TECHNICAL METHODS AND GUIDANCE DOCUMENT 2007-2012 REPORTS

COMMUNITY ENERGY AND EMISSIONS INVENTORY (CEEI) INITIATIVE

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Technical Methods and Guidance Document for 2007-2012 CEEI Reports – Community Energy and Emissions Inventory Initiative

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FURTHER INFORMATION

Community Energy and Emissions Inventory (CEEI) information and reports for each B.C. local government can be found at the Ministry of Environment website:
http://www2.gov.bc.ca/gov/topic.page?id=9CD252EC63C84868AC2325F70E21683C

B.C. local governments looking for additional information on approaches and best practices for undertaking corporate operations and/or community-wide energy conservation and greenhouse gas emissions reduction initiatives are encouraged to visit: www.toolkit.bc.ca.

Both rural and metropolitan B.C. local governments are incorporating climate change adaptation planning as well as greenhouse gas emission reduction initiatives into their community planning. For more information on the process of climate change adaptation please see "Preparing for Climate Change; An Implementation Guide for Local Governments in BC" available at: www.toolkit.bc.ca. B.C. local governments looking for additional information, community case studies, and best practices for climate change adaptation planning are also encouraged to visit: www.retooling.ca.

1. INTRODUCTION

1.1 Community Energy and Emissions Inventory (CEEI) Initiative

Local government involvement is an essential element of climate action. Over 50% of British Columbia's greenhouse gas (GHG) emissions are under the direct or indirect influence of municipal governments.

The Government of British Columbia, the Union of B.C. Municipalities and the majority of local governments across the province have signed the "Climate Action Charter"[1] – which collectively commits signatory local governments to develop strategies and take actions to achieve the following goals:

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

To support local governments to meet Charter commitments, the Community Energy and Emissions Inventory (CEEI) initiative provides a provincial framework for tracking and reporting energy, greenhouse gas GHG emissions and supporting indicators at a community-wide scale.

The reports provide local governments and other users with accurate, consistent and relevant community-level (i.e., within the local government's jurisdictional boundary) energy and GHG emissions information.

CEEI Reports strive to:

- meet agreed-to standards;
- be reproducible across communities and time; and
- be available to B.C. local and provincial governments and other agencies in a user-friendly and transparent format.

The CEEI is intended to provide a cost-effective, rigorous and flexible data collection, analysis and reporting system for B.C. local governments and other interested parties. The system establishes and enables inventory baselines, ongoing monitoring and periodic reporting to inform community decision making and support provincial objectives related to energy use and GHG emissions.

The CEEI initiative is supported by a multi-agency committee led by the Climate Action Secretariat, Ministry of Environment. This committee was formed in 2007 and continues to work with local governments, data providers and contractors to establish and refine inventory and reporting methods and formats.

National and provincial reporting follows data aggregation and methodologies determined by international, national and provincial agreements and obligations. The methods used to establish

1 See: http://www.cscd.gov.bc.ca/lgd/library/CARIP_2013_Summary_Report.pdf. Additional resources can be found at the "Climate Action Toolkit" (www.toolkit.bc.ca) – provided through collaboration between UBCM and the Province

CEEI reports are based on community-level needs and available consumption and/or activity data – distinct from provincial GHG emissions reporting. Therefore, direct comparisons or cross-utilization of emissions data between CEEI community-level and provincial reports are inappropriate.

1.2 CEEI Reports

2007-2012 CEEI reports for British Columbian regional districts and municipalities provide information on energy and GHG emission estimates in four primary sectors and seven "supporting indicators".

Primary sectors include:

- buildings
- on-road transportation (Lower Mainland)
- solid waste
- land-use change from deforestation

Supporting indicators include:

- housing type
- residential density
- commute by mode
- green space
- floor area
- walkscore (where available)
- proximity to transit (where available)

The 2007-2012 CEEI reports also include additional emissions information on two memo items at the regional district level: enteric fermentation from agricultural livestock and large industrial facilities (commensurate with how the data is published under the B.C. Reporting Regulation). Due to accuracy and/or privacy concerns, memo item emissions categories are provided for information purposes only and are not included in total reported emissions profiles.

For the 2007-2012 CEEI reports, significant changes from previous iterations have occurred in the following areas:

- 2007-2010 reports had commute distance as a supporting indicator, but this data is no longer available for 2012.
- Emissions from land-use change caused by deforestation were previously a memo item that was only reported out in 2007 at the regional district level. As of 2012 onwards, it will be a primary sector item with information available only at the municipal level.
- 2007-2010 reports had large industrial facilities as a memo item at both the municipal and regional district level. As of 2012, large industrial facilities will be reported out as memo items only at the regional district level in line with the B.C. Reporting Regulation.
- Data for supporting indicators will now be published at the census tract level where available. Census tracts are small, relatively stable geographic areas that typically have populations between 2,500 and 8,000.
- 3 new supporting indicators have been added to the 2012 reports; Proximity to transit, proximity to services and floor space.

- Due to an aging (2007) and limited sample size of real odometer readings in regional districts outside of Metro Vancouver and the Fraser Valley, transportation data will be withheld outside the Lower Mainland in the release of the 2012 reports. Annual data from the Lower Mainland (AirCare program) has a higher sample size (statistically sound) of real odometer readings which provides the assurance necessary for release.

National and Provincial GHG Reporting – Emissions Sectors and "Memo Items"

Canada produces a National Inventory Report using reporting categories and methodologies for estimating greenhouse gas emissions and removals set out in the United Nations Framework Convention on Climate Change (UNFCCC). GHG emissions and removals are grouped into six sectors: Energy; Industrial Processes; Solvent and Other Product Use; Agriculture; Land Use, Land-Use Change; and Forestry and Waste. See:

- http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

British Columbia also follows UNFCCC conventions and categories, utilizing national and provincial inventory data to produce the B.C. GHG Inventory Report. See:

- http://www2.gov.bc.ca/gov/topic.page?id=50B908BE85E0446EB6D3C434B4C8C106

GHG inventories can include both reported emissions and removals that are "counted" in GHG emission totals, and "memo items" that are not included in the totals but are documented for transparency and GHG accounting purposes.

1.3 Purpose and Structure of the Technical Methods and Guidance Document

This document describes the principles, methods and sources used for collection and analysis of the data used for the 2007-2012 CEEI reports. This document is intended to:

- provide a reference source for ongoing preparation of CEEI reports in a transparent and straightforward manner;
- support local governments' understanding of the methods used to report energy and GHG emissions;
- support local governments interested in accessing and utilizing energy and GHG emission data to develop or review targets, policies or actions as part of their GHG planning process; and
- identify improvements in data collection and analysis for energy and GHG emissions reporting.

The document also includes background and contextual information, suggestions for using CEEI reports, and the methodologies and data sources for each of the sectors included in the 2007-2012 CEEI reports.

2 CONTEXT FOR CEEI REPORTING

This section provides brief summaries and links to some of the best practices internationally that underlie community-level GHG emissions reporting, and a summary of related British Columbia GHG inventories.

2.1 Protocols and Guidance for Community Inventories

At its outset, the CEEI reporting framework had little international guidance; however, a number of national and international level documents have been developed over the past several years that support or describe community GHG emissions inventories. The recently released Global Protocol for Cities (GPC)[2] is anticipated to become the international standard for cities.

As a result, various efforts have informed the ongoing development of the CEEI reporting framework. They are described briefly below.

2.1.1 Federation of Canadian Municipalities – Partners for Climate Protection

The current standard GHG inventory guidelines for local governments in Canada are provided by the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP)[3]. This guidance document (FCM 2008) has been used by a number of the members of the PCP program across Canada. Members are now encouraged to use the GPC and PCP Protocol: Canadian Supplement to the International Emissions Analysis Protocol. In B.C. as of 2016, more than 70 jurisdictions are signatories to the program.

2.1.2 World Resources Institute (WRI), C40 Cities

In 2014, the World Resources Institute, C40 Cities Climate Leadership Group and ICLEI – Local Governments for Sustainability (ICLEI) partnered to create a GHG Protocol standard for cities known as Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)[4].

Although earlier attempts at local government-based inventorying were drafted (i.e., by the World Resources Institute/World Business Council for Sustainable Development and by ICLEI) the Global Protocol for Cities (GPC) marks the first true international standard for community-wide greenhouse gas inventorying.

2 http://www.ghgprotocol.org/city-accounting

3 http://www.fcm.ca/Documents/reports/PCP/Developing_Inventories_for_Greenhouse_Gas_Emissions_and_Energy_Consumption_EN.pdf

4 See http://www.ghgprotocol.org/city-accounting/

2.1.3 Other Relevant Organizations or Initiatives

The Climate Registry[5] – may in the future support and recommend the use of other standards for community inventories in support of their members. The Province of B.C. is a founding member and reporter to The Climate Registry.

The Standards Council of Canada[6]– is associated with the International Organization for Standardization (ISO) and provides documentation relevant to GHG emissions inventories through Technical Committee 207 on Environmental Management.[7] One document in particular, *Greenhouse Gases - Part 1: Specification with guidance at the organizational level for quantification and reporting of greenhouse gas emissions and removals*[8], is directly relevant to CEEI inventories. The FCM PCP framework document and the ICLEI protocol both reference this guidance document.

International Panel on Climate Change (IPPC) – methods and standards for emissions inventories are based on guidelines produced by the International Panel on Climate Change (IPCC 2014)[9]. The *IPCC Guidelines for National Greenhouse Gas Inventories* (2006) – provides methodologies for estimating national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases. The scope and detail of this document is not targeted to the local government level, however it does provide overarching generic guidance.

2.2 Related British Columbia GHG Inventory Efforts

2.2.1 Provincial GHG Inventory Reporting

Provincial GHG inventory reporting is intended to provide sound, science-based, comparable and consistent reporting of GHG sources and sinks in British Columbia to support of the *Greenhouse Gas Reductions Target Act* [10] (GGRTA). The Act requires this reporting to fulfill reporting requirements under part 1(4)(a). This reporting is needed to show how the province is meeting the GGRTA legislated targets to reduce provincial emissions by 33% below 2007 levels by 2020 and 80% below 2007 levels by 2050.

The *British Columbia Greenhouse Gas Inventory Report* provides total B.C. emissions estimates which are used to track progress towards emissions reduction targets. The reports, summaries and additional information are available at: http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/provincial-ghg-inventory.

5 www.theclimateregistry.org
6 www.scc.ca/en/web/scc-ccn
7 www.tc207.org
8 ISO (2006), International Standard ISO/TC 207 WG5 N162. Greenhouse Gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. 28pp.
9 www.ipcc.ch
10 See: http://www.leg.bc.ca/38th3rd/3rd_read/gov44-3.htm

2.2.2 B.C. Government (Public Sector) Carbon Neutral Inventories

As part of the provincial government's commitment to achieve carbon neutrality under the GGRTA, provincial public sector organizations (provincial ministries, agencies, crown corporations, health authorities, boards of education and post-secondary institutions) must measure, reduce, report and offset the carbon emissions from their operations. This inventory includes buildings and fleet vehicles owned or leased by public sector organizations, paper use, and in the case of provincial ministries, business travel as well. The requirement to become "carbon neutral" took effect January 1, 2010, and the Province has successfully achieved carbon neutrality every year to date. Refer to the B.C Best Practices Methodology for Quantifying Greenhouse Gas Emissions and Scope Summary for B.C. Public Sector Greenhouse Gas Emissions.

2.2.3 Local Government (Corporate) Carbon Neutral Inventories

A commitment under the BC Climate Action Charter requires local governments to become carbon neutral with respect to their corporate operations by 2012. Corporate operations encompass activities that are under the control of or directly managed by municipalities (such as energy use from buildings, travel and corporate fleets) utilizing data collected and reported by municipalities. Protocols and scope for these inventories have been developed by the Green Communities Committee: a joint committee involving provincial agencies and Union of British Columbia Municipalities (UBCM) members and representatives. The protocols strive to utilize existing inventories and resources to reduce data entry requirements and streamline the "Carbon Neutral Local Government" reporting process.

A "Carbon Neutral Local Government Workbook" has been developed to support municipalities in this effort. Refer to the B.C. Climate Action Toolkit.[11]

11 See: http://www.toolkit.bc.ca/sites/default/files/CarbonNeutralWorkbook.V2_noapdcs_03.12_0.pdf

3 CEEI REPORTING – PURPOSE, PRINCIPLES AND USE

This section documents the intent and framework that underlies the CEEI initiative, as well as some of the uses that CEEI reports can support.

3.1 CEEI Purpose and Objectives

The purpose of Community Energy and Emissions Inventory (CEEI) Reports is to provide local governments and other users with accurate, consistent and relevant community-level (i.e., within the local government's jurisdictional boundary) energy and GHG emissions information.

CEEI reports strive to: (1) meet agreed-to standards; (2) be reproducible across communities and through time; and (3) be available to B.C. local and provincial governments and other agencies in a user-friendly and transparent format.

3.2 CEEI Guiding Principles

The CEEI initiative strives to follow the principles below, consistent with international and North American GHG inventory protocols:

Relevance – CEEIs serve as the primary inventory information resource of energy consumption and GHG for B.C. local governments. The more CEEIs accurately reflect energy consumption and greenhouse gas emissions at the local government community scale, and as a representative suite of supporting indicators are further developed, CEEI reports will increasingly serve the decision making needs of its primary users including councils, staff and community participants. The information is intended to support policy development and planning addressing energy consumption/conservation and GHG reduction initiatives.

Completeness – CEEI generates standardized reports – accounting for key energy and greenhouse gas emission sources and activities within regional district and municipal boundaries. The structure and contents of CEEI reports are guided by international and inter-jurisdictional protocols and standards for reporting sectors, sub-sectors and "memo items" – with supporting sources and any specific "exclusions" noted.

Consistency – Methods and approaches used for CEEI Reporting are documented and consistently applied to enable meaningful analysis of energy and emissions between communities and over time. As data collection and analysis methods improve or are revised, inventory information is revised and duly documented. As inventories evolve (e.g., to include additional sectors and/or sources), "base year" inventory reports are updated to support consistent use of CEEI Reports.

Accuracy – CEEI methods support quantification of energy use and GHG emissions that are systematically neither over nor under actual use and emissions, with reporting uncertainties reduced as far as practicable. CEEI Reports are sufficiently accurate to provide report users with reasonable assurance as to the integrity of the reported information.

Transparency and Confidentiality – CEEI reports are user-friendly and available in an easily readable and understandable format, enabling the facilitation of presentations to Councils and

community participants. Methods and assumptions, including references to accounting calculation methodologies and data sources used in CEEI reports, are documented and accessible to interested users. The CEEI initiative respects the confidentiality needs of data providers and their clients. Data that could be used to reveal unwarranted business or personal information will be aggregated to larger areas or groupings for documentation and reporting purposes. The CEEI initiative respects competitive business rights and confidentiality obligations while striving for transparency to the fullest extent possible. Information related to CEEI reports is subject to the *Freedom of Information and Protection of Privacy* (FOIPP) *Act*.

Continuous Improvement – The CEEI Working Group recognizes that community needs, inventory data sources and reporting methodologies evolve and improve over time. The Working Group strives to continue to improve the accuracy of data collection and analysis methods, on an ongoing basis. CEEI reports and their supporting materials provide information on data gaps and assumptions as well as planned improvements. Where modifications or additions are incorporated in CEEI Reports, supporting materials are updated and appropriate recalculations are undertaken to maintain consistency in reported emissions and emission trends.

3.3 Use of CEEI Reports

Local governments committed to reducing greenhouse gases and acting on climate change can utilize CEEI reports to fulfill a number of specific commitments or responsibilities, including:

- meeting one of the three voluntary commitments made by communities that are signatory to the Climate Action Charter[12] –to measure and report on community-level emissions;
- meeting "Milestone One" of the Federation of Canadian Municipalities Partners for Climate Protection (FCM-PCP) program[13] – an approved community energy and emissions framework;
- supporting local governments in their obligations under the *Local Government (Green Communities) Statutes Amendment Act* (2008) to develop GHG targets, energy policies and actions in Regional Growth Strategies, Official Community Plans or other local government-led plans or policies; and
- providing the provincial government, and other agreed-to users, with information on local government contributions towards reducing energy consumption and greenhouse gas emissions including the Province's target of reducing GHG emissions by 33% from 2007 levels by 2020 and interim reductions targets.

12 See: http://www.cscd.gov.bc.ca/lgd/greencommunities/climate_action_charter.htm The Climate Action Charter acknowledges the shared goals of the Province of British Columbia, Union of B.C. Municipalities and signatory local governments, and the collaborative effort required between all parties to reduce GHG emissions. As of February 2014, 182
B.C. local governments and the Islands Trust are Charter signatories.

13 The program includes over 70 B.C. participating communities and over 250 across Canada. For additional information, see the FCM website: http://www.fcm.ca/home/programs/partners-for-climate-protection.htm

Benefits and uses of CEEI reports include:

- **A Recognized Inventory** – The common format and the supporting documentation of inventory and data analysis of CEEI reports provides individual local governments with an accepted and broadly understood reporting methodology, without resorting to contract or staff resources. Individual communities are also able to enhance or supplement CEEI reports as desired to meet additional information needs.
- **Forecasting** – Initial CEEI reports provide a "snapshot" (or "base year") of energy and emissions information, and over time will provide trend data that can be used to assess assumptions and accuracy of forecasts and actions intended to influence emissions – CEEI community-level data can be used to develop and assess the utility of alternative forecasts or scenarios (e.g., using building and transportation data and emissions factors and population growth assumptions to roughly forecast energy and emissions levels into the future).[14]
- **Target-setting** – The provincial government has set targets of a 33% reduction in province-wide GHG emissions by 2020 and 80% by 2050 (from a 2007 base year). Subsequently, It prepares a provincial inventory report (beginning with 2007 emissions) to support documentation and assessment of province-wide progress towards those targets. Similarly, CEEI reports can be used to support municipal governments in setting targets and assessing initiatives towards their achievement.[15] Provincial legislation requires all local governments to include GHG reduction targets, policies and actions in their Official Community Plan (OCP) or Regional Growth Strategies (RGS).
- **Target Periods** – As well as longer term targets, the provincial government has set interim goals and target dates (2012, 2016, 2020) for GHG emissions reduction. CEEI reports will be produced biennially, providing communities with the flexibility to set target periods in common with the Province or choose other dates aligned with community-specific needs or processes (such as OCP or RGS review).
- **Developing Action Plans** – The CEEI reports can provide a broad structure (i.e., sector and activity categories) to support communities in determining which actions to pursue in reducing energy and GHG emissions. A prioritized listing and description of actions comprise the core of any community energy and emissions plan.[16]
- **Monitoring** – Biennial CEEI reports allow communities to monitor the progress they are making in reducing energy consumption and GHG emissions. While the reports enable comparisons among jurisdictions, analysis and comparison should be undertaken with caution, as community-level emissions can vary with regional and local conditions such as weather and economic factors. Data limitations may also constrain reporting of community-level emissions trends. The effectiveness of CEEI reports in this regard will be reviewed and addressed as part of the Working Group's commitment to continuous improvement.

14 Over one-third of B.C. communities and practitioners have already used GHG modelling techniques to develop future scenarios of community-level energy consumption and greenhouse gas emissions.

15 The Climate Action Toolkit – www.toolkit.bc.ca – showcases a number of success stories (case studies) on how such modeling has supported communities to identify GHG targets, policies and actions.

16 The Province commissioned the Community Energy Association to develop the Community Energy and Emissions Planning Guide for local governments. See the introductory CEEI page on the Climate Action Toolkit website for more

4 CEEI REPORTING FOUNDATIONS

4.1 Greenhouse Gases and Emissions Sources Included in CEEI

Greenhouse gases include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and hydrofluorocarbons (HFCs). CEEIs include only carbon dioxide, methane, and nitrous oxides. Fluorinated organic GHG emissions (e.g., PFCs, SF_6, and HFCs) are not included in CEEI reports as they are relatively insignificant "community-level" emission. At the community level the main sources of emissions are: (1) the burning of fossil fuels for carbon dioxide emissions; (2) automobile exhaust for nitrous oxide emissions; and (3) landfills for methane emissions.

CEEI reports include three main sources of GHG emissions:

1. **Direct emissions** from the burning of fossil fuels;
2. **Indirect emissions** from the production of electricity at electricity generation plants; and
3. The decomposition of biomass to greenhouse gases (including CH_4 and CO_2) in landfills (i.e., "**landfill gas**").

Direct emissions are the result of consumption of an energy type by an end user and introduction of the GHG directly into the atmosphere. Indirect emissions are the result of consumption of an energy type by an energy utility upstream of consumption by the end user. For example, the use of natural gas to fire a boiler and heat a building or of gasoline by a vehicle driver creates a direct emission, whereas the use of electricity by an end user (e.g., to heat a building or to charge a battery) creates an indirect emission.

Emissions are currently reported on for four primary sectors:

1. **Building sector** - the natural gas and electricity consumed by end users and the resulting calculation of direct and indirect GHG emissions.
2. **On-road transportation sector (Lower Mainland)** - uses direct estimates of GHG emissions produced by vehicles licensed on the road.
3. **Community solid waste sector** - uses methods to estimate direct GHG emissions produced by the decomposition of organic matter in landfills (and to a lesser extent, the GHG emissions associated with the incineration of solid waste).
4. **Land-use change from deforestation** – uses air photo interpretation to estimate GHG emissions produced from deforestation.

In addition to the four primary sectors, the reports include additional information ("memo items") at the regional district level for large industrial facilities and enteric fermentation from agricultural livestock. Finally, each report includes a listing of seven supporting indicators, which include housing type, mode of commute to work, residential density, parks and protected greenspace area, average floor space, proximity to services and proximity to transit.

4.2 Units of Measure – Emissions, Coefficients and Global Warming Potential

Standard unit of measurement - is the unit used to report greenhouse gas emissions is "equivalent CO_2" (CO_2e) in units of mass. The unit of mass depends upon the scale of the emissions. CEEI reports GHG emissions in tonnes CO_2e.

Emission coefficient - is a numerical value that quantifies the amount of GHGs released into the atmosphere from a specified source. Coefficients are expressed as the mass of pollutant emitted per source unit. All sources have one or more associated emissions coefficient(s). There is one emissions coefficient for electricity, whereas there are three emissions coefficients for natural gas – one for each of the constituent greenhouse gases (CO_2, N_2O, and CH_4). The total CO_2e for a quantity of energy burned (from natural gas) equals the sum of the three constituent greenhouse gases.

Global warming potential (GWP) – this concept has been developed to enable comparison of the ability of different GHGs to trap heat in the atmosphere (radiative forcing).[17] By definition, the GWP from the release of 1 kg of CO_2 is one, with the GWP of other GHGs stated relative to CO_2. CEEI reporting uses the "100-Year GWP", as recommended by the Intergovernmental Panel on Climate Change, for the major gases and groups of gases[18] :

Table 1: Global Warming Potential (GWP) for GHGs back to baseline year – Summary

GHG	2007 CEEI Reports 100-Year GWP	Updated 2007 – 2012 CEEI 100-Year GWP
Carbon Dioxide (CO_2)	1	1
Methane (CH_4)	21	25
Nitrous Oxide (N_2O)	310	298
Sulphur Hexafluoride (SF_6)	23 900	22 800
Hydrofluorocarbons (HFCs)	140 – 11 700	92 – 14 800
Perfluorocarbons (PFCs)	2 600 – 50 000	7 390 – 12 200

4.3 Emissions Calculations and Data Sources for the CEEIs

CEEIs are derived from consumption and activity data. Detailed methods and data sources for each inventory sector are described in subsequent sections of this document, with a summary provided below.

17 The term "radiative forcing" refers to the amount of heat-trapping potential for a GHG, measured in units of power per unit of area (e.g., watts per metre squared) that would result from the emission of one kilogram of a GHG to that from the emission of one kilogram of carbon dioxide over a fixed period of time.

18 See: https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

The following generic steps are used to assign and calculate GHG emissions for CEEI reports:

1. Consumption and activity data is received from data providers (if not available from primary sources, data is gathered or derived from other reliable sources).

2. Consumption and activity data is assigned to a local government (unless already provided in appropriate geographically-segregated format, census divisions and census subdivisions) based on information embedded in the data received or gathered from other sources.

3. Consumption and activity data are converted to standard units – using the emissions factors and global warming potentials for each fuel source or direct emission included in CEEIs.

Buildings - energy and GHG emissions figures from electricity, natural gas, and piped propane use are based on energy consumption data ("actual") provided by BC Hydro, FortisBC, Pacific Northern Gas, and various smaller utilities. Community-level consumption and emissions for heating oil, propane and wood is derived by first estimating the total energy required for heating and other uses, and then subtracting the electricity and gas consumption from this total. The remainder is then attributed to heating oil, propane or wood – using a ratio for each based on other available data.[19]

On-road transportation emissions - are based on activity data (e.g., the number and type of vehicles licensed for on-road use) provided by the Insurance Corporation of British Columbia, fuel consumption rates published by Natural Resources Canada and estimates of vehicle kilometres travelled (based on odometer reading data).

Community solid waste (landfills) emissions - are based on estimates of landfill gas production calculated from the mass of solid waste tipped at landfills and attributed to contributing municipalities and unincorporated areas. For 2007-2012 CEEI reports, these data were obtained from either regional district staff or other resource materials.

4.4 Description of Sectors and Supporting Indicators

The sectors in each report and the data included in each sector are described below.

- **Building sector-** is subcategorized into residential and commercial/small-medium industrial. Large industrial facilities have been separated out from the core CEEI reports, but still listed as a memo item for local government information. Most subcategories includes the number of connections, the amount of actual (not normalized[20]) energy consumed (e.g., electricity (kWh)

19 For access to the report "Residential Heating Oil, Propane, and Wood Heat Estimates for BC Communities", December 2009 by Enerficiency Consulting for the CEEI Working Group; please contact climateactionsecretariat@gov.bc.ca

20 Normalization refers to a process that removes the effect of outside influences (e.g., weather, fuel prices, economic conditions) on the use of energy in buildings year-over-year. For example, energy consumption is normalized for weather by removing the effects of abnormal winters or summers. Actual energy consumption is required under prevailing community inventory protocols, so normalization is not used.

and natural gas (GJ)), and the resulting CO_2e totals for each building subcategory as well as a CO_2e subtotal for the sector. Rough estimates for residential heating oil, propane and wood use have also been included where considered significant.

- **On-road transportation sector (Lower Mainland)** - is subcategorized into several vehicle classes. Each subcategory includes an estimate of the amount of fuel used (e.g., gasoline, diesel, and propane), and the resulting CO_2e totals for each vehicle class as well as a CO_2e subtotal for the sector.
- **Solid waste sector** - states the estimated mass of waste disposed by each local government based on data available from community and/or regional landfill(s), with the associated CO_2e (methane) net of any known landfill gas flaring, capturing, etc.
- Land-use Change from Deforestation - estimates of hectares deforested broken down into development categories along with resulting CO_2e emissions.
- **Grand total** - lists the amount of energy and CO_2e of core items (not including memo items) for each energy type and direct emission source, as well as the total combined energy and CO_2e.
- **Supporting indicators** - Seven supporting indicators are provided within each local government's CEEI report to begin to monitor the extent to which local government policy tools and associated efforts will have an impact within each CEEI sector.

4.5 Local Government Boundaries Used for CEEI Reports

The boundary of a local government jurisdiction is a defined geographic unit. In accordance with protocols, CEEIs for local governments can only include energy and emissions data from sources that can be ascribed to specific geographic units. British Columbia "local government" units include 28 Regional Districts, one Region (Stikine) and 162 Municipalities. Municipalities can be incorporated under the following names: City, District, Town, Village, Indian Government District, Island Municipality, Mountain Resort or Resort.

Regional Districts are also described as "census divisions."[21] "Census subdivisions"[22] include municipalities and unincorporated areas within Regional Districts. "Indian Reserves" (defined under the *Federal Indian Act)* and "Indian Settlements" (located on Crown Land) are also identified as census subdivisions.

CEEI reports are provided for Regional Districts and Regions, Municipalities, and Unincorporated Areas. Unincorporated Areas reports include all census subdivisions that are not incorporated as municipalities within a Regional District or Region, including Indian Reserves and Indian Settlements. Due to the unique nature of the Islands Trust federation of local island governments, separate reports are produced for the individual areas within.

21 The term "census division" (CD) is: a general term for provincially legislated areas (such as county, municipality and regional district) or their equivalents. Census divisions are intermediate geographic areas between the province level and the municipality (i.e., "census subdivision").

22 "Census subdivision" (CSD) is the general term for municipalities (as determined by provincial/territorial legislation) or areas treated as municipal equivalents for statistical purposes (e.g., Indian reserves, Indian settlements and unorganized territories).

Table 2: Type and Count of Census Subdivisions (2011)

Census Subdivision	Count
Incorporated	
City	49
District Municipality	52
Indian Government District	2
Island Municipality	1
Town	14
Village	43
Unincorporated	
Indian Reserve	419
Electoral Area	158
Nisga'a Land	1
Nisga'a Village	5
Indian Settlement	3

5 RESIDENTIAL COMMERCIAL AND INDUSTRIAL BUILDINGS SECTOR

5.1 Protocol and Guiding Principles

Protocols for community greenhouse gas emissions suggest that local government inventories include: (1) all direct emissions from fuels that are burned within the local government's geopolitical boundary; and (2) all indirect emissions from electricity that is produced by burning fuels inside or outside of the geopolitical boundary. The CEEI buildings sector indicators utilize methods and data that follow these guidelines. Table 3 presents an assessment of the methods and data for the buildings sector against guiding principles.

Table 3: Alignment of Buildings Sector Information with Guiding Principles – Assessment of 2007-2012 Methods and Data

Guiding Principles*	Alignment with Principles	Notes
Relevance	High	The GHG sources are appropriate for the intended user.
Completeness	Moderate to High	All relevant information is included with the exception of energy consumption in some industrial and commercial facilities that exceed the data provider's thresholds for confidentiality.
Consistency	Moderate to High	Meaningful comparisons are possible for most building subsectors.
Accuracy	Moderate	Bias and uncertainties are reduced as far as is practicable although estimates for heating oil, delivered propane and wood use lessen the accuracy of some local government inventories.
Transparency and Confidentiality	High	Sufficient and appropriate GHG-related information is disclosed, with the exception of energy consumption in some industrial and commercial facilities that exceed the data provider's thresholds for confidentiality.
Continuous Improvement**	Moderate	Disclosure for a number of large industries should substantially improve with the implementation of existing Reporting Regulation and with realization of individual agreements with large industry.

* ISO 14064-2:2006, Greenhouse Gases – Part 2: Specifications with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements

** Continuous improvement is additional to ISO Principles. This principle will monitor the progressiveness of the CEEI initiative over time.

5.2 Components Included and Excluded

All utility provided electricity, natural gas, and piped propane consumed within a local government boundary is included in CEEI inventories where confidentiality rights permit. Estimates of heating oil, delivered propane and wood are also included.

Greenhouse gas emissions from non-energy industrial processes (such as chemical reactions during the production of industrial goods) were not included in 2007-2010 CEEI inventories as this data in neither available through the utilities nor subject to significant influence from local governments. Self-generated electricity (e.g. industrial on-site generation, solar panels, etc.) were also not included. The 2007– 2012 CEEI reports have expanded the scope of categorical industrial emissions to

represent all of those under reported under the *Reporting Regulation*. Section 5.2.3, Buildings Subcategories provides further details.

5.2.1 Methodology

CEEI reports have been designed to calculate and manage GHG emissions associated with energy consumption in buildings. The methodology for calculating GHG emissions is consistent with the *Greenhouse Gas Protocol*[23] developed by the World Resources Institute and World Business Council for Sustainable Development. CEEI draws upon the BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions to determine emission factors and global warming potentials that are incorporated into its calculations[24]. This includes indirect emissions from purchased electricity and stationary fuel combustion.

Electricity and natural gas consumption data is obtained from energy utilities as described above. The calculation for GHG emissions in buildings is:

energy consumption *x* emissions factor/coefficient *x* Global Warming Potential = CO_2e Equation 5-1

Total energy, reported in GJ, for each of the residential, commercial and industrial subsectors is based on the consumption of electricity and natural gas for each connection. For residential and commercial subsectors, "connection" refers to number of customers, while for industry, "connection" refers to the number of facilities.

Large industrial facilities are required to quantify emissions under British Columbia Reporting Regulations, according to the Western Climate Initiative Essential Requirements for Mandatory Reporting – Canadian Harmonization Version[25]. More details on industrial emissions are provided in 5.2.3, Buildings Subcategories.

5.2.2 Heating Oil, Propane and Wood

Consumption data from electricity, natural gas and piped propane use is directly available from utilities, but data on the usage of heating oil, delivered propane and wood is not. Therefore, these emissions are estimated in the CEEI reports. As a result, data for these fuels **should be used with caution.**

Estimates are derived from the number and type of dwellings within each jurisdiction and the average dwelling consumption by region from the BC Hydro Conservation Potential Review. Actual electricity and natural gas consumption are subtracted from the total, with the remainder assumed to be heating oil, propane, or wood. A more detailed explanation is provided in the report; Residential, Heating Oil, Propane and Wood Consumption Estimates for B.C. Communities.[26] Due to accuracy limitations, data is withheld when wood, oil and propane are less than 5% of total emissions.

23 World Resources Institute and the World Business Council for Sustainable Development. The Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard. Revised Edition.
24 http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology_for_quantifying_ghg_emissions.pdf
25 http://www2.gov.bc.ca/gov/content/environment/climate-change/stakeholder-support/reporting-regulation/quantify-emissions
26 For access to the report "Residential Heating Oil, Propane, and Wood Heat Estimates for BC Communities", December 2009 by Enerficiency Consulting for the CEEI Working Group; please contact climateactionsecretariat@gov.bc.ca

5.2.3 Buildings Subcategories

Although this sector is titled "buildings", energy consumption data reported within its individual subsectors such as electricity and natural gas may be used for purposes other than consumption within a building. For example, commercial electrical energy consumption data includes streetlights in its calculations.

Energy consumption data in the buildings sector is organized into the following subsectors:

1. **Residential buildings -** are defined as buildings occupied as people's residences, but not necessarily occupied as a residence full-time. This subsector includes single family housing, row housing, multi-family housing and other housing types (such as mobile homes and cottages). Note that most large multi-family buildings are charged for natural gas under a commercial rate and have been included in the commercial/small-medium industrial subsector.
2. **Commercial and small to medium industrial buildings -** are reported as a single category as it is difficult to clearly delineate further subcategories within this group. This subsector includes offices, commercial retail outlets, government buildings (such as schools and hospitals), other institutions and small to medium industrial facilities. This category also includes any other customers that do not fall under the residential or large industrial subsectors. These include irrigation and streetlights.

Large industrial: Changes between 2007-2010 reports and 2012 reports.

a. **2007-2010 –** Electricity use in this subsector was previously defined as an industrial customer using more than 7 GWh per year. For natural gas the definition is based on the rate structure which the customer is charged under. In some cases, institutions purchasing gas at industrial rates would be classified as an "industrial customer" as a result.

b. **2012 –** The industrial sector is now defined as facilities that report under the *B.C. Reporting Regulation*[27], which sets out the requirements for greenhouse gas emissions reporting from B.C. facilities emitting 10,000 tonnes or more of carbon dioxide equivalent emissions per year. While large emitters were previously broken down by natural gas and electricity energy consumption and emissions in a single large industrial category, they will now be further disaggregated by industrial categories and categorical emissions as seen in table 4.

The energy consumed and the related greenhouse gas emissions are shown for each subsector, along with the number of connections or accounts reported by the utility.

27 http://www.bclaws.ca/civix/document/id/loo92/loo92/272_2009

Table 4: Industrial Categories and Categorical Emissions

Industrial Categories
Agriculture Food and Products
Cement and Lime
Electricity and Heat Generation
Forest Products
Manufacturing and Refineries
Mining and Smelting
Oil and Gas
Waste Treatment

Categorical Emissions
Total Stationary Combustion
Total Industrial Process
Total Flaring
Total Venting
Total Fugitive
Total On-site Transportation
Total Waste
Total Wastewater
Total Combined Industrial Process and Stationary Combustion
Total Emissions
Total Emissions from excluded biomass (tonnes CO2e)

5.3 Data Sources

There are four significant electricity and natural gas utilities in the Province, as well as a number of smaller utilities. Where possible, each utility provides consumption data for their respective customers within local government boundaries in British Columbia.

Table 5: Energy Types Provided by Supply/Distribution Companies

Supplier/Distributor	Energy Type	Region Served
BC Hydro	Electricity	BC
FortisBC - Electricity	Electricity	Southwestern BC
Fortis BC - Natural Gas	Natural Gas and Piped Propane	BC
PNG	Natural Gas and Piped Propane	Northern BC
Nelson Hydro	Electricity	Nelson and area
City of Kelowna	Electricity	Kelowna
City of Summerland	Electricity	Summerland
City of Penticton	Electricity	Penticton
City of Grand Forks	Electricity	Grand Forks
City of New Westminster	Electricity	New Westminster
Princeton Power and Light	Electricity	Princeton and area

Supplier/Distributor	Energy Type	Region Served
Sun Peaks Utilities	Piped Propane	Sun Peaks
Port Alice Gas	Piped Propane	Port Alice
Big White Gas	Piped Propane	Big White (KBRD)
Star Gas	Natural Gas	Silver Star (NORD)
Cal-gas	Piped Propane	Canyon Ridge (Golden)
Corix	Piped Propane	Panorama (EKRD)
Silversmith Power & Light	Electricity	Sandon (RDCK)
Yukon Electric	Electricity	Stikine

Note: Princeton Power and Light was purchased by Fortis BC in 2007.

For large emitters in 2012, data was obtained directly from the industrial facility greenhouse gas emissions report summaries reported through the *BC Reporting Regulation*[28].

5.4 "Withheld" Data - Confidentiality Issues

Energy utilities are responsible for the confidentiality of customer information. As a result, utilities will withhold data when a single customer exceeds 50% of the local government's total consumption in the subsector to which it belongs.

Large industrial customers may dominate energy consumption within a municipality (e.g., census subdivision) or regional district (e.g., census division). Examples of these large industrial customers include cement plants, pulp and paper mills, saw mills and mining operations. In most of these cases, energy utilities withhold all consumption data so that a large industrial operation's energy consumption cannot be reverse calculated, or factored out, of the totals. Therefore, industrial data for a number of 2007-2010 CEEI inventories was withheld. However, starting in 2012 (with data available back to 2010), data from *B.C.'s Reporting Regulation* has allowed the reporting of any industrial facility subject to the regulation.

This is one of the primary reasons that large industrial facilities are considered as a "memo item" in the CEEI reports. From 2007-2010 where energy consumption data in the industrial sector has been withheld by the utilities, the number of connections appears within the industrial listing, but is annotated as "withheld" to indicate that cannot be provided. In the 2012 reports, the number of connections for large industrial facilities represents the number of facilities that reported under the regulation in that regional district.

5.5 Data Accuracy

Most data provided by the utilities is considered to be very accurate overall. There may be some errors in assigning consumption to the correct local government but these are not considered to be significant in most cases[29]. However, there is accuracy issues associated with the manner in which the utilities assign customers to building subcategories (e.g., residential, commercial, and industrial).

28 http://www2.gov.bc.ca/gov/content/environment/climate-change/reports-data/industrial-facility-ghgs

29 For 2012, Fortis BC switched to a new data collection system which does not seem to align with municipal boundaries as well as the previous data. Therefore some regional have had to have 2012 natural gas data adjusted for each municipality to align with 2010 data. CEEI is working with Fortis to resolve this issue in future years.

The most significant of these is that multi-family buildings are often considered to be 'commercial' by gas utilities. A related accuracy issue is the assignment of mixed use buildings without separate metering.

Unlike the utility data, the wood, heating oil, and delivered propane consumption is estimated based on typical residential consumption values. These estimates are considered to have low accuracy and be quite rough. Caution should be used with these consumption values.

Data used in *B.C.'s Reporting Regulation* for large industrial facilities is very accurate. Operations that report with 25,000 tonnes or more of carbon dioxide equivalent (CO2e) emissions per year are required to provide a supplementary report including a verification statement from an accredited third party verifier.

5.6 Planned Improvements

The CEEI Working Group is collaborating with BC Hydro and other energy utilities on alternative methods to provide more accurate and comparable CEEI data.

Some of the methodology and data issues in this sector may be resolved with the completion of "AddressBC". This project is managed by the Integrated Cadastral Information Society (ICIS)[30] and is intended to act as a central, point-based civic address registry for British Columbia that provides precise location of a property, building or access point. Once in place, it is anticipated that users (such as energy utilities) will be able to retrieve address points and locations quickly and accurately.

As the province's utilities look to revise their classification systems to align more closely with each other and with that of the British Columbia Assessment Authority, there may be an opportunity to provide further breakdowns of building subsectors (e.g., categorization of residential buildings into single family detached homes, townhomes, condominiums and apartments).

Since remote communities that rely on diesel generators for electricity should have more in-depth information on diesel consumption, this data may be considered in preparation for undertaking 2014 CEEI reports.

30 See: http://www.icisociety.ca/

6 ON-ROAD TRANSPORTATION SECTOR

6.1 Protocol and Guiding Principles

Protocols for community greenhouse gas emissions suggest that local government inventories include all the emissions from fuel that is burned within the local government's geopolitical boundary. The logic behind the protocol is sensible, as ownership and responsibility for GHG emissions must be assigned to specific local governments in CEEI reports. However, there are practical difficulties in applying the protocol due to the nature of the mobile emissions sources in on-road transportation and specifically in accounting for GHG emissions as vehicles cross geopolitical boundaries.

6.1.1 Methodology Selected

The Province commissioned a background report, *Assessing Vehicular GHG Emissions: A Comparison of Theoretical Measures and Technical Approaches*,[31] to review and assess these alternative approaches for application in CEEI reports. The report considered three approaches (or methodologies):

- **Fuel sales** – relying on records of total automotive fuel purchased within specified geopolitical boundaries. This is the simplest (but not necessarily most accurate) solution for calculating community on-road GHG emissions. However, a province-wide dataset by geopolitical boundary is not available, and furthermore even with such data, difficulties remain in assigning fuel purchased (and the corresponding consumption by a vehicle) to a specific local jurisdiction.
- **Modeling** – involves estimating GHG emissions from within a geopolitical boundary using traffic counts and software (such as EMME/2[32] or TransCAD[33]). While this approach has potential application in large urban centers, the report found this method to be cost prohibitive for application at a province-wide scale.
- **Resident-based** – utilizing the number and type of vehicles registered in a geopolitical boundary, the fuel consumption rate of individual vehicles and an estimate of the annual vehicle kilometres traveled (VKT) by various vehicle classes to calculate GHG emissions by geopolitical area.

The report recommended the *resident-based* methodology, using vehicle registration data, as the most practical, accurate and cost effective province-wide approach for CEEI reporting needs. The specific transportation methodology in the CEEI reports has changed over time while maintaining the resident-based approach as described above. The current methodology uses third-party regional VKT estimates combined with data summarized through the CEEI database.

The resident-based approach provides a much finer level of detail to local governments than other methods, including the type of vehicles present in the community and the average, weighted fuel consumption rates of vehicle classes. This information could support future analysis of related trends and indicators.

31 For access to the report "Assessing Vehicular GHG Emissions: A Comparison of Theoretical Measures and Technical Approaches", please contact climateactionsecretariat@gov.bc.ca
32 See: www.inro.ca/en/products/emme/index.php
33 See: www.caliper.com/tcovu.htm

Table 6 presents an assessment of the on-road transportation sector calculations (using the *resident-based* methodology) against CEEI guiding principles.

Table 6: Alignment of On-road Transportation Sector Information with Guiding Principles – Assessment of 2007-2012 Methods and Data

Guiding Principles*	Alignment with Principles	Notes
Relevance	High	The GHG sources are appropriate for the intended user, although it could be argued that GHG emissions are not accurately assigned to geopolitical boundaries because the VKT used in the fuel calculation is not confined to a geopolitical boundary.
Completeness	Low	The estimates include on-road transportation within the Lower Mainland with a focus on passenger vehicles. The estimates do not include marine, rail, aviation, and other off-road transportation.
Consistency	High	Meaningful temporal comparisons will be possible.
Accuracy	Moderate	Passenger vehicle VKT estimates are statistically sound, with bias and uncertainties reduced as far as is practical. Validation of results is not yet possible at the level of census subdivision (e.g., municipality). Commercial vehicle fuel efficiency and VKT are based on North American default values.
Transparency and Confidentiality	Moderate to High	Sufficient and appropriate GHG-related information is disclosed with the exception of individual ICBC registration data that could compromise the privacy rights of registrants.
Continuous Improvement	Moderate	Streamlined calculation methods and increased transparency have been made for 2012.

* ISO 14064-2:2006, Greenhouse Gases – Part 2: Specifications with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements

6.2 Components Included and Excluded

Vehicles included in CEEI reports are grouped into vehicle classes in the on- road transportation sector using a number of criteria (see Methodology). CEEI reports for 2007-2012 vehicles that are licensed for use on public roads. Vehicles that are not licensed to operate on public roads are not included in CEEI reports. Such vehicles include golf carts, snowmobiles, farm vehicles, road construction vehicles and other industrial machinery.

CEEI reports do not include:

- marine transportation such as ferries, recreational boats and commercial ships;
- transportation of people and freight on rail lines running through local government boundaries; or
- air transportation from airports (note: the energy in buildings and on-road vehicles associated with airports is however, included in the buildings sector).
- transportation data outside of the Lower Mainland

One or more of these modes of transportation may be added in the future depending upon local government information needs and future community greenhouse gas emissions protocols, (see section 6.6 Planned Improvements).

6.3 Methodology

The 2007-2012 CEEI transportation data is calculated in order to best represent the GHG emissions associated with fuel consumed by vehicles. The methodology used to calculate the GHG emissions from fuel consumption data is consistent with the Greenhouse Gas Protocol[34] developed by the World Resources Institute and World Business Council for Sustainable Development.

6.3.1 Fuel Consumption

Individual vehicle registration data, fuel consumption rates, and vehicle kilometers traveled are used to calculate fuel consumption using the following formula

vehicle X proportion of year insured X fuel consumption rate X quarterly vehicle kilometers traveled = fuel consumed **Equation 6-1**

Fuel consumption data is grouped into vehicle classes (see *4. Group the Vehicles into Classes*) and placed into geopolitical boundaries (see *6. Place Vehicles into Geopolitical Boundaries*).

Fuel consumed is calculated using the following nine steps, described in detail below:

1. Filter the Vehicle Registration Data
2. Identify vehicle characteristics using VIN and other data fields
3. Group vehicles into sub-sectors
4. Match the characteristics to the NRCan Fuel Consumption Rate
    - In the case of vehicles that are undefined by NRCan, a default Fuel Consumption Rate is applied
5. Calculate reference-case average VKT by sub-sector and insurance type from AirCare odometer data
6. Assign VKT to individual vehicles
7. Calculate Fuel Consumption for each individual vehicle by using the formula above
8. Place vehicles into organizational units by postal code in the Lower Mainland
9. Summarize total fuel consumed by sub-sector

Step 1. Combine and summarize the Vehicle Registration Data

Vehicle registration data is received in quarterly sets from the Insurance Corporation of British

34 World Resources Institute and the World Business Council for Sustainable Development, The Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard. Revised Edition. http://www.wri.org/publication/greenhouse-gas-protocol

Columbia (ICBC) and is combined and summarized into an annual dataset. Each record in the dataset represents a unique vehicle. Changes to a vehicle's insurance policy however, will create another occurrence of the vehicle in the dataset. For example, if ownership of a vehicle changes once during the year, two records for the same vehicle will appear in the dataset. If the vehicle record includes a change of location during a quarter, the vehicle is assigned to the location where it was insured for the greatest portion of the quarter.

Each vehicle record includes percent time insured for the specific characteristics of the associated insurance policy. If the insurance policy changes, the percent time insured under each policy is reflected in the dataset. If the insurance policy of a vehicle is cancelled, and no other insurance policy on the vehicle is registered, the vehicle does not appear in subsequent quarterly datasets. If a storage policy is taken out on a vehicle, the vehicle appears as a record in the dataset, although the vehicle is not included in the fuel consumption estimates for the percent of the year for which the storage policy was in effect.

With this information, CEEI inventories reflect the total number of vehicles licensed on the road in the Lower Mainland in the 2007, 2010 and 2012 calendar years, but more importantly, the inventories accurately reflect the amount of time vehicles spend licensed for use on the road in accordance with any changes to insurance policies.

Step 2. Identify vehicle characteristics using VIN and ICBC identification fields

The reports classify vehicles in two broad categories – *personal* and *commercial*. Personal vehicles include small cars, large cars, trucks, vans and SUVs, and are classified based on body style and weight consistent with the NRCan Fuel Consumption Guide. Commercial vehicles are those heavier than 4 536 kg (10 000 lbs), following classifications based on MOBILE 6.2C. These vehicles are separated in the reports into *medium duty vehicles* (Class 3-7), and *heavy duty vehicles* (Class 8a and 8b). This is intended to separate commercial vehicles into those that tend to travel within the boundaries of a region (i.e., medium duty vehicles) and those that tend to travel between regions (i.e., heavy duty vehicles).

ICBC provided records of all vehicles licensed for use on public roads in British Columbia for 2007, 2010 and 2012. Each record represents a unique vehicle, identified by a Vehicle Identification Number (VIN), and information associated with the location of the registered owner of the vehicle and the region in the province that the vehicle is insured to operate.

The VIN is a 17 digit alphanumeric code assigned by the manufacturer. VINs were first described by the International Standards Organization (ISO) 3779.[35] Automobile manufacturers are required by law to affix a VIN to all vehicles manufactured for use on the road.

The coding within a VIN provides critical information that is used to assign fuel consumption rates to individual vehicles and group vehicles into the vehicle classes reported in CEEI.

35 www.iso.org/iso/catalogue_detail?csnumber=9305

ICBC does not decode the VIN of an insured vehicle and therefore, many of the vehicles are not adequately identified to allow a match to a fuel consumption rate. For example, ~355 000 vehicles are described as "Other Type 2 2WHDR" and "Other Type 2 4WHDR" in the 2007 ICBC dataset. Although an average fuel consumption rate could be applied to these vehicles, by decoding their VINs, the vehicles have been matched with the fuel consumption rate reported by NRCan (see below).

The VIN decoder tables link characteristics to each of the first 10 characters of the VIN. The first digit, for example, identifies the location (country) of manufacture, the next three digits (usually) identify the make, model and sub-model; other digits identify the transmission, the fuel type, the engine size, etc.

The characteristics from the VIN decoder are used for light-duty vehicles only. Partial data is available through the decoder but not currently used for medium or heavy-duty vehicles.

For vehicles with VINs that were unable to be decoded (~1.4%), the vehicle is assigned a vehicle type (see Step 4) based on ICBC License Type and vehicle weight.

Step 3. Match the VIN to the NRCan Fuel Consumption Rate

Vehicle characteristics are critical in order to match an individual vehicle to its fuel consumption rate. Since there is no relationship between a vehicle and its VIN in the ICBC dataset and any of the fuel consumption tables utilized, each vehicle must be matched to its corresponding fuel consumption rate.

The VIN of individual vehicles in the ICBC dataset are decoded and the vehicle make and model are matched to vehicles in the fuel consumption tables. This is done to assign vehicle fuel consumption ratings to individual vehicles, as well as to identify vehicle type (see Step 4). In instances where a vehicle's characteristics cannot be matched to a model in the fuel consumption tables, it is assigned a default fuel consumption rate based on vehicle type (see Step 4).

Fuel efficiency ratings for passenger vehicles from 1995 to 2012 are from NRCan 2 cycle fuel efficiency testing. Additional fuel efficiencies for vehicle models prior to 1995 are estimated based on engine size, transmission and other mechanical properties of the vehicle. Fuel efficiency ratings for commercial vehicles are adapted from a US Environmental Protection Agency table of miles-per-gallon estimates by MOBILE vehicle class.

Step 4. Group the vehicles into Classes

Vehicles are summarized into broad categorizations as follows:

- small passenger cars;
- large passenger cars;
- light duty trucks;
- vans and SUVs;
- medium-duty commercial vehicles;
- heavy-duty commercial vehicles;
- buses;

- taxis and limousines;
- motor homes; and
- motorcycles and scooters.

Each class is further broken down by fuel type.

The criteria used to group vehicles into classes are described in Table 7. For light duty passenger vehicles, the NRCan vehicle type classification is used. Where there is no match with the NRCan fuel efficiency tables, vehicle type is assigned based on vehicle weight for small cars or body style for SUVs and vans. Medium and heavy duty vehicles are assigned based on vehicle weight, while all other vehicle types are assigned according to the ICBC licensing.

Table 7: Examples of Vehicles Included in the 2007-2012 CEEI

Vehicle Class	Criteria	Example
Small Passenger Cars	Defined by NRCan as a two seater, minicompact, subcompact, compact, or small station wagon	Honda Civic
Large Passenger Cars	Defined by NRCan as a midsize, full size or mid-size station wagon	Audi A6
Vans and SUVs	Defined by NRCan as an SUV, van or minivan	Dodge Caravan
Light Trucks	Defined by NRCan as a pickup truck	Ford F150
Medium Duty Vehicles	ICBC License Type plus GVW	Ford F350 Super Duty
Heavy Duty Vehicles	ICBC License Type plus GVW	Kenworth Tractor Trailer
Motorhomes	ICBC Licence Type	Gulfstream
Motorcycles and Mopeds	ICBC Licence Type	Honda VFR
Bus	ICBC Insurance Type	Ford E350 Club
Taxi/Limousine	ICBC Insurance Type	Taxi

Step 5. Calculate reference-case average VKT by sub-sector and insurance type from AirCare odometer data

VKT data for passenger vehicles is derived from 2007 (2008 and newer model year vehicles were exempt from AirCare making data more incomplete after 2007) odometer readings from the Motor Vehicle Emissions Inspection and Maintenance Program (AirCare) of the South Coast British Columbia Transportation Authority (Translink).

Odometer readings are first converted into kilometres driven between testing periods for each vehicle and then used in an econometric analysis that related kilometres driven by different vehicle classes (e.g., small cars) to real fuel prices, real per capita incomes, age of vehicles, etc. This econometric approach results in different VKT estimates for each vehicle type and each vehicle model year.

Previously the CEEI reports incorporated estimates in jurisdictions outside of the Lower Mainland based on actual odometer readings from ICBC APV 9T Transfer Tax forms (which are completed

when a vehicle changes ownership). The average for each vehicle class for each regional district was then calculated, as well as the percentage difference between the actual average and the average based on the Fraser Valley coefficients for vehicle class and region. As these estimates were based on a limited sample size back in 2007, the decision was made to withhold the data outside of the Lower Mainland due to concerns on completeness and accuracy. The Province continues to explore other options to improve VKT data.

VKT data for commercial vehicles is taken from the US EPA table of average annual mileage accumulation rates.

Step 6. Assign VKT to individual vehicles

Each individual vehicle is assigned a VKT value. If there is a calculated Aircare VKT for the specific vehicle, that value is used. For all other Metro-Vancouver or Fraser Valley vehicles, VKT is assigned based on vehicle type, fuel and usage.

Heavy duty vehicles and any others that were not assigned a VKT value use the appropriate value from the table of defaults.

Step 7. Calculate Fuel Consumption for each individual vehicle by using the formula above

Using the assigned VKT and fuel efficiency rating for each vehicle, with the portion of the year that the vehicle was insured, annual fuel consumption for the vehicle is calculated using Equation 6-1.

Step 8. Place vehicles into Geopolitical Boundaries in the Lower Mainland

Each unique vehicle is allocated to census division and census subdivision based on the postal code of the registered owner. In some cases postal codes may cross municipal boundaries. For this situation an allocation table was created by overlaying postal code boundaries with municipal boundaries and census population data. A percentage of vehicles assigned to a postal code was then allocated to each municipality or unincorporated area based on this table.

A small number of records in the ICBC data do not contain a postal code (~0.05%) or the postal code of the registered owner is out of province (~0.3%). These vehicles are ignored and are not assigned to a CSD.

Step 9. Summarize total fuel consumed by sub-sector

Individual vehicle fuel consumption is summed for each local government by vehicle type and fuel. VKT is also summed in order to calculate average VKT by vehicle type and fuel.

6.3.2 Greenhouse Gas Emissions

Greenhouse gas emissions are calculated from fuel consumption data using the following formula:

fuel consumption x emissions coefficient x global warming potential = CO2e **Equation 6-2**

In line with the most current GHG quantification methodologies for British Columbia, CEEI draws upon the BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions for emission factors and global warming potential incorporated into its calculations[36]. Section 4.1 of the BC Best Practices document addresses direct emissions from mobile fuel consumption.

6.4 Data Sources

Vehicle Registration Data: vehicle registration data is provided by the Insurance Corporation of British Columbia.

Fuel Consumption Rates: fuel consumption rates for passenger vehicles originate from Natural Resources Canada's fuel consumption tables. Fuel consumption data for commercial vehicles are default values for each age of each vehicle class from the MOBILE 6.2C model of the US EPA. US EPA adjustment factors reflecting the difference between test and real driving conditions (using a built-in algorithm) were incorporated for vehicles older than 2008 model year.

Vehicle Kilometres Traveled (VKT): VKT data (including origin of data) was provided to the CEEI by Pacific Analytics' as described in their letter report of December 22, 2008 – CEEI VKT Study-Part of the CEEI Reporting Initiative.[37]

Postal Code File: postal codes are contained in the Provincial Translation Master File, provided by BC Stats.

6.5 Data Accuracy

Fuel Consumption Rates: the US Environmental Protection Agency (EPA) changed the manner in which it estimates fuel efficiency beginning in 2008.[38] To compensate for real world driving conditions (e.g., faster speeds and acceleration, air conditioning, colder outside temperatures), the US EPA's fuel efficiency data were adjusted. The value for this adjustment would range from perhaps a 5% decline (for Hybrids and other very efficient vehicles) to as much as 10% for larger, less fuel efficient vehicles.

For 2007-2012 CEEI reports, an adjustment algorithm based on individual vehicle city and highway fuel efficiency rates was applied to each vehicle's fuel consumption rate.[39] This adjustment factor was not applied to the fuel consumption rates for vehicles over 4 536 kg (10 000 lbs) NVW as the fuel consumption rates are not the reported values from a manufacturer's test.

Fuel consumption rates for large commercial diesel trucks are considered inaccurate, since these rates are not assigned to vehicles by their manufacturers and larger trucks have such variable loads.

36 http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology_for_quantifying_ghg_emissions.pdf
37 For access to the report "Vehicle Kilometres Travelled Study", please contact climateactionsecretariat@gov.bc.ca
38 Note: the US EPA uses fuel efficiency reported in miles per gallon, whereas Environment Canada uses fuel consumption rates reported in litres per 100 kilometres driven.
39 http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology_for_quantifying_ghg_emissions.pdf

For CEEI, large Commercial Diesel trucks (e.g., Heavy City and Heavy Highway) were estimated using EPA values, and adjusting by GVW, so the values were not outrageously inaccurate.

Vehicle Kilometres Traveled: Estimating VKT involves a degree of error as actual odometer readings are not available for all vehicles.[40] This is an identified data gap and efforts are underway between the Province and other agencies to obtain a more accurate measure of VKT for use in future CEEI reports. While a more reliable measure of VKT is desired, we can be relatively confident about the VKT estimates in the 2007-2012 CEEI reports for the Lower Mainland.

The averages used for larger commercial trucks consuming diesel fuel are questionable and have been provided for use in CEEI reports by Pacific Analytics with a cautionary note.

Placing Vehicles into Geopolitical Boundaries: As vehicle registrations are assigned to communities by postal code, there are problems with overlapping postal codes. The allocation table created by overlaying postal code and municipal boundary maps significantly reduces this problem. However, some errors remain due the size of the census population blocks which are used to build the allocation table. These issues are most noticeable in rural areas using central post boxes.

Vehicles are assigned to a municipality or regional district according to the registered owner's postal code. Some of these vehicles may operate predominantly in other communities. This can be problematic, since vehicles in a commercial fleet may be registered at a single location, regardless of where in the Province they operate.

6.6 Planned Improvements

A priority moving forward will be to determine reliable transportation emissions beyond the Lower Mainland for all of B.C.

Greenhouse gas emissions for marine, rail, air travel and off-road vehicles may also be included in future CEEI reports.

In the next iteration of the CEEI reports we intend to use NRCan's updated 5 cycle fuel efficiency factors. The 5-cycle testing procedure supplements the standard (2-cycle) city and highway tests by integrating three additional test cycles that account for air conditioner use, cold temperature operation and driving at higher speeds with more rapid acceleration and braking.

The Province will continue to explore other options to improve VKT data at the census subdivision level.

40 For access to the report Assessing Vehicular GHG Emissions: A Comparison of Theoretical Measures and Technical Approaches, please contact climateactionsecretariat@gov.bc.ca

7 MUNICIPAL SOLID WASTE SECTOR

Municipal solid waste (MSW) is produced within municipalities and regional districts and disposed at regional landfills and waste incineration facilities. The decomposition of MSW in landfills over time results in the release of embedded carbon as methane (CH_4) under anaerobic conditions (in the absence of oxygen) and CO_2 under aerobic conditions (in presence of oxygen). Combustion of MSW in incineration facilities results in CO_2, CH_4 and N_2O emissions.

7.1 Protocol and Guiding Principles in CEEI

7.1.1 Carbon Neutral Emissions

CO_2 emissions from biogenic[41] MSW decomposition or incineration are considered "carbon-neutral"[42] and not included in GHG totals from municipalities and regional districts. CH_4 and N_2O emissions are included in GHG totals.

7.1.2 Allocating GHG Emissions to Municipalities

GHG emissions from a disposal facility are attributed to the municipality or regional district where the MSW is produced and therefore not necessarily the region where the disposal facility is located. Table 8 presents an assessment of the MSW sector calculations against CEEI guiding principles.

Table 8: Alignment of Municipal Solid Waste Sector Information with Guiding Principles – Assessment of 2007-2012 Methods and Data

Guiding Principles*	Alignment with Principles	Notes
Relevance	High	The GHG sources, "Waste In Place" methodology and attribution are appropriate for the intended user.
Completeness	High	All relevant information is included, though extrapolations were made where historical records were incomplete.
Consistency	Moderate to High	Results are provided consistently for each regional district and municipality. Data used includes a combination of best sources from landfill information, and from attributing data from census attributions.
Accuracy	Low to Moderate	Data is considered to be highly uncertain due to mixed data sources and the varying sophistication of landfill management records, particularly in attributing regional landfill waste to member municipalities.
Transparency and Confidentiality	Moderate	CEEI fully discloses available data and methodological approaches. Not all managed landfills report directly.

[41] The term "biogenic" refers to emissions that arise from the natural carbon cycle and are produced by living organisms or biological processes.

[42] "Carbon neutral" refers to greenhouse gas emissions that result in no net increase in greenhouse gases in the atmosphere over the long term. The carbon portion of organic materials in MSW – biogenic MSW - is derived from CO_2 in the atmosphere, which is absorbed by plant tissue and converted to organic matter. When biogenic MSW decomposes or is incinerated, part of the carbon is released to the atmosphere as CO_2. Thus, the atmosphere sees no net increase in CO_2 emissions.

Guiding Principles*	Alignment with Principles	Notes
Continuous Improvement	Moderate to High	Significant improvements in accuracy are anticipated as landfill gas capture systems are installed and related reporting requirements under the Landfill Gas Management Regulation are implemented.

* ISO 14064-2:2006, Greenhouse Gases – Part 2: Specifications with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements

7.2 Inclusions and Exclusions

The updated 2007-2012 CEEI reports include estimates of the historic annual MSW tonnages disposed of at all regional district landfills and each community's estimated share of greenhouse gas emissions. Inventories include greenhouse gas emissions from:

- landfills;
- unmanaged landfills; and
- incineration facilities. Note: The Metro Vancouver Waste-to-Energy facility is the only facility that has been identified.

CEEI reports do not include GHG emissions from:

- MSW that is not deposited at a regionally operated landfill (for example, a forestry landfill);
- biogenic MSW sent to compost centres (as it decomposes aerobically and releases only CO_2); or
- demolition, land clearing and construction waste (to the extent these amounts were identified and have been separated out of landfill tonnage calculations).

7.3 Methodology

7.3.1 Methane Emissions at Landfills

Two fundamentally different methodologies have historically been used to estimate GHG emissions from landfills – Waste-in-Place (WIP) and Waste Commitment (WC).

7.3.1.1 *Waste-In-Place (WIP)*

WIP is a method used to estimate the actual annual emissions from a landfill based on the decomposition of all MSW previously disposed at the landfill. This method requires information on historical MSW tonnages sent to the landfill and on the decay rate and methane generation potential of the MSW. The decay rate and the methane generation potential varies with precipitation, waste composition and other factors. GHG emissions using the WIP method are calculated using the first-order decay equation presented in the US EPA's Land GEM model and shown in Equation 7-1:

$$E_Y = \sum_{i=1}^{N} \sum_{j=1}^{10} kL_0 \left(\frac{M_i}{10}\right) e^{\left[-k\left(N-i+\frac{(j-1)}{10}\right)\right]}$$

Equation 0-1

where: E_Y is the methane emission (m^3 CH_4) from the landfill in year Y, the year for which the calculations are made
M_i is the mass of MSW disposed in year "i" (tonnes)
j is the time increment in $1/10^{th}$ years
N is the number of years that MSW disposal is accounted for
k is the decay rate (/year)
L_0 is the methane generation potential of MSW (m^3 CH_4/tonne MSW)

Based on this equation, the most recent MSW that is disposed at the landfill will generate the most methane. The further back in time MSW was disposed, the less methane is generated in the year for which calculations are made.

An example is shown in Figure 1 for methane emissions from a hypothetical wet landfill (higher decay rate (k value)) and a hypothetical dry landfill (low k value) in 2010. The graph shows that MSW disposed in 2009 is responsible for about 9% of the methane generated in 2010 for the wet landfill and 2% of the methane generated for the dry landfill. MSW disposed in 1975 is responsible for about 0.5% of the methane generated in 2010 from the wet landfill and 1% of methane generated from the dry landfill.

MSW decomposes much more quickly in wet landfills than dry landfills, as shown in Figure 1. Accurate quantification of GHG emissions from dry landfills requires longer historical time horizons than from wet landfills. In Figure 1, for example, tracking MSW disposed in a wet landfill back to 1975 captures 96% of the GHG emissions from the landfill in 2010. The remaining 4% of emissions are from MSW disposed prior to 1975. For a dry landfill, tracking MSW disposed to 1975 captures only 52% of the GHG emissions from the landfill in 2010, with the remaining 48% of emissions due to MSW disposed before 1975.

For CEEI reports the start year for the WIP calculation of methane emissions for each B.C. landfill is set as 1977 or the year the landfill opened, whichever is more recent. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories[43] suggests using waste disposal data for at least 50 years. However, accuracy gained by historical accounting is offset by the uncertainty and/or lack of data regarding organic solid waste disposal in a landfill. Therefore in British Columbia, given historical data availability and uncertainty, a reasonable compromise between quantification and uncertainty suggests that 1977 is the earliest year to account for in emissions calculations.

43 Intergovernmental Panel on Climate Change (IPCC), 2006. IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, H. S. Eggleston, L. Buendia, K. Miwa, T. Ngara, K. Tanabe, Eds. (Institute for Global Environmental Strategies, Hayama, Japan, 2006).

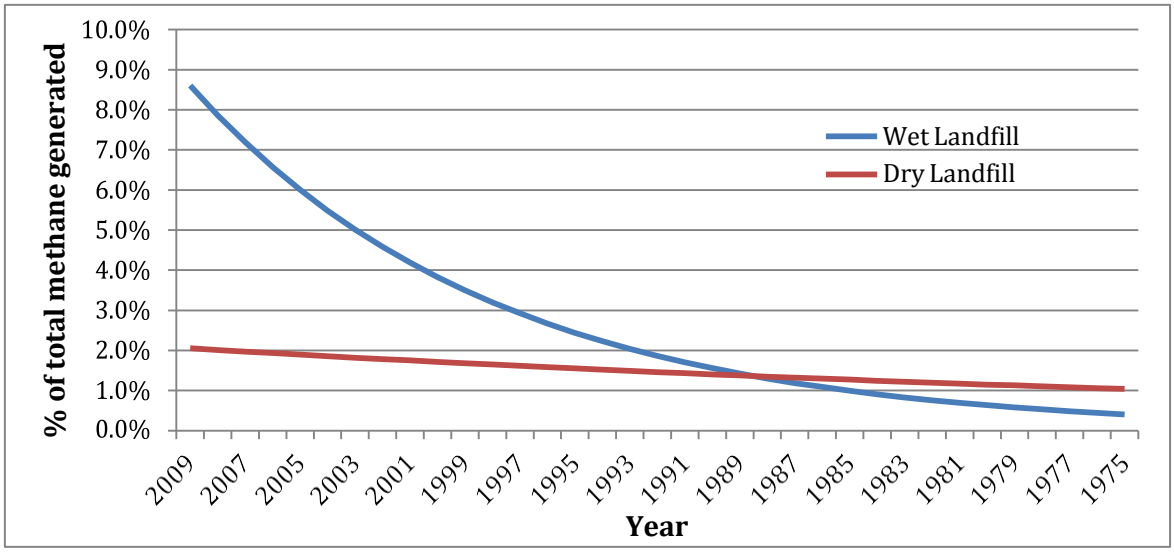

Figure 1: Methane released in 2010 and contributions from historical MSW tonnages

7.3.1.2 *Waste Commitment*

Waste commitment (WC) is a used to estimate GHG emissions in the absence of historical waste data, based on the amount of solid waste disposed of in a given year. Therefore, this method only requires the provision of MSW tonnage data for a single year. GHG emissions are calculated by multiplying the mass of MSW disposed by a standard emission factor, according to Equation 7-2.

$$E = MSW \times EF \qquad \textbf{Equation 0-2}$$

Where: E is the estimated emissions (tonnes CO_2e)
MSW is the mass of solid waste disposed in a given year (tonnes)
EF is the standard GHG emission factor (tonnes CO_2e/tonne MSW)

The waste commitment method is poorly suited for estimating actual annual emissions at a landfill for two reasons. First, it ignores the contribution to emissions of previously disposed waste. Secondly, it assumes that all deposited waste in a year decomposes instantaneously instead of over many years.

7.3.2 Choice of Emissions Quantification Methodology

GHG emissions from landfills reported in the CEEI are estimated using the waste-in-place (WIP) method. This methodology was chosen for the following reasons:

- **Consistency** – the WIP method is used to estimate emissions in the British Columbia Greenhouse Gas Inventory Report (2012) and the Landfill Gas Management Regulation; and
- **Accuracy** – the WIP method complements reporting the other CEEI sectors, providing the best available estimate of emissions over the reporting period (i.e., 2007-2012).

7.3.2.1 *Avoided Waste Emissions*

Currently, CEEI Solid Waste sector reports only on the WIP emissions.

However, a different method other than WIP is needed to demonstrate the avoided future waste emissions. The avoided-waste-emissions (AWE) is attained from reductions in annual MSW disposal resulting in changes to current behavior. For example, if a Regional District reduced its MSW tonnage by 50% between 2009 and 2010, data provided using the WIP method would be misleading as it would only show a small difference (~5%) between 2010 and 2011 GHG emissions estimates.

To more accurately account for avoided future emissions (either organic or inorganic waste being diverted from the landfill), the relevant calculation should cover the avoided waste emissions for the period of significant decomposition of MSW (had it made it to the landfill, that MSW would have emitted significant methane amounts for many years into the future).

In practice, the AWE are calculated for a reference period between the time the waste reduction happened (e.g., diversion from the landfill) and a time period in the future – either a fixed reference period (e.g., 25 years into the future), a fixed reference year (e.g., from present to 2030), or a fixed amount of decomposition (e.g., 90%).

The AWE methodology provides an estimate of avoided emissions using a physically-based, first order decay equation of the same type as the WIP methodology. Combining the two methods presents a dual picture – both the present day effect of our past actions (WIP) and the future effect of our present day actions (AWE). Currently, CEEI Solid Waste sector reports only on the WIP emissions. We will look at GHG emission estimates using the AWE method for future CEEI reports as a supporting indicator[46] for local governments in measuring progress towards emission reductions.

7.3.2.2 *Estimated Values*

Despite the use of various data sources (see equation 7.4 below), significant data gaps remained, both for MSW produced by regional districts and municipalities and MSW tonnages sent to landfills between 1977 and 2012. Two estimation methods were used where data was missing for MSW tonnage sent to landfills for the years 1977 to 2012.

The first method – for cases where the total MSW disposed between 1977 and 2012 had been provided by the Regional District or the Golder Associate Report – utilized equation 7-3 to estimate historical MSW tonnages for specific years:

$$MSW_i = \frac{\left(MSW_{1977-2012} - \sum_j^N MSW_{known,j}\right)}{Y} \times \frac{TPC_i}{TPC_{average}} \times \frac{P_i}{P_{average}}$$ **Equation 0-3**

where: MSW_i is the estimated MSW disposed at the landfill in year "i"
$MSW_{1977-2012}$ is the total reported MSW tonnage disposed at the landfill between 1977 and 2012
$MSW_{known,j}$ is the reported MSW tonnage disposed at the landfill in year "j"
N is the number of years with reported MSW tonnage disposed at the landfill
Y is the number of years with unknown MSW tonnage disposed at the landfill
TPC_i is the MSW tonnage per capita for the Regional District in year "i"
$TPC_{average}$ is the average MSW tonnage per capita for the Regional District between 1977 and 2012
P_i is the population of the Regional District in year "i"

[46] Refer to Section 10 for more information on supporting indicators

Tonnage per capita (TPC) data for each Regional District are primarily from the RCBC Municipal Solid Waste Tracking Reports, which provide data for the years 1990 and 2001-2012. TPC data from 1977 to 1989 are assumed to be the same as 1990. TPC data between 1991 and 2000 are estimated by linear extrapolation between the reported 1990 and 2001 TPC values. 1977 to 2012 population data for regional districts are from B.C. Stats.[44]

The second method – for cases where the total MSW disposed between 1977 and 2012 is not known – utilized Equation 7- to estimate historical MSW tonnages for specific years.

$$MSW_i = TPC_i \times P_i$$ **Equation 0-4**

7.3.2.3 *Determining L_0 and k values*

Methane generation potential (L_0) and methane decomposition rate (k) are key variables in calculating GHG emissions from landfills using the WIP method. These variables can vary significantly between landfills depending on multiple factors, including precipitation, waste composition (especially organic content and moisture content), temperature, pH and buffer capacity, availability of nutrients, waste density and particle size, and landfill characteristics (e.g., depth of landfill, leachate runoff).[45]

Accurate L_0 and k values require detailed site-specific measurements of these variables at each landfill. Site specific data are not available for the large majority of landfills in B.C., and as a result, often L_0 and k must be estimated. The Ministry of Environment published the "Landfill Gas Generation Assessment Procedure Guidance Report" intended for use by landfill managers to estimate GHG emissions from their landfills as required under the Landfill Gas Management Regulation. This guidance document lists default values for L_0 and k (shown in Table 9 and Table 10 below). These stated values assume that when the carbon component of MSW decomposes, it is converted into 50% methane and 50% carbon dioxide.[46]

44 See: http://www.bcstats.gov.bc.ca/Home.aspx

45 See Section 8.2 of Environment Canada's National Inventory Report 1990-2013: Greenhouse Gas Sources and Sinks in Canada

46 Carbon dioxide emissions are not included in GHG totals since they are considered carbon-neutral.

Table 9: Methane Generation Potential based on Waste Characterization

Waste Characterization	Methane Generation Potential (L_0) (m^3 CH_4/tonne MSW)
Relatively Inert	20
Moderately Decomposable	120
Decomposable	160

Table 10: Methane Generation Rate based on Waste Characterization and Precipitation

Annual Precipitation	Methane Generation Rate		
	Relatively Inert	Moderately Decomposable	Decomposable
< 250 mm	0.01	0.01	0.03
>250 to <500 mm	0.01	0.02	0.05
>500 to <1 000 mm	0.02	0.04	0.09
>1 000 to <2 000 mm	0.02	0.06	0.11
>2 000 TO <3 000 mm	0.03	0.07	0.12
>3 000 mm	0.03	0.08	0.13

Appendix A of the Landfill Gas Management Regulation guidance document categorizes different waste types as relatively inert, moderately decomposable and decomposable. MSW composition data and precipitation data for a given landfill can then be used to determine L_0 and k values.

Average L_0 and k values for B.C landfills are determined on the basis of reported compositions. These averages are summarized in Table 11 and Table 12. The average annual precipitation data for the nearest weather station is used to determine k values for each landfill.[47]

Table 11: Average Waste Composition for B.C. Landfills

Waste Characterization	B.C. Average
Relatively Inert	28.0%
Moderately Decomposable	44.7%
Decomposable	27.4%

47 Refer to Environment Canada's Climate Data Archive: http://climate.weather.gc.ca/

Table 12: Average L_0 and k Values for B.C. Landfills

Variable	Average Value
L_0 (m^3 CH_4/tonne)	100
K (/year)	
< 250 mm	0.019
>250 to <500 mm	0.031
>500 to <1 000 mm	0.057
>1 000 to <2 000 mm	0.071
>2 000 to <3 000 mm	0.081
>3 000 mm	0.088

7.3.2.4 *Proportioning GHG Emissions to Municipalities*

MSW composition is collected for CEEI through Ministry of Environment surveys sent to Regional Districts. Where MSW contributions by municipality in 2007-2012 have not been reported by the regional district, they are estimated based on B.C. Stats population statistics, using Equation 7-5:

$$MSW_m = MSW_{RD} \times \frac{P_m}{P_{RD}}$$ **Equation 0-5**

Where: MSW_m is the MSW tonnage attributed to the municipality
MSW_{RD} is the MSW tonnage produced by the Regional District
P_m is the municipality population in 2007-2012
P_{RD} is the Regional District population in 2007-2012

7.3.2.5 *Converting Methane Volume to CO_2-Equivalent Mass*

GHG emissions calculated under the WIP method are in units of m^3 CH_4. To convert to CO_2e units in mass, equation 7-6 is used:

$$GHG_{CO2e,mass} = GHG_{CH4,volume} \times 0.6785 \frac{kg\ CH4}{m3\ CH4} \times 25 \times 0.001$$ **Equation 0-6**

where: $GHG_{CO2e,mass}$ is emissions reported as CO_2e in units of mass (tonnes)
$GHG_{CH4,volume}$ is emissions reported as CH_4 in units of volume (m^3)
0.6785 is the density of methane at standard temperature of 15 deg.C and pressure of 1 atm (kg/m^3)
25 is the global warming potential of CH_4
0.001 is the conversion factor from kilograms to tones.

7.3.2.6 *Landfill Gas Capture*

Several landfills in B.C have a landfill gas capture system in place that reduces GHG emissions from the landfill by capturing and combusting CH_4 while releasing CO_2 emissions. Before attributing emissions to associated regional districts and municipalities, the landfill gas captured in 2007-2012 was subtracted from the total estimated GHG emissions from the landfill.

The primary data source for landfill gas capture in 2007-2012 was obtained directly from regional districts (see data sources below).

7.3.2.7 *Metro Vancouver Waste Disposal and GHG Emissions Allocation*

The Metro Vancouver area produces the largest amount of MSW in the province. It sends MSW to three very different waste disposal facilities:

1. Cache Creek Landfill (dry landfill, k = 0.05)
2. Vancouver Landfill (wet landfill, k = 0.11)
3. Waste-to-Energy Facility (called as mass burn facility)

An emission factor of 0.53 tonnes CO2e/tonne MSW was used for MSW disposal in the Metro Vancouver region in 2012. This factor, which changes annually with changing composition of the waste and changing quantities flowing to the three facilities, is provided by Metro Vancouver.

MSW from each municipality can be sent to any of the three disposal sites as determined by Metro Vancouver. Since a tonne of MSW will produce very different GHG emissions depending on which disposal site it is sent to, it is difficult to precisely assign GHG emissions among Metro Vancouver municipalities.

To address this issue, and at the request of Metro Vancouver, it is assumed that each municipality contributes MSW to each of the three disposal facilities proportionate to its share of population in the Metro Vancouver region. The GHG emissions attributed to municipalities are therefore based on the average from the three disposal sites, allowing their GHG emissions to be reasonably compared to one another. Metro Vancouver calculated the GHG emissions based on their MSW tonnage information and reflects a better representation of the data.

7.4 Data Sources

Historical accounts of MSW tonnage sent to landfills are key input variables in the WIP method for calculating GHG emissions, as well as the contributions of MSW from individual municipalities and regional districts in 2007-2012. Several data sources were used to determine: (1) the MSW tonnages sent to landfills, and (2) the municipalities and regional districts from which the solid waste was produced.

7.4.1 Data Supplied by Regional Districts

A survey was sent to the solid waste managers of each regional district in B.C, requesting the following information regarding MSW tonnages:

- total MSW produced in the regional district in 2007-2012;
- breakdown of MSW produced by municipality and electoral area;
- landfills where MSW was sent in 2007-2012; and
- estimates of total MSW sent to landfills between 1977 and 2012.

Approximately three quarters of regional districts responded to the 2007-2012 surveys –each with varying levels of detail. As most of the largest regional districts responded, accurate information for at least 90% of the estimated total MSW generated in B.C., including both 2007-2012 and historical MSW tonnages, can be accounted for. Alternate data sources (described below) were used for the remainder of MSW tonnages not reported directly by regional district.

In addition to completing the survey, many regional districts publish annual reports on solid waste. These reports often include MSW tonnages generated in the regional district, as well as the landfills where MSW is sent. Data from these reports were used whenever possible.

7.4.2 Data Supplied by Ministry of Environment

The Ministry of Environment maintains internal records of MSW tonnages for regional districts and landfills. Requests sent to Ministry regional offices have resulted in useful information concerning both total MSW tonnages produced by a number of regional districts and MSW tonnages sent to landfills in specific years.

7.4.3 Recycling Council of B.C. Reports

The Recycling Council of B.C. (RCBC) was contracted by the Ministry of Environment to publish "B.C. Municipal Solid Waste Tracking Reports" from 1997-98 through to the 2006 calendar year. These reports include total MSW produced by most regional districts for certain years, as well as MSW tonnages sent to landfills. The reports are somewhat limited as completion of the survey by regional districts was voluntary and not all of the regional districts had extensive MSW tonnage information. In many cases however, relevant information was provided for MSW tonnages between 2003 and 2005, with less complete data for 2006.

7.4.4 Golder Report

In February 2008, Golder Associates was contracted by the Ministry of Environment to produce a report entitled "Inventory of Greenhouse Gas Generation from Landfills in British Columbia". The purpose of the report was to obtain a preliminary indication of GHG production at the 35 largest landfills in B.C. to inform development of the Ministry's Landfill Gas Management Regulation. Included in the report were MSW tonnages sent to each of the 35 landfills from 1977 to 2007, based on whether the data was provided to or estimated by Golder Associates or obtained from Recycling Council of B.C. reports. This data has assisted in the development of the 2007 – 2012 CEEI reports.

7.5 Data Accuracy

GHG emission estimates from solid waste disposal as reported in the CEEI are highly uncertain. There are several reasons for this uncertainty.

First, estimated emissions depend crucially on the L_0 and k values assigned to the landfill. A slight variance in these values results in a large variance in estimated GHG emissions. The majority of L_0 and k values are estimated with only a small number, and are based on a site-specific study. These studies are often limited in scope and do not account for all characteristics of the landfill. Though the determination of L_0 and k values is continually improving, there is still significant uncertainty surrounding the accuracy of the determined GHG emission values.

Second, MSW tonnages produced by regional districts and municipalities are often estimated based on population and tonnage per capita data due to lack of landfill and municipal data provided within the survey. This estimation method is an approximation and actual MSW production may vary significantly from what is reported in the CEEI.

Third, there is significant uncertainty regarding the operational characteristics of landfills operating in B.C. In many cases, there are several unknown variables, including the landfill opening date, historical tonnages sent to the landfill, and the municipalities and regional districts that contribute to the landfill. In addition, there is uncertainty around landfills that may have closed in previous years. If historical MSW tonnages sent to a closed landfill are neither reported nor estimated, then total GHG emissions attributed to a regional district or municipality will be underestimated.

7.6 Planned Improvements

There should be significant improvements in the accuracy of GHG emissions from solid waste disposal in future CEEI reports. The installation of landfill gas capture systems with a certain minimum percentage efficiency required, in accordance with the Ministry's Landfill Gas Management Regulation, will result in substantial data on landfill gas generation rates over the years. These data can be used to significantly improve the accuracy of L_0 and k values for the largest landfills in B.C., thus improving the accuracy of GHG emissions estimates.

In addition, CEEI surveys sent to regional districts will continue and will align with mandatory reporting under the Landfill Gas Management Regulation. As regional districts continue to improve on the completeness of the MSW tonnage data, there will be less reliance on population-based estimates, leading to further improvements in the accuracy of GHG emission estimates.

8 LAND-USE CHANGE – DEFORESTATION SECTOR – 2007 & 2012 ONLY

The 2007-2012 CEEI reports include 2007 estimates of hectares of deforestation for each regional district broken down into agriculture and urban development categories along with resulting CO_2e emissions. The reports also include 2012 deforestation estimates for municipalities and electoral areas further broken down into nine categories (deforestation as a result of hydro, industry, minning, urban development, oil and gas, recreation, transportation, agriculture and foresty). It is anticipated that 2012 deforestation estimates for regional districts will be available once further mapping is completed and compiled.

Deforestation data is now available at the municipal level. Since deforestation is often in the control of municipalities, it is now included within the scope of the CEEI, with the intention to help prompt reductions in the sector.

8.1 Protocol and Guiding Principles

Following international protocols on boundary delineation, all deforestation events and the resulting greenhouse gas emissions are assigned to geopolitical units. In the case of land-use change (2007 only) for the 2007-2010 CEEI reports, the smallest geopolitical unit reported is a census division (e.g., regional district). For the 2007-2012 CEEI reports, the smallest geopolitical unit reported is the municipal level.

Table 13 presents an assessment of the guiding principles for the land-use change for the deforestation sector.

Table 13: Evaluation of Guiding Principles for the Land-Use Change – Deforestation Sector

Guiding Principles*	Relative Compliance	Notes
Relevance	High	Data will be useful for policy proposals related to the *Zero Net Deforestation Act (not in-force)*. Reductions in deforestation count as reductions in emissions under the *Greenhouse Gas Reduction Targets Act*.
Completeness	Low to moderate	Only deforestation data is included. Mapping at a municipal scale is 100% sampling, while regional districts are sampled at lower intensities.
Consistency	Moderate	With completed recalculation of data, spatial and temporal comparisons are possible and meaningful. As the resolution of the method improves over time some temporal comparisons of datasets may become less meaningful.
Accuracy	Medium	Sample rate is small for regional districts and the size of the area sampled is large. Information gathered on municipal data is 100% reflective of the true area. Boundary issues lessen the accuracy of some local government data. Due to variable sample rates, some regional districts may be more accurately estimated than others. Average rates for 2000-2007 have been used to estimate 2007 levels. Average rates from 2008-2012 have been used to estimate 2012

		levels.
Transparency and Confidentiality	High	Sufficient and appropriate GHG-related information is disclosed.
Continuous Improvement	High	Options to reduce uncertainty at the scale of a municipality have been implemented by completion of a mapping program. Further mapping is being conducted to update the regional district estimates for 2012.

*ISO 14064-2:2006, Greenhouse Gases – Part 2: Specifications with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements

8.2 Components Included and Excluded

The 2007-2012 CEEI reports include deforestation but not afforestation or the conversion of non-forested land to forest.

For the purposes of greenhouse gas accounting, deforestation is defined, per UNFCCC protocols, as "the direct human-induced conversion of forested land to non-forested land". Deforestation includes activities such as clearing of forest for urban development or agriculture. Human activities that do not cause a land-use change, such as forest harvesting followed by regeneration of a new forest and natural events such as beetle-killed forests or forest fires, are excluded. Change of land from forest to non-forest due to the impacts of climate change is also excluded. Areas that are deforested and *expected* to be reclaimed (i.e. mines) count as deforestation. In the case of unclear situations such as "brown fields" (cleared forest for potential urban type development, but then sit idle) or log and leave, a judgment call is made, but often this will be considered to be a form of deforestation. When old deforested sites are revisited during quality control processes and they have subsequently been found to have regrown, older estimates are adjusted accordingly. However, changes are now being made to the decision making procedure for much older events (e.g. pre 1990), applying a more case-based criteria to the decision of whether or not a site can be considered 'deforested' or not.

British Columbia uses the same criteria for a deforestation event that Canada uses internationally, which is described as:

1 hectare minimum area, 20 metres minimum width, 5 metres minimum tree height at maturity and 25% minimum crown closure[48]

8.3 Methodology

CEEI uses deforestation emissions data estimated by the Canadian Forest Service (CFS) and Environment Canada in the Environment Canada National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 1990-2013.[49] Satellite images and aerial photographs from various years were compared and interpreted to determine whether or not deforestation had occurred.

48 Crown closure is the proportion of tree canopy overlying the forest floor. "25% crown closure" implies that 1/4 of the ground surface area has tree growth above it.

49 See: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

The CFS chose sample plots to provide reasonable estimates within each terrestrial ecozone[50] across Canada. The CFS sample plot network, including mapped deforestation events, was overlaid with a map of the census divisions to obtain estimates of deforestation. Specific and 100% coverage[51] mapping was completed for municipalities in BC in addition to the CFS's national sampling. The mapping was contracted by BC to CFS specifications, with quality assurance and database management conducted by the CFS.

The Canadian Forest Service models the amount of greenhouse gas emissions from each hectare of land that was deforested based on the general age, type and density of forest prior to deforestation. This information is gathered through satellite imagery and aerial photographs within each combination of terrestrial ecozone and province. These calculations assume that all carbon contained in the forest above ground is released to the atmosphere either during or in the years following a deforestation event.

8.4 Data Sources

The Canadian Forest Service [52] and Environment Canada provide the data for the Land Use Change: Deforestation sector.

8.5 Data Accuracy

The data as reported by provincial staff is considered to be moderately accurate due to inherent uncertainties in mapping, and due to the fact that mapping has been completed to provide estimates at the provincial and national level, but not at the regional district level. To achieve these large-scale estimates, a low sampling rate for most regional districts was used. Samples were designed to provide accurate estimates for large areas (200 kilometres by 200 kilometres), and were not intended to provide accurate estimates at the regional district level. Therefore, estimates at the municipality level are considered to be of higher accuracy than those at a regional district level.

In addition, the information reported in 2007-2010 CEEIs was assigned to the year 2007 from interpretations of 2000 and 2008 satellite imagery and aerial photographs. Information for the 2007 - 2012 CEEI was derived from 2008 and 2012 satellite imagery and aerial photographs. Due to the temporal time scales in which air photos taken, the accuracy level of this data is deemed to be moderate. For additional information on methods employed to determine deforestation mapping, refer to Canada's National Deforestation Monitoring System: System Description[53].

To reduce uncertainties noted in previous CEEI reports, the Canadian Forest Service and the Province of British Columbia significantly updated the sample plot mapping to: (1) completely map municipalities in B.C. for the 2008-2012 time period, (2) extend the deforestation sample plot network; and (3) integrate data from the 2000-2007 time period to improve analysis.

50 Terrestrial Ecozones are a Canada-wide ecosystem classification. B.C. contains three zones (see links under the Environment Canada website). Terrestrial ecozones are on a similar scale to B.C. Ecodomains in the Ecoregions of British Columbia series.
51 Except for the following municipalities: Northern Rockies (Fort Nelson), Hudson's Hope, Tumbler Ridge, Mackenzie and Stewart.
52 http://www.nrcan.gc.ca/forests
53 http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/36042.pdf

8.6 Planned Improvements

Further mapping is being conducted to update the regional district estimates for the 2014 CEEI reports.

9 AGRICULTURE – ENTERIC FERMENTATION SECTOR – 2007 & 2012 ONLY

9.1 Protocol and Guiding Principles

The 2007-2012 CEEI reports calculate enteric fermentation totals using the same titles and emission factors as in the B.C. Provincial Inventory Report which match the National GHG Inventory (NIR) from Environment Canada.

The NIR includes three categories of emissions for the agricultural sector: enteric fermentation, manure management and agricultural soils[54]. It estimates that total emissions in 2012 from the three categories in B.C. were about 2.0 million tonnes of CO_2e (2.0 MT), composed of approximately 0.93 MT CO_2e from enteric fermentation, 0.34 MT CO_2e from manure management, and 0.73 MT CO_2e from soils and pasture, range and paddock manure.

Since CEEI reports are only able to capture enteric fermentation in their calculations for reasons described in Table 14, the inventory of emissions from agricultural sources is incomplete. Therefore, agricultural emissions are included only as a "memo item" and not added into the total emissions for each government area.

Table 14: Evaluation of Guiding Principle for the Agriculture – Enteric Fermentation Sector

Guiding Principles*	Relative Compliance	Notes
Relevance	Low	Local governments have limited influence on livestock populations under the B.C. *Right to Farm Act*. Measures taken to reduce emissions per animal are not reflected in the CEEI calculations. See also "completeness" below.
Completeness	Low	Due to data and scientific challenges as noted in this section, only emissions from enteric fermentation are attributed to agriculture in CEEI reports. Manure management and agricultural soils are not included. This leaves out a significant portion (over half) of the total estimated emissions for this sector.
Consistency	High	Animal populations are taken from the well-established Census of Agriculture. Emissions calculations are consistent with the NIR and IPCC methods.

54 Chapter 6 (Agriculture) of the 1990-2012 National Inventory Report describes how the Agriculture section was developed

Guiding Principles*	Relative Compliance	Notes
Accuracy	Moderate	The Census of Agriculture is believed to be accurate but emissions per animal are based on national figures which do not address regional variation in livestock management systems.
Transparency and Confidentiality	High	Animal populations are from Statistics Canada which follows rigorous legislated methods to ensure confidentiality of its sources. Calculation methods are available and documented in the methods and standards.
Continuous Improvement	Medium	Emissions from manure management and agricultural soils may be added in the future to reflect other types of primary agricultural activities.

*ISO 14064-2:2006, Greenhouse Gases – Part 2: Specifications with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements

9.2 Components Included and Excluded

The 2007-2012 CEEI reports include only enteric fermentation. Manure Management and Agricultural Soils are excluded (see 9.3.2 and 9.3.3 below).

Furthermore, the categories in the NIR do not include all GHG emissions resulting from agricultural operations. For example: emissions from the use of diesel in trucks to deliver hay are included in the transportation sector, emissions from water and space heaters associated with farming industries are included in "buildings" and emissions from diesel used in tractors would be considered an "off-road" emission, meaning that none of these are included in the "Agriculture" sector of CEEI.

9.3 Methodology

9.3.1 Enteric Fermentation

The 2014 National GHG Inventory 6.2.2 states:

"For each animal category/subcategory, CH4 emissions are calculated, by province, by multiplying the animal population of a given category/subcategory by its corresponding emission factor."

CEEI calculates enteric fermentation emissions based on the number of livestock for each regional district where census data is available. Types of livestock include bulls, dairy cows, beef cows, beef heifers, heifers for slaughter, steers, claves, horses, goats, buffalo, pigs and sheep.

For each regional district, the number of animals is multiplied by the estimated methane emissions from each animal (from the NIR) to give total methane (CH_4) emissions. These are multiplied by the methane's global warming potential (25) to determine carbon dioxide equivalent (CO_2e) emissions.

In line with the most current GHG quantification methodologies for British Columbia, CEEI draws upon the BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions for emission factors and global warming potential incorporated into its calculations[55].

9.3.2 Manure Management

The 2014 National GHG Inventory 6.3.1.1 describes the manure decomposition process that results in methane emissions:

"Shortly after manure is excreted, the decomposition process begins. In well-aerated conditions, decomposition is an oxidation process producing CO2; however, if little oxygen is present, carbon is reduced, resulting in the production of CH4. The quantity of CH4 produced depends on manure characteristics and on the type of manure management system".

Manure management is excluded from CEEI because the emissions values used by the NIR do not reflect regional and local variations in the storage and use of manure. Emissions from manure vary considerably with the method of storage, length of storage and moisture content. This variation can greatly affect methane emissions from manure. Therefore, since there is currently no systematic observation of farm practices in B.C, the calculation of manure management at the local and regional level is not able to reflect a sufficient level of reliability within CEEI reporting.

9.3.3 Agricultural Soils

Sections 6.4 and 6.4.1 in the 2014 National GHG Inventory) describe the process by which emissions are generated from agriculture soils as follows:

"Emissions of N2O from agricultural soils consist of direct and indirect emissions as well as emissions from animal manure deposited on pasture, range and paddock. The emissions of N2O from anthropogenic nitrogen inputs occur directly from the soils to which the nitrogen is added, and also indirectly through two pathways: (1) volatilization of nitrogen from synthetic fertilizer and manure as NH3 and NOx and its subsequent deposition off-site; and (2) leaching and runoff of synthetic fertilizer, manure and crop residue. ″

Direct sources of N2O found in soils include the application of synthetic nitrogen fertilizers and animal manure, crop residue decomposition, and the cultivation of histosols[56]. Emissions from agricultural soils are not included due to insufficient information at a local level. Fertilizer sales are a significant factor in determining soil emissions, but these are only released and reported on at a provincial scale. As a result, only one totaled sum of fertilizer sales is available for the entire province of BC, and this makes it an incompatible with CEEI reporting scales which require data specification at the municipal and regional district level.

55 http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology_for_quantifying_ghg_emissions.pdf

56 Histosols is a term that refers to soil composed of mainly organic material.

9.4 Data Sources

CEEI determined livestock counts from the 2011 Census of Agriculture and based emissions calculations on this population data[57]. Livestock counts are based on the number of livestock recorded in B.C. on May 10, 2011.

The Statistics Canada Census of Agriculture is collected every five years as mandated by the *Statistics Act*. It includes most farm animals, and tabulates them by type and local government area.

The Census of Agriculture reports by Census Division (CD) which is equivalent to a regional district (RD) in B.C., and by Census Subdivisions (CSD), which is equivalent to a city, municipality or re- gional district electoral area in B.C.

Animal counts are suppressed (not shown) in the Census of Agriculture totals where they would identify operations of individual farm operators. Most of these suppressions occur at the level of Census Subdivision. Agriculture livestock emissions for cities, municipalities and electoral areas where counts are suppressed due to confidentiality constraints are not included in the CEEI reports.

9.5 Data Accuracy

The Census of Agriculture (as a "census" rather than a sample or model) is intended to be a complete livestock count.

The same estimates of methane emissions from enteric fermentation are used for all Canadian live- stock and therefore do not reflect regional variations, therefore, the level accuracy of this sector within CEEI reporting is deemed to be moderate.

9.6 Planned Improvements

Future versions of CEEI reports may include the other two categories, Manure Management and Agricultural Soils. Their inclusion depends on data availability at a regional district scale, and sufficient accuracy (reflecting local conditions) to make the inventory meaningful.

Future versions of CEEI reports may add higher resolution by reporting by CSD (municipality, city or village). Livestock emissions are the most likely candidate for this as the Census of Agriculture contains information by CSD. Additionally, alternative sources of data will continue to be sought to fill gaps where Statistics Canada data does not suffice.

57 Statistics Canada, 2011 Census of Agriculture, Farm and Farm Operator Data. Catalogue no. 95-640-XWE

10 SUPPORTING INDICATORS

10.1 Guiding Principles

The 2012 CEEI reports include a number of supporting indicators in recognition of the important influence that these community characteristics have on community-wide emission reductions[58]. These indicators can help to inform local and provincial government climate action policy and decision-making by:

- monitoring the effectiveness of local and provincial government GHG reduction policy measures;
- supporting local government to set GHG emission targets in Official Community Plans and Regional Growth Strategies;
- assisting with efforts to model future land use scenarios and their impacts on GHG emissions;
- providing a common set of indicators applicable to all communities across B.C.;
- publicly profiling community progress to encourage community dialogue and friendly competition; and
- complementing other community-driven sustainability indicators.

The list of CEEI supporting indicators was developed through workshops, research and follow up analysis with representatives from BC local governments, provincial ministries, utilities and other stakeholders. Throughout the selection process, preference was given to indicators that best meet the following selection criteria:

- within the influence of local government;
- meaningful (i.e., policy relevant);
- easily understood by a broad range of audiences;
- comparable (i.e., to indicators used by other municipalities, regional districts and others);
- focused on results rather than processes/actions;
- measurable (i.e., data is currently available or could be generated);
- easily, affordably and consistently measured over time; and
- data available from a 3rd party.

A growing number of governments around the world are recognizing the value of establishing indicators and targets to support climate action. Although indicators are important for tracking progress, it is also important to remember that they are a "proxy", and consideration should be given to supplementing them with other more detailed assessments of community characteristics. In addition, an understanding of "local context" is needed to inform local government decision making, and to understand the successes or challenges of individual communities in reducing fossil fuel-based energy use and GHG emissions relative to other jurisdictions.

58 Supporting indicators are not included in the CEEI emissions calculations for each local government.

10.2 Components Included and Excluded

There are seven supporting indicators included in the 2012 CEEI reports:

- **Housing Type:** Private dwellings by structural type;
- **Commute to Work:** Employed labour force by mode of commute;
- **Residential Density:** Population and dwelling units per "net" land area;
- **Parks and Protected Greenspace:** Land area that is parks and protected greenspace;
- **Proximity to Transit (*new in 2012):** Persons, dwelling units and employment within walking distance of a "quality" transit stop/line;
- **Proximity to Services (*new in 2012):** Walk Score® http://www.walkscore.com/CA-BC/
- **Floor Space (*new in 2012):** Average floor area by building category and era.

Commute Distance, "employed labour force by commuting distance", will no longer be reported, as the data in no longer available through the Census or the National Household Survey.

Ten additional supporting indicators (under 5 themes – land use & transportation, buildings, waste & water, land use change, and community & renewable energy) are included in the 2012 CEEI reports as place-holders (i.e. without data) and may be included with data in future CEEI reports:

- **Transit Ridership:** annual per capita transit ridership;
- **Residential Energy Intensity:** average energy use per square metre of floor space;
- **Solid Waste Diverted:** tonnes of solid waste diverted from landfill;
- **Avoided Waste Emissions:** tonnes of CO_2e of future emissions avoided due to reduced waste.
- **Water Use:** per capita water use;
- **Impervious Surface Cover:** % change in impervious surface cover;
- **Tree Canopy Cover:** % change in tree canopy cover;
- **District Energy:** # and energy output (e.g., buildings connected, energy consumed in GJ or kWh) of district energy systems by energy type (e.g. renewable or non-renewable);
- **On-site Renewable Energy:** # and energy output (in GJ or kWh) from households producing and/or consuming on-site renewable heat (e.g., biomass, solar, thermal, geo-ex-change) and/or electrical (e.g., solar photovoltaic, small wind, small scale hydro) energy; and
- **Energy Recovery From Waste:** energy (GJ or kWh) recovered from waste (e.g., from landfill, sewage treatment, industrial operations and farms).

Neighbourhood Level Reporting for Supporting Indicators
CEEI now includes data at the Census Tract level where available.

10.3 Methodology

Housing Type: Total number of occupied private dwellings by structural type of dwelling
Structural type by dwelling defines the characteristics of a dwelling's structure, e.g. a single-detached house, a semi-detached house, a row house, an apartment and a flat in a duplex. Data for Housing Type is collected and reported on every five years in the Census of Canada. The 2012 CEEI reports includes data from the 2011, 2006, 2001 and 1996 Census, where available.

Commute to Work: Employed labour force by mode of commute
Mode of commute indicates the primary mode that employed residents aged 15 and over use to travel between home and the workplace. The indicator does not measure trips with multiple modes of transportation, nor does it measure the seasonal variation in mode of transportation, or trips made for purposes other than the commute from home to work. Data for Commute to Work was collected and reported every five years in the Census of Canada in years 2006 and before, and in the National Household Survey in 2011. The 2012 CEEI reports include data from the 2011, 2006, 2001 and 1996, where available.

Residential Density
Residential density is calculated by dividing total population and dwelling units of a local municipality by the "net" land area. "Net" land area is calculated as the total land area of surveyed parcels with the following areas subtracted: federal, provincial, and local parks and protected areas; Indian Reserves; water features (e.g., lakes, main rivers); Agricultural Land Reserve; waste disposal sites; airports where digitally available; and woodlots (in 2012 only). Excluding these parcels provides a more precise picture of where people live or where future development could occur. Land data used to compute residential density represents totals as of the end of 2009 for the 2007 data, and the end of 2012 for 2012 data. Residential density has only been calculated for municipalities and for islands within the Islands Trust.

Parks and Protected Greenspace
Parks and protected greenspace is calculated using provincial, local and federal GIS data sets held within the Province. Marine areas have been excluded from both the total area calculations as well as the total parks calculations. In addition, Indian Reserves have been excluded from all totals. Data represents totals as of the end of 2009 for 2007 reports and the end of 2012 for 2012 reports.

Proximity to Transit
Proximity to Transit data comes from two different sources. Translink data is used for Metro Vancouver's member municipalities. BC Transit data is used for all communities outside of Metro Vancouver for which data is available.

Translink data methodology: The following indicators are reported:

- % of population & employees within 400m of bus service (lines);
- % of population & employees within 400m of bus-based frequent transit network (FTN)
- % of population & employees within 800m of a rapid transit station (points)
- % of population & employees within 400m/800m of full FTN (combined 400m to line segments of bus based FTN and 800 m to each rapid transit station)

Population and employment data is captured for the buffers as defined above. If the centre point of a dissemination area is included in the buffer, the population/employment data for the whole dissemination area will be included.

BC Transit data methodology: The following indicators are reported:

- % of population, dwelling units, & employed persons within 400m of a bus stop;

- % of population, dwelling units, & employed persons within 400m of a bus stop within a bus corridor with:
    - 15 minute (or less) headways[59] during morning and afternoon peak periods;
    - 30 minute (or less) headways during morning and afternoon peak periods.

The methodology for capturing population, dwelling unit and employment data is the same as that used by Translink (see above). The definition of a bus corridor is based upon Translink's Frequent Transit Network (FTN).[60] Peak periods are defined as 7:00 to 9:00am and 15:00 to 18:00pm. The stop times are used to calculate the headway on every bus route segment around a bus stop. The headway is first calculated by route then averaged for each road segment by combining routes. The headway is an average during a giving period and does not guarantee minimal wait time.

Proximity to Services: Walk Score® www.walkscore.com
The Walk Score rankings are drawn from this site http://www.walkscore.com/CA-BC/. To learn about the Walk Score methodology, visit https://www.walkscore.com/methodology.shtml.

Floor Space
CEEI receives the Building Information Report (BIR) from BC Assessment. Each BC Assessment record within the BIR is then assigned (by CEEI) to a standard building category and a building era, and allocated to either a Census Tract, a municipality or a Regional District unincorporated area. Depending on building type, BC Assessment calculates floor area data differently, and so CEEI collates values to ensure consistency across methods[61].

10.4 Data Sources

Housing Type: Total number of occupied private dwellings by structural type of dwelling

- Census of Canada:
  http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/OpenData.aspx
    - 2011 Census Profile for British Columbia Census Divisions and Census Subdivisions
    - 2011 Census Profile for British Columbia Census Tracts in Census Metropolitan Area (CMAs) and Tracted CAs

Commute to Work: Employed labour force by mode of commute

- http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/2011Census.aspx
    - National Household Survey – Mobility and Migration

59 A headway is the average interval of time between vehicles moving in the same direction on the same route
60 http://www.translink.ca/en/Plans-and-Projects/Frequent-Transit-Network.aspx
61 For more information on the methodology, please contact climateactionsecretariat@gov.bc.ca

Residential Density

- Population: Census of Canada, 2011; BC Stats Population Estimates, 2009;
- Total Land Area: a GIS calculation from Tantalis;
- Parks and Protected Areas: Tantalis Provincial Parks, National Parks, Local greenspace data;
- First Nations Reserve Lands: CLAB;
- Water Features: TRIM ocean, waterbodies, watercourses;
- Agricultural Land Reserve: Agricultural Land Commission;
- Waste Disposal Sites: Tantalis
- Airfields: TRIM
- Woodlots: Forest tenures

Parks and Protected Areas

- Total Land Area: a GIS calculation from Tantalis;
- Parks and Protected Areas: Tantalis Provincial Parks, National Parks, Local greenspace data;
- First Nations Reserve Lands: CLAB;
- Water Features: TRIM ocean, waterbodies, watercourses;
- Agricultural Land Reserve: Agricultural Land Commission;

Proximity to Transit

BC Transit data:

- Data was prepared by BC Transit.
- Population data: StatsCan Census (2011) - point centroid of dissemination blocks with population and dwelling counts (all of BC)
- Employment data: Pitney Bowes business data (2013) - point locations for businesses indicating type of business and number of employees (all of BC)
- Transit data: BC Transit's bus stop database (point locations for all bus stops), route layer (line layer of all bus routes and patterns), GTFS (files for Victoria, Kamloops, Squamish, and Whistler) providing schedule information for routes at the stop level of detail
- Additional data: Digital Road Atlas (DRA) for BC, Municipality layer for BC

Translink:

- Data was prepared by the Data and Information, Strategic Planning & Stakeholder Relations Division of Translink. The South Coast BC Transportation Authority expressly disclaims any representations and warranties of any kind with respect to the files, reports or information being released. In particular, the South Coast BC Transportation Authority and any additional parties do not represent or warrant that the information or any information contained in these files or reports is accurate, complete or current. Neither the South Coast BC Transportation Authority nor any third parties, employees or representatives will be liable for damages of any kind, including, without limitation, direct, special, indirect, consequential, punitive or exemplary damages for loss of income profit or savings, and claims of third parties, arising out of or in connection with the use of the files, reports, or information provided.
- Sources of data were Pitney Bowes Canada Business Points 2012, and Translink Transit Data 2012 (rapid transit and bus networks). Figures do not include First Nations territories.

Proximity to Services: Walk Score® www.walkscore.com

- The Walk Score rankings are drawn from this site http://www.walkscore.com/CA-BC/.

Floor Area

- BC Assessment provides Floor Area data within their BIR. The GIS Assessment Fabric Layer also originates from BC Assessment and is obtained from the Integrated Cadastral Information Society (ICIS). GIS Census Boundaries are downloaded from the Stats Canada website.

Data sources for the other "placeholder" indicators are still being researched and confirmed. As part of the CEEI principle of "continuous improvement", input on available and relevant data sources from local governments and measurement professionals are welcomed.

10.5 Data Accuracy

Although significant effort is made to ensure CEEI data accuracy, data may still not align with a local government's own data (e.g., from building permits, zoning, trip diary surveys). As mentioned previously, local data and analysis is invaluable to help inform local government climate action decision making. For residential density and parks and protected greenspace, data is accurate to the degree that provincial datasets are accurate.

10.6 Planned Improvements

The CEEI strives for continuous improvement. Potential future refinements have been noted during this year's supporting indicator collection process, and efforts will continue to be made to further refine and improve the data. In addition, the CEEI remains committed to integrating new and innovative policy relevant indicators into its future reports as they become available.

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12 GLOSSARY OF TERMS

Base Year – The emissions level against which to measure change over time, comprised of the annual emissions by activities within the boundaries of the analysis for a selected year.

Biogenic – The emissions that arise from the natural carbon cycle and are produced by living organisms or biological processes.

Carbon Dioxide (CO_2) – The most common GHG, consisting of a single carbon atom and two oxygen atoms. CO_2 is released by respiration the burning of fossil fuels, and is removed from the atmosphere by photosynthesis in green plants.

Carbon Dioxide equivalents – See "CO_2e".

Carbon Neutral –An organization is carbon neutral if it has (1) calculated the total emissions for which it is responsible, (2) pursued actions to minimize those emissions, and (3) applied emissions offsets to net those emissions to zero.

Chlorofluorocarbons (CFCs) – Compounds of carbon containing both chlorine and fluorine. They are non-poisonous and inert at ordinary temperatures and easily liquifiable under pressure, which make them excellent refrigerants, solvents, foam-makers and for use in aerosol sprays. Chlorofluorocarbons (CFCs) do not occur naturally. The use of CFCs is strictly regulated.

CO_2e (Carbon Dioxide Equivalents) – A common unit for combining emissions of greenhouse gases with different levels of impact on climate change. It is a measure of the impact that each gas has on climate change and is expressed in terms of the potency of carbon dioxide. For carbon dioxide itself, emissions in tons of CO_2 and tons of CO_2e are the same, whereas for nitrous oxide and methane, stronger greenhouse gases, one ton of emissions is equal to 298 tons and 25 tons of CO_2e respectively.

Coefficients – See "Emission Factors".

Community Scope Definitions

- Scope 1 emissions are all sources located within the geographic boundary of the jurisdiction (e.g., use of fuels such as heavy fuel oil, natural gas or propane used for heating buildings);
- Scope 2 emissions are indirect emissions that result as a consequence of activity within the jurisdiction's geographic boundary but which may occur outside of the jurisdiction (i.e., purchased electricity from hydroelectricity generation elsewhere);
- Scope 3 emissions are regional sources of emissions that occur outside of the jurisdiction's geographic boundary but which are the result of consumption patterns of residents or businesses in the jurisdiction (e.g., fuel used by an airport).

Direct Emissions – Emissions from assets that are owned or controlled by the reporting organization.

Electoral Area – A grouping of unincorporated areas that are represented by one director in the regional district.

Emission Coefficients – See "Emission Factors".

Emission Factors/Coefficients – A unique value for determining the amount of a GHG emitted for a given quantity of fossil fuel consumed. These factors are expressed in terms of the ratio of emissions of a particular pollutant (e.g. carbon dioxide) to the quantity of the fuel used (e.g. kilograms of coal). For example, when burned, 1 ton of coal = 2.071 tons of CO_2.

Gigajoule (GJ) – A joule is a measurement of energy equal to energy needed to apply one Newton of force to move an object a distance of one metre. One joule is the equivalent of lifting an apple one metre. A gigajoule is the equivalent of one billion joules, a barrel of oil contains roughly 6 GJ of energy.

Global Warming Potential (GWP) – The ratio of radiative forcing that would result from the emission of one kilogram of a GHG to that from the emission of one kilogram of carbon dioxide over a fixed period of time.

Greenhouse Effect – The effect of heat retention in the lower atmosphere as a result of absorption and re-radiation by clouds and various greenhouse gases of long-wave terrestrial radiation. Incoming, short-wave radiation, including visible light and heat, is absorbed by materials which then behave as black bodies re-radiating at longer wavelengths. Certain substances (e.g. carbon dioxide) absorb long-wave radiation, are heated by it, and then begin to radiate it, still as long-wave radiation, in all directions, some of it downwards. Despite its name, the actual heating in a real greenhouse is caused mainly by the physical obstruction of the glass, which prevents warm air from leaving and cooler air from entering.

Greenhouse Gases (GHG) – Gases which are transparent to solar (short-wave or light) radiation but opaque to long-wave (infrared or heat) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. Thereby reducing the amount of earth's radiation that escapes to space, with consequent warming of the lower atmosphere and the earth's surface (see Greenhouse Effect). For the purposes of this standard, GHGs are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydroflurocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).

Histosols – Soil composed mainly of organic materials.

Hydrofluorocarbons (HFCs) – GHGs used primarily as a refrigerant, comprising a class of gases containing hydrogen, fluorine, and carbon.

Indirect Emissions – Emissions that occur because of a local government's actions, but are produced by sources owned or controlled by another entity. For example, the purchase of electricity that was generated by emission-producing fuel outside of the jurisdiction's boundaries.

Intergovernmental Panel on Climate Change (IPCC) – An organization established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988 to assess information in the scientific and technical literature related to all significant components of the issue of climate change, and providing technical analysis of the science of climate change as well as guidance on the quantification of GHG emissions.

Kilowatt Hour (kWh) – The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)

Landfill Gas (LFG) Production – Estimation of the amount of methane gas produced by the decomposition of organic solid waste. LFG can be estimated by two methods: waste commitment and waste-in-place.

Measures – These are the actions by local government or other community stakeholders that are undertaken to reduce GHG emissions.

Methane (CH_4) – A GHG resulting from the anaerobic decomposition of vegetative materials in wetlands, urban landfills, and rice paddies, the production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The principle constituent of natural gas, methane is a single carbon atom linked to four hydrogen atoms.

Municipality – An administrative entity composed of a clearly define territory and its population. Municipalities can be incorporated under a variety of names such as City, District, Town, Village, Indian Government District, etc.

Municipal Solid Waste (MSW) – More commonly known as garbage, MSW includes all waste produced within a municipalities boundaries that require disposal at a regional landfill or other waste facility. MSW includes demolition, land clearing and construction waste.

Nitrous Oxide (N_2O) – A potent greenhouse gas produced in relatively small quantities. It is composed of a two nitrogen atoms and a single oxygen atom and is typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Perfluorocarbons (PFCs) – A GHG consisting of a class of gases containing carbon and fluorine. Originally introduced as alternatives to ozone depleting substances they are typically emitted as by-products of industrial and manufacturing processes.

Regional District – An administrative entity composed of regional municipalities and electoral areas. Regional districts provide a government for unincorporated areas, a forum for intermunicipal cooperation and are an organization upon which provincial mandates can by imposed such as for regional waste management planning.

Sectors – Records are organized into sectors that contain similar activities or emissions sources. Key community sectors include: residential, commercial and industrial buildings; transportation; land-use change from deforestation and waste.

Sulfur Hexafluoride (SF_6) – a GHG consisting of a single sulfur atom and six fluoride atoms and primarily used in electrical transmission and distribution systems.

Unmanaged Landfills: Landfills where waste decays aerobically in the top layers due to a lack of solid waste management practices.

Vehicle Kilometres Traveled (VKT) – A standard measure of vehicular traffic in a community. A VKT is equivalent to a single vehicle traveling one kilometre (regardless of the number of passengers).

Vehicle Identification Number (VIN) – A unique and identifying 17 digit alphanumeric code assigned to a vehicle by the manufacturer.

13 ACRONYMS

Table 15: Acronyms

Acronym or Abbreviation	Full Name or Definition
B.C.	British Columbia
CD	Census Division
CEEI	Community Energy and Emissions Inventory
CFS	Canadian Forest Service
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide (global warming) equivalent
CSD	Census Subdivision
DLC	Demolition, land clearing, and construction waste
DOC	Degradable Organic Carbon content
EERMS™	Energy and Emissions Reporting and Monitoring System
EPA	(US) Environmental Protection Agency
FCM	Federation of Canadian Municipalities
GHG	Greenhouse Gas
GVW	Gross Vehicle Weight
HES	Hyla Environmental Services Ltd.
HFC	Hydrofluorocarbon
ICBC	Insurance Company of British Columbia
ICIS	Integrated Cadastral Information Society
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LFG	Landfill Gas
MSW	Municipal Solid Waste
NIR	National Inventory Report
NRCan	Natural Resources Canada
NVW	Net Vehicle Weight
PCP	Partners for Climate Protection
PFC	Perfluorocarbons
PNG	Pacific Northern Gas (NE) Ltd.
SF_6	Sulphur hexafluoride
SUV	Sports Utility Vehicle
TEEM™	Transportation Energy and Emissions Module
TMF	Translation Master File

VIN	Vehicle Identification Number

14 CEEI SCOPE OVER TIME

Table 16: CEEI Scope Over Time

Sector	Source	Source Data Year	2007	2010	2012
Buildings • **Electricity** • **Natural Gas** • **Heating Oil / Propane / Wood**	 Utilities Utilities Estimates	2007, 2010, 2012	Municipal, Regional District (CORE ITEM) Heating Oil, Propane/ Wood raw estimates made.	Municipal, Regional District (CORE ITEM) Data weather-adjusted from 2007	Municipal, Regional District (CORE ITEM) Data weather-adjusted from 2007
Solid Waste	Estimates / Landfills	2007, 2010, 2012	Municipal, Regional District (CORE ITEM)	Municipal, Regional District (CORE ITEM)	Municipal, Regional District (CORE ITEM)
Transportation (Lower Mainland) • **VKT** • **Vehicle Registration** • **Fuel Efficiency**	 AirCare / Estimates Insurance Corporation of British Columbia Natural Resources Canada	 2005 - 2008, 2007 – 2010, 2009 - 2012 2007, 2010, 2012	Municipal, Regional District (CORE ITEM)	Municipal, Regional District (CORE ITEM)	Municipal, Regional District (CORE ITEM)
Large Industrial Emitters • **Electricity** • **Natural Gas** • **Reporting Regulation Data**	 Utilities (2007/2010) Utilities (2007/2010) Province of BC (2012)	2007, 2010, 2012	Municipal, Regional District (MEMO ITEM)	Municipal, Regional District (MEMO ITEM)	Regional District (MEMO ITEM)
Land-Use Change • **Deforestation Area**	Canadian Forest Service / Environment Canada	2000, 2008, 2012	Regional District (MEMO ITEM)	Not Reported	Municipal (CORE ITEM)
Enteric Fermentation • **Livestock Counts**	Statistics Canada	2006, 2012	Regional District (MEMO ITEM)	Not Reported	Regional District (MEMO ITEM)
Housing Type	Statistics Canada	1996, 2001, 2006, 2012	Municipal, Regional District (MEMO ITEM)	Not Reported	Municipal, Regional District (MEMO ITEM)
Residential Density • **Population** • **Area**	 BC Stats GIS	2007, 2009, 2012	Municipal, Regional District (MEMO ITEM)	Not Reported	Municipal, Regional District, Census Tract

					(MEMO ITEM)
Commute by Mode	Statistics Canada	1996, 2001, 2006, 2012	Municipal, Regional District (MEMO ITEM)	Not Reported	Municipal, Regional District (MEMO ITEM)
Commute Distance	Statistics Canada	2006	Municipal (MEMO ITEM)	Not Reported	Not Reported
Green Space	GIS	2009, 2010, 2012	Municipal, Regional District (MEMO ITEM)	Not Reported	Municipal, Regional District, Census Tract (MEMO ITEM)
Floor Area	BC Assessment	2012	Not Reported	Not Reported	Municipal, Regional District (MEMO ITEM)
Proximity to Services	Walkscore	2012	Not Reported	Not Reported	Municipal (MEMO ITEM)
Proximity to Transit	BC Transit, Translink	2012	Not Reported	Not Reported	Municipal (MEMO ITEM)

15 EMISSION FACTORS

Table 17: CEEI Emission Factors

Public Utility	**Emission Factor ($kgCO_2e$/ GJ)**		
Year	2007	2010	2012
BC Hydro	7.22	7.04	3.80
City of New Westminster *(BC Hydro reseller)*	7.22	7.04	3.80
FortisBC	2.26	2.21	1.19
City of Kelowna *(FortisBC reseller)*	2.26	2.21	1.19
City of Grand Forks *(FortisBC reseller)*	2.26	2.21	1.19
City of Summerland *(FortisBC reseller)*	2.26	2.21	1.19
City of Penticton *(FortisBC reseller)*	2.26	2.21	1.19
Silversmith *(FortisBC reseller)*	2.26	2.21	1.19
Nelson Hydro	1.02	0.99	0.54
		All years	
Fortis Gas (Propane)		60.84	
Pacific Northern Gas (Propane)		60.84	
Sun Peaks (Propane)		60.84	
Port Alice (Propane)		60.84	
Big White (Propane)		60.84	

Public Utility	Emission Factor ($kgCO_2e$/ GJ)
Cal-Gas (Propane)	60.84
Corix (Propane)	60.84
Residential Wood	23.48
Residential Heating Oil	67.68
Residential Propane	60.84
Star Gas (Natural Gas)	49.75
Fortis Gas (Natural Gas)	49.75
Pacific Northern Gas (Natural Gas)	49.75

For additional information on emission factors used in CEEI please refer to http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology_for_quantifying_ghg_emissions.pdf


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