2021 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions

For Public Sector Organizations, Local Governments, Modern treaty nations And Community Emissions

B.C. Ministry of Environment and Climate Change Strategy

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1 Introduction

In November 2007, British Columbia enacted legislation to establish provincial targets for reducing greenhouse gas (GHG) emissions by 40% than the level of those emissions in 2007 by 2030, 60% by 2040, and 80% by 2050. Under the *Climate Change Accountability Act (CCAA)*, the B.C. public sector must be carbon neutral in its operations for 2010 and every year thereafter.[1] Provincial public sector organizations (PSOs)[2] are required to report annually to confirm they have achieved carbon neutrality, in accordance with the *CCAA* and the *Carbon Neutral Government Regulation (CNGR)*.

This document, sets out the current best practices for quantifying and reporting greenhouse gas (GHG) emissions from B.C.'s provincial public sector organizations, local governments, Modern Treaty Nations and other communities. This document and its predecessors represent a catalogue of emissions factors and emissions calculation methodologies that draw heavily on protocols established by the World Resources Institute and the Climate Registry, and published emission factors from authoritative sources such as: Environment and Climate Change Canada's National Inventory Report, Natural Resources Canada, and the UK Department of Environment, Food and Rural Affairs. This document also represents the consolidation of the previously stand-alone versions of PSO, Local Government (LG) and Community Energy and Emissions Inventory (CEEI) emissions methodology guides. It can be used by anyone using these other documents, or other groups who wish to calculate their corporate emissions. Please note that the private sector entities subject to the B.C. Greenhouse Gas Emission Reporting Regulation must utilize quantification methods prescribed by the Regulation.

For the 2021 reporting year, this document underwent a review and update to better assist users in quantifying their emissions, including: an improved structure that organizes information based on emission categories, updated emission factors, and clear calculations and examples for how emission factors were derived for data not readily available from authoritative sources.

Measuring greenhouse gas emissions is an important first step in reducing emissions and the activities/operations responsible for producing them, in support of meeting B.C.'s legislated greenhouse gas emission reduction targets under the CCAA.

This document provides a basis for users to measure their greenhouse gas emissions with consistent and up-to-date best practices and provides comparable emissions reporting province-wide.

[1] See http://www.bclaws.ca/civix/document/id/complete/statreg/07042_01, for the *Climate Change Accountability Act*, Bill 44 – 2007 and the *Carbon Neutral Government Regulation,* B.C. Reg. 392/2008. The legislation also requires core government business travel to be carbon neutral as of October 2007. This requirement does not apply to the broader provincial public sector, as defined in Note 12.

[2] PSOs encompass Provincial government entities funded through the Consolidated Revenue Fund (e.g., ministries, special offices, and tribunals) and broader public sector agencies including health authorities, school districts, colleges and universities, and Crown corporations under the Government Reporting Entity.

1.1 Users/Audience

1.1.1 Public Sector Organizations

All PSO questions related to GHG quantification, scope and the Clean Government Report Tool (CGRT) should be directed to **Carbon.Neutral@gov.bc.ca**.

The *CNGR* defines the activities or emission sources that are "in scope" for the purposes of PSO emission reporting and offsetting. Since it was introduced in 2008, "in scope" activities/sources have been clarified through a series of policy decisions which have been summarized in the Scope Summary Document.

The emissions factors and emissions calculation methodologies described in this document have been integrated into the Clean Government Reporting Tool (CGRT), the online tool provided by the B.C. government, to support PSO GHG measurement and reporting requirements. Centralized provision of the toolset facilitates consistent reporting across all organizations, offers the capacity to quickly implement updates, and provides broader analytical capabilities to assist organizations in analysing their emissions data.

CGRT contains emission factors across all PSO reporting categories. When PSOs report their annual energy consumption in the tool, CGRT applies the appropriate emission factor and global warming potential (see Section 1.2 below) to the entered consumption/activity data and calculates total GHG emissions.

This document contains emission quantification information for the following in-scope activities for PSOs:

- Section 2: Stationary Sources: Buildings
- Section 3: Mobile Sources: Transportation
- Section 4: Office Paper

Categories concerning Provincial Government (ministries and independent offices) only:

- Sections 5-7: Business Travel and Accommodation

For each activity category, the emission type is specified (either direct or indirect emissions), and a brief description of the category is given along with an explanation of data sources and where to locate emission factors. Where emission factors are not readily available from authoritative sources, an explanation is provided for how that emission factor was derived, including sample calculations.

1.1.2 Local Governments and Modern Treaty Nations

Local Governments

All local government and Modern Treaty Nation questions related to GHG quantification and scope should be directed to **LGCAP@gov.bc.ca**.

Almost every local government in B.C. has voluntarily signed the Climate Action Charter (CAC) committing to develop strategies and take actions to achieve the following goals:

- being carbon neutral in respect of their corporate operations;[3]
- measuring and reporting on their community's GHG emissions profile; and
- creating complete, compact, more energy efficient rural and urban communities.

Under the CAC, the joint Provincial Government – Union of British Columbia Municipalities (UBCM) Green Communities Committee (GCC) was created to support local governments in planning and implementing climate change initiatives.

Modern Treaty Nations

The Province's relationship with Modern Treaty Nations in British Columbia is distinct and unique. Modern treaties set out constitutionally protected rights and obligations of the parties. The Province's work with Modern Treaty Nations to fully implement these treaties occurs both with individual Nations and collectively through the Alliance of British Columbia Modern Treaty Nations.

Measuring and Reporting Emissions

Local governments and Modern Treaty Nations are eligible for the new Local Government Climate Action Program (LGCAP). Although measuring and reporting corporate GHG emissions is not mandatory for the first year of the program, beginning in the second year it will be an eligibility requirement for LGCAP funding.

The boundaries for calculating emissions are based on the energy used in the delivery of traditional local government and Modern Treaty Nation services:[4]

- Administration and Governance;
- Drinking water, Stormwater and Wastewater;
- Solid Waste Collection, Transportation and Diversion;
- Roads and Traffic Operations;
- Arts, Recreational and Cultural Services; and
- Fire Protection.

[3] Solid waste facilities regulated under *the Environmental Management Act* are not included in operations for the purposes of this Charter.

[4] Within the traditional service sectors not all emissions will be captured. Any emissions related to the operation and maintenance of traditional services are included. Emissions related to new construction, business travel, employee commuting and materials are not included.

To ensure alignment, comparability and consistency in GHG quantification approaches, the GCC recommends aligning with the same methodologies that are utilized by PSOs in this document. To ensure methodology, emission factors and outputs from individual tools are consistent and comparable, a local government or Modern Treaty Nation will be required to meet the following standards for their measurement processes:

1. Use the same corporate boundaries as defined in the Workbook;
2. Use the GHG measurement methods and emission factors in this guide, and updates as provided by the Climate Action Secretariat;
3. Complete and adhere to the Business Processes Checklist;
4. Report on annual total corporate emissions as calculated by a GHG inventory tool (via an Energy Consumption Summary Reporting Template**)**; and

All of the supporting materials for these standards are available on the Climate Action Toolkit website.

By understanding and applying the information contained in this methodology document and completing the *Self Certified Business Process Checklist* available at BC Climate Action Toolkit, local governments and Modern Treaty Nations can be assured that their GHG emissions inventories are accurate and consistent across British Columbia.

The following sections of this document apply directly to local governments and Modern Treaty Nations for their in-scope activities:

- Section 2: Stationary Sources - Buildings (**except for** Stationary Space Conditioning and Refrigeration)
- Section 3: Mobile Sources – Transportation (**except for** Mobile Air Conditioning)
- Annex – Glossary of Terms and Acronyms, Global Warming Potentials, Selected References, Document Version Control

For each activity category, a brief description is given along with an explanation of data sources and emission factor calculations. Note emissions from office paper and business travel are **not** in scope for local governments and Modern Treaty Nations.

All local government and Modern Treaty Nation questions related to GHG quantification and scope should be directed to **LGCAP@gov.bc.ca**.

1.1.3 Other Users

Other potential users of this document include the broad community of users of the Community Energy and Emissions Inventory (CEEI) reports, energy and emissions modelling and planning consultants, energy utilities, academic researchers and non-governmental organizations.

Historic CEEI reports were released along with a Technical Methods and Guidance Document that provides details on the process by which the greenhouse gas emissions estimates in the CEEI reports are produced. Using common emission factors and referring to this document in the specific guidance material for the CEEI program will ensure comparability across the different programs referenced above.

Historic reports can be found on the CEEI webpage, alongside more recent 2007 – 2019 community level utilities and solid waste data.

All questions related to the CEEI should be directed to **LGCAP@gov.bc.ca**.

1.2 Global Warming Potential and Emissions Calculations

Greenhouse gases vary in their ability to trap heat in the atmosphere (radiative forcing).[5] "Global warming potential" (GWP) is a measure of this ability. The GWP of a greenhouse gas accounts for both the immediate radiative forcing due to an increase in the concentration of the gas in the atmosphere and the lifetime of the gas. The GWP for each GHG is expressed as the ratio of its heat trapping ability relative to that for carbon dioxide (CO_2). Updates to British Columbia's GWPs were made in line with updates by the United Nations Framework Convention on Climate Change (UNFCCC) and the Canadian Federal Government to GWPs approved by the Intergovernmental Panel on Climate Change's (IPCC's) 4th Assessment Report.

For example, the GWP of CO_2 equals one. Methane (CH_4) has a GWP of 25, indicating that its radiative forcing is 25 times that of CO_2. In other words, releasing one tonne of CH_4 will have the same warming impact as releasing 25 tonnes of CO_2. This impact is often expressed using the concept of carbon dioxide equivalent, or CO_2e: that is, one tonne of CH_4 can also be expressed as 25 tonnes of CO_2e. See Annex 2 for a complete list of GWPs for all gases covered by the *Carbon Neutral Government Regulation* [6] under the *Climate Change Accountability Act* (formerly the *Greenhouse Gas Reductions Targets Act (GGRTA))*.

GWPs are particularly important within the context of emissions reporting since international protocols require the reporting of both individual GHGs and their carbon dioxide equivalents (CO_2e). For this reason, the calculation of GHG emissions generally involves:

(1) multiplying the emission factor for a GHG by an appropriate measure of consumption (activity) to produce the corresponding emissions for that GHG, and then
(2) multiplying those emissions by its GWP to produce the corresponding CO_2e emissions.

The primary source document for emission factors is Environment and Climate Change Canada's (ECCC) *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2019* (NIR), released in 2021.[7] International documents, such as the Climate Registry's *General Reporting Protocol*, have been used for some emission factors.[8] B.C.-specific emission factors have been developed in other cases, using data provided by B.C. energy companies and business travel providers.

[5] The term "radiative forcing" refers to the amount of heat-trapping potential for a GHG and is measured in units of power per unit of area (watts per metre squared).
[6] Carbon Neutral Government Regulation. (Dec. 9, 2008). Available: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/392_2008#section4
[7] Environment Canada. (2021). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2019.* The Canadian Government's Submission to the United Nations Framework Convention on Climate Change. Available: https://unfccc.int/documents/271493
[8] The Climate Registry. (2019). *General Reporting Protocol*, *Version 3.0*. B.C. is a member of the Climate Registry, which is a cross-border initiative to develop common measurement, verification, and reporting requirements for GHG emissions. Available: www.theclimateregistry.org.

The emission factors reported in this document represent the B.C. Government's understanding of the factors appropriate for emission sources and fuel types in 2021.The factors themselves and other key inputs (e.g., energy conversion factors, GWPs) will be updated as GHG measurement methodologies and data sources evolve.

1.3 Principles for Determining Emission Factors

The following principles guided the development of the GHG emission factors and estimation methods found in this document:

1) If information is available, the preference is to use emission factors that best reflect an organization's individual circumstances; for example, the particular source of electricity or fuel. Over time, the B.C. Government will continue to develop and apply B.C.-specific emission factors to improve the accuracy of GHG tracking.
2) Where B.C.-specific information is not available, standardized emission factors from national and international data sources are used. Factors are taken from ECCC's National Inventory Report and other recognized sources.
3) Measurement and reporting requirements should not be overly burdensome or costly. Therefore, in certain cases, such as where an emissions source is too small to justify additional data gathering by an organization, simplified methods for estimating emissions are provided.
4) In developing simplified estimation methods, upper bound assumptions are used in accordance with the principle of conservativeness to support an overestimation, rather than an underestimation of emissions.

1.4 Scope of Reporting

Emission factors are expressed in kilograms (kg) or metric tonnes (t) of GHG emissions per unit of consumption activity. Typically, the factors for a given category of activity – for example, building energy or fleet fuel consumption – are expressed in common units to enable comparison across different fuel types, travel modes, etc.

The CNGR lists six distinct greenhouse gases or groups of gases:

- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- hydrofluorocarbons (HFCs),
- sulphur hexafluoride (SF_6), and
- perfluorocarbons (PFCs).

For most organizations, the primary GHGs emitted in significant amounts are the three principal gases associated with fuel combustion for energy (CO_2, CH_4, and N_2O) and, to a much lesser extent, HFCs released from refrigeration and air conditioning equipment.[9]

In the case of liquid fossil fuel blends with biofuel (e.g., ethanol, biodiesel), gasoline or diesel are combined with varying proportions of biofuels (e.g., E10, B5, B20), resulting in emission factors that are weighted averages of the biofuel and fossil fuel factors. However, since international protocols require the separate reporting of biogenic emissions from combustion (see Table 9 in Section 3.1), the CO_2 emissions from the biofuel component (Bio CO_2) must be calculated and reported separately from those of the fossil fuel component.

Wherever possible, emission factors are specified by individual gases. In certain instances, an aggregate factor for multiple gases is provided in kg or t of carbon dioxide equivalent (CO_2e) emissions. CO_2e is the standard unit for measuring and comparing emissions across GHGs of varying potency in the atmosphere (as seen in Section 1.3).

[9] In British Columbia, PFCs and SF_6 are produced primarily in aluminum and magnesium smelting/processing and semi-conductor manufacturing. SF_6 is also used as a cover gas in electricity transmission equipment.

2 Stationary Sources – Buildings

The following section outlines the direct and indirect GHG emissions that are produced from activities associated with the lighting, heating, and cooling of facilities and the powering of machinery and equipment within those facilities.[10]

2.1 Stationary Fuel Combustion

Type: Direct Emissions

Description: A variety of fossil fuels may be combusted to produce heat and power including:

- natural gas,
- propane,
- light fuel oil (No. 2 heating oil),
- heavy fuel oil (No. 5 heating oil),
- kerosene,
- marine diesel,
- diesel fuel, and
- gasoline.

In addition to fossil fuels, wood fuel and wood waste may also be combusted to produce heat. For the purpose of aligning emissions reporting with international protocols, biogenic emissions (Bio CO_2, CH_4, and N_2O) from biomass combustion including wood, wood waste, ethanol, biodiesel, and renewable natural gas must be reported.[11]

For biomass combustion, Bio CO_2 emissions must be reported separately from CH_4 and N_2O emissions but PSOs are only required to offset the CH_4 and N_2O emissions from biomass combustion.[12]. Any organization considering biomass should be aware that there are ongoing international discussions around the proper treatment of biomass and how to best account for the BioCO_2 storage and emissions of different harvested wood products (e.g. waste wood vs. virgin wood) and the associated forest management practices occurring on the land base. The impacts of future accounting changes can be minimized to the extent that biomass is diverted from waste streams and that non-waste biomass comes from sustainably managed forest lands.

[10] See http://www.bclaws.ca/Recon/document/ID/freeside/392_2008 for the *Carbon Neutral Government Regulation,* B.C. Reg. 392/2008.

[11] The CO_2 released *to* the atmosphere during combustion of biomass is assumed to be the same quantity that had been absorbed *from* the atmosphere during plant growth. Since CO_2 absorption from plant growth and the emissions from combustion occur within a relatively short timeframe of one another (typically 100-200 years), there is no long-term change in atmospheric CO_2 levels. For this reason, biomass is often considered "carbon-neutral", and the Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories* specifies the separate reporting of CO_2 emissions from biomass combustion. See: IPCC (2006), *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* p. 5.5; and the Climate Registry (2019), *General Reporting Protocol Version 3.0*, p. B-4.

[12] Based on current international standards, British Columbia already reports the CH_4 and N_2O portions of biomass combustion as line items in the Provincial Inventory Report. Bio CO_2 biomass emissions are currently reported as memo items.

In CGRT, stationary fuel consumption data are entered either in common units of energy usage (e.g., Gigajoules (GJ), kilowatt hours (kWh)) or are converted to GJ within the application itself.

Data sources: The standardized emission factors for stationary fuel combustion are drawn from the 1990-2019 NIR (Part 2) as follows:[13]

Table 1: Stationary Fuel Combustion

Fuel Type	Table	Source
Natural Gas	A6.1-1 (CO_2) A6.1-3 (CH_4, N_2O)	BC – Marketable Residential, Construction, Commercial/Institutional, Agriculture
Propane	A6.1-4	All Other Uses
Light Fuel Oil	A6.1-5	Forestry, Construction, Public Administration and Commercial/Institutional
Heavy Fuel Oil	A6.1-5	Residential, Forestry, Construction, Public Administration and Commercial/Institutional
Kerosene	A6.1-5	Forestry, Construction, Public Administration and Commercial/Institutional
Diesel Fuel	A6.1-5	Refineries and Others
Marine Diesel	A6.1-14	Marine – Diesel
Gasoline	A6.1-14	Off-road Gasoline 4-stroke
Wood Fuel – Industrial (50% moisture)	A6.6-1	Wood Fuel/Wood Waste – Industrial Combustion
Wood Fuel – Residential (0% moisture)	A6.6-1	Conventional Stoves – Residential Combustion
Ethanol (E100)	A6.1-14	Renewable Fuels
Biodiesel (B100)	A6.1-14	Renewable Fuels

Energy conversion factors to convert to GJ from cubic metres of natural gas and litres of liquid fuels are drawn from Statistics Canada's *Report on Energy Supply and Demand in Canada* (RESD).[14]

Calculations: In B.C., the *Renewable and Low Carbon Fuel Requirements Regulation* (*RLCFRR*) sets the requirements for renewable fuel in the province's transportation and heating fuel blends.[15] Effective January 1st, 2011, fuel suppliers were required to incorporate 5% renewable fuel content for gasoline and 4% for diesel. In CGRT, for any given volume of reported gasoline consumption, 95% of the fuel is deemed to be fossil fuel gasoline and the remaining 5% is ethanol. For diesel, 96% is fossil fuel diesel and 4% is biodiesel.

[13] Environment Canada. (2021). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2019,* Part 2. Available: https://publications.gc.ca/site/eng/9.506002/publication.html
[14] Statistics Canada (2021). *Report on Energy Supply and Demand in Canada 2018*, p. 130. Available: https://www150.statcan.gc.ca/n1/en/catalogue/57-003-X
[15] See http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/394_2008 for the *Renewable and Low Carbon Fuel Requirements Regulation,* B.C. Reg. 394/2008.

Table 2: Renewable Fuel Content in Fossil Fuels

Gasoline	Diesel
95% gasoline	96% diesel
5% ethanol	4% biodiesel

Additionally, FortisBC offers a renewable natural gas product for its customers. Eligible customers have the option of purchasing a portion of their natural gas usage as renewable natural gas by paying the higher commodity cost. Note that if an organization captures their own biogas for stationary combustion, they should calculate the percentage of pure methane in the biogas and then apply the renewable natural gas emissions factors accordingly.

2.1.1 Sample Calculation

Table 3 provides a sample application of an emission factor to calculate GHG emissions based on 100 litres of propane consumption in buildings.

Table 3: Sample Emissions Calculation

Step	Formula	Calculation		
1. Convert the actual consumption to a common unit of measurement.	Actual Consumption (L) x Energy Conversion Factor (GJ/L) = Converted Fuel Consumption (GJ)	100 L X 0.02531 GJ/ L = **2.531 GJ**		
2. Calculate the emissions of each GHG using the appropriate emission factor.	Converted Fuel Consumption (GJ) x Emission Factor by GHG (kg/GJ) = Emissions by GHG	**CO_2** 2.531 GJ x 59.86 kg **CO_2**/GJ = 151.5 kg **CO_2**	**CH_4** 2.531 GJ x .0009 kg **CH_4**/GJ = 0.0023 kg **CH_4**	**N_2O** 2.531 GJ x 0.0043 kg **N_2O**/GJ = 0.0109 kg **N_2O**
3. Convert the emissions of each greenhouse gas to CO_2 equivalency (CO_2e) using the appropriate Global Warming Potential.	Emissions by GHG x GWP = Emissions (kg CO_2e)	**CO_2** 151.5 kg **CO_2** x 1 = 151.5 kg **CO_2e**	**CH_4** 0.0023 kg **CH_4** x 25 = 0.0570 kg **CO_2e**	**N_2O** 0.0109 kg **N_2O** x 298 = 3.243 kg **CO_2e**

4. Sum across the gases to calculate total CO_2e emissions.	**CO_2** + **CH_4** + **N_2O** (all in kg **CO_2e**) = Total **CO_2e**	151.5 kg **CO_2e** + 0.0570 kg **CO_2e** + 3.243 kg **CO_2e** = 154.8kg **CO_2e**
5. Convert total emissions from kg to tonnes for reporting purposes.	Emissions in kg CO_2e/1 000 kg/t = Emissions in tonnes CO_2e	154.8 kg **CO_2e**/1 000 kg/t = 0.155 t **CO_2e**

2.2 Stationary Space Conditioning and Refrigeration

Type: Direct Fugitive Emissions

Description: Fugitive refrigerant emissions from stationary space conditioning equipment are attributed to the leakage and loss of HFC- and PFC-based refrigerants from space conditioning and commercial-type refrigeration systems. Refrigerant loss can occur during the manufacturing, operation, maintenance, and disposal of such equipment.

Data sources: The Climate Registry's General Reporting Protocol offers three methods for reporting and/or estimating emissions from stationary air conditioning and refrigeration.[16] The "Advanced Mass Balance" method is provided for organizations that have access to detailed data on refrigerant purchases, sales, storage, and changes in total equipment capacity. The "Simplified Mass Balance" method is available for organizations that have access to the amount of refrigerant purchased for new and existing equipment, as well as the amount of refrigerant disposed of, recovered, and recycled. The "Screening Method" is used to estimate fugitive emission releases from HFC and PFC refrigerants when detailed information is not available and all small emissions sources are less than 10% of total emissions.[17]

Calculations: Emissions from stationary space conditioning and refrigeration for the B.C. Government were calculated using both the "Simplified Mass Balance" and "Screening Method" using HVAC incident report log and equipment inventory information.

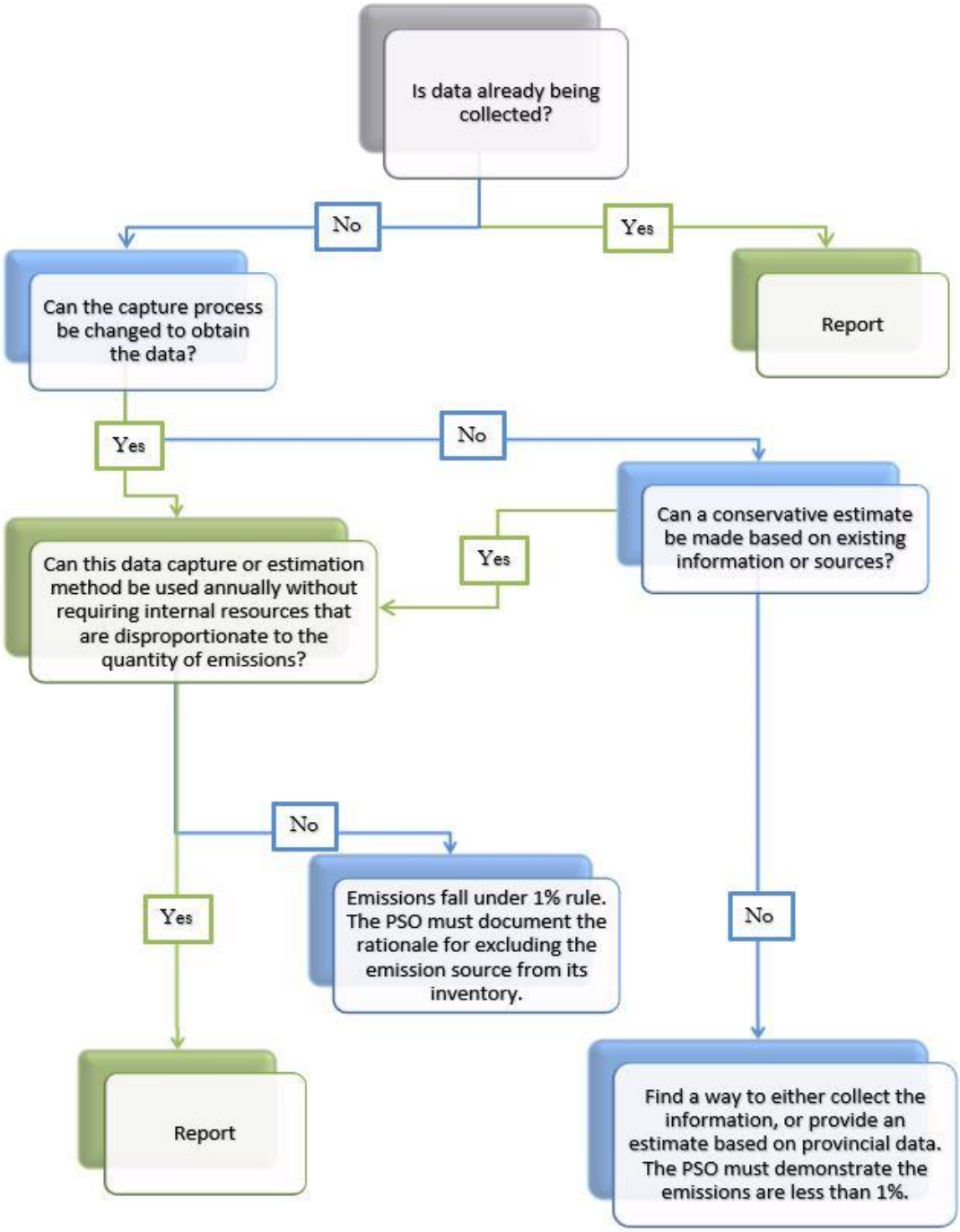
Table 4: Methods for Quantifying Fugitive Emissions

Reference	Method	Source
The Climate Registry (2019), *General Reporting Protocol Version 3.0*	Simplified Mass Balance Screening Method	C-18 C-19

[16] The Climate Registry (2019). *General Reporting Protocol Version 3*.0, C-17. Available: https://www.theclimateregistry.org/protocols/General-Reporting-ProtocolV3.pdf.
[17] Ibid., C-3.

2.2.1 How to Treat Small Emissions

Dealing with small emissions sources can be challenging. For local governments, Modern Treaty Nations and PSOs, if an emissions source is onerous to collect *and* is expected to comprise less than 1% of the organization's total emissions inventory, it is considered out of scope. The decision tree below was developed to help PSOs and LGs determine whether a certain source of emissions falls under this rule. Other methods to address small emission sources are outlined in the General Reporting Protocol. If an emissions source is considered out of scope after using the decision tree, the source of the emission and the rationale for its exemption should be included as a part of a PSO's self-certification documentation and annual reporting.



2.3 Purchased Electricity

Type: Indirect Emissions

Description: The Ministry of Environment and Climate Change Strategy annually publishes a set of greenhouse gas (GHG) emission intensity factors for electricity use. The published factors are used by grid-connected entities in quantifying GHG emissions of electricity which is not self-generated. Their use is required by PSOs under B.C.'s CNGR, for offset projects as prescribed in relevant GHG emission offset protocols, and by other customers of BC Hydro and FortisBC who wish to calculate emissions associated with their electricity use. Electricity in B.C. is supplied to customers through the integrated grid (southern and western B.C.), the Fort Nelson grid (northeast B.C.), and through community generating stations for isolated grid communities (throughout B.C.).[18]

Data sources: Emission factors for purchased electricity in B.C. are those published by GGIRCA. GGIRCA electricity emission factors are updated annually and published in March of each year.

Emissions from PSO buildings located in provinces other than British Columbia must be measured and reported using emission factors for those provinces. Those emission factors are drawn from the 1990-2019 NIR (Part 3) under "Generation Intensity":[19]

Table 5: Non-B.C. Purchased Electricity

Utility Provider	Source
Alberta	Table A13-10
Ontario	Table A13-7
Quebec	Table A13-6
Nova Scotia	Table A13-4

Calculations: The methodology for determining B.C. electricity emission intensity factors is set in Schedule D of the Greenhouse Gas Emission Reporting Regulation (GGERR). Emission factors for PSO buildings located in other provinces (listed in Table 5) were calculated using a three-year average of generation intensities (2017-2019). Emission factors for PSO buildings located in other countries such as the U.K., India, Japan, China, and Hong Kong are based on data from the International Energy Agency (IEA) for CO_2 emissions per kWh from electricity and heat generation.[20] The published three-year rolling averages (2012-2014) for individual countries were incorporated into this report.

[18] B.C. Ministry of Environment and Climate Change Strategy. *Frequently Asked Questions: Electricity Emission Intensity Factors for Grid-Connected Entities*. Available: https://www2.gov.bc.ca/assets/gov/environment/climate-change/ind/quantification/electricity_emission_intensity_factors_for_grid-connected_entities_faq.pdf

[19] Environment Canada (2021). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2019,* Part 3, p. 58. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

[20] International Energy Agency. (2022). Available: http://www.iea.org/

2.4 District Energy Systems, Purchased Steam, Hot Water, etc. for Stationary Sources

Type: Indirect Emissions

Description: Several organizations use centralized steam or hot water systems to heat buildings. Some (e.g., Vancouver Coastal Health Authority) produce heat, use a portion for their own consumption, and sell the surplus. Others purchase heating and/or cooling from a commercial or municipal district energy utility. These providers meet the definition of a District Energy System: "An underground infrastructure asset where thermal energy is provided to multiple buildings from a central energy plant or plants. Steam or hot water produced at the plant is transmitted interminably through highly insulated underground thermal piping networks. The thermal energy is transferred to the building's heating system, avoiding the need for boilers in individual buildings."[21]

This thermal energy can be created using a variety of input feedstock fuels including biomass (forest, agricultural, municipal solid waste), biogas, renewable energy (e.g., solar and wind), natural gas, recovered waste heat, and cool water. As such, it provides the opportunity to utilize locally available energy to provide space conditioning and hot water at a community scale and, importantly, the opportunity to centrally substitute feedstock fuels over time. This is an important way for communities to create sustainable, resilient energy delivery systems and manage the risk of dependence on a single fuel or technology.

When an organization produces heating or cooling for its own consumption, the resulting GHG emissions are determined by applying the appropriate emission factors of the fuels consumed by the system (refer to Section 2.1). Where an organization purchases heating or cooling from another entity, estimating emissions requires information on the fuels consumed and the generation, distribution, and system efficiencies.

Data sources: The average efficiency of district energy systems can vary significantly depending on characteristics such as the age of the plant, distribution losses, and operation and maintenance practices. A District Energy emissions calculator based on the General Reporting Protocol has been developed for organizations to help them determine which of the tiers they should use for emissions measurement and reporting purposes.[22] The calculator can be found on the Carbon Neutral Government Program Requirements page under "Links and Tools".

- STEP 1: Use the calculator to determine the district energy system's emissions intensity.
- STEP 2: Compare the calculated emissions intensity with the thresholds provided in the calculator.
- STEP 3: Select the tier where the calculated value falls by referencing the upper and lower thresholds.

As there is no upper bound to Tier 10, CGRT calculates emissions based on the lower-bound of each tier to provide consistent conservative estimates across all tiers.

[21] See the International District Energy Association's (2019) definition at: https://www.districtenergy.org/topics/district-heating

[22] The Climate Registry (2019). *General Reporting Protocol*, *Version 3.0*. Available: https://www.theclimateregistry.org/protocols/General-Reporting-ProtocolV3.pdf

Organizations can continue loading their purchased steam in pounds (lbs) or kilograms (kg) into CGRT for conversion into megajoules (MJ) of energy. Note the previous tiered steam emission factors for steam (Natural Gas at 65%, 75%, and 85%) from previous iterations of the *BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions* document have been carried over into the new tiers in CGRT. The RESD provides an average conversion factor for translating kg of steam into MJ of energy.[23]

Organizations should document all the variables they input into the calculator as a record for reference by other/future staff, for annual Self Certification purposes, and for possible third-party verification. This documentation should be updated on an annual basis as system efficiencies will vary based on local climate, exposure, occupancy patterns, heating controls, insulation, and other factors. Documentation, or any questions about the foregoing for PSOs, should be sent to Carbon.Neutral@gov.bc.ca.

Note: Where a PSO produces heating/cooling energy and sells a portion to another PSO, the producing PSO must account for that quantity of energy sold as a negative value, or separately identify the emissions from the sales using the District Energy calculator. These emissions are then deducted from the producer's GHG inventory to avoid double counting when aggregating emissions across the B.C. public sector. However, if an organization produces heating/cooling energy and sells a portion to another organization that is not a PSO, they must report in full the emissions resulting from the production and distribution of that energy.

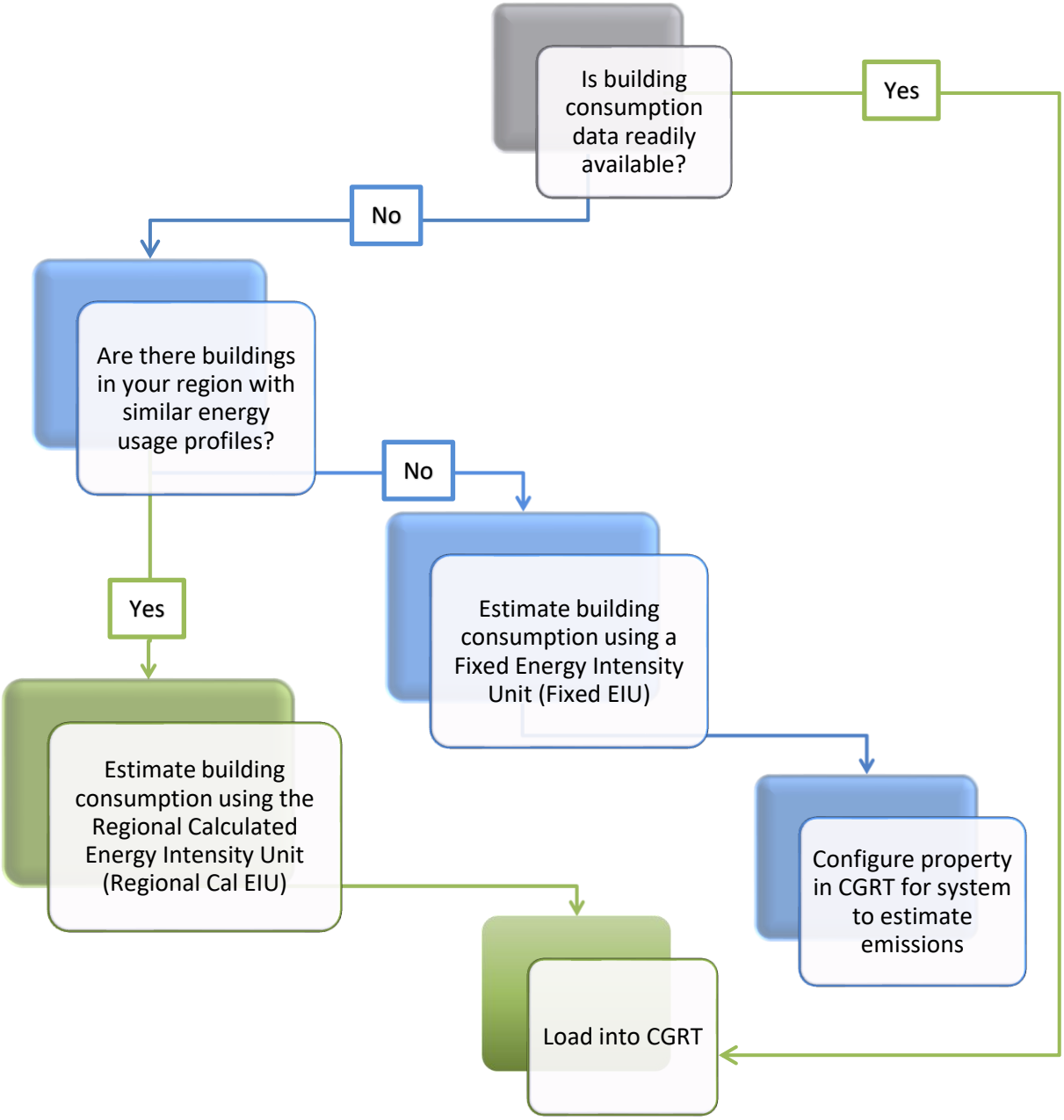
2.5 Estimating a Building's Energy Use

The following information is intended to provide a summary of two estimation methods to estimate energy consumption when such data is not readily available.

These methods rely on a building's Gross Floor Area; the total area, as measured between the principal exterior surfaces of the enclosing fixed walls of the building(s). This includes all areas inside the building(s) such as: occupied tenant areas, common areas, stair wells, meeting areas, break rooms, restrooms, elevator shafts, mechanical equipment areas, and storage rooms.[24] The following flowchart demonstrates the process of choosing the best approach to estimating a building's energy use.

[23] Statistics Canada (2021). *Report on Energy Supply and Demand in Canada 2018,* p. 131. Available: https://www150.statcan.gc.ca/n1/en/catalogue/57-003-X

[24] Energy Star Portfolio Manager. *Glossary*. Available: https://portfoliomanager.energystar.gov/pm/glossary



2.5.1 Regional Calculated Energy Intensity Unit (Regional Calc EIU)

This method allows an organization to estimate its energy use for a given building from data available for similar buildings in their portfolio within the same climatic region. For this approach to be reasonably accurate, energy data should be available for a sufficient proportion of a PSO's buildings portfolio within the same climatic region. As guidance, it is suggested that energy data should be available for at least 51% of a PSO's buildings in particular category (e.g., educational facilities) and within the same climatic region. In addition, having at least 2 years of historical data is recommended to smooth out year-over-year variability.

Using available energy data from a PSO's buildings within a specific climatic region and classification, this approach involves calculating the energy use per square meter (i.e., energy intensity) and applying that energy intensity to the floor area of the similar buildings requiring estimates. Once consumption is estimated in this way, load that estimated consumption data into CGRT to determine the resulting emissions. The calculations below demonstrate how the estimated consumption data could be converted to emissions outside of CGRT by applying the appropriate emission factors and GWP to estimate related greenhouse gas emissions.

Table 6: Regional Energy Intensity Unit Estimation Calculation

Step	Formula for each energy type
1. For similar buildings (i.e., office/region) with data, determine their combined annual consumption for each energy type and divide by their combined floor area	Annual energy type use / Total square meters of related floor area [a] = Annual Regional Energy Intensity Factor ($GJ/year/m^2$)
2. Estimate the quantity of each energy type used in the Building to be Estimated (BTBE)	Floor area of the BTBE x Annual Regional Energy Intensity Factor ($GJ/year/m^2$) = Annual Energy type Use in BTBE (GJ)
3. Apply the emission factor by energy type to yield total emissions by energy type	Emission Factor (kg/GJ) x Consumption (GJ) = Emissions by GHG (kg)
4. Apply the global warming potentials to yield total emissions	Emissions by GHG (kg) x GWP = Emissions (kg CO_2e)
5. Sum across the gases to calculate total CO2e emissions	**CO_2** + **CH_4** + **N_2O** (all in kg **CO_2e**) = Total **CO_2e**
6. Convert total emissions from kg to tonnes for reporting purposes.	Emissions in kg CO_2e / 1,000 kg / t = Emissions in tonnes CO_2e

a. If the floor area of a building has changed within the reporting period, multiply each area by the number of days during the year for which it was effective. Sum the results and divide that sum by the total number of days in the year to get a prorated area to use for that year.

2.5.2 Fixed Energy Intensity Unit (Fixed EIU)

This estimation method applies energy intensity factors from the Comprehensive Energy Use Database (CEUD) published by Natural Resources Canada (NRCan) through the Office of Energy Efficiency.[25] This database includes statistics on energy use by province, building use, type, and energy type.

Table 7: Fixed Energy Intensity Unit Estimation Calculation

Step	Formula for each Energy type
1. For each energy type, determine the annual consumption amount.	EIU (GJ/month/m^2) x square meters of floor area [a] x 12 months = annual consumption amount (GJ)
2. Apply the emission factor by energy type to yield total emissions by energy type	Emission Factor (kg/GJ) x Consumption (GJ) = Emissions by GHG (kg)
3. Apply the global warming potentials to yield total emissions	Emissions by GHG (kg) x GWP = Emissions (kg CO_2e)
4. Sum across the gases to calculate total CO2e emissions	$CO_2 + CH_4 + N_2O$ (all in kg CO_2e) = Total CO_2e
5. Convert total emissions from kg to tonnes for reporting purposes.	Emissions in kg CO_2e/1,000 kg/t = Emissions in tonnes CO_2e

a. If the area of a building has changed within a monthly reporting period, multiply each area by the number of days during the month for which it was effective. Sum the results and divide that sum by the total number of days in the month to get a prorated area to use for that month.

2.5.3 Hybrid Energy Estimations

In some instances, energy data may be available for one energy type in a building but not for another. It is appropriate then to estimate the unknown energy type using one of the methods above. Similarly, the regional calculation may be used to estimate one energy type within a building while other energy types in the same building may use the Fixed EIU.

[25] Natural Resources Canada (NRCan) through the Office of Energy Efficiency Comprehensive Energy Use Database: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm

3 Mobile Sources – Transportation

Transportation is another source of GHG emissions. Two categories of emissions are discussed in detail below:

- Direct emissions from fossil fuels combustion in vehicles and equipment.
- Direct fugitive emissions from mobile air conditioning systems.

3.1 Mobile Fuel Combustion

Type: Direct Emissions

Description: Emission factors are specified for seven transport modes:

- Light-duty vehicles (excluding trucks, SUVs, and minivans)
- Light-duty trucks (including SUVs and minivans)[26]
- Heavy-duty
- Motorcycles
- Off-road vehicles and equipment (e.g., snowmobiles, ATVs, lawnmowers and trimmers, tractors, construction equipment)
- Marine
- Aviation

Eight fuel types have different emission factors associated with them:

- Gasoline
- Diesel
- Biodiesel
- Ethanol
- Marine Gasoline
- Marine Diesel
- Aviation Gasoline
- Aviation Turbo Fuel

[26] The NIR defines light-duty cars and trucks as those with a Gross Vehicle Weight Rating (GVWR) of 3,900 kg or less and heavy duty as those vehicles with a GVWR greater than 3,900 kg.

CGRT accepts fuel consumption data in litres by mode of transport and fuel type. This information is required because the emission factors for CH_4 and N_2O vary by vehicle type and transport mode.

Hybrid electric vehicles are not considered separately since their fuel consumption is captured under gasoline cars and trucks. The higher fuel economy of these vehicles relative to conventional gasoline cars and trucks is reflected in their lower overall fuel consumption, and therefore, lower GHG emissions. Hydrogen powered transit busses and electric vehicles produce zero emissions at the tailpipe and are not included in emissions reporting for mobile sources. However, the electricity consumed by an electric vehicle is tracked as part of a building's plug load.

Data sources: The following table outlines emission factors for mobile fuel combustion from the 1990-2019 NIR (Part 2) Table A6.1-14:[27]

Table 8: Mobile Fuel Combustion

Transport Mode	Fuel Type	Source
Light-duty Vehicle	Gasoline (E5) Diesel (B4)	Tier 1 Advanced Control
Light-duty Truck (includes SUV and Minivan)	Gasoline (E5) Diesel (B4)	Tier 1 Advanced Control
Heavy-duty	Gasoline (E5) Diesel (B4)	Three-way Catalyst Advanced Control
Motorcycle	Gasoline (E5)	Non-catalytic Controlled
Off-Road (Vehicle/Equipment)	Gasoline (E5) Diesel (B4)	Off-road Gasoline 4-stroke Off-road Diesel $\geq$ 19kW, Tier 4
Marine	Gasoline (E5) Diesel (B4)	Marine
Aviation	Gasoline Turbo Fuel	Aviation
Various	Biodiesel (B100) Ethanol (E100)	Renewable Fuels

Note: Accepted units in CGRT for the above emission factors are in kg/L.

[27] Environment Canada (2021). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2019,* Part 2, p. 217. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

Calculations: In practice, biofuels are blended with fossil fuels, specifically gasoline or diesel, in varying proportions (e.g., E10, B5, B20), so that the actual emission factor is a weighted average of the biofuel and fossil fuel factors.[28] The following equation can be used to calculate the Bio CO_2 portion of fleet fuels.

Renewable Fuel (Ethanol or Biodiesel)	**x**	**Biofuel Proportion** (5%, 10%, 15%, 20%)	**=**	**Bio CO_2**

Below are examples of how to calculate the Bio CO_2 portions of a standard light-duty gasoline and light-duty diesel vehicle. Values for renewable fuels are derived from Table 1.

Light-duty Vehicle – Gasoline (E5):	1.508 kg/L (Ethanol)	**x**	5%	**=**	**0.0754 kg/L**
Light-duty Vehicle – Diesel (B4):	2.472 kg/L (Biodiesel)	**x**	4%	**=**	**0.09888 kg/L**

Table 9: Sample CO_2e Calculation

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Transport Mode	**Fuel Type**	**Emission Factor (kg/L) [a]**				
		Bio CO_2	CO_2	CH_4	N_2O	CO_2e
Light-duty Vehicle	Gasoline (E5)	0.0754	2.1919	0.00023	0.00047	2.3385
	Diesel (B4)	0.09888	2.57328	0.00005	0.00022	2.64012

[a] Emission factors in columns (4) through (6) are those listed in Table 8.

[28] International protocols require the separate reporting of biogenic emissions from fossil fuel-based emissions (see Section 2.1**Error! Reference source not found.**), the CO_2 emissions from the biofuel component must be calculated and reported separately from those of the fossil fuel component.

3.2 Mobile Air Conditioning

Type: Direct Fugitive Emissions

Description: Atmospheric releases of motor vehicle coolants such as hydrofluorocarbons (HFCs) occur throughout the lifecycle of motor vehicle air conditioning (MVAC) units. Unlike a building's heating, ventilation, and air conditioning (HVAC) systems, MVAC servicing is not part of the regular service schedule. Moreover, fuel consumption, which is measurable, does not provide insight into MVAC use. Given differences in climate, usage on the coast is likely to be very different from that in the interior.

Data sources: The Climate Registry offers a "Screening Method" for estimating emissions based on an upper bound capacity charge for MVAC equipment multiplied by an operating emission factor.[29] This method has been used to calculate a default emission factor, in kg of HFCs per vehicle. To apply the default factor, organizations must provide the number of vehicles in its fleet with MVAC.

The Climate Registry recommends an upper bound capacity charge of 2 kg and an operating emission factor of 20 percent of capacity per year for mobile air conditioning.[30] The most common refrigerant used in MVAC is HFC-134A, with a global warming potential of 1,430.

Calculations: Multiplying the 2 kg capacity charge by the 20 percent operating emission factor and converting to CO_2e emissions yields a default emission factor of 572 kg CO_2e per vehicle per year.

Table 10: Per Vehicle Estimate of HFCs from Mobile Air Conditioning

Greenhouse Gas (kg)	Emissions per Vehicle per Year (kg CO_2e)
Hydrofluorocarbons	572

[a] default emission factor for HFCs from mobile air conditioning are emissions which consist of HFC-134a.

Organizations typically have two options for calculating and reporting mobile cooling emissions. Organizations with information on the MVAC servicing for their fleets (e.g., for transit fleets) may use that data to report their HFC emissions directly using the Climate Registry's "Simplified Mass Balance Approach."[31] This method requires information on the quantities of each refrigerant used and recovered from MVAC equipment reported directly. Organizations without access to detailed mobile refrigerant information may estimate and report their annual refrigerant use at 572 kg CO_2e per each vehicle with air conditioning. This value provides a conservative estimate of emissions resulting from HFC-134a use.

[29] The Climate Registry (2019). *General Reporting Protocol Version 3.0*, C-19. Available: https://www.theclimateregistry.org/protocols/General-Reporting-ProtocolV3.pdf
[30] The Climate Registry (May 2021). *2021 Climate Registry Default Emission Factors*, Table 4.1, p. 67. Available: https://www.theclimateregistry.org/wp-content/uploads/2021/05/2021-Default-Emission-Factor-Document.pdf
[31] Ibid., (2019). C-18.

4 Office Paper

Type: Indirect Emissions

Description: Emission factors for office paper are differentiated by size and the percentage of post-consumer recycled (PCR) content. In practice, the PCR content can range between 0 and 100 percent.[32]

Three different sizes of office paper (any colour) are in scope – 8.5" x 11", 8.5" x 14" and 11" x 17". In each case, data on the number of 500-sheet (20lb) packages are entered into CGRT.

Some organizations may be using alternative paper types such as wheat, eucalyptus, sugarcane, bamboo, etc. While these papers likely have emission factors that differ from conventional paper, limited literature is currently available on their carbon intensity. As a best approximation, the emission factors in CGRT for 100% PCR of the corresponding paper size should be applied to these alternative paper types.

Data sources: Ideally, it would be best to specify emission factors that accurately reflect the extraction, transportation, manufacturing, and disposal processes for specific paper purchases. In the absence of paper-specific information, proxy emission factors have been derived from the Environmental Paper Network Paper Calculator.[33] This tool assesses the lifecycle impacts of paper production and disposal and is updated regularly with peer-reviewed data.

The Paper Calculator inputs the paper grade (e.g., copy paper), quantity by weight and PCR content and estimates the associated GHG emissions in pounds of CO_2e.

Calculations: To generate the emission factors in CGRT, the weight of a 500-sheet package was first determined for each paper size. This weight (in metric tons) and the PCR content were then entered into the Paper Calculator and the resulting estimate of GHG emissions was converted from lbs to kg CO_2e. Emission factors for other PCR contents (e.g., 85 percent) can be interpolated by averaging between the values shown.

It should be noted that, unlike the other emission factors within this document, the office paper entries in CGRT are lifecycle emission factors.[34]

[32] See the Ecopaper Database at http://c.environmentalpaper.org/home for a listing of papers available in the Canadian marketplace and their PCR contents.
[33] Environmental Paper Network. (2021). *Paper Calculator 4.0*. Available: http://c.environmentalpaper.org/home
[34] Lifecycle emissions account for all emissions relating to the production, use, and disposal of a product, including the extraction of raw materials, product manufacturing, and intermediate transport steps.

SECTIONS 5-7 ARE APPLICABLE TO PROVINCIAL GOVERNMENT ONLY

5 Business Travel

Type: Indirect Emissions

Description: In accordance with the CCAA, the Provincial Government (i.e. ministries, special offices, tribunals) is required to quantify, reduce, offset, and report the business travel and accommodation emissions of its public officials.

Quantification methods: The GHG Protocol provides three methods for quantifying business travel emissions listed below in order of preference.[35] The Protocol recommends the selection of a method based on availability of data:

1. **Fuel-based method:** involves determining the amount of fuel(s) consumed during business travel and applying the appropriate emission factor for the fuel(s).
2. **Distance-based method:** involves determining the distance and travel mode(s) and applying the emission factor appropriate for the mode(s).
3. **Spend-based method** involves determining the expenditures and travel mode(s) and applying the emission factors appropriate for the mode(s).

Data sources: Beginning with the 2016 reporting year, the business travel emissions of the Provincial Government were quantified using data collected through a combination of:

1. iExpenses (the system used to reimburse employees for out-of-pocket travel expenses); and
2. The Government's accounting system which also tracks:
    - ministry directly-paid expenditures on airfare, and
    - employee travel vouchers for other modes.

These two data sources are described in Sections 5.1 and 5.2, respectively, below.

5.1 iExpenses Data

The B.C. Government's iExpenses system tracks travel mode(s), some fuel type(s), and some travel distance(s) in addition to related expenditures.

Calculations: Where travel distances are collected by iExpenses, business travel emissions can be quantified using the distance-based method. Otherwise, travel emissions must be calculated with the spend-based method. Table 11 below illustrates when each method is used with iExpenses data.

5.1.1 iExpenses: Distance and Spend-based Methods

Employees using iExpenses enter mandatory information about their business trips, including the type of expense they incurred (see column 2 in Table 11), the travel mode (column 3) and fuel used along with other details (column 4).

Total kilometres travelled are determined/captured by the system where employees travel by:

- air or ferry on common routes,

[35] Greenhouse Gas Protocol. Available: https://ghgprotocol.org/

- between common origin/destination combinations, and
- rental/personal vehicle.

The distance data in combination with mode and fuel type then enables the application of the distance-based method to quantify related emissions. However, not all iExpenses entries include the data points necessary for the distance-based method. Employees who travel by air or ferry on rarely used routes, or between small cities, are unable to select the specific locations from which they depart and arrive. In these situations, they select "Other" or "Other BC" and GHGs must be calculated using a spend-based method.

Column 6 of Table 11 indicates which section of the document provides more detail on the related estimation methods in Column 5.

Table 11: iExpenses Business Travel Selections

(1) Employee's Travel Mode	(2) iExpenses "Expense Type" Selection	(3) iExpenses "Travel Mode" Selection	(4) Key iExpenses Dropdown Selection	(5) GHG Estimation Method	(6) Section w/ Detailed Description
Air Travel, common routes	Air You Paid	Helicopter, Airplane, Float Plane	Route	Distance-Based	6.3
Air Travel, Other routes	Air You Paid	Helicopter, Airplane, Float Plane	"Other" or "Other BC" as Route option	Spend-Based	6.4
All rental vehicles	Car Rental	Car, other, Truck/SUV	Fuel type, vehicle type	Distance-Based	6.1
Personal vehicle	Mileage	Car, other, Truck/SUV	Fuel type, vehicle	Distance-Based	6.1
Ferries	Ferry	N/A	Route	Distance-Based	6.2
Rail, Intercity Bus, other public transport	Public Transport	Other	N/A	Spend-Based	6.4
Taxis	Public Transport	Taxi	N/A	Spend-Based	6.4
City Bus, Skytrain, SeaBus	Public Transport	Transit	N/A	Spend-Based	6.4
Accommo-dation	Accommo-dation	Hotel, Private, Other	N/A	Nightly stay-based	7

5.2 Other Accounting System Data

In addition to iExpense tracking of employee out-of-pocket travel expenses, employee travel expenditures are also tracked within the government accounting system including:

- ministry directly-paid expenditures on airfare; and
- employee (paper-based) travel vouchers for travel on other modes.

Column 5 of Table 12 below indicates which section of this document provides more detail on the related travel mode in Column 4.

Table 12: Non-iExpenses Business Travel Selections

(1)	(2) Subaccount	(3) Travel Mode Possibilities	(4) Most Frequent Travel Mode	(5) Section with Detailed Description
Directly Paid Air Travel	Victoria to Vancouver	Float Plane, helicopter, short-haul air	Float Plane	6.4
	In-Province	Short-haul flights; medium-haul air	Short-Haul	
	Out-of-Province	Medium and long-haul flights	Long-Haul	
	Out-of-Canada	Long-haul flights	Long-Haul	
Travel Voucher or Other Modes	Victoria to Vancouver	All ground transport modes and accommodations	N/A	6.5
	In-Province			
	Out-of-Province			
	Out-of-Canada			

6 Business Travel – Distance and Spend-based

6.1 Car, Truck, or SUV (Distance-based)

Description: This section covers travel by taxis, rental cars, and business use of personal vehicles. It provides distance-based emission factors based on average fuel efficiencies for common combinations of vehicle and fuel types. Vehicle types are: (1) cars (including hybrid electric vehicles) and (2) pickup trucks/SUVs. Fuel types are gasoline and diesel. Fuel efficiencies from NRCan are expressed in liters per 100 kilometres driven. Emission factors are expressed in kilograms per kilometre in CGRT.

Data sources: For road travel, NRCan publishes "city" and "highway" fuel economy ratings by vehicle manufacturer and model.[36] It is expected that most Government travel falls between the conditions modeled for city and highway driving, tending closer to city estimates.[37] The city data used in Table 13 (below) to calculate average fuel efficiencies reflect city consumption and, therefore, does not require the application of an uplift factor.

For gasoline and diesel vehicles, data were obtained from NRCan Comprehensive Energy Use Database, Transportation Sector – British Columbia and Territories (2018).[38] Distances for road travel can be derived from the Government of B.C.'s Traveller Information System.[39] For hybrid and electric vehicles, data wer obtained from NRCan 2021 Fuel Consumption Guide.[40] Explanation of terms used in NRCan datasets can be found here.

It should be noted that when charging an electric vehicle at a building owned by your organization, the emissions for charging the vehicle will be attributed to that building unless there is a separate meter for electric vehicles such as school buses.

[36] Natural Resources Canada. (2021). *2021 Fuel Consumption Guide.* Available: https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/fuel-consumption-guide/21002.
[37] The NRCan city ratings have been used here for several reasons. For example, most highway driving in the province's metropolitan areas is characterized by considerable congestion, leading to higher fuel consumption. In the Interior, fuel efficiencies are likely to be higher than the theoretical (best practices) NRCan ratings, given weather and terrain. As a result, the city ratings can be assumed to capture some of the actual highway driving efficiencies in B.C. and lead to a more conservative estimate of the GHG emissions from business road travel.
[38] Natural Resources Canada. (2020). Comprehensive Energy Use Database, Transportation Sector, British Columbia and Territories. Available: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive/trends_tran_bct.cfm
[39] DriveBC. (n.d.). "Plan your route." Available: https://drivebc.ca/directions.html
[40] Natural Resources Canada. (2021). Fuel consumption ratings. Available: https://open.canada.ca/data/en/dataset/98f1a129-f628-4ce4-b24d-6f16bf24dd64

Table 13: Average Fuel Efficiencies for Car, Truck, or SUV Travel

Travel Mode	Vehicle/Fuel Type	Average Fuel Efficiency	Emission Factor (kg CO_2e/km)	Dataset	Source	Reference
Car (includes taxi)	**Gasoline** (standard blend)	0.082 L/km	0.192	CEUD – Transportation Sector – B.C. (2018)	Table 21	Cars On-Road Average Fuel Consumption (L/100 km) – Motor Gasoline
	Diesel	0.066 L/km	0.174			Cars On-Road Average Fuel Consumption (L/100 km) – Diesel Fuel Oil
	Hybrid	0.078 L/km	0.182	Plug-in hybrid electric vehicles 2012-2021	Consumption – City	Average of all "B" type vehicles
Light Truck (includes SUV and Minivan)	**Gasoline**	0.109 L/km	0.258	CEUD – Transportation Sector – B.C. (2018)	Table 37	Passenger Light Truck On-Road Average Fuel Consumption (L/100 km) – Motor Gasoline
	Diesel	0.089 L/km	0.234			Passenger Light Truck On-Road Average Fuel Consumption (L/100 km) – Diesel Fuel Oil
	Hybrid	0.098 L/km	0.232	Plug-in hybrid electric vehicles 2012-2021	Consumption – City	Average of all "B" type vehicles
Electric Vehicle	**Electricity**	0.197 kWh/km	0.0079	Battery-electric vehicles 2012-2021	Consumption – City	Average of all vehicles listed

Calculations: To calculate emissions from distance-based car, truck, or SUV travel, apply the average fuel efficiency (L/km) by the CO_2e of the vehicle fuel type.

Table 14: Sample Emission Factor Calculation for Car Travel

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Travel Mode	**Vehicle/Fuel Type**	**Average Fuel Efficiency (L/km)**	**Emission Factor (kg/L) [a]**					**CO_2e kg/km**
			Bio CO_2	CO_2	CH_4	N_2O	CO_2e	(8) * (3)
Car	Gasoline	0.082	0.0754[b]	2.1919	0.00023	0.00047	2.3385	0.1917

[a] Emission factors in columns (5) through (7) are those listed in Table 8 for Light-Duty Vehicle – Gasoline (E5) from 1990-2019 NIR (Part 2).
[b] Bio CO_2 value taken from Table 9.

6.2 Ferry (Distance-based)

Description: This section describes how the value of ferry travel emission factor was determined. In the context of ferry travel, the emission factor is expressed in kilograms of CO_2e per passenger kilometre (kg CO_2e/psg-km).

Data sources: BC Ferries provided emission factors for the following five ferry routes in kilograms of CO_2e per passenger trip (kg CO_2e/psg-trip).[41] The data is an average of five years spanning from April 2017 to March 2021.

Table 15: Emission Factors for BC Ferry Routes

Route Number	Ferry Route	Emission Factor (kg CO_2e/psg-trip)
(1)	Tsawwassen – Swartz Bay	5.77
(2)	Horseshoe Bay – Nanaimo	5.90
(3)	Horseshoe Bay – Langdale	2.21
(8)	Horseshoe Bay – Snug Cove	1.39
(30)	Nanaimo – Tsawwassen	7.41

Currently, CGRT is configured with a single emission factor for ferry travel in kg CO_2e/psg-km. Therefore, a five-year weighted average of the above routes was calculated to determine a single emission factor for ferry travel (see Table 16 below).

Calculation: BC Ferries provided emission factors for the routes mentioned above in kilograms of CO_2e per passenger trip (kg CO_2e/psg-trip). Using the information provided by the annual reports prepared and submitted to the BC Ferries Commissioner, a five-year utilization percentage (2017-2021) was calculated by dividing the five-year average of automobile equivalents (AEQ) by the five-year average

[41] BC Ferries average emission factors (2017-2021) were provided by Colleen Hanlan, Manager, Climate and Environment, BC Ferries Services.

capacity provided of each ferry route.[42] Data extracted from iExpenses of the trips made by Provincial Government from 2016-2020 shows that, on average during those years, about 85% of the trips were made from Metro Vancouver – Vancouver Island (routes 1, 2, and 30). There was no distinction in the iExpenses data amongst these routes, so they were weighted based on BC Ferries AEQs for each route. Metro Vancouver to Sunshine Coast was directly related to Horseshoe Bay to Langdale trips. The remainder of trips were assumed to have similar GHG intensities to the Horseshoe Bay to Snug Cove trip. They were reported as Haida Gwaii to Inside Passage (Prince Rupert), Vancouver Island to Inside Passage (Prince Rupert), Metro Vancouver to Gulf Islands, and Other. The weighting of total trips was calculated by multiplying each routes' weighting for total trips by the average percent of trips made for each route by Government employees. Dividing the emission factors provided for each route by the five-year percent average utilization multiplied by the kilometres per trip, an emission factor (kg CO_2e/psg-km) is calculated. The weighted contribution to total emissions is then calculated by multiplying each route's emission factor by its percent weighting of total trips. Next, the portion of emissions from renewable fuels (kg Bio CO_2/psg-km) is calculated by multiplying each route's weighted contribution to total emissions by the percent of biodiesel in marine diesel (assumed to be 4%). Finally, the kg fossil CO_2e per passenger kilometre for each route is calculated by subtracting the kg Bio CO_2/psg-km from each route's weighted contribution to total emissions and an average of all routes is taken to obtain one emission factor for ferry travel (listed in the table below).

Table 16: Emission Factor for Ferry Travel

Travel Mode	Emission Factor (kg CO_2e/psg-km)
Ferry	0.1117

6.3 Air Transport (Distance-based)

Description: This section provides details about distance-based air travel.

Data sources: Emission factors for distance-based air transport are from HarbourAir's 2017 GHG Report,[43] HeliJet, and the UK Department for Environment, Food and Rural Affairs (DEFRA) 2021 Government Greenhouse Gas Conversion Factors for Company Reporting.[44]

[42] BC Ferries. *Plans, Reports, Policies and Other Resources*, "Annual Reports to the Commissioner". Available: https://www.bcferries.com/in-the-community/resources
[43] Harbour Air. (2017). *Harbour Air's 2016-2017 Greenhouse Gas Report.* Available: https://www.harbourair.com/wp-content/uploads/2019/01/Harbour-Air-2017-GHG-Report.pdf
[44] DEFRA. (2021). *2021 Government Greenhouse Gas Conversion Factors for Company Reporting*. Available: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

Table 17: Distance-based Air and Public Transport

Travel Type	Travel Mode	Source	Reference
Air Transport	Float plane (Vancouver-Victoria)	HarbourAir 2017 GHG Report	Page 5, Emissions per route
	Helicopter	HeliJet	
	Airplane (short-haul <415km) Airplane (medium-haul 415-1316km) Airplane (long-haul >1316km)	DEFRA Conversion Factors 2021: condensed set [a]	Domestic (without RF) Short-haul (without RF) Long-haul (without RF)

[a] Emission factors can be found in 'Scope 3 factors: Business travel – air'.

6.3.1 Helicopter & Floatplane

The emission factor for air transport by helicopter were provided directly by HeliJet. Floatplane travel was calculated based on HarbourAir's 2017 emissions per passenger journey from operating flights between Vancouver harbour and Victoria harbour.

6.3.2 Airplane

While NRCan also publishes aggregate data on GHG emissions and passenger-km for air travel, no breakdown is provided for haul distance. In contrast, DEFRA has estimated emission factors for three categories of flights:[45]

(1) domestic,
(2) short haul international, and
(3) long haul international.

For the B.C. Government's purposes, the forgoing DEFRA categories have been applied as follows:

(1) the domestic emission factor has been applied to short haul flights,
(2) the short haul international emission factor has been applied to medium haul flights, and
(3) the long-haul international emission factor has been applied to long haul flights.[46]

The DEFRA air travel emission factors include an eight percent uplift factor based on the recommendation of the Intergovernmental Panel on Climate Change (IPCC) to account for discrepancies between geographical distance and actual flight distance.[47] These discrepancies can result from conditions such as non-linear routing that is not the shortest direct distance, delays or circling, and routings of take-off and landing. B.C.'s distance-based method uses the shortest geographical distance between the starting point and the destination. The eight percent uplift factor is used to adjust for the difference between this shortest distance calculation and the actual travel path of the aircraft.

[45] Ibid.
[46] The DEFRA categories are applied on the basis of distance rather than destination because conditions of European air travel vary substantially from those in B.C. (e.g., a typical Canadian domestic flight is likely to be much longer than a typical UK domestic flight).
[47] IPCC (1999). *Aviation and the Global Atmosphere*, Section 8.2.2.3. Available: http://www.ipcc.ch/ipccreports/sres/aviation/index.php?idp=118

6.4 Air and Public Transport (Spend-based)

Description: This section describes how emission factors can be determined for various travel modes when related expenditure data exists but little or no distance data is available. This approach generally involves one of the following algorithms for each travel mode when determining the associated emissions per dollar of expenditure.

Equation 1:	Travel Mode's **Distance-Based Emission Factor** (kg CO_2e / km)	÷	Travel Mode's **Cost per kilometre** ($ / km)	=	Travel Mode's **Spend-Based Emission Factor** (kg CO_2e / $)
Equation 2:	Travel Mode's **Average Emissions per Trip** (kg CO_2e / trip)	÷	Travel Mode's **Cost per Trip** ($ / trip)	=	Travel Mode's **Spend-Based Emission Factor** (kg CO_2e/ $)

The following tables provide emission factors for spend-based air transport, ministry directly-paid air transport, and public transport. An explanation of values and their respective references are provided above each table.

Data sources: Data for distance-based emission factors used to calculate spend-based air transport in Table 18 and Table 19 (below) are derived from Table 17. Data for transit ridership and fares to calculate spend-based public transport emission factors are provided by TransLink and BC Transit.

Within the context of air travel tracked through iExpenses, the spend-based emission factors noted in Table 18 were applied to the business travel of employees who selected:

- "float plane", "helicopter", "airplane" as travel modes, and
- "Other" or "Other BC" as their destinations.

Table 18: Emission Factors for Spend-based Air Transport

Travel Type	Travel Mode	Distance-based Emission Factor kg CO_2e / psg-km	Average Cost $ / km	Spend-based Factor kg CO_2e / $
Air Transport	Float plane	0.2086	1.52	0.1372
	Helicopter	0.4469	2.25	0.1986
	Airplane – Short Haul	0.1300	0.93	0.1295
	Airplane – Medium Haul	0.0812	0.75	0.1003
	Airplane – Long Haul	0.1021	0.81	0.1167
	Airplane – Weighted Average of Short/Med/Long Haul [a]	0.0923	0.78	0.1176

[a] In the absence of distance data, it is not possible to distinguish between short-, medium-, and long-haul airplane travel. In this case, a weighted average of the distance-based emission factors for those air travel categories has been used. The weighting is based on total distance reported in iExpenses for each category in 2019 and 2020.

In the context of ministry directly-paid expenditures on travel, expenditures are tracked within sub-accounts representing air travel:

- between Victoria/Vancouver,
- in-province travel,
- out-of-province travel, and
- out-of-country travel.

The air transport options for these subaccounts are presented in Table 19. The emission factor selected for each subaccount was based on historical data which identifies the modes most frequently taken for each subaccount (i.e., trip category).

Table 19: Emission Factors for Spend-based Ministry Directly-Paid Air Transport

Directly Paid Subaccount[48]	Common Air Transport Modes	Emission Factor kg CO_2e / $	Reference
Victoria to Vancouver	Float plane Helicopter	0.1986	Table 18: Helicopter
In-Province	Short-haul	0.1398	Table 18: Short-haul
Out-of-Province	Medium-haul Long-haul	0.1082	Table 18: Medium-haul
Out-of-Canada	Long-haul	0.1260	Table 18: Long-haul

Data sources: Data from BC Transit and Translink was used to calculate spend-based public transport emission factors. Please see below for details on how the values in Table 20 were derived.

Table 20: Emission Factors for Spend-based Public Transport

Public Transport Mode	Distance-based Emission Factor [a] kg CO_2e / psg-km	kg CO_2e / trip	Average Cost $ / km OR $ / trip	Spend-based Emission Factor kg CO_2e / $
Taxi	0.1917		2.30/km	0.0833
City Bus	0.1016	0.4821	2.55/trip	0.1891
Skytrain		0.1050	4.35/trip	0.0241
SeaBus		0.5020	4.35/trip	0.1154
Weighted Average - Transit				0.0594
Rail	0.1215		0.31/km	0.3919
Intercity Bus	-	-	-	0.1891

[48] The Standard Object of Expenditre (STOB) account numbers for these subaccounts are as follows: 5711 for Victoria to Vancouver, 5712 for In-Province, 5713 for Out-of-Province, and 5714 for Out-of-Canada.

Weighted Average – Public Transport, Other				0.1984

[a] Distance-based emission factors are derived from Table 17.

Public transport emission factors are grouped into the following sections:

- Public Transport – Taxi
- Public Transport – Transit: City Bus, Skytrain, SeaBus
- Public Transport – Other: Rail and Intercity Bus

The following sections provide a description of how each public transport mode's emission factors in Table 20 were calculated to derive emission factors for the reporting categories listed above.

6.4.1 Taxi

The spend-based emission factor for Taxi was calculated using Equation 1 which requires:

- Average taxi cost per kilometre, and
- Taxi emissions per kilometre.

Average Taxi Cost Per Kilometre

All taxis in British Columbia charge rates regulated by the Passenger Transportation Board, an independent tribunal of the Ministry of Transportation and Infrastructure.[49] Rates across British Columbia vary only slightly. The rates used for the purposes of quantifying business travel emissions are the provincial average as stated by the Board:

- **Flag Fee:** $3.32: The flag fee is the automatic minimum fee a passenger pays for a taxi. When you order a taxi, the meter will already be at $3.32 when you step inside.[50]
- **Per Kilometre Fee:** $2.03: Passengers are charged this fee for every kilometre they travel in a taxi if the taxi is not in traffic and forced to drive slowly. If it is, the following fee may apply.
- **Wait Time:** $40.79 per hour: This fee is charged if the taxi must wait.

According to two major taxi companies in Victoria and Vancouver, the average trip cost and length was:

- Victoria: $21; 9.0 km, and
- Vancouver: $15; 6.5 km,

yielding an average cost of $2.30/km.

Average Taxi Emissions Per Kilometre

Based on the conservative assumption that taxis are generally standard gasoline-fuelled cars, the distance-based emission factor is 0.19 kg of CO_2e per km travelled (refer to Table 17). This is considered a conservative assumption, as taxi companies are increasingly going electric. This assumption will be reviewed in future iterations of this document.

Spend-Based Taxi Emission Factor

Using Equation 1 and the information above, the spend-based emission factor for taxi travel is calculated as follows:

[49] Passenger Transportation Board. (2016). "Taxi Rates". Available: http://www.ptboard.bc.ca/taxi-rates.htm
[50] $3.32 is the average flag fee, but this may change slightly on a case-by-case basis.

Travel Mode's **Distance-Based Emission Factor** (kg CO_2e / km)	÷	Travel Mode's **Cost per kilometre** ($ / km)	=	Travel Mode's **Spend-Based Emission Factor** (kg CO_2e / $)
0.192	÷	2.30	=	**0.0833**

6.4.2 Transit (City Bus, Skytrain, SeaBus)

Employees who travel on a city bus, Skytrain, or SeaBus must select "Transit" within the iExpenses system. For this reason, the spend-based emission factor for the Transit travel mode was calculated as a weighted average of the city bus, Skytrain, and Seabus factors, weighted by the number of trips recorded for the period 2008-2016.[51]

City Bus:

The spend-based emission factor for City Bus was estimated using Equation 2 which requires:

- Average City Bus cost per trip, and
- Average City Bus emissions per trip.

Average Cost Per Trip

A standard trip on a city bus costs $2.50 in Victoria and $2.80 in Vancouver. Fares tend to be cheaper in the rest of the province. Therefore, $2.55 was used as the standard price of one bus trip.

Average Emissions Per Trip – BC Transit

BC Transit's reporting through the CGRT provides data on the total emissions from BC Transit operations. In 2019, BC Transit's revenue fleet service emitted 62,289 tonnes, or 62,289,000 kilograms, of fossil fuel-based CO_2e.[52] BC Transit reported approximately 58.7 million rides in 2019/20 (April 1, 2019 to March 30, 2020).[53]

Average Emissions Per Trip – TransLink

TransLink Enterprise's 2020 Accountability Report includes their revenue fleet emissions.[54] A five-year average of 134,271 tonnes, or 134,271,000 kilograms, of CO_2e was reported. Emissions from TransLink's revenue fleet make up 90% of TransLink's total emissions, and emissions from the bus fleet make up just over 80% of total TransLink emissions. Revenue service emissions were determined by multiplying by 0.8/0.9, to give 119,352 t CO_2e. TransLink reported 318,062,000 annual boardings in 2019.[55]

[51] Since data for number of trips is not accessible in iExpenses, recorded data in SMARTTEC from 2008-2016 is used for calculations in this section.
[52] Data extracted from the Clean Government Reporting Tool for 2019.
[53] BC Transit (2020). *BC Transit 2019/20 Annual Service Plan Report*. p. 11. Available: https://www.bctransit.com/documents/1529710288414
[54] TransLink (2021). *TransLink Enterprise 2020 Accountability Report.* Available: https://www.translink.ca/-/media/translink/documents/about-translink/corporate-reports/accountability_reports/2020/2020_accountability_report.pdf
[55] TransLink. (2020). *2019 Transit Service Performance Review: Summary Tables.* Available: https://www.translink.ca/-/media/translink/documents/plans-and-projects/managing-the-transit-network/tspr/tspr_2019_summary_tables.pdf

Calculating Total Emissions Per Trip – BC Transit and TransLink

Sum of Emissions (kg CO_2e)	÷	**Sum of Trips**	=	**Total** (kg CO_2e / trip)
181,641,000	÷	376,762,000	=	**0.4821**

Spend-Based City Bus Emission Factor

Using Equation 2 and the information above, the spend-based emission factor for City Bus travel is calculated as follows:

Sum of Emissions per Trip (kg CO_2e / trip)	÷	**Sum of Cost per Trip** ($ / trip)	=	**Total Spend-Based Emission Factor** (kg CO_2e/ $)
0.482	÷	2.55	=	**0.189**

Skytrain:

The spend-based emission factor for Skytrain was estimated using Equation 2 which requires:

- Average Skytrain cost per trip, and
- Average Skytrain emissions per trip.

Average Skytrain Cost Per Trip

Skytrain fares depend on the number of zones travelled (1, 2, or 3). Many different possibilities exist for trip distance within each zone. This estimate uses the price for a 2-zone trip ($4.35) combined conservatively with the longest distance logged in the system over the lifespan of iExpenses approximately 45 kilometres.

Average Skytrain Emissions Per Trip

Using the 45-kilometre distance per trip noted above, and the distance-based emission factor of 0.002334 kg CO_2e/km, a standard trip will generate 0.105 kg of CO_2e.

Spend-Based Skytrain Emission Factor

Using Equation 2 and the information above, the spend-based emission factor for Skytrain travel is calculated as follows:

Travel Mode's **Emissions per Trip** (kg CO_2e / trip)	÷	Travel Mode's **Cost per Trip** ($ / trip)	=	Travel Mode's **Spend-Based Emission Factor** (kg CO_2e / trip)
0.105	÷	4.35	=	**0.0241**

SeaBus:

The spend-based emission factor for SeaBus was estimated using Equation 2 which requires:

- Average SeaBus cost per trip, and
- Average SeaBus emissions per trip.

Average SeaBus Cost Per Trip
A one-way trip on the SeaBus costs $4.35.

Average SeaBus Emissions Per Trip
Based on 3.25 km distance for a one-way SeaBus trip, and the distance-based emission factor of 0.1547 kg CO_2e/km, a one-way SeaBus trip will generate 0.502 kg CO_2e per passenger.

Spend-Based SeaBus Emission Factor
Using Equation 2 and the information above, the spend-based emission factor for SeaBus travel is calculated as follows:

Travel Mode's **Emissions per Trip** (kg CO_2e / trip)	÷	Travel Mode's **Cost per Trip** ($ / trip)	=	Travel Mode's **Spend-Based Emission Factor**
0.502	÷	4.35	=	**0.115**

6.4.3 Weighted Average – Transit

The spend-based emission factor for the Transit travel mode was calculated as a weighted average of the city bus, Skytrain, and Seabus factors, weighted by the number of trips recorded for the period 2008-2016. According to the data, there were 378 city bus trips, 1,471 Skytrain trips, and 51 SeaBus trips. Using these values as relative weights, the Transit spend-based emission factor is:

$$\frac{378(0.1891) + 1{,}471(0.0241) + 51(0.1154)}{378 + 1{,}471 + 51} = \textbf{0.0594 kg } \mathbf{CO_2e/\$}$$

6.4.4 Other Public Transport (Rail, Intercity Bus)

Employees who travel by rail and intercity buses must select "Other" under Public Tranport within the iExpenses system. For this reason, the spend-based emission factor for the Transit travel mode was calculated as a weighted average of the factors for these two modes of travel, weighted by the number of trips recorded for the period 2008-2016.

Rail:

The spend-based emission factor for rail was estimated using Equation 1 which requires:

- Average cost of Rail per kilometre, and
- Average Rail emissions per kilometre.

Average Cost of Rail Per Kilometre

Data for the period 2008-2016 shows 36 rail trips at an average cost of $0.31/km.

Average Rail Emissions Per Kilometre

The distance-based emission factor for rail is 0.1215 kg CO_2e/km.

Spend-Based Rail Emission Factor

Using Equation 1 and the information above, the spend-based emission factor for rail travel is calculated as follows:

Travel Mode's **Distance-Based Emissions Factor** (kg CO_2e / km)	÷	Travel Mode's **Cost per Kilometre** ($ / km)	=	Travel Mode's **Spend-Based Emission Factor** (kg CO_2e/ $)
0.1215	÷	0.31	=	**0.3919**

Intercity Bus:

In the absence of reliable cost data, the spend based emission factor city bus of **0.189 kg CO_2e/$** has been applied to intercity buses. This is a conservative approach given that Table 11 of NRCan (2015) shows that intercity buses emit approximately half the emissions of city buses.[56]

6.4.5 Weighted Average – Other Public Transport

The spend-based emission factor for the "Other" public transport mode was calculated as a weighted average of the rail and intercity bus factors, weighted by the number of trips recorded for the period 2008-2016. According to the data, there were 36 rail trips and 748 intercity bus trips. Using these values as relative weights, the "Other" spend-based emission factor is:

$$\frac{(36 \times 0.3919) + (748 \times 0.1891)}{(36 + 748)} = \textbf{0.1984 kg } \mathbf{CO_2e/\$}$$

6.5 Travel Vouchers

Travel vouchers provide a paper-forms approach to obtain reimbursement for travel expenses for employees that are unable to use iExpenses. Employees generally submit completed forms to their finance staff for entry into the government's accounting system.

In this case, the travel involved can include all forms of public transport: ferry, bus, taxi, personal vehicles, transit, and accommodations. However, the accounting system provides no details about such travel other than approximate destinations based on the following sub-accounts (account numbers provided):

- Victoria/Vancouver (5701, 5720, 5730),

[56] Natural Resources Canada. (2015). *Comprehensive Energy Use Database, Transportation Sector, 1990-2012.* Available: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm

- In-Province (5702, 5731),
- Out-of-Province (5704, 5722, 5735, 5703, 5721, 5732, 5705, 5706), and
- Out-of-Country (5735).

The estimation of the emission factor for these subaccounts was based on a highly simplified approach, using an estimated total value for business travel emissions based on emission values from previous years:

Estimated Total Business Travel Emissions (kg CO_2e)	÷	**"Other Modes" Business Travel Expenditures** ($)	=	**0.2900 kg CO_2e / $**

This factor may also be used to estimate the emissions from other, non-standard, business travel expenses.

7 Accommodation

Description: In addition to transportation-related GHGs from business travel, Provincial Government entities (i.e. ministries, special offices, tribunals) are also required to quantify, reduce, offset, and report the indirect emissions that result from employee stays in hotels, bed and breakfasts, and private accommodations while on business travel.

Data sources: The B.C. emission factor for accommocation was derived from the annual Cornell Hotel Sustainability Benchmark study which provides information on energy and water usage in hotels across a total of 21,432 participating hotels from 26 international hotel chains over the past three years (2017-2019).[57] The emission factor for overnight accommodation in Canada was derived from the 2021 UK Government GHG Conversion Factors for Company Reporting.[58]

Calculations: iExpenses tracks accommodations in terms of the number of nights stayed in a hotel/motel, bed and breakfast, or private accommodations.

Table 21: Emission Factor for Accommodation

	Location	kg CO_2e / room / night
Hotel Stay	Canada B.C.	16.1 6.6
Weighted Average [a]		7.455

[a] Based on 91% BC-stay rate since 2016.

[57] Ricaurte, Eric, and Rehmaashini Jagarajan. (2021). *Hotel Sustainability Benchmarking Index 2021: Carbon, Energy, and Water.* Available: https://ecommons.cornell.edu/handle/1813/109990.

[58] U.K. Department for Business, Energy, & Industrial Strategy. (2022). *Greenhouse gas reporting: Conversion factors 2021.* Available: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

ANNEX 1: GLOSSARY OF TERMS AND ACRONYMS

Note: Definitions derived from:

- IPCC. (2018). *Fifth Assessment Report*. "Annex 2, Glossary" and "Index". Available: https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_Annexes.pdf
- Market Advisory Committee to the California Air Resources Board. (2007). "Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California."
- The Climate Registry. (2019). *General Reporting Protocol Version 3.0*. "Glossary of Terms". pp. 64. Available: https://www.theclimateregistry.org/protocols/General-Reporting-ProtocolV3.pdf

Table 22: Terms and Acronyms

Abbreviation, Acronym or Measure	Definition
Carbon dioxide (CO_2)	A naturally occurring gas (0.03% of atmosphere) that is also a by-product of the combustion of fossil fuels and biomass, land-use changes, and other industrial processes. It is the principal anthropogenic greenhouse gas. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. (IPCC)
Carbon dioxide equivalent (CO_2e)	"The universal unit of measurement to indicate the global warming potential (GWP) of each of the six greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide." (GHG Protocol) Expressing all GHGs in terms of tonnes of CO_2e allows the different gases to be aggregated.
Community Energy and Emissions Inventory	The Community Energy and Emissions Inventory (CEEI) represents energy consumption and greenhouse gas emissions from community activities in on-road transportation, buildings and solid waste. Estimates of land-use change from deforestation activities and enteric fermentation from livestock under the Agricultural sector are also available.
Biofuel	A fuel produced from dry organic matter or combustible oils produced by plants. Examples of biofuel include alcohol (from fermented sugar), black liquor from the paper manufacturing process, wood and soybean oil.
Direct emissions	Emissions from sources that are owned or leased by a PSO or sources used by local governments to deliver traditional local government services.
EDF	Environmental Defense Fund, a US-based environmental organization.
Emission factor	"A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and absolute GHG emissions". (GHG Protocol)
Emissions	"The release of substances (e.g., greenhouse gases) into the atmosphere. Emissions occur both through natural processes and as a result of human activities." (CARB)
Energy conversion factor	A factor used to convert a quantity of energy from its original physical unit into a common unit of measurement (e.g., GJ).
Fugitive emissions	The unintended or incidental release of greenhouse gases from the transmission, processing, storage, use, or transportation of fossil fuels, GHGs, other substances, including but not limited to HFC emissions from refrigeration leaks and SF_6 from electric power distribution equipment.
Gigajoule (GJ)	One billion joules, where a joule is a common unit of energy for comparing across fuel types and electricity.

Abbreviation, Acronym or Measure	Definition
Gigawatt-hour (GWh)	One million kilowatt-hours, enough electricity to power 100 homes for a year.
Global Warming Potential (GWP)	"Greenhouse gases differ in their effect on the Earth's radiation balance depending on their concentration, residence time in the atmosphere, and physical properties with respect to absorbing and emitting radiant energy. By convention, the effect of carbon dioxide is assigned a value of one (1) (i.e., the GWP of carbon dioxide =1) and the GWPs of other gases are expressed relative to carbon dioxide. For example, in the U.S. national inventory, the GWP of nitrous oxide is 298 and that of methane 25, indicating that a tonne of nitrous oxide has 298 times the effect on warming as a ton of carbon dioxide. Slightly different GWP values for greenhouse gases have been estimated in other reports. Some industrially produced gases such as sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs) have extremely high GWPs. Emissions of these gases have a much greater effect on global warming than an equal emission (by mass) of the naturally occurring gases. Most of these gases have GWPs of 1,300 - 23,900 times that of CO_2. The US and other Parties to the UNFCCC report national greenhouse gas inventories using GWPs from the IPCC's Second Assessment Report (SAR). SAR GWPs are also used for the Kyoto Protocol and the EU ETS. GWPs indicated in this document also refer to the IPCC's Second Assessment Report." (CARB)
Global Reporting Initiative (GRI)	An international initiative that has developed a sustainability reporting framework for organizations to measure and report on their economic, environmental and social performance (see: https://www.globalreporting.org/).
Greenhouse gases (GHGs)	"Greenhouse gases include a wide variety of gases that trap heat near the Earth's surface, slowing its escape into space. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor and other gases. While greenhouse gases occur naturally in the atmosphere, human activities also result in additional greenhouse gas emissions. Humans have also manufactured some gaseous compounds not found in nature that also slow the release of radiant energy into space." (CARB)
HVAC	Heating, Ventilating and Air Conditioning
Hydrofluorocarbons (HFCs)	"One of the six primary GHGs. Synthetic industrial gases, primarily used in refrigeration and other applications as commercial substitutes for chlorofluorocarbons (CFCs). There are no natural sources of HFCs. The atmospheric lifetime of HFCs is decades to centuries, and they have "global warming potentials" thousands of times that of CO_2, depending on the gas. HFCs are among the six greenhouse gases to be curbed under the Kyoto Protocol." (CARB)
Indirect emissions	Emissions that are a consequence of the operations of the reporting organization (i.e., PSO, local government, community), but occur at sources owned or controlled by another organization.
Intergovernmental Panel on Climate Change (IPCC)	"Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It is open to all members of the UN and WMO. The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature." (CARB)

Abbreviation, Acronym or Measure	Definition
Inventory	"A greenhouse gas inventory is an accounting of the amount of greenhouse gases emitted to or removed from the atmosphere over a specific period of time (e.g., one year). A greenhouse gas inventory also provides information on the activities that cause emissions and removals, as well as background on the methods used to make the calculations. Policy makers use greenhouse gas inventories to track emission trends, develop strategies and policies and assess progress. Scientists use greenhouse gas inventories as inputs to atmospheric and economic models". (CARB)
kg	Kilogram
kilotonne	1,000 tonnes
km	Kilometre
kWh	kilowatt-hour
L	Litre
lb	pound (weight)
LG	Provincial legislation such as the *Local Government Act* and the *Community Charter* defines the core authority and responsibilities of local governments.
m^3	cubic metre
Methane (CH_4)	"One of the six greenhouse gases to be curbed under the Kyoto Protocol. Atmospheric CH_4 is produced in nature, but human related sources such as landfills, livestock feedlots, natural gas and petroleum systems, coal mines, rice fields, and wastewater treatment plants also generate substantial CH_4 emissions. CH_4 has a relatively short atmospheric lifetime of approximately 10 years, but its 100-year GWP is currently estimated to be approximately 25 times that of CO_2." (CARB)
MVAC	Motor Vehicle Air Conditioning
NIR	National Inventory Report (Environment Canada)
Nitrous oxide (N_2O)	"One of the six greenhouse gases to be curbed under the Kyoto Protocol. N2O is produced by natural processes, but substantial emissions are also produced by such human activities as farming and fossil fuel combustion. The atmospheric lifetime of N2O is approximately 100 years, and its 100-year GWP is currently estimated to be 298 times that of CO_2." (CARB)
Office Paper	Multipurpose copy paper for use in laser printers, fax machines and photocopiers or multifunction devices.
Perfluorocarbons (PFCs)	"PFCs are among the six greenhouse gases to be curbed under the Kyoto Protocol. PFCs are synthetic industrial gases generated as a by-product of aluminum smelting and uranium enrichment. They also are used in the manufacture of semiconductors. There are no natural sources of PFCs. PFCs have atmospheric lifetimes of thousands to tens of thousands of years and 100-year GWPs thousands of times that of CO_2, depending on the specific PFC." (CARB)
pkg	Package
PSO	A B.C. public sector organization subject to the government's carbon neutral commitment under the *Climate Change Accountability Act*.
RESD	Report on Energy Supply and Demand (Statistics Canada).
STP	Standard Temperature and Pressure

Abbreviation, Acronym or Measure	Definition
Sulphur Hexafluoride (SF_6)	One of the six greenhouse gases to be curbed under the Kyoto Protocol. SF_6 is a synthetic industrial gas largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. There are no natural sources of SF_6. SF_6 has an atmospheric lifetime of 3,200 years. Its 100-year GWP is currently estimated to be 22,800 times that of CO_2." (CARB)
t	metric tonne, a standard measurement for the mass of GHG emissions, equivalent to 1,000 kg, 1,204.6 pounds, or 1.1 short tons.

ANNEX 2: GLOBAL WARMING POTENTIALS

Table 23 presents the 100-year Global Warming Potentials for the GHGs being tracked by the B.C. public sector. These GWPs are listed in the Carbon Neutral Government Regulation and are the 2007 values from the IPCC's *Fourth Assessment Report*; as such, they represent the standard emission factors to be used at this time in greenhouse gas emissions calculations in British Columbia.[59, 60]

Table 23: Global Warming Potentials

Greenhouse Gas	Chemical Formula	100-Year GWP
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298
HFC-23	CHF_3	14,800
HFC-32	CH_2F_2	675
HFC-41	CH_3F	92
HFC-43-10mee	$C_5H_2F_{10}$	1,640
HFC-125	C_2HF_5	3,500
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1,100
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,430
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	353
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	4,470
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	124
HFC-227ea	C_3HF_7	3,220
HFC-236fa	C_3H_2F6	9,810
HFC-245ca	$C_3H_3F_5$	693
Perflouro-methane (*)	CF_4	7,390
Perflouro-ethane (*)	C_2F_6	12,200
Perflouro-propane (*)	C_3F_8	8,830
Perflouro-butane (*)	C_4F_{10}	8,860
Perflouro-cyclobutane (*)	c-C_4F_8	10,300
Perflouro-pentane (*)	C_5F_{12}	9,160
Perflouro-hexane (*)	C_6F_{14}	9,300
Sulphur hexafluoride	SF_6	22,800

[59] British Columbia (2020). *B.C. Provincial Greenhouse Gas Inventory Report 2018*, p. 3. Available: https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory/archive

[60] Greenhouse Gases marked with an asterisk (*) were added from the *Carbon Neutral Government Regulation*.

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ANNEX 4: DOCUMENT VERSION CONTROL

Reporting Year	Page(s)	Updates Include:
2021	TOC	Updated structure
		Removed Section 3.2 Natural Gas Vehicle Emission Factors
		Removed Section 3.3.2 Public Transport (distance-based)
		Removed Section 6 Agricultural Emission Factors
	Throughout	
		Updated emission factors and their respective sources
		Section 2.3 Purchased electricity emission factors aligned with GGIRCA
2020	Figure 2	Updated decision tree to reflect available CGRT configuration
	Throughout	Updated references from SMARTTool to CGRT to reflect transition to the new tool and decommissioning of SMARTTool in 2019
	Table 21	Updated Energy Intensity Unit factors based on primary function to align with those adopted by Energy Star Portfolio Manager and configured in CGRT
	Section 3.2	Ferry emission calculation correction
	Section 2.2	Updated intention to align with GGIRCA's grid-based electricity emission factors for 2021 reporting year
	Section 3.2	Reinstated reference to the conversion of compressed natural gas to litres of gasoline and diesel equivalent
2018	Section 1	Updated dates from 2017 to 2018
	9, 12	Updated Carbon.Neutralapps@gov.bc.ca to Carbon.Neutral@gov.bc.ca
	7, 8, 29	Changed *Greenhouse Gas Reductions Target Act* (GGRTA) to *Climate Change Accountability Act* (CCAA)
	Section 3.2	Removed reference to the conversion of compressed natural gas to litres of gasoline and diesel as the web references are no longer valid
	Annex 1	Updated Glossary of Terms and Acronyms
2017	TOC	Removed Section 1.5 Structure
	Section 1.3	Reference to the National Inventory Report: Greenhouse Gas Sources and Sinks in Canada updated from 1990-2013 to 1990-2014
	Table 1, Table 2	Marine Diesel Emission Fraction for CH4, N2O and CO2e updated
	Table 1, Table 2	Wood Fuel - Residential emission factor for BioCo2, CH4, N2O and CO2e updated
	Section 2.2	Electricity emission factors for Quebec and Nova Scotia added
	Table 3	Emission factors updated for BC Hydro, Kyoquot Power, Hemlock Valley, Alberta, Ontario, United Kingdom, India, Japan, China, Hong Kong, Nova Scotia, Quebec
	Table 4	Added Table 4: Historical Emission Factors for Purchased Electricity
	Table 7	Updated Emission Factors for Fleet: Off-Road Vehicle (Diesel), Marine (Gasoline), Marine (Diesel)
	Section 4	Updated Business Travel reporting methods
	Table 22	Fixed EIU Factors updated for all Building Classifications
	Annex 5	Business Travel Methodology Added


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