METHODOLOGY FOR REPORTING 2011 B.C. PUBLIC SECTOR GREENHOUSE GAS EMISSIONS

VERSION 2.0

Ministry of Environment
Victoria, B.C.
December, 2011

Table of Contents

List of Tables

1. Introduction

In November 2007, British Columbia enacted legislation to establish provincial goals for reducing greenhouse gas (GHG) emissions. Under the *Greenhouse Gas Reductions Targets Act (GGRTA)*, the B.C. public sector must be carbon neutral in its operations for 2010 and every year thereafter.[1] Beginning for the 2008 calendar year, provincial public sector organizations (PSOs)[2] are required to report annually, in accordance with the *GGRTA* and the *Carbon Neutral Government Regulation (CNGR)*.

The *CNGR* defines the activities or emission sources that are "in scope" for the purposes of PSO emission reporting and offsetting. Since it was introduced in 2008, "in scope" activities/sources have been clarified through a series of policy decisions, which have been summarized in Annex 7.3 Scope Summary.

The primary purpose of this document is to detail the emission factors and methodology used for calculating and reporting in-scope PSO emissions for the 2011 calendar year. Emission factors express the mass of GHGs resulting from a specific kind of activity (e.g., how many kilograms of carbon dioxide are produced by burning one litre of gasoline in your car).

The government has developed its own web-based applications to assist with GHG measurement and reporting. "SMARTTool" calculates and reports the emissions from PSO buildings, supplies (paper) and fleet vehicles and equipment. "SMARTTEC," the SMART Travel Emissions Calculator, computes the GHGs from government business travel and reports the emissions through SMARTTool. The emission factors and methodologies documented in this report are used by both applications to calculate estimates of GHG emissions.

This document will be updated annually to reflect changes or clarifications to the emission factors, methodologies and scope.

1.1 Principles for Specifying Emission Factors

The government has established the following principles to guide the specification of GHG emission factors:

1) If information allows, the preference is to identify emission factors that best reflect PSO circumstances, for example, an organization's particular source of electricity or fuel. Over time the government will seek to develop and apply B.C.-specific emission factors to improve the accuracy of public sector GHG tracking.

2) Where B.C.-specific information is not available, standardized emission factors from national and international data sources will be used. In particular, factors will be taken

[1] See www.env.gov.bc.ca/cas/legislation/index.html#*GGRTA*, for the *Greenhouse Gas Reduction Targets Act*, Bill 44 – 2007 and the *Carbon Neutral Government Regulation,* B.C. Reg. 392/2008. The legislation also requires core government business travel to be carbon neutral as of October 2007. This requirement does not apply to the broader provincial public sector, as defined in Note 2.

[2] PSOs encompass core government entities funded through the Consolidated Revenue Fund (e.g., ministries, special offices, and tribunals) and broader public sector agencies – health authorities, school districts (K-12), colleges and universities, and Crown corporations under the Government Reporting Entity.

from Canada's National GHG Inventory Report (NIR),[3] and other recognized sources (see Section 1.3).

3) A key principle is to facilitate emissions tracking and ensure that measurement and reporting requirements are not overly burdensome or costly for PSOs. Therefore, in certain cases (such as where an emissions source is too small to justify additional data gathering by an organization) the government will provide simplified methods for estimating emissions.

4) In developing simplified estimation methods, upper bound assumptions will be used in accordance with the principle of conservativeness – erring on the side of overestimating rather than underestimating emissions.

1.2 GHG Emission Factors Defined

Emission factors are expressed in kilograms (kg) 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 Carbon Neutral Government Regulation lists six distinct greenhouse gases or groups of gases: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); sulphur hexafluoride (SF_6); and perfluorocarbons (PFCs). For most PSOs, the only GHGs emitted in significant amounts are the three principal gases associated with fuel combustion for energy (CO_2, CH_4 and N_2O) and, to a much lesser extent, HFCs released from refrigeration and air conditioning equipment.[4]

In the case of fossil fuel blends with biofuel (e.g., ethanol, biodiesel), gasoline or diesel are combined with varying proportions of biofuels (e.g., E10, B5, B20), resulting in emission factors that are weighted averages of the biofuel and fossil fuel factors. However, since international rules require the separate reporting of biogenic emissions from combustion (see Section 2.1); the CO_2 emissions from the biofuel component (Bio CO_2) must be calculated and reported separately from those of the fossil fuel component.

Wherever possible, PSO emission factors are specified by individual gas. In certain instances, an aggregate factor for multiple gases is provided in kg of CO_2 equivalent (CO_2e) emissions. CO_2e is the standard unit for measuring and comparing emissions across GHGs of varying potency in the atmosphere (see Section 1.3).

1.3 Global Warming Potentials and Emissions Calculations

All greenhouse gases vary in their ability to trap heat in the atmosphere. The concept of "global warming potential" (GWP or CO_2e) has been developed to enable comparison of the ability of

[3] Environment Canada. (2011). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009*. Submission to the United Nations Framework Convention on Climate Change.

[4] 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..

different GHGs to trap heat in the atmosphere (radiative forcing).[5] By definition, the GWP from the release of 1 kg of CO_2 equals one, with the GWP of other GHGs stated relative to CO_2. The GWP of a GHG accounts for both the immediate radiative forcing due to an increase in the concentration of the gas in the atmosphere, and the lifetime of the gas. For example: 1 tonne of CH_4 has a GWP of 21, indicating that it's radiative forcing is 21 times that of CO_2. See Annex 7.2 for complete list of GWP for all gases covered by the *GGRTA*.

For PSO measurement purposes, GWPs are applied after the emission factors have been used to calculate the emissions of each gas. To calculate GHG emissions, the emission factors are simply multiplied by the measure of consumption (activity), and then the GWP.

The primary source document for PSO emission factors is the *British Columbia Greenhouse Gas Inventory Report 2008* (PIR).[6] Where provincial data is not available, the factors from Environment Canada's *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009* have been used.[7, 8]

International documents, such as the Climate Registry's *General Reporting Protocol*,[9] have been used for some emission factors. B.C.-specific emission factors have been developed in other cases, using data provided by energy companies and business travel providers.

The emission factors reported in this document represent the B.C. government's understanding of the factors appropriate to PSO emission sources and fuel types for 2011 reporting purposes. As experience is gained with estimating GHG emissions in the public sector, the list of emission factors may be expanded. It is also expected that 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 Structure of this Report

The remainder of this report documents PSO emission factors for each in scope activity category or emission source, provides a sample calculation of GHG emissions and includes supplemental information in annexes:

- Section 2: Stationary Sources: Buildings, Etc
- Section 3: Indirect Emissions: Supplies (Paper)
- Section 4: Mobile Sources: Fleet
- Section 5: Business Travel (Provincial Government only)[10]

[5] The term "radiative forcing" refers to the amount of heat-trapping potential for a GHG, measured in units of power per unit of area (watts per metre squared).
[6] British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*. Annex 10.3 provides standardized factors for stationary and mobile fuel consumption and other emitting activities.
[7] Environment Canada (2011). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009*.
[8] The PIR factors match most of those found in the NIR, however, for simplicity and ease of use, the PIR factors will be referenced throughout this document where the data is available in both documents.
[9] The Climate Registry (2008). *General Reporting Protocol*, Version 1.1. B.C. is a member of the Climate Registry, which is a cross-border initiative to develop common measurement, verification and reporting requirements for GHG emissions. See: www.theclimateregistry.org.

- Section 6: Sample Calculation
- Section 7: Annexes – glossary, 1% rule decision tree, table of GWPs, scope summary, specific emission factors, SMARTTool buildings estimation method review and references

For each activity category, a brief description is given along with an explanation of data sources and emission factor calculations.

2. Stationary Sources: Buildings, Etc

GHG emissions are produced from activities associated with the lighting, heating and cooling of facilities, and the powering of machinery and equipment within those facilities.[11]

2.1 Direct Emissions: Stationary Fuel Combustion

Description: Several different fossil fuels may be consumed in PSO buildings: natural gas; propane; light fuel oil (No. 2 heating oil); kerosene; marine diesel; diesel fuel; and gasoline. In addition, several organizations burn wood fuel and wood waste in some of their buildings. For the purposes of SMARTTool reporting and in alignment with international reporting requirements, emissions from biomass combustion, including wood, wood waste, ethanol and biodiesel must be reported.[12]

For biomass combustion, CO_2 emissions must be reported separately from CH_4 and N_2O emissions[13]. PSOs are only required to offset the CH_4 and N_2O emissions from biomass combustion. PSOs considering biomass should be aware that there are ongoing international discussions around the proper treatment of biomass and how to best account for the CO_2 storage and emissions of different harvested wood products (e.g. waste wood vs. virgin wood) and the associated forest management practices occurring on the land base. The risk of future accounting changes will be minimized to the extent that biomass is diverted from waste streams, that biomass is used for the most appropriate long-term purposes and that non-waste biomass comes from sustainably managed forest lands.

In SMARTTool, building fuel consumption data are entered either in common units of energy usage (i.e., Gigajoules – GJ) or are converted to GJ within the application itself.

---

[10] Under the Carbon Neutral Public Sector commitment, only core government organizations that report through the Consolidated Revenue Fund (e.g., ministries, special offices, tribunals) are required to track the emissions from employee business travel.

[11] See www.env.gov.bc.ca/cas/legislation/index.html#*GGRTA* for the *Carbon Neutral Government Regulation,* B.C. Reg. 392/2008.

[12] The CO_2 released *to* the atmosphere during combustion of biomass is assumed to be the same quantity that had been absorbed *from* the atmosphere during plant growth. Because CO_2 absorption from plant growth and the emissions from combustion occur within a relatively short timeframe to one another (typically 100-200 years), there is no long-term change in atmospheric CO_2 levels. For this reason, biomass is often considered "carbon-neutral" and the Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories* specifies the separate reporting of CO_2 emissions from biomass combustion. See: IPCC (2006), *2006 IPCC Guidelines for National Greenhouse Gas Inventories,* p. 5.5; and the Climate Registry (2008), *General Reporting Protocol*, pp. 33-34.

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

Data sources: The standardized emission factors for stationary fuel combustion can be found in two sources; Table 34 of the 2008 PIR,[14] and the 1990-2009 NIR as follows.[15]

- The natural gas CO_2 emission factor is taken from Table A8-1 under the entry "British Columbia – Marketable".
- The natural gas CH_4 and N_2O emission factors are taken from Table A8-2 under "Residential, Construction, Commercial/Institutional, Agriculture".
- The propane emission factors are taken from Table A8-3 under the entries for "All Other Uses".
- The light fuel oil, kerosene and diesel emissions factors are taken from Table A8-4 (with light fuel oil and diesel falling under "Forestry, Construction, Public Administration and Commercial/Institutional").
- The gasoline and marine diesel emissions factors are taken from Table A8-11 under the respective entries for "Off-Road Gasoline" and "Diesel Ships".
- The wood emissions factors are taken from Table A8-26 under the entries for "Wood Fuel/Wood Waste Industrial Combustion" and "Conventional Stoves Residential Combustion".

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

Calculations: In B.C., the *Renewable and Low Carbon Fuel Requirements Regulation* (*RLCFR*) sets benchmarks for the amount of renewable fuel in the provinces transportation and heating fuel blends. Effective January 1st, 2011, fuel suppliers are required to incorporate renewable fuel contents of 5% for gasoline and 4% for diesel into the sum of total fuel sold at a provincial level. In SMARTTool, for any given volume of reported gasoline consumption, 95% of the fuel is fossil fuel gasoline and the remaining 5% is ethanol. For Diesel, 96% is fossil fuel diesel and 4% is biodiesel.

The PSO emission factors in Table 1 have been calculated by applying the energy conversion factors shown to the emission factors in Table 2. The original emission factors were manipulated only to convert them from grams to kg per unit of fuel use, except in the case of gasoline and diesel fuels, where the numbers were adjusted to account for the renewable fuel content under the *RLCFR*.

[14] British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*, pp. 62-63.
[15] Environment Canada (2011). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009,* Annex 8 pp. 191-205.
[16] Statistics Canada (2011). *Report on Energy Supply and Demand in Canada 2009*, p. 125.

Table 1: Stationary Fuel Combustion

Fuel Type	Energy Conversion Factor	Emission Factor (kg/ GJ)			
		Bio CO_2	CO_2	CH_4	N_2O
Natural Gas	0.03843 GJ/ m^3	–	49.86	0.0010	0.0009
Propane	0.02531 GJ/ L	–	59.66	0.0010	0.0043
Acetylene[17]	0.05480 GJ / m^3	–	67.87	*	*
Light Fuel Oil	0.03880 GJ/ L	2.75	67.42	0.0007	0.0008
Kerosene	0.03768 GJ/ L	–	67.25	0.0007	0.0008
Diesel Fuel	0.03830 GJ/ L	2.75	66.75	0.0035	0.0104
Marine Diesel	0.03830 GJ/L	2.75	66.75	0.0039	0.0287
Gasoline	0.03500 GJ/ L	3.19	62.13	0.0771	0.0014
Wood Fuel - Industrial	0.01800 GJ/ kg	46.67	0	0.0050	0.0011
Wood Fuel - Residential	0.01800 GJ/ kg	83.33	0	0.8333	0.0089
* Note: Acetylene used in welding equipment does not produce CH_4 or N_2O emissions					

Table 2: Source Emission Factors – Stationary Fuel Combustion[18]

Fuel Type	Units	Bio CO_2	CO_2	CH_4	N_2O
Natural Gas	kg/ m^3	–	1.916	0.000037	0.000035
Propane	kg/ L	–	1.510	0.000024	0.000108
Acetylene	kg/m^3	–	3.719	*	*
Light Fuel Oil	kg/ L	0.0980	2.616	0.000026	0.000031
Kerosene	kg/ L	–	2.534	0.000026	0.000031
Diesel Fuel	kg/ L	0.0980	2.557	0.000133	0.0004
Marine Diesel	Kg/L	0.0980	2.557	0.00015	0.0011
Gasoline	kg/ L	0.0747	2.175	0.0027	0.00005
Wood Fuel - Industrial	kg/ kg	0.840	0	0.00009	0.00002
Wood Fuel - Residential	kg/ kg	1.500	0	0.015	0.00016
* Note: Acetylene used in welding equipment does not produce CH_4 or N_2O emissions					

[17] Values were calculated based on data from: The Climate Registry (2011). *General Reporting Protocol*, Climate Registry default emission factors Released January 12, 2011. These values can be used as conservative estimates for all welding gases.

[18] See Environment Canada (2011). *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009.*, and British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*.

2.2 Indirect Emissions: Purchased Electricity

Description: In a hydroelectric-based power system such as British Columbia's, the GHG emissions from electricity can vary significantly from year to year. This variation is influenced by both the quantity purchased by consumers, and variation in water supply conditions and reservoir levels. During years with low stream flow and/or low reservoir levels, available power must be supplemented through electricity purchase from neighbouring jurisdictions or through thermal (fossil-fuel) generation and thus GHG emissions are relatively high. During years with higher stream flow and/or high reservoir levels, less thermal (fossil fired) power is needed and GHG emissions are relatively low.

Emissions also differ between electric utilities relative to the shares of hydro and thermal power in the supply mix of each utility. Depending on building locations, PSOs acquire electricity from BC Hydro, FortisBC or a municipal distributor.[19] In addition, some PSOs currently have properties in other provinces (Alberta and Ontario) and countries (England, Japan and China).

Some PSOs purchase Renewable Energy Certificates (REC's), Green Rights or Green Power from Green Power suppliers. Emissions reduced by purchasing RECs are recognized in jurisdictions where 50% or more of the power is produced from fossil fuel generators and where it has been demonstrated there is a reasonable level of assurance that the REC's are appropriately verified.

SMARTTool captures data on electricity consumption in kilowatt-hours (kWh) and makes the conversion to GJ of energy.

Data sources: BC Hydro tracks GHG emissions in its Annual Report and as part of a Global Reporting Initiative (GRI) Index.[20] This tracking includes domestic purchases of electricity from independent power producers (IPPs), which together account for the largest share of BC Hydro's reported emissions (70 percent in 2009). The emissions associated with electricity imports for domestic use are not included. This exclusion will be evaluated as policy evolves in regard to imported electricity.[21]

Taken from the BC Hydro GRI Comparative Index "EN16(2) Greenhouse Gas Intensities," the emissions factor given in Table 3 for BC Hydro represents the sum of emissions from BC Hydro power facilities and IPP purchases, divided by the electricity generated at those sources.[22]

While FortisBC and the municipal distributors do not publicly report on GHG emissions, their emissions can be estimated from electricity supply data. Information on the recent (2008) supply mix was obtained directly from utility contacts.

---

[19] There are six municipal electric utilities, respectively serving the cities of Grand Forks, Kelowna, Nelson, New Westminster, Penticton and Summerland.

[20] See: BC Hydro (2011). BC *Hydro 2011 Annual Report,* p. 93.

[21] Under voluntary international GHG protocols, BC Hydro is not required to measure and report the emissions from purchased electricity – either domestic or imported – that is passed on to consumers. BC Hydro has chosen to voluntarily report the emissions from domestic IPP purchases, but import-related emissions are not yet included in its GHG inventory. Starting in 2011, importers of electricity are required to report GHG emissions associated with the generation of this electricity.

[22] See Indicator EN16(2) of the GRI Index at: www.bchydro.com/about/company_information/reports/2010_gri/f2010_environmental_EN16_2.html.

For all provinces, the NIR reports annually on total GHG emissions, electricity generation and GHG intensity for public utilities as a whole,[23] thus the most recent version of the NIR is used for buildings in other provinces.

For properties in other countries, information is available from the International Energy Agency (IEA) on CO_2 emissions per kWh from electricity and heat generation.[24] The published three year rolling averages (2006-2008) for individual countries were incorporated into this report. These data can be used to estimate emission factors for fossil fuel combustion in international cities.

Calculations: In Table 3, the BC Hydro emission factor is based on the reported GHG Intensity for the utility's total domestic supply. The emission factor of 25 tonnes CO_2e per Gigawatt-hour (GWh) has been calculated as an average of BC Hydro's GHG intensities for 2007 through 2009.[25] A rolling three-year average is used to partially smooth out the annual fluctuation in the electricity emission factor due to changing water conditions.[26]

The FortisBC emission factor of 6 tCO_2e/ GWh has been estimated using a weighted average of the GHG intensity of Fortis' own hydroelectric plants, purchased hydro and other renewable electricity, and purchases from BC Hydro. In calculating this average, a zero emission factor was assigned to existing hydro and other renewable (energy from wood waste) generation and purchases, which accounted for just over three-quarters of the utility's 2009 supply.[27] The BC Hydro emission factor was then applied to the remaining purchases in the supply mix.

Since the cities of Grand Forks, Kelowna, Penticton and Kelowna acquire all of their electricity from Fortis, they are assigned the same emission factor. Likewise, the City of New Westminster is served by BC Hydro and so is given its emission factor. The City of Nelson's municipal utility, Nelson Hydro, generates about 55 percent of its annual electricity requirements from a local hydro plant and purchases the rest from Fortis.[28] These supply shares and the Fortis emission factor have been used to estimate a weighted average emission factor of 3 tCO_2e/ GWh.

The electricity emission factors for Alberta and Ontario are the three-year (2007-2009) average values reported for "Overall Greenhouse Gas Intensity" in the 1990-2009 NIR.[29] Their large magnitude relative to the B.C. emission factors reflects the substantially higher shares of fossil-fired generation in the supply mix, particularly in Alberta's case. Going forward, if additional emission factors are needed for facilities in other provinces, they will be calculated in the same manner as those for Alberta and Ontario.

---

[23] See, Environment Canada (2011). *National Inventory Report 1990-2009*, Table A13-7 for Ontario, and A13-10 for Alberta.

[24] See IEA (2010), *CO_2 Emissions for Fuel Combustion – Highlights*, pp. 107-109.

[25] The reported GHG intensities were 23, 28 and 25 tCO_2e/GWh, respectively, for 2007, 2008 and 2009.

[26] Since there is a lag in collecting and reporting GHG emissions data, the emission factor estimated for the most recent calendar year of data available (e.g., 2009) may not necessarily reflect the water conditions in the current year for which emissions are being measured (e.g., 2010). Averaging over a three-year period will reduce the year-to-year differences.

[27] Wood waste generated electricity has been assigned a zero emission factor given that the CO_2 emissions from biomass are not included in Fortis' GHG inventory under international reporting rules.

[28] See: www.nelson.ca/EN/main/services/electrical-services.html.

[29] Environment Canada (2011). *National Inventory Report 1990-2009 Part 3*, Table A13-7, p. 50 for Ontario, and Table A13-10, p. 53 for Alberta.

The emission factors for the U.K., India, Japan, China and Hong Kong required no further calculations as their values were already calculated and published as CO_2 emissions per kWh from electricity and heat generation[30].

Table 3: Purchased Electricity

Public Utility	Emission Factor (tCO_2e/ GWh)	Emission Factor (kg/ GJ)
BC Hydro[31]	25	6.9
Kyuquot Power	25	6.9
FortisBC	6	1.7
City of Grand Forks	6	1.7
City of Kelowna	6	1.7
Nelson Hydro	3	0.8
City of New Westminster	25	6.9
City of Penticton	6	1.7
City of Summerland	6	1.7
Alberta	913	254
Ontario	157	44
United Kingdom	497	138
India	945	263
Japan	436	121
China	764	212
Hong Kong	762	211
Note: Energy Conversion Factor = 0.0036 GJ/kWh		

2.3 Indirect Emissions: Purchased Steam and Hot Water Etc.

Description: A number of PSOs also use steam to heat buildings. Some (e.g., UBC, Vancouver Coastal Health Authority) produce steam, use a portion for their own consumption and sell the surplus. Others purchase steam from a commercial district heating supplier, such as Vancouver's Central Heat Distribution Ltd., or another PSO.

Where a PSO produces steam for its own consumption, the resulting GHG emissions are estimated by applying the appropriate combustion emission factors to the quantity of fossil fuel burned in the steam boiler. Where a PSO purchases steam from another entity, estimating emissions requires information on both the fuel source and the system efficiency.

[30] See IEA (2010), *CO_2 Emissions for Fuel Combustion – Highlights*, pp. 107-109.
[31] The BC Hydro emissions factor also applies to emissions from independent power projects that are off of the North American grid, but that sell power to BC Hydro, including the Central Coast Power Corporation (Ocean Falls in Bella Bella), the Clean Power Operating Trust (Hluey Lake in Dease Lake), the Coastal Rivers Power LP (Sandspit), and XEITL Limited Partnership (Pine Creek in Atlin)

SMARTTool captures data on purchased steam in pounds or kg and converts to GJ.

Data sources: The RESD provides an average conversion factor for translating kg of steam into GJ of energy.[32] The combustion emission factors for natural gas, light and heavy fuel oil, diesel and wood waste are provided in Table 1 on page 9.

System efficiencies can vary significantly depending on characteristics such as the age of the steam plant, distribution losses and operation and maintenance practices. Existing steam systems typically show average efficiencies of 65 to 75 percent. In the calculations below, a conservative system efficiency of 65 percent is assumed. However, PSOs are free to specify a higher system efficiency if they can provide verifiable, documented evidence in support of this efficiency from their steam supplier.

Calculations: The default emission factor in Table 4 is based on a natural gas-fired steam system operating at 65 percent efficiency. It has been calculated by dividing the appropriate combustion emission factor in Table 1 by 0.65.

In many cases, steam plants are dual-fuelled. Typically, this involves boilers that run predominantly on natural gas, with minor amounts of fuel oil or diesel during peak periods. Because the use of other fuels in dual-fuelled steam plants occurs for a very short period of time (e.g. 1-2 days per year), the natural gas-fired steam emission factors may be applied to all energy consumption from these plants.

Note: Where a PSO produces steam and sells a portion to another PSO, the producer must separately identify the emissions from the steam sales using the methodology above. These emissions are then deducted from the producer's GHG inventory to avoid double counting when aggregating emissions across the B.C. public sector.

Table 4: Purchased Steam

Steam Production Fuel Source	Emission Factor (kg/ GJ)		
	CO_2	CH_4	N_2O
Natural Gas	76.71	0.0015	0.0014
Note: Energy Conversion Factor = 0.00275 GJ/kg			

2.4 Direct Fugitive Emissions: Stationary Air Conditioning and Refrigeration

Description: Fugitive emissions from stationary air cooling are attributed to the leakage and loss of HFC and PFC based coolants from air conditioning and commercial type refrigeration systems. Coolant loss can occur during the manufacturing process, operation, and disposal of equipment.

Data sources: The Climate Registry offers three methods for reporting and/or estimating emissions from stationary air conditioning and refrigeration. The "Mass Balance" and "Simplified

[32] Statistics Canada (2011). *Report on Energy Supply and Demand in Canada 2009*. p. 125.

Mass Balance" methods can be used to measure and report coolant loss when information on system charges, top-ups, coolant disposal and coolant recycling is available. The Climate Registry also provides a "Screening Method" to estimate fugitive emission releases from HFC and PFC coolants when detailed information is not available.[33]

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

Table 5: GHG Emissions from Stationary Air Conditioning and Refrigeration across the B.C. Government (CRF) Portfolio

Year	Calculation Method	Calculated tCO2e	Total 2008 CRF GHG tCO2e	HFC Composition
2007	Simplified Mass Balance	2.33	104,753	0.0022%
2008	Simplified Mass Balance	6.61	104,753	0.0063%
2007/8	Screening Method	2.75	104,753	0.0026%

Use of either method produced emissions estimates significantly less than 1%. This is attributable in part to the prevalence of R-22, an HCFC based coolant that is not in scope for reporting under the CNGR, and in widespread use amongst PSO's.

Based on these estimates, it is expected that the fugitive emissions from stationary cooling are significantly less than 1% (approximately 0.01%) of each PSOs' total GHG footprint. If these fugitive emissions are also onerous to measure and collect it is likely the 1% rule applies (use the decision tree in Annex 7.4 to determine if it applies and see Annex 7.3 Scope Summary for more information).

Organizations who wish to voluntarily report on HFC and PFC emissions from stationary cooling may use the "Mass Balance" or "Simplified Mass Balance" methods as described in Chapter 16 of Climate Registry's General Reporting Protocol[34] to calculate and report emissions from these sources. Depending on the method chosen, organizations may require detailed information on refrigeration system purchases, servicing, and retirement.

3. Indirect Emissions: Supplies (Paper)

Another source of indirect emissions is the purchase of paper used by PSOs.

Description: Emission factors for office paper are differentiated by size and the percentage of post-consumer recycled (PCR) content in the paper. In practice, the PCR content can range between 0 and 100 percent.[35]

[33] The Climate Registry (2008). *General Reporting Protocol*, pp. 121-132.
[34] The Climate Registry (2008). *General Reporting Protocol*, pp. 121-132.
[35] See the Ecopaper Database at www.canopyplanet.org/EPD/index.php for a listing of papers available in the Canadian marketplace and their PCR contents.

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

Data sources: Ideally, it would be best to specify emission factors that accurately reflected the manufacturing process for specific PSO paper purchases. In the absence of paper-specific information, proxy emission factors have been derived from the Environmental Paper Network (EPN) Paper Calculator.[36] 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.

Table 6: Office Paper

PCR Content	Emission Factor (kg CO_2e/ pkg)		
(%)	8.5" x 11"	8.5" x 14"	11" x 17"
0	6.830	8.692	13.659
10	6.532	8.313	13.063
20	6.234	7.934	12.467
30	5.936	7.555	11.872
40	5.638	7.176	11.276
50	5.340	6.797	10.680
60	5.042	6.417	10.084
70	4.744	6.038	9.488
80	4.446	5.659	8.892
90	4.149	5.280	8.297
100	3.851	4.901	7.701

Note: PSO emission factors for office paper are based on a 500-sheet package of 20-pound bond paper weighing 2.27, 2.89 and 4.55 kg, respectively, for the three paper sizes.

Calculations: To generate the emission factors in Table 6, the weight of a 500-sheet package was first determined for each paper size. This weight (in metric tons) and the PCR content were then entered into the Paper Calculator and the resulting estimate of GHG emissions was converted from lbs to kg CO_2e. Emission factors for other PCR contents (e.g., 85 percent) can be interpolated by averaging between the values shown.

It should be noted that, unlike the other PSO emission factors documented here, the entries in Table 6 are lifecycle emission factors.[37]

[36] See: www.calculator.environmentalpaper.org/home

[37] 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.

4. Mobile Sources: Fleet

The PSO fleet of vehicles and equipment is a further source of GHG emissions. Two categories of emissions are tracked:

- Direct emissions from burning fossil fuels in vehicles and equipment; and
- Fugitive emissions from mobile air conditioning systems.

4.1 Direct Emissions: Mobile Fuel Combustion

Description: Emission factors are specified for seven transport modes:

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

Ten fuel types have different emission factors associated with them:

- Gasoline
- Diesel
- Propane
- Natural gas
- Biodiesel
- Ethanol
- Marine Gasoline
- Marine Diesel
- Aviation Gasoline
- Aviation Turbo Fuel

SMARTTool captures data on fuel consumption in litres by mode of transport and fuel type. This information is required because the emission factors for CH_4 and N_2O are differentiated by type of vehicle or other transport mode.

Hybrid electric vehicles are not identified 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 lower overall fuel consumption, and therefore lower GHG emissions, than if the hybrids had not been purchased. Hydrogen powered transit busses produce zero emissions at the tail-pipe and are therefore not included in emissions reporting.

Data sources: Table A8-11 of the 1990-2009 NIR and Table 34 of the 2008 PIR[38] provide emission factors for mobile fuel combustion sources.[39] The factors for gasoline and diesel cars and trucks are differentiated by the level of emission control technology, which relates to vehicle age[40].

For the purposes of estimating PSO emissions, the default emission factors are "Tier 1" for gasoline-fuelled light cars and trucks, "Three-Way Catalyst" for gasoline heavy trucks and "Advance Control" for all diesel-fuelled on-road vehicles.[41] The majority of PSO fleets are likely vehicles dating from the mid-1990s, when the introduction of these technologies began in the U.S. Table A8-11in the NIR also contains emission factors for propane and natural gas vehicles, motorcycles ("Non-Catalytic Controlled"), off-road vehicles, gasoline boats, diesel ships, aviation gasoline and turbo fuel and renewable or biofuels (biodiesel and ethanol). In practice, biofuels are blended with fossil fuels, specifically gasoline or diesel, in varying proportions (e.g., E10, B5, B20), so that the actual emission factor is a weighted average of the biofuel and fossil fuel factors. However, since international rules require the separate reporting of biogenic emissions from combustion (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.

In B.C., the *RLCFR* sets benchmarks for the amount of renewable fuel in the province's transportation and heating fuel blend.[42] Effective January 1st, 2011, fuel suppliers are required to incorporate renewable fuel contents of 5% for gasoline and 4% for diesel into the sum of total fuel sold at a provincial level. In SMARTTool, for any given volume of reported gasoline consumption, 95% of the fuel is fossil fuel gasoline and the remaining 5% is ethanol. For Diesel, 96% is fossil fuel diesel and 4% is biodiesel. Where applicable, the emissions factors listed in Table 7 have been adjusted to account for the renewable fuel content under the *RLCFR*. Please note that the regulation does not affect the CH_4 or N_20 factors.

Calculations: With the exception of natural gas, the NIR emissions factors in Table 7 have been converted from grams to kilograms of fuel consumption. This is the only change that has been applied to these factors, except in the case of gasoline and diesel fuels, where the numbers were adjusted to account for the renewable fuel content under the *RLCFR*.

The natural gas emission factor has been converted from kg/L to kg/kg of compressed natural gas – the form in which the fuel is dispensed at the pump. Table 8 outlines how this conversion is done.

[38] British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*, p. 62.
[39] Environment Canada (2011). *National Inventory Report 1990-2009,* Part 2, p. 196.
[40] *Ibid.,* p.46
[41] 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. *Ibid.,* p. 43.
[42] Aviation fuels have no similar regulation

Table 7: Fleet Fuel Consumption

Transport Mode	Fuel Type	Units	Emission Factor			
			Bio CO_2	CO_2	CH_4	N_2O
Light-duty Vehicle[a]	Gasoline	kg/ L	0.0747	2.175	0.00023	0.00047
	Diesel	kg/ L	0.0980	2.556	0.000051	0.00022
	Propane	kg/ L	–	1.510	0.00064	0.000028
	Natural Gas[b]	kg/ kg	–	2.725	0.013	0.000086
Light-duty Truck (includes SUV and Minivan)[a]	Gasoline	kg/ L	0.0747	2.175	0.00024	0.00058
	Diesel	kg/ L	0.0980	2.556	0.000068	0.00022
	Propane	kg/ L	–	1.510	0.00064	0.000028
	Natural Gas[b]	kg/ kg	–	2.725	0.013	0.000086
Heavy-duty [a]	Gasoline	kg/ L	0.0747	2.175	0.000068	0.00020
	Diesel	kg/ L	0.0980	2.556	0.00011	0.000151
Motorcycle	Gasoline	kg/ L	0.0747	2.175	0.00077	0.000041
Off-Road (Vehicle/ Equipment)	Gasoline	kg/ L	0.0747	2.175	0.0027	0.00005
	Diesel	kg/ L	0.0980	2.556	0.00015	0.0011
Marine	Gasoline	kg/ L	0.0747	2.175	0.0013	0.000066
	Diesel	kg/ L	0.0980	2.556	0.00015	0.0011
Aviation	Gasoline	kg/ L	–	2.342	0.0022	0.00023
	Turbo Fuel	kg/ L	–	2.534	0.000028	0.000071
Various	Biodiesel[c]	Kg/ L	2.449	0	[e]	[e]
	Ethanol[d]	kg/ L	1.494	0	[f]	[f]

Note: PSO emission factors for fleet fuel consumption are based on Tier 1 or Advance Control emission control technologies.

[a] Based on Tier 1 or Advance Control emission control technologies.

[b] Adapted from Table 34 of the 2008 PIR factors and converted to kg of compressed natural gas.

[c] Diesel CH_4 and N_2O emission factors (by transport mode) used for biodiesel.

[d] Gasoline CH_4 and N_2O emission factors (by transport mode) used for ethanol.

[e] Diesel CH_4 and N_2O emission factors (by mode and technology) are used for biodiesel.

[f] Gasoline CH_4 and N_2O emission factors (by mode and technology) are used for ethanol.

4.2 Natural Gas Vehicle Emission Factors

Light-duty natural gas vehicles are fuelled with compressed natural gas, which is measured in kilograms. Some suppliers invoice natural gas in litres even though it actually represents kilograms; this can create some confusion when entering data into SMARTTool. The NIR and PIR provide emission factors for the mobile combustion of natural gas in grams per litre (g/ L).[43, 44] As a result,

[43] Environment Canada (2011). *National Inventory Report 1990-2009 Part 2*, p. 191. These emission factors relate to natural gas in its gaseous state as it flows through a pipeline, prior to compression.

[44] British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*, p. 62.

these factors do not align with the common unit for compressed natural gas measurement at the pump.

SMARTTool specifies emission factors in kg of emissions per unit of consumption – also kg in the case of compressed natural gas. Table 8 shows the calculations that have been performed to convert the 1990-2009 NIR/2008 PIR emission factors to the format used by SMARTTool. In particular, this involves adjusting for the density of natural gas in its gaseous state at standard temperature and pressure (STP).[45]

Table 8: Natural Gas Vehicle Emission Factor Calculations

	Step	Units	CO_2	CH_4	N_2O
1.	Obtain natural gas emission factors from the 2009 NIR	g/ L	1.89	0.009	0.00006
2.	Convert to g/ m^3 by multiplying by 1,000 (L/ m^3)	g/ m^3	1,890	9	0.06
3.	Convert to g/ kg by dividing by 0.6937 (density of natural gas at STP in kg/ m^3)	g/ kg	2,724.5	13.0	0.086
4.	Convert to kg/ kg by dividing by 1 000 (g/ kg)	kg/ kg	2.725	0.013	0.000086

4.3 Direct Fugitive Emissions: Mobile Air Conditioning

Description: Atmospheric releases of HFCs can occur throughout the lifecycle of motor vehicle air conditioning (MVAC) units. Unlike a building's HVAC, however, 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.[46] This method has been used to calculate a default emission factor, in kg of HFCs per vehicle, for use in SMARTTool. In order to apply the default factor, a PSO must provide the number of vehicles in its fleet with MVAC.

The Climate Registry recommends an upper bound capacity charge of 1.5 kg and an operating emission factor of 20 percent of capacity per year for mobile air conditioning.[47] The most common refrigerant used in MVAC is HFC-134A, with a global warming potential of 1,300.

Calculations: Multiplying the 1.5 kg capacity charge by the 20 percent operating emission factor and converting to CO_2e emissions yields a default emission factor of 390 kg CO_2e per vehicle per year. Using this emission factor in conjunction with fleet inventory information the total estimate for emissions from mobile cooling was less than 1% of the BC Government's (Consolidated Revenue Fund) total GHG inventory for 2008.

[45] The natural gas density of 0.6937 kg/m^3 at STP is based on 2006 information from Terasen Gas on the chemical composition of natural gas flowing through B.C. pipelines.
[46] The Climate Registry (2008). *General Reporting Protocol*, pp. 128-132.
[47] The Climate Registry (2008). *General Reporting Protocol*, Table 16.3, p. 130.

Table 9: Per Vehicle Estimate of HFCs from Mobile Air Conditioning

Greenhouse Gas (kg)	Emissions per Vehicle per Year (kg CO_2e)
Hydrofluorocarbons	390

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

PSOs typically have two options for calculating and reporting mobile cooling emissions.

PSOs with information on the MVAC servicing for their fleets (e.g., for transit fleets) may use these data to report their HFC emissions directly using the Climate Registry's "Simplified Mass Balance Approach."[48] This method requires information on the quantities of each refrigerant used and recovered from MVAC equipment reported directly.

PSOs without access to detailed mobile refrigerant information may estimate and report their annual refrigerant use at 390 kg CO_2e per each vehicle with air conditioning. This value provides a conservative estimate of emissions resulting from HFC-134a use.

5. BUSINESS TRAVEL

Under the Carbon Neutral Public Sector commitment, only core government organizations that report through the Consolidated Revenue Fund (e.g., ministries, special offices, tribunals) are required to track the emissions from the business travel of public officials.

Calculating indirect emissions from business travel requires differing methodologies than those used for buildings and fleet emissions. Typically, information on volumes of fuel consumed is not readily available for business travel modes because it is proprietary to private entities such as airlines, taxi companies and rental car agencies. Consequently, depending on the travel mode, one of two methodologies for calculating GHG emissions was used:

1. Estimating fuel consumption using an average fuel efficiency and distance travelled, and then applying an emission factor; or
2. Appling an emission factor in GHGs per passenger-kilometre travelled to the estimated travel distance.

5.1 Travel Emissions Based on Fuel Efficiency

Description: For taxis, rental cars and business use of personal vehicles, average fuel efficiencies have been estimated by vehicle and fuel type. Vehicle types are: (1) cars (including hybrid electric vehicles); and (2) pickup trucks/SUVs. Fuel types are: (1) gasoline; (2) diesel; (3) propane; and (4) natural gas. Fuel efficiencies are expressed in litres per 100 kilometres driven.

In the case of ferries, an average fuel efficiency has been similarly estimated, expressed in litres per passenger-100 km travelled.

[48] The Climate Registry (2008). *General Reporting Protocol*, pp. 121-132.

Data sources: For road travel, both the US Environmental Protection Agency (EPA) and NRCan publish "city" and "highway" fuel economy ratings by vehicle manufacturer and model.[49] It is expected that most government travel falls between the conditions modeled for city and highway driving, tending closer to city estimates.[50]

In 2008, the EPA established new best practices for measuring fuel economy that indicated lower fuel efficiency – or increased L/100 km – than previous measurements.[51] Accordingly, fuel economy ratings that predate 2008 need to be adjusted upwards.

The Insurance Corporation of British Columbia (ICBC) maintains non-public records of the composition of the provincial vehicle fleet. These data were used to develop weighted average fuel efficiencies for the vehicle and fuel types in Table 10.

Distances for road travel were derived from the Ministry of Transportation's DriveBC road distance calculator.[52]

For ferry travel, neither BC Ferries nor Environment Canada currently publishes comprehensive data on GHG emissions. However, public data on fuel consumption, route length and passenger capacity are available from various BC Ferries sources and have been used in estimating average fuel efficiency.[53]

Calculations: In the case of road travel, an uplift factor of 7.8 percent was applied to the 2007 NRCan fuel economy ratings for city driving – to better reflect real-world fuel efficiencies. NRCan city ratings were then applied to ICBC data on the provincial vehicle stock by model, year, fuel type and other characteristics to derive average fuel efficiency estimates for each vehicle/fuel type listed in Table 10.

To calculate GHG emissions, the quantity of fuel consumption was first estimated by multiplying the average fuel efficiency for the particular vehicle/fuel type by the kilometres driven. Then, the appropriate emission factor was applied to this fuel consumption estimate.

For ferries, the average fuel efficiency in Table 20 (Annex 7.5) has been estimated using 2005/06 data on diesel consumption for five ferry routes. These fuel data were extrapolated to all 22 ferry routes based on route distance and horsepower. Fuel efficiencies in litres per passenger-100 km were then calculated by dividing the total diesel consumption for each route by the route distance and the estimated passenger load (assuming 80 percent of the ferry's total passenger capacity). These fuel efficiencies were then averaged over the 22 routes to yield 5.1 L/passenger-100 km.

[49] US EPA (2011). *Model Year 2012 Fuel Economy Guide*, and NRCan (2011), *Fuel Consumption Guide 2011*.
[50] The NRCan city ratings have been used here for a number of reasons. For example, most highway driving in the province's metropolitan areas is characterized by considerable congestion, leading to higher fuel consumption. In the Interior, fuel efficiencies are likely to be higher than the theoretical (best practices) NRCan ratings, given weather and terrain. As a result, the city ratings can be assumed to capture some of the actual highway driving efficiencies in B.C. and lead to a more conservative estimate of the GHG emissions from business road travel.
[51] See: www.epa.gov/fueleconomy/.
[52] See: www.th.gov.bc.ca/popular-topics/distances/calculator.asp.
[53] British Columbia Ferry Services Inc. (2006). *Fuel Consumption Reduction Plan*, p. 8; BC Ferries (2008a). *Routes and Schedules Regional Index*; and BC Ferries (2008b). *Variety…The Spice of Our Fleet*.

To calculate ferry emissions, the average fuel efficiency was multiplied by the passenger distance travelled and the emission factor for marine diesel then applied to the resulting fuel consumption figure. Distance travelled is based on route length as travelled by the ship, as opposed to the straight line distance between starting and destination points. For more information refer to Annex 7.5.

Table 10: Travel, Fuel Efficiency Based Emission Calculations

Travel Mode	Vehicle/Fuel Type	Average Fuel Efficiency[a]	Emission Factor (kg/L)[b]			
			Bio CO_2	CO_2	CH_4	N_2O
Car (includes Taxi)	Gasoline	10.3 L/100 km	0.0747	2.175	0.00023	0.00047
	Diesel	7.7 L/100 km	0.0980	2.557	0.000068	0.00022
Car (includes Taxi)	Hybrid	7 L/100 km	0.0747	2.175	0.00023	0.00047
	Natural Gas[c]	5.4 kg/100 km[d]	–	2.725	0.013	0.000086
	Propane	8.2 L/100 km	–	1.510	0.00064	0.000028
Light Truck (includes SUV and Minivan)	Gasoline	14.7 L/100 km	0.0747	2.175	0.00024	0.00058
	Diesel	12.5 L/100 km	0.0980	2.557	0.000068	0.00022
	Hybrid	10 L/100 km	0.0747	2.175	0.00024	0.00058
	Natural Gas[c]	8.3 kg/100 km[d]	–	2.725	0.013	0.000086
	Propane	12.6 L/100 km	–	1.510	0.00064	0.000028
Ferry	Diesel	5.1 L/psg-100 km	0.0980	2.557	0.00015	0.0011

[a] From Natural Resources Canada, ICBC, and BC Ferries sources (see Data Sources, below.)

[b] From Environment Canada 1990-2009 NIR.

[c] Emission factors adapted from NIR figures, converted to kg of natural gas, the common units for vehicle natural gas.

[d] kg/ 100km figure for Natural Gas calculated based on 1.52 L/ kg gasoline equivalency.

5.2 Travel Emission Based on Travel Distance

Description: GHG emissions for bus, skytrain, sea bus, rail, airplane and helicopter travel are all calculated using emission factors in kg CO_2e per passenger-kilometre. The categorization of airplane travel into three ranges of haul distance attempts to reduce the significant variation in emissions, since trips of comparable length are more likely to have similar aircraft types and flight patterns. However, it is recognized that the emission factors in Table 11 are approximations and that actual emissions from airplane travel varies significantly from one trip to the next.

Data sources: NRCan publishes information on total Canadian GHG emissions and passenger-km for a number of transportation modes, including urban transit (city buses) and inter-city buses.[54] The most recent year of data is 2008.

While NRCan also publishes aggregate data on GHG emissions and passenger-km for air travel, no breakdown is provided for haul distance. In contrast, the UK Department of Environment, Food and Rural Affairs (DEFRA) has estimated emission factors for three categories of flights: (1)

[54] NRCan (2011). *Energy Use Data Handbook, 1990 to 2008*, Chapter 5, Tables 4 and 5.

domestic; (2) short haul international; and (3) long haul international.[55] For the B.C. government's purposes, these categories have been adopted as follows: (1) the DEFRA 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.[56]

Calculations: The emission factors for urban and inter-city buses were calculated by dividing the NRCan data on total GHG emissions for 2008 by the total passenger-kilometres. To calculate emissions, these emission factors in kg CO_2e/psg-km were then multiplied by the distance travelled. The emissions factors for Skytrain[57] and Sea Bus[58, 59] travel were calculated based on emissions data and the total passenger kilometers.

The emission factor for rail was calculated by dividing the Transport Canada data on total passenger services fuel consumption in litres for VIA Rail Canada by the corresponding revenue passenger-kilometres[60].

The airplane emission factors from DEFRA include a nine percent uplift factor. This adjustment is recommended by the Intergovernmental Panel on Climate Change (IPCC) to account for discrepancies between geographical distance and actual flight distance.[61] 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.

In SMARTTEC, the specified distance is the shortest geographical distance between the starting point and the destination. The nine percent uplift factor was used to adjust for the difference between this shortest distance calculation and the actual travel of the aircraft.

The emission factor for helicopter and floatplane travel was calculated based on fuel consumption data provided by carriers operating flights between Vancouver harbour and Victoria harbour (Helijet and Harbour Air). Also incorporated in the emission factor is the average passenger load reported by Canadian airlines for the previous calendar year and an estimated flight distance that accounts for the non-direct route between Vancouver and Victoria harbours.

[55] DEFRA (2011). *2011 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting*, Annex 6, Table 6l.
[56] 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). DEFRA information also includes emissions listed by flight class. However, for ease of use purposes, the average emissions factor for distance-based flight provided in the DEFRA document were used in this document.
[57] TransLink Sustainability Report, December 2010. Psg-km data: Appendix 2.7, p.88; Emission data: Appendix 2.8, p.89
[58] TransLink Sustainability Report, December 2010. p.88; Emission data: Appendix 2.8, p.89
[59] TransLink Annual Report, December 2008. Psg-km data: p. 2
[60] See: www.tc.gc.ca/eng/programs/environment-ecofreight-about-voluntary-racemissions2007-2-1134.htm
[61] IPCC (1999). *Aviation and the Global Atmosphere*, Section 8.2.2.3.

Table 11: Travel Distance Based Emission Calculations

Travel Mode	Vehicle Type	Emission Factor (kg CO_2e/psg-km)
Bus	City	0.1223
	Other (Inter-city)	0.0643
Skytrain		0.00238
Sea Bus		0.1849
Rail		0.126
Airplane	Float Plane	0.213
	Short Haul (0-463 km)	0.2128
	Medium Haul (463-1,108 km)	0.1250
	Long Haul (>1,108 km)	0.1439
Helicopter		0.447

Note: B.C. Government emission factors for travel, distance based emission calculations are derived from NRCan, Transport Canada, DEFRA, Helijet and Translink BC sources (see text).

5.2 Indirect Emissions - Accommodation

Description: In addition to transportation-related GHGs from business travel, indirect emissions result from employee stays in hotels, bed and breakfasts and private accommodation.

Data sources: In March of 2011, InterVISTAS Consulting Inc. published a GHG report on the accommodation emissions for Coast Hotels and Resorts in 2009[62]. The report followed the accounting and reporting guidelines of *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, Revised Edition* published by World Resources Institute and the World Business Council for Sustainable Development.

A total of five properties were evaluated (two in Vancouver, one in Edmonton, one in Victoria and one in Prince George). The properties in Western Canada provide a spatial sampling of locations in different climates to represent different energy consumption patterns. The properties varied in size from 132 rooms in Victoria to 299 in Edmonton. The intensity based indicators for those five hotels were then extrapolated to 22 hotels in BC and 7 in Alberta.

Calculations: In Table 12 the emission factor for a night's stay has been calculated by dividing the total GHG emissions for the sample hotels by the number of potential room nights assuming full occupancy:

Emission Factor (kg/ CO_2e/ night) = 51,310 tonnes CO_2e*1000/ (7,238 rooms * 365 nights)

From this method, both a domestic BC emissions value (11.90 kg CO_{2e} / night) and a national/international emissions value (20.78 CO_{2e} / night) were derived. The national/international

[62] InterVISTAS Consulting Inc. (2011), *Coast Hotels & Resorts: Greenhouse Gas Report Fiscal Year 2009*

value is a conservative estimate as it incorporates data from electricity generation in Alberta, which results in significantly greater emissions per kilowatt hour than in the rest of Canada due to coal being the primary energy source. Based on 2010 accommodation data from SMARTTEC, 92.39% of core government accommodation stays were domestic within BC and 7.61% were national or international. Based on these figures a weighted average can be calculated to derive a single accommodation factor of 12.58 kg CO_{2e} / night.

This emission factor for hotels has been assigned to the other categories of private accommodation and bed and breakfasts in the absence of available information for those categories.

Table 12: Accommodation

Accommodation Type	Emission Factor[a] (kg CO_2e/ night)
Hotel Room	12.58
Private	12.58
Bed and Breakfast	12.58

[a] Hotel room emission factor is applied to all accommodation types.

6. SAMPLE CALCULATION

Table 13 provides a sample application of an emission factor to calculate GHG emissions, based on 100 litres of propane consumption in buildings.

Table 13: Sample Emissions Calculation

Step	Formula	Calculation		
1. Convert the actual consumption to a common unit of measurement.	Actual Consumption (L) x Energy Conversion Factor (GJ/ L) = Converted Fuel Consumption (GJ)	100 L X 0.02531 GJ/ L = 2.531 GJ		
2. Calculate the emissions of each GHG using the appropriate emission factor	Converted Fuel Consumption (GJ) x Emission Factor by GHG (kg/ GJ) = Emissions by GHG	CO_2 2.531 GJ x 59.66 kg CO_2 / GJ = 149.2 kg CO_2	CH_4 2.531 GJ x .0010 kg CH_4 / GJ = 0.0025 kg CH_4	N_2O 2.531 GJ x 0.0043 kg N_2O / GJ = 0.0108 kg N_2O
3. Convert the emissions of each greenhouse gas to CO2 equivalency (CO_2e) using the appropriate Global Warming Potential	Emissions by GHG x GWP = Emissions (kg CO_2e)	CO_2 149.2 kg CO_2 x 1 = 149.2 kg CO_2e	CH_4 0.0025 kg CH_4 x 21 = 0.0525 kg CO_2e	N_2O 0.0108 kg N_2O x 310 = 3.348 kg CO_2e
4. Sum across the gases to calculate total CO2e emissions	CO_2 + CH_4 + N_2O (all in kg CO_2e) = Total CO_2e	149.2 kg CO_2e + 0.0525 kg CO_2e + 3.348 kg CO_2e = 152.6 kg CO_2e		
5. Convert total emissions from kg to tonnes for reporting purposes.	Emissions in kg CO_2e / 1 000 kg / t = Emissions in tonnes CO_2e	152.6 kg CO_2e / 1 000 kg / t = 0.153 t CO_2e		

7. Annexes

7.1 Glossary of Terms and Acronyms

Note: Definitions derived from:

- LiveSmart BC, Glossary (available at: www.livesmartbc.ca/learn/glossary.html).
- IPCC Third Assessment Report, Glossary of Terms (available at: www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf).
- Market Advisory Committee to the California Air Resources Board (2007), "Recommendations for Designing a Greenhouse Gas Cap-and-Trade System for California."
- World Business Council for Sustainable Development and World Resources Institute (2004), *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard – Revised Edition,* pp. 96-102.
- The Climate Registry (2008), *General Reporting Protocol*, pp. 153-158.

Abbreviation, Acronym or Measure	Definition
Carbon dioxide (CO_2)	A naturally occurring gas (0.03% of atmosphere) that is also a by-product of burning 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-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 (LiveSmart BC).
Biofuel	A fuel produced from dry organic matter or combustible oils produced by plants. Examples of biofuel include alcohol (from fermented sugar), black liquor from the paper manufacturing process, wood and soybean oil.
Direct emissions	Emissions from sources that are owned or controlled by the reporting organization (i.e., PSO).
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).
EPA	(U.S.) Environmental Protection Agency
Fugitive emissions	The unintended or incidental emissions of greenhouse gases from the transmission, processing, storage, use, or transportation of fossil fuels, GHGs, other substances, including but not limited to HFC emissions from refrigeration leaks and SF_6 from electric power distribution equipment.
Gigajoule (GJ)	One billion joules, where a joule is a common unit of energy for comparing across fuel types and electricity.

Abbreviation, Acronym or Measure	Definition
Gigawatt-hour (GWh)	One million kilowatt-hours, enough electricity to power 100 homes for a year.
Global Warming Potential (GWP)	"Greenhouse gases differ in their effect on the Earth's radiation balance depending on their concentration, residence time in the atmosphere, and physical properties with respect to absorbing and emitting radiant energy. By convention, the effect of carbon dioxide is assigned a value of one (1) (i.e., the GWP of carbon dioxide =1) and the GWPs of other gases are expressed relative to carbon dioxide. For example, in the U.S. national inventory, the GWP of nitrous oxide is 310 and that of methane 21, indicating that a tonne of nitrous oxide has 310 times the effect on warming as a ton of carbon dioxide. Slightly different GWP values for greenhouse gases have been estimated in other reports. Some industrially produced gases such as sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs) have extremely high GWPs. Emissions of these gases have a much greater effect on global warming than an equal emission (by mass) of the naturally occurring gases. Most of these gases have GWPs of 1,300 - 23,900 times that of CO_2. The US and other Parties to the UNFCCC report national greenhouse gas inventories using GWPs from the IPCC's Second Assessment Report (SAR). SAR GWPs are also used for the Kyoto Protocol and the EU ETS. GWPs indicated in this document also refer to the IPCC's Second Assessment Report." (CARB)
Global Reporting Initiative (GRI)	An international initiative that has developed a sustainability reporting framework for organizations to measure and report on their economic, environmental and social performance (see: www.globalreporting.org).
Greenhouse gases (GHGs)	"Greenhouse gases include a wide variety of gases that trap heat near the Earth's surface, slowing its escape into space. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor and other gases. While greenhouse gases occur naturally in the atmosphere, human activities also result in additional greenhouse gas emissions. Humans have also manufactured some gaseous compounds not found in nature that also slow the release of radiant energy into space." (CARB)
HVAC	Heating, Ventilating and Air Conditioning
Hydrofluorocarbons (HFCs)	"One of the six primary GHGs. Synthetic industrial gases, primarily used in refrigeration and other applications as commercial substitutes for chlorofluorocarbons (CFCs). There are no natural sources of HFCs. The atmospheric lifetime of HFCs is decades to centuries, and they have "global warming potentials" thousands of times that of CO_2, depending on the gas. HFCs are among the six greenhouse gases to be curbed under the Kyoto Protocol." (CARB)
Indirect emissions	Emissions that are a consequence of the operations of the reporting organization (i.e., PSO), 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)

Abbreviation, Acronym or Measure	Definition
IPP	Independent Power Producer
kg	Kilogram
kilotonne	1,000 tonnes
km	Kilometre
kWh	kilowatt-hour
L	Litre
lb	pound (weight)
m^3	cubic metre
Methane (CH_4)	"One of the six greenhouse gases to be curbed under the Kyoto Protocol. Atmospheric CH_4 is produced in nature, but human related sources such as landfills, livestock feedlots, natural gas and petroleum systems, coal mines, rice fields, and wastewater treatment plants also generate substantial CH_4 emissions. CH_4 has a relatively short atmospheric lifetime of approximately 10 years, but its 100-year GWP is currently estimated to be approximately 21 times that of CO_2." (CARB)
MVAC	Motor Vehicle Air Conditioning
NIR	National Inventory Report (Environment Canada)
Nitrous oxide (N_2O)	"One of the six greenhouse gases to be curbed under the Kyoto Protocol. N2O is produced by natural processes, but substantial emissions are also produced by such human activities as farming and fossil fuel combustion. The atmospheric lifetime of N2O is approximately 100 years, and its 100-year GWP is currently estimated to be 310 times that of CO_2." (CARB)
Office Paper	Multipurpose copy paper for use in laser printers, fax machines and photocopiers or multifunction devices.
Perfluorocarbons (PFCs)	"PFCs are among the six greenhouse gases to be curbed under the Kyoto Protocol. PFCs are synthetic industrial gases generated as a by-product of aluminum smelting and uranium enrichment. They also are used in the manufacture of semiconductors. There are no natural sources of PFCs. PFCs have atmospheric lifetimes of thousands to tens of thousands of years and 100-year GWPs thousands of times that of CO_2, depending on the specific PFC." (CARB)
pkg	Package
PIR	British Columbia Greenhouse Gas Inventory Report (Ministry of Environment)
PSO	A B.C. public sector organization subject to the government's carbon neutral commitment under the *Greenhouse Gas Reduction Targets Act*.
RESD	Report on Energy Supply and Demand (Statistics Canada).
STP	Standard Temperature and Pressure
Sulphur Hexafluoride (SF_6)	One of the six greenhouse gases to be curbed under the Kyoto Protocol. SF_6 is a synthetic industrial gas largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. There are no natural sources of SF_6. SF_6 has an atmospheric lifetime of 3,200 years. Its 100-year GWP is currently estimated to be 22,200 times that of CO_2." (CARB)
t	metric tonne, a standard measurement for the mass of GHG emissions, equivalent to 1,000 kg, 1,204.6 pounds, or 1.1 short tons.
U.S.	United States (of America)

7.2 Global Warming Potentials

Table 14 presents the 100-year Global Warming Potentials for the GHGs being tracked by the B.C. public sector. These GWPs are listed in the Carbon Neutral Government Regulation and are the 1995 values from the IPCC's *Second Assessment Report*, as endorsed by Environment Canada and British Columbia, as such, they represent the standard emission factors to be used at this time in greenhouse gas emissions calculations in British Columbia.[63, 64, 65]

Table 14: Global Warming Potentials

Greenhouse Gas	Chemical Formula	100-Year GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
HFC-23	CHF_3	11 700
HFC-32	CH_2F_2	650
HFC-41	CH_3F	150
HFC-43-10mee	$C_5H_2F_{10}$	1 300
HFC-125	C_2HF_5	2 800
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1 000
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1 300
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3 800
HFC-152 (*)	$C_2H_4F_2$	43
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140
HFC-161 (*)	C_2H_5F	12
HFC-227ea	C_3HF_7	2 900
HFC-236cb (*)	$C_3H_2F_6$	1 300
HFC-236ea (*)	$C_3H_2F_6$	1 200
HFC-236fa	C_3H_2F6	6 300
HFC-245ca	$C_3H_3F_5$	560

[63] Environment Canada (2011). *National Inventory Report 1990-2009*, p.35.
[64] British Columbia (2011). *British Columbia Greenhouse Gas Inventory Report 2008*, p. 61
[65] Greenhouse Gases marked with an asterisk (*) were added from the *Reporting Regulation.*

HFC-245fa (*)	$C_3H_3F_5$	950
HFC-365mfc (*)	$C_4H_5F_5$	890
Perflouromethane (*)	CF_4	6 500
Perflouroethane (*)	C_2F_6	9 200
Perflouropropane (*)	C_3F_8	7 000
Perflourobutane (*)	C_4F_{10}	7 000
Perflourocyclobutane (*)	$c\text{-}C_4F_8$	8 700
Perflouropentane (*)	C_5F_{12}	7 500
Perflourohexane (*)	C_6F_{14}	7 400
Sulphur hexafluoride	SF_6	23 900

7.3 Scope Summary

This annex provides a summary about what is in-scope and out- of-scope for the purpose of measuring and reporting greenhouse gas emissions.[66] All in-scope emissions are subject to offset requirements unless otherwise noted.

Table 15: Scope - Greenhous Gas coverage

IN-SCOPE	OUT-OF SCOPE
Six Gases: • Carbon dioxide – CO_2 • Methane – CH_4 • Nitrous oxide – N_2O • Sulphur Hexafluoride– SF_6 • Perfluorocarbons – PFCs • Hydrofluorocarbons - HFCs An complete list of PFCs and HFCs is available in the Reporting Regulation.	All other gases (including HCFCs and Halons).

Table 16: Scope - Geographic Boundaries

IN-SCOPE	OUT-OF SCOPE
Public Sector Organization (PSO) operations located: • in British Columbia; and • elsewhere in the world.	

Table 17: Scope - Organizational Boundaries

IN-SCOPE	OUT-OF SCOPE
a) All PSOs within the "government reporting entity" (GRE). b) Any organization considered controlled by a PSO under Generally Accepted Accounting Principles (e.g., the PSO owns more than 50% of voting shares; controls the organization's board)	• BC Ferry Corporation • Canadian Blood Services • Municipalities • Contractors supplying services to or on behalf of PSOs.

[66] This scope summary is not intended to provide legal advice. Public Sector Organizations remain responsible for ensuring they understand and comply with the *Greenhouse Gas Reduction Targets Act*, the *Carbon Neutral Government Regulation*.

Table 18: Scope - Operational Boundaries

IN-SCOPE	OUT-OF SCOPE
GENERAL – Applies to All Emission Sources	
a. PSO Assets: Emissions from physical assets such as buildings, equipment, appliances, and motor vehicles that PSOs directly own or lease. (This includes PSO assets used by contractors.)	a. Contractor Assets: Emissions from physical assets owned or leased by contractors supplying services to or on behalf of PSOs.
b. Joint Assets: Emissions from assets jointly owned or leased by a PSO through a partnership or joint venture. (To be reported based on the PSO's ownership share.)	b. Joint Assets: Emissions from physical assets in which the PSO only has a small interest and no significant influence over its use.
c. Carbon Neutral Vendors: Emissions from these sources must be reported and offset unless the vendor's offset supplier is the Pacific Carbon Trust (e.g., emissions from business travel with Helijet).	c. Employees working from home: Emissions from assets owned, leased or used by an employee working from home.
d. Biomass/Biofuels: Emissions from the use of these fuels must be reported, but the CO_2 emissions from the "biogenic" portion are not required to be offset.	d. 1% Rule: An emission source estimated to total less than 1% of a PSO's overall emissions may be deemed out-of-scope if the effort to collect or estimate emissions is disproportionately onerous. The estimated cumulative sum of emissions exempted under this rule a PSO should not be greater than 1% of that PSO's total emissions. If in your estimations the cumulative sum is greater than 1%, please raise the issue with Secretariat staff at climateactionsecretariat@gov.bc.ca.If an emissions source is considered out-of-scope for this reason, the source of the emission and the rationale for its exemption should be included as a part of the Carbon Neutral Action Report for the PSO. For example, based on rough estimates for core government, stationary fugitive emissions from cooling are not expected to comprise more than 0.01% of any public sector organization's total emissions. To determine if an emissions source is out of scope under this rule, please see the decision tree in Annex 7.4.
STATIONARY Emission Sources	
a. Direct or indirect energy emissions from buildings owned or leased by the PSO and: • occupied by the PSO or vacant • under operating or capital lease to a local government[67] • or under operating lease to non-GRE entities	a. Direct or indirect energy emissions from buildings owned by the PSO but under • operating/capital lease to another PSO; or • capital lease to non-GRE entities

[67] Local Governments who have signed the Climate Action Charter will be carbon neutral for 2012. Until 2012, PSOs will be required to report on and offset emissions from buildings under an operating or capital lease to local government. A final decision on emissions reporting and offsetting for 2012 emissions in building leased to local governments is pending.

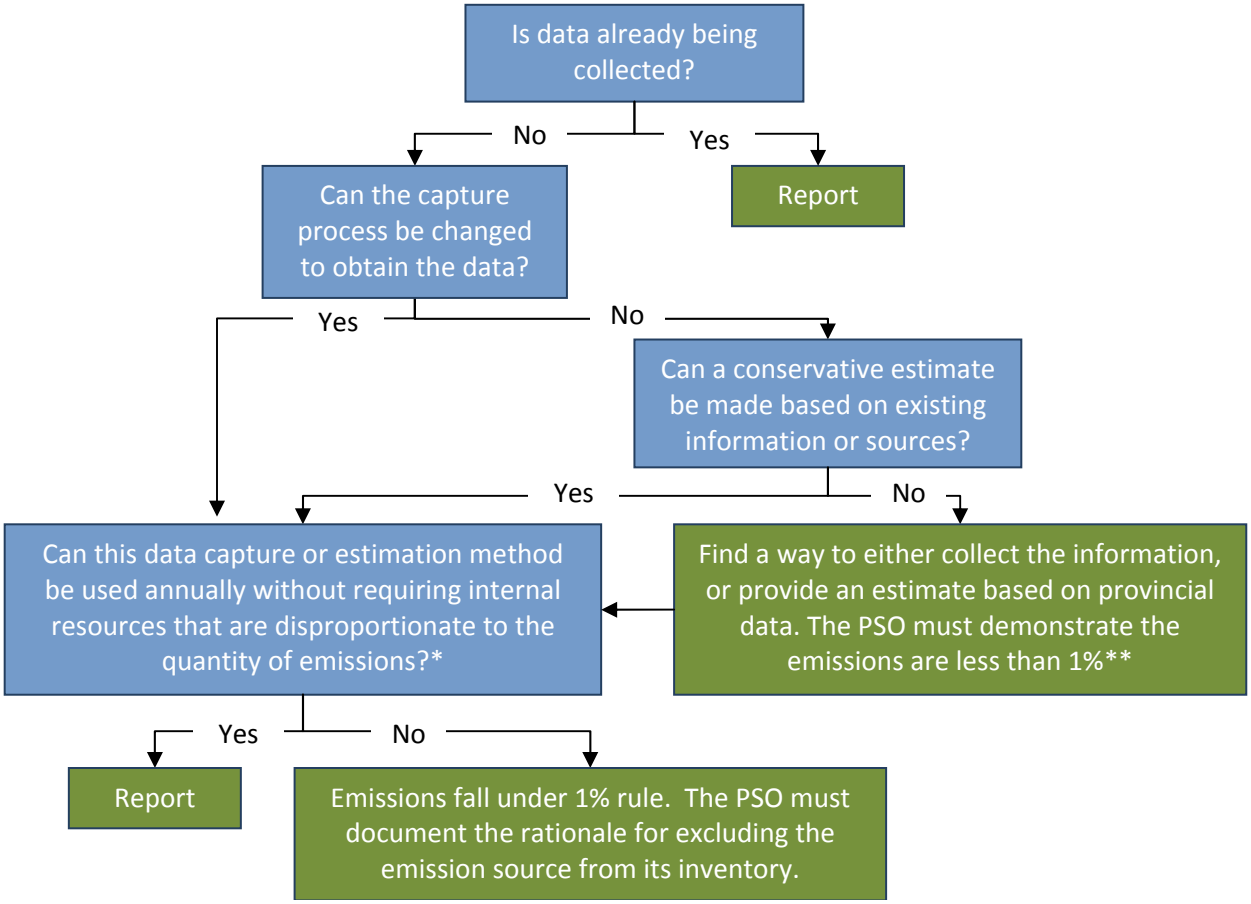
IN-SCOPE	OUT-OF SCOPE
b. Direct Emissions Those released by a PSO's assets in the combustion of fuels to produce heat, cooling, and/or electricity: • for use in the PSO's operations; or • sold to any non-GRE entities c. Indirect Emissions Those released by energy suppliers in the combustion of fuels to produce heat, cooling, and/or electricity for purchase by PSOs. d. Fugitive Emissions Those released intentionally or unintentionally : HFC emissions from air conditioning equipment. (Please note: The 1% rule may apply to HFC emissions from air conditioning and cooling.) e. Emissions from Facilities Under Construction Those released on and after the date the PSO receives an occupancy permit or similar written authorization for occupancy from the local gov't responsible.	b. Direct Emissions • Those released by a PSO's assets in the combustion of fuels to produce heat, cooling, and/or electricity sold to other PSOs (e.g., steam) • Those released by BC Hydro's assets in the generation or transmission of electricity. c. Fugitive Emissions Those released intentionally or unintentionally : • SF_6 from electricity transmission and distribution (covered under Cap and Trade Legislation). • N_2O as an anesthetic.
MOBILE Emission Sources	
a. Direct Emissions Those released by the combustion of fuels in a PSO's mobile assets including: • Cars, trucks, motorcycles; • Off-road equipment (e.g., construction) • Marine vessels and aircraft. b. School Bus/Public Transit Emissions: • Must be reported like other in-scope emissions, but offsets are not required for these emissions. Definition: A school bus is a motor vehicle used to transport students to and from school or school-related activities.	a. Direct Emissions • Those released from a PSO's mobile assets during business travel. (These emissions may still be reported where it is not practical to separate business travel from operational use.) • Those from mobile assets that are owned/leased by: o employees and used for business purposes, or commuting to/from work; and o contractors and used in the provision of services to or on behalf of PSOs.
OFFICE PAPER Emission Sources	
20 lb multipurpose copy paper purchased by PSOs for use in laser printers, fax machines and photocopiers or multifunction devices: • 8.5" x 11" • 8.5" x 14" • 11" x 17" • All colours Recycled content from 0% to 100%	• All other paper weights • Envelopes • Note pads, writing paper • Specialty papers: card stock, plotter paper, photo paper etc. • Pre-printed paper (e.g., letterhead, forms) Paper purchased for the production of educational materials and sold to students.
BUSINESS TRAVEL Emission Sources	

IN-SCOPE	OUT-OF SCOPE
Emissions from business travel of public officials funded by the Consolidated Revenue Fund. • Generally applies to ministry/tribunal employees, MLAs and ministers. Includes emissions from all modes of travel and overnight accommodations.	Business travel of public officials with Boards of Education, Health authorities and their affiliates, Crown Corporations, and Universities and Colleges.

7.4 1% Rule Decision Tree

This decision tree was developed to help PSOs determine whether or not a certain source of emissions falls under the 1% rule, which states that **if an emissions source is estimated to comprise of less than 1% of an organization's total emissions *and* is onerous to collect, it is considered out of scope**. If an emissions source is expected to fall under 1% of a PSO's total emissions, the PSO should use the following decision tree to determine whether or not it is considered onerous and can be excepted using this rule. If, after using this decision tree, an emissions source is considered out-of-scope under this rule, the source of the emission and the rationale for its exemption should be included as a part of the Carbon Neutral Action Report.

Table 19: 1% Decision Tree



* e.g. excessive person-hours of time are required to collect the information that could be put towards data collection and quality control for larger emissions sources

** Is there an alternative method for estimating? Can a formula be created to produce a conservative estimates based on available provincial data? How did you come to the conclusion that it was likely less than 1%?

7.5 Review of Fuel Efficiency Calculation for Ferries

BC Ferries has not yet published a verified emission factor that can be applied to travel calculations. Some data on fuel consumption, route length and passenger capacity however, is available from sources on the BC Ferries website. [68] Data from these sources has been used in estimating average fuel efficiency.

Fuel consumption information, along with published route and vessel data, was used to determine an average of HP/ L/ km. This information is displayed in Table 19 below.

Table 20: Average Horsepower/ Litre/ Kilometre Calculation for Ferries

Route	Vessel Class	HP	Distance (km)	Fuel Consumption (L)	L/ km	HP/ L/ km
Vancouver – Victoria	Spirit Class	21 394	44.4	4200	95	226.1651
Vancouver – Victoria	V Class	8 941	44.4	2400	54	165.4085
West Van – Bowen Island		7 305	5.6	135	24	303.0222
Alliford Bay – Skidegate		730	6.5	66	10	71.8939
Vancouver – Salt Spring Island		6 000	40.7	1515	37	161.1882
					Average HP/ L / km =	185.5356

Diesel fuel consumption was then estimated based on: (1) the calculated average HP/ L/ km figure; (2) route distance; and (3) vessel horsepower information. This was calculated for twenty-two BC Ferry routes based on available information.

Estimated diesel fuel consumption for each route was divided by 80% of each vessel's stated passenger capacity to derive an estimate of fuel consumption per passenger (L/ passenger (psg)). This number was then divided by the route distance to get a fuel efficiency calculation for each route (L/ psg/ km).

Fuel efficiency numbers for calculated routes were an average of 0.051 L/ psg/ km. Fuel efficiency factors in SMARTTEC are stated per 100km, therefore, this factor was multiplied by 100 which results in a figure of 5.10 L/ psg/ 100 km. This fuel efficiency factor was used to estimate fuel consumption for calculating emissions associated with ferry travel.

It was assumed that all fuel consumed for ferry travel by BC Ferries vessels is marine diesel. Emission factors for marine diesel published by Environment Canada were used to calculate emissions detailed in Table 20.

[68] British Columbia Ferry Services Inc. (2006) www.bcferries.com/: , *Fuel Consumption Reduction Plan*, p. 8; BC Ferries (2008a), *Routes and Schedules Regional Index*; and BC Ferries (2008b), *Variety…The Spice of Our Fleet.*

7.6 SMARTTool Buildings Energy Estimation Method Summary

7.6.1 Introduction

The following information is intended to provide a summary of the different building energy estimation methods which are currently available in SMARTTool. These methods assist client organizations in estimating building energy consumption in instances when energy consumption data for a building is not readily available.

A summary of the three building energy estimation methods currently available to PSOs in SMARTTool is presented in Table 21:

Table 21: Building Estimation Methods Summary

Method	Description	Usage
Gross-up Factor	The gross up factor is used to increase building energy consumption by a factor derived from the ratio of total floor space to floor space where the consumption is known.	Primarily used by BC Government (CRF) organizations to estimate energy consumption for floor space where Shared Services BC does not have access to utility information.
Regional Calculated Energy Intensity Unit (Regional Calc EIU)	Energy estimate is applied using a calculated energy intensity based on reported energy consumption for buildings sharing the same region and energy usage profile.	Primarily used in situations where an organization reports energy consumption for buildings with a profile similar to that which needs to be estimated.
Fixed Energy Intensity Unit (Fixed EIU)	An energy estimate is applied using pre-determined intensity factors which have been calculated using energy intensities from Natural Resources Canada.	Primarily used in situations where organizations do not have sufficient reported data from which to estimate energy consumption for the building that requires it.

7.6.2 Estimation Method Details

Gross-Up Factor:
The Gross up factor is used to increase the buildings energy usage by a factor derived from the ratio of total floor space to floor space where the building energy consumption is known. The 'grossed up' values represent the total buildings energy consumption for the organization.

When an organization reports building energy consumption, the gross up factor is applied. If a Gross-up factor for the organization is greater than one, then the reported energy consumption is increased by the specified gross-up factor. Gross-up factors can be defined for specific date ranges.

Regional Calculated Energy Intensity Unit (Regional Calc EIU)

The Regional Calculated Energy Intensity Unit estimation method allows organizations to estimate building energy consumption based on energy they have reported for buildings from a like region with the same energy profile.

Each building/facility entered into the SMARTTool building registry is assigned a region and classification. The values given to region and classification can be used to associate buildings with other buildings belonging to that organization and/or other organizations.

Buildings assigned the Regional Calc EIU estimation method are given an energy estimate for their floor space using an intensity factor calculated from the reported energy consumption of buildings with an identical region and the same classification (GJ of fuel/energy type per m2). Regional Calc EIU estimates are triggered for an organization when new building data for that organization is uploaded using SMARTLoad. Estimates are applied up to and including the month the SMARTLoad upload was performed in (i.e. the current month).

Fixed Energy Intensity Unit (Fixed EIU)

The Fixed EIU estimation method applies an energy estimate using pre-determined energy intensity factors published by Natural Resources Canada (NRC) through the Office of Energy Efficiency (OEE) Comprehensive Energy Use Database[69]. This database includes statistics on energy use by province, building use type and fuel.

Buildings entered into the SMARTTool building registry may be assigned the Fixed EIU estimation method. A classification is assigned for each energy/utility source used in a given building.

Fixed EIU estimates are triggered for an organization when data for that organization is uploaded using SMARTLoad. Buildings that have Fixed EIU specified as an estimation method are applied an estimate based on their classification. Estimates are applied up to and including the month the SMARTLoad upload was performed in (i.e. the current month).

[69] Natural Resources Canada (NRC) through the Office of Energy Efficiency (OEE) Comprehensive Energy Use Database: oee.nrcan.gc.ca/statistics/4307

7.7 Selected References

BC Hydro. 2011. BC *Hydro's Annual Report 2011*. Available at: www.bchydro.com/etc/medialib/internet/documents/annual_report/2011_BCH_AnnualReport.Par.0001.File.2011-BCH-Annual-Report.pdf

British Columbia. 2011. British Columbia Greenhouse Gas Inventory Report 2008. Available at www.env.gov.bc.ca/cas/mitigation/ghg_inventory/index.html.Climate Action Secretariat. 2008. *Draft Framework for Greenhouse Gas Measurement and Reporting*. Prepared by the Climate Neutral Working Group.

Climate Registry, The. 2008. *General Reporting Protocol*. Version 1.1. Available at: www.theclimateregistry.org/resources/protocols.

Environment Canada. 2011. *National Inventory Report: Greenhouse Gas Sources and Sinks in Canada 1990-2009*. Submission to the United Nations Framework Convention on Climate Change.

Intergovernmental Panel on Climate Change. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Volume 5. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Available at: www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

International Energy Agency. 2010. CO_2 Emissions From Fuel Combustion – Highlights.

Statistics Canada. 2011. *Report on Energy Supply and Demand in Canada 2009*. Available at: www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=57-003-X&CHROPG=1&lang=eng

US Environmental Protection Agency. 2011. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*. Available at: www.epa.gov/climatechange/emissions/usinventoryreport.html.

World Business Council for Sustainable Development and World Resources Institute. 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*. Revised edition. Available at: www.ghgprotocol.org/standards/corporate-standard

British Columbia Ferry Services Inc. 2008a. *Routes and Schedules Regional Index*. Available at: www.bcferries.com/schedules/.

British Columbia Ferry Services Inc. 2008b. *Variety…The Spice of our Fleet!* Available at: www.bcferries.com/onboard-experiences/fleet/.

British Columbia Ferry Services Inc. 2006. *Fuel Consumption Reduction Plan*. Available at: www.bcferries.com/files/AboutBCF/BCF_Fuel_Savings_Plan.pdf.


BRITISH
COLUMBIA
Ministry of
Environment