.00021260	0.00021071	0.00020813	0,00020692
Gasoline			0.00090950	0.00084823	0.00076669	0.00075989	0.00075056	0,00074620
Car			0.00002100	0.00001959	0.00001770	0.00001755	0.00001733	0,00001723
Aircraft			0.00111370	0.00103867	0.00093883	0.00093050	0.00091908	0,00091374

g. Radiative forcing. For more information, see section covering Category 3.6.

ACTIVITY DATA	SOURCE	UNIT	EMISSION FACTORS RELATED TO TRAVEL (t CO_2e/unit)					
			2020	2021	2022	2023	2024	2025
Energy (full life cycle)								
No. 6 fuel oil	ECCC	GJ	Not available		0.09252269	0.09252269	0.09172376	0.09172376
Natural gas					0.067681332	0.067681332	0.060320437	0.060320437
RNG					0.000412800	0.000412800	0.000409269	0.000409269
No. 2 fuel oil					0.092605124	0.092605124	0.092143252	0.092143252
Propane					0.075450605	0.075450605	0.069784067	0.069784067
Diesel					0.092276543	0.092276543	0.091696001	0.091696001
	Levasseur et al., 2021	kWh	N/A	0.0000345	0.0000345	0.0000345	0.0000345	0.0000345
Energy (combustion)								
Natural gas	NIR	m³	0.001926925	0.001926925	0.001936658	0.001936658	Not available	
No. 6 fuel oil		liters	0.002762888	0.002762888	0.002762238	0.002762238		
RNG		m³	0.000011355	0.000011355	0.000010658	0.000010658		
Electricity		kWh	0.0000019	0.0000017	0.0000017	0.0000019		
Waste								
Landfill	GHG Protocol, 2021	tonnes	N/A	0.6594	0.6594	0.6594	0.6594	0.6594
Incineration without energy recovery	MELCCFP, 2025		N/A	N/A	0.499	0.499	0.499	0.499
Composting	NIR		0.094138	0.094138	0.094138	0.094138	N/A	N/A
Recycling	–	–	Non applicable					
Incineration with energy recovery								
Biomethanization								
Transportation	RNC, 2022	tonne-km	N/A	N/A	0.0001816	0.0001816	0.0001816	0.0001816
Wastewater	IPCC, 2019	m³	0.0007447	0.0007447	0.0007447	0.0007447	0.0007447	0.0007447

APPENDIX 4: RSTUDIO SCRIPT TO RETRIEVE THE DISTANCE BETWEEN AIRPORTS

DIRECT FLIGHTS

Step 1

On the Packages tab, select:

- tidyverse
- readxl
- airportr
- writexl

Step 2: On the Environment tab, import the air travel workbook

Step 3: Load the data

On the Console tab, enter:

```
data <- read_xlsx ("[full path to workbook]",sheet=[number of tab containing the data])
```

Press Enter. A new line named data will appear on the Environment tab.

Step 4: Select the column containing the IATA codes ("IATA")

On the Console tab, enter:

```
data <- data %>% select(IATA)
data$depart <- 'YQB'
```

Press Enter. A new column called depart will appear.

Step 5: Calculate the distance between the departure and arrival airports

On the Console tab, enter:

```
for (i in 1:nrow(data)){
tryCatch({
data$km_aller[i] <-
airport_
distance(toupper(data$depart[i]),toupper(data$IATA[i]))
}, error=function(e){})}
```

Press Enter. A new column called km-aller [km-one way] will appear.

Step 6: Export to Excel

On the Console tab, enter:

```
write_xlsx(data,"resultatdirect.xlsx")
```

Press Enter. By default, the workbook will be saved the Documents folder in Windows.

FLIGHTS TO MULTIPLE DESTINATIONS

Step 1, 2 and 3

idem

Step 4: Select the column containing the IATA codes ("IATA1", "IATA2", etc.)

On the Console tab, enter:

```
data <- data %>%
select(IATA1,IATA2,IATA3,IATA4,IATA5)
data <- data[complete.cases(data$IATA1), ]
data$depart <- 'YQB'
```

Press Enter. A new column called depart will appear.

Step 5: Create a function to calculate the distance between airports

On the Console tab, enter:

```
distance_between_airports <- function(departure_
airport, arrival_airport) {
if (is.na(arrival_airport)) {
return(0)
} else {
return(airport_distance(toupper(departure_airport),
toupper(arrival_airport)))}}
```

Press Enter. A new line named function will appear on the Environment tab.

Step 6: Calculate the distance between the departure and arrival airports

On the Console tab, enter:

```
for (i in 1:nrow(data)) {
data$km_aller_IATA_1[i] <- distance_between_
airports(data$depart[i], data$IATA1[i])
data$km_aller_IATA_2[i] <- distance_between_
airports(data$IATA1[i], data$IATA2[i])
data$km_aller_IATA_3[i] <- distance_between_
airports(data$IATA2[i], data$IATA3[i])
data$km_aller_IATA_4[i] <- distance_between_
airports(data$IATA3[i], data$IATA4[i])
data$km_aller_IATA_5[i] <- distance_between_
airports(data$IATA4[i], data$IATA5[i])}
```

Step 7: Export to Excel

On the Console tab, enter:

```
write_xlsx(data,"resultatmulti.xlsx")
```

Press Enter. By default, the workbook will be saved the Documents folder in Windows.

APPENDIX 5: RSTUDIO SCRIPT TO RETRIEVE THE DISTANCE BETWEEN POSTAL CODES

Step 1
On the Packages tab, select:

- tibble
- gmapsdistance
- readxl
- writexl
- httr
- jsonlite

Step 2: On the Environment tab, import the postal code workbook

Step 3: Load the data
On the Console tab, enter:

data <- read_xlsx ("[full path to workbook]",sheet=[number of tab containing the data])

Press Enter. A new line named data will appear on the Environment tab.

Step 4: Add the Google Maps API key
On the Console tab, enter:

api.key <- "[API key]"

code_postal$distance <- NAfor(i in 1:nrow(code_postal)){

result <- gmapsdistance(code_postal$[column name][i], code_postal$[column name][i], mode = 'driving', key = api_key)

Step 5: Verify the result
On the Console tab, enter:

if (!is.null(result$Distance)) {

distance_m <- result$Distance

code_postal$distance[i] <- as.numeric(distance_m) / 1000}

else {code_postal$distance[i] <- NA}

code_postal$distance <- as.character(code_postal$distance)

Step 6: Save the dataframe in xlsx format every 1,000 iterations
On the Console tab, enter:

if (i %% 1000 == 0) {write_xlsx(code_postal, "code_postal.xlsx")}}

Step 7: Export to Excel
On the Console tab, enter:

write_xlsx(data,"[workbook name]")

Press Enter. By default, the workbook will be saved the Documents folder in Windows.