2023 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions

For Public Sector Organizations, Local Governments, Modern Treaty Nations, and Community Emissions

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B.C. Ministry of Environment and Climate Change Strategy

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1 Introduction

This document describes the approach for quantifying and reporting corporate greenhouse gas (GHG) emissions for:

1. B.C.'s provincial public sector organizations (PSOs), for the purposes of meeting legislative requirements to be carbon neutral, and
2. Local governments (LGs) and Modern Treaty Nations (MTNs) for the purposes of reporting under the Local Government Climate Action Program.

This document provides a basis for PSOs, LGs and MTNs to measure their GHG emissions with consistent and up-to-date best practices and provides comparable emissions reporting province-wide.

This document consolidates previous stand-alone methodology documents for B.C.'s PSOs, LGs and MTNs, and the Community Energy and Emissions Inventory. It can be used by its target audience and by other groups wishing to calculate corporate GHG emissions. Please note that the private sector entities subject to the B.C. Greenhouse Gas Emission Reporting Regulation must use quantification methods prescribed by the Regulation.

This document consolidates emissions factors and emissions calculation methodologies appropriate for use in British Columbia. The numerical emissions factors can be found in the Emission Factors Catalogue[1]. It draws heavily on:

- Protocols established by:
  - The World Resources Institute,
  - The Climate Registry,
  - The International Standards Organization: Standard 14064 (ISO 14064) on Greenhouse gases, and
- Published emission factors from authoritative sources such as:
  - Environment and Climate Change Canada's (ECCC) National Inventory Report,
  - Natural Resources Canada, and
  - The UK Department for Environment, Food and Rural Affairs.

1.1 Public Sector Organizations

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

[1] The Emission Factors Catalogue can be accessed on the Carbon Neutral Government program's website and the Local Government Climate Action Program's website.

The emissions factors and emissions calculation methodologies described in this document have been integrated into CGRT, the online tool provided by the B.C. government to support PSO GHG measurement and reporting requirements.

CGRT contains emission factors for all PSO reporting categories. When PSOs report their annual energy consumption and activity data in the tool, CGRT applies the appropriate emission factor and global warming potential (see Section 1.4.1 below) and calculates total GHG emissions.

1.1.1 Policy Context

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.[2] PSOs[3] are required to report annually in accordance with the CCAA and the CNGR.

In May 2018, the Province of B.C. enacted legislation to establish provincial targets for reducing GHG emissions by 40% below 2007 levels by 2030, 60% by 2040, and 80% by 2050. Later that year, the CleanBC Plan set targets for the B.C. public sector to reduce building emissions by 50% and fleet emissions by 40% by 2030. Given that 2010 was the first year with complete public sector emissions data, the CleanBC public sector targets are set against a baseline year of 2010.

Measuring GHG 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 GHG emission reduction targets under the CCAA.

1.1.2 In-Scope Activities

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

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

There are categories that apply to the Provincial Government (ministries and independent offices) only:

- Sections 5-7: Business Travel and Accommodation

For each activity category, the emission type is specified (either as direct or indirect emissions), and a brief description of the category is given, along with an explanation of data sources and where to

[2] See http://www.bclaws.ca/civix/document/id/complete/statreg/07042_01, for the *Climate Change Accountability Act* (CCAA), 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.

[3] Under the *Budget Transparency and Accountability Act*, PSOs are defined as part of the Government Reporting Entity as both Provincial government entities as reported through the Consolidated Revenue Fund (e.g., ministries and independent offices) and broader public sector agencies including health authorities, school districts, colleges and universities, and Crown corporations.

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.

PSOs are asked to direct all questions related to GHG quantification, scope, and the Clean Government Report Tool (CGRT) to Carbon.Neutral@gov.bc.ca.

1.2 Local Governments and Modern Treaty Nations

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, [4]
- 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 initiatives.

To support local governments in meeting CAC commitments, the Community Energy and Emissions Inventory (CEEI) initiative provides a provincial framework for tracking and reporting energy and emissions at a community-wide scale. The Technical Methods and Guidance Document outlines the methodologies for producing GHG emissions estimates in the CEEI reports. Using common emission factors and referring to this document in the specific guidance material for the CEEI program will promote consistency between community-wide and corporate emissions reporting.

1.2.1 Modern Treaty Nations

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

1.2.2 Policy Context

The Local Government Climate Action Program (LGCAP) is a commitment within the CleanBC Roadmap to 2030 and provides predictable, annual, and long-term funding for B.C. local governments and MTNs to take on climate action aligned with provincial and local climate objectives. To be eligible for funding in year three a number of eligibility requirements must be met, including being a signatory to the B.C. Climate Action Charter or a B.C. Modern Treaty Nation and measuring and reporting on corporate GHG emissions for local governments with populations exceeding 10,000 residents.

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

1.2.3 Measuring and Reporting Emissions

Local governments and Modern Treaty Nations are eligible for the Local Government Climate Action Program (LGCAP). There is a reporting requirement for LGs with populations exceeding 10,000 residents to measure and report their corporate inventories for year three of the Program. LGs and MTNs can report using this methodology or select an established reporting protocol to meet this requirement, if it follows the traditional local government services framework and includes emissions from contracted services. It is important that LGs use a consistent methodology over time to meet their requirement under the *Green Communities Statutes Act* to track progress to targets.

1.2.3.1 LGCAP Boundaries and In-Scope Activities

The boundaries for calculating emissions are based on the energy used in the delivery of traditional LG and MTN services:[5]

- 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.

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 LG or MTN will be required to meet the following standards for their measurement processes:

- Use the same corporate boundaries and scope as defined in the LGCAP Boundaries and Scope Guidance,
- Use the GHG measurement methods and emission factors referenced in this document, and updates as provided by the Climate Action Secretariat,
- Report on annual total traditional services emissions as calculated by a GHG inventory tool (ex. the Traditional Services Emissions Inventory Reporting Tool).

All the supporting materials for these standards are available on the LGCAP website.

The following sections of this document apply directly to LGs and MTNs for their in-scope activities:

- Section 2: Stationary Sources - Buildings (**except** for refrigerants used in space conditioning and refrigeration),
- Section 3: Mobile Sources – Transportation (**except** for Mobile Air Conditioning),
- Annex 1: Glossary of Terms and Acronyms,

[5] 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 (indirect emissions) are not included.

- Annex 2: Selected References, and
- Annex 3: 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 LGs and MTNs.

All LG and MTN questions related to GHG quantification and scope should be directed to LGCAP@gov.bc.ca.

1.3 Other Users

Other potential users of this document include energy and emissions modelling and planning consultants, energy utilities, academic researchers, non-governmental organizations, and other organizations interested in measuring their GHG emissions.

1.4 Emissions Calculation Fundamentals

This section provides context for organizations seeking to understand how emissions are calculated.

1.4.1 Global Warming Potentials

GHGs vary in their global warming potential (GWP), which is the degree to which they trap heat in the atmosphere compared to that of carbon dioxide (CO_2). The GWP of a GHG is determined by how much infrared radiation a GHG will absorb in the atmosphere, the time period of interest (e.g., the United Nations Framework Convention on Climate Change (UNFCCC) agreed that GWPs should be reported over the 100 year time horizon[6]), and how long the GHG will remain in the atmosphere. The GWP for each GHG is expressed as the ratio of that GHG's heat trapping ability relative to that for CO_2, which has a GWP of one. Updates to B.C.'s GWPs specified in the CNGR are made in line with updates by the UNFCCC and the Canadian Federal Government .

For the 2022 reporting year and onward, the GWPs in this document and the emission factors catalogue reflect the 100-year GWPs for GHGs in the IPCC's 5th Assessment Report (AR5). Emissions prior to 2022 continue to use the GWPs from the IPCC's 4th Assessment Report (AR4), as the inventory-wide impact of a change from the AR4 GWPs to the AR5 GWPs is very small (roughly 0.1%). The Climate Action Secretariat will align with other BC Government programs and update all historical GWPs to IPCC's 6th Assessment Report's GWPs when those are adopted.

Methane (CH_4) has a GWP of 28, indicating that emitting one tonne of CH_4 will have the same climate warming impact as releasing 28 tonnes of CO_2 over a 100-year time horizon. This impact is expressed using the concept of carbon dioxide equivalent, or CO_2e, as required under the CNGR: that is, one tonne of CH_4 can also be expressed as 28 tonnes of CO_2e.

[6] United Nations Framework Convention on Climate Change, Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. Part two: Action taken by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement. (2018), p. 25. Available: https://unfccc.int/sites/default/files/resource/CMA2018_03a02E.pdf#page=25

GWPs are particularly important within the context of emissions reporting since international protocols require the reporting of both individual GHGs and their CO_2e equivalents. The CNGR [7] lists the GWPs of the GHGs within its scope in its Schedule.

1.4.2 Emission Factors

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 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,
(2) multiplying those emissions by its GWP to produce the corresponding CO_2e emissions, and
(3) If necessary, convert CO_2e emissions from the unit they are currently in (e.g., g or kg) to tonnes CO_2e (t CO_2e).

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 1990-2021* (NIR), released in 2023.[8] International documents, such as The Climate Registry's *General Reporting Protocol*, have been used for some emission factors.[9] B.C.-specific emission factors have been developed in other cases, using data provided by B.C. energy utilities and business travel providers.

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

1.4.3 Principles for Determining Emission Factors

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

1) Where information is available, the Climate Action Secretariat's preference is to use emission factors that best reflect the Carbon Neutral Government (CNG) program's circumstances. For example, the emission factors for electricity or fuel come from B.C.-

[7] Carbon Neutral Government Regulation. (Dec. 9, 2008). Available: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/392_2008#Schedule

[8] Environment Canada. (2023). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2021*. The Canadian Government's Submission to the United Nations Framework Convention on Climate Change. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

[9] The Climate Registry. (2019). *General Reporting Protocol*, *Version 3.0*. The Climate Registry is a cross-border initiative to develop common measurement, verification, and reporting requirements for GHG emissions. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf.

specific data sources. The Climate Action Secretariat will continue to monitor and apply B.C.-specific emission factors to improve the accuracy of GHG reporting.

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 should not be overly burdensome or costly. In certain cases, e.g., where an emissions source is too small to justify gathering additional data, simplified emissions estimation methods are provided.

4) In developing simplified estimation methods, the Climate Action Secretariat uses assumptions to support an overestimation, rather than an underestimation of emissions.

1.4.4 Understanding Scope Categories

The General Reporting Protocol[10] classifies GHG emissions in three scopes:

Scope 1: Direct GHG emissions (e.g., the combustion of fossil fuels on an organization's site, referred to as Direct Fuel Combustion in CGRT),

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling (referred to as Purchased Energy in CGRT), and

Scope 3: All other (non-Scope 2) indirect GHG emissions that occur in the supply chain (referred to as Other Sources in CGRT).

1.4.5 In-Scope Greenhouse Gases

The CNGR lists six distinct GHGs or categories of GHGs:

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

Under LGCAP, LGs and MTNs are only required to report:

- carbon dioxide (CO_2),
- methane (CH_4), and
- nitrous oxide (N_2O).

[10] The Climate Registry. (2019). *General Reporting Protocol*, *Version 3.0*. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf, p. B-5.

For most PSOs, LGs and MTNs, 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). Other GHGs are emitted to a much lesser extent, e.g., HFCs released from refrigeration and air conditioning equipment.[11]

International protocols require biogenic CO_2 (bio-CO_2) emissions from combustion be reported separately from fossil combustion and biogenic non-CO_2 emissions.

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 CO_2e.

1.5 Small Emissions Sources

For many organizations, measuring small emissions sources can be challenging. If an emissions source is onerous to collect and the sum of the small sources is expected to comprise less than 1% of the organization's total emissions inventory, they are considered out of scope. A decision tree was developed to help LGs, MTNs and PSOs 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.

[11] 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.[12]

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, solid, liquid, and gaseous biofuels may also be combusted to produce heat. To align emissions reporting with international protocols, biogenic emissions (bioCO_2, CH_4, and N_2O) from biomass combustion including wood, wood waste, ethanol, biodiesel, and renewable natural gas must be reported.[13]

The CO_2 portion of biogenic emissions are excluded from the CNG program's total emissions for the purpose of tracking progress towards public sector CleanBC emission reduction targets.

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.[14]

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

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

[13] CO_2 emissions from the combustion of biomass are recorded as an part of the Agriculture, Forestry and Other Land Use (AFOLU) sector, outside of the scope of the Energy sector, as per the *Guidelines for National Greenhouse Gas Inventories*. See: IPCC (2019), *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories,* Energy Section 2.3.3.4, p. 2.4-5 and AFOLU Section 12.5.1, p. 12.33-34; and the Climate Registry (2019), *General Reporting Protocol Version 3.0*, p. B-7.

[14] In alignment with current international standards, B.C. 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.

Data sources: The standardized emission factors for stationary fuel combustion are drawn from the **1990-2021 NIR (Part 2)** as follows:[15]

Table 1: Stationary Fuel Combustion

Fuel Type	Table	Source
Natural Gas	A6.1-1 (CO_2)[a]	B.C. – Marketable
	A6.1-3 (CH_4, N_2O)	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	A6.1-5	Motor Gasoline
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	A6.1-14	Renewable Fuels
Biodiesel	A6.1-14	Renewable Fuels

[a] – Environment and Climate Change Canada made a significant change between the 2019 NIR and the 2021 NIR. The emission factor for natural gas has changed from a single value for every year in B.C. to one that can change annually. The proportion of methane to ethane and propane in natural gas has changed over time, and as the proportion of ethane and propane in natural gas increases, the emission factor increases.

[15] Environment Canada. (2023). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2021*, Part 2. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

Energy conversion factors to convert cubic metres of natural gas and litres of liquid fuels to GJ are drawn from Statistics Canada's *Report on Energy Supply and Demand in Canada* (RESD).[16]

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.[17] Since January 1, 2011, fuel suppliers have been required to incorporate at least 5% renewable fuel content in gasoline and 4% in diesel. In CGRT, standard gasoline is assumed to be 95% fossil fuel gasoline and the remaining 5% is ethanol. For standard diesel, 96% is assumed to be fossil fuel diesel, and 4% is biodiesel.

Table 2: Renewable Fuel Content in Fossil Fuels

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

FortisBC offers renewable natural gas to organizations in their service area. Eligible customers have the option of purchasing a portion of their natural gas usage as renewable natural gas by paying the higher commodity cost.

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.

[16] Statistics Canada (2023). *Report on Energy Supply and Demand in Canada 2004-2021*, p. 14 to 15. Available: https://www150.statcan.gc.ca/n1/en/catalogue/57-003-X

[17] 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.

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. Calculate the emissions of each GHG using the appropriate emission factor.	Actual Consumption (L) x Emission Factor by GHG (g/L) = Emissions by GHG	**CO_2**	**CH_4**	**N_2O**
		100 L x 1,515 g **CO_2**/L = 151,500 g **CO_2**	100 L x 0.0228 g **CH_4**/L = 2.28 g **CH_4**	100 L x 0.109 g **N_2O**/L = 10.9 g **N_2O**
2. Convert the emissions of each GHG to CO_2 equivalency (CO_2e) using the appropriate Global Warming Potential.	Emissions by GHG x GWP = Emissions (g CO_2e)	**CO_2**	**CH_4**	**N_2O**
		151,500 g **CO_2** x 1 = 151,500 g **CO_2e**	2.28 g **CH_4** x 28 = 63.8 g **CO_2e**	10.9 g **N_2O** x 265 = 2,889 g **CO_2e**
3. Sum across the gases to calculate total CO_2e emissions.	**CO_2** + **CH_4** + **N_2O** (all in g **CO_2e**) = Total **CO_2e** in g **CO2e**	(151,500 g **CO_2e** + 63.8 g **CO_2e** + 2,889 g **CO_2e)** = 154,450 g **CO_2e**		
4. Convert total emissions from g to tonnes for reporting purposes and round to significant figures.	Emissions in g **CO_2e** / 1,000,000 g/t = Emissions in tonnes **CO_2e**	154,450 g **CO_2e** / 1,000,000 g/t = 0.154 t **CO_2e** (in 100 L of Propane)		

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.[18]

1. 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.
2. 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.
3. The "Screening Method" may be used as a simplified estimation method to estimate fugitive emission releases from HFC and PFC refrigerants when it is not possible or efficient to use other accepted methods, and all small emissions sources are less than 10% of total emissions of reported Scope 1, Scope 2, and combustion-based biogenic emissions.[19]

Calculations: Emissions from stationary space conditioning and refrigeration can be calculated using the "Advanced Mass Balance"[20], 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-22 C-23

Refrigerant emissions may not exceed the 1% rule threshold. PSOs can learn more on the 1% rule in the Carbon Neutral Government Program in Section1.5.

[18] The Climate Registry (2019). *General Reporting Protocol Version 3*.0, C-20 to C-23. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf.

[19] Ibid., C-3.

[20] Ibid., D-21 to D-22.

2.3 Purchased Electricity

Type: Indirect Emissions

Description: The Ministry of Environment and Climate Change Strategy annually publishes electricity emission intensity factors (EEIFs) for grid-connected entities.[21] The published factors are used by grid-connected entities to quantify the GHG emissions of electricity that area not self-generated. 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.).[22]

Data sources: Emission factors for purchased electricity in B.C. are published by the director under the *Greenhouse Gas Industrial Reporting and Control Act* (GGIRCA). GGIRCA electricity emissions factors are updated annually.

Emissions related to electricity use in PSO buildings located in provinces other than B.C. must be measured and reported using emission factors for those provinces. Those emission factors are drawn from the 1990-2021 NIR (Part 3) using the average of the previous three years under "Generation Intensity":[23]

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 (2019-2021). 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.[24] The published three-

[21] B.C. Ministry of Environment and Climate Change Strategy. Electricity Emission Intensity Factors for Grid-Connected Entities. Available: https://www2.gov.bc.ca/gov/content?id=616BC0B3E8354AD3B500B279FE56B337

[22] 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/download/DFFB28009F6D4AB58F06B4F8F4AE81ED

[23] Environment Canada (2023). National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2021, Part 3, p. 58. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

[24] International Energy Agency. Available: http://www.iea.org/

year rolling averages from 2012-2014 for individual countries where BC PSOs have in-scope buildings are included.

2.3.1 Renewable energy certificates (RECs)

The CCAA does not recognize Renewable Energy Certificates (RECs), Green Rights or Green Power from Green Power suppliers as a means of lowering the emissions associated with electricity consumed or offsetting emissions for PSOs to meet their carbon neutral government obligations.

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 (DES): "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."[25]

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, upgraded heat using heat pumps, 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. 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.

The average efficiency of DESs can vary significantly depending on characteristics such as the age of the plant, distribution losses, and operation and maintenance practices. The emission factors catalogue includes ten tiers of emissions intensities for DESs for PSOs, LGs and MTNs to determine their GHG emissions, from a low-carbon DES (Tier 1) to a high-carbon DES (Tier 10). Tiers are used so that PSOs can report a fixed emission intensity for their DES, as CGRT requires using specified emission factors.

Data sources: The Climate Action Secretariat developed a DES emissions calculator based on the General Reporting Protocol to help determine which of the tiers to use for emission measurement and

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

reporting purposes.[26] The DES calculator outputs the emission intensity at the upper bound of each tier to provide conservative emission estimates across all tiers. The exception is Tier 10; while the upper bound of Tier 10 was chosen to be conservative (a DES system using diesel with 70% system efficiency), it is possible for some DESs to have higher emissions intensities than this upper bound.

- 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 of each tier. The emissions intensity of the DES will align with the upper threshold.

PSOs that purchase steam can load their purchased steam in pounds (lbs) or kg into CGRT for conversion into megajoules (MJ) of energy. Statistics Canada provides an average conversion factor for translating kg of steam into MJ of energy.[27]

PSOs 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 operations and efficiencies will vary based on local climate, exposure, occupancy patterns, heating controls, insulation, fuel types, and other factors. PSOs may submit documentation or any questions about the foregoing to Carbon.Neutral@gov.bc.ca.

2.4.1 Energy Sold by a PSO

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.

If an organization produces heating/cooling energy and sells a portion to another organization that is not a PSO, including a municipality, 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 PSOs a summary of two methods to estimate energy consumption when such data is not readily available.

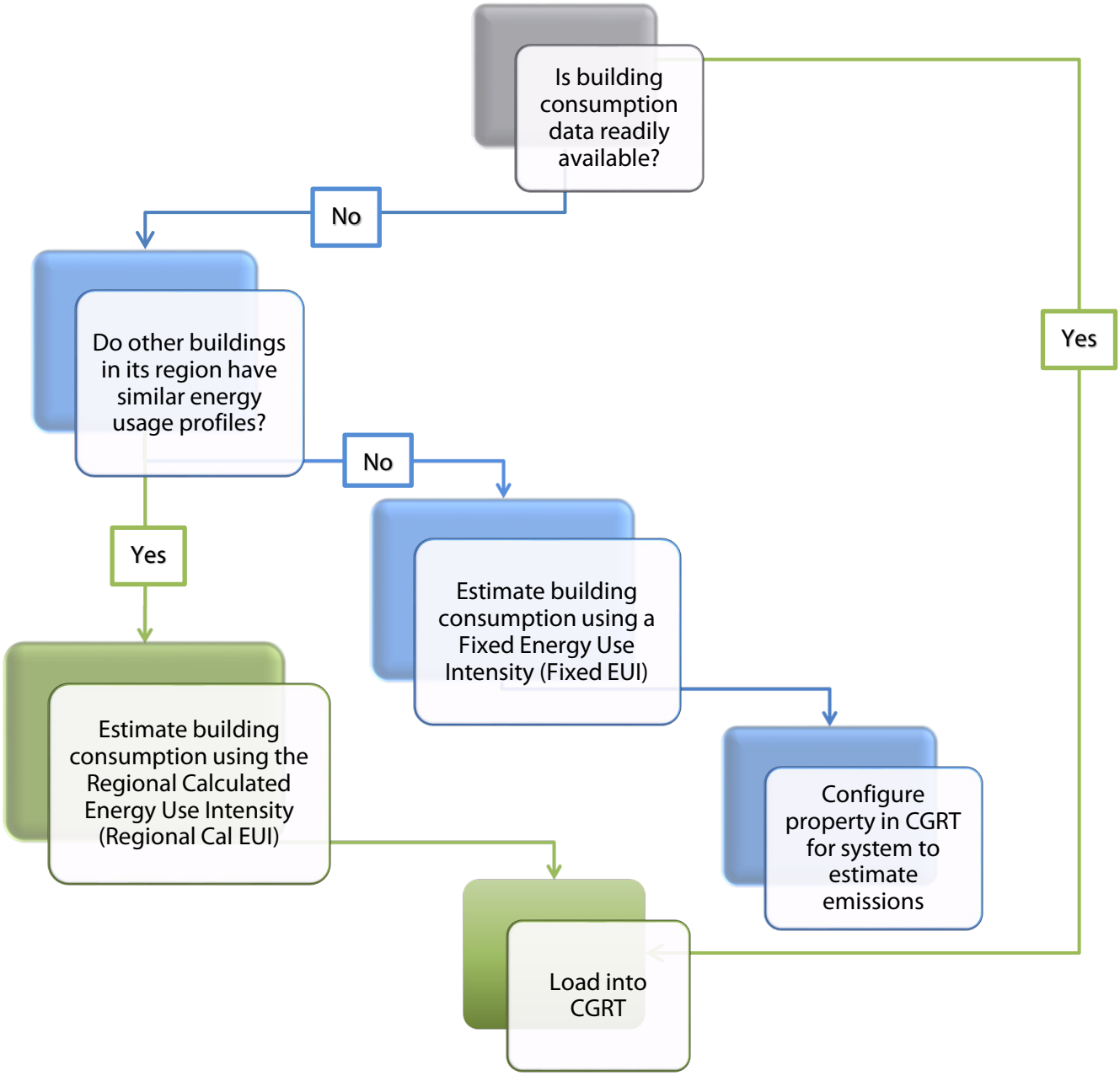
These methods rely on a building's gross floor area in metres squared (m^2), i.e., the area measured between the principal exterior surfaces of the enclosing fixed walls of the building(s). This includes *all*

[26] The Climate Registry (2019). General Reporting Protocol, Version 3.0. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf.

[27] Statistics Canada (2023). Report on Energy Supply and Demand in Canada: Explanatory Information, 2004 to 2021, p. 15. Available: https://www150.statcan.gc.ca/n1/en/catalogue/57-003-X

areas inside the building(s) such as: occupied tenant areas, common areas, stairwells, meeting areas, break rooms, restrooms, elevator shafts, mechanical equipment areas, and storage rooms.[28]

The following flowchart demonstrates the process of choosing the best approach to estimating a building's energy use.



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

2.5.1 Regional Calculated Energy Use Intensity

The Regional Calculated Energy Use Intensity (Regional Calc EUI) 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 an organization's buildings portfolio within the same climatic region. As guidance, it is suggested that energy data should be available for at least 51% of an organization's buildings in a particular category (e.g., educational facilities) and within the same climatic region. In addition, having at least two years of historical data is recommended to smooth out year-over-year variability.

Using available energy data from an organization's buildings within a specific climatic region and classification, this approach involves calculating the energy use per m^2 (i.e., its energy use intensity, or EUI) and applying that energy intensity to the floor area of the similar buildings requiring estimates. For PSOs, once consumption is estimated in this way, the estimated consumption data can be loaded into CGRT to determine the resulting emissions.

LGs and MTNs looking to estimate their energy related emissions using the Regional Calc EUI can follow the calculations below to determine how estimated consumption data can be converted to estimated GHG emissions by applying the appropriate emission factors and GWP.

Table 6: Regional Energy Use Intensity 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 m^2 of related floor area [a] = Regional Calculated Energy Use Intensity (GJ/m^2/year)
2. Estimate the quantity of each energy type used in the Building to be Estimated (BTBE)	Floor area of the BTBE (m^2) x Regional Calculated Energy Use Intensity (GJ/m^2/year) = Estimated Annual Energy Type Use in BTBE (GJ)
3. Apply the emission factor by energy type to yield total emissions by energy type	Emission Factor for Energy Type (kg/GJ) x Estimated Annual Energy Type Use (GJ) = Estimated Emissions by GHG (kg)
4. Apply the global warming potentials to yield total emissions	Estimated emissions by GHG (kg) x GWP of GHG = Estimated emissions (kg CO_2e)
5. Sum across the gases to calculate total CO_2e emissions	Emissions of ($CO_2 + CH_4 + N_2O$) (kg CO_2e) = Total Emissions (kg CO_2e)
6. Convert total emissions from kg to tonnes for reporting purposes.	Total Emissions (kg CO_2e) / (1,000 kg/t) = Total Emissions (t 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 Use Intensity

The Fixed Energy Use Intensity (Fixed EUI) estimation method uses the energy intensity factors extracted from Natural Resources Canada's (NRCan) Office of Energy Efficiency's Comprehensive

Energy Use Database (CEUD).[29] This database includes statistics on energy use by province, building use, building type, and energy type.

Table 7: Fixed Energy Use Intensity Estimation Calculation

Step	Formula for each Energy type
1. For each energy type, determine the annual consumption amount.	EUI (GJ/m^2/month) × square metres of floor area[a] (m^2) × 12 months[b] = annual consumption amount (GJ)
2. Apply the emission factor by energy type to yield total emissions by energy type	Emission Factor (kg/GJ) × Consumption (GJ) = Emissions by GHG (kg)
3. Apply the global warming potentials to yield total emissions	Emissions by GHG (kg) × GWP = Emissions (kg CO_2e)
4. Sum across the gases to calculate total CO_2e emissions	Emissions of ($CO_2 + CH_4 + N_2O$) (kg CO_2e) = Total Emissions (kg CO_2e)
5. Convert total emissions from kg to tonnes for reporting purposes	Total Emissions (kg CO_2e) / (1,000 kg/t) = Total Emissions (t 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.
b. This approach applies if the source data is available monthly as opposed to annually; if it is annual, there is no requirement to multiply by 12 months.

[29] NRCan through the Office of Energy Efficiency. Comprehensive Energy Use Database. Available: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm

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. In those instances, organizations may estimate the unknown energy type using one of the methods above. Similarly, the Regional Calc EUI may be used to estimate one energy type within a building while other energy types in the same building may use the Fixed EUI.

3 Mobile Sources – Transportation

Transportation is another in-scope 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)[30]
- Heavy-duty
- Motorcycles
- Off-road vehicles and equipment (e.g., snowmobiles, ATVs, lawnmowers and trimmers, tractors, construction equipment)
- Marine
- Aviation

Eleven fuel types have different emission factors associated with them:

- Gasoline
- Diesel
- Biodiesel
- Ethanol
- Marine Gasoline
- Marine Diesel
- Aviation Gasoline
- Aviation Turbo Fuel
- Propane
- Natural Gas[31]
- Electricity

[30] 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.

[31] The density of natural gas is given as 0.6937 kg/m^3 at standard temperature and pressure and is based on 2006 information from Terasen Gas (now FortisBC Gas) on the chemical composition of natural gas flowing through B.C. pipelines at the time.

CGRT accepts PSO 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 and plug-in 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. In the case of battery-electric vehicles and plug-in hybrid electric vehicles, the grid-sourced electricity emissions are based on the emissions intensity of the grid electricity that charges the vehicle. The electricity consumed by these vehicles may be tracked as part of a building's plug load or may be distinguished as mobile electricity.

Hydrogen powered transit busses produce zero emissions at the tailpipe and are not included in emissions reporting for mobile sources.

Data sources: The following table outlines emission factors for mobile fuel combustion from the 1990-2021 NIR (Part 2) Table A6.1-14: [32]

Table 8: Mobile Fuel Combustion

Transport Mode	Fuel Type	Source
Light-duty Vehicle	Gasoline Diesel	Tier 2 Advanced Control
Light-duty Truck (includes SUV and Minivan)	Gasoline Diesel	Tier 2 Advanced Control
Heavy-duty	Gasoline Diesel	Three-way Catalyst Advanced Control
Motorcycle	Gasoline	Non-catalytic Controlled
Off-Road (Vehicle/Equipment)	Gasoline Diesel	Off-road Gasoline 4-stroke Off-road Diesel ≥ 19kW, Tier 4
Marine	Gasoline Diesel	Marine
Aviation	Gasoline Turbo Fuel	Aviation
Various	Biodiesel Ethanol	Renewable Fuels

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

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

[32] Environment Canada (2023). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2021*, Part 2, p. 217. Available: https://publications.gc.ca/site/eng/9.506002/publication.html

biofuel and fossil fuel factors.[33] The emissions factor values in CGRT and the emission factors catalogue for bio and non bio emissions already include the proportion of biofuels consumed. Users need not calculate these emission factors themselves.

Equation:	**Renewable Fuel Bio CO_2 emission factor** (100% Ethanol or Biodiesel)	×	**Biofuel Proportion** (4%, 5%, 10%, 15%, 20%)	=	**Bio CO_2 for renewable portion**

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 the NIR and are available in the Emission Factors Catalogue.

Light-duty Vehicle – Gasoline (E5):	**1.508 kg/L (Ethanol)**	×	**5%**	=	**0.0754 kg/L**
Light-duty Vehicle – Diesel (B4):	**2.472 kg/L (Biodiesel)**	×	**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)**				
		Bio CO_2	**CO_2**	**CH_4**	**N_2O**	**CO_2e[a]**
Light-duty Vehicle	**Gasoline (E5)**	**0.0754**	**2.192**	**0.00014**	**0.00022**	**2.202**
	Diesel (B4)	**0.09888**	**2.57328**	**0.00005**	**0.00022**	**2.633**

[a] The total non-Bio CO_2 emissions are calculated using the following equation, where numbers in brackets refer to the column number: $(7) = (4) + (5) \times GWP_{CH4} + (6) \times GWP_{N2O}$

Where:

- GWP_{CH4} is the GWP of methane (28), and
- GWP_{N2O} is the GWP of nitrous oxide (265).

[33] International protocols require the separate reporting of biogenic emissions from fossil fuel-based emissions (see Section 2.1), 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.[34] 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.[35] 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]

[a] This value assumes that MVAC systems use HFC-134a as their refrigerant.

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 General Reporting Protocol's "Simplified Mass Balance Approach."[36] 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.

[34] The Climate Registry (2019). *General Reporting Protocol Version 3.0*, C-23. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf

[35] The Climate Registry (June 2023). *2023 Climate Registry Default Emission Factors*, Table 4.1, p. 74. Available: https://theclimateregistry.org/wp-content/uploads/2023/06/2023-Default-Emission-Factors-Final-1.pdf

[36] The Climate Registry (2019). *General Reporting Protocol Version 3.0*, C-22. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.pdf

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.[37]

Three different sizes of office paper (any colour) are in scope for PSOs – 8.5" x 11", 8.5" x 14" and 11" x 17". In each case, PSOs enter data on the number of 500-sheet (20lb) packages into CGRT. LGs and MTNs may also use the paper emission factors contained in the emission factors catalogue.

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 the catalogue for 100% PCR of the corresponding paper size should be applied to alternative paper types.

The Climate Action Secretariat is undertaking research on the relative merits of alternative types of paper, including their emissions intensities and environmental and social impacts. This research will inform potential future adjustments to methodology to support more accurate reporting of alternative paper types in future.

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 were derived from the Environmental Paper Network Paper Calculator.[38] 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 tonnes) 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.[39]

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[37] See the Ecopaper Database at http://c.environmentalpaper.org/home for a listing of papers available in the Canadian marketplace and their PCR contents.

[38] Emission factors are based on information provided by the Environmental Paper Network's Paper Calculator up to 2012. A newer version of the calculator (Version 4.0) is available at: http://c.environmentalpaper.org/home. Paper emission factors will be updated for the 2024 reporting year.

[39] 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.

5 Business Travel

Type: Indirect Emissions

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

PSOs, Local Governments and Modern Treaty Nations can use the methodology described in this section to voluntarily measure and report their business travel emissions.

PSOs are advised not to enter business travel data into CGRT, because the system is unable to differentiate voluntarily reported data from data that is required under the CCAA. PSOs may use Sections 5 through 7 to guide quantification of travel related emissions, and voluntarily report these emissions in their CCARs. PSOs that choose to report travel emissions in their CCARs shall omit these emissions from their official totals.

Quantification methods: The GHG Protocol provides three methods for quantifying business travel emissions listed below in order of preference.[40] The Protocol recommends the selection of a method based on availability of data:

1. **Fuel-based method:** determine the amount of fuel consumed during business travel and apply the appropriate emission factor for the fuel
2. **Distance-based method:** determine the distance and travel mode and apply the emission factor appropriate for the mode
3. **Spend-based method** determine the expenditures and travel mode and apply the emission factors appropriate for the mode

Data sources: Since the 2016 reporting year, Provincial Government business travel emissions have been 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 travel on other modes.

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

PSOs, Local Governments and Modern Treaty Nations that voluntarily measure and report business travel emissions may organize data to align with the descriptions of iExpenses in this section.

5.1 iExpenses Data

The B.C. Government's iExpenses system tracks travel modes, some fuel types, and some travel distances in addition to related expenditures.

[40] The Greenhouse Gas Protocol (2004). *The Greenhouse Gas Protocol – a Corporate Accounting and Reporting Standard*. Available: https://ghgprotocol.org/

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).

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
Accommodation	Accommodation	Hotel, Private, Other	N/A	Nightly stay-based	7

5.2 Other Accounting System Data

Employee travel expenditures are also tracked within the government accounting system and includes:

- 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 km driven. Emission factors are expressed in $kgCO_2e/km$ in CGRT.

Data sources: For road travel, NRCan publishes "city" and "highway" fuel economy ratings by vehicle manufacturer and model.[41] It is expected that most government travel falls between the conditions modeled for city and highway driving, tending closer to city estimates.[42] The data used in Table 13 (below) to calculate average fuel efficiencies reflect city consumption.

For gasoline and diesel vehicles, data was obtained from NRCan Comprehensive Energy Use Database, Transportation Sector – British Columbia and Territories.[43] Distances for road travel can be derived from the Government of B.C.'s Traveller Information System.[44] For hybrid and electric vehicles, data was obtained from NRCan 2021 Fuel Consumption Guide.[45] Explanation of terms used in NRCan datasets can be found here.

[41] Natural Resources Canada. (2021). *2021 Fuel Consumption Guide*. Available: https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/fuel-consumption-guide/21002.

[42] The NRCan city ratings have been used here for several reasons. 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.

[43] 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

[44] DriveBC. (n.d.). "Plan your route." Available: https://drivebc.ca/directions.html

[45] 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 ($kgCO_2e$/ km)	Dataset	Source	Reference
Car (includes taxi)	**Gasoline** (standard blend)	0.082 L/km	0.192	CEUD – Transportation Sector – B.C. (2018)	CEUD Transportation Sector – British Columbia and Territories, 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 2012-2022	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)	CEUD Transportation Sector – British Columbia and Territories, 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 2012-2022	Consumption – City	Average of all "B" type vehicles
Electric Vehicle	**Electricity**	0.197 kWh/km	0.0079	Battery-electric vehicles 2012-2022	Consumption – City	Average of all vehicles listed

Calculations: To calculate emissions from distance-based car, truck, or SUV travel, apply the average fuel economy (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[b]	(8) * (3)
Car	Gasoline	0.082	0.0754[c]	2.1919	0.00014	0.000022	2.201	0.181

[a] Emission factors in columns (5) through (7) are those for gasoline (standard) in the emission factors catalogue

[b] The total non-Bio CO_2 emissions are calculated using the following equation, where numbers in brackets refer to the column number: $(8) = (5) + (6) \times GWP_{CH4} + (7) \times GWP_{N2O}$

Where:

- GWP_{CH4} is the GWP of methane (28), and
- GWP_{N2O} is the GWP of nitrous oxide (265).

[c] 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).[46] The data is an average of five years spanning from April 2017 to March 2021.

Table 15: Emission Factors for BC Ferries Routes

Route Number	Ferry Route	Emission Factor ($kgCO_2e$/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 capacity provided of each ferry route.[47] 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

[46] BC Ferries average emission factors (2017-2021) were provided by BC Ferries Services.

[47] BC Ferries. *Plans, Reports, Policies and Other Resources*, "Annual Reports to the Commissioner". Available: https://www.bcferries.com/in-the-community/resources

emission factor (kg CO_2e/psg-km) is calculated. The weighted contribution to total emissions is then calculated by multiplying each routes 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 ($kgCO_2e$/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 Harbour Air's 2017 GHG Report,[48] Helijet, and the UK Department for Environment, Food and Rural Affairs (DEFRA) 2021 Government Greenhouse Gas Conversion Factors for Company Reporting.[49]

Table 17: Distance-based Air and Public Transport

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

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

6.3.1 Helicopter & Floatplane

The emission factors for air transport by helicopter were provided directly by Helijet. Floatplane travel was calculated based on Harbour Air'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, UK's Department of Environment, Food and Rural Affairs (DEFRA) has estimated emission factors for three categories of flights:[50]

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

[48] 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

[49] DEFRA. (2021). *2021 Government Greenhouse Gas Conversion Factors for Company Reporting*. Available: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2021

[50] Ibid.

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.[51]

The DEFRA air travel emission factors include an eight percent uplift factor based on the recommendation of the Intergovernmental Panel on Climate Change to account for discrepancies between geographical distance and actual flight distance.[52] 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.

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.

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[51] 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).

[52] IPCC (1999). *Aviation and the Global Atmosphere*, Section 8.2.2.3. Available: http://www.ipcc.ch/ipccreports/sres/aviation/index.php?idp=118

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 ($kgCO_2e$/psg-km)	Average Cost ($/km)	Spend-based Emission Factor ($kgCO_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[53]	Common Air Transport Modes	Spend-Based Emission Factor ($kgCO_2e/\$$)	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] ($kgCO_2e$/psg-km)	Trip-based Emission Factor ($kgCO_2e$/trip)	Average Cost ($/km OR $/trip)	Spend-based Emission Factor ($kgCO_2e/\$$)
Taxi	0.1917	N/A	2.30/km	0.0833
City Bus	0.1016	0.4821	2.55/trip	0.1891
Skytrain	N/A	0.1050	4.35/trip	0.0241
SeaBus	N/A	0.5020	4.35/trip	0.1154
Weighted Average - Transit	N/A	N/A	N/A	0.0594
Rail	0.1215	N/A	0.31/km	0.3919
Intercity Bus	N/A	N/A	N/A	0.1891
Weighted Average – Public Transport, Other	N/A	N/A	N/A	0.1984

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

[53] The Standard Object of Expenditure (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.

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. The sections are:

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

6.4.1 Public Transport - Taxi

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

- Average taxi cost per kilometre
- Taxi emissions per kilometre

Average Taxi Cost Per Kilometre

All taxis in B.C. charge rates regulated by the Passenger Transportation Board, an independent tribunal of the Ministry of Transportation and Infrastructure.[54] Rates across B.C. 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, i.e., the meter will already be at $3.32 when a passenger steps inside.[55]
- **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:

[54] Passenger Transportation Board. (2016). "Taxi Rates". Available: http://www.ptboard.bc.ca/taxi-rates.htm

[55] $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 Public Transport - 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.[56]

City Bus:

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

- Average City Bus cost per trip
- 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 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.[57] BC Transit reported approximately 58.7 million rides in 2019/20 (April 1, 2019 to March 30, 2020).[58]

Average Emissions Per Trip – TransLink

TransLink Enterprise's 2020 Accountability Report includes their revenue fleet emissions.[59] 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

[56] 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.

[57] Data extracted from the Clean Government Reporting Tool for 2019.

[58] BC Transit (2020). *BC Transit 2019/20 Annual Service Plan Report*. p. 11. Available: https://www.bctransit.com/documents/1529710288414

[59] 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

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.[60]

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:

Bus **Emissions per Trip** (kg CO_2e/trip)	÷	Bus **Cost per Trip** ($/trip)	=	Bus **Spend-Based** Emission Factor (kg CO_2e/$)
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.

[60] 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

Spend-Based Skytrain Emission Factor

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

Skytrain **Emissions per Trip** (kg CO_2e/trip)	÷	Skytrain **Cost per Trip** ($/trip)	=	Skytrain **Spend-Based** Emission Factor (kg CO_2e/$)
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:

SeaBus **Emissions per Trip** (kg CO_2e/trip)	÷	SeaBus **Cost per Trip** ($/trip)	=	SeaBus **Spend-Based** Emission Factor (kgCO_2e/$)
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 Public Transport - Other Public Transport (Rail, Intercity Bus)

Employees who travel by rail and intercity buses must select "Other" under Public Transport 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

The data for the period of 2008 to 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, as NRCan's Comprehensive Energy Use Database shows that intercity buses emit less than half the emissions of city buses per passenger-kilometre.[61]

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

[61] Natural Resources Canada. (2023). *Comprehensive Energy Use Database, Transportation Sector, 2000-2020.* Available: https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/menus/trends/comprehensive_tables/list.cfm

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),
- 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 and independent offices) 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 accommodation was derived from the 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 from 2017 to 2019.[62] The emission factor for overnight accommodation in Canada was derived from the 2021 UK Government GHG Conversion Factors for Company Reporting.[63]

Calculations: iExpenses tracks accommodations in terms of the number of nights stayed in accommodations.

Table 21: Emission Factor for Accommodation

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

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

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

[63] 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:

- Government of Canada. (2015). *List of toxic substances managed under Canadian Environmental Protection Act.* Available: https://www.canada.ca/en/environment-climate-change/services/management-toxic-substances/list-canadian-environmental-protection-act.html
- Government of Canada. (2023). *Facility Greenhouse Gas Reporting - Technical Guidance on Reporting Greenhouse Gas Emissions*. Available: https://publications.gc.ca/collections/collection_2023/eccc/En81-29-2023-eng.pdf
- 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. 71. Available: https://theclimateregistry.org/wp-content/uploads/2023/11/grp2023.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 GHG 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, biogas and soybean oil.

Abbreviation, Acronym or Measure	Definition
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.
Gigawatt-hour (GWh)	One million kilowatt-hours, enough electricity to power 100 homes for a year.
Global Warming Potential (GWP)	The global warming potential allows the comparison of the global warming impacts of different gases. It is a measure of how much energy the emissions of 1 tonne of a certain gas will absorb over a given period of time, compared to the emissions of 1 tonne of carbon dioxide (CO_2). The time period for GWPs used for GHG reporting as per international reporting standards is 100 years. The larger the GWP, the more the given gas impacts global warming compared to CO_2. For example, the GWP for nitrous oxide (N_2O) is 265, which means that 1 tonne of N_2O emissions is equivalent to 265 tonnes of CO_2 emissions. (GoC, 2023).
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: the Global Reporting Initiative's website).

Abbreviation, Acronym or Measure	Definition
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)
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

Abbreviation, Acronym or Measure	Definition
kilotonne	1,000 tonnes
km	kilometre
kWh	kilowatt-hour
L	litre
lb	pound (weight)
m^3	cubic metre
Methane (CH_4)	A colorless, odorless, flammable gas that is the simplest hydrocarbon and is the major constituent of natural gas. Methane is present in the Earth's atmosphere at low concentrations and acts as a greenhouse gas. Methane, usually in the form of natural gas, is used as feedstock in the chemical industry (e.g., hydrogen and methanol production), and as fuel for various purposes (e.g., heating homes and operating vehicles). Methane is produced naturally during the decomposition of plant or organic matter in the absence of oxygen, as well as released from wetlands (including rice paddies), through the digestive processes of certain insects and ruminant animals such as termites, sheep and cattle. Methane is also released from industrial processes, fossil fuel extraction, coal mines, incomplete fossil fuel combustion, and garbage decomposition in landfills. (GoC, 2015)
MVAC	Motor Vehicle Air Conditioning
NIR	National Inventory Report (Environment Canada)
Nitrous oxide (N_2O)	A colourless, non-flammable, sweet-smelling gas, which is heavier than air. Used as an anesthetic in dentistry and surgery and as a propellant in aerosol cans, nitrous oxide is most commonly produced via the heating of ammonium nitrate (NH_4NO_3). It is also released naturally from oceans, by bacteria in soils, and from animal wastes. Other sources of nitrous oxide emissions include the industrial production of nylon and nitric acid, combustion of fossil fuels and biomass, soil cultivation practices, and the use of commercial and organic fertilizers. (GoC, 2015)
Office Paper	Multipurpose copy paper for use in laser printers, fax machines and photocopiers or multifunction devices.

Abbreviation, Acronym or Measure	Definition
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
Sulphur Hexafluoride (SF_6)	A synthetic gas that is colourless, odorless, non-toxic (except when exposed to extreme temperatures), and non-flammable. It is heavier than air and hence stays close to the ground upon release which can cause death by suffocation if large quantities are involved. SF_6 is primarily used in the electricity industry as insulating gas for high voltage equipment. It is also used as cover gas in the magnesium industry to prevent oxidation (combustion) of molten magnesium. In lesser amounts, SF_6 is used in the electronic industry in manufacturing of semiconductors, and also as tracer gas for gas dispersion studies in the industrial and laboratory settings. Sulphur hexafluoride acts as a greenhouse gas due to its very high heat trapping capacity. (GoC, 2015)
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.

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Annex 3: Document Version Control

Reporting Year	Section(s)	Updates Include:
2023	Throughout	Formatting and font changes to align with B.C.'s Visual Identity
		Clarified context under which the document, its sections and its references apply
		Updated references and sources
		Calculation explanations updated and units made more consistent
	1	Reorganized to create PSO, LG/MTN, and Other user sections; added and updated policy context for the sections
	1.4	Incorporated previous section 1.3 as Section 1.4.3. in a new section on Emissions Calculations Fundamentals, with other sections on GWPs, EFs, scope categories and in-scope GHGs
	1.4.1	Removed references to radiative forcing and focused section on GWPs
	1.5	Moved section on small emissions sources from within the buildings section (Section 2.2.1.) to the front material, so it is clearer that it applies beyond stationary sources
	2.1	Clarified that CO_2 emissions from biogenic sources are treated separately and no longer count as part of total emissions in the CNG Program.
	2.1	Fixed NIR reference for stationary gasoline (shifted from Table A6.1-14 of NIR to Table A6.1-5)
	2.4	Enhanced clarity on district energy tiers and conservativeness
	2.5	Change language from Energy Intensity Unit to Energy Use Intensity to align with language in other Province of B.C. guidance (e.g., B.C. Energy Step Code)
	Annex 1	Update definitions of GHGs to remove references to AR4 GWPs
	Annex 2, 3 and 4	Removed Annex 2 from 2022 MD, Annex 3 is now Annex 2, Annex 4 is now Annex 3
2022	Throughout	Improved accessibility
		Changed GWP references from AR4 to AR5
	1.1	Moved the Community Emissions Inventory (CEEI) to section 1.1.2 Local
	2.3	Updated Renewable Energy Certificate policy

Reporting Year	Section(s)	Updates Include:
2022 (continued)	3.1	Update mobile emission factors to reflect more stringent federal air pollution standards
		Added electricity as a mobile fuel option
	4	Added research being undertaken on the relative merits of alternative types of paper
2021	Table of Contents (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	Removed references to Local Governments and other users in Section 1.4 Users/Audience and throughout document
		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 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
	Section 3.2	Ferry emission calculation correction
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

Reporting Year	Section(s)	Updates Include:
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 CH_4, N_2O and CO_2e updated
	Table 1, Table 2	Wood Fuel - Residential emission factor for $BioCO_2$, CH_4, N_2O and CO_2e updated
	Section 2.2	Electricity emission factors for Quebec and Nova Scotia added
	Table 3	Emission factors updated for BC Hydro, Kyuquot 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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