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Client:	City of Salmon Arm		
Project Name:	City of Salmon Arm Climate Resiliency Plan		
Subject:	Greenhouse Gas (GHG) Emission Modelling		

1 OVERVIEW

This memo provides an analysis of the community-wide greenhouse gas (GHG) emission modelling, methodology, projections and their relationship to the GHG emission reduction targets captured in the latest Official Community Plan (OCP) for the City of Salmon Arm (the City). This analysis is being completed concurrently with the development of the City's Climate Resiliency Plan and will help inform future City actions.

1.1 Context

In 2020, the City completed a Community Energy and Emissions Plan (CEEP) which informed their GHG reduction strategies and actions but is now due for an update. The City is also in the process of finalizing an updated OCP and revised targets have been proposed "to reduce CO₂ emissions in alignment with the latest values set by the Intergovernmental Panel on Climate Change (IPCC) to limit warming to 1.5°C, which are currently 48% by 2030, 65% by 2035, 80% by 2040 and 99% by 2050, compared to 2019 emissions levels."

1.2 Energy and Carbon in British Columbia

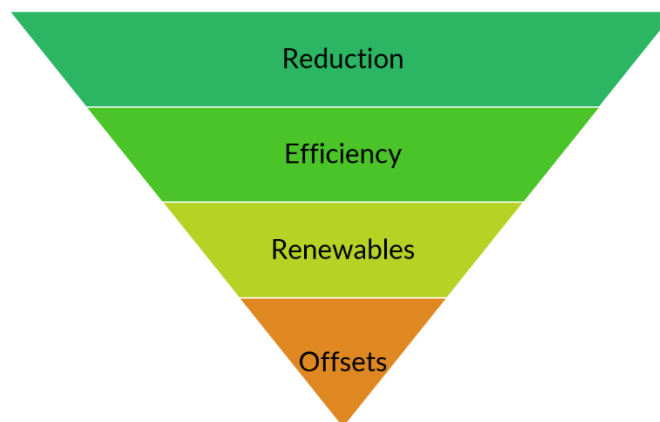
Greenhouse gas emissions are estimated in units of tonnes of carbon dioxide equivalent (CO₂e). This measurement enables the direct comparison and addition of emission contributions from a variety of GHGs by converting them to a common unit which relates their global warming potential to that of carbon dioxide. Different gases, like methane, combine and react in the atmosphere to create a warming effect, and converting them to a carbon dioxide equivalent assists us in capturing their equivalent impact. In this memo, greenhouse gas emissions, emissions and carbon are used interchangeably to capture this carbon dioxide equivalent, typically in units of tonnes.

To understand greenhouse gas emissions in British Columbia (BC), it is important to understand the relationship between energy and carbon. Since Salmon Arm is connected to the main BC Hydro integrated grid, the City's electricity is not a significant source of emissions. The grid is expected to continue to incorporate more renewable energy. BC has committed to 100% clean electricity delivered by 2030 (CleanBC, 2021).

Fossil fuels are currently an important and widely used energy source. Natural gas continues to be an important heating source in most of Canada, including Salmon Arm, for buildings. Salmon Arm has a heating dominated climate, meaning that over the course of a typical year it is necessary to use additional energy to heat buildings to maintain occupant comfort, compared with annual cooling energy requirements. According to the Community Energy and Emissions Inventory (CEEI) data, wood, oil and propane use in buildings represents a small amount of total energy use. Fossil fuels, which are used extensively in transportation and buildings, have a higher greenhouse gas emissions factor, meaning that it is desirable and necessary to reduce their use to meet the established future greenhouse gas emissions targets.

An emissions reduction hierarchy exists with the aim of prioritizing actions to reduce greenhouse gas emissions as shown in Figure 1-1. The hierarchy attempts to capture the most effective way of reducing emissions which is normally first by reducing energy consumption, then using high efficiency systems, then using renewable energy generation, and finally offsetting any remaining emissions through high-quality offsets, renewable energy certificates or purchase power agreements.

Figure 1-1 Emissions Reduction Hierarchy



To meet greenhouse gas emission reduction targets it is increasingly important to support electrification efforts in both transportation and buildings. While there are low carbon alternatives for transportation and building heating fuels, such as Renewable Natural Gas (RNG), and Hydrogenation-Derived Renewable Diesel (HDRD), their supply is expected to be limited, competitive, and costly. As such, electrification remains an important strategy in long term decarbonization as emphasized within the CleanBC Roadmap to 2030. Electrification poses additional challenges in terms of infrastructure requirements. It should be emphasized as stated before, in the emission reduction hierarchy, that energy conservation remains paramount, since lowering energy use results in lower operating costs which are also desirable.

2 METHODOLOGY

The analysis focused on the community-wide emission model using published CEEI data. Additionally, data was provided by the City quantifying the City's corporate emissions. This section outlines the methodology used to estimate and project community-wide emissions, followed by the City's corporate emissions.

Community-Wide Emissions Scope and Exclusions

The following items were determined to be in scope for the community-wide emissions model:

- Transportation
- Buildings
- Solid waste

The following items were excluded from the community-wide emissions model and analysis:

- Land Use, Land-Use Change, and Forestry (LULUCF). Data was not readily available, and as such, is excluded from the current analysis. A reasonable assumption based on current City policies is that land use is expected to remain approximately constant through 2050.

- Fugitive emissions from wastewater were excluded and require a standalone dedicated study to better assess and quantify. Fugitive emissions are the unintended release of greenhouse gases released from the chemical and biological processing and treatment of wastewater.

Corporate Emissions Scope and Exclusions

The following items were determined to be in scope for the corporate emissions analysis:

- Fleet
- Contract Fleet
- Buildings
- Contract Buildings

“Contract” fleet and buildings are associated with the contracted services that the City uses to deliver services. For example, the City oversees the Shuswap Recreation Society which manages and operates several key recreational facilities.

The following items do not appear to be tracked or included in corporate emissions tracking and were therefore excluded:

- In general, scope 3 emissions as defined by the GHG Protocol were excluded from the analysis. The following is a non-exhaustive list of such items: refrigerants, embodied carbon, employee commuting or business travel (WRI, 2004).

2.1 Community-Wide GHG Model Methodology

The modelling was developed using CEEI data for Salmon Arm, which includes vehicles, buildings and solid waste. CEEI is an initiative from the province which provides a standard framework for tracking and reporting energy consumption and GHG emissions at the community level. Note that the CEEI data is typically published two years after collection, which could pose difficulties in real-time tracking of reduction efforts.

Transportation

- A transportation model was developed using the latest available CEEI data for the year of 2022 and historic data available back to the baseline year of 2019.
- Vehicle kilometres travelled by each transit mode were aggregated and increased proportionally to match an estimated 2% annual population growth rate (matching the expected annual population increase for the City).
- A constant mode split was assumed from year 2022 onwards.
- The kilometers travelled were then translated into greenhouse gas emissions based on the most recent emission factors.
- A percentage level of Zero Emission Vehicles (ZEV) adoption was set for Light-Duty Vehicles (LDV) and Heavy-Duty Vehicles (HDV).
- LDV were assumed to progressively electrify to align with provincial goals of ZEV achieving 90% market penetration by 2030 and 100% by 2035.

- It was assumed that ZEV Heavy Duty Vehicles would be gradually increased starting in 2027, given that technology for this category of vehicles is still being refined and that it would reach 95% market adoption by 2050.
- The percentages of ZEV adoption were then refined to meet the OCP emission targets. Percentage adoption for LDV and HDV were then interpolated between the emission target years.

Buildings

- A building utilities model was established for published CEEI utility data for the City. This includes emissions from energy inputs required to operate buildings, streetlights and wastewater and water facilities.
- Most recent published emissions factors were used and kept static until 2030. Following 2030 and thereafter, Zero Carbon Building Design Standard version 4 projections representative of the BC electric grid were used. This results in a sharp decrease in electricity emissions starting in year 2031, although the grid emissions are already quite low before that year.
- Fuel consumption was increased by the annual population growth rate of 2% from 2023 through 2050 to simulate the increased energy use associated with new building stock.
- A percentage of the building stock remaining to be electrified, was then established. This represents a proportion of electrification for the remaining building stock still using fossil fuels at each given year.
- Total emissions for fuel switching were calculated by assuming typical boiler efficiencies (70% for wood, 80% for fuel oil, 85% for natural gas) and then adjusting for the efficiency of the electrified equivalent (seasonal coefficient of performance of 2.1 for air source heat pumps).
- For emission reduction target years, the percentage of electrified building stock was increased until the reduction target was met.
- Electrification percentage values were then interpolated in between target years, and emissions were calculated accordingly.
- Currently the model does not assume an increase in building energy efficiency, heat recovery or improved envelope. This assumption may be revised in the next engagement steps to formalize City actions to meet targets.

Solid Waste

- For solid waste, the City Inventory Reporting and Information System (CIRIS) spreadsheet calculator was used to calibrate emissions to current data on tonnage of waste to match published emissions for the year 2022.
- The Waste Commitment method was used, as it allows the City to focus on the waste generated in a given year. These are the emissions over which the City has the greatest control.
- The City is in charge of curbside collection, while the Columbia Shuswap Regional District (CSRD) is responsible for the regional management and planning of waste.
- Historic data suggests that there is some level of variability year to year in terms of tonnage of waste produced. Even though the City has grown since the time that the earliest published data is available, the overall waste tonnage and resulting emissions has decreased. While this would suggest a reduction in per capita solid waste, the data also shows great variability year to year, up to 48% higher than 2019 in intermediate years.
- Assumptions were made with regards to continued annual reductions in waste tonnage, as well as an intervention-based approach at specific years to increase gas collection efficiency and the proportion of gas recovered.

- By modifying the percentage of waste reduced year over year and these efficiencies and collection values, the model was calibrated to meet the target emissions, and the spreadsheet was used to calculate intermediate year emission values.

2.2 Corporate / Organizational Methodology

Corporate level emission data was provided by the City covering fleet, buildings, and infrastructure (utility) data for their most recently tracked year of 2023 as well as for the baseline year of 2019. It represents an accounting of the energy and emissions that the City is directly responsible for and has influence over. The data will be used to inform actions and is reported in this memo separately for comparison with the community-wide emissions.

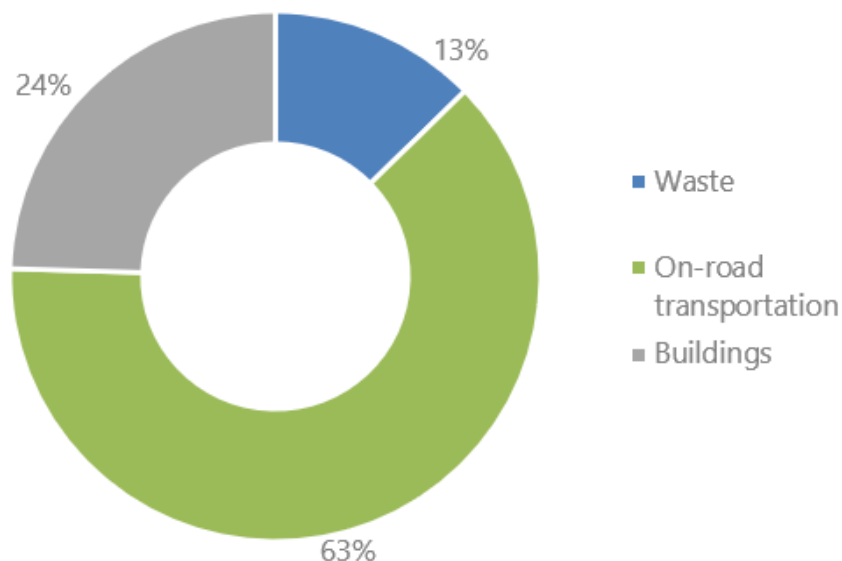
It does not appear that refrigerants, paper or fugitive emissions of wastewater facilities are currently tracked. Quantifying these emissions may be prioritized in future years to provide a more comprehensive picture of corporate emissions.

3 CURRENT STATE EMISSIONS ANALYSIS

3.1 Current Community-Wide Emissions Analysis

At the community-wide greenhouse gas emission level, transportation is the most significant contributor. 63% of the City's emissions are attributable to transportation as shown in Figure 3-1. The figure summarizes the proportion of emissions by sector using the 2019 baseline year. Note that CEEI data and targets pertain to vehicles registered in the City and not those from outside of the City passing through on the highway for tourism or other purposes.

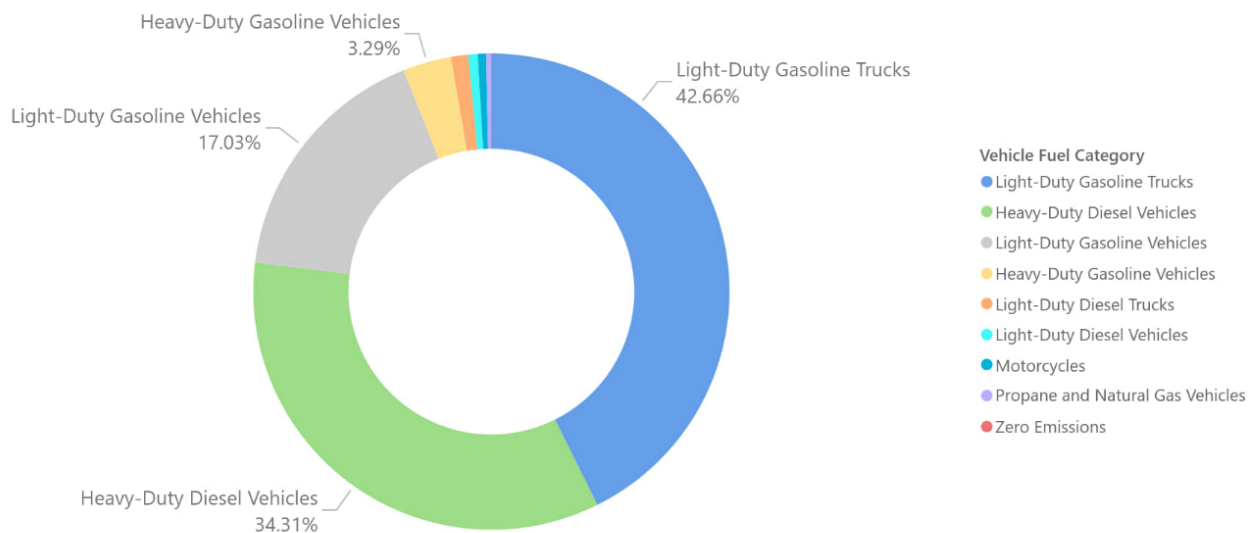
Figure 3-1 2019 Community-Wide Emissions Sector Breakdown



Transportation

Within the transportation sector, emissions are dominated by Light-Duty Gasoline Trucks, HDV and Light-Duty Gasoline vehicles. The relatively high percentage of emissions due to HDV could prove challenging to mitigate, as there are limited low carbon replacement options available in the market today. Figure 3-2 below shows the breakdown of fuel category vehicle emissions for the 2019 baseline year. Additionally, Statistics Canada reports that there have been 305 new Zero Emissions Vehicle registrations between 2017 and 2025 (Statistics Canada, n.d.)

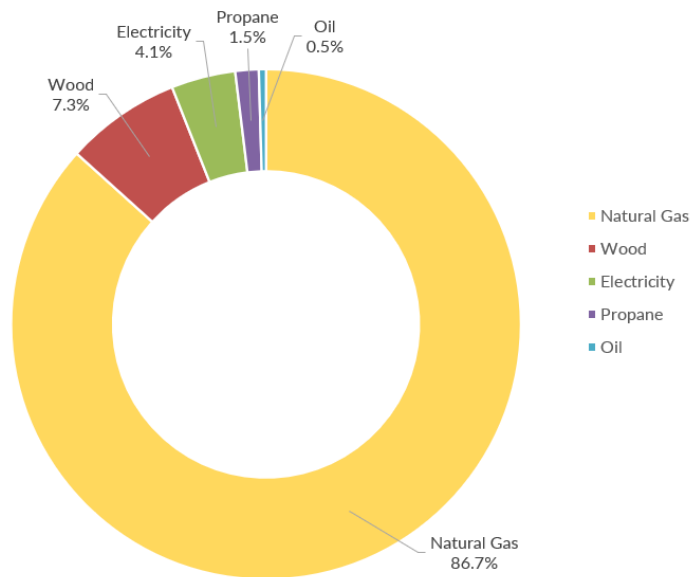
Figure 3-2 Community-Wide 2019 Transportation Emissions



Buildings

Buildings represent the second largest sector contributing to community-wide emissions. Figure 3-1 indicates 24% of the community-wide emissions are attributable to buildings. Within the buildings sector, the largest emissions come from the use of natural gas for space heating and hot water. Figure 3-3 shows the breakdown of emissions by fuel for the 2019 baseline year. Natural gas accounts for 87% of the emissions, with lower emissions from wood, electricity, propane and oil. Electricity energy use, while significant in terms of consumption levels, translates to minimal emissions (4%) due to the clean BC Hydro grid.

Figure 3-3 2019 Community-Wide Building Emissions by Fuel



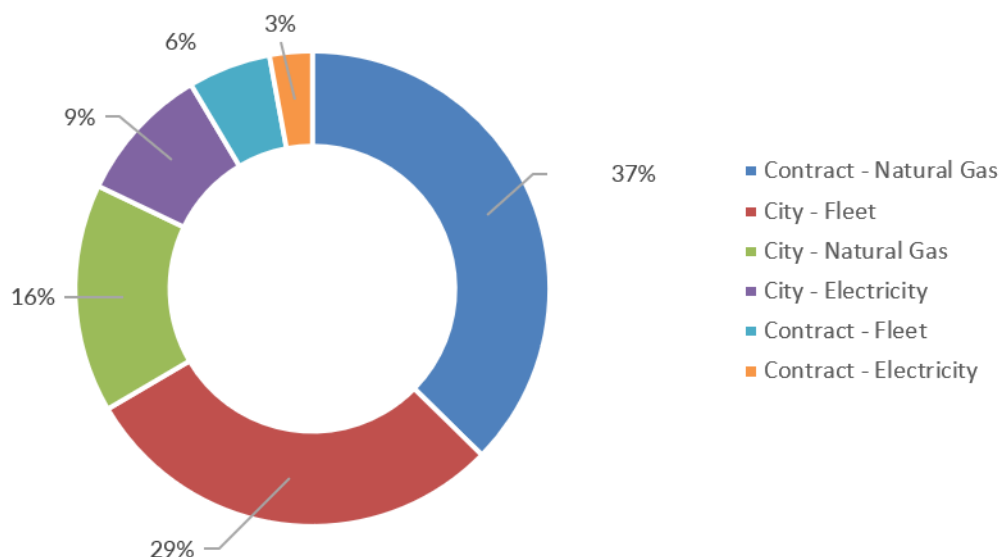
Solid Waste

Solid waste accounts for the remaining community-wide emissions. Figure 3-1 shows how solid waste accounted for 13% of the emissions for the baseline year of 2019. While the City population grew by 13% between 2007 and 2019, emissions from solid waste decreased by 30%. However, as mentioned earlier, great variability is experienced in waste flows. As an example, waste emissions were 48% higher in 2022 than in the baseline year of 2019. This variability is likely to make it more challenging to reduce emissions related to waste.

3.2 Current Corporate Emissions Analysis

Corporate emissions tracking spreadsheets were analyzed for the baseline year of 2019. This tracks the emissions that the City has direct control over, such as fleet, buildings, contracted buildings and contracted fleet as shown in Figure 3-4. Contracted buildings are primarily those managed and operated by the Shuswap Recreation Society with City oversight such as the SASCU Recreation Centre or Rogers Rink. Contracted fleet is made up entirely of SCV Waste Solution vehicles used in curbside waste collection. Unlike the emissions at the community-wide scale, the largest contribution at the corporate level is from contracted buildings' natural gas use at 37%. The City's fleet remains a close second at 29% contribution to the overall corporate emissions. Total corporate emissions for the baseline year amount to 2,012 tonnes of CO₂e. While electricity is generated from primarily renewable sources, the large consumption of electricity adds up to 11% of the total emissions due to the large amount of electricity consumed.

Figure 3-4 Corporate Emissions for Baseline Year 2019



4 PROJECTED EMISSIONS REDUCTIONS TO MEET TARGETS

4.1 Community-Wide Projections

Table 4-1 below shows the 2019 baseline year, sector emissions as reported in the Community Energy and Emissions Inventory (CEEI) which provides community-level GHG emissions and energy consumption estimates, along with the quantification of the projected emissions required to meet each of the above targets set out in the OCP. This assumes an equivalent percent reduction in emissions levels across each sector to meet targets; so long as overall reduction targets are met, there could be variance in the percent reduction between different sectors.

Table 4-1 Community-Wide Emissions Reduction Targets by Sector (tonnes CO₂e, unless noted otherwise)

Sector	2019 (Baseline)	2030 Target	2035 Target	2040 Target	2050 Target
OCP Target Reduction	0%	-48%	-65%	-80%	-99%
Transportation	74,303	38,637	26,006	14,861	743
Buildings and Infrastructure	29,032	15,096	10,161	5,806	290
Solid Waste	14,996	7,798	5,249	2,999	150
Total	118,330	61,532	41,416	23,666	1,183

Transportation

Electric vehicle adoption was the primary emissions reduction strategy modelled for the transportation sector. The rate of adoption was set up separately for LDV and HDV given current limitations of the implemented technologies available within these vehicle types. The adoption rates reported in Table 4-2 coincide with the proposed OCP emission targets established. The model assumed that full ZEV penetration is significant (98.5%), but not 100% by the year 2050 due to the current difficulty of electrifying HDV.

Table 4-2 Community-Wide Transportation Key Performance Indicators to Meet Targets

Year	2030	2035	2040	2050
EV Adoption HDV	7%	33%	65%	98.5%
EV Adoption LDV	90%	100%	100%	100%

The levels of adoption are proportional to the availability of charging infrastructure. Similarly, the increase in kilometers travelled could be decreased by various actions such as encouraging active transportation. Active transportation, which would lead to a decrease in vehicle kilometers travelled, is currently not modelled. The numbers reported are based on the modeled reductions to meet the OCP targets. The CleanBC program and roadmap are currently undergoing a review and update which may prompt further revisions to the targets for ZEVs.

Buildings

The CEEI data suggests that most emissions in the buildings sector are currently the result of fossil fuel use, primarily natural gas. The emissions projection model highlighted the challenge of increasing building emissions from the baseline year. Between 2019 and 2022 (latest year with available data), CEEI data shows an increase of 13.3% in greenhouse gas emissions. Meeting reduction targets at a sectoral level, therefore, requires additional work since emissions are not currently on a reduction trend (they have increased since the baseline year). Emission reductions are further increased after the year 2030, when emissions drop significantly to align with projected electricity emission targets by the province and utility providers. Key performance indicators are summarized in Table 4-3. The model indicated that to get emissions back on a reduction trajectory to meet the proposed targets, the pace at which buildings are retrofitted and electrified must be increased aggressively in the short term to make up for the existing increase in emissions from the baseline year.

Heat pump adoption estimated at the provincial level was used in the modeling to estimate the approximate current level of building electrification in Salmon Arm (British Columbia. Ministry of Environment and Climate Change Strategy, 2025).

Table 4-3 Building Electrification Key Performance Indicators Required to Meet Emissions Reduction Targets

Year	2030	2035	2040	2050
GHG Emissions Reduction	48%	65%	80%	98%
% Building Stock Electrified	65%	75%	87%	99%

Solid Waste

For solid waste, continued diversion efforts are required as well as bold annual reductions in tonnage of solid waste as well as timed interventions to recover gas from the landfill. The model assumes a steep reduction of waste between 2040 and 2050 to align with the proposed emission reduction targets. The assumed key performance indicator values are reported in Table 4-4. The emissions reported in Table 4-4 are the result of the modeling efforts to approximate the actual targets reported earlier in Table 4-1. The emissions from waste are not proportional to the tonnes of waste landfilled, but to the mix of organic material, gas collection efficiency and proportion of gas recovered which was assumed using reasonable assumptions, since waste records did not provide sufficient detail. In operation of a landfill, some gas is flared, while some of it may be recovered for processing for other uses (like electricity, heat or resale).

Table 4-4 Community-Wide Solid Waste Key Performance Indicators Required to Meet Emissions Reduction Targets

Year	2030	2035	2040	2050
Tonnes of Waste	12,239	10,793	8,800	1,039
GHG Emissions, tonnes CO ₂ e	7,713	5,271	2,539	229
Gas Collection Efficiency	65%	75%	90%	95%
Proportion of Gas Recovered	10%	15%	15%	15%

Figures 4-1 and 4-2 summarize the greenhouse gas emission projections from the model developed using the methodology described in Section 2 and the indicators of Section 4. Figure 4-1 shows the projected emissions from each sector. Figure 4-2 captures the progression of the reductions based on fuel source. It can be observed that the established targets are ambitious and require equally ambitious actions to achieve them. These actions will be developed in future stages of engagement.

Figure 4-1

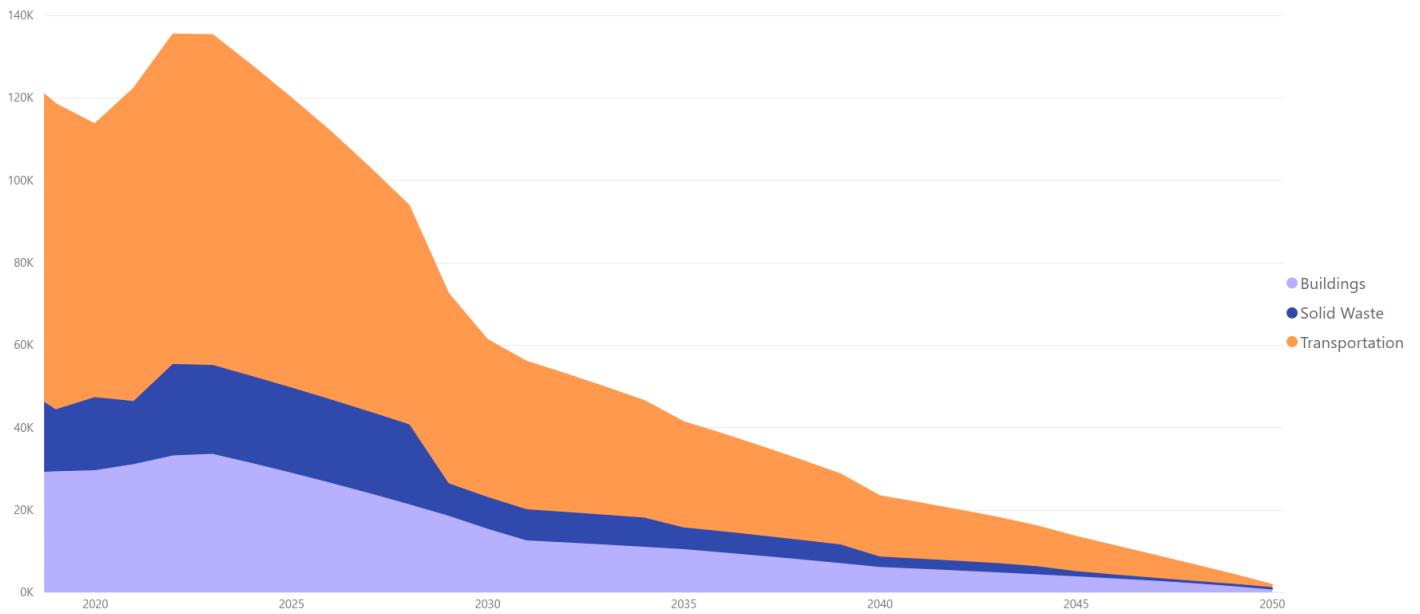
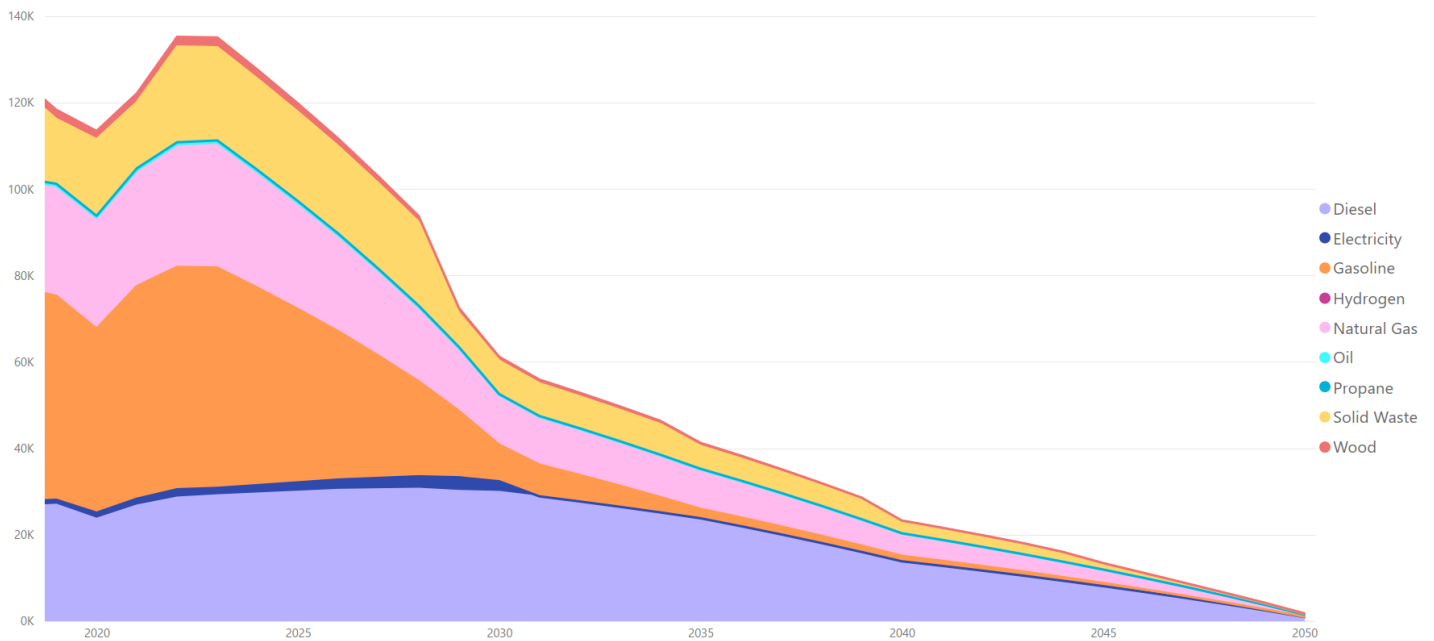


Figure 4-2



4.2 Corporate Projections

Corporate greenhouse gas emissions tracking spreadsheets used by the City were shared for the baseline year of 2019 as well as 2023. Table 4-5 below reports the target emissions for years defined in the OCP if each sector were required to comply with the established target emissions reduction. It can be observed that unlike community-wide emissions, the City's emissions are primarily from its buildings and infrastructure operations which use natural gas and electricity. Strategies to reduce emissions will closely mirror those reported in community-wide projections, namely building efficiency improvement, electrification and transition of fleet to ZEV.

The City can plan for these emission reductions by developing a financial capital plan that evaluates the condition and remaining life of their building and fleet assets. This can help inform the ability to complete the necessary building retrofits, installation of vehicle charging infrastructure and purchases of ZEVs. Contracted services, for both building and transportation will have to be evaluated periodically to ensure that emissions align with the targets established. The contracted fleet services are primarily associated with curbside collection, shown as Solid Waste in Table 4-5, present a challenge as ZEV garbage trucks are only beginning to be adopted in the market. These trucks are roughly twice the capital cost of diesel trucks but have significant operational savings in fuel and maintenance costs.

Table 4-5 Target Corporate Emissions from OCP Reduction Targets

Sector	2019 (Baseline)	2030 Target	2035 Target	2040 Target	2050 Target
OCP Target Reduction	0%	-48%	-65%	-80%	-99%
Buildings & Infrastructure (tonnes CO ₂ e)	1,311	682	459	262	13
Transportation (City fleet) (tonnes CO ₂ e)	588	306	206	118	6
Solid Waste (tonnes CO ₂ e)	114	59	40	23	1

5 SUMMARY AND CONCLUSION

This memo presents findings from the community-wide greenhouse gas emission modelling developed to meet the City's GHG emissions reduction targets established in the recently updated OCP. It suggests that electrification will play a significant role in reaching the emission targets. Electrification of buildings and transportation are necessary, as well as continued solid waste reduction and methane gas capture at an increasingly accelerated pace in order to meet the ultimate target of 99% GHG emissions reduction by 2050.

The acceleration of emissions reductions required to meet the City's emissions reduction targets is very aggressive. Corporate targets are more achievable when compared to the community targets given the community-wide emissions reduction reliance on federal and provincial policy and programming, as well as citizen action. Viable opportunities in the near-term could focus on reducing emissions from waste, advancing electrification in municipal buildings and transitioning light-duty vehicles, including the municipal fleet, to electric power. Infrastructure retirement and

technology availability will determine the timeline for residual building emissions and medium and heavy-duty transportation emissions reductions in the long-term.

The analysis presented in this memo provides guidance in the form of key performance indicators to evaluate emissions trajectory with respect to the established greenhouse gas emissions targets. Suggested City actions will be developed and confirmed in future phases of the Climate Resiliency Plan through engagement with City Staff, the project Steering Committee, Secwepemc Nation, and the public.

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Respectfully submitted,

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6 REFERENCES

British Columbia. (2021, October 25). *CleanBC Roadmap to 2030*.

https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf

British Columbia. (2024, May 28). *Community Energy and Emissions Inventory (CEEI)*. Government of British Columbia.

<https://www2.gov.bc.ca/gov/content/environment/climate-change/data/ceei/>

British Columbia. (2025, February 28). *Emission Factors Catalogue (XLSX, 392KB)*. Government of British Columbia.

https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/guidance-documents/emission_factors_catalogue.xlsx

British Columbia. Ministry of Environment and Climate Change Strategy. (2025, April). *2024 Climate Change*

Accountability Report. https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/2024_climate_change_accountability_report.pdf

C40 Cities, ICLEI – Local Governments for Sustainability, & CDP. (n.d.). *City Inventory Reporting and Information System*

(CIRIS). https://www.c40knowledgehub.org/s/article/City-Inventory-Reporting-and-Information-System-CIRIS?language=en_US

Canada Green Building Council. (2024, December). *Zero Carbon Building – Design Standard Version 4 Workbook*.

https://www.cagbc.org/wp-content/uploads/2024/06/ZCB-Design_v4_Workbook.xlsx

City of Salmon Arm. (2020). *Community Energy and Emissions Plan*.

<https://www.salmonarm.ca/AgendaCenter/ViewFile/Item/123?fileID=569>

City of Salmon Arm. (2025, March). *Second Revised OCP Draft*. <https://www.salmonarm.ca/464/OCP2024>

Statistics Canada. (n.d.). *New motor vehicle registrations, quarterly, by geographic level (Salmon Arm, British Columbia)*.

<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002501&pickMembers%5B0%5D=1.4498&pickMembers%5B1%5D=3.1&cubeTimeFrame.startMonth=01&cubeTimeFrame.startYear=2017&cubeTimeFrame.endMonth=04&cubeTimeFrame.endYear=2025&referencePeriods=20170101%2C20250401>

World Resources Institute and World Business Council for Sustainable Development. *A Corporate Accounting and*

Reporting Standard. Revised ed. Washington, DC: World Resources Institute, 2004. <https://ghgprotocol.org/corporate-standard>.