City of Vernon Greenhouse Gas Emissions: Modelling and Reduction Targets Report

February 2020

CITY OF Vernon

Community Energy Association

Executive Summary

The City of Vernon is taking action to protect the community, improve quality of life and reduce local and global risks associated with a changing climate. Vernon has signed on to the BC Climate Action Charter, committing to working towards reduced carbon operations, measuring community emissions, and creating a complete, compact community. Provincial legislation requires that each local government establish targets, plans and strategies to do their part to mitigate climate change.

The purpose of this Modelling & Targets Report for the City of Vernon is to inform the municipality of their most recent complete emissions inventory (2017), identify targets for greenhouse gas emission reduction that are informed by the Intergovernmental Panel on Climate Change (IPCC) recommendation to limit warming to 1.5 °C, and model the impacts of potential (categorical) high-level actions to reduce greenhouse gas emissions and meet these targets.

Vernon's current greenhouse gas emissions inventory (2017) is dominated by mobility fuels, natural gas consumption for heating in buildings, and emissions associated with waste decomposition at the regional landfill.

Vernon's Climate Action Advisory Committee has proposed Council adopt targets aligned with the IPCC recommendation, which aims to limit global warming to no more than 1.5 degree Celsius by stopping production of carbon emissions by 2050. To support Vernon reaching these targets a staged approach is proposed and it is recommended that the City adopt the following interim targets;

- 23% below 2017 levels by 2025
- 52% below 2017 levels by 2030
- 76% below 2017 levels by 2040

The City of Vernon contracted Community Energy Association to propose a suite of categorized high-level mitigation actions that can be implemented to reduce greenhouse gas emissions and model the impacts of actions on those emissions. The actions are categorized into the following 'Big Moves':

- Decarbonize transportation (passenger transportation as well as fleet, medium- and heavy-duty vehicles)
- Shifting travel beyond the car to active and assisted transportation
- Eliminate the impact of new buildings
- Retrofit Existing Buildings
- Divert and compost organic waste
- Waste diversion and re-use

In addition to this climate mitigation assessment, the City of Vernon engaged Integral Group to complete a similar activity to assess climate adaptation opportunities. A summary of their assessment is provided in a separate report. It is the intent of the forthcoming Climate Action Plan to identify synergies between the proposed mitigation and adaptation actions, undertake public engagement on the actions and draft a final plan that will identify goals and their implementation within the framework of climate resilience.

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Section 1: Introduction

The City of Vernon is in the process of developing a Climate Action Plan (CAP). The plan will combine mitigation and adaptation actions, taking opportunities to integrate these into low-carbon resilience strategies where feasible. The plan will identify both corporate and community-wide actions.

In 2018, the City established a Climate Action Advisory Committee (CAAC) (formerly the Climate Action Task Force) to assist in developing the CAP. The mandate of the Committee is to provide recommendations to Council on policies and strategic initiatives that relate to climate change mitigation and adaptation; information is brought by staff to the Committee for review.

In advance of the Climate Action Plan development, the City conducted separate climate mitigation and adaptation identification and evaluation processes. The mitigation process intended to result in community wide emissions inventories and future Green House Gas (GHG) emissions projections and reduction targets based upon specific actions. Community Energy Association presents this summary report which details Vernon's current emissions (2017), proposes emission reduction targets for 2025, 2030, and 2040 in order for Vernon to achieve their 2050 objective of 100% emission reductions, and summarizes (at a high-level) the mitigation actions the City and the community must complete at a minimum to achieve significant emission reduction impacts.

This document is a companion document to the *Interim Community Energy and Emissions Inventory and Projections Report – DRAFT*, which was submitted to the City in October 2019 and included in this report as Appendix 2.

Section 2: Current Community Emissions

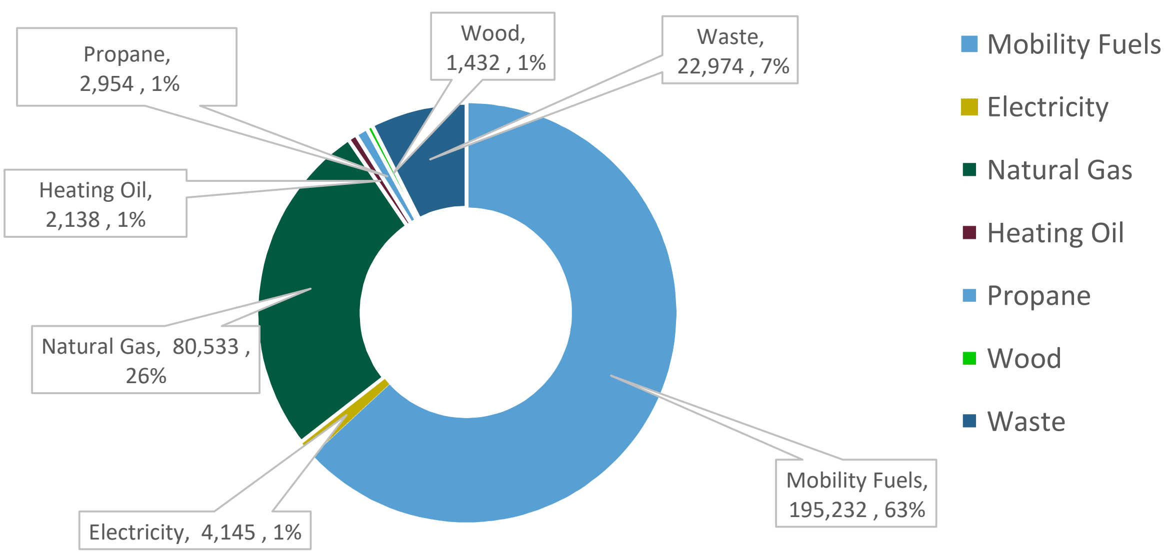
Community inventory data was collected for the City of Vernon from 2007 to 2018, but the most recent inventory year that is complete is 2017, so it is the year used to describe Vernon's current energy consumption and greenhouse gas emissions and is the baseline for modelling and projected emission reduction impacts out to 2050. The community inventory includes emissions both from residents, businesses, industry, and emissions from the corporation of the City of Vernon. The specifics of the emissions from the corporation of the City of Vernon are provided in a separate report.

In 2017 in Vernon:

- Energy consumption for the community is estimated at 6,219,942 GJ
- Greenhouse gas emissions for the community are estimated at 309,407 tonnes of CO_2e
- Energy expenditures are estimated for the community at $167,205,092

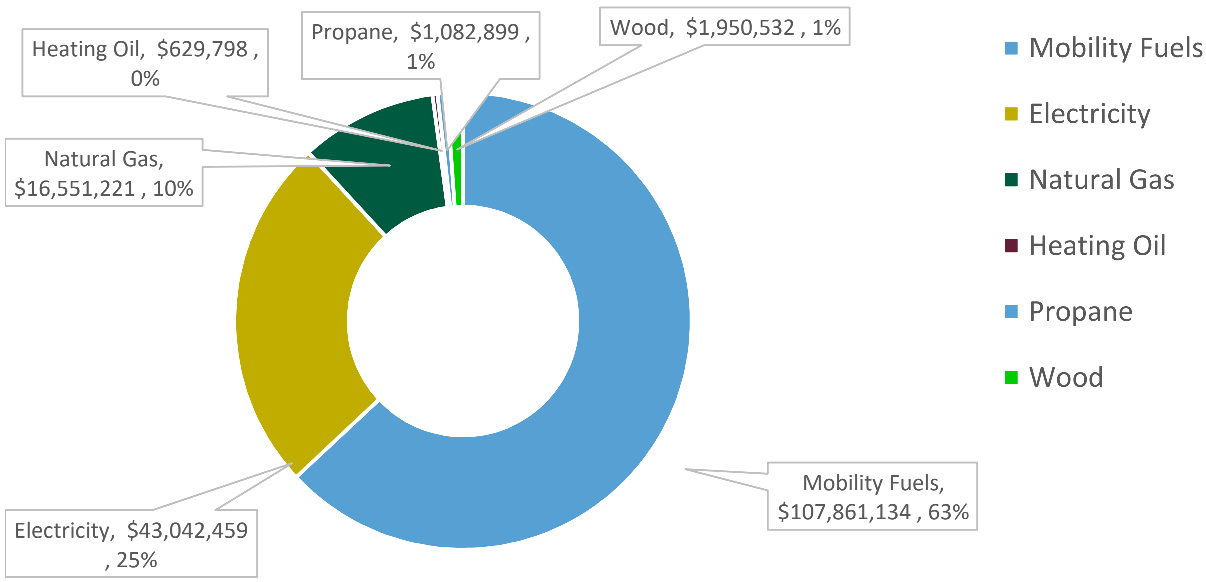
The vast majority of community greenhouse gas emissions in Vernon are due to mobility fuels (gasoline & diesel), and natural gas (Figure 1). Waste contributes a small proportion of greenhouse gas emissions, while electricity, heating oil, propane, and wood are almost negligible. Greenhouse gas emissions split by fuel type and waste are shown in Figure 1.

FIGURE 1 – GHG EMISSIONS BY FUELS AND WASTE IN 2017



Estimated energy expenditures by fuel type only (waste is not included) are shown in Figure 2. Mobility fuels and electricity are the two largest expenditures, with natural gas costs third.

FIGURE 2 – ENERGY EXPENDITURES BY FUEL IN 2017, %



The following two figures show the proportion of energy consumption, greenhouse gas emissions, and estimated energy expenditures for 2017. Figure 3 shows the split between fuel types and waste, while Figure 4 shows the split by sector; buildings, transportation, waste.

FIGURE 3 – PROPORTION OF ENERGY, EMISSIONS, AND COST BY FUELS AND WASTE IN 2017, %

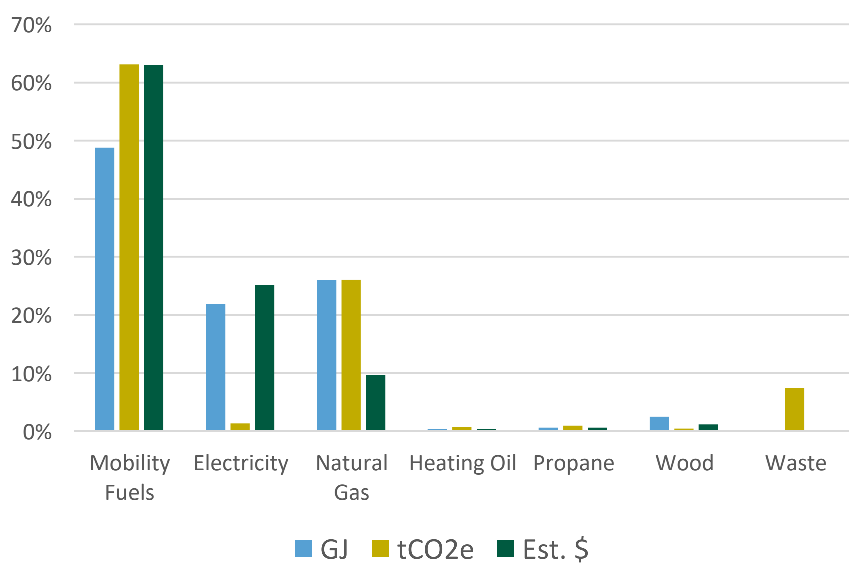
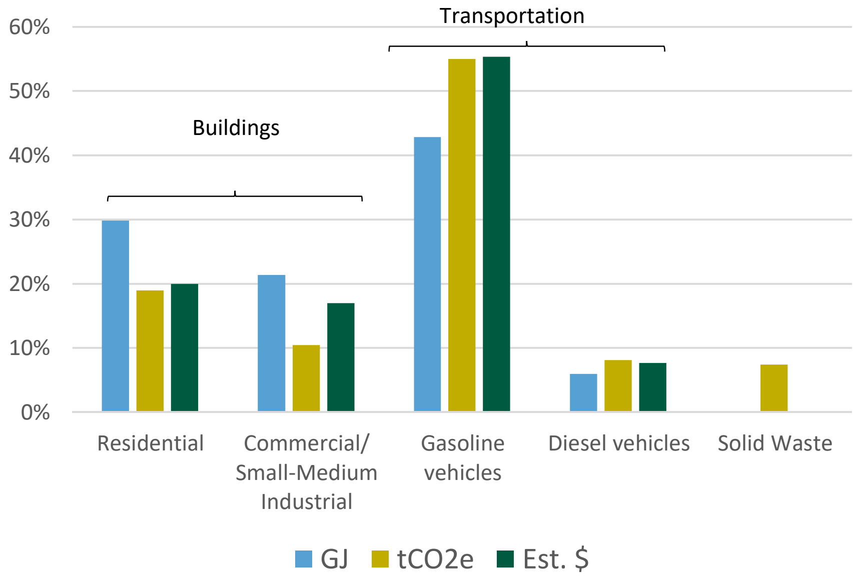


Figure 4 – Proportion of energy, emissions, and cost by sector in 2017, %



The City of Vernon's influence on greenhouse gas emission sources spans the spectrum of direct control to little influence as described in the image below, thus collaboration with community stakeholders both in the City of Vernon and across the region will be necessary for the City to achieve its targets as detailed in Section 3.

Direct Control	Direct Influence	Indirect Influence	Little Influence
Municipal infrastructure, buildings & fleet	Transportation network Land use patterns Solid waste Building efficiency standards	Transportation mode share Residential & business energy efficiency Food security	Air travel Industrial energy efficiency Vehicle standards Energy utilities

2.1 Forecasted Emissions in Business As Usual Scenario

If Vernon were to take no additional action with respect to climate mitigation, greenhouse gas emissions would increase as per Business As Usual (no change to current policies, regulations, behaviours). Figure 5 and Figure 6 depict the projected energy use by fuel type (electricity, gasoline, diesel, natural gas, etc.) and sector (buildings and transportation) for the Business As Usual Scenarios respectively. The sharp decrease in the use of mobility fuels post 2040 is due to the already enacted provincial legislation surrounding electric vehicles and the associated reduction in emissions that would ensue.

FIGURE 5. FORECASTED ENERGY USE BY FUEL FOR BUSINESS AS USUAL SCENARIO (GJ/YR)

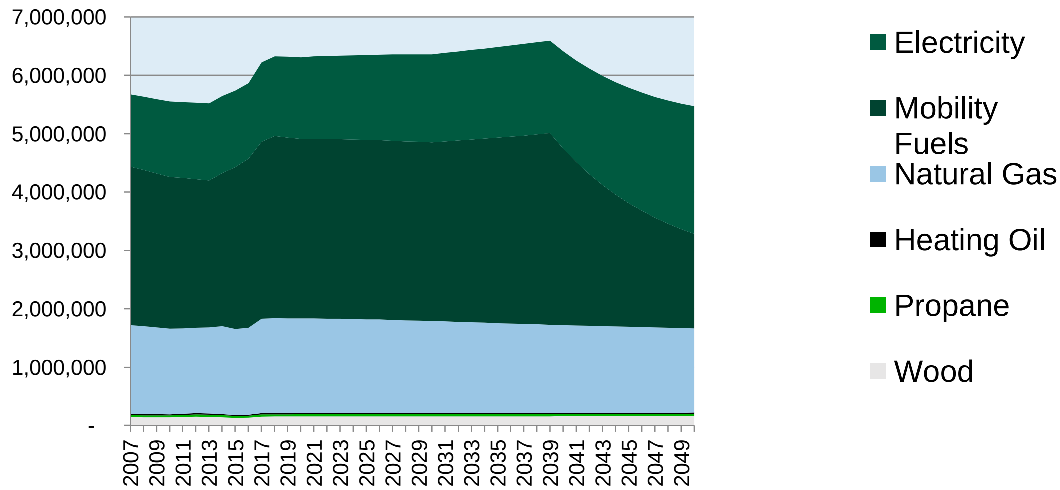
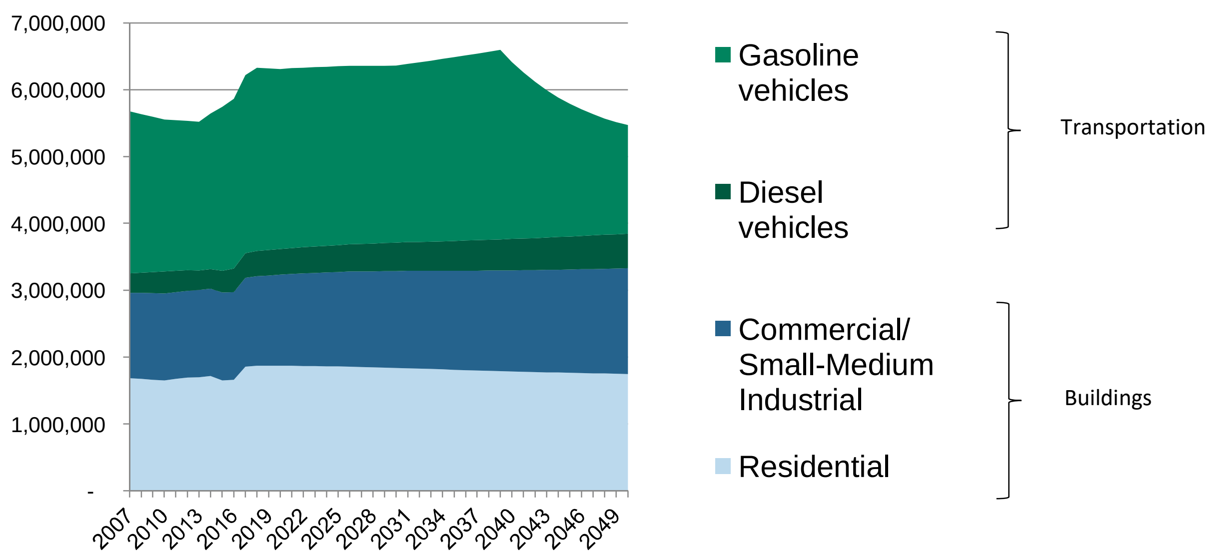


FIGURE 6. FORECASTED ENERGY USE BY SECTOR FOR BUSINESS AS USUAL SCENARIO (GJ/YR)



Section 3: Targets – How We Get There

To reach the targets proposed in this section will take ongoing commitment by the City of Vernon over the next 30 years. The City will need to collaborate extensively with other governmental and non-governmental partners to promote the necessary per capita reductions in greenhouse gas emissions within the City of Vernon:

23% below 2017 levels by **2025**

- Equivalent to 29 % per capita reduction*

52% below 2017 levels by **2030**

- Equivalent to 58% per capita reduction

76% below 2017 levels by **2040**

- Equivalent to 81% per capita reduction

100% below 2017 levels by **2050**

- Equivalent to 100% per capita reduction

=

Every person and business reducing emissions 3% every year from 2017 to 2050 on average

**per capita = per person*

Reaching the targets will take ongoing commitment, with the biggest changes in how people get around the community. More cycling, walking, e-mobility and transit can make a significant difference in the short term, as it reduces the use of vehicles (and the emissions they create). The biggest shift will be to electric vehicles over time as existing internal combustion engine (ICE) vehicles are replaced. This will reduce emissions (BC Hydro electricity is 98% emission-free) and save 90% of the fuel cost since ICE are only about 20% efficient and gasoline is twice as expensive as electricity for the same amount of energy. How we heat our homes will change as well. New buildings will be much more efficient (80% more efficient as compared to today's base building code by 2030) and we will shift heating from natural gas to electricity through the uptake of electric air source heat pumps (Fortis BC has recently committed to 15% renewable natural gas content by 2030, however our models do not take this into account at this time). In addition, we will stop wasting our food scraps and yard trimmings, instead of being buried in a landfill, they will be collected for compost. Vernon is situated within the Regional District of North Okanagan, the RDNO already operates a gas capture and utilization system at the regional landfill, we assume capture efficiency and utilization will continue to increase.

The timeline in Table 1 details some of the changes necessary to meet the targets, further specifics will be identified through the development of the Climate Action Plan. The City has an important role to play in setting up the infrastructure required, establishing policy/regulation, creating or promoting incentives to drive the change, and supporting the transition to a low carbon community through education and outreach to citizens.

TABLE 1. TARGETS & ACTIONS TO MEET 2050 100% GREENHOUSE GAS EMISSION REDUCTION TARGET

2020	0% per-capita GHG reduction	▪ Targets and actions committed to (development of Climate Action Plan). ▪ Infrastructure starting to be deployed. ▪ Policies identified and developed to shape future growth. ▪ Budget approvals process for further policy and infrastructure development initiated
2025	29% per-capita GHG reduction	▪ EVs or low carbon fuels comprise 20% of vehicles on the road (5,700) ▪ 20% of existing homes complete home-energy retrofits - air tightness, insulation upgrades (interior and exterior), high-efficiency windows and doors (4,300) ▪ Step Code adopted and being implemented, all new buildings constructed 20% more efficient than baseline (Baseline will be Energy Step Code relevant Step). ▪ 75% of new homes implement low carbon energy systems
2030	58% per-capita GHG reduction	▪ EVs or low carbon fuels comprise 50% of vehicles on the road (15,000) ▪ 50% of buildings have low carbon energy systems (12,500 private dwellings and half of all businesses)
2040	81% per-capita GHG reduction	▪ EVs or low carbon fuels comprise 75% of vehicles on the road (25,000) ▪ 75% of buildings using low carbon energy systems (21,000 private dwellings and ¾ of all businesses) ▪ No organics from Vernon go to the landfill
2050	100% per-capita GHG reduction	▪ 100% of vehicles and buildings use low carbon energy systems ▪ 100% of landfill emissions collected and utilised

The citizens and businesses of Vernon have the biggest role. The change depends on their individual choices about how to get around, where to live, and how to handle food waste and yard material. To engage citizens and businesses, the forthcoming Climate Action Plan will necessarily depend on ongoing, sustained engagement to help residents understand their choices and how those choices impact the direction of the community.

3.1 Pathway for Greenhouse Gas Emission Reductions

CEA's modelling tool was used to project the impact of the actions detailed in the following section (Figure 7). Acknowledging current local government powers, there are limitations as to the authority the City has over community-wide greenhouse gas emissions. This fact, paired with emerging technologies and almost certain innovations in the clean energy sector over the next decade means that many of the solutions to achieve 1.5 degrees will not be available to the City in the near future. With the actions and levers currently within the authority of the City, it is not possible to meet 100% of the target for 2050 (grey coloured area of 'remaining emissions' in Figure 7). CEA's model is intentionally conservative which is based on currently available technology (e.g. nothing is available today for electrification of commercial fleets which encompass medium and heavy-duty vehicles) and existing adoption rates for low-emission technologies (for example, electric air source heat pumps, and electric vehicles). Adoption rates will increase in the future as communities and their residents move through the technology adoption lifecycle, where rates peak at percentages greater than 50. These realities (low adoption rates, available technology), paired with the City's current resources (staff, policies, authority, and most importantly limited budget) inform the projections. Access to significant funding, and ability to influence community-wide emissions through policy could significantly improve the ability of local governments to influence their community-wide emissions, however that this plan reflects the present-day scenario.

The ‘remaining emissions’ are detailed by fuel type (Figure 9) and sector (Figure 10), the ‘remaining emissions’ in both figures are those that are above the 1.5 ° C target (Draft) red line of each figure. By fuel type, the remaining greenhouse gas emissions in 2050 include natural gas and mobility fuels (gasoline and diesel) primarily. By sector type, the remaining greenhouse gas emissions in 2050 include transportation and buildings (residential and commercial/small – medium industrial). Commercial buildings are Part 3 non-residential buildings, including offices, commercial retail outlets, government buildings (such as schools and hospitals), other institutions and industrial facilities. This category also includes any other customers that do not fall under the residential subsectors.

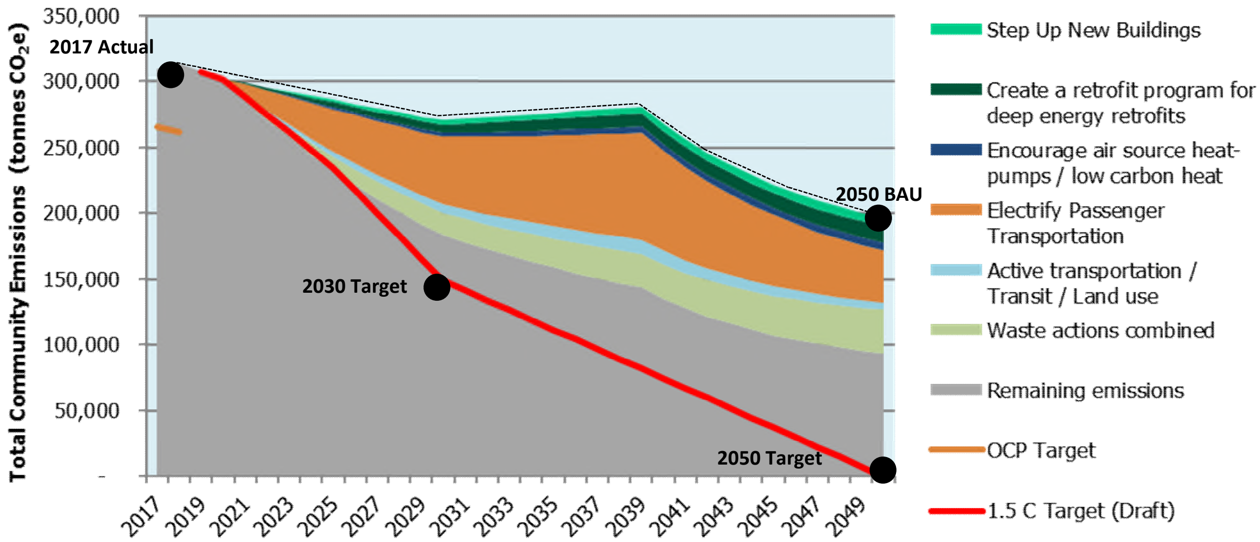
Though not included in the model, CEA anticipates the ‘remaining emissions’ can be addressed in the future as per the following;

- Accelerated adoption of electric air source heat pumps as economies of scale are realized and they achieve capital and operating cost parity with natural gas furnaces
- The City of Vernon is provided more authority with respect to requiring existing building retrofits opportunities. The CleanBC Plan does indicate an intent to explore increased authority around energy efficiency in retrofits.
- Electricity or low-carbon fuelled options for medium and heavy-duty vehicles are commercialized
- Sequestering and/or offsetting greenhouse gas emissions
- The City accelerates the pace of implementation, which would require a significant increase of resources (human and financial). Any increase in the rate of implementation or resources allocated will mostly likely result in the City achieving greenhouse gas emission reductions in excess of our current forecasts. This requires early and active engagement with regional partners (e.g. Kal Tire, or other prominent organizations) who can help to support and demonstrate leadership.
- New Provincial and Federal programs that we cannot yet anticipate. A past example of a successful program that would be beneficial to the City of Vernon was the Province’s Live Smart BC Efficiency Incentive Program.

Given this, we recommend the City of Vernon update and re-evaluate the model and impact of actions every 3-5 years.

With respect to the current modelling depicted in Figure 7, the Business As Usual forecast (black dotted line) indicates a 37% reduction in greenhouse gas emissions from 2017 would be achieved by 2050 if Vernon adhered only to existing policies and regulations and if no additional resources were allocated to accelerate implementation. The model (Figure 7) shows that working towards the proposed targets will require change primarily in the areas of retrofitting (building envelope energy efficiency initiatives including exterior insulation wrap, increased interior insulation, and high-efficiency windows & doors), and electrifying heating for buildings, diverting organic waste from landfills, increasing landfill gas capture efficiency and electrifying passenger transportation.

FIGURE 7. ANTICIPATED GREENHOUSE GAS EMISSION REDUCTIONS FOR BIG MOVES



Section 4: Actions & Impacts

By undertaking the actions summarized below (high-level), the City can affect reductions in future community energy consumption and greenhouse gas emissions. The following figures show the projected emissions reductions that can result from the actions in this plan, compared to forecasted emissions in a scenario of Business As Usual.

FIGURE 8. BUSINESS AS USUAL SCENARIO - GREENHOUSE GAS EMISSIONS BY FUELS & WASTE (TONNES/YEAR)

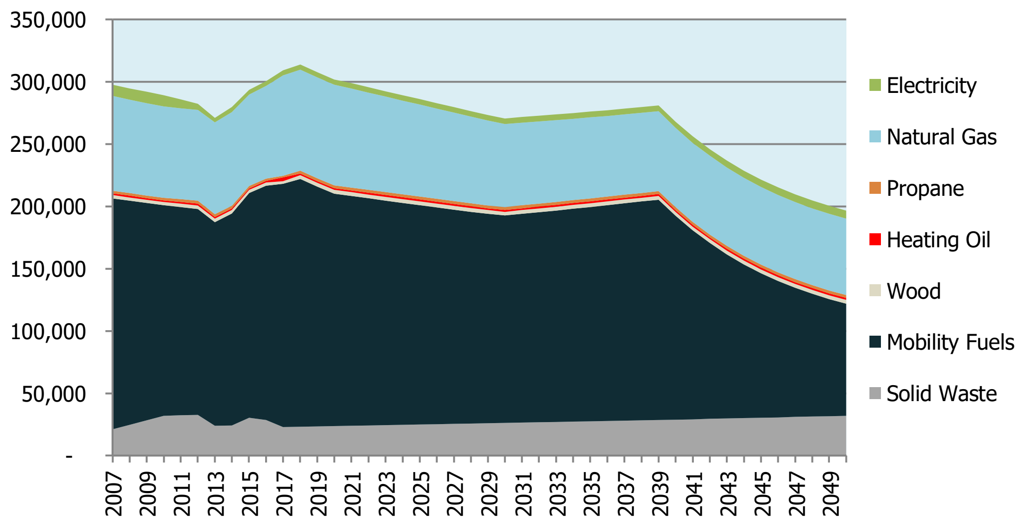


FIGURE 9. IMPACTS OF MITIGATION ACTIONS – GREENHOUSE GAS EMISSIONS BY FUELS & WASTE (TONNES/YEAR)

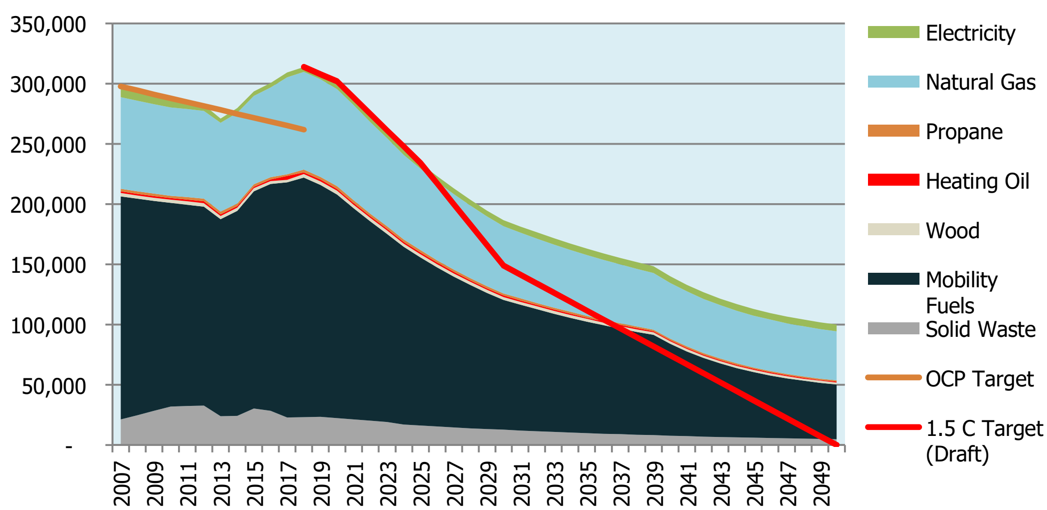
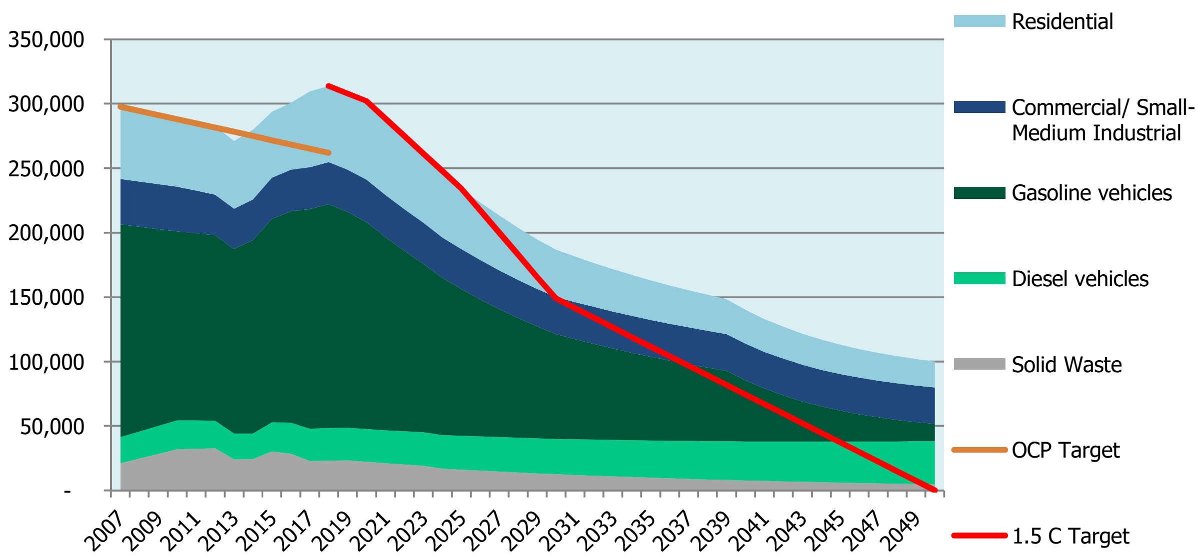


FIGURE 10. IMPACTS OF MITIGATION ACTIONS – GREENHOUSE GAS EMISSIONS BY SECTOR (TONNES/YEAR)



Through CEA's decades of experience in helping BC local governments with energy & emissions, and deep thinking on what strategies a community should focus on to achieve maximum emissions reductions, CEA has developed a suite of Big Moves for local governments to focus on if they have indicated their intent to limit emissions aligned with the IPCC 1.5-degree target. In Vernon, the Climate Action Advisory Committee has proposed adoption of the 1.5-degree target to Council. Given this context, the following is a summary of seven Big Moves that Vernon will need to undertake, at a minimum, to reduce emissions to meet the targets summarized in Section 3. A detailed implementation plan (timing, budget, policies, etc.) including supplementary actions that will address 'remaining emissions' as per our modelling, will be detailed in the forthcoming Climate Action Plan.

The Big Moves are characterized by sector;

- **Zero Emission Transportation**
    - Decarbonize passenger transportation as well as commercial fleets and medium- and heavy-duty vehicles. Vernon can do this by;
        - Adopting ZEV-ready building requirements
        - Designing, funding (leveraging grants, etc.) and building a public ZEV charging network
        - Incentivizing zero-emission car sharing and ride-hailing
    - Change travel modes to those beyond the car via active and assisted transportation (such as walking cycling and public transit).
      Vernon can do this by;
        - Building safe routes for walking, cycling, and other forms of zero emission mobility (e-bikes, scooters, where appropriate low-speed EV's such as golf carts)
        - Support a zero-emission transit network
        - Identify and reduce policy barriers to e-mobility on demand, such as electric scooter and/or electric bike sharing
- **Zero Emission Buildings**

- Construct new buildings so that all the community’s new buildings are energy efficient and operate exclusively with zero-emission energy sources.
  Vernon can do this by:
  - Adopt the BC Energy Step Code and supplement with incentives targeting zero-emissions heating systems, i.e. electric air source heat pumps
  - Require building energy labelling and benchmarking (to inform consumers and encourage real-estate market value in energy efficiency).
  - Coordinate outreach and education to support the building industry through the transition to high-performance low carbon construction
- Retrofit Existing Buildings so that the community’s existing buildings are energy efficient and generate zero greenhouse gas emissions in operation.
  Vernon can do this by:
  - Exploring financing and incentive mechanisms to enable deep energy retrofits
  - Reduce barriers to heat pump adoption
  - Coordinate with the Province in the development of retrofit requirements

- **Organic Waste**
  - Divert Organic Waste from the landfill and compost organic material; use or sell compost materials.
  - Capture Value from Waste, landfill gas collection and flare, or ideally re-use. Vernon will need to coordinate with the Regional District of North Okanagan as they do not have direct influence or control over the landfill.

The following table (Table 2) summarizes the suite of actions detailed above and provides initial estimates of their impacts specific to the City of Vernon (modelling completed using Vernon’s 2017 emissions inventory) for 2025, 2030, 2040 and 2050. As compared to Table 1 which summarizes what must be done to achieve the targets, Table 2 summarizes the impacts that will be observed based on the initial mitigations identified as part of this report.

TABLE 2. SUMMARY OF PROPOSED MITIGATION ACTIONS & IMPACTS

Sector	**Zero Emission Transportation**		**Zero Emissions Buildings**			**Organic Waste Re-Use**
Big Move	**Decarbonize Transportation (Personal, Industrial, Commercial, Corporate Fleets)**	**Shift Beyond the Car: Active & Assisted Transportation**	**Retrofit Existing Residential Buildings**	**Eliminate the impact of new buildings (residential and commercial)**	**Electric Air Source Heat Pump Adoption (applicable to existing buildings only)**	**Divert Organic Waste & Improve landfill gas collection efficiency** **Capture Value from Waste**
2020 – 2025						
Expected Emissions Reductions by 2025 **(54, 104 tonnes CO_2 reduction between 2020 – 2025)**	31,805 CO_2e	4,294 CO_2e	3,654 CO_2e	1,907 CO_2e	1,700 CO_2e	10,744 CO_2e
Necessary Implementation	5,700 EVs or 20% of corporate fleet	300 single-occupancy vehicle kilometers travelled shifted per person, (2.5 % reduction of total vehicle km travelled per person)	4,300 dwellings	All new buildings must be 20% more efficient that baseline (Baseline is the current adopted Step as per the BC Energy Step Code) 75% of new builds use low carbon energy systems	1,300 dwellings	34% reduction in organics going to landfill 10% improvement in landfill gas collection efficiency
Percentage of total expected emission reductions (this period).	58%	8%	7%	4%	3%	20%
2025 - 2030						
Expected Emissions Reductions **(87,171 tonnes CO_2e reduction between 2025 - 2030)**	51,004 CO_2e	6,886 CO_2e	6,256 CO_2e	3,347 CO_2e	2,985 CO_2e	16,693 CO_2e

Necessary Implementation	14,400 EVs, 48% of fleet	600 single-occupancy vehicle kilometers travelled shifted per person (5.1% reduction of total vehicle km travelled per person)	7,600 dwellings	All new buildings must be 20% more efficient that baseline (Baseline is the current adopted Step as per the BC Energy Step Code – the baseline will be a higher step than the one adopted for 2020-2025) 75% of new builds use low carbon energy systems	2,300 dwellings	51% reduction in organics to landfill and 10% improvement in landfill gas collection efficiency (if not achieved previously)
Percentage of total expected emission reductions (This period).	59%	8%	7%	4%	3%	19%
2030 – 2040						
Expected Emissions Reductions **(132,808 tonnes CO_2e reduction between 2030 - 2040)**	75,965 CO_2e	10,256 CO_2e	10,145 CO_2e	5,428 CO_2e	4,840 CO_2e	26,174 CO_2e
Necessary Implementation	24,100 EVs, 73% of fleet	1,200 single-occupancy vehicle kilometers travelled shifted per person. (10.5% reduction of total vehicle km travelled per person)	12,300 dwellings	All new buildings must be 20% more efficient that baseline (Baseline is the current adopted Step as per the BC Energy Step Code – the baseline will be a higher step than the one adopted for 2025-2030)	3,700 dwellings	73% reduction in organics going to landfill and 10% improvement in landfill gas collection efficiency (if not achieved previously)

Percentage of total expected emission reductions (This period)	57%	8%	7%	4%	4%	20%
2040 - 2050						
Expected Emissions Reductions **(103,236 tonnes CO_2e reduction between 2040 - 2050)**	39,456 CO_2e	5,327 CO_2e	12,311 CO_2e	6,587 CO_2e	5,873 CO_2e	33,682 CO_2e
Necessary Implementation	34,100 EVs, 94% of fleet	1,900 single-occupancy vehicle kilometers travelled shifted per person. (16.1% reduction of total vehicle km travelled per person)	14,900 dwellings	All new buildings must be 20% more efficient that baseline (Baseline will be the current adopted Step as per the BC Energy Step Code)	4,500 dwellings	85% reduction in organics going to landfill, and 10% improvement in landfill gas collection efficiency (if not achieved previously)
Percentage of total emission reductions (this period)	38%	5%	12%	6%	6%	33%

Appendix 1: Energy & Emission Inventory Data – Community Level

This appendix contains the raw energy & emissions community inventory data for each complete each year available (either partial or complete) back to 2007.

2018				
Sector	Subsector Description	Fuel	GJ	t CO_2e
On-Road Transportation	Mostly private	Gasoline	2,743,393	173,632
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	376,298	25,213
2017				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,664,292	170,181
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	370,459	25,050
Solid Waste	Community Solid Waste	Solid Waste	0	22,974
Buildings	Residential	Electricity	636,227	1,885
Buildings	Residential	Natural Gas	1,008,495	50,297
Buildings	Residential	Propane	36,956	2,260
Buildings	Residential	Heating Oil	20,942	1,432
Buildings	Residential	Wood	154,804	2,954
Buildings	Commercial/Small-Medium Industrial	Electricity	721,509	2,138
2016				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,543,355	163,955
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	352,929	24,085
Solid Waste	Community Solid Waste	Solid Waste		28,603
Buildings	Residential	Electricity	585,461	1,735
Buildings	Residential	Natural Gas	891,335	44,454
Buildings	Residential	Propane	32,089	1,962
Buildings	Residential	Heating Oil	18,183	1,243
Buildings	Residential	Wood	134,415	2,565
Buildings	Commercial/Small-Medium Industrial	Electricity	708,121	2,098
2015				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,448,661	157,851
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	329,222	22,467
Solid Waste	Community Solid Waste	Solid Waste	0	30,386
Buildings	Residential	Electricity	592,325	1,755
Buildings	Residential	Natural Gas	876,903	43,734
Buildings	Residential	Propane	31,673	1,937
Buildings	Residential	Heating Oil	17,948	1,227
Buildings	Residential	Wood	132,675	2,531
Buildings	Commercial/Small-Medium Industrial	Electricity	718,401	2,129
2014				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,328,830	150,126

On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	290,669	19,836
Solid Waste	Community Solid Waste	Solid Waste	0	24,363
Buildings	Residential	Electricity	598,985	1,775
Buildings	Residential	Natural Gas	921,030	45,935
Buildings	Residential	Propane	34,291	2,097
Buildings	Residential	Heating Oil	19,431	1,329
Buildings	Residential	Wood	143,641	2,741
Buildings	Commercial/Small-Medium Industrial	Electricity	719,825	2,133
2013				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,222,805	143,291
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	293,066	20,000
Solid Waste	Community Solid Waste	Solid Waste	0	24,109
Buildings	Residential	Electricity	599,841	1,666
Buildings	Residential	Natural Gas	894,235	44,598
Buildings	Commercial/Small-Medium Industrial	Electricity	722,976	2,008
2012				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,230,627	143,795
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	313,803	21,415
Solid Waste	Community Solid Waste	Solid Waste	0	32,692
Buildings	Residential	Electricity	593,516	2,253
Buildings	Residential	Natural Gas	886,101	44,193
Buildings	Residential	Propane	36,956	2,260
Buildings	Residential	Heating Oil	20,942	1,432
Buildings	Residential	Wood	154,804	2,954
Buildings	Commercial/Small-Medium Industrial	Electricity	719,249	2,730
2010				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,273,862	146,582
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	328,263	22,402
Solid Waste	Community Solid Waste	Solid Waste	0	32,035
Buildings	Residential	Electricity	588,106	4,139
Buildings	Residential	Natural Gas	872,832	43,531
Buildings	Residential	Propane	33,225	2,032
Buildings	Residential	Heating Oil	18,827	1,287
Buildings	Residential	Wood	139,176	2,655
Buildings	Commercial/Small-Medium Industrial	Electricity	703,374	4,950
Buildings	Commercial/Small-Medium Industrial	Natural Gas	595,431	29,696
2007				
Sector	Subsector Description	Fuel	GJ	t CO2e
On-Road Transportation	Mostly private	Gasoline	2,424,703	165,046
On-Road Transportation	Mostly commercial / institutional	Diesel Fuel	287,668	20,232
Solid Waste	Community Solid Waste	Solid Waste	0	21,205
Buildings	Residential	Electricity	565,777	4,086
Buildings	Residential	Natural Gas	918,712	45,819

Buildings	Residential	Propane	34,518	2,111
Buildings	Residential	Heating Oil	19,560	1,337
Buildings	Residential	Wood	144,593	2,759
Buildings	Commercial/Small-Medium Industrial	Electricity	674,318	4,870
Buildings	Commercial/Small-Medium Industrial	Natural Gas	605,846	30,215

Appendix 2: Vernon Interim Community Energy & Emissions Inventory and Projections Report

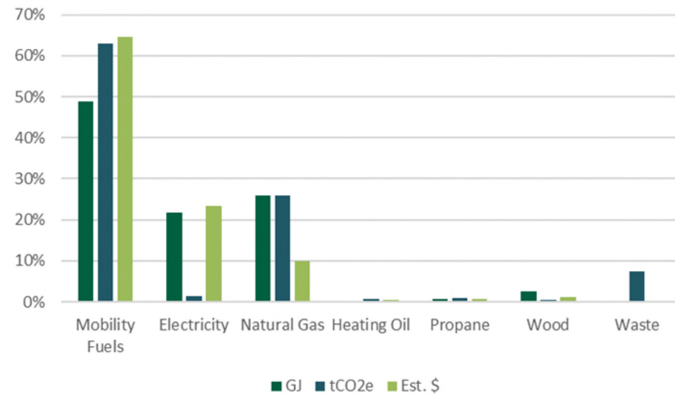
Summary

This document provides inventory emissions data from 2007 to 2018 for the City of Vernon, and identifies Business As Usual (BAU) projections for emissions through to 2050. It has been created to help the City with understanding its current energy and emissions situation, in light of the draft community GHG reduction targets congruent with the IPCC's recent 1.5°C report.

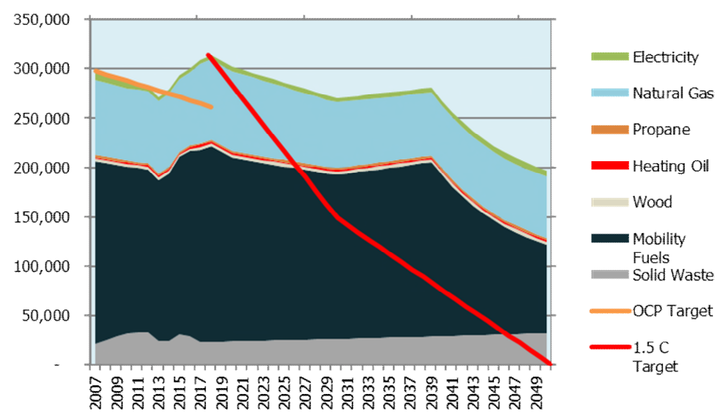
In 2017, the last year with a mainly complete inventory for the whole community:

- Energy consumption is estimated at 6,219,942 GJ
- GHG emissions are estimated 309,407 tonnes of CO_2e
- Energy expenditures are estimated at $167,205,092

How this splits by fuels is shown in the adjacent figure.



Inventory data from 2007 to 2018 was collected, with BAU projections through to 2050. These are shown in the adjacent figure, split by fuel, and compared to the current OCP target (12% below 2007 levels by 2018), and 1.5°C targets (45% reduction from 2010 levels by 2030, 100% reduction by 2050).



From 2007 to 2018, Vernon's emissions rose by 5%, due mostly to increases in mobility fuel and natural gas usage. This indicates that there is significant work necessary if the City wishes to meet the 1.5°C 2030 target.

The next step will be to develop specific actions to meet these sectoral targets, in order to meet the overall GHG targets.

Introduction

This short document describes inventory data from 2007 to 2018 for the City of Vernon, and Business As Usual (BAU) projections through to 2050. It has been created to help the City with understanding its current energy and emissions situation, in light of the interest by the Climate Action Advisory Committee for Vernon to meet community GHG reduction targets congruent with the IPCC's recent 1.5°C report.

Current Energy Consumption & Emissions

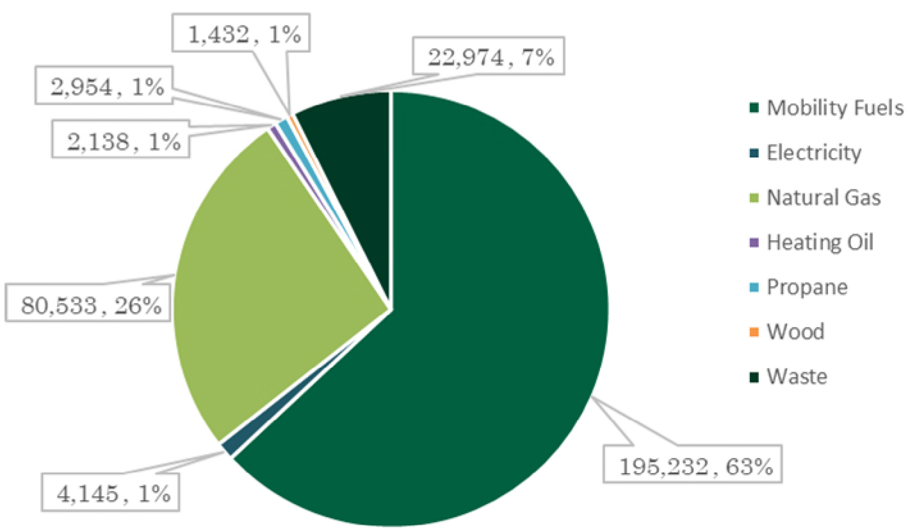
Inventory data was collected from 2007 to 2018, but the most recent inventory year that is almost fully complete is 2017, so that is used to describe Vernon's current energy consumption and emissions.

In 2017:

- Energy consumption is estimated at 6,219,942 GJ
- GHG emissions are estimated at 309,407 tonnes of CO_2e
- Energy expenditures are estimated at $167,205,092

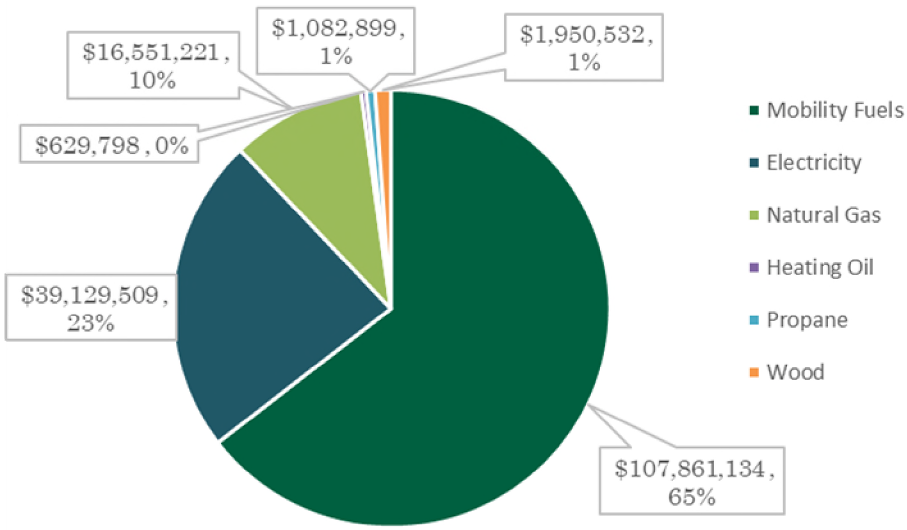
GHG emissions split by fuels and waste are shown in Figure **1**. The vast majority of emissions are due to mobility fuels (gasoline & diesel), and natural gas. Waste contributes a small proportion, while electricity, heating oil, propane, and wood are almost negligible.

FIGURE 11 – GHG EMISSIONS BY FUELS AND WASTE IN 2017



Estimated energy expenditures by fuel are shown in Figure **2**. Mobility fuels and electricity are the two largest, but natural gas is also significant. It is interesting that although electricity has very low GHG emissions, due to the amount of money spent on it, consumption of it should also be tackled in order to manage community energy expenditures. Electricity produces very few GHGs per unit of energy, but is quite an expensive fuel.

FIGURE 12 – ENERGY EXPENDITURES BY FUEL IN 2017, %



The following two figures conveniently show the proportion of energy consumption, emissions, and estimated energy expenditures all together. The first figure shows the split between fuels and waste, the second by sector.

FIGURE 13 – PROPORTION OF ENERGY, EMISSIONS, AND COST BY FUELS AND WASTE IN 2017, %

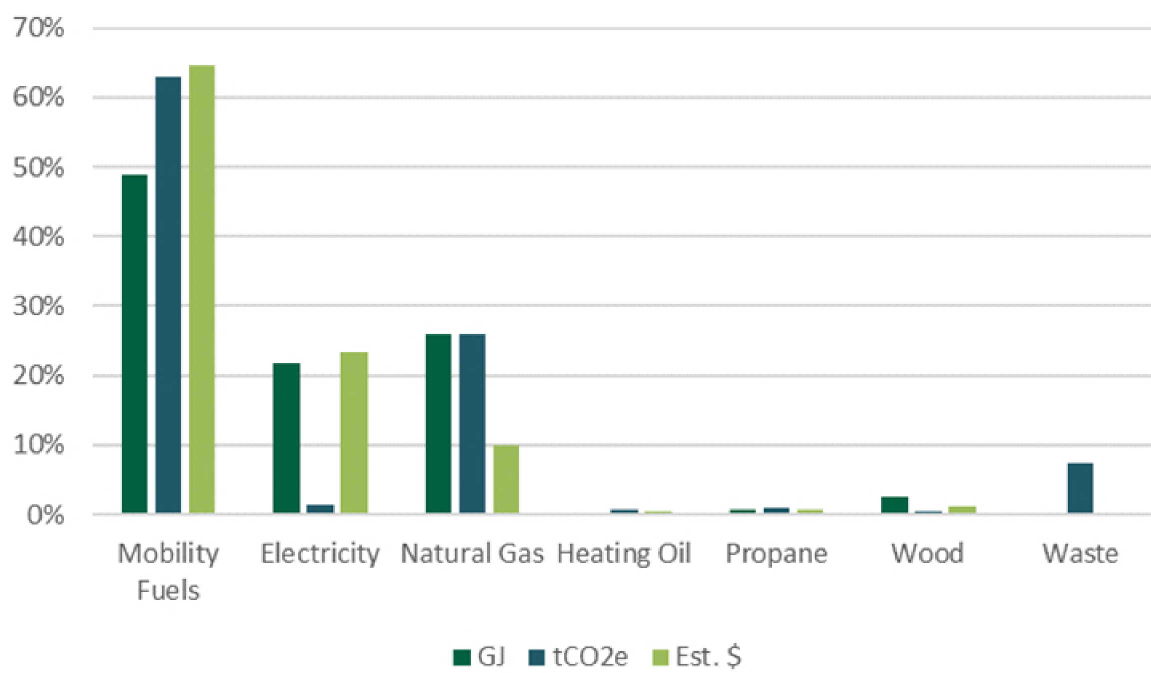
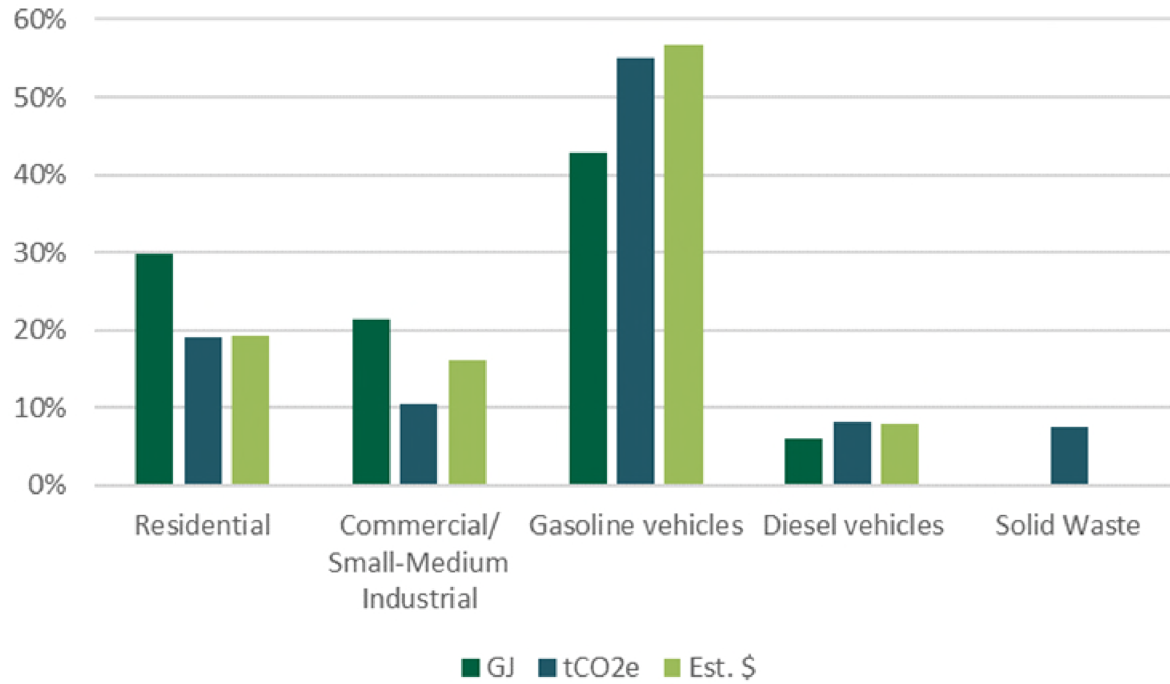


FIGURE 14 – PROPORTION OF ENERGY, EMISSIONS, AND COST BY SECTOR IN 2017, %



All sectors should be tackled, although emissions from waste contribute the lowest among sectors.

Trends and Forecast

Inventory data from 2007 to 2018 is shown in this section, with Business As Usual (BAU) projections through to 2050.

Figure 15 shows the BAU projections compared to the current OCP target, and emissions targets that would be congruent with meeting 1.5°C. In the OCP, the City decided to try to meet a GHG reduction target of 12% below 2007 levels by 2018. The City has not met this target. Radical action is necessary to meet the 1.5°C aligned reduction target of carbon neutrality by 2050.

These emission numbers and targets are also represented in Table 3.

1.5°C targets

From the IPCC's report, community GHG emission reduction targets congruent with meeting 1.5°C are, from 2010 levels:

- 45% reduction by 2030
- 100% reduction by 2050

FIGURE 15 – INVENTORY AND BAU PROJECTIONS, IN RELATION TO THE CURRENT OCP GHG EMISSION REDUCTION TARGET, AND 1.5°C TARGETS

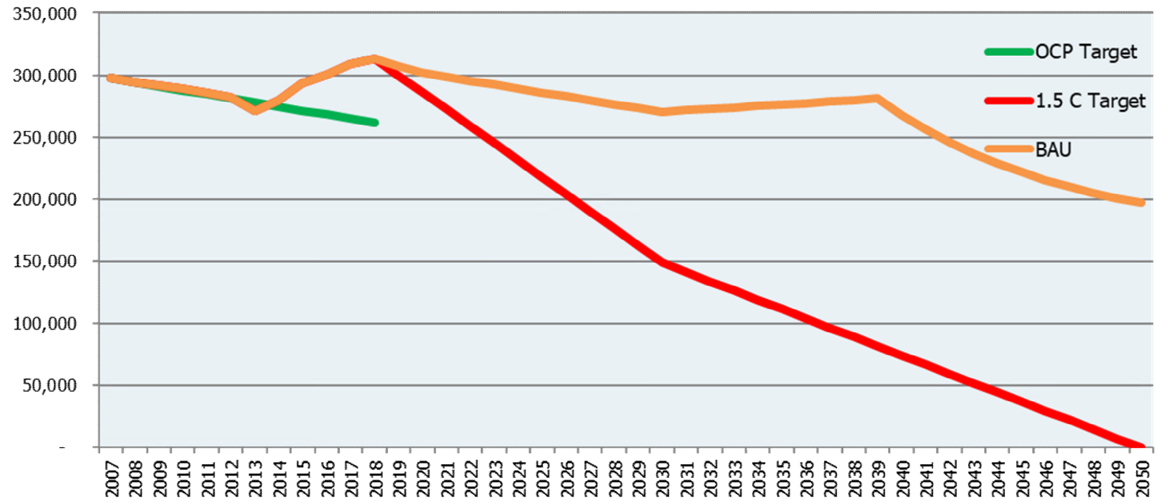


TABLE 3 – EMISSIONS AND TARGETS

	2007	2010	2019	2030	2050
Inventory & BAU estimate	297,682	289,309	307,707	270,785	197,006
OCP target trajectory	297,682	287,939	n/a	n/a	n/a
1.5°C target trajectory	297,682	289,309	300,092	148,932	0

From 2007 to 2018, Vernon's emissions increased by 5%, which indicates the need for significant change. If the City wishes to meet the stringent targets that are congruent with meeting 1.5°C, then highly impactful actions will need to be adopted quickly.

Figure 16 and Figure 17 are similar to Figure 15, but they show exactly where emission reductions have fluctuated historically, will change in a BAU scenario, and where reductions will need to be made to meet the 1.5°C targets.

FIGURE 16 – INVENTORY AND BAU PROJECTIONS SPLIT BY FUELS & WASTE, WITH OCP AND 1.5°C TARGETS

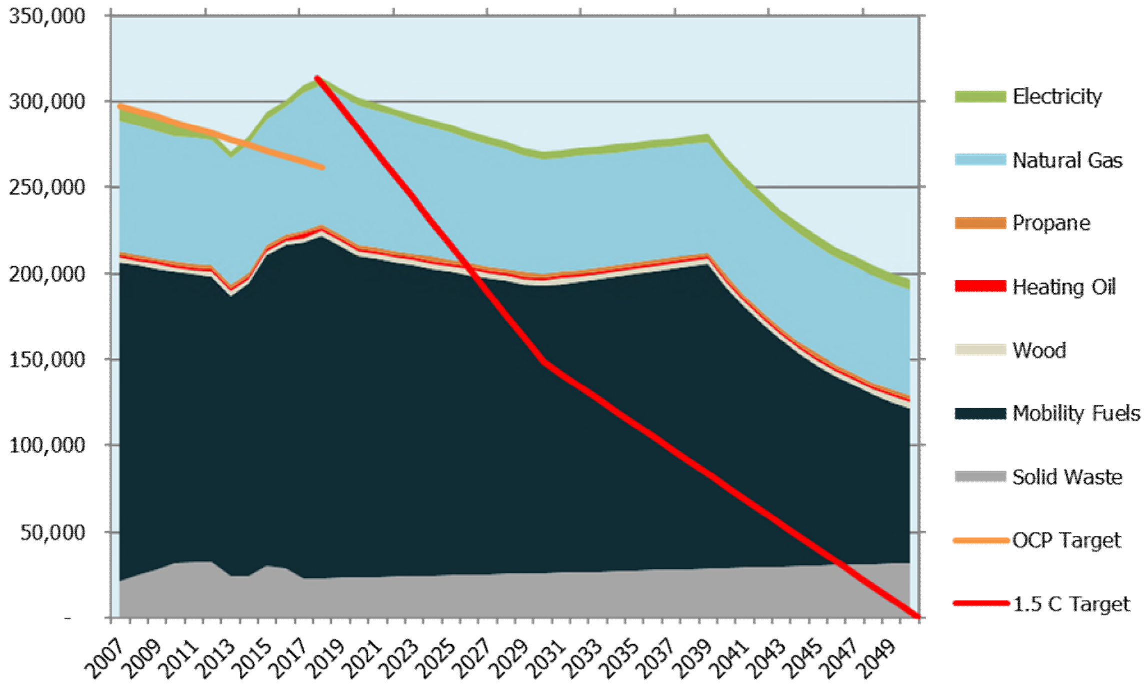
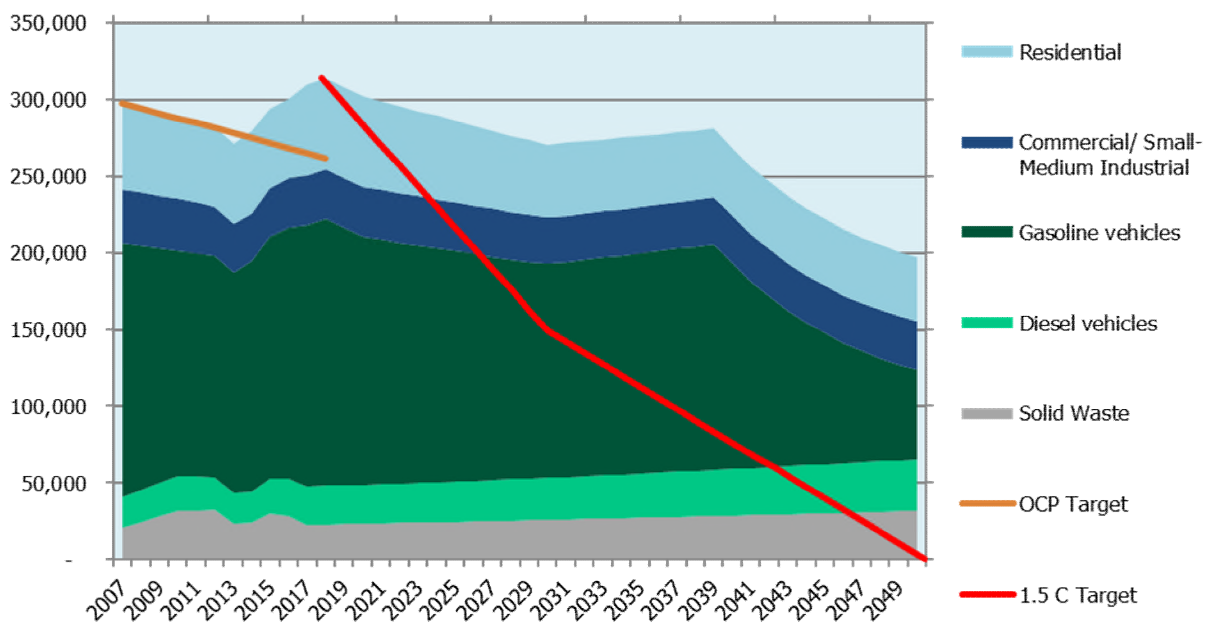


FIGURE 17 – INVENTORY AND BAU PROJECTIONS SPLIT BY SECTOR, WITH OCP AND 1.5°C TARGETS



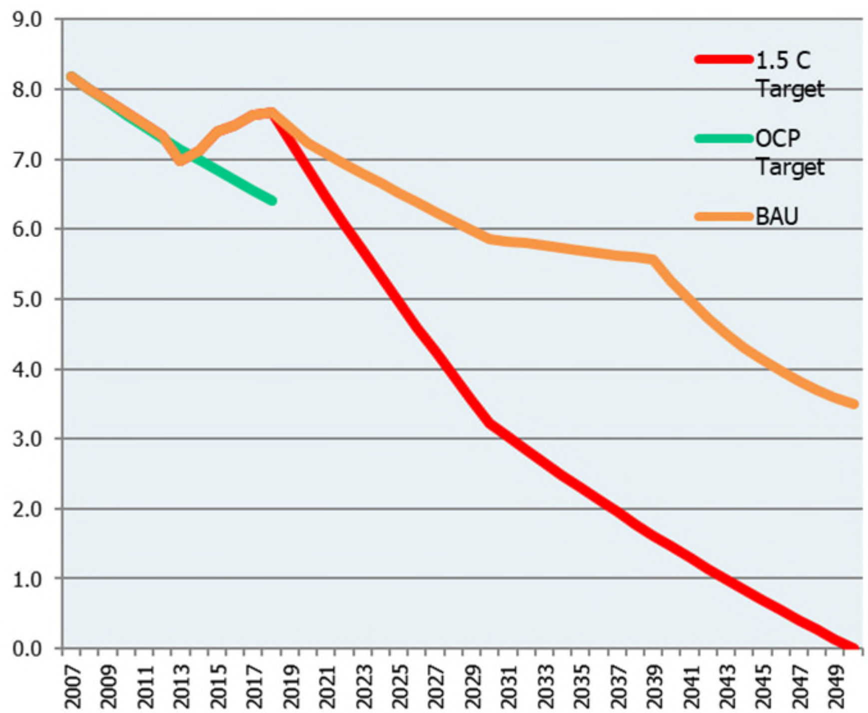
From 2007 to 2018, emissions have primarily fluctuated with gasoline fuel usage. This is likely due to fluctuations in economic activity. Residential natural gas emissions remained consistent until 2017, where it saw a 10% increase. Waste emissions have remained relatively consistent, albeit starting from a low base.

Projecting forwards, in a BAU scenario it is believed that emissions from passenger vehicles will decrease because of vehicle electrification, and residential emissions will continue to slowly decrease.

Despite this progress, to meet the 2030 targets natural gas and mobility fuels will need to be tackled for the residential, commercial / small-medium industrial, and vehicle sectors. For 2050 targets, all sectors will need to be tackled.

Given Vernon's considerable population growth (2007: 36,403; 2018: 40,930; 2050 projection: 56,457), it is worth also reflecting on per capita emissions. A growing population makes it more challenging to reduce absolute GHG emissions, as each additional person requires energy for their daily needs. Per capita emissions and targets are shown in Figure 18.

FIGURE 18 – PER CAPITA INVENTORY AND BAU PROJECTIONS, IN RELATION TO THE CURRENT OCP GHG EMISSION REDUCTION TARGET, AND 1.5°C TARGETS



Per capita:

- Vernon's GHG emissions decreased by 6% from 2007 to 2018.
- The 1.5°C 2030 target would be a 61% decrease from 2007 levels

From a per capita perspective, it is clear that Vernon has made some progress in reducing its GHG emissions. However, even in this context the 1.5°C targets continue to be challenging to meet.

Appendix 1 – Methodology & Assumptions

This appendix contains details on the methodology and assumptions for creating the community energy & emissions inventories and projections for Vernon.

Inventories

Vernon's inventories were created using data for electricity, natural gas, heating oil, propane, wood and waste obtained from the Province of BC, and data on gasoline and diesel sales from Vernon gas stations obtained from Kent Group. Based on the data compiled, full inventory years are: 2007, 2010, 2012, 2014, 2015, 2016, and 2017. Partial inventory information was also obtained for 2013 and 2018, which was also factored in to the model.

Emissions factors for inventory years are shown in the following table, and are sourced from the Province of BC.

TABLE 4 – EMISSIONS FACTORS USED FOR INVENTORY YEARS

GHG/GJ, by Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Gasoline Vehicles	0.068	0.067	0.066	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Diesel Vehicles	0.070	0.070	0.069	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
Mobility fuels	0.068	0.067	0.066	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.064
Electricity	0.007	0.007	0.007	0.007	0.005	0.004	0.003	0.003	0.003	0.003	0.003
Natural gas	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Wood	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.014
Heating oil	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.141
Propane	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.039

Some of the emission factors have changed over time. The emission factors for mobility fuels have decreased as a result of the Renewable and Low Carbon Fuel Requirements Regulation. The emissions factor for electricity has decreased as a result of ongoing efforts to decarbonise the BC Hydro electricity grid.

The buildings and waste data sources have been the Province of BC's Community Energy & Emissions Inventory (CEEI) data,[1] and utilities and landfill waste data at the utility level.[2]

Assumptions made with respect to the inventories are as follows:

- The Province of BC made a series of standard assumptions in the creation of the CEEI data, which are outlined on the CEEI webpage: https://www2.gov.bc.ca/gov/content/environment/climate-change/data/ceei. The CEEI inventory years in the preceding charts are 2007 and 2010.
- The Province of BC made other assumptions for the the other buildings and landfill waste emissions information after 2012, which are outlined in the community level spreadsheets on the Provincial Inventory webpage: https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory
- In creating the inventories, CEA made other assumptions in addition to these:

[1] https://www2.gov.bc.ca/gov/content/environment/climate-change/data/ceei
[2] https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory

- For all years of fuel data (2007-2018), Kent Group data was used as described below. This is because the most recent year that the Province provided transportation data for Vernon was 2010.
- Though FortisBC gas data was included with the new Provincial inventory up to 2017, only residential numbers were incorporated for all years, with commercial/industrial data only incorporated up to 2010, as commercial/industrial data for 2012 and beyond included large industrial. FortisBC commercial/industrial gas data post-2012 is therefore prorated with population growth. It has been decided not to include large industrial gas consumption for two reasons. Firstly, BC Hydro does not provide large industrial electricity consumption, and so this component of the inventory would be incomplete. Secondly, the City has no control over the emissions from the plant whatsoever.

Fuel data was derived through Kent Group fuel sales data for the City of Vernon for 2007-2018. The fuel sales approach to estimating transportation energy consumption and emissions is different to the one that the Province has taken with CEEI before. It will include tourism and through-traffic, while the Province's approach would have only included vehicles registered in the community. For a discussion on the pros and cons of the different approaches see 'Assessing vehicular GHG emissions, a comparison of theoretical measures and technical approaches' by Pacific Analytics[3].

In addition to these methodological challenges, a major drawback is fuel sales through card lock stations are not included with the data. This means that many commercial diesel vehicles are excluded. Based on a previous release of the CEEI data, and making assumptions based on population growth, commercial card lock vehicles may have accounted for 48,500 tonnes in 2012. If that is approximately accurate, then that would constitute a considerable omission as Vernon's 2012 GHG emissions are estimated at 282,000 tonnes of CO_2e excluding most commercial vehicles. 48,500 tonnes would be about 17% of this.

Emissions from Land Use, Land Use Change, and Forestry are not included. The Province has only provided these for Vernon for 2012.

Projections

As previously described, there are full or partial inventory years that describe the community's emissions profile from 2007-2018. From 2019 onwards, all of the data is an estimate as a BAU projection.

The assumption is that energy consumption and emissions will increase proportionally with increases to population, although the impact of policies from higher levels of government are also incorporated, and other assumptions. Only policies that have already been adopted (or are likely to) and that will have quantifiable impacts are incorporated. Assumptions are:

- The Province's incremental steps to net zero energy ready buildings by 2032.
- Tailpipe emissions standards.
- Renewable & low carbon transportation fuel standards.

[3] See: https://www2.gov.bc.ca/assets/gov/environment/climate-change/z-orphaned/ceei/ceei-comparison-study.pdf

- An average annual decrease of 1.228% in natural gas consumption per residential connection is included, as FortisBC does in its planning.
- The CleanBC target for Renewable Natural Gas in natural gas, of 15% by 2030.
- The Province's CleanBC Plan zero emission vehicle mandate of 100% of new vehicles by 2040, and increases up to that point.
- How the impacts of a changing climate will affect building energy consumption.

The final assumption had the following methodology:

- Climate change data for the region was obtained from ClimateData.ca.
- Projected global emissions to 2030 currently places the world in the range for the IPCC's Fifth Assessment Report's Representative Concentration Pathway (RCP) 6.0 scenario.
- RCP 6.0 scenario not available on ClimateData.ca, therefore RCP 4.5 (median values) used as a proxy. This is a more conservative scenario.
- Decreases in residential and commercial natural gas consumption are assumed to be proportional to decreases in Heating Degree Days (HDD's) and the proportions of natural gas consumed for space heating for each sector, with this data obtained from the Navigant 2017 Conservation Potential Review for FortisBC Gas.
- Decreases in residential and commercial electricity consumption assumed to be proportional to decreases in HDD's and the proportions of electricity consumed for space heating for each sector. However, for residential this is partially offset by, and for commercial more than offset by the proportions of electricity consumed for space cooling by each sector and how this will increase proportional to projected increases to Cooling Degree Days (CDD's). These proportions were obtained from the Navigant 2016 Conservation Potential Review for BC Hydro.