Comox Valley Regional District 2021 GPC BASIC+ Community Greenhouse Gas (GHG) Emissions Inventory Report

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

Executive Summary

There is increasing evidence that global climate change resulting from emissions of carbon dioxide (CO_2) and other greenhouse gases (GHGs) is having a significant impact on the ecology of the planet. Delayed actions to respond to the effects of climate change are expected to have serious negative impacts on global economic growth and development.

Beyond the costs associated with delayed climate action, there are cost savings to be realized through efforts to improve energy efficiency, conserve energy, and reduce GHG emissions intensity. To make informed decisions on reducing energy use and GHG emissions at the community scale, community managers must have a good understanding of these sources, the activities that drive them, and their relative contribution to the total. This requires the completion of an energy and GHG emissions inventory. To allow for credible and meaningful reporting locally and internationally, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (the GPC Protocol) was developed. The GPC Protocol has been adopted by the Global Covenant of Mayors—an agreement led by community networks to undertake a transparent and supportive approach to measure GHG emissions community-wide. The Global Covenant of Mayors and the Federation of Canadian Municipalities promotes the use of the GPC Protocol as a standardized way for municipalities to collect and report their actions on climate change.

This project set out to compile a detailed GHG inventory for the Comox Valley Regional District (CVRD) for the 2021 reporting year using the GPC Protocol. The CVRD has historically relied on the Provincial 2018, 2010 and 2012 Community Energy and Emissions Inventories (CEEI) to baseline and track community GHG emissions. However, there have been some limitations to the CEEI which has resulted in the CVRD preparing a GPC BASIC+ inventory. Following the requirements of the GPC Protocol, the GHG inventories considered emissions from all reporting Sectors, including Stationary Energy, Transportation, Waste, Industrial Process and Product Use (IPPU), and Agriculture, Forestry and Other Land Use (AFOLU). The purpose of this document is to describe the quantification methodologies used to calculate GHG emissions for the 2021 reporting year, and to present the CVRD's 2021 community GHG emissions.

In 2021, the CVRD's BASIC+ GHG emissions totaled 433,983 tonnes of carbon dioxide equivalent (tCO_2e). On an absolute basis, this is an 1.8% decrease from the 2018 reporting year GHG emissions and a decline of 6.0% on a per capita basis. Due to limitations in how to quantify GHG emissions resulting from land use change (e.g., residential development) and ecosystem sequestration, these GHG emissions have been excluded from the CVRDs GHG emissions inventory, but have been disclosed, until a more robust measurement methodology can be developed.

A summary of the 2021 GHG emissions is presented in Table E-1 and Figure E-1.

Table E-1 BASIC+ 2018 Reporting Year And 2021 Reporting Year GHG Emissions

Sector	Sub-Sector	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)
Stationary Energy	Residential Buildings	80,923	82,499
	Commercial & Institutional Buildings	35,720	34,628
	Agriculture, Forestry & Fishing activities	424	459
	Manufacturing Industries & Construction	935	950
	Non-Specified Sources	1	3
	Energy Industries	0	0
	Fugitive Emissions	1,216	1,356
Transportation	In-Boundary On-road Transportation	203,335	193,781
	Trans-Boundary On-road Transportation	4,562	4,348
	Waterborne Navigation	35,121	36,160
	Aviation	297	284
	Off-road Transportation	9,736	9,661
Waste	Solid Waste	22,861	24,756
	Biological Treatment of Waste	1,960	2,474
	Incineration & Open Burning	87	91
	Wastewater Treatment & Discharge	11,754	11,131
IPPU	IPPU	22,840	22,827
AFOLU	Land-Use	-284,541	-284,530
	Livestock	10,109	8,311
	Non-CO_2 Land Emission Sources	242	266
Change in GHG Emissions from Reporting year		**442,125**	**433,983**
Total Per Capita GHG Emissions (tCO_2e / Capita)		**6.2**	**5.8**
Change GHG Emissions per Capita from Reporting year			**-6.0%**
Change in GHG Emissions from Reporting year			**-1.8%**

Data in the table above is depicted in Figure E-1.

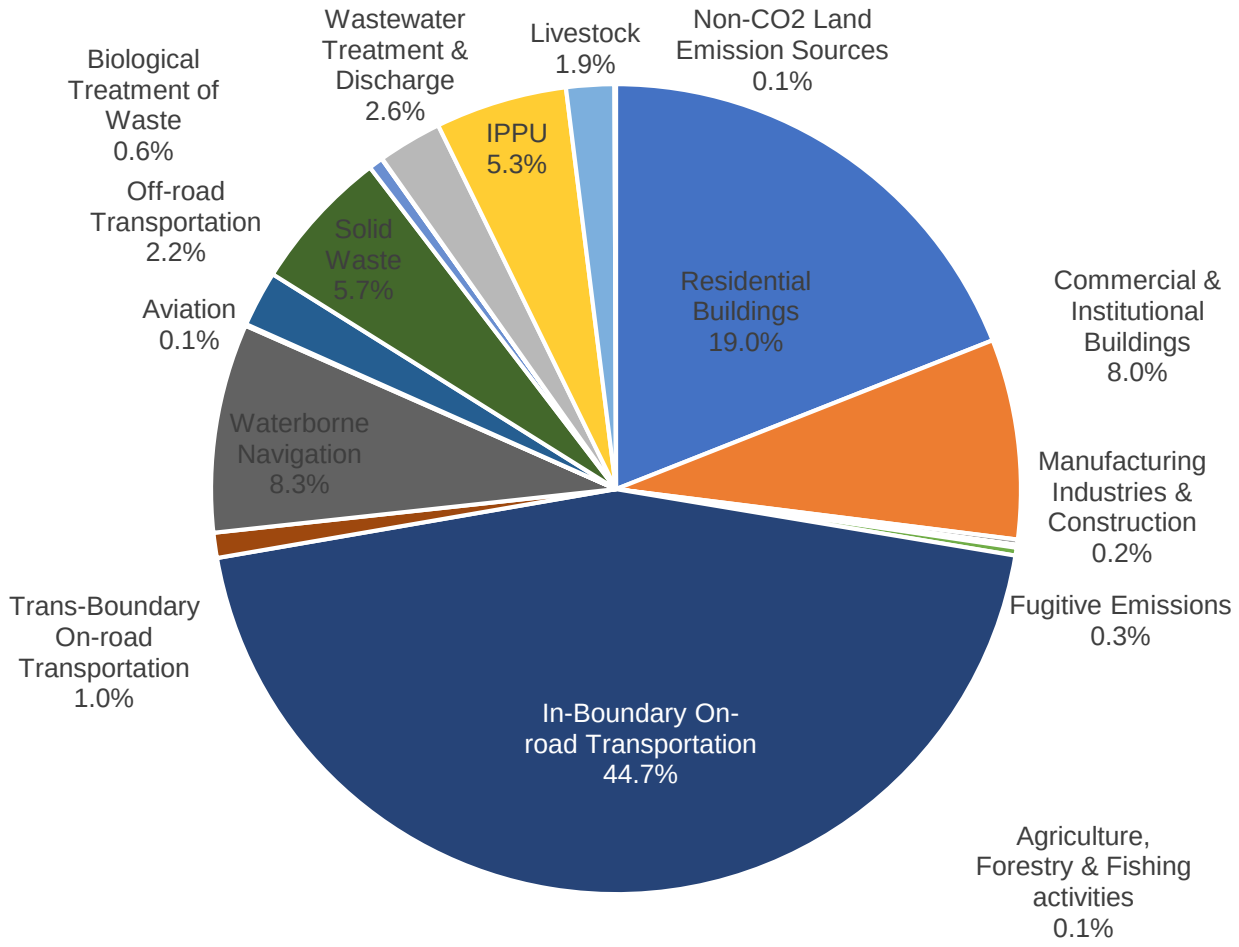

Figure E-1 CVRD's 2021 BASIC+ GHG Emissions Profile

Abbreviations

ACI	Annual Crop Inventory
AFOLU	Agriculture, Forestry, and Other Land Use
BC	British Columbia
C40	C40 Cities Climate Leadership Group
CH_4	Methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
CEEI	Community Energy and Emissions Inventories
CVRD	Comox Valley Regional District
eMWh	megawatt hours equivalents
FCM	Federation of Canadian Municipalities
GDP	gross domestic product
GHG	greenhouse gas
GJ	Gigajoules
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GLHA	Gibson's Landing Harbour Authority
GWP	global warming potentials
HDV	Heavy Duty Vehicle
HFC	Hydrofluorocarbons
ICBC	Insurance Corporation of BC
ICLEI	International Council for Local Environmental Initiatives
IE	included elsewhere
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Product Use

ISO	International Organization for Standardization
kg	Kilograms
kW	Kilowatt
kWh	kilowatt hours
L	Litres
LDT	Light Duty Truck
LDV	Light Duty Vehicle
MWh	megawatt hours
N_2O	nitrous oxides
NE	not estimated
NIR	National Inventory Report
NPRI	National Pollutant Release Inventory
NO	not occurring
ORVE	Off-Road Vehicle and Equipment
PCP	Partnership for Climate Protection
PFC	Perfluorocarbons
SC	Other Scope 3
SF_6	sulfur hexafluoride
T	Tonnes
VIA	Victoria International Airport
WIP	waste-in-place
WRI	World Resources Institute

Glossary

Air pollution	The presence of toxic chemicals or materials in the air, at levels that pose a human health risk.
Reporting year	This is the reference or starting year to which targets and GHG emissions projections are based.
BASIC	An inventory reporting level that includes all Scope 1 sources except from energy generation, imported waste, IPPU, and AFOLU, as well as all Scope 2 sources (GPC, 2014).
BASIC+	An inventory reporting level that covers all GPC BASIC sources, plus Scope 1 AFOLU and IPPU, and Scope 3 in the Stationary Energy and Transportation Sectors (GPC, 2014).
Biogenic emissions	Emissions produced by living organisms or biological processes, but not fossilized or from fossil sources (GPC, 2014).
Carbon dioxide equivalent (CO_2e)	The amount of carbon dioxide (CO_2) emissions that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs. The CO_2e emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP) for the given time horizon. For a mix of GHGs, it is obtained by summing the CO_2e emissions of each gas (IPCC 2014).
Climate change	Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2014).
Emission	The release of GHGs into the atmosphere (GPC, 2014).
Emission factor(s)	A factor that converts activity data into GHG emissions data (GPC, 2014).
Flaring	The burning of natural gas that cannot be used.
Fossil fuels	A hydrocarbon deposit derived from the accumulated remains of ancient plants and animals which is used as an energy source.
Fugitive emission	Emissions that are released during extraction, transformation, and transportation of primary fossil fuels. These GHG emissions are not combusted for energy.
Geographic boundary	A geographic boundary that identifies the spatial dimensions of the inventory's assessment boundary. This geographic boundary defines the physical perimeter separating in-boundary emissions from out-of-boundary and transboundary emissions (GPC, 2014).
Gigajoule (GJ)	A gigajoule (GJ), one billion joules, is a measure of energy. One GJ is about the same energy as: • Natural gas for 3-4 days of household use • The electricity used by a typical house in 10 days

Global warming	A gradual increase in the Earth's temperature which is attributed to the greenhouse effect caused by the release of greenhouse gas (GHG) emissions into the atmosphere.
Global warming potential (GWP)	An index measuring the radiative forcing following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference substance, carbon dioxide (CO_2). The GWP thus represents the combined effect of the differing times these substances remain in the atmosphere and their effectiveness in causing radiative forcing. The Kyoto Protocol is based on global warming potentials over a 100-year period (IPCC 2014).
Greenhouse gas (GHG)	GHGs are the seven gases covered by the UNFCCC: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3) (GPC, 2014).
GHG intensity	The annual rate to which GHG emissions are released in the atmosphere, relative to a specific intensity.
Gross domestic product (GDP)	An economic measure of all goods and services produced in an economy.
In-boundary	Occurring within the established geographic boundary (GPC, 2014).
Reporting year	The year for which emissions are reported (GPC, 2014).
Scope 1	Emissions that physically occur within a community.
Scope 2	Emissions that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross Community boundaries.
Scope 3	Emissions that occur outside a community but are driven by activities taking place within a community's boundaries.
Tonne of CO_2e	A tonne of greenhouse gases (GHGs) is the amount created when we consume: • 385 litres of gasoline (about 10 fill-ups) • Enough electricity for three homes for a year (38,000 kWh)
Transboundary GHG emissions	Emissions from sources that cross the geographic boundary (GPC, 2014).

1.0 INTRODUCTION

1.1 CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

Since the industrial revolution, human activities such as burning fossil fuels, deforestation, agricultural practices, and other land use changes have resulted in the release of unnaturally large volumes of greenhouse gas (GHG) emissions into the Earth's atmosphere causing global climate systems to change. In its sixth assessment report, the Intergovernmental Panel on Climate Change (IPCC) concluded that "the scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years."[1] To substantially reduce the risks and effects of climate change, and limit global warming to 1.5°C, scientists and policy makers have come to the agreement that global society must dramatically reduce greenhouse gas (GHG) emissions 50–60% by 2030, 80% by 2040, more than 90% by 2050 with the remaining emissions being offset or neutralized (e.g., direct air capture, reforestation, etc.) and be net negative in the second half of the century. Recognizing the importance and benefits to addressing climate change, many governments – including the Government of Canada and Province of British Columba, and the CVRD as well as publicly traded organizations representing more than $23 trillion in market capitalization have now committed to these GHG reduction targets.[2]

1.2 COMMUNITIES AND GREENHOUSE GAS EMISSIONS

Communities are centers of communication, commerce, and culture. They are, however, also a significant and growing source of energy consumption and GHG emissions. On a global scale, communities are major players in GHG emissions. They are responsible for more than 70% of global energy-related carbon dioxide emissions and thus represent the single greatest opportunity for tackling climate change.

For a community to act on mitigating climate change and monitor its progress, it is crucial to have good quality GHG emissions data to build a GHG inventory. Such an inventory enables cities to understand the breakdown of their emissions and plan for effective climate action. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol) seeks to support exactly that, by giving cities the standards and tools that are needed to measure the emissions, build more effective emissions reduction strategies, set measurable and more ambitious emission reduction goals, and to track their progress more accurately and comprehensively.

Until recently there has been no internationally recognized way to measure community-level emissions. Inventory methods that community managers have used to date around the globe vary significantly. This inconsistency has made comparisons between cities and over the years difficult. The GPC Protocol offers an internationally accepted, credible emissions accounting and reporting practice that will help communities to develop comparable GHG inventories.

[1] https://www.ipcc.ch/assessment-report/ar6/
[2] sciencebasedtargets.org/news/more-than-1000-companies-commit-to-science-based-emissions-reductions-in-line-with-1-5-c-climate-ambition

1.3 VARIANCE FROM COMMUNITY ENERGY AND EMISSIONS INVENTORIES (CEEI)

The CVRD has historically relied on annual Provincial Community Energy and Emissions Inventories (CEEI) to track community GHG emissions. However, there have been some limitations to the CEEI in that it is an in-boundary inventory, the most recent version containing transportation data was published in 2010, and the CEEI Protocol does not fully meet the requirements of the GPC Protocol BASIC or BASIC+ reporting requirements which is the required reporting standard for local governments that have committed to the Global Covenant of Mayors—an agreement led by city networks to undertake a transparent and supportive approach to measure GHG emissions community-wide. A high-level summary of the differences between the CEEI and GPC Protocol inventories are presented in Table 1.

Table 1 Summary of GHG Inventory Scope Differences

Reporting Sector	CEEI	GPC BASIC	GPC BASIC+
Residential Buildings	✓	✓	✓
Commercial And Institutional Buildings And Facilities	✓	✓	✓
Manufacturing Industries And Construction	✓	✓	✓
Energy Industries		✓	✓
Energy Generation Supplied To The Grid		✓	✓
Agriculture, Forestry And Fishing Activities		✓	✓
Non-Specified Sources		✓	✓
Fugitive Emissions From Mining, Processing, Storage, And Transportation Of Coal		✓	✓
Fugitive Emissions From Oil And Natural Gas Systems		✓	✓
On-Road Transportation	✓	✓	✓
Railways		✓	✓
Waterborne Navigation		✓	✓
Aviation		✓	✓
Off-Road Transportation		✓	✓
Solid Waste	✓	✓	✓
Biological Waste	✓	✓	✓
Incinerated And Burned Waste		✓	✓
Wastewater		✓	✓
Emissions From Industrial Processes			✓
Emissions From Product Use			✓

Reporting Sector	CEEI	GPC BASIC	GPC BASIC+
Emissions From Livestock	✓		✓
Emissions From Land			✓
Emissions From Aggregate Sources And Non-CO_2 Emission Sources On Land	✓		✓

1.4 PURPOSE OF THIS DOCUMENT

The purpose of this document is to describe the quantification methodologies used by the CVRD to calculate its BASIC+ GHG emissions for the 2018-2021 reporting years. The focus of this report is on the 2021 reporting year.

This document also supports the preparation of future community GHG emissions inventories, by:

- Defining GHG emissions data sources to be relied on.
- Establishing quantification methods and assumptions.
- Evaluating the quality of the data sources and emission factors.
- Supporting consistent quantification of the inventory results over time.

2.0 GLOBAL PROTOCOL FOR COMMUNITY (GPC) SCALE EMISSION INVENTORIES PROTOCOL

2.1 OVERVIEW

The GPC Protocol is the result of a collaborative effort between the GHG Protocol at the World Resources Institute (WRI), C40 Cities Climate Leadership Group (C40), and ICLEI—Local Governments for Sustainability (ICLEI). The GPC Protocol is recognized as one of the first set of standardized global rules for cities to measure and publicly report community wide GHG emissions. It sets out requirements and provides guidance for calculating and reporting community wide GHG emissions, consistent with the 2006 IPCC guidelines on how to estimate GHG emissions (IPCC, 2006). Specifically, the GPC Protocol seeks to:

- Help cities develop a comprehensive and robust GHG inventory to support climate action planning.
- Help cities establish a reporting year GHG emissions inventory, set GHG reduction targets, and track performance.
- Ensure consistent and transparent measurement and reporting of GHG emissions between cities, following internationally recognized GHG accounting and reporting principles.
- Enable community wide GHG inventories to be aggregated at subnational and national levels.
- Demonstrate the important role that cities play in tackling climate change and facilitate insight through benchmarking—and aggregation—of comparable GHG data.

2.2 GPC PROTOCOL STRUCTURE

The GPC Protocol sets several assessment boundaries which identify the restrictions for gases, emission sources, geographic area, and time span covered by a GHG inventory:

- The GHG inventory is required to include all seven Kyoto Protocol GHGs occurring within the geographic boundary of a community. These include:
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
  - Hydrofluorocarbons (HFCs)
  - Perfluorocarbons (PFCs)
  - Sulfur hexafluoride (SF_6)
  - Nitrogen trifluoride (NF_3)
- The GHG emissions from community-wide activities must be organized and reporting under the following five Sectors, based on the selected reporting level:
  - Stationary Energy
  - Transportation
  - Waste
  - Industrial Processes and Product Use (IPPU)

- Agriculture, Forestry, and Other Land Use (AFOLU)

The GPC Protocol also requires that a community define an inventory boundary, identifying the geographic area, time span, gases, and emission sources.

Under the GPC Protocol, a community has the option of reporting GHG emissions under three different levels:

- Territorial - A City only reports on GHG emissions occurring within the city boundaries
- City-Induced – A City accounts for all GHG emissions as a result of activities that occur within Under the City-Induced framework, there are two levels of reporting available to cities - BASIC and BASIC+
  - **BASIC—**This level covers stationary energy and transportation GHG emissions that physically occur within a city (Scope 1) and those that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross city boundaries (Scope 2). The BASIC level also includes waste GHG emissions that may occur outside of a city but are driven by activities taking place within a city's boundaries (Scope 3). The BASIC level aligns with the current GHG reporting requirements of most voluntary reporting programs for local governments.
  - **BASIC+—**This level covers the same scopes as BASIC and includes more in-depth and data dependent methodologies. Specifically, it expands the reporting scope to include Scope 1 emissions from Industrial Process and Product Use (IPPU), Agriculture, Forestry, and Other Land-Use (AFOLU), and Scope 3 GHG emissions from transboundary transportation. The sources covered in BASIC+ also align with sources required for national reporting in IPCC guidelines.

Activities taking place within a community can generate GHG emissions that occur inside a Community boundary as well as outside a Community boundary. To distinguish between these, the GPC Protocol groups emissions into three categories based on where they occur: Scope 1, Scope 2, or Scope 3 emissions. The GPC Protocol distinguishes between emissions that physically occur within a Community (Scope 1), from those that occur outside a Community but are driven by activities taking place within a Community's boundaries (Scope 3), from those that occur from the use of electricity, steam, and/or heating/cooling supplied by grids which may or may not cross community boundaries (Scope 2). Scope 1 emissions may also be termed "territorial" emissions, because they are produced solely within the territory defined by the geographic boundary (see Figure 1).

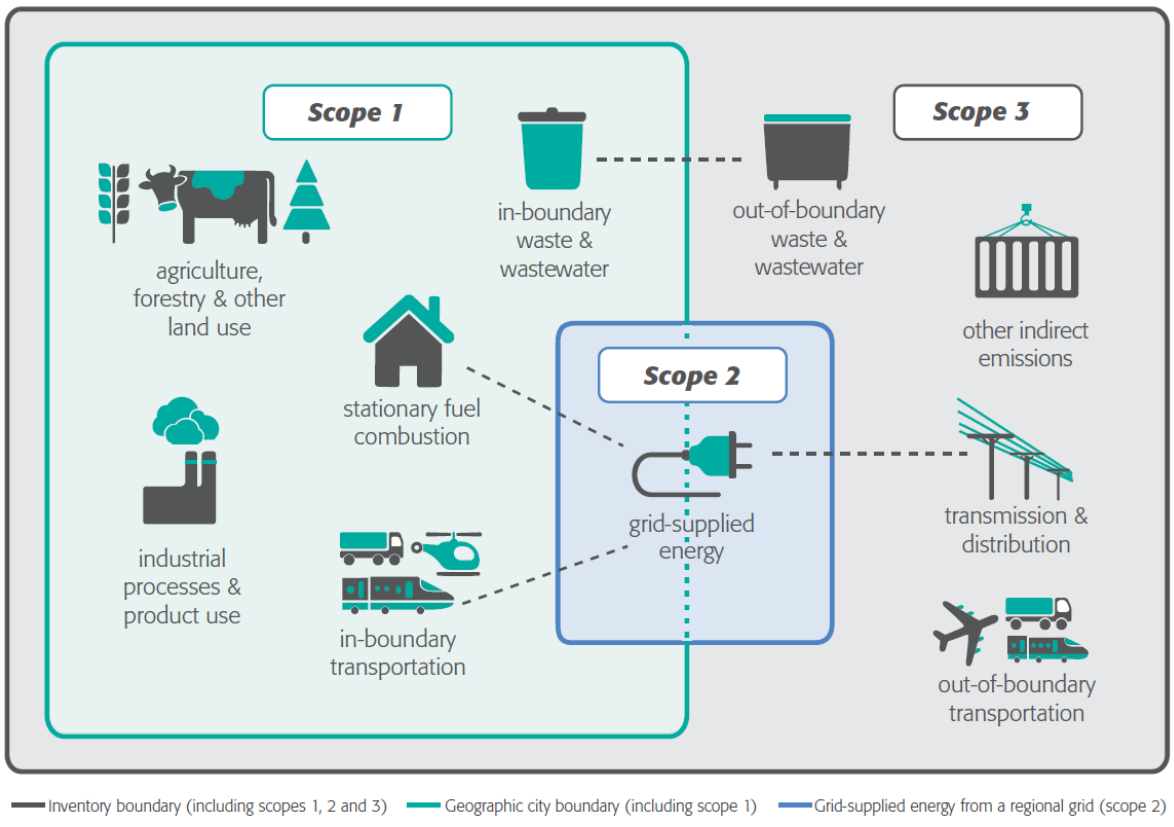

Figure 1 Sources and Boundaries of a Community's GHG Emissions (GPC 2014)

2.3 GHG EMISSION CATEGORIES

As noted previously, the GPC Protocol requires that different emission sources to be categorized into six main reporting Sectors. These high-level categories are described in more detail in Section 2.3.1 to Section 2.3.6. More information on how GHG emissions are captured within the GPC Protocol is available on the Greenhouse Gas Protocol website.

2.3.1 Stationary Energy

Stationary energy sources are typically one of the largest contributors to a community's GHG emissions. In general, these emissions come from fuel combustion and fugitive emissions. They include the emissions from energy to heat and cool residential, commercial, and industrial buildings, as well as the activities that occur within these residences and facilities. Emissions associated with distribution losses from grid-supplied electricity/steam/heating/cooling are also included, as are some fugitive emissions from sources such as coal piles, natural gas. They include the emissions from energy to heat and cool residential, commercial, and industrial buildings, as well as the activities that occur within the residences

and facilities. Emissions associated with distribution losses from grid-supplied electricity/steam/heating/cooling are also included, as are fugitive emissions from sources such as coal piles, natural gas pipelines, and related Off-road Transportation GHG emission sources.

The Stationary Energy Sector includes the following Sub-Sectors:

- Residential buildings
- Commercial and institutional buildings and facilities
- Agriculture, forestry, and fishing activities
- Manufacturing industries and construction
- Energy industries
- Energy generation supplied to the grid*
- Non-specific sources
- Fugitive emissions from mining, processing, storage, and transportation of coal
- Fugitive emissions from oil and natural gas systems

*Emissions related with electricity generation activities occurring within a community's boundaries are to be reported; however, the GHG emissions from these sources are not reported separately as they are accounted for elsewhere and to prevent double counting (GPC 2014).

Under the GPC Protocol, cities are to report off-road GHG emissions under the Off-road Transportation Sub-Sector if and only if the GHG emissions are occurring at transportation facilities (e.g., airports, harbors, bus terminals, train stations, etc.). Other off-road transportation GHG emissions that occur on industrial premises, construction sites, agriculture farms, forests, aquaculture farms, and military premises, etc., are to be reported under the most relevant Stationary Energy Sub-Sector (GPC, 2014). For example, GHG emissions from commercial building off-road construction equipment would be included in the Commercial And Institutional Buildings And Facilities Sub-Sector, whereas GHG emissions from residential lawn mowers would be reported under the Residential Buildings Sub-Sector.

2.3.2 Transportation

The GHGs released to the atmosphere to be reported in the Transportation Sector are those from combustion of fuels in journeys by on-road, railway, waterborne navigation, aviation, and off-road. GHG emissions are produced directly by the combustion of fuel, and indirectly using grid-supplied electricity. Unlike the Stationary Energy Sector, transit is mobile and can pose challenges in both accurately calculating GHG emissions and allocating them to a specific Sub-Sector. This is particularly true when it comes to transboundary transportation, which includes GHG emissions from trips that either start or finish within a community's boundaries (e.g., departing flight emissions from an airport outside a Community boundaries) (GPC, 2014). Transboundary GHG emissions are only required for GPC BASIC+ GHG reporting.

The Transportation Sector includes the following Sub-Sectors:

- On-road

- Railways
- Waterborne
- Aviation
- Off-road

As noted previously, cities are to report off-road GHG emissions under the Off-road Transportation Sub-Sector if and only if the GHG emissions are occurring at transportation facilities (e.g., airports, harbors, bus terminals, train stations, etc.). For example, off-road railway maintenance support equipment GHG emissions are reported under the Off-Road Transportation Sub-Sector.

2.3.3 Waste

Cities produce GHG emissions that arise from activities related to the disposal and management of solid waste. Waste does not directly consume energy, but releases GHG emissions because of decomposition, burning, incineration, and other management methods.

The Waste Sector includes the following Sub-Sectors:

- Solid waste disposal
- Incineration and open burning
- Biological treatment of waste
- Wastewater treatment and discharge

Under the GPC Protocol, the Waste Sector includes all GHG emissions that result from the treatment or decomposition of waste regardless of the source of the waste (e.g., another community's waste in a Community's landfill). However, the GHG emissions that are associated with waste from outside a Community's boundary that is treated or decomposes within a Community boundary are deemed to be "reporting only" emissions and do not contribute to the GHG inventory (GPC 2014).

Any GHG emissions that result from the combustion of waste or waste related gases to generate energy, such as a methane capture and energy generation system at a landfill, are reported under Stationary Energy Generation Supplied To The Grid Sub-Sector (GPC, 2014). Any waste related GHG emissions that are combusted but not related to energy generation are reported in the appropriate Waste Sub-Sector. Lastly, any waste GHG emissions that are released to the atmosphere are also captured in the appropriate Waste Sub-Sector.

2.3.4 Industrial Processes and Product Use (IPPU)

Emissions from this Sector are only required for BASIC+ GHG reporting under the GPC Protocol. This Sector encompasses GHG emissions produced from industrial processes that chemically or physically transform materials and using products by industry and end-consumers (e.g., refrigerants, foams, aerosol cans) (GPC, 2014).

The IPPU Sector includes the following Sub-Sectors:

- Industrial processes
- Product use

Any GHG emissions associated with energy use for industrial processes are not reported in the IPPU Sector; rather, they are reported under the appropriate Stationary Energy Sub-Sector.

2.3.5 Agriculture, Forestry, and Other Land Use (AFOLU)

Emissions from the AFOLU Sector are only required for BASIC+ GHG reporting. AFOLU GHG emissions are those that are captured or released because of land-management activities. These activities can range from the preservation of forested lands to the development of crop land. Specifically, this Sector includes GHG emissions from land-use change, manure management, livestock, and the direct and indirect release of nitrous oxides (N_2O) from soil management, rice cultivation, biomass burning, urea application, fertilizer, and manure application (GPC, 2014).

The AFOLU Sector is organized into the following Sub-Sectors:

- Livestock
- Land
- Aggregate sources and non-CO_2 emission sources on land

2.3.6 Other Scope 3 Emissions

Cities, by their size and connectivity, inevitably give rise to GHG emissions beyond their boundaries. The GPC Protocol already includes the following Scope 3 emissions in other Sectors:

- On-road, waterborne, and aviation transboundary transportation
- Transmission and distribution losses associated with grid-supplied energy
- Solid waste disposal
- Biological treatment of solid waste
- Wastewater treatment and discharge

Cities may voluntarily report on other Scope 3 emissions as they are estimated. In the case of the CVRD, no other Scope 3 GHG emissions, other than those listed above, have been estimated.

2.4 ACCOUNTING AND REPORTING PRINCIPLES

All GHG inventories following the GPC Protocol are required to meet GHG accounting principles. Specifically, these inventories should be relevant, consistent from year to year, accurate and transparent about methodologies, assumptions, and data sources. The transparency of inventories is fundamental to the success of replication and assessment of the inventory by interested parties.

The GHG inventories must also properly account for key energy and GHG emission sinks, sources, and reservoirs (SSR) that are occurring within municipal boundaries. The SSRs are a convenient way to identify and categorize all the GHG emissions to determine if they should be included or excluded from a GHG inventory. A "Source" is something that releases GHG emissions to the atmosphere, such as a diesel generator. A "Sink" is a process or item that removes GHG from the atmosphere, such as photosynthesis and tree growth. Finally, a "Reservoir" is a process or item with the capability to store or accumulate a GHG removed from the atmosphere by a GHG sink, such as a wetland or a peat bog. By assessing and reporting on the applicable SSRs, users of the GHG inventory can have confidence that the inventory is complete and representative of the types and quantities of the GHGs being released within community limits.

2.5 BASE AND REPORTING YEAR RECALCULATIONS

As communities grow and expand, significant changes to the GHG emissions profile can alter materially thus making it difficult to meaningfully assess GHG emission trends and changes over time. The GPC Protocol has requirements on how to treat changes in a community's GHG profile—this is presented in Table 2.

Table 2 GPC Protocol Recalculation Thresholds

Threshold	Example Change	Recalculation Needed	No Recalculation Needed
Changes in the assessment boundary	A local government is annexed in or removed from the administrative boundary	✓	
	Change in protocol reporting method (e.g., from BASIC to BASIC+, addition of GHGs reported, etc.)	✓	
	Shut down of a power plant		✓
	Building a new cement factory		✓
Changes in calculation methodology or improvements in data accuracy	Change in calculation methodology for landfilled municipal solid waste (MSW) that results in a material change in GHG emissions to that sector (i.e., +/-10%).	✓	
	Adoption of more accurate local emission factors, instead of a national average emission factor that results in a material change in GHG emissions (i.e., +/-10%).	✓	
	Change in electricity emission factor due to energy efficiency improvement and growth of renewable energy utilization.		✓
Discovery of significant errors	Discovery of mistake in unit conversion in formula used.	✓	

2.6 DATA QUALITY

Data collection and the assessment of its quality is an integral component of compiling any GHG inventory. Like the IPCC, the GPC Protocol requires users to establish first whether a source exists, and then assess the data availability and quality. To support GHG reporting, the following notation keys are used.

- If the GHG sink, source or reservoir does not exist, a “NO” is used to indicate it is “not occurring”.
- If the GHG sink, source or reservoir does occur, and data is available, then the emissions are estimated. However, if the data is also included in another emissions source category or cannot be disaggregated, the notation key “IE” would be used to indicate “included elsewhere” to avoid double counting.
- When GHG emissions are occurring in the CVRD, but data is not available, then the notation key “NE” would be used to indicate “not estimated”.

For GHG data that does exist, in accordance with the GPC Protocol, an assessment of quality is also made on emission factors and GHG estimation methodologies deployed. The GPC Protocol data quality assessment notation keys are summarized in Table 3.

Table 3 GPC Protocol Data Quality Assessment Notation Keys

Data Quality	Activity Data	Emission Factor
High (H)	Detailed activity data	Site-specific emission factors
Medium (M)	Modeled activity data using robust assumptions	More general emission factors
Low (L)	Highly modeled or uncertain activity data	Default emission factors

3.0 GHG ASSESSMENT BOUNDARIES

This section sets out the reporting boundaries of the CVRD's GHG inventory.

3.1 SPATIAL BOUNDARIES

This GHG inventory is defined geographically by the CVRD's jurisdictional boundaries. As shown in Figure 2, the CVRD consists of 3 municipalities and 3 electoral areas. For the purposes of this report, only the CVRD GHG emissions are presented. A breakdown of GHG emissions by each CVRD municipality and electoral area has been presented in a separate report.

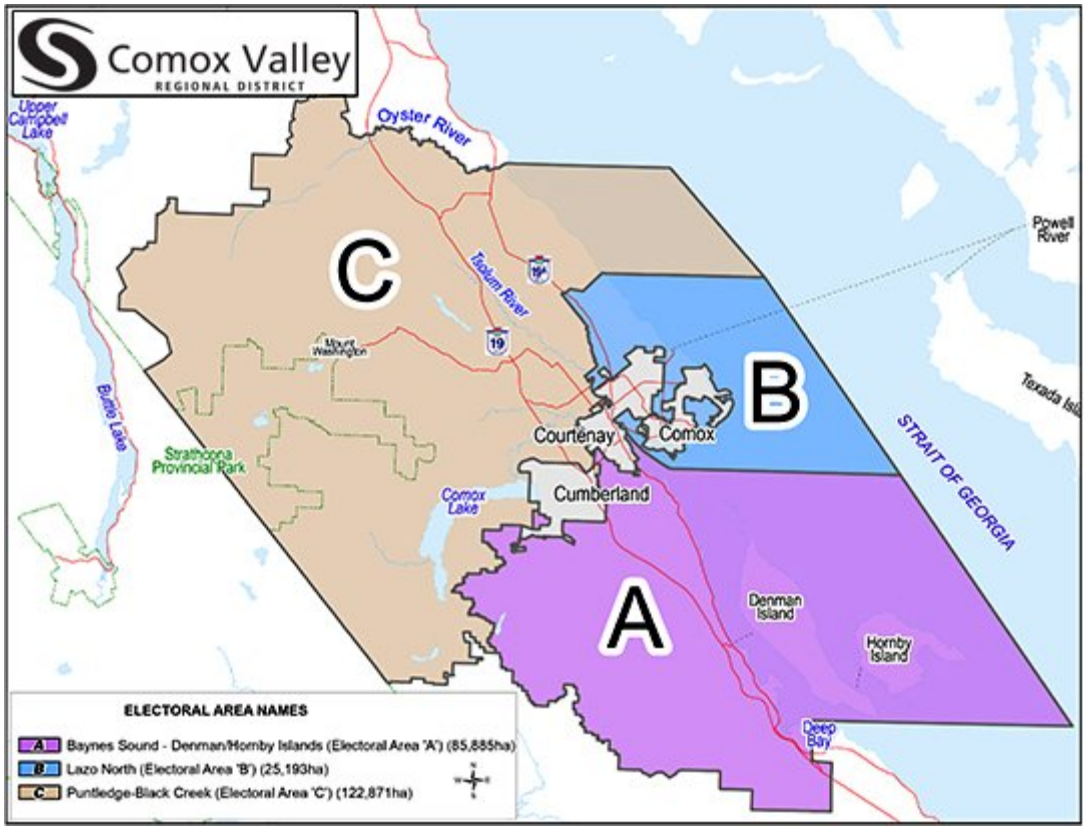

Figure 2 GHG Boundary

Additional GHG inventory related information is presented in the following table.

Table 4 Inventory Information

Inventory Boundary	Community / District Information
Name of Community / District	Comox Valley Regional District

Municipality / Electoral Area	• City of Courtenay • Town of Comox • Village of Cumberland • Electoral Area A: Baynes Sound • Electoral Area B: Lazo North • Electoral Area C: Puntledge-Black Creek
Country	Canada
Inventory Year	2021
Geographic Boundary	See Figure 2
Land Area (hectares)	129,391
Resident population	74,727
GDP (US$)	Unknown at time of reporting
Composition of Economy	Government
Climate	Temperate, warm summer

3.2 TEMPORAL BOUNDARIES

3.2.1 2021 GHG Boundary

This inventory covers all GHG emissions for the 2021 reporting year. Where 2021 data was not available, the most recent year's data have been used, and the timescale noted accordingly. These are as follows:

- **Global Warming Potentials (GWP)**. The BC government has communicated that is adopting GWPs from the fifth IPCC report. On this basis, the CVRD is applying GWPs from the fifth IPCC report.
- **Emission Factors**. Other than the electricity emission factor, all emission factors are derived from Environment and Climate Change Canada's National Inventory Report for the 2020 reporting year. These emission factors have been applied to the 2021 reporting year. This is deemed to be the best available information at the time of reporting.
- **Stationary Energy: Residential, Commercial and Institutional Buildings**. The 2021 natural gas and electricity energy data was provided to the CVRD in draft form and may be subject to change. Furthermore, the 2021 data did not include an estimate for the Electoral Areas and had to be estimated. The estimate was derived by taking the total energy for the City of Courtenay, Town of Comox and the Village of Cumberland for the 2020 and 2021 reporting years, calculating the change in energy consumption and applying this factor to the 2020 Electoral Area natural gas and electricity energy volumes.
- **Stationary Energy: Residential, Commercial and Institutional Buildings**. The 2019-2021 propane, heating oil and wood GHG emissions were estimated using linear regression methods. The data used in the estimates included historical propane and wood energy data published in the 2016-2018 CEEIs, and heating degree days (HDD) published by Environment and Climate Change Canada.

- **Stationary Energy: Fugitives**. Fortis BC provided total fugitive emissions per connection for the 2020 reporting year at the Victoria Capital Regional District level. The 2020 value was used to derive a 2018-2019 and 2021 estimates.
- **Transportation: On-Road**.
    - The on-road transportation emissions are based on the number of registered vehicles for the 2020 reporting year. While the 2021 vehicle registration data is available, it is believed that the data is incorrect as it shows a 17% increase in vehicle registrations between 2020 and 2021 which does not align with the change in population. This large increase has been noted in other jurisdictions where there has been a year over year decline in the population. On this basis, the 2020 vehicle registration data is grown using the reported population change between 2020 and 2021.
    - Insurance Corporation of BC (ICBC) compiles data on an April 1 to March 31 basis, and thus the 2018 and 2021 on-road GHG emission estimates are based on the number of registrations from April 1 – March 31 and may not accurately represent the actual vehicle population for each given reporting year.
    - ICBC did not report vehicle registration data for the CVRD Electoral Areas. To estimate these GHG emissions, the 2010 Electoral Area vehicle counts (as available in the 2010 CEEI) were grown using the total change in ICBC vehicle registrations between 2010 and 2020 for the City of Courtenay, Town of Comox and the Village of Cumberland.
    - ICBC's publicly available vehicle registration data does not contain detailed vehicle and fuel class breakdowns (e.g., it just reports total personal vehicles). To split out the data by class and fuel type, the vehicle classes were re-allocated based on the Victoria Capital Regional District's reported vehicle class breakdown in the 2021 GHG emissions report. The Victoria Capital Regional District's reported data is based upon detailed registration data.
- **Transportation: Waterborne**. The number of recreational boats was estimated based on the number of marinas in the CVRD and the disclosed estimate of boats.[3] Recreational vessel fuel consumption rates are based on the study entitled "Marine Vessel Air Emissions in BC and Washington State Outside of the Greater Victoria Regional District (GVRD) and FVRD for the Year 2000".
- **Waste: Incineration & Opening Burning.** Incineration and open burning GHG emissions are estimated using a 2015 particulate matter emissions inventory for the Comox Valley. The GHG emissions are adjusted to 2018 and 2021 using population data.
- **AFOLU: Land-Use.** The land cover change analysis requires a consistent land-use category attribution and spatial data. Landsat spatial data was available for the 2015 and 2020 reporting years. Since annual data is not available, the change between land cover data years (2015-2020) for all areas was averaged and may not represent actual changes in each year.

3.3 GHG EMISSION SOURCES AND SCOPES

The following table summarizes the CVRD's GHG emissions by source and GHG emission scope.

[3] https://www.comox.ca/community/marinas#:~:text=Comox%20is%20home%20to%20four,Comox%20Marina%20and%20Point%20Holmes

Table 5 Summary of Emissions Scope and GPC Protocol Reporting Sector

GHG Emissions Scope	GPC Protocol Reporting Sector
Scope 1	The GHG emissions occurring from sources located within the CVRD's limits: • Stationary fuel combustion: – Residential buildings – Agriculture, forestry, and fishing activities – Commercial and institutional buildings, and facilities – Manufacturing industries and construction – Fugitive emissions from oil and natural gas systems • Transportation: – On-road: in boundary – Waterborne navigation – Off-road • Waste: – Solid waste disposal – Biological treatment of solid waste – Wastewater treatment and discharge • Industrial processes and product use (IPPU): – Product use • Agriculture, Forestry, and Other Land Use (AFOLU): – Land-use: emissions sequestered (*reported, but not included in the total*) – Livestock – Aggregate sources and non-CO_2 emission sources on land
Scope 2	The GHG emissions occurring from using grid-supplied electricity, heating and/or cooling within the CVRD's boundary: • Stationary fuel combustion: – Residential buildings – Commercial and institutional buildings and facilities • Transportation: – On-road
Scope 3	Other GHG emissions occurring outside of the CVRD's limits as a result of the CVRD's activities: • Stationary Energy: – Transmission, Distribution, and Line Losses • Transportation: – On-Road: Transboundary – Waterborne Navigation

3.4 GHG REPORTING

Where relevant, the GPC Protocol recommends using methodologies that align with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The GHG inventory is required to include all seven Kyoto Protocol GHGs occurring within the geographic boundary of a community.

Each GHG listed above has a different global warming potential (GWP) due to its ability to absorb and re-emit infrared radiation. This chemical property is recognized by the GWP set out by the IPCC Fifth Assessment Report. A larger GWP value means the substance has a greater affinity to absorb and re-emit infrared radiation. The GWP of these GHGs are CO_2 = 1.0, CH_4 = 28, N_2O = 265 (IPCC, 2014).

Total GHG emissions are normally reported as CO_2e, whereby emissions of each of the GHGs are multiplied by their GWP and are reported as tonnes of CO_2e.

The GHG inventory results following the GPC Protocol reporting table format is presented in Section 5.0. The GPC Protocol reporting format is presented in Table 6 below which also indicates the reporting level (BASIC / BASIC+) for each source.

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
I	**Stationary Energy Sources**		
I.1	**Residential Buildings**		
I.1.1	BASIC	1	Emissions from in-boundary fuel combustion
I.1.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.1.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.2	**Commercial and Institutional Buildings/Facilities**		
I.2.1	BASIC	1	Emissions from in-boundary fuel combustion
I.2.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.2.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.3	**Manufacturing Industry and Construction**		
I.3.1	BASIC	1	Emissions from in-boundary fuel combustion
I.3.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.3.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.4	**Energy Industries**		
I.4.1	BASIC	1	Emissions from in-boundary production of energy used in auxiliary operations
I.4.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.5	**Agriculture, Forestry, and Fishing Activities**		
I.5.1	BASIC	1	Emissions from in-boundary fuel combustion
I.5.2	BASIC	2	Emissions from consumption of grid-supplied energy
I.5.3	BASIC+	3	Transmission and distribution losses from grid-supplied energy
I.7	**Fugitive Emissions from Mining, Processing, Storage, And Transportation of Coal**		
I.7.1	BASIC	1	In-boundary fugitive emissions

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
I.8	**Fugitive Emissions from Oil and Natural Gas Systems**		
I.8.1	BASIC	1	In-boundary fugitive emissions
II	**Transportation**		
II.1	**On-road Transportation**		
II.1.1	BASIC	1	Emissions from in-boundary transport
II.1.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.1.3	BASIC+	3	Emissions from transboundary journeys
II.2	**Railways**		
II.2.1	BASIC	1	Emissions from in-boundary transport
II.2.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.2.3	BASIC+	3	Emissions from transboundary journeys
II.3	**Waterborne Navigation**		
II.3.1	BASIC	1	Emissions from in-boundary transport
II.3.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.3.3	BASIC	3	Emissions from transboundary journeys
II.4	**Aviation**		
II.4.1	BASIC	1	Emissions from in-boundary transport
II.4.2	BASIC	2	Emissions from consumption of grid-supplied energy
II.4.3	BASIC+	3	Emissions from transboundary journeys
II.5	**Off-road**		
II.5.1	BASIC	1	Emissions from in-boundary transport
II.5.2	BASIC	2	Emissions from consumption of grid-supplied energy
III	**Waste**		
III.1	**Solid Waste Disposal**		
III.1.1	BASIC	1	Emissions from waste generated and treated within the Community
III.1.2	BASIC	3	Emissions from waste generated within but treated outside of the Community
III.2	**Biological Treatment of Waste**		
III.2.1	BASIC	1	Emissions from waste generated and treated within the Community
III.2.2	BASIC	3	Emissions from waste generated within but treated outside of the Community
III.3	**Incineration and Open Burning**		

Table 6 GPC Protocol Summary Table

GPC Protocol Reference Number	Reporting Level	Emissions Scope	GHG Emissions Source
III.3.1	BASIC	1	Emissions from waste generated and treated within the Community
III.3.2	BASIC	3	Emissions from waste generated within but treated outside of the Community
III.4	**Wastewater Treatment and Discharge**		
III.4.1	BASIC	1	Emissions from wastewater generated and treated within the Community
III.4.2	BASIC	3	Emissions from wastewater generated within but treated outside of the Community
IV	**Industrial Processes and Product Use (IPPU)**		
IV.1	BASIC+	1	In-boundary emissions from industrial processes
IV.2	BASIC+	1	In-boundary emissions from product use
V	**Agriculture, Forestry, and Other Land Use (AFOLU)**		
V.1	BASIC+	1	In-boundary emissions from livestock
V.1	BASIC+	1	In-boundary emissions from land
V.1	BASIC+	1	In-boundary emissions from other agriculture
VI	**Other Scope 3 Emissions**		
VI.1	BASIC / BASIC+	3	Other indirect emissions

4.0 GHG METHODOLOGIES BY SOURCE CATEGORY

The following sections describe the reporting source category, assumptions, activity data applied, and quantification methodology. The results of the analysis are presented in Section 5.0.

4.1 STATIONARY ENERGY

4.1.1 Overview

Stationery energy sources are one of the largest contributors to the CVRD's GHG emissions. For the District, the Stationary Energy Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Residential Buildings
  - Commercial & Institutional Buildings
  - Agriculture, Forestry & Fishing Activities
  - Manufacturing Industries & Construction
  - Non-Specified Sources
  - Fugitive Emissions From Oil And Natural Gas Systems
- Scope 2 Emissions:
  - Emissions From The Consumption Of Grid-Supplied Electricity, Steam, Heating, And Cooling.
- Scope 3 Emissions:
  - Transmission And Distribution Losses Of Electricity, Steam, Heating, And Cooling.

4.1.2 Scope 2: Market Based Method

As per the GPC Protocol, cities can report on Scope 2 GHG emissions using either the market-based, or the location-based method. A market-based method utilizes utility-specific grid emission intensity factor, whereas a location-based method uses a regional or Provincial average grid emission intensity factor. At present, the fuel mix and GHG emissions data relative to the CVRD's energy consumption is not available. As such, the CVRD is defaulting to the BC Provincial 2021 electricity grid consumption intensity factor of 0.00970 tCO_2e/MWh reported by the BC Government.[4]

4.1.3 Activity Data

BC Hydro and Fortis BC provided the Province of BC electricity and natural gas consumption data itemized by community in MWh and GJ, respectively. Based on the utility provider descriptions of the data, each is categorized as follows:

- Residential Buildings based on the BC Hydro and Fortis BC descriptor: "Residential"

[4] https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/reporting/quantify/electricity

- Commercial and Institutional Buildings/Facilities based on BC Hydro and Fortis BC descriptors: “Commercial”, and “CSMI”

The 2021 energy data was provided to the CVRD in draft form and may be subject to change.

The Province developed 2012-2018 residential fuel oil, propane and wood GHG energy use estimates from the number and type of dwellings and the average dwelling consumption by authority and region from the BC Hydro Conservation Potential Review. This data was used to estimate the 2021 reporting year GHG emissions for all CVRD members.

Fortis BC provided a fugitive emission factor for the 2020 reporting year for the Victoria Capital Regional District. This factor was used to estimate 2018-2021 fugitive emissions in the CVRD.

Residential, commercial, and institutional building related off-road GHG emissions included in the Stationary Energy Sector are based on the 2022 NIR as prepared by Environment and Climate Change Canada. These emissions are pro-rated to the CVRD on a per capita basis. Agriculture, forestry and fishing, and manufacturing industries and construction related off-road GHG emissions included in the Stationary Energy Sector are based on the 2022 NIR as prepared by Environment and Climate Change Canada. These emissions are pro-rated to the CVRD on the number of employees in each of the reported sectors.

4.1.4 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2021 GHG emissions:

- The 2021 natural gas and electricity energy data was provided to the CVRD in draft form and may be subject to change. Furthermore, the 2021 data did not include an estimate for the Electoral Areas and had to be estimated. The estimate was derived by taking the total energy for the City of Courtenay, Town of Comox and the Village of Cumberland for the 2020 and 2021 reporting years, calculating the change in energy consumption and applying this factor to the 2020 Electoral Area natural gas and electricity energy volumes.
- BC Hydro estimates that the combined energy losses- transmission and distribution- to be approximately 6.28%. This value was used to calculate the Scope 3 emissions for each Stationary Energy Sub-Sector.
- Fortis BC provided total fugitive emissions per connection for the 2020 reporting year at the Victoria Capital Regional District level. The 2020 value was used to derive a 2018-2019 and 2021 estimates.
- The 2019-2021 propane, heating oil and wood GHG emissions were estimated using linear regression methods. The data used in the estimates included historical propane and wood energy data published in the 2016-2018 CEEIs, and heating degree days (HDD) published by Environment and Climate Change Canada.
- The assignment of off-road emissions based on per-capita and number of workers in each industry is reasonable.

4.1.5 Data Quality Assessment

Table 7 presents the activity data quality assessment for the stationary energy sources.

Table 7 Stationary Energy Data Source Quality Assessment

Data	Quality Assessment Rating
Electricity	Medium for Source Category; Low for Distribution between CVRD Members
Natural Gas	Medium for Source Category; Low for Distribution between CVRD Members
Agriculture, Forestry & Fishing Activities	Low
Manufacturing Industries & Construction	Low
Fugitive Emissions	Medium
Transmission, Distribution and Line Losses	Medium
Off-Road Transportation Emissions	Low

4.1.6 Calculation Methodology

The Province of BC developed residential fuel oil, propane and wood GHG energy use estimates using heating degree days (HDD) the number and type of dwellings and the average dwelling consumption by authority and region contained in the BC Hydro Conservation Potential Review.

To calculate GHG emissions from electricity, natural gas, heating oil, propane, and wood, the total net annual energy values (where applicable, less transmission, distribution, and line losses of 6.28%) were multiplied by applicable emissions factors. These values were then multiplied by the pollutant's GWP to give total CO_2e emissions in tonnes.

These quantification methods are captured as follows:

$$\textbf{Energy}_{\text{Stationary Energy – Electricity}} = Electricity * (1 - Line\ Loss\ (\%))$$

$$\textbf{Energy}_{\text{Stationary Energy – Transmission, Distribution, and line Losses}} = Electricity * Line\ Loss\ (\%)$$

$$\textbf{Emissions}_{\text{Stationary Energy – Electricity}} = Fuel\ (MWh) * EF_{tCO2e}$$

$$\textbf{Emissions}_{\text{Stationary Energy – Natural Gas}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

$$\textbf{Emissions}_{\text{Stationary Energy – Propane}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

$$\textbf{Emissions}_{\text{Stationary Energy – Wood}} = (Fuel\ (GJ) * EF_{CO2}) + (Fuel\ (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel\ (GJ) * EF_{N2O} * GWP_{N2O})$$

Emissions $_{\text{Stationary Energy – Heating Oil}}$ *= (Fuel (GJ) * EF_{CO2}) + (Fuel (GJ) * EF_{CH4} * GWP_{CH4}) + (Fuel (GJ) * EF_{N2O} * GWP_{N2O})*

The emission factors used in the 2021 reporting year are from the 2022 NIR. These are summarized in Table 8.

Table 8 Stationary Energy GHG Emission Factors

Emission Factor	Units	tCO_2e	Quality Assessment Rating
Electricity (BC Hydro)	tCO_2e / MWh	0.00960000	Medium
Natural Gas	tonne CO_2e / m^3	0.0019374	Medium
Propane	tonne CO_2e / L	0.0015478	Medium
Heating Oil	tonne CO_2e / GJ	0.0683759	Medium
Wood	tonne CO2e / kg	0.0004227	Medium

4.2 TRANSPORTATION

4.2.1 Overview

Transportation covers all GHG emissions from combustion of fuels in journeys by on-road, railways, waterborne navigation, aviation, and off-road. GHG emissions are produced directly by the combustion of fuel, and indirectly using grid-supplied electricity. For the CVRD, the Transportation Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - On-road: In Boundary
  - Waterborne
  - Aviation
  - Off-road
- Scope 2 Emissions:
  - Emissions from the consumption of grid-supplied electricity.
- Scope 3 Emissions:
  - On-road: Transboundary
  - Waterborne
  - Aviation
  - Off-road

4.2.2 Activity Data

The Insurance Corporation of BC (ICBC) provided 2018 and 2021 registered vehicle counts for the following classes: personal vehicles, electric vehicles, commercial vehicles, motorcycles, and motor

homes for the City of Courtenay, Town of Comox and the Village of Cumberland.[5] No data was available for the electoral areas.

BC Transit provided total 2018 and 2021 diesel fuel use. This data was used to estimate GHG emissions from buses serving the CVRD.

Courtenay Airpark provided fuel consumption volumes.

Marine ferry GHG emissions were estimated using published BC Ferries fuel statistics. The Transport Canada Vessel Registration System provided the total number of registered waterborne vehicles for the reporting year.

BC Ferries reported the number of trips for the routes servicing the CVRD (Routes 17, 21 and 22). This data was used to estimate GHG emissions from ferries serving the CVRD.

Other off-road transportation emissions are based on the 2022 NIR as prepared by Environment and Climate Change Canada.

4.2.3 Assumptions and Disclosures

The following assumptions were made in the calculation of the Transportation Sector GHG emissions:

- The Insurance Corporation of BC (ICBC) provided 2018 and 2021 registered vehicle counts for the following classes: personal vehicles, electric vehicles, commercial vehicles, motorcycles, and motor homes for the City of Courtenay, Town of Comox and the Village of Cumberland. As these totals were not broken down by vehicle fuel type or class, the vehicle classes were allocated based on the Victoria Capital Regional District's reported vehicle class breakdown in the 2021 GHG emissions report.
- ICBC did not report vehicle registration data for the CVRD Electoral Areas. To estimate these GHG emissions, the 2010 Electoral Area vehicle counts (as available in the 2010 CEEI) were grown using the total average change in vehicle counts between 2010 and 2021 for the City of Courtenay, Town of Comox and the Village of Cumberland. For the 2018 and 2021 reporting years, the grown Electoral Area vehicle classes were re-allocated based on the Victoria Capital Regional District's reported vehicle class breakdown in the 2021 GHG emissions report.
- Vehicle fuel consumption rates and Vehicle Kilometer Travelled (VKT) were taken from the Victoria Capital Regional District GHG emissions report. The Victoria Capital Regional District values are based upon detailed vehicles registration data and total fuel sales in the CRD. It is assumed that the vehicle fuel efficiencies and KVTs would be similar in the CVRD.
- Data from the Comox Valley Mobility Primer was used to estimate in-boundary and transboundary splits at the regional (97.8% / 2.2%) and municipal level (average of 39.6% / 60.4%).

[5] https://public.tableau.com/app/profile/icbc/viz/VehiclePopulationIntroPage/VehiclePopulationData

- The number of recreational boats was estimated based on the number of marinas in the CVRD and the disclosed estimate of boats.[6] Recreational vessel fuel consumption rates are based on the study entitled "Marine Vessel Air Emissions in BC and Washington State Outside of the Greater Victoria Regional District (GVRD) and FVRD for the Year 2000".
- Diesel GHG emissions from BC Transit buses are pro-rated to the CVRD based on the proportion of population in each municipality within the CVRD. A more accurate estimation method would be to prorate fuel use based on total bus service kilometers in the CVRD. However, this data is not available, and thus the method applied provides the best estimate at the time of reporting.
- The aviation GHG emissions are prorated based on the each CVRD member population relative to the CVRD population.
- BC Ferries did not disclose its total reported fuel use for the CVRD. As such, the number of trips for each of the routes servicing the CVRD was used with an estimated fuel consumption rate of 1,121 liters of diesel per trip to derive an estimate of ferry GHG emissions. The emissions associated with Route 17 were halved to avoid double counting with other jurisdictions.
- The marine ferry GHG emissions are prorated based on the each CVRD member population relative to the CVRD population.
- No railway GHG emissions are occurring in the CVRD.
- The off-road transportation emissions are based on the 2022 NIR as prepared by Environment and Climate Change Canada and prorated based on population. This is deemed to be the best available data.

4.2.4 Data Quality Assessment

Table 9 presents the activity data quality assessment for the transportation data sources.

Table 9 Transportation Data Quality Assessment

Data	Quality Assessment Rating
Split Between In-Boundary and Transboundary Traffic	Medium-High
Vehicle Registry Data	Medium-Low
Vehicle Kilometers Travelled (VKT) Data	Medium-High
Aviation GHG Data	High
Waterborne GHG Data	Low
Other Off-Road Transportation GHG Data	Low

6 https://www.comox.ca/community/marinas#:~:text=Comox%20is%20home%20to%20four,Comox%20Marina%20and%20Point%20Holmes

4.2.5 Calculation Methodology

4.2.5.1 On-Road

The GPC Protocol identifies several methods for determining on-road emissions. The vehicle kilometers travelled (VKT) methodology was utilized to estimate the GHG emissions from on-road transportation (Scope 1) and transboundary transportation (Scope 3). The VKT uses the number and type of vehicles registered in a geopolitical boundary, the estimated fuel consumption rate of individual vehicles, and an estimate of the annual vehicle kilometres traveled (VKT) by various vehicle classes. To estimate the split between on-road in-boundary and transboundary traffic, data from the streetlight corridor study was applied. The results of the survey as it applies to the CVRD is presented in Table 10.

Table 10 CVRD On-Road In-Boundary/Transboundary Split

Aspect	By Vehicle
Estimated proportion of on-road in-boundary travel	97.8%
Estimated proportion of on-road transboundary travel	2.2%

To quantify the 2018 and 2020 reporting year on-road and transboundary GHG emissions, the following steps were taken:

1. Collect reported ICBC vehicle registration data for the City of Courtenay, Town of Comox and the Village of Cumberland for the 2010, 2018-2020 reporting years.
2. For the City of Courtenay, Town of Comox and the Village of Cumberland, grow the 2020 vehicle population based on the annual population change between 2020 and 2021.
3. For the Electoral Areas, grow the 2010 vehicle population based on the annual average vehicle population change between 2010 and 2021 using the City of Courtenay, Town of Comox and the Village of Cumberland vehicle data.
4. Allocate vehicle registration data counts based on the Victoria Capital Regional District's reported vehicle class breakdown in the 2021 GHG emissions report for the City of Courtenay, Town of Comox, Village of Cumberland and Electoral Areas.
5. Assign estimated vehicle fuel consumption rates, and estimated VKT to each of the vehicle classes (Table 11).
6. Estimate total fuel use by vehicle classification (Table 12).
7. Summate and allocate estimated fuel use, by vehicle class using the applicable in-boundary and transboundary split.
8. Pro-rate the diesel fuel use from busses.
9. Summate and allocate estimated bus fuel use using the applicable in-boundary and transboundary split.

Table 11 Estimated VKT And Fuel Efficiencies by Vehicle Class For Reporting Year

Vehicle Classification	Estimated VKT / Year	Estimated Fuel Efficiency (L/100 km)
Diesel-HDV	25,730	45.6

Vehicle Classification	Estimated VKT / Year	Estimated Fuel Efficiency (L/100 km)
Diesel-LDT	12,916	11.8
Diesel-LDV	14,746	9.2
Diesel-ORVE	Not Estimated	45.6
Electric-HDV	9,651	30.0
Electric-LDT	10,290	20.0
Electric-LDV	11,328	20.0
Electric-ORVE	Not Estimated	30.0
Gasoline-HDV	9,180	54.1
Gasoline-Hybrid-HDV	8,214	37.9
Gasoline-Hybrid-LDT	8,901	10.0
Gasoline-Hybrid-LDV	9,799	7.0
Gasoline-Hybrid-ORVE	Not Estimated	37.9
Gasoline-LDT	8,901	12.2
Gasoline-LDV	9,799	9.0
Gasoline-ORVE	Not Estimated	54.1
Hydrogen-Hybrid-LDV	10,883	Not Estimated
Hydrogen-LDV	11,717	Not Estimated
Hydrogen-LDT	12,840	Not Estimated
Motorcycle - Electric	1,973	17.0
Motorcycle - Non catalyst	1,973	9.9
Natural Gas-HDV	25,730	22.9
Natural Gas-LDT	12,916	8.3
Natural Gas-LDV	14,746	5.4
Natural Gas-ORVE	Not Estimated	22.9
Propane-HDV	25,730	22.9
Propane-Hybrid-LDV	16,384	13.1
Propane-LDT	12,916	12.6
Propane-LDV	14,746	8.2
Propane-ORVE	Not Estimated	22.9

Table 12 Total Registered Vehicles & Estimated Fuel Use For Reporting Year

Vehicle Classification	Total Estimated Registered Vehicles	Total Estimated Fuel Use	Units
Diesel-HDV	1,267	15,298,749	Liters (L)
Diesel-LDT	5,274	8,051,516	Liters (L)
Diesel-LDV	367	496,562	Liters (L)

COMOX VALLEY REGIONAL DISTRICT 2021 GPC BASIC+ COMMUNITY GREENHOUSE GAS (GHG) EMISSIONS INVENTORY REPORT

GHG Methodologies by Source Category
April 11, 2023

Vehicle Classification	Total Estimated Registered Vehicles	Total Estimated Fuel Use	Units
Diesel-ORVE	512	-	Liters (L)
Electric-HDV	-	-	kWh
Electric-LDT	-	-	kWh
Electric-LDV	538	1,219,832	kWh
Electric-ORVE	-	-	kWh
Gasoline-HDV	601	2,984,074	Liters (L)
Gasoline-Hybrid-HDV	-	-	Liters (L)
Gasoline-Hybrid-LDT	148	131,426	Liters (L)
Gasoline-Hybrid-LDV	894	613,443	Liters (L)
Gasoline-Hybrid-ORVE	0	-	Liters (L)
Gasoline-LDT	32,473	35,142,801	Liters (L)
Gasoline-LDV	20,547	18,159,474	Liters (L)
Gasoline-ORVE	936	-	Liters (L)
Hydrogen-Hybrid-LDV	-	-	Liters (L)
Hydrogen-LDV	0	-	Liters (L)
Hydrogen-LDT	-	-	Liters (L)
Motorcycle - Electric	0	163	kWh
Motorcycle - Non catalyst	2,700	528,436	Liters (L)
Natural Gas-HDV	0	2,866	Kilogram (kg)
Natural Gas-LDT	4	4,005	Kilogram (kg)
Natural Gas-LDV	1	774	Kilogram (kg)
Natural Gas-ORVE	-	-	Kilogram (kg)
Propane-HDV	18	103,324	Liters (L)
Propane-Hybrid-LDV	0	719	Liters (L)
Propane-LDT	44	71,462	Liters (L)
Propane-LDV	6	6,746	Liters (L)
Propane-ORVE	15	-	Liters (L)
Total	**66,346**	**N/A**	**N/A**

Once the fuels were allocated amongst the vehicle classes and sectors, the GHG emissions were calculated accordingly. The GHG quantification method is captured, for all fuel types, is as follows:

$$\textbf{Emissions}_{\text{On-road}} = \text{In-Boundary Split \%} * ((\text{Vol. Fuel} * EF_{CO2}) + (\text{Vol. Fuel} * EF_{CH4} * GWP_{CH4}) + (\text{Vol. Fuel} * EF_{N2O} * GWP_{N2O}))$$

$$\textbf{Emissions}_{Transboundary} = Transboundary\ Split\ \% * ((Vol.\ Fuel * EF_{CO2}) + (Vol.\ Fuel * EF_{CH4} * GWP_{CH4}) + (Vol.\ Fuel * EF_{N2O} * GWP_{N2O}))$$

The emission factors used in the reporting year GHG inventory are from the 2020 B.C. Best Practices Methodology For Quantifying Greenhouse Gas Emissions. These are summarized in Table 13.

Table 13 Vehicle GHG Emission Factors

Vehicle Class	Units	tCO_2e	Quality Assessment Rating
Gasoline-LDV	tonne CO_2e / L	0.00234581	Medium-Low
Gasoline-LDT	tonne CO_2e / L	0.00237884	Medium-Low
Gasoline-HDV	tonne CO_2e / L	0.00227660	Medium-Low
Gasoline-ORVE	tonne CO_2e / L	0.00241650	Medium-Low
Gasoline-Hybrid-LDV	tonne CO_2e / L	0.00234581	Medium-Low
Gasoline-Hybrid-LDT	tonne CO_2e / L	0.00237884	Medium-Low
Gasoline-Hybrid-HDV	tonne CO_2e / L	0.00227660	Medium-Low
Gasoline-Hybrid-ORVE	tonne CO_2e / L	0.00241650	Medium-Low
Electric-LDV	tonne CO_2e / kWh	0.00002990	Medium-Low
Electric-LDT	tonne CO_2e / kWh	0.00002990	Medium-Low
Electric-HDV	tonne CO_2e / kWh	0.00002990	Medium-Low
Electric-ORVE	tonne CO_2e / kWh	0.00002990	Medium-Low
Diesel-LDV	tonne CO_2e / L	0.00264884	Medium-Low
Diesel-LDT	tonne CO_2e / L	0.00264926	Medium-Low
Diesel-HDV	tonne CO_2e / L	0.00262975	Medium-Low
Diesel-ORVE	tonne CO_2e / L	0.00288375	Medium-Low
Hydrogen-Hybrid-LDV	tonne CO_2e / L	-	Medium-Low
Hydrogen-LDV	tonne CO_2e / L	-	Medium-Low
Hydrogen-LDT	tonne CO_2e / L	-	Medium-Low
Natural Gas-LDV	tonne CO_2e / kg	0.00308863	Medium-Low
Natural Gas-LDT	tonne CO_2e / kg	0.00308863	Medium-Low
Natural Gas-HDV	tonne CO_2e / kg	0.00308863	Medium-Low
Natural Gas-ORVE	tonne CO_2e / kg	0.00308863	Medium-Low
Propane-LDV	tonne CO_2e / L	0.00153934	Medium-Low
Propane-LDT	tonne CO_2e / L	0.00153934	Medium-Low
Propane-HDV	tonne CO_2e / L	0.00153934	Medium-Low
Propane-ORVE	tonne CO_2e / L	0.00153934	Medium-Low

Vehicle Class	Units	tCO_2e	Quality Assessment Rating
Propane-Hybrid-LDV	tonne CO_2e / L	0.00153934	Medium-Low
Motorcycle - Non catalyst	tonne CO_2e / L	0.00238780	Medium-Low
Motorcycle - Electric	tonne CO_2e / L	0.00002990	Medium-Low

4.2.5.2 Aviation: Courtenay Airpark

The CVRD's 2021 aviation emissions estimate is based on reported fuel sales and applicable emissions factors (Table 14). The GHG quantification method is as follows:

$$Emissions_{\text{Per Aviation Class}} = CVRD\ Population * ((Vol.\ Fuel * Aviation\ Class\ EF_{CO2}) + (Vol.\ Fuel * Aviation\ Class\ EF_{CH4} * GWP_{CH4}) + (Vol.\ Fuel * Aviation\ Class\ EF_{N2O} * GWP_{N2O}))$$

Table 14 Aviation GHG Emission Factors

Units	tCO_2e	Quality Assessment Rating
tCO_2e/L fuel	0.00258188	Medium-Low

4.2.5.3 Waterborne Transportation

4.2.5.3.1 BC Ferries

Marine waterborne transportation emissions encompass GHG emissions from the use of the BC Ferries. GHG emissions from BC Ferries are estimated using a provincially derived GHG emissions factor (Table 15), the number of reported trips, and an estimated fuel volume per trip for the following routes:

- Route 17 - Comox - Powell River
- Route 21 - Baynes Sound: Buckley Bay to Denman Island
- Route 22 - Lambert Channel: Denman Island to Hornby Island

The emissions associated with Route 17 were halved to avoid double counting since it crosses with other jurisdictions.

Table 15 BC Ferries GHG Emission Factors

Aspect	Units	tCO_2e	Quality Assessment Rating
Ferry (Diesel)	tonne CO_2e / L	0.0029136	Medium-Low

4.2.5.3.2 Other Watercraft

The GHG emissions from the operation of personal and commercial watercraft were estimated based on the number of marinas in the CVRD and the disclosed estimate of boats. It was assumed that 50% of the boats are sail (60% diesel; 40% gas) and 50% are power (25% diesel, 75% gas). To estimate the GHG emissions, the estimated annual fuel consumption rates from the Victoria Harbour Study "Marine Vessel Air Emissions in BC and Washington State Outside of the GVRD and FVRD for the Year 2000" and BC based emission factors were applied (Table 16).

Table 16 Watercraft GHG Emission Factors

Aspect	Units	tCO_2e	Quality Assessment Rating
Marine Gasoline	tonne CO_2e / L	0.0022522	Medium-Low
Marine Diesel	tonne CO_2e / L	0.0029136	Medium-Low

The GHG quantification method, that was applied to the BC Ferries and other watercraft was as follows:

$$\textbf{Emissions}_{\text{Waterborne}} = ((\text{Vol. Fuel} * EF_{CO2}) + (\text{Vol. Fuel} * EF_{CH4} * GWP_{CH4}) + (\text{Vol. Fuel} * EF_{N2O} * GWP_{N2O}))$$

Due to a lack of available data, no GHG emissions from commercial boats could be estimated.

4.2.5.4 Off-Road

Currently, there is limited data available to estimate off-road GHG emissions. As such, a GHG emissions estimate for each off-road category was developed using Provincial emissions data from the 2022 NIR, and BC's population and employment statistics from Statistics Canada.

Residential, commercial, and institutional building related off-road GHG emissions were included in the Stationary Energy Sector are based on the 2022 NIR as prepared by Environment and Climate Change Canada. These emissions are pro-rated to the CVRD on a per capita basis. Agriculture, forestry and fishing, and manufacturing industries and construction related off-road GHG emissions included in the Stationary Energy Sector are based on the 2022 NIR as prepared by Environment and Climate Change Canada. These emissions are pro-rated to the CVRD on the number of employees in each of the reported sectors. Other off-road GHG emissions were pro-rated to the CVRD on a per capita basis and were reported in the Transportation Other Off-Road Sub-Sector.

The GHG quantification method is presented below:

$$\textbf{Emissions}_{\text{Residential, Commercial, And Institutional Building Off-Road}} = (\text{NIR Off-Road GHG Emissions}_{BC} / \text{BC Population}_{BC}) * \text{Current Reporting Year Population}_{CVRD}$$

$$\textbf{Emissions}_{\text{Agriculture, Forestry And Fishing, And Manufacturing Industries And Construction Off-Road}} = (\text{NIR Off-Road GHG Emissions}_{BC} / \text{BC Employment Statistics}_{BC}) * \text{Current Reporting Year Employment Statistics}_{CVRD}$$

$$\textbf{Emissions}_{\text{Other Off-Road}} = (\text{NIR Off-Road GHG Emissions}_{BC} / \text{BC Population}_{BC}) * \text{Current Reporting Year Population}_{CVRD}$$

4.3 WASTE

Cities produce GHG emissions because of the disposal and management of solid waste, incineration and open burning of waste, the biological treatment of waste, and through wastewater treatment and discharge. Waste does not directly consume energy, but releases GHG emissions because of decomposition, burning, incineration, and other management methods.

For the CVRD, the Waste Sector encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 3: Emissions:
  - Solid waste disposal
  - Biological treatment of waste
  - Incineration and opening burning
  - Wastewater treatment and discharge

4.3.1 Activity Data

The CVRD provided annual solid waste volumes, composting volumes (including biosolids data), fugitive landfill gas GHG emissions from the Comox Valley Waste Management Centre (CVWMC) for the 2018 and 2021 reporting years. These values were allocated to each CVRD member based on total waste and compost volumes generated.

The CVRD provided a 2015 particulate matter emissions inventory for the Comox Valley. This data source was used to estimate incineration and open burning GHG emissions.

The CVRD provided wastewater volumes for the City of Courtenay, Town of Comox and the Electoral Areas. The CVRD also provided an estimate of the number of homes using septic systems.

4.3.2 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2021 GHG emissions:

- To quantify GHG emissions from the landfill, the first order decay model was deployed by the Comox Strathcona Waste Management (CSWM) service. The first order decay model uses an annual volume and approximate composition of the garbage (over three decades) to estimate GHG emissions. It is assumed that the GHG emissions data provided is reasonably accurate and the method deployed correct.

- Composting GHG emissions are estimated based on the total tonnage estimated by the CVRD. It is assumed that all compost, other than the City of Courtenay's waste steam, is treated aerobically. The City of Courtney's organic waste stream is treated anaerobically.
- It is assumed that the wastewater influent volumes include septage received.
- Is it is assumed that wastewater is treated to a secondary level and that the annual mean for biological oxygen demand (BOD) of treated wastewater is 240 mg/L and the annual mean for Total Kjeldal Nitrogen (TKN) is 47 mg/L.
- It is assumed that 9,000 homes in the CVRD region are on septic systems and the average size of a household in the CVRD is 2.5 people.
- Incineration and open burning GHG emissions are estimated using a 2015 particulate matter emissions inventory for the Comox Valley. The GHG emissions are adjusted to 2018 and 2021 using population data.

4.3.3 Data Quality Assessment

Table 17 presents the activity data quality assessment for the waste data sources.

Table 17 Waste Data Quality Assessment

Data	Quality Assessment Rating
Landfill fugitive methane data	Medium
Wastewater volume data	High
Wastewater BOD and TKN data	Low
Wastewater septic system data	Medium-Low for Source Category; Low for Distribution between CVRD members
Composting waste data (compost and biosolids)	High for Source Category; Medium for Distribution between CVRD members
Incineration and open burning data	Medium-Low for Source Category; Low for Distribution between CVRD members

4.3.4 Calculation Methodology

4.3.4.1 Solid Waste

The Comox Valley Waste Management Centre (CVWMC) provided 2018 - 2021 landfill GHG emissions estimates and solid waste tonnage by CVRD member. The GHG emissions were allocated based on solid waste tonnage sent to the landfill by CVRD member.

4.3.4.2 Biological Treatment of Solid Waste

The CVRD provided 2021 composting data which is assumed to be treated aerobically. The composting emission factor used in the estimation of GHG emissions was derived from the 2006 IPCC Guidelines for

National Greenhouse Gas Inventories (Volume 5, Chapter 4: Biological Treatment of Solid Waste) (Table 18).

Table 18 Composting Emission Factor

Emission Factor	Units	tCO_2e	Quality Rating Assessment
Composting: Anerobic	tCO_2e / kg waste	0.00019150	Low
Composting: Aerobic	tCO_2e / kg waste	0.00002800	Low

To quantify GHG emissions from the biological treatment of solid waste, the following GHG quantification methods was deployed:

$$Emissions_{Anaerobic\ Waste} = Compost\ Waste_{Total} * EF_{CH4} * GWP_{CH4}$$

4.3.4.3 Waste Incineration And Open Burning

Incineration and open burning GHG emissions are estimated using a 2015 particulate matter emissions inventory for the Comox Valley. In 2015, it was estimated that 1,849 tonnes of organic material are burned per year in the rural areas of the CVRD. For the purposes of estimation, it is assumed that all open burning occurs in the Electoral Areas of the CVRD. The GHG emissions are adjusted to 2018 and 2021 using population data.

The emission factor used in the estimation of GHG emissions was derived from 2001 US EPA GHG methodology quantification guidance document (Chapter 16, Open Burning). It is assumed that the material being burned is evenly split amongst leaf species, forest residues, and weeds. The emission factor is presented in Table 19.

Table 19 Open Burning Emission Factor

Emission Factor	Units	tCO_2e	Quality Rating Assessment
Open Burning	tCO_2e / tonne waste	0.04622430	Medium-Low

To quantify GHG emissions from the biological treatment of solid waste, the following GHG quantification methods was deployed:

$$Emissions_{Open\ Burning} = Burned\ Waste_{Total} * EF_{CO2}$$

4.3.4.4 Wastewater Treatment And Discharge: Treatment Systems

Wastewater is currently treated prior to discharge. To estimate GHG emissions, the total wastewater volumes (m^3), the average biological oxygen demand (BOD) and the average Total Kjeldal Nitrogen (TKN) in treated wastewater area used. IPCC default wastewater methane (CH_4) producing capacity (0.6

kg CH_4/kg BOD) and methane correction factor (MCF) (0.1 – unit less) were used to estimate CH_4 from the wastewater. To estimate N_2O from the wastewater, the Total Kjeldal Nitrogen (TKN) annual average in conjunction with the total wastewater volumes to calculate the total TKN in the wastewater. The IPCC default conversion value of 0.01 kg N_2O-N/kg sewage-N was used to estimate N_2O from the wastewater. These factors used are for treated wastewater being deposited into deep or moving waters. It is likely that ocean sequesters more CH_4 than what has been estimated.

To quantify GHG emissions from the wastewater treatment, the following GHG quantification method is deployed:

$$\textbf{Emissions}_{\text{Wastewater CH4}} = ((\text{Wastewater}_{m3} * (\text{BOD}_{ml/L} / 1000) * (0.06_{\text{kg CH4/kg BOD}} * 0.01)) / 1000) * GWP_{CH4}$$

$$\textbf{Emissions}_{\text{Wastewater N2O}} = ((\text{Wastewater}_{m3} * (\text{TKN}_{ml/L} / 1000) * 0.01_{\text{kg N2O-N/kg sewage-N}}) / 1000) * GWP_{N2O}$$

4.3.4.5 Wastewater Treatment And Discharge: Septic Systems

It is estimated that approximately 9,000 households in the CVRD are on septic systems. The number of homes and the number of people within a household was used to estimate the fugitive wastewater GHG emissions from septic systems. The method is presented as follows:

$$\textbf{Emissions}_{\text{Septic}} = \text{Homes}_{\text{Septic}} * \text{Average Size of Census Family}_{\text{CVRD}} * EF$$

The emission factor derived from septic GHG emissions research by the Water Environment Research Foundation is presented in Table 20.

Table 20 Septic System Emission Factor

Emission Factor	Units	tCO_2e	Quality Rating Assessment
Septic Systems	tCO_2e / capita / year	0.0010302	Medium-Low

4.4 INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)

4.4.1 Overview

Emissions from the IPPU Sector are only required for BASIC+ GHG reporting under the GPC Protocol. This Sector encompasses GHG emissions produced from industrial processes that chemically or physically transform materials and using products by industry and end-consumers (e.g., refrigerants, foams, and aerosol cans) (GPC, 2014).

For the CVRD, the IPPU encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Product use

No significant GHG emissions from Industrial Processes, like the release of chemicals and refrigerants because of manufacturing or processing of materials, are reported to be occurring and thus the notation key for "Not Occurring" has been used to indicate this. It should be noted that the reporting threshold for the BC government is 10,000 tCO_2e so it is possible that there are small industrial GHG emissions sources occurring within the CVRD, but there is no data to support a conclusion.

4.4.2 Activity Data

As there is limited data available on Product Use GHG emissions, the GHG Emissions estimate was derived on a per capita basis using the 2022 NIR GHG data for the Province of BC and BC population data for the reporting year.

4.4.3 Data Quality Assessment

Table 21 presents the activity data quality assessment for the IPPU data sources.

Table 21 IPPU Data Quality Assessment

Data	Quality Assessment Rating
Industrial process emissions data	Low
Industrial product use emissions data	Low

4.4.4 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2021 GHG emissions:

- The product use emissions are based on the 2022 NIR product use GHG emissions as prepared by Environment and Climate Change Canada.
- The NIR uses the Tier 1 methodology to estimate these emissions and thus uncertainty around their accuracy remains quite high.

4.4.5 Calculation Methodology

4.4.5.1 Product Use Emissions

For the 2021 reporting year, only the emissions estimated were production and consumption of halocarbons, SF_6 and NF_3 were estimated for the province. To estimate product use GHG emissions for the CVRD, a per capita estimate was developed using the Provincial emissions data from the 2022 NIR, and BC's NIR reporting year population from Statistics Canada. This value was applied to the 2021 reporting year based on the CVRD population to estimate the total product use emissions.

The GHG quantification method is presented below:

$$Emissions_{Product\ Use} = (NIR\ Product\ Use\ GHG\ Emissions_{BC} / NIR\ Population_{BC}) * Current\ Reporting\ Year\ Population$$

4.5 AGRICULTURE, FORESTRY, AND OTHER LAND USE (AFOLU)

4.5.1 Overview

The AFOLU Sector includes emissions from livestock, land-use, and all other agricultural activities occurring within a community's boundaries. For the CVRD, the AFOLU encompasses the following GHG emissions scopes and Sub-Sectors:

- Scope 1 Emissions:
  - Land (*reported, but not included in the GHG totals*)
  - Livestock
  - Aggregate Sources and Non-CO_2 Emissions Sources On Land

4.5.2 Activity Data

The 2015 and 2020 Agriculture and Agri-Food Canada semi-decadal land use time series remotely sensed imagery datasets were used to estimate land-cover change between 2018 and 2021. The CVRD provided jurisdictional boundary geospatial datasets.

Livestock counts were derived using Statistics Canada data.

Aggregate sources and non-CO_2 emissions sources on land were estimated using GHG emissions data from the 2022 NIR, and land-use data from the 2021 Statistics Canada Census of Agriculture, to create a GHG emissions per hectare value.

4.5.3 Assumptions and Disclosures

The following assumptions were made in the calculation of the 2021 GHG emissions:

- It is conservatively assumed that all cropland is used for livestock and agricultural purposes.
- Infrequent and small source open burning may be occurring, but there is no data to estimate this emissions source.
- The land cover change analysis requires a consistent land-use category attribution and spatial data. Landsat spatial data was available for the 2018 and 2021 reporting years. Since annual data was not available, the change between land cover data years (2018-2021) for all areas was averaged and may not represent actual changes in each year.

4.5.4 Data Quality Assessment

Table 22 presents the activity data quality assessment for the AFOLU data sources.

Table 22 AFOLU Data Quality Assessment

Data	Quality Assessment
Land-use data	High
Urea application GHG data	Low
Direct, indirect, and manure nitrous oxide (N_2O) GHG data	Low
Livestock data	Medium

4.5.5 Calculation Methodology

4.5.5.1 Land Use

Remotely sensed imagery was used to estimate land-cover changes during the 2018-2021 reporting periods. Using the remotely sensed imagery an annual average land-use change between land classes (e.g., cropland, forestland, etc.) was determined and applied to BC-based emission factors to estimate GHG emissions resulting from changes between land-uses for the reporting year.

The spatial data sources representing land cover in this analysis did not categorize lands by the 6 IPCC land-use categories. To align with the IPCC land classification definitions (as required by the GPC Protocol), the following data categories were re-assigned to the most appropriate IPCC land class.

Table 23 IPCC Land Use Classification Cross-References

Data Label	Definition	IPCC Land Use Classification
Settlement	Urban and rural residential, commercial, industrial, transportation or other built infrastructure use	Settlement

Data Label	Definition	IPCC Land Use Classification
Settlement Forest	Settlement areas mostly or entirely covered by tree canopy	Settlement
Vegetated Settlement	Settlement areas with observable vegetation such as lawns, golf courses, and settlement areas with 30-50% tree canopy	Settlement
High Reflectance Settlement	Settlement areas with high spectral reflectance such as pavement, buildings, or other surfaces with little to no observable vegetation	Settlement
Very High Reflectance Settlement	Settlement areas with very high spectral reflectance such as pavement, buildings, or other surfaces with no observable vegetation	Settlement
Roads	Primary, secondary, and tertiary roads	Settlement
Water	Open water	Other
Forest	Land covered by trees with a canopy cover >10% and a minimum height of 5m, or capable of growing to those measurements within 50 years	Forest Land
Forest Wetland	Wetland with forest cover (canopy cover over 10% and minimum height 5m, or capable of growing to those measurements within 50 years)	Wetlands
Forest Regenerating after Harvest <20 years	Forest regenerating from tree harvesting activity that took place less than 20 years prior	Forest Land
Forest Wetland Regenerating after Harvest <20 years	Wetland with forest cover regenerating from tree harvesting activity that took place less than 20 years prior	Wetlands
Forest Regenerating after Fire <20 years	Forest Regenerating after a fire less than 20 years prior	Forest Land
Forest Regenerating after Harvest 20-29 years	Forest regenerating from tree harvesting activity that took place 20 to 29 years prior (this class is identified beginning in 2010)	Forest Land
Forest Wetland Regenerating after Harvest 20-29 years	Wetland with forest cover regenerating from tree harvesting activity that took place 20 to 29 years prior	Wetlands
Cropland	Annual and perennial cropland	Cropland
Annual Cropland	Annual cropland (identified beginning in 2015)	Cropland
Land Converted to Cropland	Cropland that did not appear to be cropland 10 years prior (this class is identified beginning in 2010)	Cropland
Land Converted to Annual Cropland	Annual cropland that did not appear to be cropland 10 years prior (this class is identified beginning in 2015)	Cropland
Grassland Managed	Natural grass and shrubs used for cattle grazing	Grassland

Data Label	Definition	IPCC Land Use Classification
Grassland Unmanaged	Natural grass and shrubs with no discerned human intervention (e.g., perpetual meadows, tundra)	Grassland
Wetland	Wetland with vegetation at or above the surface of the water	Wetlands
Newly-Detected Settlement <10 years	Settlement (21) that was first identified as a Settlement land use less than 10 years prior (this class is identified beginning in 2010)	Settlement
Newly-Detected Settlement Forest <10 years	Settlement Forest (24) that was first identified as a Settlement land use less than 10 years prior (this class is identified beginning in 2010)	Settlement
Newly-Detected Vegetated Settlement <10 years	Vegetated Settlement (28) that was first identified as a Settlement land use less than 10 years prior (this class is identified beginning in 2010)	Settlement
Newly-Detected High Reflectance Settlement <10 years	High Reflectance Settlement (22) that was first identified as a Settlement land use less than 10 years prior (this class is identified beginning in 2010)	Settlement
Newly-Detected Very High Reflectance Settlement <10 years	Very High Reflectance Settlement (29) that was first identified as a Settlement land use less than 10 years prior (this class is identified beginning in 2010)	Settlement
Other Land	Rock, beaches, ice, barren land	Other
Snow and Ice	Snow and Ice on mountains (this class is identified only in 2020)	Other

The analysis resulted in an estimate of an annual average change in hectares' value for each land class. Once the land use change values were determined for the reporting year, BC-based and IPCC emission factors were applied to estimate reported and disclosed (not-reported) GHG emissions from land use (Table 24).

Table 24 Land-Use Change Emission Factors

Land-Use Classification	Emission Factor	Units	Quality Assessment Rating
Forestland	224.1	tCO_2e / ha	Low
Shrubland/Scrubland	112.0	tCO_2e / ha	Low
Grasslands	205.7	tCO_2e / ha	Low
Wetlands	471.5	tCO_2e / ha	Low
Cropland	239.8	tCO_2e / ha	Low
Settlements	0	tCO_2e / ha	Low
Other	0	tCO_2e / ha	Low

Land-Use Classification	Emission Factor	Units	Quality Assessment Rating
Forestland	1.8	tCO_2e / ha / year	Low
Shrubland/Scrubland	0.1	tCO_2e / ha / year	Low
Grasslands	2.6	tCO_2e / ha / year	Low
Wetlands	3.3	tCO_2e / ha / year	Low
Croplands	0.4	tCO_2e / ha / year	Low
Settlements	0	tCO_2e / ha / year	Low
Other	0	tCO_2e / ha / year	Low

The GHG quantification methods for land use change is presented below:

$$\textbf{Emissions}_{\text{Lands Not Converted}} = \text{Land Type}_{ha} * EF_{Sequester}$$

$$\textbf{Emissions}_{\text{Lands Converted}} = \text{Land Type}_{ha} * (EF_{Release} / (\text{Current Land Reporting}_{Year} - \text{Last Land Reporting}_{Year} + 1))$$

4.5.5.2 Emissions from Livestock

Emissions from Livestock includes enteric fermentation and manure management emission sources. IPCC derived emission factors were used to estimate this emissions source (Table 25).

Table 25 Livestock Emission Factors

Animal	Enteric Methane (tCO_2e / head / year)	Methane from Wastes (tCO_2e / head / year)	Quality Assessment Rating
Dairy Breeding Herd	2.875	0.325	Medium
Beef Herd	1.200	0.069	Medium
Cattle: Others>1, Dairy Heifers	1.200	0.150	Medium
Cattle: Others<1	0.820	0.074	Medium
Pigs	0.038	0.075	Medium
Breeding Sheep	0.200	0.005	Medium
Other Sheep	0.200	0.005	Medium
Lambs < 1 year	0.080	0.002	Medium
Goats	0.125	0.003	Medium
Sheep / Lamb / Goat	0.151	0.004	Medium
Horses	0.450	0.035	Medium
Deer (Stags & Hinds)	0.260	0.007	Medium
Deer (Calves)	0.130	0.003	Medium

Animal	Enteric Methane (tCO_2e / head / year)	Methane from Wastes (tCO_2e / head / year)	Quality Assessment Rating
Poultry	-	0.002	Medium

The GHG quantification methods to estimate livestock emissions is presented below:

$$Emissions_{Livestock} = Livestock\ Type_{Head} * (EF_{Enteric\ Methane} + EF_{Methane\ From\ Waste})$$

4.5.5.3 Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land

Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land includes direct N_2O emissions from agricultural soil management and indirect N_2O emissions from applied nitrogen. To estimate these GHG emissions, the total area of farmland for BC is used in conjunction with 2022 NIR data to develop a tCO_2e / ha value. This is then be applied to the total crop land in hectares to derive a GHG emissions estimate.

The GHG quantification method is presented below:

$$Emissions_{Direct\ \&\ Indirect\ N2O} = ((BC_{Direct\ N2O\ Emissions} + BC_{Indirect\ N2O\ Emissions} + BC_{Indirect\ N2O\ Manure\ Management\ Emissions}) / BC_{Land\ In\ Crops\ ha}) * CVRD\ Cropland_{ha}$$

$$Emissions_{Urea\ Application} = CVRD\ Cropland_{ha} * 0.133\ tCO_2e / ha$$

5.0 2021 GHG REPORTING YEAR RESULTS

5.1 OVERVIEW

This section presents the 2021 reporting year GHG emissions for the CVRD. The following table classifies each of the GPC Protocol GHG emission categories by scope and reporting level. Note that these are cumulative.

Table 26 GHG Emissions Reporting Breakdown by GPC Reporting Method

GHG Emissions Scope	BASIC Reporting Level	BASIC+ Reporting Level
Scope 1	• Emissions from in boundary fuel combustion • In boundary fugitive emissions • Emissions from in boundary transport	Everything in the box at left, plus in-boundary emissions from: • Industrial process and product use • Livestock • Land use • Emissions from Aggregate Sources and Non-CO_2 Emission Sources on Land
Scope 2	• Emissions from consumption of grid-supplied energy	• Emissions from consumption of grid-supplied energy
Scope 3	• Emissions from solid waste, and composting generated within but treated outside of the GHG boundaries	Everything in the box at left, plus: • Transmission, distribution, and line losses from grid-supplied energy • Emissions from transboundary journeys
Outside of Reporting Scopes & GPC Protocol	• Upstream fuel emission extraction, processing, and transport • Food and drink imports • Construction materials (imports) • Other supply chain emissions • Vehicle fuel exports	

5.2 SUMMARY

Total BASIC, and BASIC+ emissions for the CVRD for the 2021 reporting year are presented in the Figure 3 below.

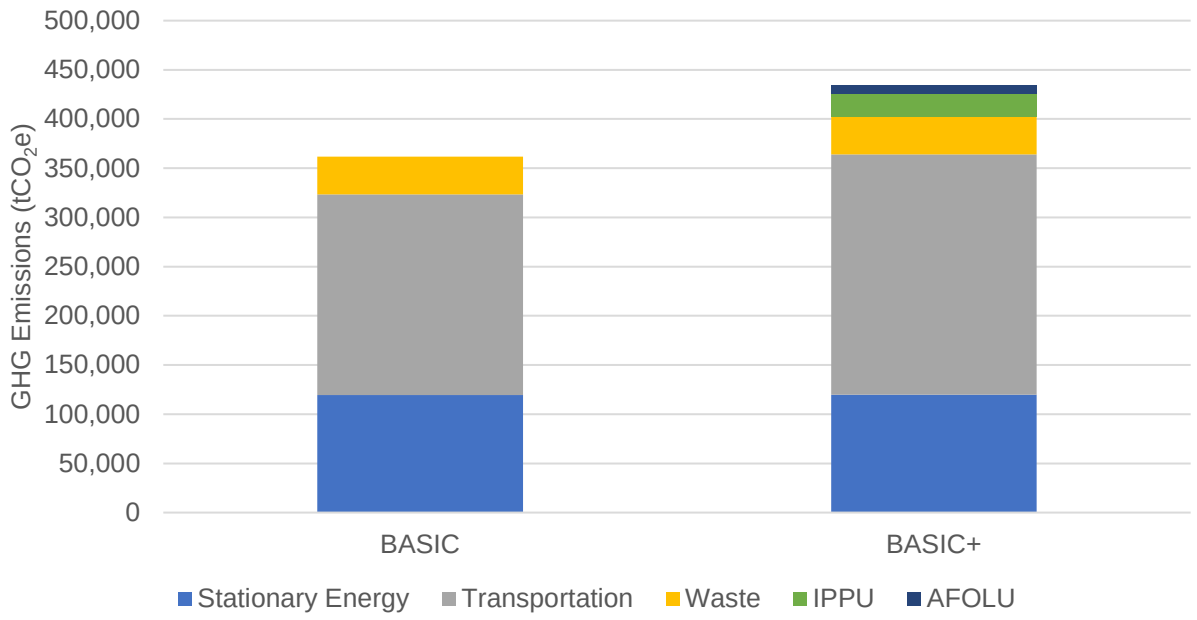

Figure 3 2021 GHG Emissions Summary by GPC Reporting Level

Emissions by reporting level are presented in Table 27 below which shows a difference in emissions under the GPC Protocol's BASIC, and BASIC+ reporting levels. This is due to the inclusion of additional sources in BASIC+ which are very significant for almost any growing community. These additional emissions include transboundary emissions, industrial and product use emissions, and emissions from land-use change. Under the GPC Protocol, emissions included within each higher reporting level are cumulative from lower levels.

Table 27 Breakdown of the CVRD's 2021 GHG Emissions in GPC Reporting Format

GHG Emissions Source (by Sector)		Total GHGs (metric tonnes CO_2e)					
		Scope 1	Scope 2	Scope 3	BASIC	BASIC+	BASIC+ S3
Stationary Energy	Energy use (all emissions except I.4.4)	113,421	6,068	407	119,489	119,895	119,895
	Energy generation supplied to the grid (I.4.4)	NO					
Transportation	(all II emissions)	203,819	12	40,403	203,830	244,233	244,233
Waste	Waste generated in the Community (III.X.1 and III.X.2)	38,452		0	38,452	38,452	38,452
	Waste generated outside community (III.X.3)	2,326					
IPPU	(all IV emissions)	22,827				22,827	22,827
AFOLU	(all V emissions)	8,576				8,576	8,576
Other Scope 3 (S3)	(all VI emissions)			0			0
TOTAL		**387,094**	**6,079**	**40,809**	**361,771**	**433,983**	**433,983**

NOTES:
Notation Keys: IE = Included Elsewhere; NE = Not Estimated; NO = Not Occurring.
Cells in green are required for BASIC reporting
Cells in green and blue are required for BASIC+ reporting
Cells in purple are for disclosure purposes only but are not included in the summary totals as required by the GPC Protocol.
Cells in orange are not required for BASIC or BASIC+ reporting

Table 28 presents the breakdown of the CVRD's BASIC+ GHG emissions by Sector and Sub-Sector.

Table 28 Breakdown of the CVRD's 2021 BASIC+ GHG Emissions in the GPC Protocol Reporting Format

GPC ref No.	GHG Emissions Source (by Sector and Sub-Sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	**Stationary Energy**				
I.1	Residential buildings	78,193	4,035	270	82,499
I.2	Commercial and institutional buildings and facilities	32,460	2,032	136	34,628
I.3	Manufacturing industries and construction	950	IE	IE	950
I.4.1/2/3	Energy industries	NO	NO	NO	NO
I.4.4	Energy generation supplied to the grid	NO			
I.5	Agriculture, forestry, and fishing activities	459	IE	IE	459
I.6	Non-specified sources	3	NO	NO	3
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			NO
I.8	Fugitive emissions from oil and natural gas systems	1,356			1,356
Sub-Total	(community induced framework only)	**113,421**	**6,068**	**407**	**119,895**
II	**Transportation**				
II.1	On-road transportation	193,769	12	4,348	198,129
II.2	Railways	NO	NO	NO	NO
II.3	Waterborne navigation	105	IE	36,055	36,160
II.4	Aviation	284	IE	NO	284
II.5	Off-road transportation	9,661	IE	IE	9,661
Sub-total	(community induced framework only)	**203,819**	**12**	**40,403**	**244,233**
III	**Waste**				
III.1.1/2	Solid waste generated in the Community	24,756		NO	24,756
III.2.1/2	Biological waste generated in the Community	2,474		NO	2,474
III.3.1/2	Incinerated and burned waste generated in the Community	91		NO	91
III.4.1/2	Wastewater generated in the Community	11,131		NO	11,131
III.1.3	Solid waste generated outside the Community	2,326			
III.2.3	Biological waste generated outside the Community	NO			
III.3.3	Incinerated and burned waste generated outside community	NO			

Table 28 Breakdown of the CVRD's 2021 BASIC+ GHG Emissions in the GPC Protocol Reporting Format

GPC ref No.	GHG Emissions Source (by Sector and Sub-Sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
III.4.3	Wastewater generated outside the Community	NO			
Sub-total	(community induced framework only)	**38,452**		**0**	**38,452**
IV	**Industrial Processes and Product Uses**				
IV.1	Emissions from industrial processes occurring in the Community boundary	IE			IE
IV.2	Emissions from product use occurring within the Community boundary	22,827			22,827
Sub-Total	(community induced framework only)	**22,827**			**22,827**
V	**Agriculture, Forestry, and Other Land Use**				
V.1	Emissions from livestock	8,311			8,311
V.2	Emissions from land (not included in total)	-284,530			-284,530
V.3	Emissions from aggregate sources and non-CO_2 emission sources on land	266			266
Sub-Total	(community induced framework only)	**8,576**			**8,576**
VI	**Other Scope 3**				
VI.1	Other Scope 3			NE	NE
Total	(community induced framework only)	**387,094**	**6,079**	**40,809**	**433,983**

NOTES:
Cells in green are required for BASIC reporting
Cells in green and blue are required for BASIC+ reporting
Cells in purple are for disclosure purposes only but are not included in the summary totals as required by the GPC Protocol.
Cells in orange are not required for BASIC or BASIC+ reporting

5.3 TOTAL GHG EMISSIONS

Under the BASIC+ method, the CVRD's GHG emissions totaled 433,983 tCO_2e. On a per capita basis, this works out to 5.8 tCO_2e per person (Table 29).

Table 29 Total Energy and GHG Emissions Per Person by Sector

Sector	Sub-Sector	Energy (GJ)	GHG Emissions (tCO_2e)	GJ Per Capita	tCO_2e Per Capita
Stationary Energy	Residential Buildings	3,224,004	82,499	43	1.10
	Commercial & Institutional Buildings	1,424,968	34,628	19	0.46
	Manufacturing Industries & Construction	333,159	950	4	0.01
	Agriculture, Forestry & Fishing activities	6,229	459	0	0.01
	Non-Specified Sources	-	3	-	0.00
	Fugitive Emissions	-	1,356	-	0.02
Transportation	In-Boundary On-road Transportation	2,857,945	193,781	38	2.59
	Trans-Boundary On-road Transportation	64,126	4,348	1	0.06
	Waterborne Navigation	486,226	36,160	7	0.48
	Aviation	3,814	284	0	0.00
	Off-road Transportation	131,057	9,661	2	0.13
Waste	Solid Waste		24,756		0.33
	Biological Treatment of Waste		2,474		0.03
	Waste Incineration & Open Burning		91		0.00
	Wastewater Treatment & Discharge		11,131		0.15
IPPU	Product Use		22,827		0.31
AFOLU	Land-Use: Emissions Sequestered		(284,748)		(3.81)
	Land-Use: Emissions Release		218		0.00
	Livestock		8,311		0.11
	Non-CO_2 Land Emission Sources		266		0.00
Total		**8,531,527**	**433,983**	**114.2**	**5.81**

Total GHG emissions for 2021 are 433,983 tCO_2e and have decreased 1.8% from the 2018 reporting year. Scope 1 and 2 Emissions are 89.2% and 1.4% of the total GHG inventory. Scope 1 emissions are the GHG emissions that result from the combustion of fuel in sources within the CVRD's boundaries,

primarily from Stationary Energy and Transportation. Scope 1 GHG emissions also include IPPU and some AFOLU GHG emissions. Scope 2 emissions result from the use of electricity supplied to the CVRD which includes emissions associated with the generation of electricity and other forms of energy (e.g., heat and steam). Scope 2 emissions are low compared to other geographies, due to the predominance of hydroelectric generation technologies in the BC. Scope 3 emissions are emissions from electricity line losses, transboundary traffic, and emissions associated with the CVRD that are occurring outside of the CVRD's boundaries. For 2021, Scope 3 GHG emissions make up 9.4% of the GHG inventory. This breakdown by emission scope is depicted in Figure 4.

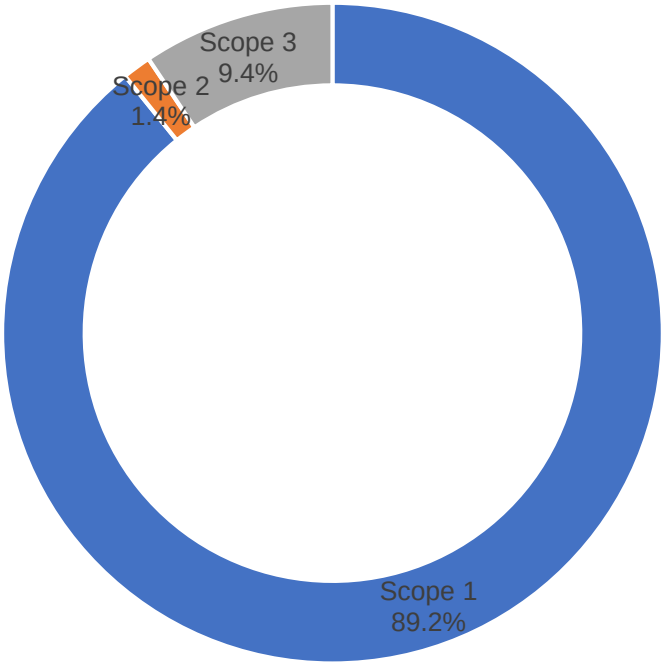

Figure 4 CVRD BASIC+ GHG Emissions by Emissions Scope

A breakdown of GHG emissions by reporting scope for the 2018 and 2021 reporting years are presented in Table 30 below.

Table 30 Change in GHG Emissions Between 2018 & 2021 Reporting Years

Emissions Scope	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change
Scope 1	386,320	387,094	0.2%
Scope 2	15,208	6,079	-60.0%
Scope 3	40,597	40,809	0.5%
Total	**442,125**	**433,983**	**-1.8%**

5.4 SECTORAL GHG EMISSIONS ANALYSIS

5.4.1 Stationary Energy

Stationary energy sources are one of the largest contributors to the CVRD's GHG emissions. In 2021, excluding sequestered GHG emissions, it contributed 27.6% of the community's GHG emissions. In general, stationary energy emissions include the energy to run manufacturing processes and other industrial activities (e.g., compressor stations), energy to heat and cool residential, commercial, and industrial buildings, as well as the activities that occur within these residences and facilities. Fugitive methane emissions from natural gas pipelines and other distribution facilities, and related off-road GHG emissions, are also reported in this Sector. The table below shows the breakdown of energy use in the stationary energy reporting category.

Table 31 summarizes the energy and GHG emissions for the 2021 reporting year.

Table 31 2021 Energy and GHG Emissions by Stationary Energy Sector

Sector	Electricity (tCO_2e)	Natural Gas (tCO_2e)	Heating Oil (tCO_2e)	Propane (tCO_2e)	Wood (tCO_2e)	Other Sources (tCO_2e)	**Total GHG Emissions (tCO_2e)**	**Total Energy (GJ)**
Residential Buildings	4,306	30,064	28,629	4,407	12,893	2,200	**82,499**	**3,224,004**
Commercial & Institutional Buildings	2,168	27,681	-			4,779	**34,628**	**1,424,968**
Manufacturing Industries & Construction						950	**950**	**333,159**
Agriculture, Forestry & Fishing activities						459	**459**	**6,229**
Non-Specified Sources						3	**3**	**No Data**
Fugitive Emissions						1,356	**1,356**	
Total GHG Emissions (tCO_2e)	**6,474**	**57,745**	**28,629**	**4,407**	**12,893**	**9,748**	**119,895**	
Total Energy (GJ)	**2,402,743**	**1,491,743**	**418,852**	**72,228**	**501,880**	**100,914**		**4,988,360**

It can be seen in Figure 5 that natural gas use contributed to 48.2% of the CVRD's total Stationary Energy GHG emissions.

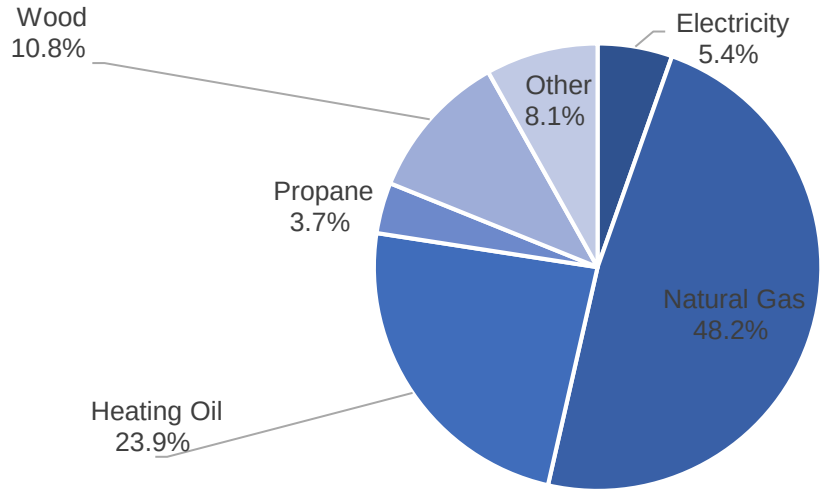

Figure 5 Stationary Energy GHG Emissions Contribution to the GHG Inventory

Figure 6 shows that the stationary GHG emissions largely arise from the operation of residential and commercial buildings.

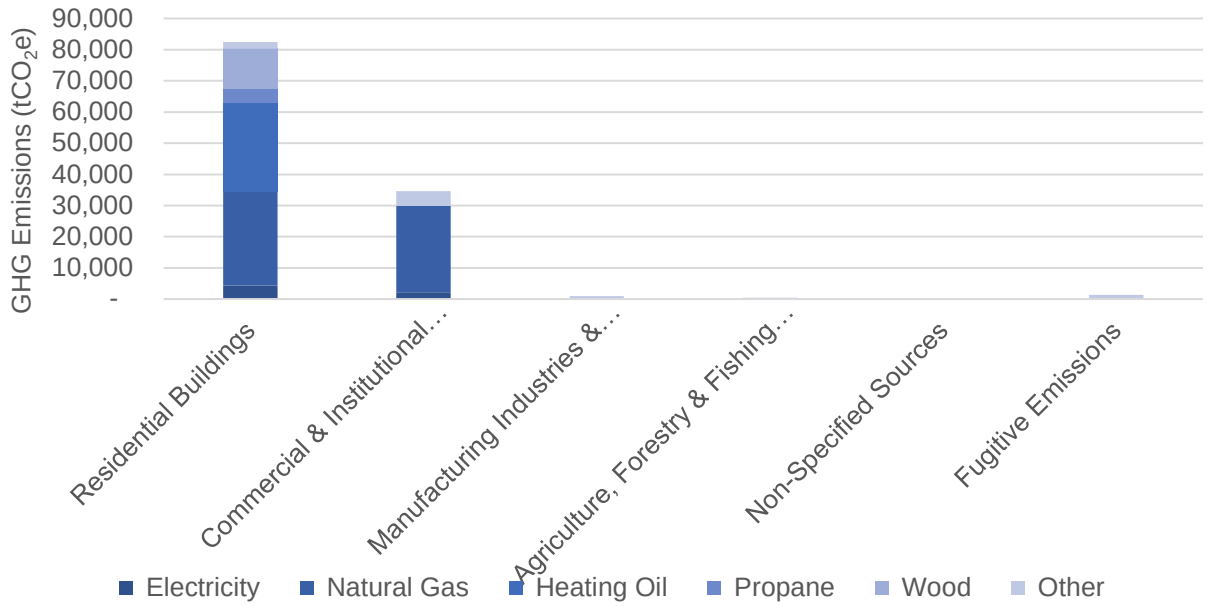

Figure 6 Total Stationary Energy Use By Sub-Sector

Stationary energy has increased 6.7% since the 2018 reporting year (Table 32). Much of the associated increase in GHG emissions has been offset by a significantly lower electricity emission factor in 2021 (as compared to 2018).

Table 32 Stationary Energy—Energy and GHG Emissions Trends

Sector	Change in GJ: 2018 & 2021	Change in tCO_2e: 2018 & 2021
Residential Buildings	7.1%	2.0%
Commercial & Institutional Buildings	5.8%	-3.1%
Manufacturing Industries & Construction	-4.7%	1.6%
Agriculture, Forestry & Fishing activities	1.6%	8.3%
Non-Specified Sources		0.0%
Fugitives		11.5%
Total	**5.9%**	**0.6%**

5.4.2 Transportation

Transportation covers all emissions from combustion of fuels in journeys by road, rail, water, and air, including inter-community and international travel. For the 2021 reporting year, transportation GHG emissions accounted for 56.3% of the CVRD GHG inventory with the bulk of transportation GHG emissions resulting from the on-road transportation sub-sector (81.1%). The transportation GHG emissions are produced directly by the combustion of fuel or indirectly because of the use of grid-supplied electricity. Unlike stationary emission sectors, transit is mobile and can pose challenges in both accurately calculating emissions and allocating them to the cities linked to the transit activity. The following sections summarize energy and GHG emissions by on-road transportation, which is then followed by off-road transportation (marine, aviation, and other).

Table 33 summarizes the on-road energy and GHG emissions for the 2021 reporting year.

Table 33 2021 On-Road Transportation Energy And GHG Emissions by Fuel Type

Fuel Type	Number of Registered Vehicles	Total Fuel Use	Fuel Use Units	Energy (GJ)	GHG Emissions (tCO_2e)
Electricity	539	1,219,995	kWh	4	12
Gasoline	58,299	57,559,654	Liters (L)	1,995,018	135,066
Diesel	7,421	23,846,827	Liters (L)	922,395	62,746
Propane	83	182,252	Liters (L)	4,653	281
Hydrogen	0	-	Liters (L)	-	-
Natural Gas	5	7,645	Kilograms (kg)	0	24
Total	**66,346**	**N/A**	**N/A**	**2,922,071**	**198,129**

Overall, GHG emissions from on-road transportation has declined by 4.7% compared to the 2018 reporting year. Figure 7 provides a breakdown of GHG emisisons by vehicle classification. Nearly ¾ of the GHG emissions comr from light duty vehciles and trucks.

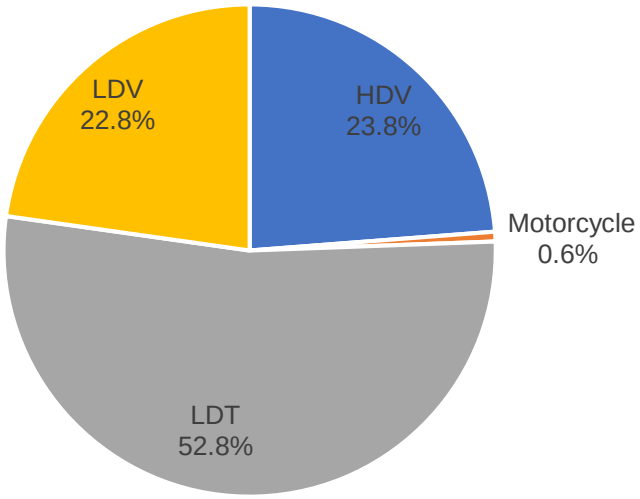

Figure 7 Breakdown of On-Road GHG Emissions by Vehicle Type

Table 34 summarizes the aviation, waterborne, and off-road transportation energy and emissions by fuel type. These GHG emissions contribute to 18.9% of the total transportation GHG emissions and 10.7% to the total inventory, after excluding for land use sequestration (Figure 8).

Table 34 2021 Aviation, Waterborne, and Off-Road Transportation Energy and Emissions by Fuel Type

Fuel Type	Total	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Marine Gasoline	28,169	Liters (L)	977	63
Marine Diesel	12,545,199	Liters (L)	485,248	36,097
Marine Natural Gas	-	Liters (L)	-	-
Aviation Jet Fuel	109,903	Liters (L)	3,814	284
Other Off-Road Transportation Diesel	3,388,232	Liters (L)	131,057	9,661
Total	**N/A**	**N/A**	**621,096**	**46,105**

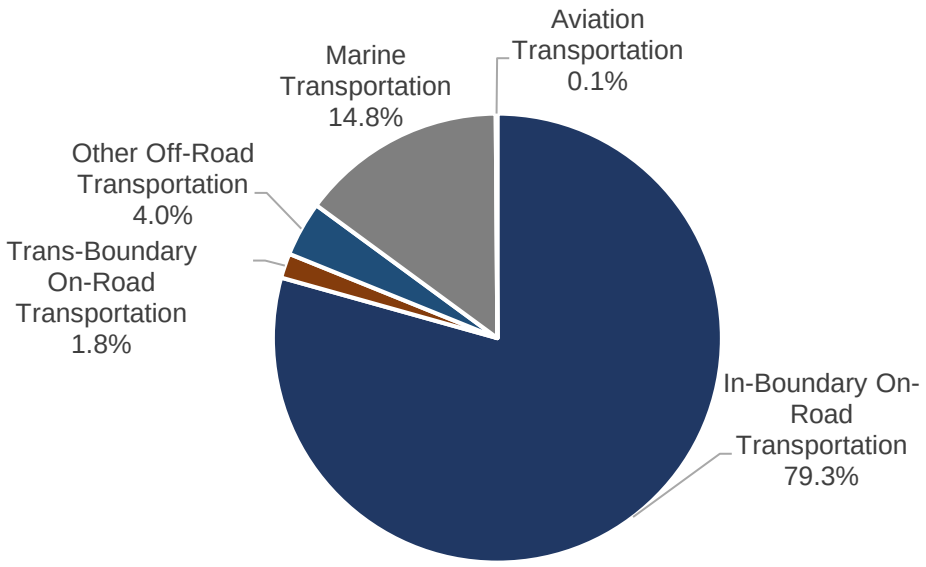

Figure 8 Summary of Transportation GHG Emissions by Sub-Sector

5.4.3 Waste

Communities produce solid waste, compost, and wastewater. Waste does not directly consume energy, but when deposited into landfills, or left exposed to the atmosphere, it decomposes and releases methane (CH_4) gas which is a potent GHG. The GHG emissions from the solid waste, composting, and wastewater facilities for the reporting year is summarized in the following table. For the 2021 reporting year, waste emissions contributed 8.9% to the GHG inventory after excluding sequestration GHG emissions. A breakdown of the Waste Sub-Sector GHG emissions is presented in Table 35.

Table 35 Summary of Waste Sub-Sector GHG Emissions

Sector	2021 GHG Emissions (tCO_2e)	GHG Emissions Per Capita (tCO_2e / Capita)	Change from Reporting year (2018)
Wastewater Treatment And Discharge	11,131	0.15	-5.3%
Biological Treatment of Solid Waste	2,474	0.03	26%
Waste Incineration and Open Burning	91	0.00	5%
Solid Waste	24,756	0.33	8.3%
Total	**38,452**	**0.51**	**4.9%**

For the 2021 reporting year, in scope GHG emissions from waste have increased by 4.9% compared to the 2018 reporting year. Fluctuations in waste will occur over the reporting periods as waste is driven by

both the population, as well as economic prosperity in the region. The Solid Waste Sub-Sector contributes more than 64% of total waste GHG emissions (Figure 9). To reduce the amount of waste landfilled, and thus GHG emissions, the CVRD and its members are making a significant effort to reduce waste going to landfills through organics diversion and recycling.

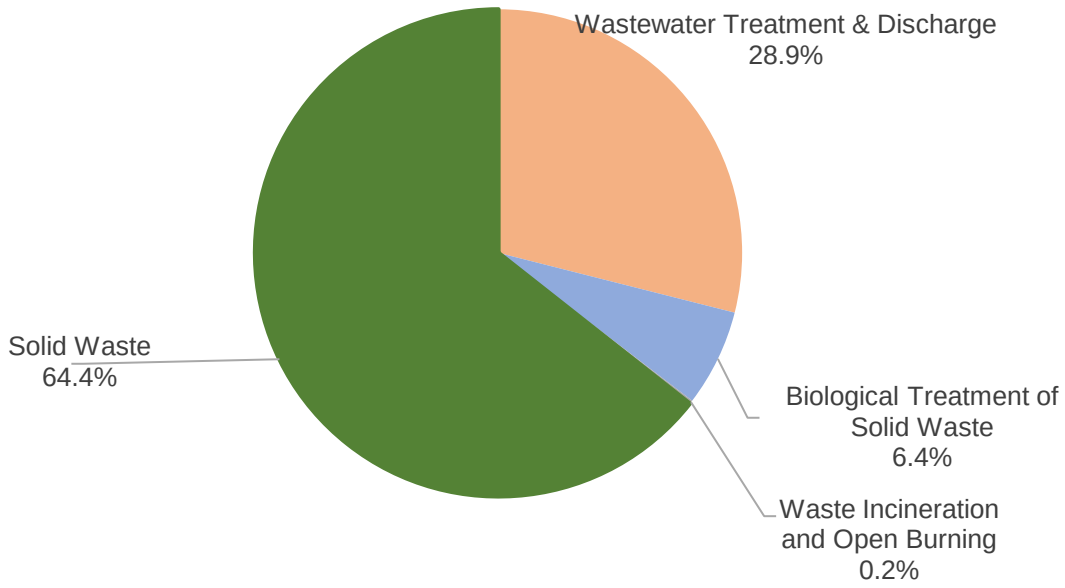

Figure 9 2021 GHG Emissions from Waste (tCO_2e)

5.4.4 Industrial Processes and Product Use (IPPU)

Reporting on IPPU GHG emissions is required for BASIC+ reporting only. Industrial GHG emissions are produced from a wide variety of non-energy related industrial activities which are typically releases from industrial processes that chemically or physically transform materials. During these processes, many different GHGs can be produced. It is not clear if there are industrial GHG emissions occurring within the CVRD's boundaries and thus a "Not Estimated" notation is used in the GPC tables.

Also included in the IPPU Sector is Product Use GHG emissions. Certain products used by industry and end-consumers, such as refrigerants, foams or aerosol cans, also contain GHGs which can be released during use and disposal and thus, as with best-practice, must be accounted for. For the reporting year, only the emissions estimated were production and consumption of halocarbons, SF_6 and NF_3 were estimated for the CVRD on the basis that other GHG emissions sources identified in the NIR are not likely to be occurring in the CVRD. The sources of these GHG emissions are typically fridges, heat pumps, and air conditioners. To estimate Product Use GHG emissions for the CVRD, a per capita estimate was developed using the Provincial emissions data from the 2022 NIR, and BC's NIR reporting year population from Statistics Canada. This value was applied to the 2021 reporting year population to estimate the total Product Use emissions for the CVRD.

Between the 2018 and 2021 reporting years, IPPU GHG emissions have decreased by 0.1% (Table 36).

Table 36 Product Use GHG Emissions for the 2018 and 2021 Reporting Years

Sub-Sector	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change
Product Use Emissions	22,827	22,840	-0.1%

5.4.5 Agriculture, Forestry, and Other Land Use

The AFOLU Sector includes GHG emissions from livestock, land use, and all other agricultural activities occurring within the CVRD's boundaries.

The following information is provided for disclosure purposes only. Using remotely sensed imagery, land cover data was used to estimate land use changes between the reporting years. In 2021, the CVRD's greenspace is estimated to have sequestered and stored 284,748 tCO_2e (Table 37), released 218 tCO_2e for a net reduction of 284,530 tCO_2e. Due to limitations in how to quantify GHG emissions resulting from land use change (e.g., residential development) and ecosystem sequestration, these GHG emissions have been excluded from the CVRDs GHG emissions inventory, but have been disclosed, until a more robust measurement methodology can be developed.

Table 37 Summary of Land-Use Change in 2021

Land Type	Total Hectares (Ha)	GHG Emissions Sequestered (tCO_2e)	GHG Emissions Released (tCO_2e)
Forestland	149,229.2	(270,104.9)	-
Shrubland	-	-	-
Cropland	1,822.9	(735.3)	-
Grassland	3,816.7	(571.7)	-
Wetlands	4,041.3	(13,336.2)	-
Settlements	11,286.7	-	218.2
Other Land	82,187.4	-	-
Total	**252,384.2**	**(284,748.0)**	**218.2**

5.4.5.1 Livestock and Other Agriculture

In addition to land use change, GHG emissions from the AFOLU Sector are produced through a variety of non-land use pathways, including livestock (enteric fermentation and manure management), and aggregate sources and non-CO_2 emission sources on land (e.g., fertilizer application). Under this Sector, the CVRD reports on GHG emissions from the following sources, and Sub-Sectors:

- Scope 1 GHG Emissions:
  - Livestock:

- Methane (CH_4) Emissions from Enteric Fermentation
- Methane (CH_4) Emissions from Manure Management
- Direct Nitrous Oxide (N_2O) GHG Emissions

– Aggregate Sources and Non-CO_2 Emissions Sources on Land

- Direct Nitrous Oxide (N_2O) Emissions from Agricultural Soil Management
- Indirect Nitrous Oxide (N_2O) Emissions from Applied Nitrogen

The GHG emissions from this source is presented in Table 38.

Table 38 Summary of Livestock and Aggregate Sources and Non-CO_2 Emissions Sources On Land Change GHG Emissions Between 2018 and 2021

Land Type	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change From 2018
Livestock	10,109	8,311	-17.8%
Aggregate Sources and Non-CO_2 Emissions Sources On Land	242	266	9.9%
Total	**10,351**	**8,576**	**-17.1%**

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance and Quality Control (QA/QC) procedures are applied to add confidence that all measurements and calculations have been made correctly and to reduce uncertainty in data. Examples include:

- Checking the validity of all data before it is processed, including emission factors
- Performing recalculations to reduce the possibility of mathematical errors
- Recording and explaining any adjustments made to the raw data
- Documenting quantification methods, assumptions, emission factors and data quality

With respect to the GHG inventory, the data was subject to various quality assurance and quality control checks throughout the collection, analysis, and reporting phases. Specifically, the following procedures were followed:

- Upon receipt of data from the CVRD, the data was checked for completeness (e.g., all months of data are present), relevancy (e.g., the correct calendar year is presented), and reasonableness (e.g., comparing similar transportation data sets). Incorrect or incomplete datasets were queried directly with the data provider.
- Where estimates were used (e.g., fuel oil consumption), all possible data sources were considered for their accuracy and relevance to the community before a final method and data source was selected.
- All manual data transfers were double-checked for data transfer accuracy.
- The inventory was compared to other third-party inventories (e.g., CEEI) to assess for reasonableness of the estimates.
- The inventory underwent internal CVRD reviews to confirm assumptions, data and reasonableness of the estimates.

7.0 RECOMMENDATIONS

To remain accurate and reflective of the current community conditions, the CVRD should revise and improve its GHG emissions inventory either annually or in line with capital planning cycles (i.e., every 3-4 years), to which there are the following aspects should be focused on:

- Improving activity data collection and management, including Sector and Sub-Sector allocations.
- Performing recalculations, where applicable, and tracking GHG emissions over time.
- Reviewing methodologies and data to assess for opportunities to improve the estimates.
- Assessing changes to boundaries, methodologies, assumptions or data that may be material and require a reporting year restatement.

The next section provides a summary of specific GHG inventory improvement recommendations.

7.1 INVENTORY ASSUMPTIONS, ASSESSMENT, AND RECOMMENDATIONS

In the preparation of the 2021 GHG emissions inventory, there are several assumptions were made in the analysis that will have some influence on accuracy of the CVRD's estimate of GHG emissions. Most emission sources have been calculated with a high level of confidence, due to the presence of utility records, and direct energy and emissions data being provided by stakeholders. Data sources and assumptions with medium to high uncertainty are presented in Table 39 which summarizes the main assumptions, possible impacts on the data, and recommended improvement. It is recommended that the CVRD prioritize improvements that are likely to have a material (>5%) influence on the GHG inventory estimate.

Table 39 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
Stationary Energy	The 2021 natural gas and electricity energy data was provided to the CVRD in draft form and may be subject to change. Furthermore, the 2021 data did not include an estimate for the Electoral Areas and had to be estimated. The estimate was derived by taking the total energy for the City of Courtenay, Town of Comox and the Village of Cumberland for the 2020 and	Immaterial impact on the GHG inventory (<5%)	Update the GHG inventory when the 2021 data is published by the province.

Table 39 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
	2021 reporting years, calculating the change in energy consumption and applying this factor to the 2020 Electoral Area natural gas and electricity energy volumes.		
Stationary Energy	The energy utility providers provide energy in lump sum amounts for: residential, commercial, and industrial. As such, energy consumption from the pulp mill and agricultural buildings, could not be split out. A related accuracy issue is the assignment of mixed-use buildings without separate metering.	No impact on the GHG inventory. The change would only happen between reporting sectors.	Work with the utility provider to get a more detailed breakdown of energy use by sub-sector. Reach out to the pulp mill to see if they would be amendable to sharing their energy consumption data.
Stationary Energy	Propane, fuel oil and wood GHG emissions are estimated by the province using an energy balance model. This does not likely represent actual fuel consumption within the CVRD.	Immaterial impact on the GHG inventory (<5%)	Consider completing a residential energy labelling program. With such a program, an energy and fuel profile for buildings could be developed so that a reasonable estimate of other fuel use be determined.
Stationary Energy	Manufacturing, mining construction and agricultural off-road emissions were estimated on a per employee per capita basis using the 2022 NIR estimates. The off-road emissions were estimated by the NIR using an IPCC Tier 1 approach and thus will have high uncertainty.	Immaterial impact on the GHG inventory (<5%)	No recommendations currently.
Stationary Energy	FortisBC provided a total estimate of fugitive emissions for the CRD region for 2020; however, this did not include upstream fugitive emissions	Immaterial impact on the GHG inventory (<5%)	Work with FortisBC to refine this estimate.

Table 39 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
	as suggested as best practice by the GPC Protocol.		
Transportation	ICBC has not been collecting off-road vehicle data so this source could not be estimated.	Possible material impact on the GHG inventory (>10%)	Work with ICBC to begin collecting this data regionally.
Transportation	ICBC did not provide detailed reporting year vehicle registration data for the CVRD. There appears to be a data quality issue between the 2020 and 2021 vehicle registration data as there is a spike in registrations (>10%) in 2021 which is not consistent with the change in population. This effect has also been noted in the Victoria CRD.	It is likely that the vehicle registration data exceeds the materiality threshold (10%).	Work with ICBC to understand the data error and request a detailed registry database that includes dates so that a better estimate of GHG emissions can be determined.
Transportation	The GHG emissions from recreational watercraft were estimated based on an average boat count at a harbor. The energy split is based on a publicly available year 2000 study.	Immaterial impact on the GHG inventory (<5%)	Work with the harbors to deploy a database tracking the types of boats entering the harbor.
Transportation	BC Ferries fuel consumption was estimated based on route distance and number of trips.	Immaterial impact on the GHG inventory (<5%)	Work with BC Ferries to improve this estimate and/or get actual fuel volumes.
Waste	The number of homes on septic was estimated in the 2018 and 2021 GHG inventories.	Immaterial impact on the GHG inventory (<5%)	No recommendations currently.
Waste	Incineration and open burning GHG emissions were estimated and are based on data in a 2015 air quality report.	Immaterial impact on the GHG inventory (<5%)	No recommendations currently.
IPPU	Product use emissions were estimated on a per capita basis using the 2022 NIR estimates. The product use emissions were estimated by	Immaterial impact on the GHG inventory (<5%)	No recommendations currently.

Table 39 Summary of GHG Inventory Assumptions, Estimated Impacts, and Recommended Improvements

Sector	Assumption	Possible Impact on The GHG Inventory	Recommended Improvements
	the NIR using an IPCC Tier 1 approach and thus will have high uncertainty.		
AFOLU	GHG estimates for land use change are based on a period of years (2018-2021) and thus were averaged for each period. As there was no annual data, land use change for the reporting year was estimated using the average value between the data years. Furthermore, there were issues with the spatial data (not being consistent, granular enough for analysis, and not all land-classes considered).	Possibly a material impact on the GHG inventory (>10%)	Work with the planning department to track land-use change annually so that a more refined estimate can be made. Work with the GIS department to gather and process LIDAR data for the region. Aim to collect this data every 3-5 years.
AFOLU	The land-use sequestration and storage GHG emission factors are taken from the literature, for BC ecozones, and may not reflect the productivity, or lack thereof, of land uses in the CVRD. The land-change emission factors for changes between land types were derived by the Province. These are average values by ecozone and are based on a 20-year horizon. Since land-use change in the CVRD is typically related to development, it was assumed that the loss of emissions is immediate which may overestimate GHG emission losses. In both emission factor applications, the use of non-site emission factors may result in an over or underestimate of GHG emissions.	Possibly a material impact on the GHG inventory (>10%)	Work with the Province and the post-secondary institutions to derive refined sequestration emission factors.

8.0 REFERENCES

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Comox Valley Regional District – Municipalities and Electoral Areas
2018 and 2021 Reporting Years Energy & GHG Emissions Inventory

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TABLE OF CONTENTS

SUMMARY

Climate change has emerged as the next unprecedented social, economic, and environmental challenge facing society today. It poses a serious threat to quality of life, jobs, and physical and natural assets. Scientists believe that the human-production of greenhouse gas (GHG) emissions since pre-industrial times have already surpassed the Earth's "carrying capacity" of natural systems and pose significant future risks to human well-being.

Recognizing the role that Comox Valley Regional District (CVRD) plays in achieving a significant and immediate reduction in GHG emissions, the CVRD has completed a 2018 and 2021 GHG emissions inventory with the intent of using this information to establish short and long-term GHG emission reduction targets.

To understand what climate commitments the Region can make, the CVRD seeks a better understanding of the energy and GHG emissions at the regional level, as well as at the local government level which includes 3 municipalities and 3 electoral areas. The following document presents a summary of energy and GHG emissions at both the CVRD and local government level for the 2018 and 2021 Reporting Years. This document compliments a 2021 inventory report which describes the methodologies and data sources applied to derive the estimate of GHG emissions for the CVRD and its members. A summary of the 2018 and 2021 energy and GHG emissions by local government is presented in **Table 1** and **Table 2**.

Table 1. Summary of GHG Emissions By CVRD Local Government

Local Government	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
City of Courtenay	187,209	182,848	-2.3%
Town of Comox	94,587	93,487	-1.2%
Village of Cumberland	25,243	26,886	6.5%
Electoral Areas	135,086	130,763	-3.2%
Total CVRD GHG Emissions	**442,125**	**433,983**	**-1.8%**

Table 2. Summary of Energy Use By CVRD Local Government

Local Government	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)
City of Courtenay	3,618,928	3,574,458	-1.2%
Town of Comox	1,838,772	1,828,321	-0.6%
Village of Cumberland	468,198	498,595	6.5%
Electoral Areas	2,694,100	2,630,153	-2.4%
Total CVRD Energy Consumption	**8,619,998**	**8,531,527**	**-1.0%**

1 INTRODUCTION

1.1 GHG Emissions & Climate Change

There is overwhelming evidence that global climate change resulting from emissions of carbon dioxide and other greenhouse gases (GHGs) is having a significant impact on the ecology of the planet. In addition, climate change is expected to have serious negative impacts on global economic growth and development.

Beyond the costs associated with delayed action, there are cost savings to be realized through efforts to conserve energy and to use it more efficiently, and economic opportunities available to communities that develop local energy supply and infrastructure. Actions to encourage energy efficiency and conservation and to promote implementation of renewable energy will assist local governments in developing energy resilient communities, in addition to mitigating climate change. Local governments are at the forefront of global action on climate change, setting both ambitious commitments and targets while going about the difficult task of reducing emissions. Per the latest report from the C40 Cities Climate Leadership Group, ICLEI Local Governments for Sustainability, UN Habitat, and others, most GHG reduction commitments are set for 2030, 2040 or 2050 and range from a 10% to 100% reduction (**Figure 1**).

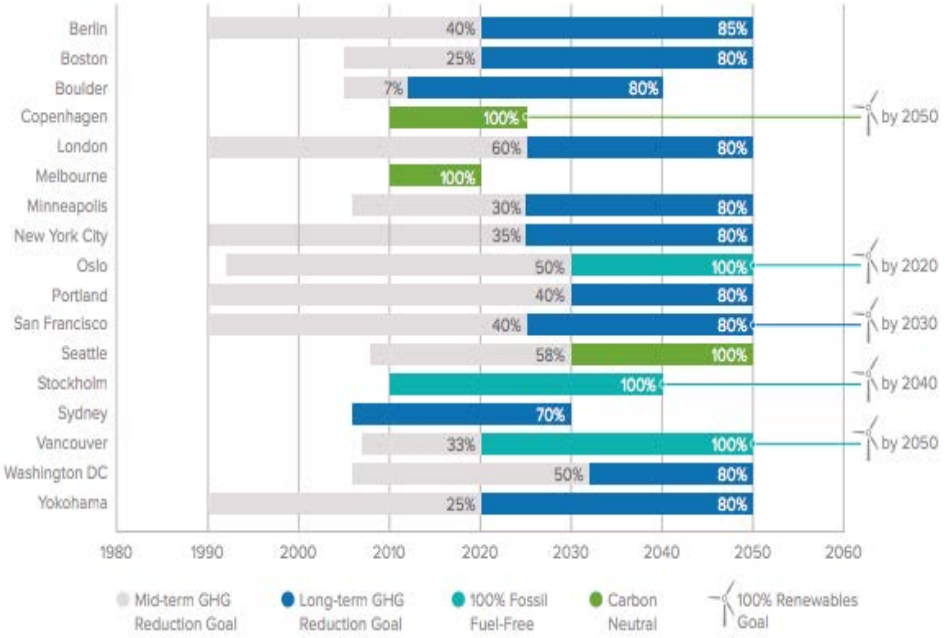

Figure 1. Summary of Long-Term Global GHG Emission Reduction Targets[1]

[1] http://www.c40.org/

1.2 GPC Protocol

To make informed decisions on reducing energy use and GHG emissions at the regional and local government scale, community managers must have a good understanding of these sources, the activities that drive them, and their relative contribution to the total. This requires the completion of an energy and GHG emissions inventory. To allow for credible and meaningful reporting locally and internationally, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (the GPC Protocol) was developed as a partnership between ICLEI-Local Governments for Sustainability, The World Resources Institute (WRI) and C40 Cities Climate Leadership Group (C40), with additional collaboration by the World Bank, United Nations Environment Program (UNEP) and UN-Habitat. The GPC Protocol has now become recognized as the standardized way for local governments to collect and report their actions on climate change. Over 9,000 cities have committed to using the GPC Protocol.

The Protocol has two established levels of reporting: BASIC and BASIC+ which are defined as the following:

- The BASIC level covers scope 1 and scope 2 emissions from stationary energy and in-boundary transportation, as well as scope 1 and scope 3 emissions from waste.
- The BASIC+ level covers the same scopes as BASIC and includes more in-depth and data dependent methodologies. Specifically, it expands the reporting scope to include emissions from industrial process and product use (IPPU), agriculture, forestry and other land-use (AFOLU), and transboundary transportation.

1.3 Variance from Community Energy and Emissions Inventories (CEEI)

The CVRD has historically relied on annual Provincial Community Energy and Emissions Inventories (CEEI) to track community GHG emissions. However, there have been some limitations to the CEEI in that it is an in-boundary inventory, the most recent version containing transportation data was published in 2010, and the CEEI Protocol does not fully meet the requirements of the GPC Protocol BASIC or BASIC+ reporting requirements which is the required reporting standard for local governments that have committed to the Global Covenant of Mayors—an agreement led by city networks to undertake a transparent and supportive approach to measure GHG emissions community-wide. A high-level summary of the differences between the CEEI and GPC Protocol inventories are presented in **Table 3**.

Table 3. Summary of GHG Inventory Scope Differences

Reporting Sector	CEEI	GPC BASIC	GPC BASIC+
Residential Buildings	✓	✓	✓
Commercial And Institutional Buildings And Facilities	✓	✓	✓
Manufacturing Industries And Construction	✓	✓	✓
Energy Industries		✓	✓
Energy Generation Supplied To The Grid		✓	✓
Agriculture, Forestry And Fishing Activities		✓	✓
Non-Specified Sources		✓	✓

Reporting Sector	CEEI	GPC BASIC	GPC BASIC+
Fugitive Emissions From Mining, Processing, Storage, And Transportation Of Coal		✓	✓
Fugitive Emissions From Oil And Natural Gas Systems		✓	✓
On-Road Transportation	✓	✓	✓
Railways		✓	✓
Waterborne Navigation		✓	✓
Aviation		✓	✓
Off-Road Transportation		✓	✓
Solid Waste	✓	✓	✓
Biological Waste	✓	✓	✓
Incinerated And Burned Waste		✓	✓
Wastewater		✓	✓
Emissions From Industrial Processes			✓
Emissions From Product Use			✓
Emissions From Livestock	✓		✓
Emissions From Land			✓
Emissions From Aggregate Sources And Non-CO_2 Emission Sources On Land	✓		✓

1.4 Purpose of Document

The purpose of this document is to provide the 2018 and 2021 GPC BASIC+ energy and GHG emissions inventories at the regional and local government level. This document compliments a 2021 inventory report which describes the methodologies and data sources applied to derive the estimate of GHG emissions for the CVRD region and local governments.

2 INVENTORY SCOPE

2.1 GPC BASIC+ Inventory Scope

In accordance with the GPC Protocol, the 2018 and 2021 BASIC+ GHG inventories presented herein accounts for GHG emissions from the following Reporting Sectors:

- **Stationary Energy** – These are GHG emissions from fuel combustion, fugitive emissions, and some off-road transportation sources (e.g. construction equipment, residential mowers, etc.). They include the emissions from energy to heat and cool residential, commercial, institutional, and light/heavy industrial buildings, as well as the activities that occur within these residences and facilities.
- **Transportation** – These are GHG emissions from the combustion of fuels as a result of vehicular on-road, off-road, including marine, aviation, and other off-road, and trans-boundary journeys.
- **Waste** – These are GHG emissions from the disposal and management of solid waste, the biological treatment of waste, and wastewater treatment and discharge. Waste does not directly consume energy, but releases GHG emissions because of decomposition, burning, and other management methods.
- **Industrial Process and Product Use (IPPU)** – These are GHG emissions from products such as refrigerants, foams or aerosol cans can release potent GHG emissions, known as product use GHG emissions. There are no known industrial process emissions significant enough to measure in the CVRD.
- **Agriculture, Forestry and Other Land-Use (AFOLU)** – These are GHG emissions that are captured or released as a result of land-management activities. These activities can range from the preservation of forested lands to the development of crop land. This Sector includes GHG emissions from land-use change, manure management, livestock, and the direct and indirect release of nitrous oxides (N_2O) from soil management, urea application, fertilizer and manure application. Due to limitations in how to quantify GHG emissions resulting from land use change (e.g., residential development) and ecosystem sequestration, these GHG emissions have been excluded from the CVRDs GHG emissions inventory, but have been disclosed, until a more robust measurement methodology can be developed.

2.2 GHG Emissions Boundary

The GHG inventories are defined geographically by the CVRD, which includes 3 municipalities and 3 electoral areas, as shown in Figure 2.

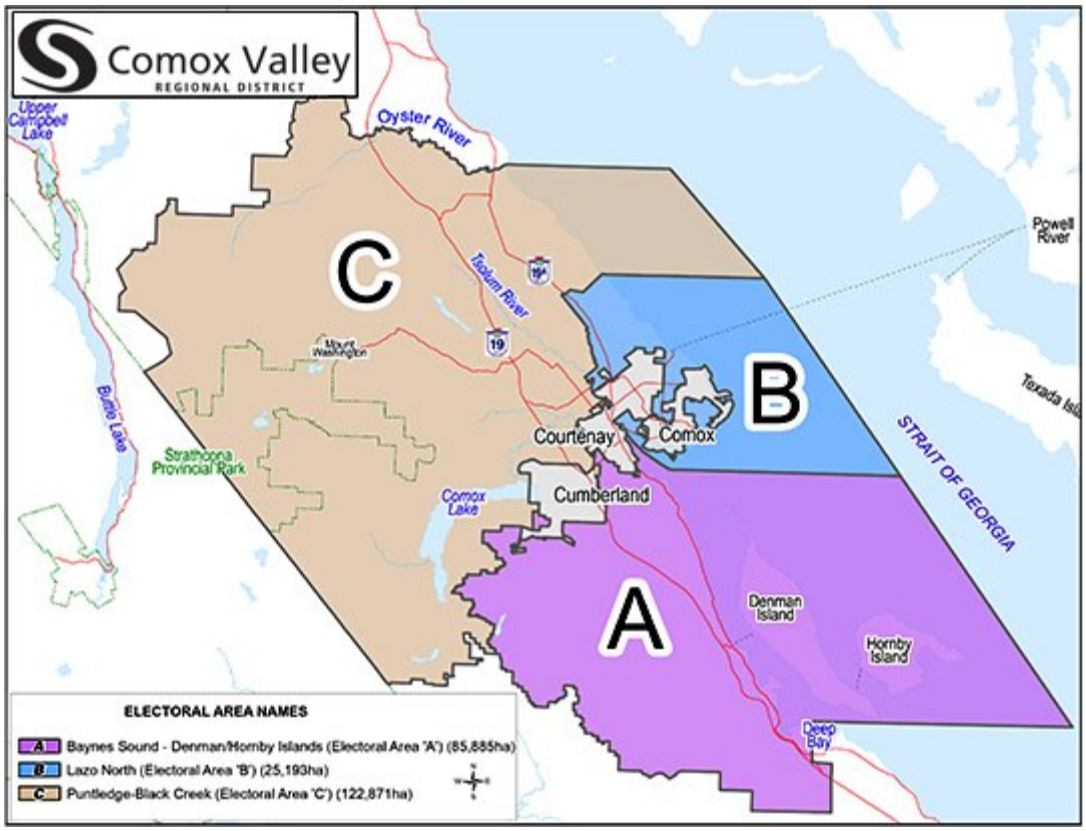

Figure 2 CVRD GHG Boundary

2.3 Assumptions & Disclosures

The following inventories covers all GHG emissions for the 2018 and 2021 Reporting Years. Where data was not available, the most recent year's data have been used, and the timescale noted accordingly. These disclosures are as follows:

- **Global Warming Potentials (GWP)**. The BC government has communicated that is adopting GWPs from the fifth IPCC report. On this basis, the CVRD is applying GWPs from the fifth IPCC report.
- **Emission Factors**. Other than the electricity emission factor, all emission factors are derived from Environment and Climate Change Canada's National Inventory Report for the 2020 reporting year. These emission factors have been applied to the 2021 reporting year. This is deemed to be the best available information at the time of reporting.
- **Stationary Energy: Residential, Commercial and Institutional Buildings**. The 2021 natural gas and electricity energy data was provided to the CVRD in draft form and may be subject to change. Furthermore, the 2021 data did not include an estimate for the Electoral Areas and had to be estimated. The estimate was derived by taking the total

energy for the City of Courtenay, Town of Comox and the Village of Cumberland for the 2020 and 2021 reporting years, calculating the change in energy consumption and applying this factor to the 2020 Electoral Area natural gas and electricity energy volumes.

- **Stationary Energy: Residential, Commercial and Institutional Buildings**. The 2019-2021 propane, heating oil and wood GHG emissions were estimated using linear regression methods. The data used in the estimates included historical propane and wood energy data published in the 2016-2018 CEEIs, and heating degree days (HDD) published by Environment and Climate Change Canada.
- **Stationary Energy: Fugitives**. Fortis BC provided total fugitive emissions per connection for the 2020 reporting year at the Victoria Capital Regional District level. The 2020 value was used to derive a 2018-2019 and 2021 estimates.
- **Transportation: On-Road**.
    - The on-road transportation emissions are based on the number of registered vehicles for the 2020 reporting year. While the 2021 vehicle registration data is available, it is believed that the data is incorrect as it shows a 17% increase in vehicle registrations between 2020 and 2021 which does not align with the change in population. This large increase has been noted in other jurisdictions where there has been a year over year decline in the population. On this basis, the 2020 vehicle registration data is grown using the reported population change between 2020 and 2021.
    - Insurance Corporation of BC (ICBC) compiles data on an April 1 to March 31 basis, and thus the 2018 and 2021 on-road GHG emission estimates are based on the number of registrations from April 1 – March 31 and may not accurately represent the actual vehicle population for each given reporting year.
    - ICBC did not report vehicle registration data for the CVRD Electoral Areas. To estimate these GHG emissions, the 2010 Electoral Area vehicle counts (as available in the 2010 CEEI) were grown using the total change in ICBC vehicle registrations between 2010 and 2020 for the City of Courtenay, Town of Comox and the Village of Cumberland.
    - ICBC's publicly available vehicle registration data does not contain detailed vehicle and fuel class breakdowns (e.g., it just reports total personal vehicles). To split out the data by class and fuel type, the vehicle classes were re-allocated based on the Victoria Capital Regional District's reported vehicle class breakdown in the 2021 GHG emissions report. The Victoria Capital Regional District's reported data is based upon detailed registration data.
- **Transportation: Waterborne**. The number of recreational boats was estimated based on the number of marinas in the CVRD and the disclosed estimate of boats.[2] Recreational vessel fuel consumption rates are based on the study entitled "Marine Vessel Air Emissions in BC and Washington State Outside of the Greater Victoria Regional District (GVRD) and FVRD for the Year 2000".
- **Waste: Incineration & Opening Burning.** Incineration and open burning GHG emissions are estimated using a 2015 particulate matter emissions inventory for the

[2] https://www.comox.ca/community/marinas#:~:text=Comox%20is%20home%20to%20four,Comox%20Marina%20and%20Point%20Holmes

Comox Valley. The GHG emissions are adjusted to 2018 and 2021 using population data.

- **AFOLU: Land-Use.** The land cover change analysis requires a consistent land-use category attribution and spatial data. Landsat spatial data was available for the 2015 and 2020 reporting years. Since annual data is not available, the change between land cover data years (2015-2020) for all areas was averaged and may not represent actual changes in each year. Due to limitations in how to quantify GHG emissions resulting from land use change (e.g., residential development) and ecosystem sequestration, these GHG emissions have been excluded from the CVRDs GHG emissions inventory, but have been disclosed, until a more robust measurement methodology can be developed.

Details surrounding all GHG emissions sources quantification methods, assumptions, and assessment of uncertainties are contained in a complimentary GHG emissions methodology document and are not presented herein.

3 COMOX VALLEY REGIONAL DISTRICT ENERGY & GHG EMISSIONS

3.1 Base Year (2018) Energy & GHG Emissions

In 2018, the CVRD's GHG BASIC+ emissions totaled 442,125 tCO_2e. Excluding sequestration GHG emissions, on-road transportation GHG emission sources contributed 57.2% to the GHG inventory, almost all of which came from passenger vehicles, light trucks, and SUVs (82.2%). As the second largest source, the residential and commercial buildings accounted for 26.7% of total GHG emissions with 40.8% of those GHG emissions coming from natural gas for heating and cooling, 23.6% from heating oil, 13.7% from electricity use, 14.2% from wood and propane use for heating and the remainder from industrial activities and other-related off-road activities like residential lawn mowing. Off-road transportation, which includes marine, aviation, and other off-road emission sources contributed 10.2% to the overall GHG inventory. Solid waste, organic waste treatment methods, and wastewater treatment and discharge accounted for 8.3% of the total community GHG emissions. IPPU emissions accounted for 5.2% of total GHG emissions.

A summary of the GHG emissions by sector and energy use by source is presented in the following table and figures.

Table 4. Base Year (2018) CVRD Regional GHG Energy & GHG Emissions by Source

Source	Type	Consumption	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Stationary Energy					
Residential Buildings	Electricity	429,252	MWh	1,545,296	10,860
	Natural Gas	457,252	GJ	457,252	22,790
	Fuel Oil	15,985	L	411,975	28,159
	Propane	1,798	L	71,042	4,335
	Wood	493,640	GJ	493,640	12,681
	Diesel	784,642	L	30,350	2,098
Commercial & Industrial Buildings	Electricity	211,936	MWh	762,963	5,362
	Natural Gas	518,596	GJ	518,596	25,847
	Fuel Oil	0	L	0	0
	Diesel	1,686,714	L	65,242	4,511
Manufacturing Industries & Construction	Natural Gas	349,688	GJ	349,688	935
Agriculture, Forestry And Fishing Activities	Diesel	158,573	L	6,134	424
Non-Specified Sources					1
Natural Gas Fugitive Emissions					1,216

Source	Type	Consumption	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Total				**4,712,179**	**119,220**
On-Road Transportation					
Electric Vehicles	Electricity	12,609	MWh	1	4
Hydrogen Vehicles	Hydrogen	0	L	0	0
Passenger Vehicles	Gasoline + Diesel	23,249,472	L	807,983	50,514
Light Trucks, Vans, SUVs	Gasoline + Diesel	48,707,351	L	1,730,048	109,780
Heavy Duty Vehicles	Gasoline + Diesel	19,168,306	L	728,050	46,029
Propane Vehicles	Propane	246,247	L	6,287	356
Natural Gas Vehicles	Natural Gas	7,883	kg	0	23
Motorcycles	Gasoline	530,815	L	18,398	1,192
Total On-Road Transportation				**3,290,766**	**207,897**
Off-Road Transportation					
Marine, Aviation and Other Off-Road Vehicles	Marine Gasoline + Marine Diesel + Jet Fuel	15,967,508	L	617,054	45,154
Total Off-Road Transportation				**617,054**	**45,154**
Waste					
Wastewater					11,754
Composting					1,960
Waste Incineration and Open Burning					87
Solid Waste					22,861
Total Waste					**36,662**
Agriculture Forestry & Other Land Use (AFOLU)					
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-284,759
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					218
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					10,351
Total AFOLU					**10,351**
Industrial Process & Product Use (IPPU)					
Process Use Emissions					22,840
Total IPPU					**22,840**
TOTAL				**8,619,998**	**442,125**
TOTAL Per Capita				**120.5**	**6.2**

Energy consumption and GHG emissions by source are shown in **Figure 3**, **Figure 4** and **Figure 5**.

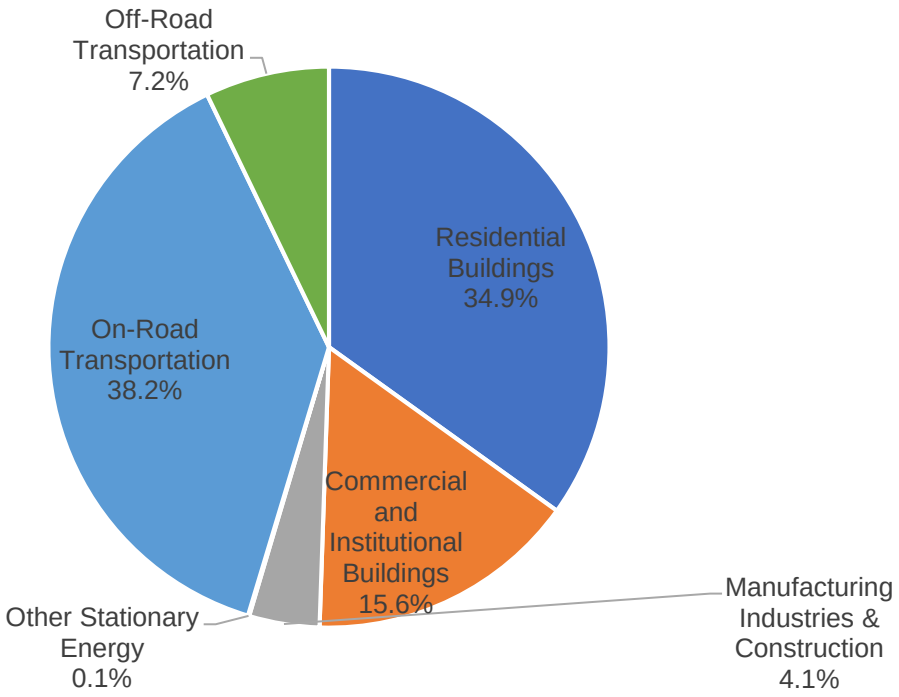

Figure 3. 2018 Regional Energy Consumption By Sector

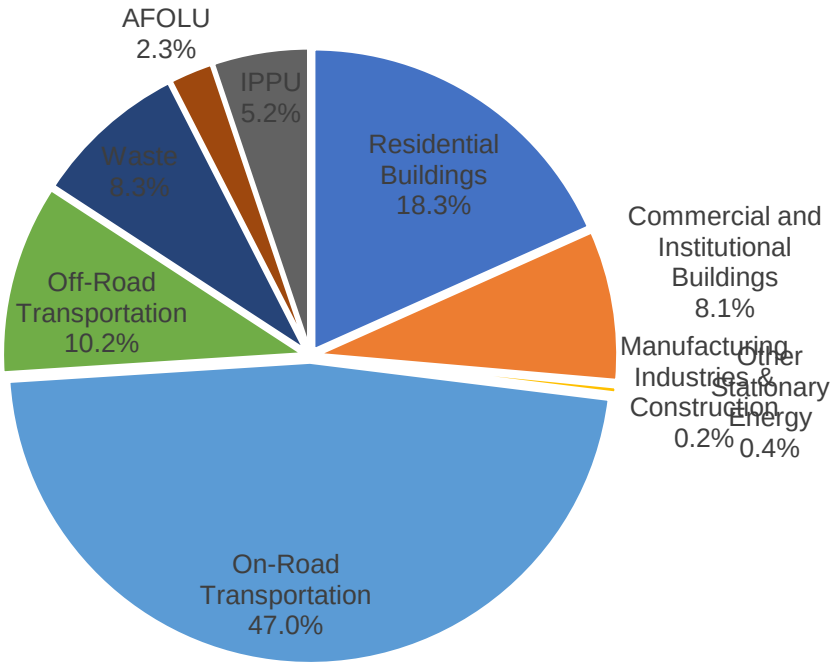

Figure 4. 2018 Regional GHG Emissions By Sector

GHG emissions by fuel type is presented in **Figure 5**. Note that non energy related emissions are not included in this chart.

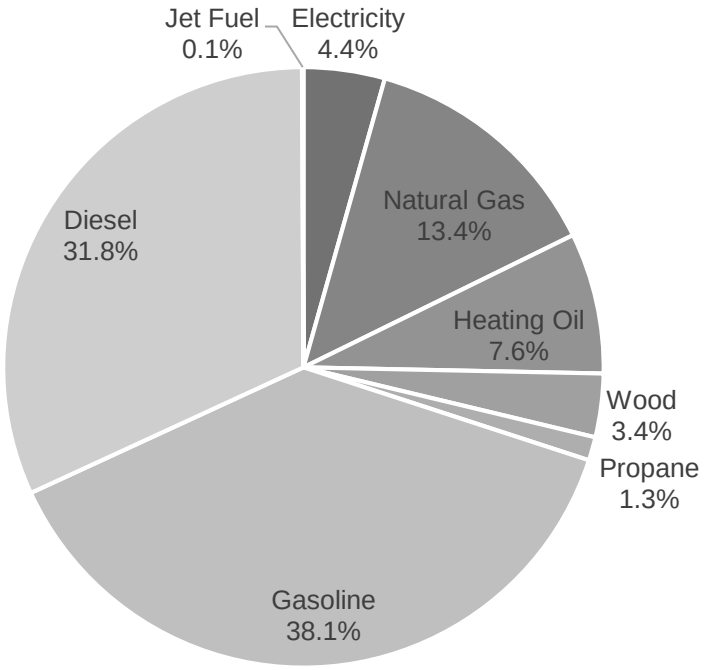

Figure 5. 2018 Regional GHG Emissions By Fuel Type

3.2 Reporting Year (2021) Energy & GHG Emissions

In 2021, the CVRD's BASIC+ GHG emissions totaled 433,983 tCO_2. On an absolute basis, this is a 1.8% decrease from the 2018 GHG emissions and a decline of 6.0% on a per capita basis.

Similar to the 2018,exclusing sequestration GHG emissions, on-road transportation GHG emissions is the largest source of GHG emissions accounting for 56.3% to the GHG inventory, almost all of which came from passenger vehicles, light trucks, and SUVs (81.1%). As the second largest source, residential and commercial buildings GHG emissions contributed to 27.6% of total GHG emissions with 48.2% of those GHG emissions coming from natural gas for heating and cooling, 23.9% from heating oil for heating, 5.4% from electricity use, 14.5% from wood and propane use for heating and the remainder (7.4%) from industrial activities and other-related off-road activities like residential lawn mowing. Off-road transportation, which includes marine, aviation, and other off-road emission sources contributed 10.6% to the overall GHG inventory. Solid waste, organic waste treatment methods, and wastewater treatment and discharge accounted for 8.9% of the total community GHG emissions. IPPU emissions accounted for 5.3% of total GHG emissions.

A summary of the 2021 GHG emissions by sector and energy use by source is presented in the following table and figures.

Table 5. Reporting Year (2021) CVRD Regional GHG Energy & GHG Emissions by Sector

Source	Type	Consumption	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Stationary Energy					
Residential Buildings	Electricity	443,892	MWh	1,597,998	4,306
	Natural Gas	603,197	GJ	603,197	30,064
	Fuel Oil	16,251	L	418,852	28,629
	Propane	1,828	L	72,228	4,407
	Wood	501,880	GJ	501,880	12,893
	Diesel	771,679	L	29,849	2,200
Commercial & Industrial Buildings	Electricity	223,542	MWh	804,745	2,168
	Natural Gas	555,387	GJ	555,387	27,681
	Fuel Oil	0	L	0	0
	Diesel	1,676,229	L	64,837	4,779
Manufacturing Industries & Construction	Natural Gas	333,159	GJ	333,159	950
Agriculture, Forestry And Fishing Activities	Diesel	161,035	L	6,229	459
Non-Specified Sources					3
Natural Gas Fugitive Emissions					1,356
Total				**4,988,360**	**119,895**
On-Road Transportation					
Electric Vehicles	Electricity	15,135	MWh	4	12
Hydrogen Vehicles	Hydrogen	0	L	0	0
Passenger Vehicles	Gasoline + Diesel	19,269,479	L	669,876	45,071
Light Trucks, Vans, SUVs	Gasoline + Diesel	43,325,743	L	1,534,037	104,536
Heavy Duty Vehicles	Gasoline + Diesel	18,282,822	L	695,184	46,941
Propane Vehicles	Propane	182,252	L	4,653	281
Natural Gas Vehicles	Natural Gas	7,645	kg	0	24
Motorcycles	Gasoline	528,436	L	18,316	1,265
Total On-Road Transportation				**2,922,071**	**198,129**
Off-Road Transportation					
Marine, Aviation and Other Off-Road Vehicles	Marine Gasoline + Marine Diesel + Jet Fuel	16,071,503	L	621,096	46,105
Total Off-Road Transportation				**621,096**	**46,105**
Waste					
Wastewater					11,131

Source	Type	Consumption	Units	Energy (GJ)	GHG Emissions (tCO_2e)
Composting					2,474
Waste Incineration and Open Burning					91
Solid Waste					24,756
Total Waste					**38,452**
Agriculture Forestry & Other Land Use (AFOLU)					
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-284,748
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					218
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					8,576
Total AFOLU					**8,576**
Industrial Process & Product Use (IPPU)					
Process Use Emissions					22,827
Total IPPU					**22,827**
TOTAL				**8,531,527**	**433,983**
TOTAL Per Capita				**114.2**	**5.8**

Energy consumption and GHG emissions by source are shown in **Figure 6**, **Figure 7** and **Figure 8**.

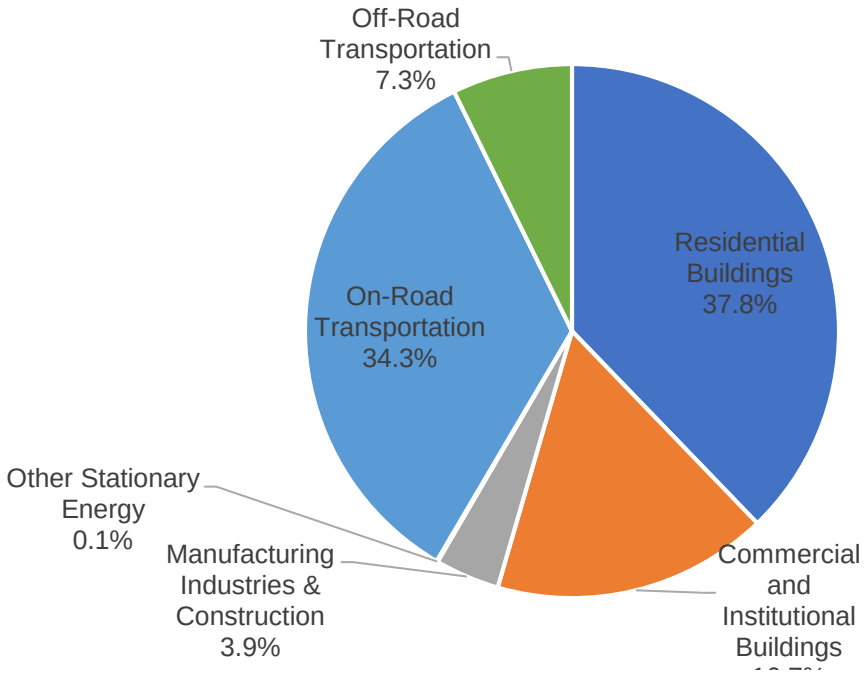

Figure 6. 2021 Regional Energy Consumption By Sector

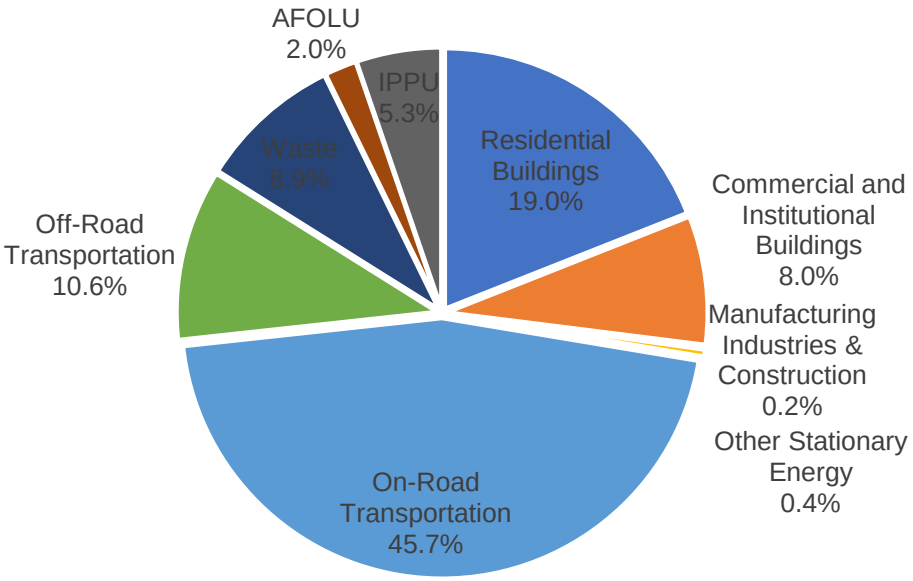

Figure 7. 2021 Regional GHG Emissions By Sector

GHG emissions by fuel type is presented in **Figure 8**. Note that non energy related emissions are not included in this chart.

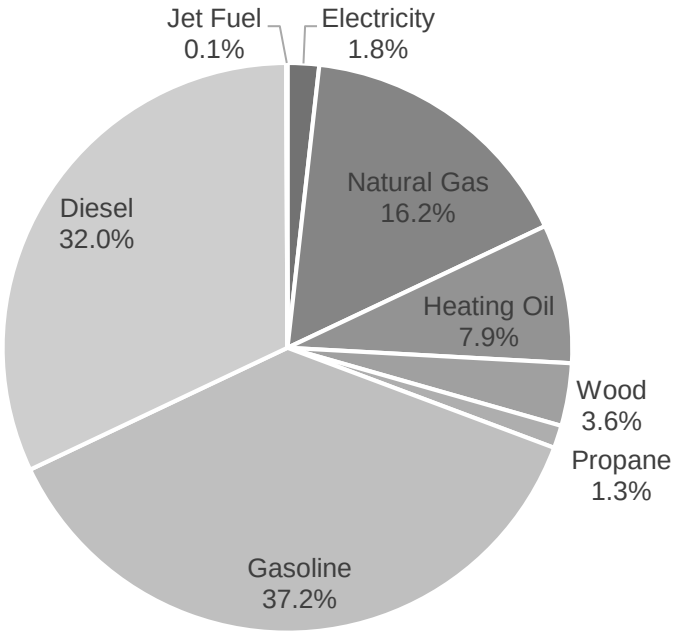

Figure 8. 2021 Regional GHG Emissions By Fuel Type

3.3 Energy & GHG Emissions Trends

Table 6 presents the changes between the 2018 and 2021 reporting years. Compared to the 2018 GHG emissions inventory, GHG emissions have declined in 2021 by 1.8%. Overall, GHG emissions related to buildings, waste and transportation decreased due to changing emission factors, commuting behavior changes (people working from home) and waste diversion.

The table below shows that building energy increased, the building related GHG emissions decreased. This is due to the province's adjustment of the electricity emissions factor between 2019 (40.7 tCO_2e/kWh) and 2020 (9.7 tCO_2e/kWh). Process use emissions did not change significantly which was likely driven by COVID related shutdowns and the changes that ensured.

On-road transportation GHG emissions have decreased significantly despite an increase in vehicle registrations. The statistics are showing that while the COVID restrictions have been lifted, there are less people commuting to work. The possible increase in GHG emissions have also been slightly mitigated by shifting preferences towards electric vehicles.

There was an increase in composting emissions which is the direct result of waste diversion programs which result in some direct GHG emissions, but overall have a net reduction impact as the process avoids releasing more fugitive emissions from the landfill.

Table 6. Change in CVRD GHG Energy & GHG Emissions

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Stationary Energy							
Residential Buildings	Electricity	1,545,296	1,597,998	3.4%	10,860	4,306	-60.4%
	Natural Gas	457,252	603,197	31.9%	22,790	30,064	31.9%
	Fuel Oil	411,975	418,852	1.7%	28,159	28,629	1.7%
	Propane	71,042	72,228	1.7%	4,335	4,407	1.7%
	Wood	493,640	501,880	1.7%	12,681	12,893	1.7%
	Diesel	30,350	29,849	-1.7%	2,098	2,200	4.8%
Commercial & Industrial Buildings	Electricity	762,963	804,745	5.5%	5,362	2,168	-59.6%
	Natural Gas	518,596	555,387	7.1%	25,847	27,681	7.1%
	Fuel Oil	-	-	-	-	-	-
	Diesel	65,242	64,837	-0.6%	4,511	4,779	5.9%
Manufacturing Industries & Construction	Natural Gas	349,688	333,159	-4.7%	935	950	1.6%
Agriculture, Forestry And Fishing Activities	Diesel	6,134	6,229	1.6%	424	459	8.3%
Non-Specified Sources				-	1	3	102.5%
Natural Gas Fugitive Emissions				-	1,216	1,356	11.5%
Total		**4,712,179**	**4,988,360**	**5.9%**	**119,220**	**119,895**	**0.6%**
On-Road Transportation							
Electric Vehicles	Electricity	1	4	600.9%	4	12	168.7%
Hydrogen Vehicles	Hydrogen	-	-	-	-	-	-
Passenger Vehicles	Gasoline + Diesel	807,983	669,876	-17.1%	50,514	45,071	-10.8%
Light Trucks, Vans, SUVs	Gasoline + Diesel	1,730,048	1,534,037	-11.3%	109,780	104,536	-4.8%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Heavy Duty Vehicles	Gasoline + Diesel	728,050	695,184	-4.5%	46,029	46,941	2.0%
Propane Vehicles	Propane	6,287	4,653	-26.0%	356	281	-21.1%
Natural Gas Vehicles	Natural Gas	0	0	-3.0%	23	24	3.4%
Motorcycles	Gasoline	18,398	18,316	-0.4%	1,192	1,265	6.1%
Total On-Road Transportation		**3,290,766**	**2,922,071**	**-11.2%**	**207,897**	**198,129**	**-4.7%**
Off-Road Transportation							
Marine, Aviation and Other Off-Road Vehicles	Gasoline + Diesel + Jet Fuel	617,054	621,096	0.7%	45,154	46,105	2.1%
Total Off-Road Transportation		**617,054**	**621,096**	**0.7%**	**45,154**	**46,105**	**2.1%**
Waste							
Wastewater					11,754	11,131	-5.3%
Composting					1,960	2,474	26.2%
Incineration & Open Burning					87	91	4.6%
Solid Waste					22,861	24,756	8.3%
Total Waste					**36,662**	**38,452**	**4.9%**
Agriculture Forestry & Other Land Use (AFOLU)							
Land-Use: Emissions Sequestered					-284,759	-284,748	0.0%
Land-Use: Emissions Released					218	218	0.0%
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					10,351	8,576	-17.1%
Total AFOLU					**10,351**	**8,576**	**-17.1%**
Industrial Process & Product Use (IPPU)							
Process Use Emissions					22,840	22,827	-0.1%
Total IPPU					**22,840**	**22,827**	**-0.1%**

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
TOTAL		**8,619,998**	**8,531,527**	**-1.0%**	**442,125**	**433,983**	**-1.8%**

Table 7 presents the changes between the 2018 and 2021 years for each CVRD local government.

Table 7. Change in Member GHG Energy & GHG Emissions

Member	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
City of Courtenay	3,618,928	3,574,458	-1.2%	187,209	182,848	-2.3%
Town of Comox	1,838,772	1,828,321	-0.6%	94,587	93,487	-1.2%
Village of Cumberland	468,198	498,595	6.5%	25,243	26,886	6.5%
Electoral Areas	2,694,100	2,630,153	-2.4%	135,086	130,763	-3.2%
Total	**8,619,998**	**8,531,527**	**-1.0%**	**442,125**	**433,983**	**-1.8%**

4 CITY OF COURTENAY

4.1 2021 Profile

Profile	
Population	28,902
Dwellings	13,414
Registered Vehicles	29,726
Energy (Thousands of GJ)	3,574
GHG Emissions (tCO_2e)	182,848

4.2 2018 & 2021 Energy & GHG Emissions

Table 8 presents a summary comparison of the City of Courtenay' 2018 and 2021 energy and GHG emissions.

Table 8. Estimated Energy and GHG Emissions By Reporting Source

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Stationary Energy							
Residential Buildings	Electricity	501,498	562,344	12.1%	3,524	1,515	-57.0%
	Natural Gas	218,394	304,258	39.3%	10,885	15,164	39.3%
	Fuel Oil	111,467	113,328	1.7%	7,619	7,746	1.7%
	Propane	19,244	19,565	1.7%	1,174	1,194	1.7%
	Wood	133,384	135,611	1.7%	3,426	3,484	1.7%
	Diesel	11,714	11,544	-1.4%	810	851	5.1%
Commercial & Industrial Buildings	Electricity	404,361	401,624	-0.7%	2,842	1,082	-61.9%
	Natural Gas	267,740	268,674	0.3%	13,344	13,391	0.3%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
	Fuel Oil	-	-	-	-	-	-
	Diesel	25,182	25,077	-0.4%	1,741	1,848	6.2%
Manufacturing Industries & Construction	Natural Gas	134,970	128,855	-4.5%	361	367	1.8%
Agriculture, Forestry And Fishing Activities	Diesel	2,367	2,409	1.8%	164	178	8.5%
Non-Specified Sources				-	-	-	-
Natural Gas Fugitive Emissions				-	620	718	15.9%
Total		**1,830,321**	**1,973,289**	**7.8%**	**46,510**	**47,539**	**2.2%**
On-Road Transportation							
Electric Vehicles	Electricity	0	2	696.9%	2	6	205.5%
Hydrogen Vehicles	Hydrogen	-	-	-	-	-	-
Passenger Vehicles	Gasoline + Diesel	371,593	308,193	-17.1%	23,227	20,733	-10.7%
Light Trucks, Vans, SUVs	Gasoline + Diesel	795,283	700,106	-12.0%	50,522	47,721	-5.5%
Heavy Duty Vehicles	Gasoline + Diesel	372,442	342,042	-8.2%	23,592	23,127	-2.0%
Propane Vehicles	Propane	1,714	1,205	-29.7%	97	73	-25.1%
Natural Gas Vehicles	Natural Gas	0	0	1.8%	14	15	8.5%
Motorcycles	Gasoline	9,627	9,620	-0.1%	623	664	6.5%
Total On-Road Transportation		**1,550,659**	**1,361,168**	**-12.2%**	**98,078**	**92,340**	**-5.9%**
Off-Road Transportation							
Marine, Aviation and Other Off-Road Vehicles	Gasoline + Diesel + Jet Fuel	237,948	240,001	0.9%	17,414	17,817	2.3%
Total Off-Road Transportation		**237,948**	**240,001**	**0.9%**	**17,414**	**17,817**	**2.3%**
Waste							
Wastewater					1,906	1,546	-18.9%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Composting					0	74	-
Incineration & Open Burning					0	0	-
Solid Waste					11,745	12,718	8.3%
Total Waste					**13,650**	**14,338**	**5.0%**
Agriculture Forestry & Other Land Use (AFOLU)							
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-2,138	-2,136	-0.1%
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					67	67	0.0%
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					2,741	1,951	-28.8%
Total AFOLU					**2,741**	**1,951**	**-28.8%**
Industrial Process & Product Use (IPPU)							
Process Use Emissions					8,816	8,863	0.5%
Total IPPU					**8,816**	**8,863**	**0.5%**
TOTAL		**3,618,928**	**3,574,458**	**-1.2%**	**187,209**	**182,848**	**-2.3%**

5 TOWN OF COMOX

5.1 2021 Profile

Profile	
Population	15,211
Dwellings	6,672
Registered Vehicles	14,097
Energy (Thousands of GJ)	1,828
GHG Emissions (tCO_2e)	93,487

5.2 2018 & 2021 Energy & GHG Emissions

Table 9 presents a summary comparison of the Town of Comox's 2018 and 2021 energy and GHG emissions.

Table 9. Estimated Energy and GHG Emissions By Reporting Source

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Stationary Energy							
Residential Buildings	Electricity	256,268	276,244	7.8%	1,801	744	-58.7%
	Natural Gas	155,560	189,225	21.6%	7,753	9,431	21.6%
	Fuel Oil	69,384	70,542	1.7%	4,743	4,822	1.7%
	Propane	11,969	12,169	1.7%	730	742	1.7%
	Wood	83,104	84,491	1.7%	2,135	2,170	1.7%
	Diesel	6,394	6,076	-5.0%	442	448	1.3%
Commercial & Industrial Buildings	Electricity	144,373	148,052	2.5%	1,015	399	-60.7%
	Natural Gas	171,059	194,913	13.9%	8,526	9,715	13.9%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
	Fuel Oil	-	-	-	-	-	-
	Diesel	13,744	13,198	-4.0%	950	973	2.4%
Manufacturing Industries & Construction	Natural Gas	73,667	67,816	-7.9%	197	193	-1.9%
Agriculture, Forestry And Fishing Activities	Diesel	1,292	1,268	-1.9%	89	93	4.6%
Non-Specified Sources				-	-	-	-
Natural Gas Fugitive Emissions				-	397	416	4.8%
Total		**986,814**	**1,063,994**	**7.8%**	**28,778**	**30,147**	**4.8%**
On-Road Transportation							
Electric Vehicles	Electricity	0	1	477.7%	2	4	121.5%
Hydrogen Vehicles	Hydrogen	-	-	-	-	-	-
Passenger Vehicles	Gasoline + Diesel	197,250	157,748	-20.0%	12,330	10,612	-13.9%
Light Trucks, Vans, SUVs	Gasoline + Diesel	328,721	286,801	-12.8%	20,832	19,539	-6.2%
Heavy Duty Vehicles	Gasoline + Diesel	189,006	186,802	-1.2%	11,970	12,633	5.5%
Propane Vehicles	Propane	910	617	-32.2%	51	37	-27.7%
Natural Gas Vehicles	Natural Gas	0	0	-1.8%	7	8	4.6%
Motorcycles	Gasoline	5,298	5,137	-3.1%	343	355	3.4%
Total On-Road Transportation		**721,185**	**637,106**	**-11.7%**	**45,535**	**43,188**	**-5.2%**
Off-Road Transportation							
Marine, Aviation and Other Off-Road Vehicles	Gasoline + Diesel + Jet Fuel	130,774	127,221	-2.7%	9,564	9,437	-1.3%
Total Off-Road Transportation		**130,774**	**127,221**	**-2.7%**	**9,564**	**9,437**	**-1.3%**
Waste							
Wastewater					1,092	862	-21.0%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Composting					348	319	-8.3%
Incineration & Open Burning					0	0	-
Solid Waste					4,454	4,823	8.3%
Total Waste					**5,894**	**6,004**	**1.9%**
Agriculture Forestry & Other Land Use (AFOLU)							
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-573	-573	0.0%
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					0	0	-
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					5	5	9.9%
Total AFOLU					**5**	**5**	**9.9%**
Industrial Process & Product Use (IPPU)							
Process Use Emissions					4,812	4,704	-2.2%
Total IPPU					**4,812**	**4,704**	**-2.2%**
TOTAL		**1,838,772**	**1,828,321**	**-0.6%**	**94,587**	**93,487**	**-1.2%**

6 VILLAGE OF CUMBERLAND

6.1 2021 Profile

Profile	
Population	4,688
Dwellings	1,918
Registered Vehicles	3,402
Energy (Thousands of GJ)	499
GHG Emissions (tCO_2e)	26,886

6.2 2018 & 2021 Energy & GHG Emissions

Table 10 presents a summary comparison of the Village of Cumberland's 2018 and 2021 energy and GHG emissions.

Table 10. Estimated Energy and GHG Emissions By Reporting Source

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Stationary Energy							
Residential Buildings	Electricity	73,625	82,393	11.9%	517	222	-57.1%
	Natural Gas	32,546	47,984	47.4%	1,622	2,392	47.4%
	Fuel Oil	21,491	21,850	1.7%	1,469	1,493	1.7%
	Propane	3,704	3,766	1.7%	226	230	1.7%
	Wood	25,764	26,194	1.7%	662	673	1.7%
	Diesel	1,721	1,873	8.8%	119	138	16.0%
Commercial & Industrial Buildings	Electricity	36,834	35,892	-2.6%	259	97	-62.6%
	Natural Gas	50,038	59,468	18.8%	2,494	2,964	18.8%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
	Fuel Oil	-	-	-	-	-	-
	Diesel	3,701	4,068	9.9%	256	300	17.2%
Manufacturing Industries & Construction	Natural Gas	19,835	20,901	5.4%	53	60	12.3%
Agriculture, Forestry And Fishing Activities	Diesel	348	391	12.3%	24	29	19.7%
Non-Specified Sources				-	1	3	102.5%
Natural Gas Fugitive Emissions				-	86	108	25.7%
Total		**269,606**	**304,778**	**13.0%**	**7,789**	**8,708**	**11.8%**
On-Road Transportation							
Electric Vehicles	Electricity	0	0	692.1%	0	1	203.7%
Hydrogen Vehicles	Hydrogen	-	-	-	-	-	-
Passenger Vehicles	Gasoline + Diesel	38,043	34,747	-8.7%	2,379	2,338	-1.7%
Light Trucks, Vans, SUVs	Gasoline + Diesel	82,407	72,300	-12.3%	5,227	4,925	-5.8%
Heavy Duty Vehicles	Gasoline + Diesel	41,959	46,547	10.9%	2,651	3,140	18.5%
Propane Vehicles	Propane	258	282	9.1%	15	17	16.3%
Natural Gas Vehicles	Natural Gas	0	0	-43.5%	2	1	-39.7%
Motorcycles	Gasoline	977	1,037	6.1%	63	72	13.2%
Total On-Road Transportation		**163,643**	**154,913**	**-5.3%**	**10,337**	**10,494**	**1.5%**
Off-Road Transportation							
Marine, Aviation and Other Off-Road Vehicles	Gasoline + Diesel + Jet Fuel	34,949	38,904	11.3%	2,558	2,888	12.9%
Total Off-Road Transportation		**34,949**	**38,904**	**11.3%**	**2,558**	**2,888**	**12.9%**
Waste							
Wastewater					276	246	-10.7%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Composting					1,612	1,632	1.2%
Incineration & Open Burning					0	0	-
Solid Waste					1,376	1,490	8.3%
Total Waste					**3,264**	**3,368**	**3.2%**
Agriculture Forestry & Other Land Use (AFOLU)							
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-4,537	-4,537	0.0%
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					7	7	0.0%
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					0	0	9.9%
Total AFOLU					**0**	**0**	**9.9%**
Industrial Process & Product Use (IPPU)							
Process Use Emissions					1,296	1,427	10.1%
Total IPPU					**1,296**	**1,427**	**10.1%**
TOTAL		**468,198**	**498,595**	**6.5%**	**25,243**	**26,886**	**6.5%**

7 ELECTORAL AREAS

7.1 2021 Profile

Profile	
Population	25,926
Dwellings	12,408
Registered Vehicles	19,121
Energy (Thousands of GJ)	2,630
GHG Emissions (tCO_2e)	130,763

7.2 2018 & 2021 Energy & GHG Emissions

Table 11 presents a summary comparison of the CVRD's Electoral Areas 2018 and 2021 energy and GHG emissions. The Electoral Areas (EA) consist of the following:

- Electoral Area A: Baynes Sound
- Electoral Area B: Lazo North
- Electoral Area C: Puntledge-Black Creek

Due to data limitations, separate energy and GHG emissions profiles for each EA cannot be provided at this time.

Table 11. Estimated Energy and GHG Emissions By Reporting Source

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Stationary Energy							
Residential Buildings	Electricity	713,905	677,018	-5.2%	5,017	1,824	-63.6%
	Natural Gas	50,753	61,730	21.6%	2,530	3,077	21.6%
	Fuel Oil	209,632	213,132	1.7%	14,329	14,568	1.7%

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
	Propane	36,125	36,728	1.7%	2,204	2,241	1.7%
	Wood	251,389	255,585	1.7%	6,458	6,566	1.7%
	Diesel	10,521	10,356	-1.6%	727	763	4.9%
Commercial & Industrial Buildings	Electricity	177,396	219,177	23.6%	1,247	591	-52.6%
	Natural Gas	29,759	32,332	8.6%	1,483	1,611	8.6%
	Fuel Oil	-	-	-	-	-	-
	Diesel	22,616	22,495	-0.5%	1,564	1,658	6.0%
Manufacturing Industries & Construction	Natural Gas	121,217	115,587	-4.6%	324	330	1.7%
Agriculture, Forestry And Fishing Activities	Diesel	2,126	2,161	1.6%	147	159	8.4%
Non-Specified Sources				-	-	-	-
Natural Gas Fugitive Emissions				-	113	113	0.0%
Total		**1,625,438**	**1,646,300**	**1.3%**	**36,143**	**33,501**	**-7.3%**
On-Road Transportation							
Electric Vehicles	Electricity	0	0	601.4%	0	1	168.9%
Hydrogen Vehicles	Hydrogen	-	-	-	-	-	-
Passenger Vehicles	Gasoline + Diesel	201,097	169,189	-15.9%	12,578	11,387	-9.5%
Light Trucks, Vans, SUVs	Gasoline + Diesel	523,637	474,829	-9.3%	33,199	32,351	-2.6%
Heavy Duty Vehicles	Gasoline + Diesel	124,643	119,793	-3.9%	7,816	8,040	2.9%
Propane Vehicles	Propane	3,405	2,550	-25.1%	193	154	-20.2%
Natural Gas Vehicles	Natural Gas	-	-	-	-	-	-
Motorcycles	Gasoline	2,496	2,522	1.0%	162	174	7.7%
Total On-Road Transportation		**855,278**	**768,883**	**-10.1%**	**53,948**	**52,107**	**-3.4%**

Source	Type	2018 Energy (GJ)	2021 Energy (GJ)	Change (%)	2018 GHG Emissions (tCO_2e)	2021 GHG Emissions (tCO_2e)	Change (%)
Off-Road Transportation							
Marine, Aviation and Other Off-Road Vehicles	Gasoline + Diesel + Jet Fuel	213,383	214,970	0.7%	15,618	15,962	2.2%
Total Off-Road Transportation		**213,383**	**214,970**	**0.7%**	**15,618**	**15,962**	**2.2%**
Waste							
Wastewater					8,481	8,477	0.0%
Composting					0	449	-
Incineration & Open Burning					87	91	4.6%
Solid Waste					5,287	5,725	8.3%
Total Waste					**13,854**	**14,741**	**6.4%**
Agriculture Forestry & Other Land Use (AFOLU)							
Land-Use: Emissions Sequestered **(Disclosure Only - Not Included In Total)**					-277,511	-277,501	0.0%
Land-Use: Emissions Released **(Disclosure Only - Not Included In Total)**					144	144	0.0%
Livestock, Aggregate Sources and Non-CO_2 Emission Sources on Land					7,605	6,620	-13.0%
Total AFOLU					**7,605**	**6,620**	**-13.0%**
Industrial Process & Product Use (IPPU)							
Process Use Emissions					7,917	7,833	-1.1%
Total IPPU					**7,917**	**7,833**	**-1.1%**
TOTAL		**2,694,100**	**2,630,153**	**-2.4%**	**135,086**	**130,763**	**-3.2%**