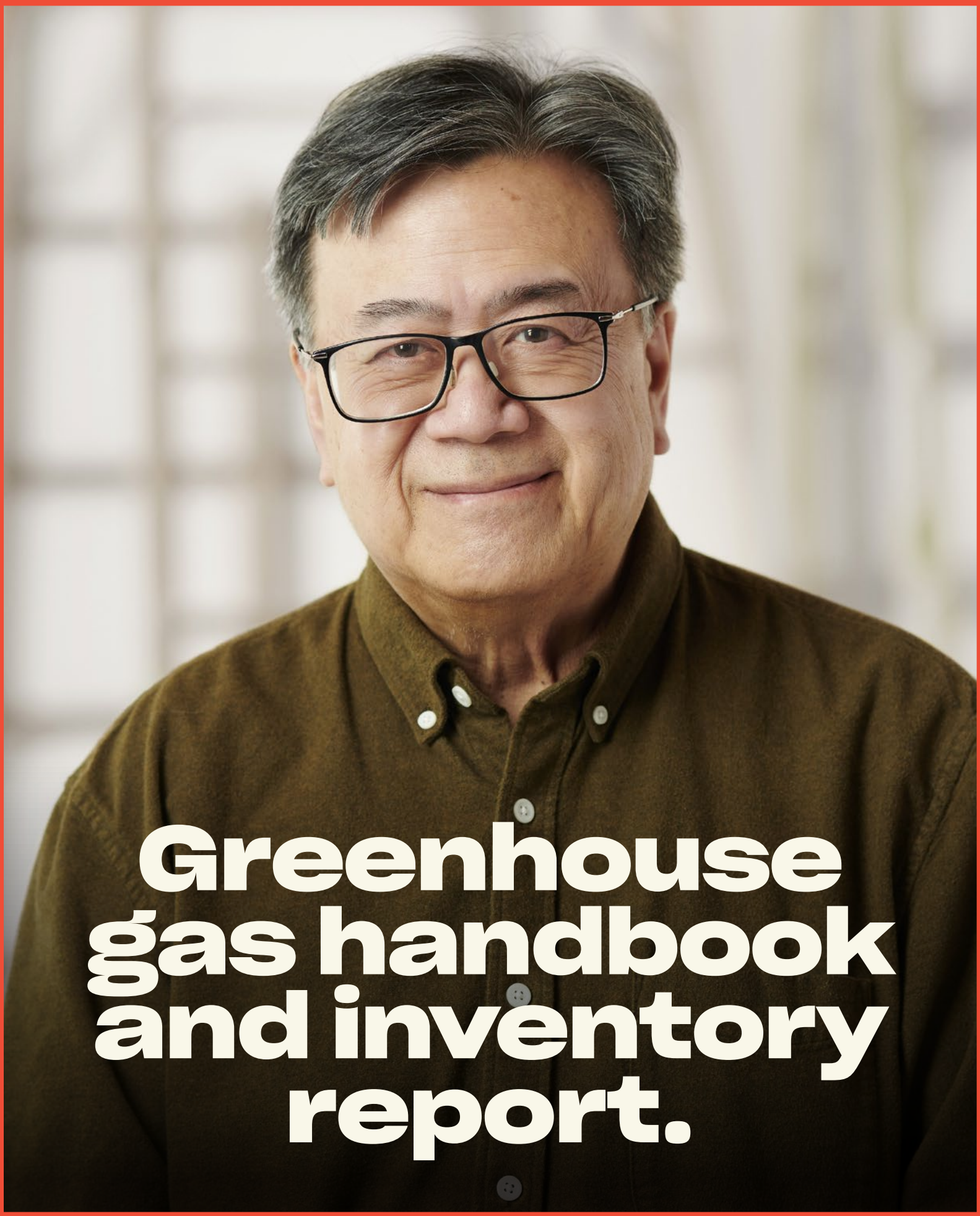

Greenhouse gas handbook and inventory report.

Vancity

2020 ANNUAL REPORT

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1 Introduction

This document outlines the procedures and methodologies Vancity shall use to assess and estimate the emissions of greenhouse gasses associated with its operational footprint and reports on Vancity's operational, not financed, greenhouse gas emissions inventory for 2020. The procedures and methodology have been developed to comply with the CSA/ISO 14064-1 standard entitled *Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals*. The procedures methodology also aligns with the World Resources Institutes' GHG Protocol standard [1, 2] and were designed to reflect the principles of: relevance, completeness, consistency, accuracy, and transparency [1]. Finally, the procedures were developed to be independent of a specific implementation or technology solution.

1.1 The Organization

As of December 31st, 2020, Vancity employed 2,601 people or 2,368 full-time equivalents (FTE).

1.2 Objectives

Vancity's objectives in estimating its operational greenhouse gas emissions inventory are:

- Leadership – define its role in the community as a leader in sustainability.
- Environmental Stewardship – reduce its impacts on the environment.
    - Climate Change - reduce or maintain its operational emissions of greenhouse gases in the face of organizational growth.
    - Identifying Actions – identify efficient measures to reduce its emissions of greenhouse gasses and impacts on the environment.
    - Inform carbon offset purchase to maintain operational carbon neutrality.

1.3 Carbon Neutrality intention

Since 2007, Vancity has understood carbon neutrality as the result of an organization offsetting its operational greenhouse gas emissions such that its net impact on the climate is neutral. Vancity targets reductions in both the size and intensity of its operational emissions before purchasing offsets as a measure of last resort.

Note that Vancity's recent commitment to net zero in its lending portfolio by 2040 is outside the scope of this document. For more information on financed emissions and net zero, see the 2020 Annual Report page 14 and rethink.vancity.com

The process for selecting offsets has evolved in the last few years. Vancity has employed a

unique process in selecting and purchasing carbon offsets. An employee working group screened organizations that offered the offsets and then qualified suppliers proceeded with an annual request for proposal where projects were selected on an individual basis in alignment with the criteria below. The process for selecting carbon offsets moved to a direct award in 2017. The same methodology as previous years is still employed to ensure that Vancity maintains consistent standards for any carbon offset project that is selected.

1.3.1 Vancity's offset criteria

Original guidance came from the Carbon Advisory Group (experts from The David Suzuki Foundation, The Pembina Institute, and Ecotrust Canada), and from criteria outlined within the "Purchasing Carbon Offsets: A Guide for Canadian Consumers, Businesses, and Organizations" paper, published by the David Suzuki Foundation and The Pembina Institute, 2009. In 2012, in addition to the original guidance, Vancity consulted with external and internal subject matter experts to expand its criteria and use only offsets from projects that: Directly reduce energy consumption and/or; create some kind of renewable energy; focus on waste reduction and utilize biological sequestration.

In addition, projects must:

- Be additional (the reduction in emissions would not have occurred without the carbon finance)
- Be validated by a third-party assessor to identify a baseline and quantify emissions reductions
- Be verified by a third-party assessor to make sure that the greenhouse gas emission reductions were actually achieved using independent, recognized, standard quantification methodologies. Note: projects that create more than 5,000 tonnes of greenhouse gas emission (tonnes of CO_2e) reductions per year will need to have separate groups do the validation and verification
- Be able to show unique ownership of the offset credits

Vancity prefers projects that:

- Are Canada-based and local (with a preference to those based in British Columbia);
- Have no negative environmental or social impacts;
- Contribute to sustainable development in the community of which they are a part and support Vancity's ethical principles;
- Demonstrate a leadership role;

- Educate the public about climate change;
- Provide social and community co-benefits, such as those that directly support/engage communities, local/small business, and/or projects with First Nation's ownership;
- That have obtained certification with applicable standards.

Projects which demonstrate involvement in the mining and/or fossil fuel extraction and production industry will not be considered.

2 Roles and Responsibility

The following table outlines the roles and responsibilities that shall be assigned before estimating the greenhouse gas emissions inventory. Note that multiple people or a group can be responsible for a single role and that a single person can be responsible for more than one role.

Name	Responsibility	Training Level
Verification Officer (VO)	This officer is responsible for coordinating the overall emissions inventory effort. The officer is responsible for overseeing the other officers and ensuring they are following the appropriate procedures. The officer is also responsible for coordinating the verification and audit process.	This officer should be familiar with the relevant data collection and modeling standards as well as an understanding of the overall process including verification.
Data Collection Officer/Provider (DCO)	This officer is responsible for collecting, managing and logging all data used to estimate Vancity's greenhouse gas emissions inventory, as described in this document. The officer is responsible for ensuring all data is reported to them and that the data adheres to the specified data collection standards. Where possible, data quality testing is performed. Finally, the officer is responsible for ensuring that all data collection procedures in this document adhere to the relevant standards.	This officer should have a thorough understanding of the relevant data collection process standards as well as quality assurance procedures.
Modeling Officer (MO)	This officer is responsible for ensuring the emissions inventory model adheres to the methodologies described in this document. The officer is also responsible for reviewing the methodologies described in this document to ensure they are current and adhere to the relevant standards. Finally, this officer is responsible for running the model and reporting the results of the emissions inventory to the Data Collection Officer.	This officer should have a thorough understanding of the relevant standards and modeling methodologies through participation in for mal training on ISO 14064-01. The officer needs to possess sufficient quantitative skills to understand and run the model.
Finance Officer (FO)	This officer is responsible for collecting and reporting activity data derived from accounting records to the Data Collection Officer.	This officer should be familiar with the accounting system and accounting practices at Vancity
Energy Assessment Officer (EAO)	This officer is responsible for collecting and recording energy use (electrical and fuel) at all Vancity facilities and reporting this information to the Data Collection Officer. This officer may be an external contractor.	This officer should be familiar with energy systems and utility reporting processes.

Survey Officer (SO)	In some cases, for example employee commuting, a survey may need to be conducted to estimate activity data or other model parameters. The survey officer shall be responsible for conducting and interpreting such a survey.	This officer should be familiar with survey methodologies including how to correctly conduct a survey and interpret the results.
External Verification Officer (EVO)	This officer is optional. If chosen this officer is responsible for providing expert guidance on the overall emission inventory process. This officer might be a steering committee or some other advisory group.	This officer should be a recognized expert or leader in the area they are providing direction in.

3 General Procedures

The following describes the general procedure that shall be followed in estimating the greenhouse gas emissions inventory:

	Procedure	Role
2.1	Identification and review of the responsibilities and authorities of each officer will be done on an annual basis at the beginning of each reporting period (in January/February).	VO
2.2	At the beginning of each reporting period a roles and responsibilities document shall be completed listing the names and contact information for each officer.	VO
2.3	This document shall be logged each reporting period and be available to the auditor.	DCO
2.4	The training needs of officers will be assessed by the Verification Officer at the beginning of each reporting period based on the training level requirements identified above.	VO
2.5	Appropriate orientation/awareness training will be conducted with all new officers within the first quarter of each reporting period, as well as regular quarterly check-ins to ensure a strong feedback loop is established.	VO

	Procedure	Role
3.1	The procedures described in this document shall be followed to estimate Vancity's greenhouse gas emissions inventory.	All
3.2	The reporting period shall be January 1st to December 31st of the year reported with the exception of Energy data for which the reporting year will be October 1st of the previous year to September 30th of the current year of the reporting period.	n/a
3.3	Interim internal reporting periods occur quarterly (following the end of the quarter) for select data.	n/a
3.4	This document and the procedures described within it shall be reviewed at a minimum of once a reporting period to ensure compliance and conformance with the relevant standards (ISO 14064-1 [1] and GHG Protocol [2] standards). The review shall occur while the inventory is being estimated.	VO
3.5	The document revision numbers shall be incremented after an update as follows: the major revision number shall be incremented if this document or the procedures undergo significant change, for example the relevant standards change or there is a major change in a calculation methodology; the minor revision number shall be incremented in all other cases.	DCO

The following describes the steps necessary to complete the greenhouse gas emissions inventory:

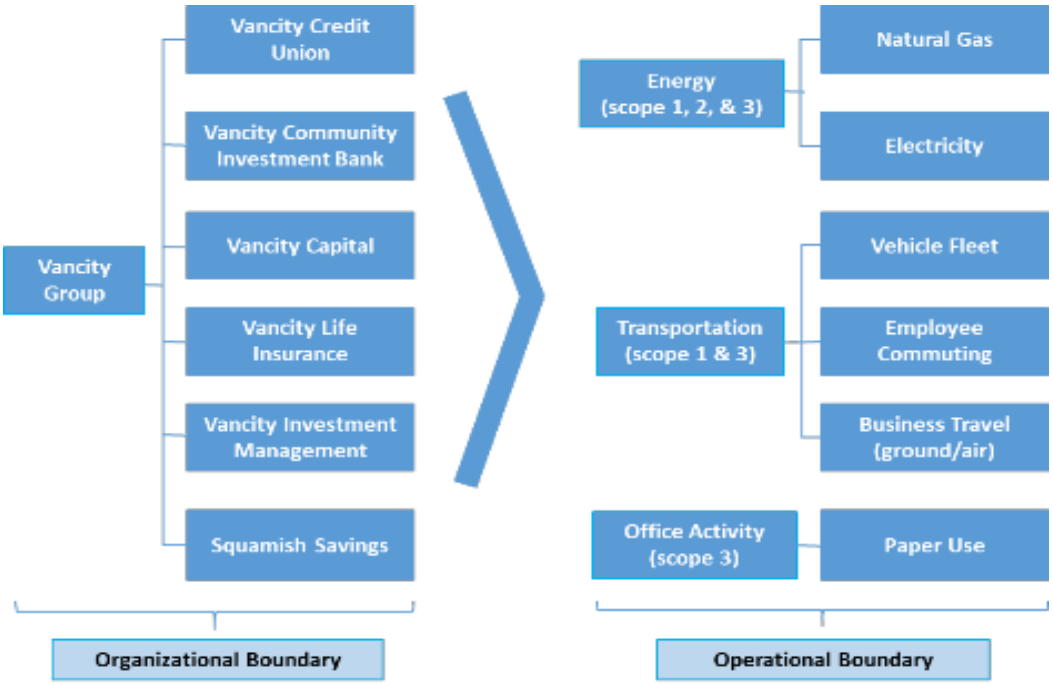
Step	Description	Role
1	Assign roles and responsibilities	VO
2	Read and review this document for adherence to standards, correctness, and completeness. Document any changes	VO

3	Review and update emission factors and other model parameters as required.	DCO/ MO
4	Collect and input activity data.	DCO
5	Using the modelling procedures described in this document, estimate the emissions inventory.	MO
6	Document the results and record all relevant information	VO/ DCO
7	Verify and audit the results and the process	All

4 Organizational Boundary

Vancity is comprised of six subsidiaries that are collectively referred to as the Vancity Group (See Figure 1). ISO 14064-1 recommends that: "Where possible, organizations should follow the organizational boundaries already in place for its financial accounting, provided these are explicitly explained and followed consistently.[1]" Following this recommendation, Vancity has selected the Control approach, specifically the Operational Control approach, to define its organizational and operational boundaries. Vancity shall include in its emissions inventory all operational sources and sinks associated with the organizations it exercises direct, operational control over. These include: Vancity Credit Union, Vancity Community Investment Bank (VCIB), Vancity Capital, Vancity Life Insurance Services (VLISL), Vancity Investment Management Ltd. (VCIM), and Squamish Savings. Financed emissions are outside the boundary considered in this inventory report and handbook.

Figure 1: 2020 Vancity Organizational and Operational Boundary



The following describes the procedures used to review the organizational boundary:

	Procedure	Role
4.1	The organizational boundary shall be reviewed once per reporting period, at the beginning of the period, to ensure it is compliant with the relevant standards and reflects any changes in Vancity's business operations. For example, the organizational boundary would change if a subsidiary was sold or a new one purchased. Any changes to the boundary must be justified and recorded in this document.	VO
4.2	If the organizational boundaries change the base year inventory shall be recalculated (see Section 7).	MO
4.3	If the organizational boundary changes the exact nature of the change shall be noted in Organizational Boundary Changes.	VO

4.1 Organizational Boundary Changes

Table 3 below describes changes to the organizational boundary that have occurred since the base year (2007).

Table 3: Organizational Boundary Changes

Year	Change	Rationale
2011	Inhance Investment Management	Company was fully divested in 2010
2011	Vancity Community Foundation	Vancity Community Foundation is not under the direct operational control of the Vancity Group. ISO 14064-1 recommends "organizations follow the organizational boundaries already in place for financial accounting". Excluding the Vancity Community Foundation is consistent with this recommendation.
2011	Vancity Insurance Services	Portion of insurance services divested in 2010, only life insurance services remain (as noted by name change).
2013	Inventure Solutions	Inventure Solutions evolved into Vancity's IT department and is no longer a separate entity.
2017	Vancity Community Investment Bank (VCIB)	Citizens Bank of Canada has changed to Vancity Community Investment Bank.
2018	Vancity Capital	Vancity Capital remains a subsidiary even though it has been integrated within the Member Experience and Community Engagement Division within Vancity Credit Union
2020	Vancity Community Investment Bank (VCIB)	VCIB acquired a subsidiary at the end of 2019, CoPower Inc., which has been integrated into VCIB operations. CoPower consisted of six employees.

5 Operational Boundary: Greenhouse Gas Sources and Sinks

5.1 Emissions Sources and Categories

As discussed in Section 4, Vancity shall use the operational control approach to define its organizational and operation boundary. Vancity shall include in its inventory all sources and sinks for which it has operational control over and for which it is practically and economically feasible to assess (see Figure 1).

5.1.1 Direct (Scope 1)

As a financial institution Vancity has few sources of direct (Scope 1) greenhouse gas emissions. They include a small fleet of light duty vehicles and the operation of boilers and natural gas consuming appliances at facilities Vancity owns and/or operates. In 2016, the Scope 1 criteria was changed to include leased facilities at which Vancity controls the natural gas consumption. Control of natural gas consumption was established as all facilities at which the consumption is sub-metered for the space that Vancity leases. Natural gas which is burned in boilers not controlled by Vancity and is used to provide heat to Vancity facilities has been included in other indirect emissions (Scope 3), section 5.1.3 below.

5.1.2 Energy Indirect (Scope 2)

Vancity controls a range of facilities including office buildings and branches to serve its customers. Energy – delivered in the form of electricity - is required to operate these facilities. Emissions associated with electricity make up Vancity's energy indirect (scope 2) emission sources.

5.1.3 Other Indirect (Scope 3)

Through a stakeholder engagement process, Vancity identified a number of other indirect (Scope 3) emission sources which are pertinent to its business operations and for which it is reasonable and cost effective to quantify. Other indirect emissions are the consequence of Vancity's activities but occur from sources not controlled by the company. Vancity established an environmental/climate change advisory committee made up of leading Canadian environmental organizations. This group provided assistance and guidance in establishing an appropriate operational boundary with regards to other indirect emission sources. Vancity is including the following sources of other indirect emissions in its emissions inventory: natural gas heating in facilities it does not control, business travel, employee commuting and paper usage. In 2017, non-company car Modo usage became a material contributor to Vancity's overall operational GHG emissions and was added to its scope 3 emissions under business travel. The sources identified are considered to be within operational control and are thus consistent with Vancity's objective of reducing or holding constant its greenhouse gas emissions. It should be stressed that both ISO 14064-1 and the GHG Protocol standards consider the reporting of other indirect (Scope 3) emissions optional [1, 2]. Table 4 describes Vancity's operational boundary, listing the emission sources and sinks Vancity shall include in its inventory.

Table 4: Greenhouse Gas Sources and Sinks

	Source	Classification / Scope	Description
Energy	Natural Gas Combustion	Direct/1 & Other Indirect/3	Vancity burns natural gas to heat, cool, and supply hot water to its facilities. If the gas is burned in an appliance operated by Vancity the associated emissions are classified as Direct (Scope 1) otherwise they are classified as Other Indirect (Scope 3).
	Electricity Use	Energy Indirect/2	Vancity uses electricity to heat, cool, light, and run appliances at its facilities.
Transportation	Vehicle Fleet	Direct/1	Vancity leases and operates a small fleet of light-duty vehicles.
	Employee Commuting (Single Occupancy and High Occupancy Vehicles)	Other Indirect/3	Vancity employees commute from their residences to various Vancity facilities.
	Business Related Air Travel	Other Indirect/3	Vancity employees travel by air to conduct business activities.
	Business Related Vehicle Travel	Other Indirect/3	Vancity employees travel by private vehicle to conduct business activities.
	Car Allowance	Other Indirect/3	Vancity employees travel by private vehicle to conduct business activities. Car allowances are used to compensate those employees who travel frequently.
Office Activity	Paper Use	Other Indirect/3	Vancity paper purchasing as a result of its business operations and marketing materials and advertising campaigns.

Due to the nature of financial institutions, it is neither practical nor in many cases possible to directly measure greenhouse gas emissions from the sources identified in the Operational Boundaries listed, therefore emissions were estimated using a model. The model is of the form:

$$Total\ Emissions = \sum_{Sources}\big((Emission\ Factor)\ \times\ (Activity\ Level)\big)$$

For all emission sources an emission factor was identified. The emission factor specifies the amount of emissions per unit of activity. Activity data was collected or estimated to quantify the activity level. These methodologies and procedures are described in further detail below and have been adopted from various sources including the World Resources Institute (WRI) [3, 4].

5.2 Inventory Exclusions

5.2.1 Other Modes of Employee Commuting

Vancity gathers information on the typical commuting habits of Vancity employees. An annual survey, administered by Acuere Consulting in the fall, assesses the following commuting

transportation modes: drove alone, carpool/vanpool driver (with at least 2 adults in the vehicle, carpool/vanpool passenger (with at least 2 adults in the vehicle), walked all the way (includes jogging, rollerblading, skateboarding, etc.), bicycle and e-bike, motorcycle, public transit, worked from home/telecommuting, and other. Vancity includes emissions from private internal combustion engines and taxis in its emissions inventory. Emissions from transit have been excluded. As a Scope 3 emissions source reporting emissions from employee commuting is optional, Vancity has chosen to report only emissions from private internal combustion engines and taxis to incentivize employees to choose more sustainable transportation.

5.2.2 Immaterial Sources

Vancity commissioned the Pembina Institute to examine three potential sources of emissions to determine if they were material, greater than one per cent of the total GHG inventory, and should be measured and included in the inventory. The three sources of emissions were ferry travel, standalone ATMs and refrigerant leakage from kitchen refrigerators and HVAC systems. The report found that none of the three activities were likely to be material sources of emissions. Even under the highest emissions scenarios all three failed to meet the materiality threshold and as result are not included in the emissions inventory.

6 Quantification Methodology and Procedure

As it is neither practical nor in many cases possible to directly measure greenhouse gas emissions from the sources identified in Section 5 emissions will be estimated using a model.

For all emission sources, emission factors shall be identified. The emission factors specify the amount of emissions per unit of activity. Activity data shall be collected or estimated to quantify the activity level. This section describes how to obtain or calculate the emissions factors and collect or estimate the activity data for each greenhouse gas emission source identified in Section 5.

6.1 Methodological Guidance and Secondary Data Sources

The foremost authority on greenhouse gas emissions inventories is the Intergovernmental Panel on Climate Change (IPCC). The IPCC, through the publication of their five assessment reports, has established the scientific basis for the causation and calculation of climate change. Their reports underpin the methodological guidance documents and secondary data sources that comprise the rest of this chapter.

As noted in Chapter 1, The Vancity Group's GHG Emissions Inventory is prepared in conformance with the CSA/ISO 14064-1 standard. This ISO standard provides high-level guidance for the quantification and reporting of the GHG inventory. ISO 14064-1 does not

provide specific methodological guidance on quantification procedures or references to secondary data sources that are required to complete the inventory.

The WRI Corporate Standard builds on ISO 14064-1 by providing guidance for establishing organizational and operational corporate boundaries as well as the various Scopes that are to be included in a GHG inventory. This standard served as the basis for the overall design of the GHG inventory.

ISO 14064 and the WRI Corporate Standard provide no specific guidance on the selection of emissions factors that are to be used in the completion of a GHG inventory. The B.C. Government publishes a "Best Practices Methodology for Quantifying Greenhouse Gas Emissions"[15] does specify emissions factors and subsequently ensures consistency in the completion of GHG inventories across the province. This document, which conforms with ISO 14064 and the WRI Corporate Standard, serves as the basis for the selection of emissions factors. The BC Best Practices document draws heavily on factors published by Environment Canada that are used in the completion of Canada's national inventory report. Other data sources reference in the document include Natural Resources Canada and Statistics Canada.

The remainder of this chapter specifies the primary data collection and the various secondary data sources that are to be incorporated into the GHG inventory model. As per the procedure outlined in Chapter 3, the emissions factors and modeling parameters are reviewed annually and updated if they have changed from the previous year. This approach aligns with the BC Best Practices that updates factors every other year unless the factors change significantly in a given year, in which case they are updated annually. Annual updates emphasize correctness by choosing the most up-to-date factors.

6.2 Energy

6.2.1 Facilities

Vancity owns and/or leases both office space and retail space to service its customers. Its energy related emissions are associated with the operation of these facilities. To estimate these emissions information about each facility is required.

	Procedure	Role
6.1	Once per reporting period, at the beginning of the period, the following information shall be obtained for each facility: 1)The name 2)The number of employees (FTE) at the facility 3) If electricity is metered at the facility 4) If natural gas is metered at the facility 5) If the facility is controlled (owned) by Vancity 6) The area (sqft or m^2) 7) The per cent of the year the facility has been in operation 8) The type or category of building 9) The province in which it is located	DCO/ EAO

	10) The address	
6.2	For each Vancity subsidiary a head office shall be assigned from the list of facilities	DCO
6.3	Only if a facility is added or removed as a result of a divestment or merger shall the base year inventory be recalculated (see Section 7). Facilities added or removed as a result of organic growth shall not trigger a recalculation, and the base year shall not be recalculated if the facility did not exist in the base year. Furthermore, if the addition or removal of a facility as a result of a divestment or merger results in less than 3% change in total square footage, or less than 1.5% change in total employees, the base year shall not be recalculated.	MO

6.2.2 Electricity

6.2.2.1 Emission Factors

The majority of Vancity's facilities are located in the province of British Columbia and thus Vancity purchases the bulk of its electricity from BC Hydro. The B.C. Government "Best Practices" guide specifies the use of a 3-year average of BC Hydro's published emission factors to be used to calculate GHG emissions from electricity use. In 2018, this factor is 10.67 CO2eq/GWh (the average of 12, 11, and 9). Also in accordance with the BC Best Practices document, Vancity has applied National Inventory Report factors for the Vancity Community Investment Bank locations in Calgary and Toronto.

	Procedure	Role
6.4	The electricity emission factor shall be measured in Metric Tonnes per Gigawatt Hour (t/GWh).	n/a
6.5	If available the electricity emissions factors shall account for the import and export of electricity in each jurisdiction.	DCO
6.6	The electricity emissions factor from the BC Best Practices document (based on a 3-year average of BC Hydro factors) shall be used. The latest National Inventory Report shall be used for all provinces outside of B.C. that Vancity operates a facility in.	DCO/ MO

6.2.2.2 Activity Data

Electricity consumption is metered at most Vancity facilities. At non-metered facilities consumption is estimated using a model. The model estimates an average energy use per unit area for all metered Vancity facilities, categorizes these facilities, and then assumes that similar non-metered facilities use approximately the same energy per unit area (see Appendix B).

	Procedure	Role
6.9	Electricity consumption shall be measured in Kilowatt Hours (kWh).	n/a
6.10	Electricity consumption measurements for all metered Vancity facilities shall be collected at a minimum of once a reporting period, at the beginning of the period. The province the facility is located shall also be recorded so that the appropriate emission factor can be selected.	EAO/ DCO
6.11	Where there is no meter at a facility or it is otherwise infeasible to measure electricity consumption, the model described in Appendix B shall be used to estimate consumption for the period at the beginning of the next period. Note that for facilities located outside of B.C., estimates from Natural Resources Canada are used (see Appendix B for details).	MO/ EAO

6.12	The model described in Appendix B shall be reviewed each reporting period, at the beginning of the period, to ensure that the underlying assumptions are valid and the estimates up to date for the current reporting year.	MO

6.2.3 Natural Gas

6.2.3.1 Emission Factor

Combustion of natural gas releases three greenhouse gases, CO_2, CH_4, and N_2O. The precise chemical makeup of natural gas varies from province to province and the emissions factor varies accordingly. Emission factors from the latest National Inventory Report shall be used. Emission factors specific to each province shall be used for CO_2 and emission factors for "residential, commercial, institutional and agriculture" shall be used for CH_4, and N_2O. There are also emissions associated with natural gas distribution. However, as distribution emissions are small (about one per cent based on FortisBC (Terasen) Gas' 2005 estimate of 0.539 kg/GJ) they shall not be included [8].

	Procedure	Role
6.13	The natural gas emission factor shall be measured in Metric Tonnes / Cubic Metre (t/m^3)	n/a
6.14	The natural gas emission factor for CO_2 shall be obtained at the beginning of each period from the most recent National Inventory Report (e.g. [6]): Greenhouse Gases Sources and Sinks in Canada (Annex 12) authored by Environment Canada. The emission factors for "Residential, Construction, Commercial/Institutional, Agriculture" shall be used.	DCO
6.15	The natural gas emission factors shall be reviewed each reporting period at the beginning of the period. Should the emission factors change, the base year inventory shall be recalculated (see Section 7).	DCO/ MO

6.2.3.2 Activity Data

The majority of Vancity facilities are located in the province of British Columbia and thus Vancity purchases the bulk of its natural gas from FortisBC. Natural gas is sold by energy units GJ but the National Inventory Report lists emission factors in g / m^3. The conversion factor from GJ of natural gas to m^3 shall be obtained from the natural gas company. At this time there is not sufficient gas consumption outside of B.C. to justify refining this conversion factor for other provinces and therefore the B.C. conversion factor shall be used in all cases. Natural gas consumption is metered at most Vancity facilities. At non-metered facilities consumption is estimated using a model. The model estimates average gas use per unit area for all metered Vancity facilities, categorizes these facilities, and then assumes that similar non-metered facilities use approximately the same amount of gas per unit area (see Appendix B).

	Procedure	Role
6.16	Natural gas consumption shall be measured in in Cubic Metres (m^3)	n/a
6.17	Natural gas consumption measurements for all metered Vancity facilities shall be collected at a minimum of once a reporting period at the beginning of the period.	EAO/ DCO
6.18	Natural gas is usually reported by the gas company in Gigajoules (GJ). A conversion factor from GJ to m^3 shall be obtained from the gas company.	DCO
6.19	Where there is no meter at a facility or it is otherwise infeasible to measure natural gas consumption, the model described in Appendix B shall be used to estimate consumption for the period at the beginning of the next period.	EAO/ MO

6.3 Transportation

Vancity has a number of transportation related greenhouse gas emission sources within its operational boundary. These primarily include work related travel by air and by vehicle and employee commuting to and from work. Business travel (air or ground) is often not associated with a specific facility but is instead associated with a business unit such as a subsidiary within the overall organization. To address this issue, emissions resulting from business travel shall be associated with the head office of the corresponding subsidiary. Employee commuting may also be assigned exclusively to the main office if a single full-time equivalent estimate is not available at the branch level. Vancity does not publish GHG emissions for each facility and thus only the cumulative calculated value is required.

Full-Time Equivalent (FTE) is used to normalize the sample from the Transportation survey as it tracks travel more accurately than Headcount. FTE numbers are supplied by Vancity's Human Resources Department. The FTE, as of December 31st, 2020, which excludes consultants, Vancity Community Foundation and Board members, was 2,368.

6.3.1 Vehicle Travel

There are a number of categories of vehicle travel within Vancity's operational boundary. For each of these, total fuel consumption (the activity data) shall be estimated or measured and a set of emission factors shall be obtained to estimate emissions. Only gasoline and diesel fuel types shall be modeled as they make up the overwhelming majority of fuel types currently in use [9]. Furthermore, the emissions associated with these other fuel types are often low or zero. Blended fuels such as biodiesel or ethanol shall be considered equivalent to the fuel they are blended with (e.g. diesel or gasoline) as the (non-lifecycle) greenhouse gas emissions are nearly equivalent.

6.3.1.1 Emission Factor

Although emissions of CH_4 and N_2O are released by internal combustion engines, they are comparatively small (less than eight per cent of the total CO_2eq emissions factor in the worst case after incorporating GWPs) and highly uncertain [7]. The uncertainty stems from the fact that these emissions factors are both highly dependent on engine and emissions control technology and actual operating conditions. The National Inventory Report lists three CH_4, and N_2O emissions factors for both gasoline and diesel burned in light duty vehicles. Since the exact emissions control technology and operating conditions for vehicles included in the Vancity inventory are not known, the most conservative (highest emissions value) shall be used. Estimates of uncertainty shall be sourced from the uncertainty table in the National Inventory Report.

	Procedure	Role
6.20	Vehicle travel emission factors shall be measured in Grams per Litre (g/L) of fuel.	n/a
6.21	Vehicle travel emission factor for CO_2 shall be obtained from the most recent National Inventory Report: Greenhouse Gases Sources and Sinks in Canada (Annex 12 – Mobile Combustion) authored by Environment Canada at the beginning of each period. Because CO_2 emission factors are generally independent of current emissions control technology but dependant on the fuel type, emission factors for both gasoline and diesel fuel shall be obtained.	DCO
6.22	Vehicle travel emission factors for CH4 and N2O emissions shall be obtained from the most recent National Inventory Report. Since the age of vehicles and operating conditions of vehicles is not known the most conservative (highest emissions value) shall be used.	n/a
6.23	Vehicle travel CO_2 emission factors (gasoline and diesel) shall be reviewed each reporting period at the beginning of the period. Should the emission factors change the base year inventory shall be recalculated (see Section 7).	DCO/ MO

6.3.1.2 Activity Data

For the purpose of estimating greenhouse gas emissions, vehicle travel activity data shall be measured in fuel consumption. Ideally actual fuel consumption would be directly measured; however, it is often not tracked and therefore must be estimated. As the distance traveled by a vehicle is often known or can be estimated, fuel consumption can be estimated by multiplying the distance travelled by an appropriate estimate of fuel economy. There is some uncertainty associated with fuel economy because it is dependent on many factors including age and vehicle operating conditions; nevertheless this provides the most reasonable estimate of total fuel consumption when it is not directly measured. Fuel economy estimates can be obtained from Natural Resources Canada (NRCan). They provide estimates for both specific vehicles and vehicle groups. See Appendix D for details on sources of fuel economy estimates published by Natural Resources Canada.

6.3.1.2.1 Transportation Survey

For some vehicle travel sources neither fuel consumption nor distance traveled is directly tracked, such as for commuting and car allowances. For these sources an annual transportation survey is used to estimate distance traveled and ultimately total emissions. Vancity has developed a transportation survey in cooperation with Acuere Consulting. The survey shall be used to estimate emissions associated with employee commuting (see Section 6.3.1.3), business vehicle travel (see Section 6.3.1.2.3), and vehicle transportation allowance travel (see Section 0).

	Procedure	Role
6.23	The travel survey shall be reviewed once a reporting period prior to running the survey to ensure correctness (e.g. facility and subsidiary names are up to date).	SO
6.24	The travel survey shall be conducted at a minimum of once a reporting period, generally in the fall.	SO
6.25	The travel survey shall have a minimum response rate of 30%.	SO

6.3.1.2.2 Vancity Vehicle Fleet

Vancity leases and operates a small fleet of vehicles. Actual fuel consumption is not tracked at this time; however, both the type of vehicle and the distance travelled is tracked.

	Procedure	Role
6.26	Vehicle fleet activity shall be measured in Litres (L) of fuel.	n/a
6.27	For every vehicle in the fleet the VIN, license plate number, make, model, year, fuel type, and subsidiary it is associated with shall be obtained and confirmed at the beginning of each period.	DCO
6.28	Natural Resources Canada publishes an annual Fuel Consumption Guide (e.g. [10]). For every vehicle in the fleet, the highway and city fuel economy in L/100km shall be obtained from this guide.	DCO
6.29	Where the vehicle operating modes are not known an average fuel economy shall be calculated for each vehicle in the fleet. The following formula, obtained from Natural Resources Canada's Fuel Consumption Guide, shall be used to calculate average fuel economy: Average Fuel Economy (L/100km) = (0.55)x(City Fuel Economy) + (0.45)x(Highway Fuel Economy)	MO
6.30	The odometer reading (km) shall be obtained from the employee responsible for the vehicle on a quarterly basis at the same intervals from year to year.	DCO
6.31	Annual distance travelled shall be calculated by subtracting the last reading in the current reporting period by the last reading from the previous reporting period. For example, to calculate the 2020 distance travelled, the 2019 Q4 reading is subtracted from the 2020 Q4 reading.	MO
6.32	For every vehicle in the fleet fuel consumption (L) shall be calculated using: Fuel Consumption (L) = (Annual Distance Traveled (km)) x (Average Fuel Economy (L/100km))/100	MO
6.33	Based on the fuel type, the appropriate emission factor (diesel or gasoline) shall be used to calculate total emissions.	MO
6.34	Both the methodology Natural Resources Canada uses to estimate fuel economy and the weighting between city and highway driving should be reviewed each reporting period at the beginning of the period. If significant changes are made the base year inventory may need to be recalculated. See Section 7 for guidance.	MO/ VO
6.35	The vehicle fleet inventory shall be reviewed twice per reporting period, at the beginning of the period and end of the period, to ensure it is accurate.	DOC

6.3.1.2.3 Business Vehicle Travel

Vancity compensates employees for use of their private vehicles for business related travel using two methods: (1) mileage reimbursement (referred to as business vehicle travel in this document) and (2) transportation allowances. This section details the calculation for business vehicle travel. Business vehicle travel is broken into two parts.

The first part is the use of an employee's personal vehicle for business travel. In this case, the employee submits the number of kilometers driven for reimbursement. The reimbursement value is used to calculate the number of kilometers driven and the resulting emissions.

The second part of business vehicle travel is the use of Modo vehicles booked through Vancity's corporate account. This, is in addition to the company branded Modo vehicle, secured exclusively for Vancity use and permanently housed at Vancity Centre. In 2017, non-company car Modo usage became a material contributor to Vancity's overall GHG emissions and was added to its Scope 3 emissions under business travel.

The following procedures describe how activity data is estimated to calculate the emissions from business vehicle travel.

	Procedure	Role
6.36	Business vehicle travel activity shall be measured in Litres (L) of fuel.	n/a
6.37	For reimbursed mileage, the total mileage reimbursed ($) for the reporting period, the reimbursement rate ($/km), and the subsidiary the travel is billed to shall be obtained quarterly. If the reimbursement rate changes during the reporting period, the lesser of the two reimbursement rates will be used for the reporting period to ensure emissions calculations are as conservative as possible. Automobile allowance rate per CRA guidelines for automobile reimbursement is used [25]	FO/ DCO
6.38	The total distance of reimbursed travel (km) shall be calculated using: (Total Mileage Reimbursed ($)) / (Reimbursement Rate ($/km)) The total distance of Modo usage is provided by Modo.	MO
6.39	An average fuel economy shall be obtained from Natural Resources Canada (see Appendix D for details on sources) for each fuel type (gasoline and diesel) once per period at the beginning of the period. Note that a change in average fuel economy shall **not** trigger a recalculation of the base year inventory.	DCO
6.40	The percentage of gasoline and diesel vehicles shall be obtained from the Travel Survey. It is assumed that on average the annual distance traveled by diesel and gasoline-fuelled vehicles is equivalent.	SO
6.41	Total fuel consumption (L) shall be calculated for each fuel type (gasoline and diesel) using: Total Fuel Consumption (L) = (Total Distance Traveled (km)) x (% Vehicles of the Fuel Type) x (Average Fuel Economy of the Fuel Type (L/100km)/100)	MO
6.42	Based on the fuel type, the appropriate emission factor (diesel or gasoline) shall be used to calculate total emissions.	MO

6.3.1.2.4 Transportation Allowance Travel

The following procedures describe how activity data associated with car allowances is estimated.

	Procedure	Role
6.43	Transportation allowance travel activity shall be measured in Litres (L) of fuel.	n/a
6.44	The total number of employees with car allowances shall be obtained once per period at the beginning of the period.	FO/ DOC
6.45	The average annual fuel price for regular gasoline and diesel shall be obtained from Statistics Canada (Table 326-0009) for each region Vancity has operations in up to the month the Travel Survey was conducted. For Hybrid vehicles, gasoline engines are used and also due to the range in fuel efficiency for Hybrids, the average annual fuel price will be assigned the same cost per litre as gasoline as stated above.	DCO
6.46	The subsidiary, facility name, average spending on fuel per week, % of work-related travel, and fuel type shall be obtained from the Travel Survey annually for each respondent who indicates they are receiving a car allowance.	SO
6.47	For each applicable response from the previous step the average annual fuel consumption shall be estimated using: Total Fuel Consumption (L) = (% Work Related Travel) x (Average Spending on Fuel per Week($))/(Average Annual Fuel Price for the Fuel Type ($/L)) x (Number of Working Weeks in a Year)	MO
6.48	Based on the fuel type, the appropriate emission factor (diesel or gasoline) shall be used to calculate total emissions.	MO
6.49	The number of employees who have Transportation allowances but did not respond to the survey shall be calculated by subtracting the total number of employees with car allowances by the total number of respondents indicating they were receiving car allowances.	MO/ SO
6.50	Average emissions per car allowance shall be calculated by dividing the total estimated emissions of respondents by the total number of respondents.	MO
6.51	Total emissions of non-respondents shall be estimated by multiply the average emissions per Transportation allowance by the number of non-respondents.	MO
6.52	Total car allowance emissions shall be the sum of the estimated respondent's emissions and the estimated non-respondent's emissions.	MO

6.3.1.3 Employee Commuting

Greenhouse gas emissions associated with employee commuting are very challenging to estimate and correspondingly, there is significant uncertainty associated with the estimate. The most common estimation approach is to conduct a travel survey to assess how often employees are commuting, what modes of transportation they are using, how far they are traveling, etc. The employee commuting model is described in Appendix E. It should be noted that this model only accounts for emissions from employee vehicles; emissions associated with transit and other modes of commuting are not estimated, see section 5.2.1 for details.

In 2020, two changes were made to adjust the methodology to better capture the impacts of the COVID-19 pandemic. In response to the significant increase in work-from-home employees, the calculation for average emissions per trip was expanded to average emissions per effective trip in order to account for telecommutes (zero emission trips). Previously only physical trips were included. Vancity will continue to use effective trips in its calculations from 2020 and beyond. Its operations were also categorized into two states of operation. In quarter (Q) one, it was "business-as-usual" for the organization and for the remainder of the year (Q2 to Q4), it was "business-during-COVID", where more than half of employees transitioned to working from home and a select number of branches were open. To reflect "business-as-usual" for Q1, the previous year's (2019) emissions per employee per week was used and for the remainder of the year, the 2020 emissions per employee per week was used, as per methodology below. This change to categorization is only applicable to 2020.

Emissions for Q1 2020 = (2019 Emissions per Employee per Week) x (Number of FTEs for Q1) x (Number of Working Weeks in a Year for a Vancity Employee / 4 quarters (or 12 months) * one quarter (or three months))

Emissions for Q2 to Q4 2020 = (2020 Emissions per Employee per Week) x (Avg. Number of FTEs for Q2 to Q4) x (Number of Working Weeks in a Year for a Vancity Employee/4 quarters * three quarters)

Total emissions for 2020 = (Emissions from Q1) + (Emissions from Q2 to Q4)

	Procedure	Role
6.53	Employee commuting emissions shall be estimated once per period using the Employee Commuting Emissions Model described in Appendix E.	MO
6.54	The Employee Commuting Emissions Model shall estimate the total emissions of greenhouse gasses per employee effective trip for Vancity as a whole.	MO
6.55	Total emissions per employee per week shall be calculated using: (Emissions from SOV and HOV / physical trips and telecommutes) x 10 one-way effective trips for a full-time (equivalent) employee (FTE)	MO
6.56	Total emissions shall be calculated using: Total Emissions (t) = (Emissions per Employee per Week) x (Number of FTEs per year) x (Number of Working Weeks in a Year for a Vancity Employee)	MO

6.3.2 Air Travel

6.3.2.1 Emission Factor

The UK Department for Environment, Food and Rural Affairs (DEFRA) publishes the most widely used air travel emission factors [11]. These emission factors are specified as a function of flight length and are based on UK flight patterns. As per the BC Best Practices, Vancity has adopted these emission factors and reclassified the flight lengths to be compatible with the North American aviation environment. Vancity also tracks cabin class for all flights and uses emission factors specific to each cabin class.

It is widely recognized that the climate change impact of aviation emissions are attributable to more than just carbon dioxide [12,13]. Various other factors influence the overall total impact. The Radiative Forcing Index (RFI) is the mostly widely used measure to consider non-CO_2 climate forcing. In previous years a conservative estimation of 2 was assumed as the RFI because a more specific value was unavailable. In recent years DEFRA began publishing factors that incorporate a more precise RFI and these are now incorporated into the GHG model. The RFI from DEFRA (1.89) was also assumed for the float plane and helijet transportation factors since these are not incorporated into the factors taken from the BC Best Practices Guide.

	Procedure	Role
6.56	Air travel emission factors shall be measured in Metric Tonnes per Kilometre (t/km) per person.	n/a
6.57	Flight length classifications (e.g. short, medium, or long haul) shall be obtained from the World Resources Institute, specifically the "WRI Transport Tool" model, once per period at the beginning of the period.	DCO
6.68	Emission factors for each flight length classifications shall be obtained from DEFRA (e.g. [11]) or the World Resources Institute, specifically the "WRI Transport Tool" model, whichever is most current, once per period at the beginning of the period. Note if DEFRA emission factors are used the CH_4 and N_2O emission factors shall be converted from CO_2e to CH_4 and N_2O.	DCO
6.59	A radiative forcing factor of 2 shall be used.	MO
6.60	Emission factors shall be multiplied by the radiative forcing factor.	MO
6.61	Air travel emission factors shall be reviewed each reporting period at the beginning of the period. If the methodology, emission factors, or flight length classification change the base year inventory shall be recalculated (see Section 7).	DCO/ MO
6.62	The radiative forcing factor shall be reviewed each reporting period, at the beginning of the period to ensure it is consistent with the most current research. If the factor is updated the base year inventory shall be recalculated (see Section 7).	DCO/ MO

6.3.2.2 Activity Data

The most common method used to estimate the one-way length of a flight is to calculate the great circle distance between the airport of origin and airport of destination; the shortest distance between two points on a sphere. However, as this is the shortest distance between two points, the IPCC recommends adding an additional nine to ten per cent to account for non-direct routing and delays [11,12].

	Procedure	Role
6.63	Air travel activity shall be measured in Kilometres (km) per person.	n/a
6.64	The Finance Officer (FO) shall report all employee business air travel to the Documentation Collection Officer at the end of each quarter. The FO shall report the departure, destination, and intermediate airport codes and the subsidiary the travel is associated with.	FO/ DCO
6.65	For each airport the latitude and longitude shall be obtained in degrees, minutes and seconds from world-airport-codes.com. If the specific airport is not known then the nearest international airport shall be used.	DCO
6.66	For each flight segment the total one-way distance traveled (km) shall be calculated using the great-circle distance algorithm. If the flight is round trip the distance shall be multiplied by 2.	MO
6.67	The flight length shall be multiplied by a factor of 1.09 to account for non-direct routing.	MO
6.68	The flight length shall determine the flight length classification (e.g. short, medium, or long haul) and the appropriate emission factor to use (see emission factor procedures).	MO
6.69	The flight cabin class shall determine the cabin class classification (e.g. economy or business/first class) and the appropriate emission factor to use (see emission factor procedures).	

6.4 Office Activity

6.4.1 Paper Use

6.4.1.1 Emission Factor

There is significant uncertainty associated with estimating emissions of greenhouse gases resulting from the production and disposal of paper. A 2002 study completed by the US-based Paper Task Force estimates GHG emissions for paper from virgin and recycled sources. This study is endorsed by the US Office of the Federal Environmental Executive. The report was commissioned by Environmental Defense, amongst others, and was used to develop an online calculator. The online calculator www.papercalculator.org is now run by the Environmental Paper Network. The calculator estimates greenhouse gases based on the amount of paper (measured by weight), the type of paper, and the per cent of recycled content. Paper use is measured by collecting data on paper purchased, as it is assumed that the amount of paper purchased is equivalent to paper used.

The following citation must be included in any report produced that includes values derived from the calculator: *"Environmental impact estimates were made using the Environmental Paper Network Paper Calculator. For more information, visit* www.papercalculator.org."

	Procedure	Role
6.69	Paper use emission factors shall be measured in Metric Tonnes per Metric Tonnes (t/t) of paper as a function of recycled content (post consumer waste).	n/a
6.70	Paper use emission factors shall be obtained for office paper (Uncoated Freesheet) once per reporting period at the beginning of the period.	DCO
6.71	Paper use emission factors shall be obtained from Environmental Paper Network's online calculator.[1]	DCO/ MO
6.72	Paper use emission factors shall be reviewed each reporting period, at the beginning of the period. Only if the methodology used to derive the emission factors changes shall the base year inventory be recalculated (see Section 7).	DCO/ MO
6.73	Paper use data will be collected quarterly.	DCO

[1]The calculator does not explicitly list emission factors; however, they can be extrapolated (see Appendix C for details).

6.4.1.2 Activity Data

Tracking paper use in a large and diffuse organization such as Vancity is difficult. Nevertheless, procedures have been developed to capture this as best as is reasonably possible. It is assumed that Paper use is the same as Paper purchased as paper purchased will eventually be used. It is not feasible to track paper use at the facility level and thus paper use shall be reported at the subsidiary level; as with transportation emissions, subsidiary level emissions shall be reported against the subsidiary head office. Paper use estimation procedures have been in place for a considerable period of time at Vancity and are described in detail in Appendix F.

7 Base Year

As Vancity has revised its procedures in 2007 to meet the ISO 14064-1 standards, Vancity has defined its base year as the 2007 emission inventory estimates. 2007 was the first year that complete activity data was collected.

Throughout 2009 a number of transactions occurred related to Vancity Group subsidiaries including the removal of Citizens Bank from the personal banking marketplace and the sale of both Vancity Insurance Services and Inhance Investment Management Incorporated. These sales resulted in the elimination of 155 full-time equivalent positions (a 6.96 per cent drop in total employees).

The methodology Vancity uses to assess and estimate the emissions of greenhouse gases associated with its business outlines that if the addition or removal of a facility as a result of a divestment or merger results in more than 1.5 per cent change in total employees, the base year shall be recalculated. As a result of a number of divestments initiated in 2009, the base year was recalculated.

Vancity's original base-year GHG Inventory was 5,504 tonnes CO_2 equivalent. The recalculated total is 5,241 tonnes CO_2 equivalent**.** Revised GHG emissions by scope and by source for the 2007 base year are provided below. Note, that although the divestitures had a significant impact on total employees, it did not have a significant impact on facilities. As a consequence, the baseline for energy and natural gas use has not been adjusted.

Table 5 – Total 2007 GHG Emissions by Scope – Original and Revised

	Revised Tonnes CO_2 equivalent	Tonnes CO_2 equivalent	Uncertainty (+/- %)
Scope 1	466	468	15.7%
Scope 2	386	386	0.0%
Scope 3	4,389	4,650	5.1%

Totals	**5,241**	**5,504**	**4.5%**

Table 6 - Total 2007 GHG Emissions by Source – Original and Revised

	Revised Tonnes CO_2 equivalent	Tonnes CO_2 equivalent	Uncertainty (+/- %)
Electricity	386	386	18.1%
Natural Gas	1,109	1,109	7.7%
Vehicle Fleet Travel	34	36	9.6%
Vehicle Travel	54	58	19.1%
Car Allowance	376	402	2.9%
Commuting	2006	2,146	9.1%
Air Travel	465	498	High*
Paper	811	868	High*

*Uncertainty not assessed but is high.

Base Year Recalculation:

Determining when to recalculate the base year is ultimately up to the discretion of the Verification Officer. Recommendations as to when the base year should and should not be recalculated have been made throughout this document. The following procedures should guide the Verification Officers in this decision. Neither ISO nor WRI provide guidance on how to adjust the base year when an acquisition is made and there is no historical activity data available. In this case the base year shall be calculated using a rolling average. If a business unit is divested, historical emissions related to that business unit shall be subtracted from the base year. Emissions from energy shall be determined based on the facilities that the business units occupied at the time of the base year. Emissions from transportation and office activities shall be pro-rated based on the number of employees working for the business unit during the base year.

7.1 Emissions Targets Recalculation

When the base year has been recalculated emissions targets shall also be updated to reflect the new emissions total. Updated emissions targets shall represent the same relative targets as the original target.

	Procedure	Role
7.1	If changes to the quantification methodologies and procedures described in this document result in significant change of the estimated emissions inventory the base year shall be recalculated. Significant change shall be defined as a per cent change greater than 10%.	VO/ MO

7.2	The base year shall not be recalculated if activity levels (i.e. activity data) change unless this change is a result of a change in the collection or estimation procedures.	VO
7.3	If an emission factor changes then the reason for this change shall be determined. If the change is a result of improved understanding or knowledge then the base year shall be recalculated; however, if the change is a result of technological improvement then the base year shall not be recalculated.	VO/ MO
7.4	As discussed in Section 0, the base year shall **not** recalculate as a result of so called "organic growth". Only as a result of structural change - divestment or acquisition of organizational entities - shall the base year be recalculated. Note that, if the entity divested or acquired did not exist in the base year the base year shall not be recalculated.	VO/ MO
7.5	If an organizational entity is acquired and historical activity data exists or a reasonable and defensible estimate can be made the base year shall be recalculated to incorporate this acquisition. If historical activity data does not exist and cannot be estimated then the base year shall be calculated using a rolling average.	VO/ MO
7.6	If any change in a procedure or methodology results in per cent change to the base year that is less than 10% then the decision to recalculate the base year shall be left to the discretion of the Verification Officer	VO
7.7	If the base year is recalculated the justification for this shall be documented	VO/ DCO
7.8	If the base year is recalculated the emission reduction targets shall be recalculated using the same relative targets.	VO/ MO
7.9	In the event of organizational change the base year shall be recalculated by accounting for the historical emissions of the investiture or divestiture. These emissions will be added to the baseline if it is an investiture and subtracted from the baseline in the result of a divesture. As mentioned above if the investiture/divestiture did not exist during the base year, no recalculation is necessary.	VO/ MO

8 Uncertainty

ISO 14064-1 specifies that an uncertainty assessment should be conducted but does not specify a methodology. In absence of a specific methodology, the IPCC and WRI guidelines will be followed [16, 17]. There are two fundamental sources of uncertainty associated with any model: (1) model uncertainty and (2) parameter uncertainty. Assessing model uncertainty involves evaluating the mathematical equations used to characterize the relationship between the input parameters and outputs, but is in general beyond the scope of this assessment. Parameter uncertainty refers to the uncertainty associated with the inputs to the model (e.g. emission factors, measurement equipment tolerances, etc.) and will be the focus of this uncertainty assessment.

There are two common approaches to estimating and propagating uncertainty: (1) first order error prorogation (Gaussian Method) and (2) Monte Carlo simulation. Monte Carlo simulation is valid in all situations but is significantly more complex to perform and is at this time beyond the scope of this assessment. First order error propagation is much simpler to perform but is only valid if certain conditions hold true (see [17]). First order error propagation shall be used and it shall be assumed that these assumptions hold true. See the IPCC or WRI guides for specific on this method [16, 17]. To describe uncertainty a confidence interval must be specified. The most commonly used confidence interval is 95 per cent [16, 18].

As described in the WRI guide, there will be significant uncertainty associated with the uncertainty assessment itself. Technical understanding, data constraints and practical limitations make it difficult to perform a systematic and comprehensive uncertainty assessment. In some cases estimating uncertainty is not possible, for example paper, as the uncertainties are so great or the scientific understanding so limited. In these cases a specific estimate cannot be made and the uncertainty will be assessed qualitatively. The assessment approach described has its limitations and in the future it may be necessary to develop a more sophisticated approach based Monte Carlo simulation; however, at this time it should provide a reasonable characterization of the uncertainty of the emissions inventory. Furthermore, the purpose of an uncertainty assessment is as much to identify where improvements can be made with maximum value, which this assessment will facilitate.

	Procedure	Role
8.1	First order error propagation shall be used to assess uncertainty. The conditions under which this method is valid shall be assumed to be true.	MO
8.2	The 95% confidence interval shall be used.	MO
8.3	The uncertainty analysis shall be performed/reviewed once per reporting period, at the beginning of the period, to ensure that estimates are up to date and to identify any potential improvements or data quality issues.	DCO/ MO

8.1 Uncertainty Sources and Estimates

This section describes the parameter and model uncertainties that have been identified and assessed. For the purpose of this uncertainty assessment it is assumed that all uncertainties are normally distributed. Although in some cases this may not hold true it is a reasonable assumption for the scope of this uncertainty assessment. The Bias column is used to provide an indication of whether this assumption holds true and if it does not, which direction the bias is believed to be in.

8.1.1 Energy

There are three main sources of uncertainty associated with energy related emission estimates:

1. Emission Factors (Electricity and Natural Gas)
2. Natural Gas and Electricity Meters
3. Energy Use Model

8.1.1.1 Emission Factors

Environment Canada publishes uncertainty estimates of the emission factors (associated with fuel combustion in the National Inventory Report. Statistics Canada, the data provider for the National Inventory Report states the following with regards to their data on electricity disposition: *Since the survey is a census of the target population, there is no sampling error. Given the very high response rate and the error detections based on other sources, non-*

sampling errors are reduced[1]. Thus, it was assumed that the only uncertainty in the electricity emissions factors is caused by the fuel combustion emission uncertainty.

Type	Description	Source	Bias	+/- %
Parameter	Fuel Combustion Uncertainty (CO2)	Environment Canada (2015): National Inventory Report (1990-2013)	No	11
Parameter	Fuel Combustion Uncertainty (CH4)	Environment Canada (2015): National Inventory Report (1990-2013)	No	34
Parameter	Fuel Combustion Uncertainty (N2O)	Environment Canada (2015): National Inventory Report (1990-2013)	No	48

8.1.1.2 Natural Gas and Electricity Meters

Measurements Canada regulates the tolerance of both electricity and natural gas meters under the Electricity and Gas Inspection Act and corresponding specifications:

Type	Description	Source	Bias	+/- %
Parameter	Electricity Meter Tolerance	S-E-01 Specifications for the Calibration, Certification and Use of Electricity Calibration Consoles	No	0.5
Parameter	Natural Gas Meter Tolerance	LMB-EG-08 - Specifications for Approval of Type of Gas Meters and Auxiliary Devices	No	1.5

8.1.1.3 Energy Use Model

See Appendix B for details on the uncertainty associated with the Energy Use Model

8.1.2 Transportation

There are many sources of uncertainty associated with transportation related emissions. The following sources have been assessed:

- Vehicle Odometers
- Fuel Economy
- Fuel Emission Factors
- Fuel Price
- Radiative Forcing Factor
- Aviation Emission Factors
- Flight Routing
- Earth Radius
- Car Allowance Travel Model
- Employee Commuting Model
- Number of Working Weeks

Both commuting and car allowance estimates are based on a survey conducted once per reporting period, typically in the Fall as this represents a conservative 'typical' commuting

[1] Electricity Survey Data Accuracy Statement: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&lang=en&db=imdb&adm=8&dis=2&SDDS=2151#a3

period. The survey provides only a single snapshot of the activity data in a very dynamic organization. Facilities and employees are added and removed throughout the course of a reporting period, some before and some after the survey is conducted. The results of the travel survey will inevitably be biased and reflect the organization and its operations at the time the survey is conducted. In a growing organization this means the estimates would likely be positively biased (estimates would likely be higher than actuals) and in a shrinking organization, negatively biased, assuming the survey is conducted at the end of the reporting period, as it has in the past. Car allowance results in particular are likely to be biased as there is an incentive for employees to report a higher than actual percentage of work-related travel.

8.1.2.1 Vehicle Emission Uncertainty Sources

Odometer

Vehicle odometer tolerance is not specifically regulated; manufactures are only required to specify the tolerance. However, Honda Motor Company was recently sued in the US on grounds that odometers in their vehicles were biased and outside of what was deemed as reasonable tolerance [19, 20]. As a result, the court ordered that owners of Honda vehicles have their warranty coverage extend by five per cent. It shall be assumed that other manufactures either are or will be in compliance with this tolerance.

Fuel Economy

There is uncertainty associated with fuel economy estimates because they are dependent on factors such as the vehicle weight, engine technology, fuel type, and actual operating conditions. Two sources of fuel economy estimates are used: (1) Natural Resources Canada's Fuel Consumption Guide and (2) Natural Resources Canada's Canadian Vehicle Survey. The estimates published in the Fuel Consumption Guide are based on a standard test procedure but there is uncertainty as to what degree the test procedure captures actual real-world driving conditions. A 2005 Consumers Reports study found that in a test of 303 light duty vehicles that actual fuel economy deviated from the published rating by between +21% and -28% [21]. The study also found that 90 per cent of the vehicles tested had fuel economies worse than the published rating. Although this was a US study, US and Canadian test procedures were the same at the time of the study. It should be noted that the US has recently revised their test procedure and Canada is likely to follow. The Canadian Vehicle Survey provides rough data quality rankings and corresponding confidence intervals.

Fuel Emission Factors

The IPCC estimates the uncertainty associated with fuel emission factors to be less than five per cent (Section 2.1.1.6 [16]). As part of the national reporting procedure Environment Canada

commissioned a study to quantify the uncertainty associated with various fuel emission factors. Unfortunately these values were not published in their report.

Fuel Prices

Statistics Canada publishes monthly average fuel prices. Confidence intervals shall be calculated to estimate the uncertainty of the average annual fuel price.

Employee Commuting Model

The model used to estimate employee commuting does not estimate uncertainty and as previously discussed there will be biases present in the survey. Without having a more detailed understanding of biases present in the survey it is difficult to estimate uncertainty; however, an estimate of uncertainty was made based on discussions with the model developer and fuel economy uncertainties.

Car Allowance Travel

Assessing uncertainty from a survey is difficult; there is no simple way of assessing the accuracy of estimates made by respondents or how representative the estimates at the time of the survey are over the course of a year. In addition, there will be biases present in the survey. To provide some measure of uncertainty, confidence intervals shall be calculated for both the fuel spending per week and per cent of work-related travel.

Working Weeks

There is uncertainty associated with the average number of weeks in a year a full-time employee works. Vancity's Human Resources department provided an estimate from which an uncertainty estimate was derived which includes care days, average vacation days and statutory holidays.

Type	Description	Source	Bias	+/- %
Parameter	Odometer Tolerance	Karen Vaughn vs. Honda Motor Co Inc (US District Court)	-	5.0
Parameter	Fuel Economy (Both Fuel Types) - Fuel Consumption Guide	Consumer Reports Study [21]	-	30.0
Parameter	Gasoline Emission Factor	IPCC (2000) - IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Section 2.1.1.6) [16]	No	5.0
Parameter	Diesel Emission Factor	IPCC (2000) - IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Section 2.1.1.6) [16]	No	5.0
Parameter	Fuel Price	Statistical Methods	No	(variable)
Parameter	Car Allowance Travel	Statistical Methods	+	(variable)
Model	Employee Commuting Model	Expert Elicitation	?	30.0
Parameter	Working Weeks	Expert Elicitation	?	5.0

8.1.2.2 Aviation Emission Uncertainty Sources

There is considerable uncertainty associated with both the impact and release of aviation emissions. In particular there is great uncertainty associated with the radiative forcing factor. Recent studies have suggested the value could be as much as two times current estimates but don't give a specific uncertainty estimate [13]. At this time there is no widely accepted measure of uncertainty associated with the radiative forcing of aviation emissions. Because of variations in aircraft, fuels, flight paths, loads, and operating conditions there is significant uncertainty associated with aviation emissions factors that are a function of distance traveled; however, there are no published estimates. Finally, there is model uncertainty associated with estimating the length of a flight. The IPCC suggests that due to air traffic control inefficiencies and indirect flight routing that the flight length be increased by between nine to 10 per cent over the direct route [11, 12]. This value shall be assumed to capture the uncertainty in the flight length as well. As there is significant uncertainty associated with radiative forcing and no published estimates of emission factor uncertainties, the uncertainties associated with aviation emissions will not be assessed quantitatively, although it shall be assumed that they are large.

Type	Description	Source	Bias	+/- %
Parameter	Radiative Forcing Factor	Sausen et. al. (2005) - Aviation radiative forcing in 2000: An update on IPCC (1999)	No	2x
Parameter	Aviation Emission Factors	None	?	?
Model	Flight Routing	IPCC (1999) - Aviation and the Global Atmosphere (Section 8.2.2.3) [12]	No	9.0
Parameter	Earth's Radius	NASA (nssdc.gsfc.nasa.gov/planetary /factsheet/earthfact.html)	No	0.5

8.1.3 Office Activity

8.1.3.1 Paper

There are significant uncertainties with regards to both paper consumption activity data and emission factors. There are no published estimates of uncertainty associated with the emission factor but it is believed to be very high, likely orders of magnitude. As a result uncertainties associated with paper will not be assessed as the results would be meaningless. It should be noted that the WRI has actually removed paper from their emissions inventory citing that the uncertainty was too great [22].

9 Reporting

To claim ISO 14064 conformance Vancity must either produce a report as specified in ISO 14064-1 Section 7 or receive a third-party verification statement. Vancity will report annually on their GHG inventory and will undertake the steps necessary for third-party verification.

	Procedure	Role
9.1	A GHG inventory/carbon footprint report and a Carbon Neutral report shall be prepared at the end of each reporting period and be verified by a third party.	VO
9.2	The reports shall be prepared in accordance with CSA/ISO 14064-1, *Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* [1].	VO
9.3	The reports shall document the results of the review of this document and any changes made including supporting sources.	VO
9.4	The reports shall document any deviations from the procedures described in this document and the reasons for these deviations.	VO
9.5	The reports shall document any problems encountered and potential solutions and an implementation strategy.	VO

9.1 Reporting Requirements

CSA/ISO 14064-1 recommends documenting directed actions that result in a reduction of greenhouse gas emissions. If and only if the reduction is reported then the standard requires that the reductions associated with each action are reported separately and that the following is described:

a) the directed action,
b) the spatial and temporal boundaries of the directed action,
c) the approach used to quantify GHG emission or removal differences, and
d) the determination and classification of GHG emission or removal differences attributable to directed actions as direct, indirect or other types of GHG emissions or removals.

The standard also requires that any offsets, purchased or developed, be explicitly reported ([1] Section 4.2.2).

10 Information Management

ISO 14064-1 requires that information management procedures be implemented. Documentation supporting the design, development and maintenance of the inventory shall be retained to support the verification process and provide a historical record. This task is the primary responsibility of the Data Collection Officer. In determining what information needs to be retained the following principles can be applied:

1) At any point in time, all past emissions inventories should be able to satisfy an audit.
2) At any point in time, any past emissions inventory should be able to be recalculated from the retained records

In general the following information needs to be retained in some form:

	Information
1)	The verification report described in Section 9
2)	The procedures, processes, and methodologies used to estimate the emissions inventory (i.e. this document) and relevant sources
3)	All emission factors and their sources
4)	All activity data, activity data models, and their sources
5)	All models
6)	All supporting documentation and sources
7)	The emissions inventory, reported at the facility level

The following directory structure shall be created on a single, backed-up storage location and used to store and maintain all information:

- Emissions Inventory
    - Procedures and Reporting – Contains a copy of this document and other relevant documents and supporting source material
    - Model – Contains a clean copy of all major versions of the model
    - Year (2007, 2008, 2009 ...)
        - Report – Contains the Verification Report.
        - Data – Contains raw activity data and survey results.
        - Model – Contains the emissions inventory model.
        - Base Year – Contains the emissions inventory model of the current base year.

11 Verification Procedure

ISO 14064-1 requires a verification procedure be established with the auditor/verifier. The following describes the general procedures that shall be followed (see Section 8 of [1] for further details).

	Procedure	Role
11.1	Before verification is conducted the procedures described in this document shall have been completed.	n/a
11.2	The appointed auditor/verifier shall have the necessary background, training, and competency to perform the verification as defined in ISO 14065 (see Section 8.3.3 of [1] for further details).	VO
11.3	The objectives, scope, level of assurance, materiality, and data sampling and custody criteria shall be discussed and established with the verifier.	VO
11.4	A verification statement shall be obtained from the verifier that includes as a minimum: a description of the objectives, scope and criteria of the verification activities, a description of the level of assurance, and the verifier's conclusion indicating any qualification or limitations (see Section 8.3.4 of [1] for further details).	VO
11.5	The verification statement shall be reviewed to ensure it is consistent with criteria established with the verifier.	VO

Appendix A Roles and Responsibilities Form

	Name	Contact Information (Phone/Email)
Data Collection Officer		
1		
2		
3		
Verification Officer		
1		
2		
3		
Modeling Officer		
1		
2		
3		
External Verification Officer		
1		
2		
3		
Finance Officer		
1		
2		
3		
Energy Assessment Officer		
1		
2		
3		
Survey Officer		
1		
2		
3		

Appendix B Energy Use Model

A number of Vancity's facilities are not metered for electricity and/or natural gas use. For these facilities a model is used to estimate facility energy use. There are many factors that influence building energy use such as age, type, construction quality, and weather. However, it is not feasible to develop a model to incorporate all of these factors. To simplify, the model only the building type and the province it is located in shall be considered. It shall be assumed that based on this categorization that the buildings Vancity operates are similar and that its energy use per unit area is on average similar. A statistical analysis of the 2006 electricity and gas use for metered Vancity facilities located in B.C. indicates that this is a reasonable assumption (see Tables 7 and 8, and Figure 3 and 3).

There were insufficient numbers of the Mall Building category so the Mall and Strip Mall categorise were combined into a single Mall category. No statistically significant difference was found between Mall and Free Standing building categories (ie. factors other than the building type are responsible for variations in energy use). The analysis also showed that electricity use per m^2 is normally distributed (see Figure 2) and that natural gas use per m^2 appears to be normally or log-normally distributed (see Figure 3). This analysis shows that it is reasonable to use Vancity's metered facilities to estimate energy use of its non-metered sites for Strip Mall, Mall and Free Standing building categories.

Table 7: Electricity per m^2 Descriptive Statistics

Electricity Use per m^2 Analysis					
Free Standing (FS)	**Usage (kWh)**	**Strip Mall (SM)**	**Usage (kWh)**	**Mall (M)**	**Usage (kWh)**
Mean	248.5894138	Mean	251.3535836	Mean	242.5451558
Standard Error	15.71835506	Standard Error	15.55491491	Standard Error	65.97193604
Standard Deviation	62.87342024	Standard Deviation	69.56369426	Standard Deviation	93.29840669
Minimum	158.99196	Minimum	117.7051507	Minimum	176.5732198
Maximum	354.9852696	Maximum	399.1797105	Maximum	308.5170918
Sum	3977.430621	Sum	5027.071673	Sum	485.0903116
Count	16	Count	20	Count	2
Confidence Level(95.0%)	33.50288059	Confidence Level(95.0%)	32.55681101	Confidence Level(95.0%)	838.252926

Table 8: Natural gas per m^2 Descriptive Statistics

Natural Gas Use per m^2 Analysis			
Free Standing (FS)	**Usage (GJ)**	**Strip Mall (SM)**	**Usage (GJ)**
Mean	0.423048	Mean	0.381238
Standard Error	0.069411	Standard Error	0.059119
Standard Deviation	0.259713	Standard Deviation	0.196074
Sample Variance	0.067451	Sample Variance	0.038445
Minimum	0.080014	Minimum	0.133146
Maximum	1.191162	Maximum	0.783595
Sum	5.922668	Sum	4.193619
Count	14	Count	11

Confidence Level(95.0%)	0.149954	Confidence Level(95.0%)	0.131724

Figure 2: - Electricity Use Histogram for Freestanding and Mall building Categories

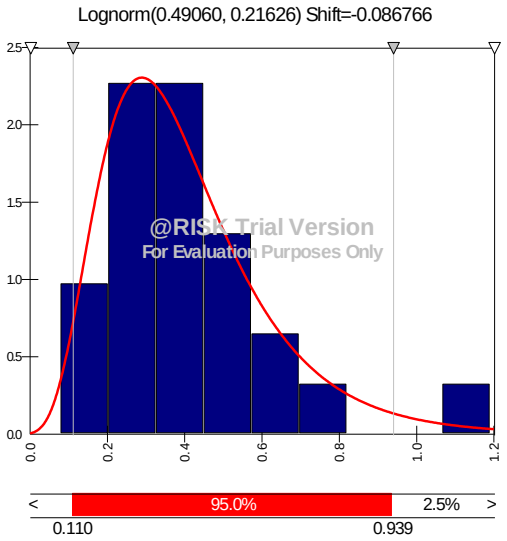
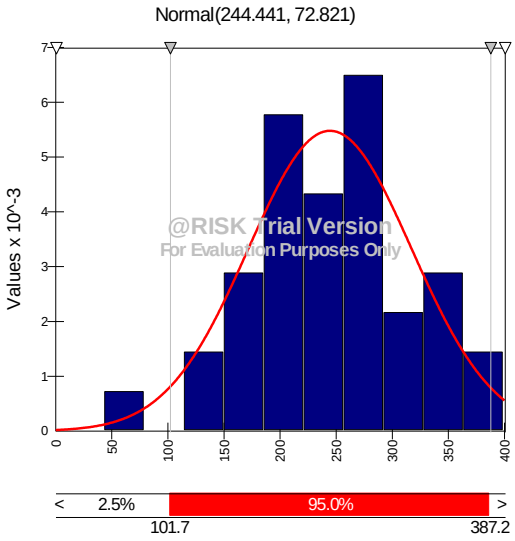


Figure 3- Natural Gas Use Histogram for Freestanding and Mall building Categories



For the Office Building category, estimates based on Natural Resources Canada's energy use surveys shall be used. The most recent and most relevant survey is the "Survey of Commercial and Institutional Energy Use" [23]. This report provides an average energy use per square metre (GJ/m^2) by province for various building categories (Table 2.4 in the SCIEU report). The split between electricity and natural gas is reported by province but not by building category, so this breakdown was estimated based on the average of all building types (Table 1.2 in the SCIEU report). This process shall be used to develop estimates when there are an insufficient number of metered facilities to generate a statistically valid estimate; a minimum of 5 facilities are needed (see **Error! Reference source not found.**9).

Rough estimates of uncertainties can also be obtained from the report using the quality ranking of the statistics (A, B, C, etc.) and the corresponding coefficient of variation (CV). The confidence interval for the calculated parameters shall be based on the maximum CV for each parameter (A: 20%; B: 30%; C: 40%). To calculate the cumulative CV of the calculated parameters, the following formulae are used:

Addition of Std. Deviation: $S_X = \text{sqrt}(S_A^2 + S_B^2 + ...)$
Multiplication of Std. Deviation: $S_X = X*\text{sqrt}((S_A/A)^2 + (S_B/B)^2 + ...)$
S: standard deviation
X: the calculated parameter

A and B: intermediate parameters

Table 9: NRCan Office BEPI

Natural Gas	**GJ/m2/yr**	**kwh/sf/yr**
BC Nat Gas	0.510	13.16
ON Nat Gas	0.735	18.97
AB Nat Gas	0.866	22.35
Electricity	**kWh/m2/yr**	**kwh/sf/yr**
BC Elec	138.11	12.83
ON Elec	136.42	12.67
AB Elec	191.82	17.82

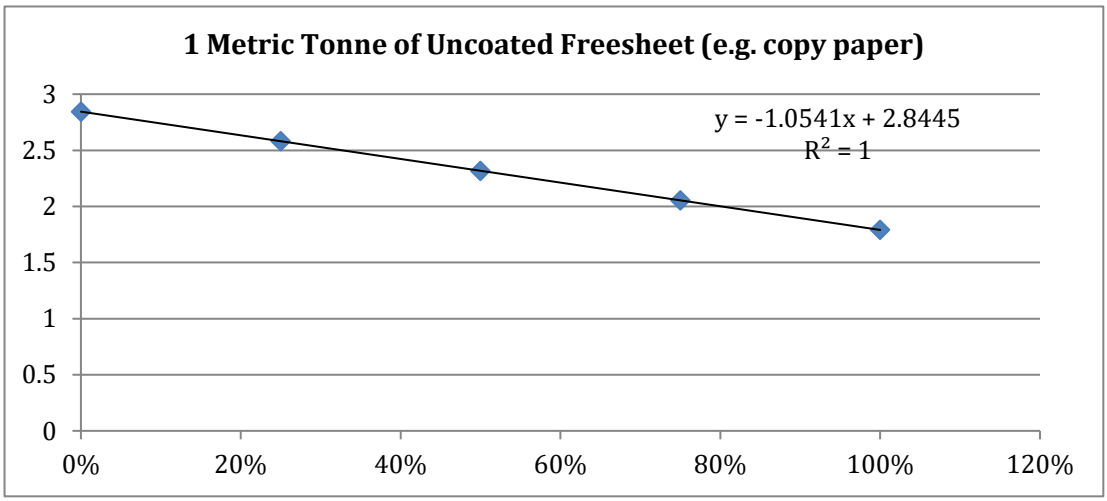
Office locations			
Q4 2018 to Q3 2019 building locations		Electric	Fuel
Vancity Centre	Metered	Metered	Metered
815 West Hastings	Proportionate Share	Proportionate Share	Proportionate Share
Central Surrey (1300,1350 HVAC) ICF/CLA	Sub-metered	Sub-Metered	Sub-metered
DRS	Metered	Metered	Metered
369 Terminal Ave (3rd and 6th floor)	Sub-metered	Sub-metered	Uses NRCan gas numbers for BC
Calgary	NRCan Alberta	NRCan Alberta	NRCan Alberta
Toronto	NRCan Ontario	NRCan Ontario	NRCan Ontario

Appendix C Paper Use Emission Factor Sample Derivation

To obtain a paper use emissions factor Environmental Paper Network's online calculator is used. The calculator does not explicitly list emission factors; however, they can be extrapolated by calculating the greenhouse gas emissions associated with 1 Metric Tonne of each paper type for the following recycling percentages: 0%, 25%, 50%, 75%, 100%. Presently the relationship is linear ($R^2 = 1$) and a linear regression can be used to determine emission factors as a function of recycled content. For example:

Inputs:
Paper Type: Uncoated Freesheet
Amount: 1 Metric Tonne
% Recycled Content: 0%, 25%, 50%, 75%, 100%

% Recycled Content	lbs of CO2	Kg of CO2	Metric Tonnes of CO2 / Metric Tonne of paper
0%	6,271	2844.477	2.84
25%	5,690	2580.94	2.58
50%	5,109	2317.403	2.32
75%	4,528	2053.866	2.05
100%	3,947	1790.329	1.79



This formula (y = -1.054x + 2.844) can then be used to calculate the emissions factor as a function of recycled content, where y is the emission factor in Metric Tonnes per Metric Tonne of paper and x is the per cent recycled content.

Appendix D Natural Resources Canada Fuel Economy Estimates

Natural Resources Canada (NRCan) publishes a number of fuel economy estimates for both specific vehicles and vehicles classes.

Specific Vehicles

Every year NRCan publishes a fuel consumption guide (available online) listing the tested city and highway fuel economy ratings for all vehicles sold in Canada (for example [10]). They also report an average fuel economy rating that can be used when the driving mode is not known.

Vehicle Classes

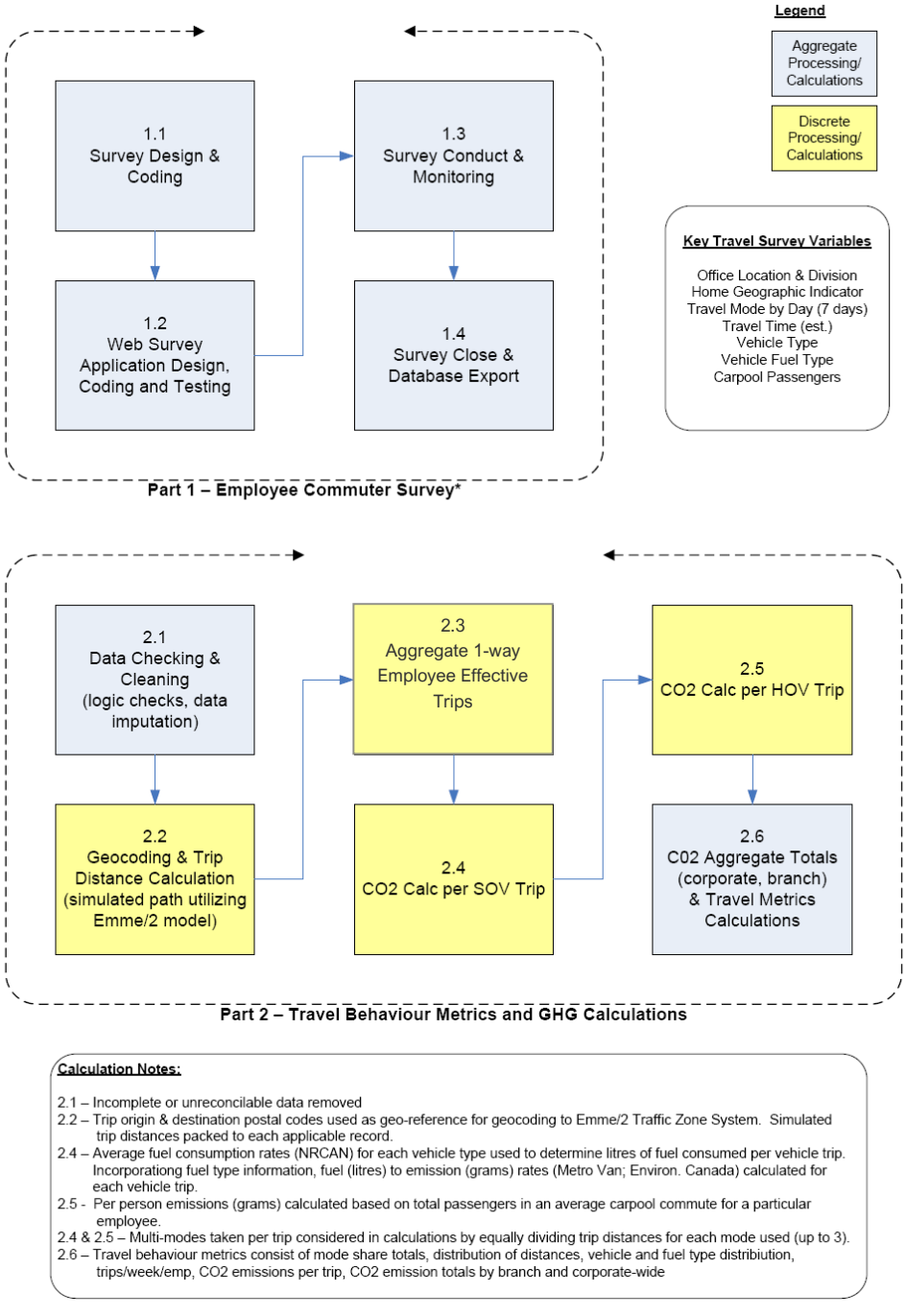
NRCan publishes a number of fuel economy statistics. The data is collected through a number of methods and aggregated in three main data collections:

(1) Vehicle Fuel Economy Information System (VFEIS) (maintained by Transport Canada) [24]
(2) Vehicle Information System (VIS) [24]
(3) National Energy Use Database (NEUD)

The VFEIS and VIS systems contain the same data that is published in the fuel consumption guides and the NEUD contains estimates based on models (e.g. Transportation End Use Model) and survey results. From the NEUD NRCan produces the Energy Use Data Handbook which includes a section on transportation. In addition, NRCan also publishes summary reports based on the surveys they conduct.

Appendix E Employee Commuting Emissions Model

The output of Acuere commuting model (depicted in the diagram below) is an estimate of CO_2 emissions and GWP ($CO2_e$) for a Vancity employee effective trip per week. In the GHG model, the GWP of the emissions shall be estimated based on the ratio of CH_4 and N_2O to CO_2 from the National Inventory Report factors used elsewhere in the transportation model.



Appendix F Paper Use Estimation Procedure

Procurement of paper based products for use by the Vancity Group is generally decentralized. Apart from general office paper used for photo copiers, faxes, member statements, company letterhead, stationary, and envelopes, departments order and purchase their own paper products as needed.

The following table lists examples of departments that have been identified as purchasers of paper products and the use of the paper.

Department	Paper purchased
Vancity Marketing	Brochures, posters, letterhead and envelopes, buckslips, mailers and other advertising and marketing campaign materials
Purchasing	Member forms, both generic and custom, statements, memo pads, letterhead, cheques, deposit books, brochures, business cards, branch vouchers, envelopes, other miscellaneous office paper
Corporate Communications	Member newsletters and other communications, corporate reports, corporate business plans, employee communications
Governance	AGM and election materials including statement stuffers, ballots, voting cards, envelopes
Visa	Card carriers, backers and inserts, terms and conditions

Procedure:

1. Paper use data is collected by Data Collection Officer from each of the departments listed above on a quarterly basis. Paper use data is collected through an online system and is based on paper purchased/ordered as it is assumed that the paper purchased is equivalent to paper used.
2. Total weight of paper purchased, as well as per cent of paper that is post consumer waste (PCW) is tabulated and summarized.

Appendix G Materiality Analysis

Vancity GHG Emission Materiality Analysis

Quantifying the emissions from employee ferry travel, banking machine operation and fugitive refrigerant emissions

Nathan Lemphers

December 2009

the PEMBINA institute
Sustainable Energy Solutions

The Pembina Foundation for Environmental Research and Education is a national registered charitable organization that enters into contractual agreements with environmental research and education experts, such as the Pembina Institute, to deliver on its work.

The Pembina Institute
Box 7558
Drayton Valley, Alberta
Canada T7A 1S7
Phone: 780-542-6272
Email: info@pembina.org

About the Pembina Institute

The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about the Pembina Institute, visit www.pembina.org or contact info@pembina.org. Our engaging monthly newsletter offers insights into the Pembina Institute's projects and activities, and highlights recent news and publications. Subscribe to Pembina eNews: http://www.pembina.org/enews/subscribe.

1. Introduction

The purpose of this report is to assess the materiality of greenhouse gas (GHG) emissions from three previously unaccounted sources in Vancity's business practice: Employee ferry travel; standalone automated banking machines; and refrigerants. Vancity's materiality threshold for inclusion into its GHG emission management model is one percent of total annual emissions. That is, if any of these sources exceed one percent of Vancity's annual GHG emissions, then those sources should be included in its management model.

2. Employee Ferry Travel

The purpose of this analysis is to determine if the emissions from Vancity employee travel by ferry is material to Vancity's GHG footprint.

An estimated 200-300 Vancity employees traveled one-way between Vancouver and Vancouver Island in 2008. The majority of employees traveled between Swartz Bay and Tsawwassen. A minority traveled both between Departure Bay and Horseshoe Bay, and between Duke Point and Tsawwassen.

BC Ferries was contacted to obtain the most recent ferry GHG emission figures, but it's representatives are in the process of releasing updated greenhouse gas emissions for the fleet and were unable to provide current numbers.[1] Greenhouse gas emissions accurate to August 2009 were acquired and have been included in the calculations. Because of the limitations of these emission figures, the emissions for walk-on and drive-on ferry passengers were aggregated, and one single blended emission factor was applied on a per passenger basis.

[1] BC Ferries plans to release these updated figures in January 2010. (Personal Communications, Ross Cameron, BC Ferries).

Table 1: Vancity Employee-related GHG emissions on BC Ferries

Route	kg CO2e/ one-way crossing /passenger	# Passengers	kg C02e	
Swartz Bay - Tsawwassen	13.1	200	2621.01	
Departure Bay - Horseshoe Bay	17.1	25	426.71	
Duke Point - Tsawwassen	36.6	25	915.93	
	TOTAL	250	**3963.65**	**TOTAL KG CO2**
			3.96	metric tonnes CO2
			0.07	**% of total annual Vancity GHG emissions**
			0.11	% of Scope 3

High End Calcs	
300	Max Vancity Ferry Passengers
10991.13	Using most polluting route (DP - TSW)
10.10	metric tonnes CO2
0.19	**% of total annual Vancity GHG emissions**
0.27	% of Scope 3

Table 1 shows that, with a breakdown of 200, 25 and 25 passengers traveling from Swartz Bay, Departure Bay and Duke Point respectively, only 3.96 metric tonnes of carbon dioxide are created by Vancity employee passenger travel annually. This represents only 0.07 percent of total Vancity GHG emissions and 0.1 percent of Scope 3 emissions.

When considering, under extreme circumstances, all employees taking the most polluting ferry journey (from Duke Point to Tsawwassen), only 10.10 metric tonnes of GHGs are emitted or 0.19 percent of total Vancity GHG emissions and 0.27 percent of Scope 3 emissions.

Therefore, it is reasonable to conclude that the GHG emissions related to Vancity employee travel on BC Ferries is immaterial to Vancity's GHG emissions management program. Employee ferry travel would have to increase five times the current amount to cross Vancity's materiality threshold of one percent of total emissions. That said, if ferry travel were replaced by a more polluting form of transport (e.g. seaplanes), it is conceivable that those emissions would be material. Ferry travel, given alternative transportation modes, is relatively less polluting.

3. Banking Machines

Standalone automated banking machines (ABMs) have also been identified as a potential source of GHG emissions not previously included in Vancity's GHG emission management program. To carryout a materiality analysis, the number of banking machines was obtained along with the energy consumption of a typical banking machine and the most recent estimate of BC Hydro's GHG emission per GWh for British Columbia's Lower Mainland. [2]

Vancity currently has six standalone ABMs in operation. Table two explains the average electricity consumption of ABMs in Canada and also the most current average GHG emissions per kWh in British Columbia's Lower Mainland.[3]

Table two: Vancity standalone ABM GHG emissions

kwh/year/ABM	#of ABM	tGHG / KWH in Van	Total tGHG for 6 ABM	% Total
2490	6	0.000022	0.33	**0.01**
			% Scope 2	
				0.04

Avg tGHG emissions / GWh in BC (2008)
22

Given the calculations shown in table two, the Vancity standalone ABM annual GHG emissions are immaterial to Vancity's GHG emission management program. One reason why this number is low is because of BC Hydro's use of low GHG emission hydroelectric power rather than coal-fired power. The number of Vancity standalone ABMs would have to increase one hundredfold for their collective emissions to cross Vancity's materiality threshold of one percent total GHG emissions.

[2] This electricity consumption rate for standalone ABMs was obtained from work the Pembina Institute has carried out with other banking institutions in Canada and is considered an industry standard.

[3] This average was obtained by BC Hydro and reflects its emissions per kWh in 2008.

4. Fugitive Refrigerant Emissions

The fugitive GHG emissions from refrigerants in Vancity's refrigerators and HVAC units are another potential material source of unaccounted GHG emissions. To carry out this materiality analysis, information was gathered from building management personnel at Vancity and experts in the field of HVAC GHG emission accounting. The GHG Protocols's tool for calculating HFC-PRC emissions, considered a global standard, was used to analyze the data.

Of the three areas The Pembina Institute analyzed, calculating the fugitive emissions from Vancity's refrigerators and HVAC units was the most difficult. Vancity hasn't previously had the need to inventory its HVAC units and the absence of this data presented a key uncertainty to this analysis. The global warming potential among different refrigerants can vary by over three orders of magnitude, making attempts at estimation highly uncertain. The experts in the field of GHG emission accounting consulted felt that given the size and nature of Vancity's operations (in a temperate climate and without industrial-scale refrigerators), it is unlikely that Vancity's fugitive GHG emissions from refrigerants are material.[4]

Despite the lack of HVAC data, the number of refrigerators owned by Vancity, and amount of refrigerant used by Vancity, was obtained. Using the HFC-PFC emissions tool, shown in table three, the fugitive GHG emissions from refrigerators was determined.

Table three: GHG Protocol HFC-PFC Emissions Calculator with Vancity Refrigerator Data

A	B	C	D	E	F	G	H
Refrigeration/Air-Conditioner Equipment Name	Number of Units	Type of Refrigerant	GWP of Refrigerant	Refrigerant Charge (kilograms)	Annual Leakage Rate (%)	Conversion Factor (tonnes/kilograms)	Operation Emissions (tonnes of CO2 equivalent/yr)
Optional		Optional	See Table 1	See Table 2	See Table 2		B x D x E x F x G
Kitchen Refrigerators	80	HFC134a	1,300	0.50	1%	1.00E-03	0.26

Based on the data provided in table three, the total annual fugitive GHG emissions for Vancity's 80 refrigerators is 0.26 metric tonnes or 0.005% of total annual GHG emissions. Given the likely insignificance of fugitive GHG emission from Vancity's HVAC units, it is reasonable to conclude that fugitive refrigerant emissions are currently immaterial.[5]

[4] Personal communications, Michael Leering, Canadian Standards Association; Mark Stephenson, CohosEvamy; Brian Gouge, University of British Columbia; Rich Wong, Pembina Institute.

[5] An inventory of Vancity's HVAC units is scheduled to be completed in 2010. This inventory will be crucial in creating a more defensible materiality check for Vancity's fugitive refrigerant emissions.

5. Conclusion

In conclusion, at this time, GHG emissions from employee ferry travel, standalone automated banking machines and fugitive refrigerants are immaterial (i.e. less than one percent of total annual GHG emissions) to Vancity's GHG footprint. It is recommended that the materiality analysis be revisited once Vancity has developed an HVAC inventory and once BC Ferries releases new GHG emission figures.

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