



CITY OF BEND



2016 COMMUNITY GREENHOUSE GAS INVENTORY

PREPARED BY GOOD COMPANY
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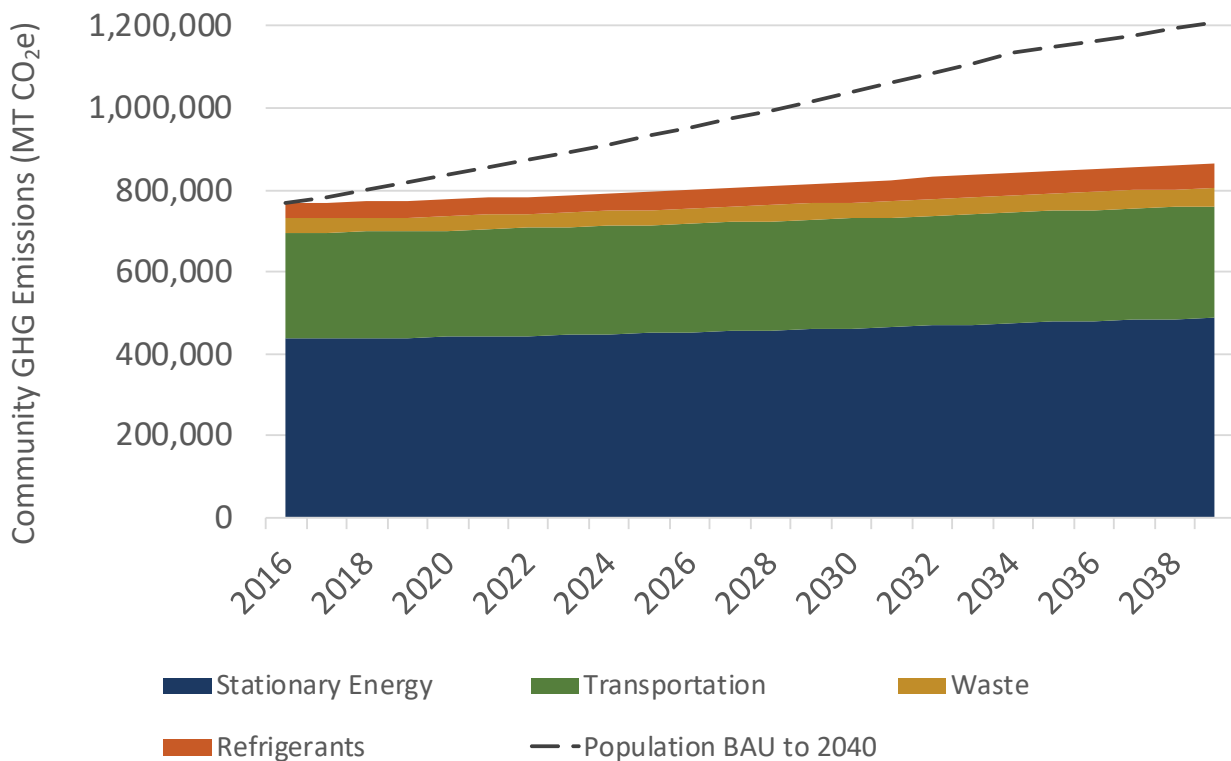
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I. EXECUTIVE SUMMARY

The City of Bend conducted a Community Greenhouse Gas (GHG) Inventory to better understand local sources of GHG emissions to inform development of a Community Climate Action Plan (C-CAP) and to establish a community emissions tracking system to measure progress as the C-CAP is implemented. The inventory follows internationally recognized community GHG inventory protocol and accounts for all significant sources of GHG emissions driven by activities taking place within the City's geographic boundaries.

- Bend's largest sources of local sector-based emissions include residential and commercial energy use by buildings (57% of total) and residential on-road transport (27%). For buildings electricity is the largest source of emissions (58%); followed by natural gas (40%); and other fuels (2%). Smaller local sources of emissions include refrigerant loss from buildings and vehicles (6%) and landfilled waste disposal (4%). See stacked areas on Figure 1.
- Figure 1 also forecasts Bend's community emissions. The dotted grey line shows 2016 emissions rates with projected community population growth to 2040. The stacked, colored areas show the emissions benefit of existing State and Federal policies. As can be seen these policies reduce emissions by 28% compared to the population BAU.
- Even with existing climate policies, Bend's emissions will grow 13% by 2040, which highlights the need for additional local, regional, state, and federal climate action.
- Beyond sector-based emissions, the inventory also considers emissions from production of household consumption of imported goods, food, and energy products (not shown on Figure 1). When included, these emissions more than double community emissions. The largest sources include consumption of meat, clothing, furniture, and upstream energy production. See Figure 4 for details.

Figure 1: Bend's FY2016 community emissions, by sector, and existing policy forecast to 2040



* Electricity emissions calculated using location-based method

II. INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC), the United Nations body that regularly convenes climate scientists, has identified human activity as the primary cause of the climate change that has occurred over the past few decades and quickened in recent years. Consensus statements from the IPCC suggest that human-caused greenhouse gas emissions (GHG) must be reduced significantly – perhaps more than 50% globally, and by 90% in wealthier nations that are the largest emitters – by mid-century in order to avoid the worst potential climate impacts on human economies and societies that have been projected. The common international goal often referenced, to mitigate the worst climate impacts, is to limit global average temperature increases to no more than 2°C relative to temperatures at the start of the industrial revolution. As of 2018 – we’ve already passed the halfway point – average temperatures have increased by more than 1°C since the industrial revolution.

It’s with this understanding and urgency that the City of Bend conducted this community greenhouse gas (GHG) inventory. A GHG inventory quantifies the GHG emissions associated with a specific boundary – such as the geographic boundary of a community or operational control within an organization – for a specific period of time such as a fiscal or calendar year. This report summarizes the results of Bend 2016 Community Greenhouse Gas (GHG) Emissions Inventory. A community emissions inventory considers many sources of emissions generated by the activities of residents, businesses, and government operations within Bend’s UGB, including:

Stationary Energy use by residential, commercial, and industrial buildings and facilities represents a large source of community emissions. These emissions come from “tailpipes” during combustion of natural gas and fuels to generate electricity for use in Bend.

Transportation Energy, and particularly on-road vehicle transportation, of passengers and freight also represents a large fraction of community emissions. Like stationary energy, transportation emissions are generated at the tailpipe as well as upstream during production of fuels.

Fugitive Emissions of refrigerants are lost from transportation and building cooling systems. Refrigerants are powerful global warming gases. Therefore, relatively small losses have a large climate impact. Likewise, a fraction of natural gas is lost during local distribution.

Waste disposal in landfills and wastewater treatment produces methane, most of which is collected and used for energy, but a fraction leaks out to the atmosphere having a negative climate impact.

Household Consumption emissions that are generated outside of the community during the production of goods, food, energy and services that are consumed by residents of Bend. These emissions are large in scale but are more difficult to accurately measure over time compared to other sources of emissions included in the inventory.

Upstream Energy Production produces emissions from the energy used to extract and process raw materials into energy products as well as from the process emissions created during extraction. These emissions are in addition to the “tailpipe” emissions described above for the Stationary and Transportation Energy.

The 2016 inventory will be used to inform development of Bend’s Community Climate Action Plan (C-CAP) and will be updated periodically to track community progress towards community goals. This report also provides a 2040 Business-As-Usual (BAU) Emissions Forecast, which estimates future emissions based on population growth as well as emissions considering the future benefits of existing state and federal policy and programs to inform the scale of additional actions required to meet community goals.

III. INVENTORY BOUNDARIES

Bend's inventory follows Greenhouse Gas Protocol's *Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)*.¹ The GPC is focused on Sector-based Emissions. Bend's inventory also includes an estimate of the emissions embodied in local consumption of fuels, consumer goods, construction materials, and food.

The first step in any GHG inventory is setting the inventory boundary. The boundary includes defining the geographic area, time span, emissions sources and gases covered in the inventory. Bend's inventory collected fiscal year 2015-16 data for Bend's urban growth boundary (UGB). The inventory accounted for all seven Kyoto gases, but only four were relevant: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and hydrofluorocarbons (HFC).

Emissions sectors and sub-sectors included in the GPC are shown in Figure 2. These are compared to emissions included in Bend's FY16 inventory and Scope Category. Scope categories distinguish between those emissions that occur within the City's geographic boundaries from those that occur outside the City's boundaries, but that are driven by activity within the boundaries (Scope 2 and Scope 3).

Figure 2: Crosswalk of emission and Scope categories.

Emissions Sector / Sub-Sector	Included in Bend Inventory	Scope 1	Scope 2	Scope 3
Stationary Energy				
<i>Residential Buildings</i>	•	✓	✓	
<i>Commercial Buildings and Facilities</i>	•	✓	✓	
<i>Industrial Facilities</i>	•	✓	✓	
<i>Energy Generation Supplied to the Grid</i>	NE	✓		
<i>Agriculture, Forestry, and Fishing</i>	NO	✓	✓	
<i>Fugitive Emissions from Natural Gas Systems</i>	•	✓		
<i>Fugitive Emissions from Coal Production</i>	NO	✓		
Transportation				
<i>On-Road Passenger and Commercial Vehicles</i>	•	✓	✓	
<i>On-Road Freight Vehicles</i>	•	✓	✓	
<i>On-Road Transit Vehicles</i>	•	✓	✓	
<i>Off-Road Vehicles and Equipment</i>	•	✓	✓	
<i>Aviation</i>	•	✓		
<i>Waterborn Navigation</i>	NO	✓		
Waste				
<i>Solid Waste Generated in City</i>	•			✓
<i>Wastewater Generated in City</i>	•			✓
<i>Biological Treatment of Waste Generated in City</i>	NE			✓
<i>Incineration of Waste Generated in City</i>	NE			✓
Industrial Process and Product Use				
<i>Product Use (refrigerants)</i>	•	✓		
<i>Industrial Processes</i>	NO	✓		
Agriculture, Forestry, and Land Use				
<i>Livestock</i>	NO	✓		
<i>Land</i>	NE	✓		
<i>Other Agriculture</i>	NO	✓		
Other Scope 3 Emissions Sources				
<i>Household Consumption</i>	•			✓
<i>Upstream Energy Production</i>	•			✓
NE = Emissions occur but are not reported or estimated - see justification in exclusions NO = Activity or process does not occur within City				

Scope 1	GHG emissions from sources located within the city boundary.
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity within the City's geographic boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking places within the City's geographic boundary

¹ GPC has become the recommended or required standard for international reporting to Carbon Disclosure Project's Cities Survey and the Global Covenant of Mayors for Climate & Energy. While Bend does not currently participate in these endeavors currently – Bend's inventory has been conducted to allow for adoption in the future. GPC may be downloaded at <https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities>.

IV. INVENTORY RESULTS

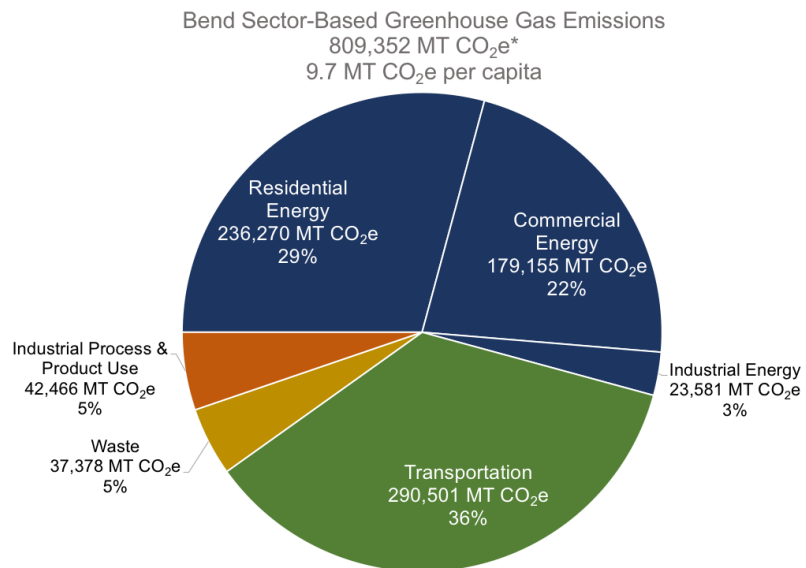
SECTOR-BASED EMISSIONS

The Bend community generated 809,352 MT CO₂e of local, sector-based emissions. For sense of scale, this quantity of emissions is equivalent to the carbon sequestered annually by over 1 million acres of average U.S. forest – a land area about 50 times the size of the City of Bend.

Bend's sector-based emissions² are similar in many ways to other communities around Oregon. These emissions are shown in Figure 3 and come primarily from combustion of natural gas and electricity use in buildings (blue segments) as well as gasoline and diesel combustion in vehicles to transport people and goods (green segment). Emissions from waste include landfill disposal of community solid waste and wastewater treatment (yellow). Emissions from local product use include refrigerant gas loss from buildings and vehicles and natural gas loss from the local distribution system (orange).

Figure 3: Bend's FY16 Sector-Based GHG Emissions

Note Figure 3 presents location-based emissions for electricity. Market-based emissions details are included in Figure 5 and Figure 7*



HOUSEHOLD CONSUMPTION AND UPSTREAM ENERGY EMISSIONS

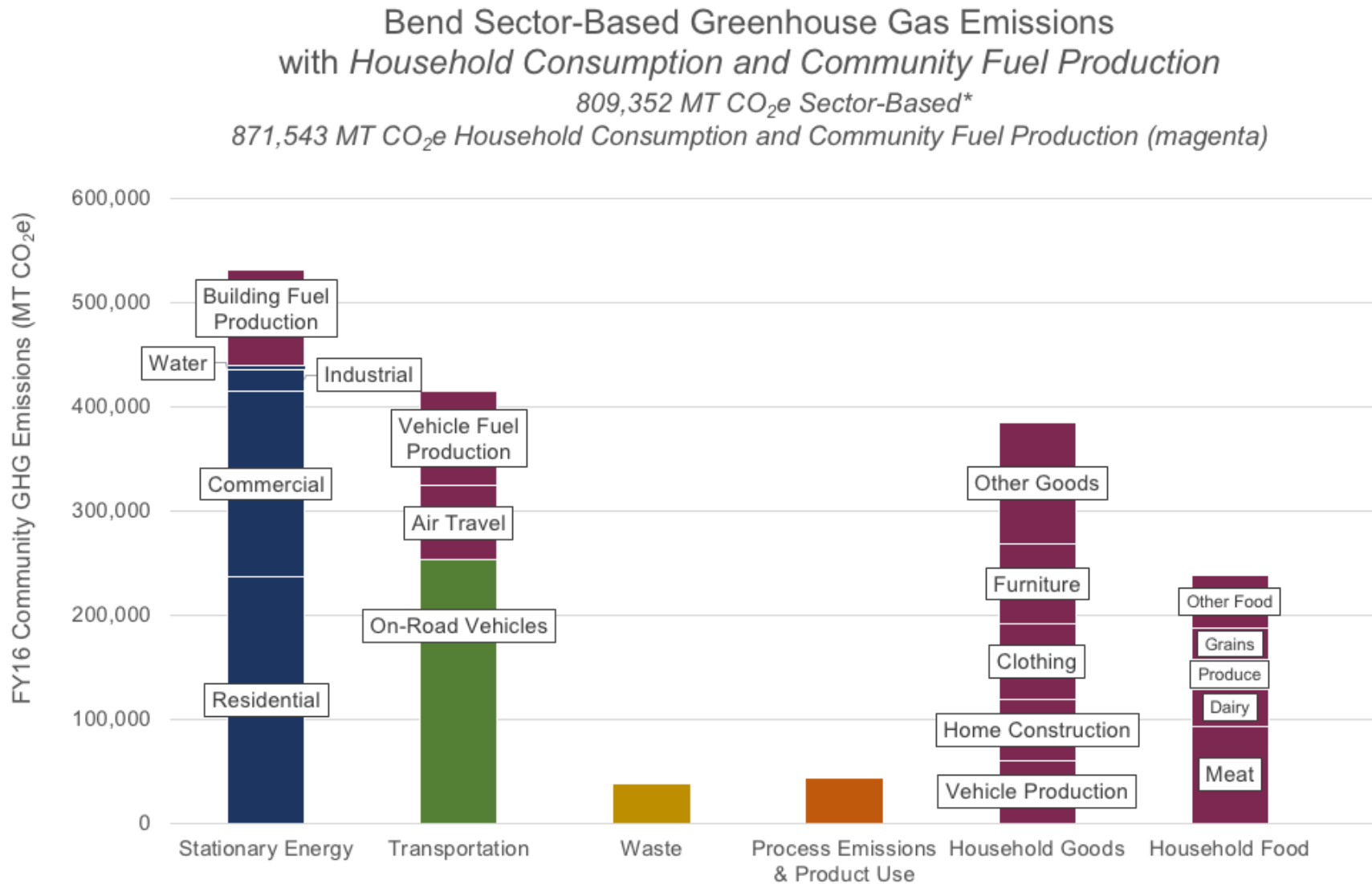
In addition to accounting for sector-based emissions, Bend's Community GHG Inventory also considers emissions that are generated outside of the community during the production of goods, food, energy and services that are consumed by residents of Bend. These emissions total 871,543 MT CO₂e. Figure 4 compares the scale of sector-based emissions versus emissions from household consumption and upstream fuels production³. ***The scale of the emissions from household consumption is almost equal to sector-based emissions generated locally, which supports the need to address these emissions during the community climate action planning process.***

Households consumption of imported goods, food, and services is a significant source of community emissions. Within this category, emissions from the production of meat, furniture, clothing, and vehicles; home construction; and services consumed by Bend residents that are produced outside of the City, such as health care and education. While household consumption represents a significant source of emissions, these emissions are imported and therefore the community has less control over the energy sources and efficiency of production. That said – the community does control demand for various types of products which presents mitigation opportunities.

² Sector-based emissions inventories (or in-geographic boundary inventories) include local emissions, within the City's boundaries, from energy use by homes, businesses, and vehicles as well as emissions from landfilling solid waste and wastewater treatment.

³ Sector-based emissions account for "tailpipe" emissions from the combustion of fuels. There are also "upstream" emissions that account for the energy and process emissions during extraction and refinement of fuels.

Figure 4: Detailed summary of sector-based emissions and comparison to emissions from household consumption and fuel production.



Note* Figure 3 presents location-based emissions for electricity. Market-based emissions details are included in Figure 5 and Figure 7

Note2: Other Goods include electronics, toys, personal care products, cleaning products, printed reading materials, paper, office supplies, and medical supplies.

Figure 5: Summary Table of Bend 2016 Community Emissions

*See page 9 for a discussion of location-based and market-based electricity emissions

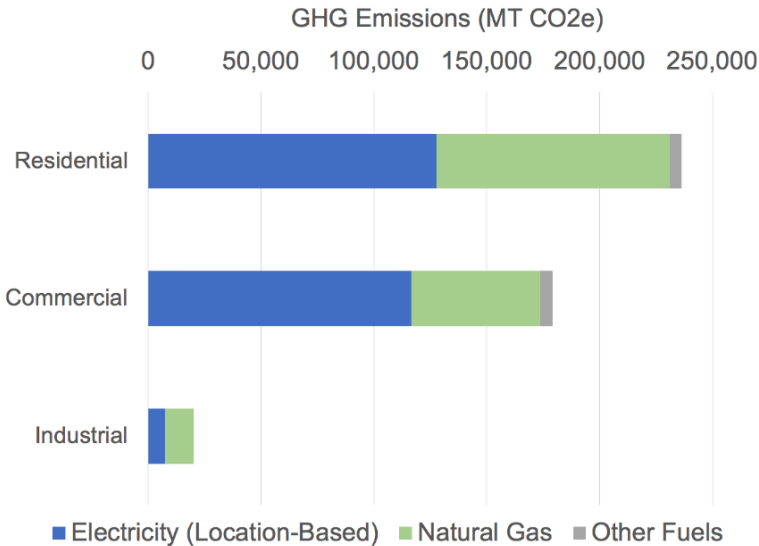
Emissions Sector / Sub-Sector	FY 16 GHG Emissions (MT CO ₂ e)	Notes
Stationary Energy	439,007	
<i>Residential Buildings</i>		
Electricity (Location-Based)	127,711	Based on carbon intensity (CI) of regional electric grid
Electricity (Market-Based)	199,669	Based on CI for local utilities and customer purchase of green energy
Natural Gas	103,347	
Other Fuels	5,212	Includes propane and fuel oil use
<i>Commercial Buildings and Facilities</i>		
Electricity (Location-Based)	116,608	Based on carbon intensity (CI) of regional electric grid
Electricity (Market-Based)	204,511	Based on CI for local utilities and customer purchase of green energy
Natural Gas	57,229	
Other Fuels	5,318	Includes propane and fuel oil use
<i>Industrial Facilities</i>		
Electricity (Location-Based)	7,603	Based on carbon intensity (CI) of regional electric grid
Electricity (Market-Based)	16,115	Based on CI for local utilities and customer purchase of green energy
Natural Gas	12,784	
Other Fuels	NE	
Water (energy)	3,195	
Transportation	290,501	
Passenger Travel	212,380	Includes passenger cars and light trucks
Off Road	32,587	
Commercial Services	20,967	
Truck Freight	18,201	
Rail Freight	158	
Transit	734	
Bend Airport	5,474	Local airport emissions only. See Other Scope 3 for other Air Travel
Waste	37,378	
Solid Waste Generated in City	32,200	
Wastewater Generated in City	4,056	Process emissions only - energy use included in Stationary
Biological Treatment of Waste	1,122	
Industrial Process and Product Use	42,466	
Product Use (refrigerants)	36,810	
Fugitive Emissions from Natural Gas Systems	5,656	
Agriculture, Forestry, and Land Use	0	
Livestock	0	
Land	NE	
Other Agriculture	0	
Other Scope 3 Emissions Sources	871,543	
<i>Household Consumption</i>		
Goods	384,726	Includes production emissions for imported construction materials, clothing, furniture, vehicles, and other goods
Food	238,476	
Services - Air Travel	66,240	Air travel by Bend residents that originates at airports outside of Bend
<i>Upstream Energy Production</i>		
Transportation Fuels	90,323	
Natural Gas	42,948	
Electricity	48,830	
GPC Emissions (location-based electric)	809,352	
Per Capita	9.7	
GPC Emissions (market-based electric)	977,725	
Per Capita	11.7	
GPC (location-based) + Other Scope 3	1,680,895	
Per Capita	20.1	
GPC (market-based) + Other Scope 3	1,849,267.9	
Per Capita	22.1	
NE = Emissions occur but are not reported or estimated - see justification in exclusions		
NO = Activity or process does not occur within City		

DETAILED RESULTS FOR SIGNIFICANT EMISSIONS

Stationary Energy

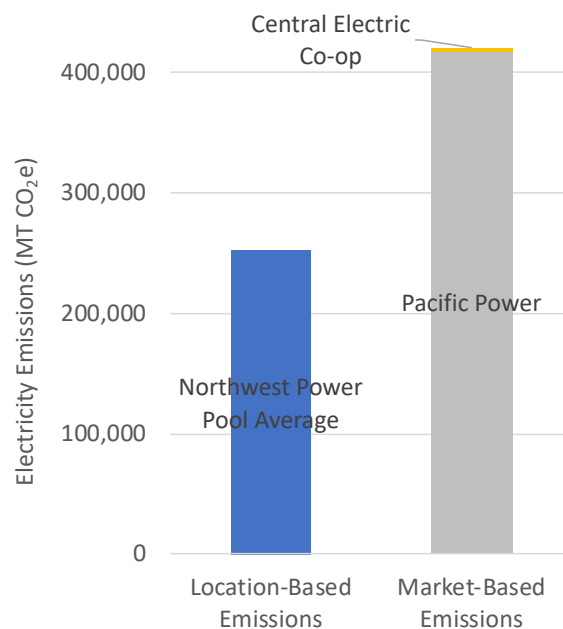
Electricity and natural gas use by the residential and commercial sectors are the largest GPC emissions. Bend residents' homes have a larger impact than their commercial business. Industrial energy is small by comparison. By energy type, electricity had the largest impact (58% of total building energy); followed by natural gas (40%); and other fuels (2%). Figure 6 shows stationary energy emissions broken down by sub-sector and energy type.

Figure 6: Comparison of stationary energy use, by sub-sector and energy type.



GPC requires that communities' report electricity emissions using the location-based method (blue bar on Figure 7). **Location-based emissions** are calculated using the regional electricity grid's GHG intensity and represent the average impacts of electricity use and efficiency efforts. GPC also recommends that communities calculate **Market-based emissions** which are based on the GHG intensity of electricity contracts with local utilities. Bend's market-based emissions are much larger than the location-based. Pacific Power's electricity generation from coal in 2016 is the major driver. Conversely, CEC represents a very small fraction of market-based emissions as its contracts with Bonneville Power Administration are largely served by low-GHG hydroelectric and nuclear power. The market-based method also accounts for community participation in utility green power programs. In 2016, Pacific Power's customers voluntarily purchased 10% zero GHG renewable electricity which decreases Bend's market-based emissions.

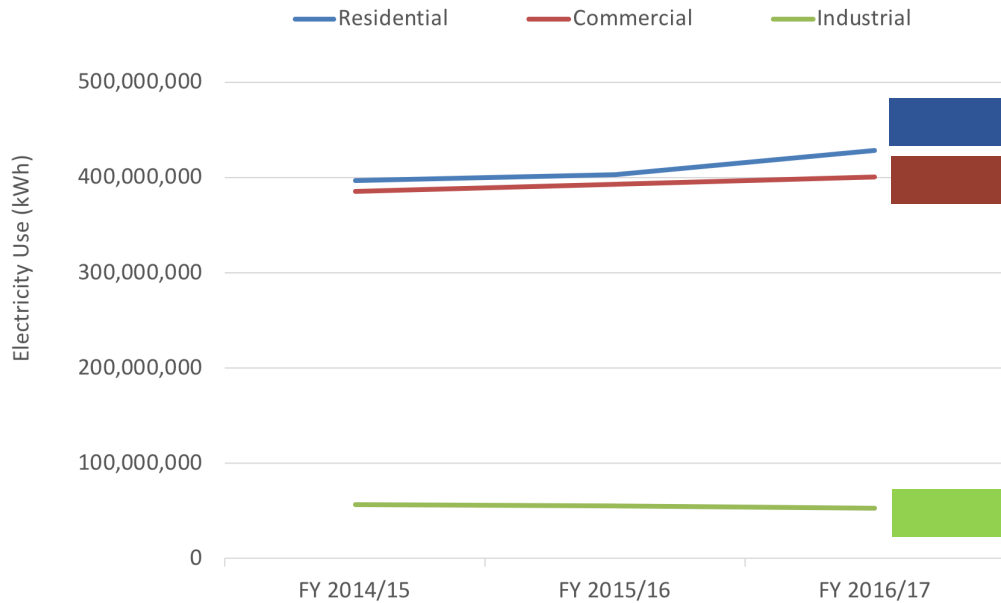
Figure 7: Comparison of location-based and market-based electricity emissions



Total community electricity use increased by 5% between FY15 and FY17, with residential sector use increasing by 7.9% during the period and

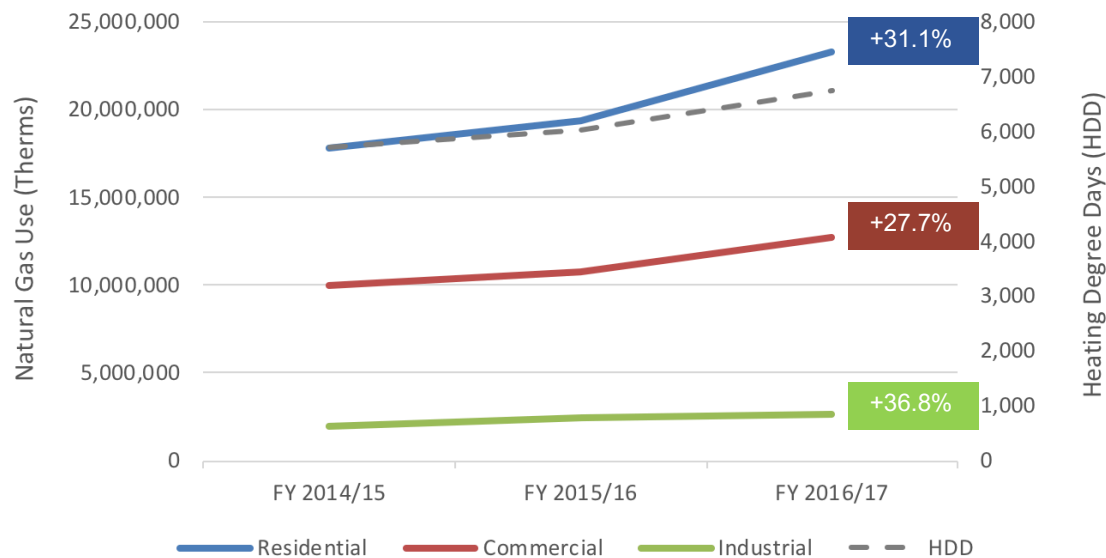
commercial sector use increasing by 3.7% (see Figure 8). Industrial electricity use decreased by 6.8% between FY15 and FY17.

Figure 8: Bend electricity use (in MWh), by sector. Percent (%) change, FY15-FY17.



Total community natural gas use increased by 30% between FY15 and FY17, with residential sector use increasing by 31.1% during the period; commercial sector use increasing by 27.7%; and industrial use increasing by 36.8% between FY15 and FY17 (see Figure 9). There are two suspected drivers for the overall increase in stationary energy use: 1) the Bend community population is growing at a pace of 2.2% annually, and 2) the winter of FY17 was colder than the previous two years increasing the heating load. This is demonstrated by the increase in heating degree days (Figure 9) which is a measure of the energy needed for space heating.

Figure 9: Bend natural gas use (in therms), by sector. Percent (%) change, FY15-FY17.



Transportation

Local, on-road transportation of passengers is Bend's leading source of transportation-related emissions. See Figure 10. These emissions originate from residential-owned passenger cars and trucks, which primarily use gasoline (E10) and relatively small quantities of diesel (B5). Roughly 2/3 of these emissions are the result of trips inside the City's boundaries, while the remaining 1/3 originate inside the City's boundaries, but have a destination outside the City or the inverse.

The next largest source is air travel by Bend households. While Bend does have a small municipal airport, the majority of these emissions are from Bend residents departing from airports outside of the Bend community. Off road equipment, which is dominated by construction equipment and also includes recreational vehicles, is the next largest category. Commercial service vehicles include local freight, restaurant delivery, and service providers such as electricians, plumbers, etc. Heavy-duty freight vehicles operating within the UGB represent 6% of transportation-related emissions.

Figure 10: Distribution of on-road transport emissions, by vehicle category, as estimated by RSPM.

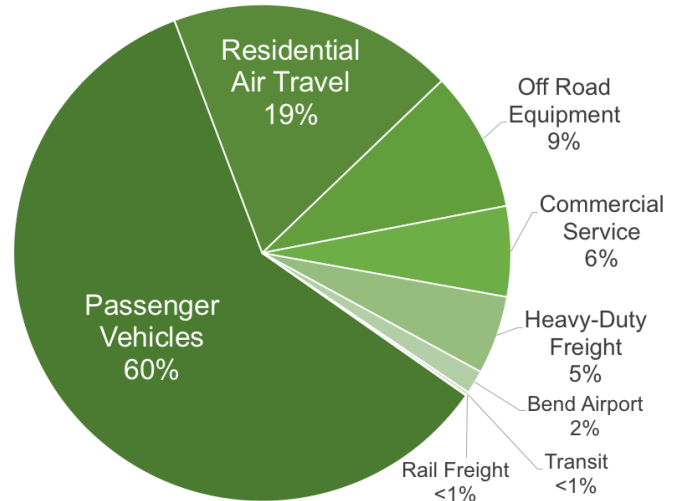
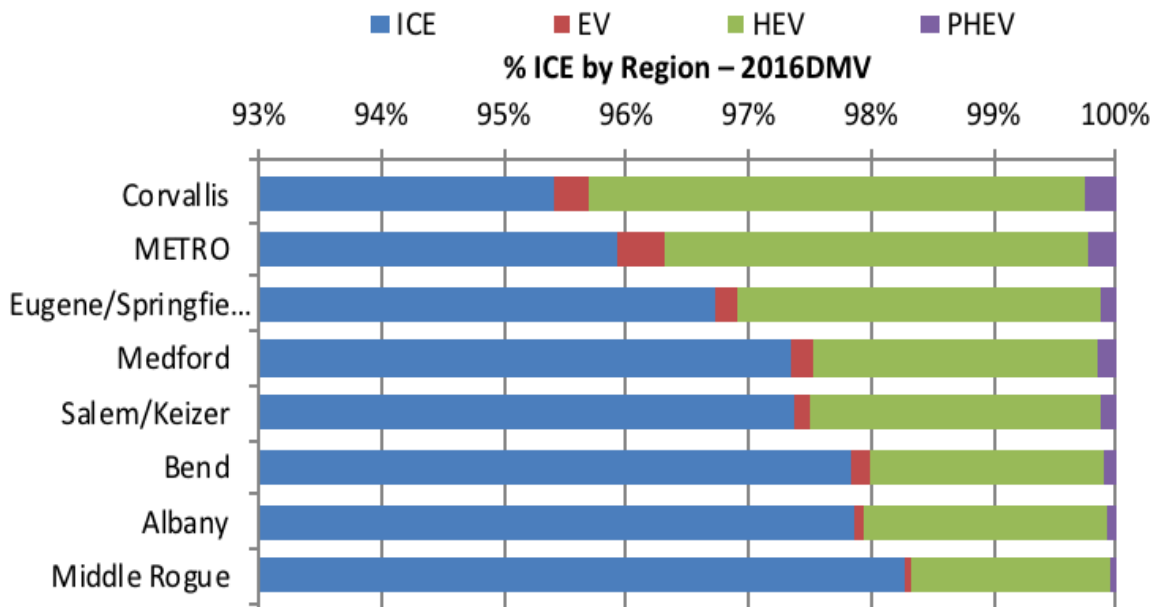


Figure 11 compares 2016 DMV registration data on the % of internal combustion engine vehicles (ICE), which are typically less efficient than electric vehicles (EV), hybrid electric vehicles (HEV), or plug in hybrid EVs (PHEV) for regions around Oregon. This graphic illustrates a climate action opportunity and potential progress metric focused on increasing the fuel efficiency of the community's vehicle fleet. A second important metric going forward is the number of trips diverted from vehicles to bike or walking.

Figure 11: Comparison of fuel-efficient vehicle in Oregon communities.



Other Scope 3 Emissions

Bend's inventory goes beyond GPC requirements to include two known large sources of Other Scope 3 Emissions – household consumption of goods and upstream emissions for production of fuels used by the community. Household consumption of imported goods, food, and services is a significant source of community emissions. These sources of emissions are not currently included in the GPC, due to limitations related to accurately accounting for these emissions over time at the community level.⁴ While these accounting limitations are real, the scale of consumption-based emissions is large enough to warrant inclusion in community climate action plans.

Oregon Department of Environmental Quality (ODEQ) highlighted the importance of consumption-based emissions in the [State of Oregon's Greenhouse Gas Inventory](#). The most recent version of Oregon's inventory (released in May 2018) shows that sector-based emissions are on a downward trend, but that consumption-based emissions have increased by 10% between 2010 and 2015.

Within this category, emissions from the production of imported food, furniture, clothing, vehicles, and home building materials consumed by Bend residents that are produced outside the community. While household consumption represents a significant source of emissions, these emissions are imported and therefore the community has less control over the energy sources and efficiency of production. That said – the community does control demand for various types of products which presents mitigation opportunities. The Scope 3 emissions that are considered in this inventory include:

Household Goods: Emissions from extraction, manufacture, and transportation of raw materials into final products such as construction, automobile, furniture, clothing, and other goods.

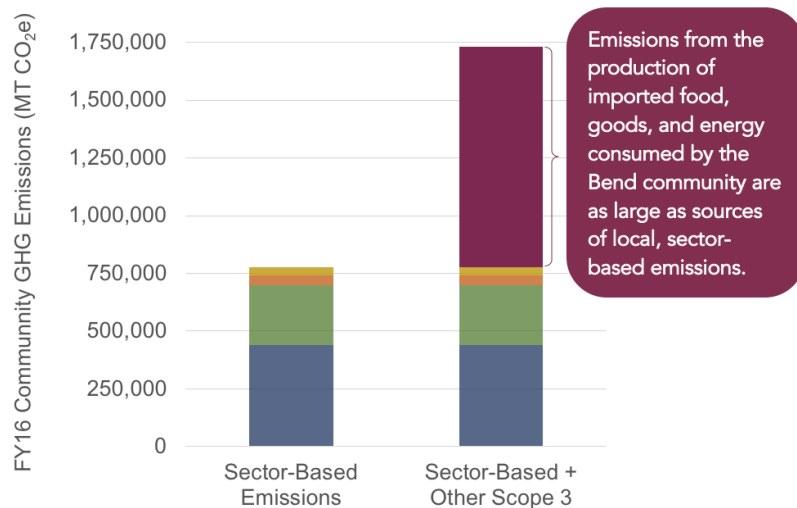
Household Food: Emissions from agricultural (energy for irrigation, production of fertilizers, methane emissions from livestock, etc.), transportation of raw materials and finished products emissions. Categories included are cereal, dairy, meat, produce, and other foods.

Energy (Fuel Production): Process and energy emissions from the extraction and production into usable fuel products (e.g. electricity from household outlets, gasoline pumped into cars, natural gas combusted by furnaces, etc.). These upstream emissions are considered at the community-scale for electricity, natural gas, gasoline, diesel, propane, and fuel oil.

As can be seen in Figure 12, the scale of consumption-based emissions as a category is larger than Bend's sector-based emissions. Figure 4 provides more details and shows that the largest sources of these emissions include meat, transportation fuels, clothing, and furniture.

ODEQ's Materials Management program is currently focused on identifying the most effective actions to address consumption-based emissions. These actions include avoiding wasted food; the recovery and reuse of building materials; and lifespan extension of consumer goods with repair, reuse and purchasing durable goods.

Figure 12: Comparison of sector-based emissions to consumption.



⁴ The GPC authors; C40 Cities; and Oregon Department of Environmental Quality are all currently working to develop tools that will allow for more accurate community tracking of these emissions in the future

V. BUSINESS AS USUAL FORECAST TO 2040

In order to effectively plan for community GHG mitigation actions, it is useful to consider a business-as-usual emissions forecast which considers long-term emissions trends based on existing local, state, and federal policies and programs, utility projections, and population growth.

The figure below shows two business-as-usual (BAU) emissions scenarios:

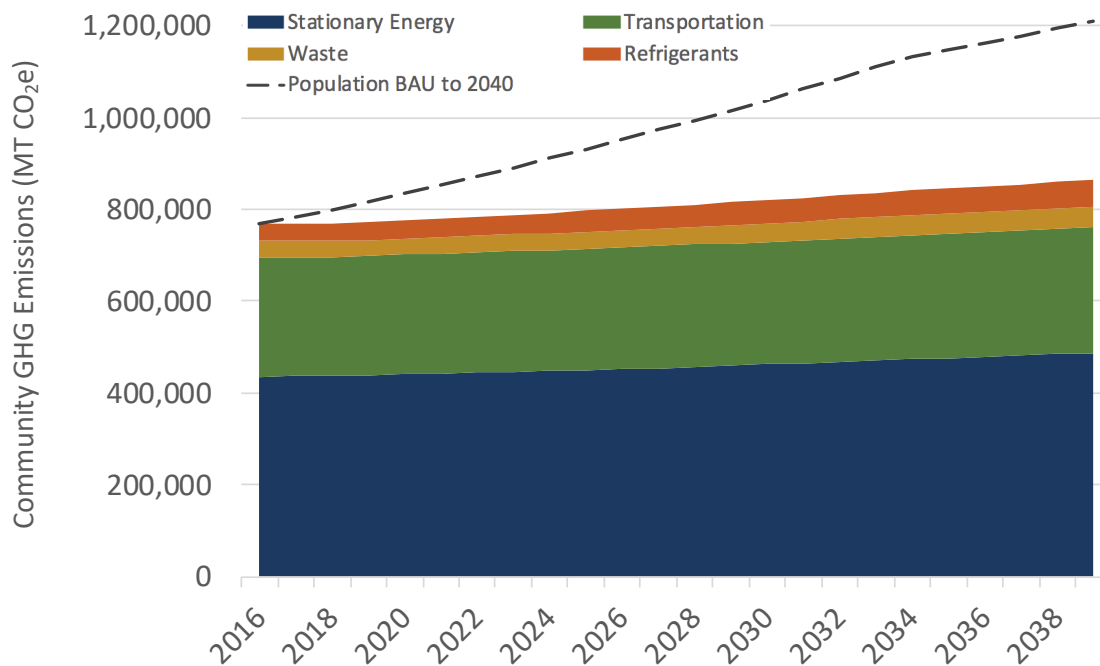
- **Population BAU:** The dashed line in Figure 13 represents 2016 community emissions rates and increases them by projected population increases.
- **Existing Policy BAU:** The stacked areas in Figure 13 shows the emissions reductions expected from existing regional, state, and federal policies.

Policies considered in the Existing Policy BAU scenario include:

- Oregon’s Renewable Portfolio Standard (RPS)⁵
- Energy Trust of Oregon’s energy efficiency programs⁶
- Federal vehicle fuel economy standards (CAFE)⁷
- Oregon SB263 (for food waste recovery)⁸

These policies are forecast to reduce emissions 28% compared to 2016 community emissions by 2040. The largest sources of emissions reductions come from increasing Federal light-duty fuel economy standards and increasing renewable electricity as a result of Oregon’s RPS. With the reductions from these existing policies, Bend’s projected 2040 community emissions are forecast to increase by 13% compared 2016 emissions.

Figure 13: Estimated future emissions reduction based on existing and future policies.



* Electricity emissions calculated using location-based method

⁵ Forecast based on PacifiCorp’s 2017 Integrated Resource Plan (May 2018) for load forecast and Energy Information Administration’s 2017 Annual Energy Outlook for forecast of annual emissions coefficients.

⁶ Forecast based on PacifiCorp’s 2017 Integrated Resource Plan (May 2018)

⁷ Forecast based on Oregon Department of Transportation GreenSTEP modeling with data and assumptions provided by City of Bend staff.

⁸ Forecast based on food waste diversion requirements in SB263.

VI. METHODOLOGY OVERVIEW

Protocols and Tools

This inventory follows [Global Protocol for Community-Scale Greenhouse Gas Emissions](#) Inventories by Greenhouse Gas Protocol (GHGP). This inventory also follows GHGP's [Scope 2 Guidance](#) for location-based and market-based electricity emissions accounting and ICLEI's [US Community Protocol](#) for guidance on calculation of consumption-based emissions.

ICLEI's ClearPath Community-Scale emissions management software was used for the majority of emissions calculations. Emissions calculations outside of ClearPath are documented in the FY16 GHG Inventory Audit Trail. The Audit Trail catalogs all data, calculation, and resource files used to complete the inventory. This Audit Trail clearly documents data sources and methods for replication in future inventories.

All community GHG emissions presented in this report are represented in metric tons of carbon dioxide equivalent (MT CO₂e). Quantities of individual GHGs are accounted for in the ICLEI's ClearPath carbon calculator and include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), CFCs, PFCs, and sulfur hexafluoride (SF₆) per the Kyoto Protocol. All GHG calculations use the global warming potentials (GWP) as defined in the International Panel on Climate Change's 5th Assessment Report (IPCC AR5).

Data Collection

Good Company worked with Gillian Ockner, Project Manager for the City of Bend to collect the data required to calculate emissions. City, County, and State staff members as well as private businesses that serve the Bend community graciously provided data and expertise. See Appendix A for additional information on data and emissions factors used in this inventory.

Two data models were used in the course of Bend's community inventory to estimate primary data using methods outlined in the previously mentioned GHG protocols. These include: Oregon Department of Transportation's (ODOT) GreenSTEP transportation model and Oregon Department of Environmental Quality's (ODEQ) Oregon Household Carbon Calculator. The ODOT model is used to estimate on-road passenger and freight transport vehicle-miles traveled and associated GHG emissions. ODEQ's Oregon Carbon Calculator was used to estimate household consumption-based emissions for the Bend community.

Summary of Inventory Exclusions

Emissions Sector / Sub-Sector	Justification for Exclusion
Agriculture, Forestry, and Fishing	No significant activity identified within City. The City should consider including land-use change emissions in the future depending on future community growth rates and the types of land being developed.
Fugitive Emissions from Coal Production	No significant activity identified within City.
Waterborn Navigation	No significant activity identified within City.
Livestock	No significant activity identified within City.
Industrial Processes	No significant activity identified within City, per EPA FLIGHT database.
Off-Road Vehicles and Equipment	State-level data is not currently available. ODEQ is about to conduct a detailed state-wide emissions off-road inventory. Oregon's off-road inventory should be considered as a data source for future inventories.
Incineration of Waste Generated in City	No significant activity identified within City.
Industrial propane and fuel oil	Based on the relatively small emissions from industrial electricity and natural gas use – use of these fuels expected to be small and therefore were not estimated.

APPENDIX A: SUMMARY OF DATA AND EMISSIONS FACTORS

Figure 14: Inventory summary of data and emissions factors.

Emissions Category	Category Description	Description of Data and Emissions Factors
Stationary Energy		
Residential Energy	These categories include direct emissions from natural gas, fuel oil, propane combustion by the residential, commercial, and industrial sectors within the City of Bend's geographic boundaries. Also includes the indirect emissions from grid electricity use by the same sectors for the same geographic boundaries.	Electricity and natural gas data provided by utilities and considered highly accurate. Fuel oil and propane use estimated using state-level per capita fuel usage data and Bend's annual population. Emissions factors for natural gas, fuel oil, and propane are programmed into ICLEI's ClearPath and are considered highly accurate. The Electricity location-based emissions factors are taken from EPA eGRID 2016 data for the Northwest Power Pool (NWPP) subregion. Market-based factors for PacificCorp and Central Electric Cooperative, Inc. are provided by Oregon Department of Environmental Quality.
Commercial Energy		
Industrial Energy		
Water	Direct emissions from pumping and treating potable water for consumption.	Electricity data is provided by City staff and local private vendors and is considered highly accurate. A small fraction energy use, for one of the private vendors, was estimated using a known delivered water volume and energy intensity values (kWh / gallon) from other local vendors to estimate pumping energy use. Location-based and market-based electricity emissions factors are as described for Stationary Energy.
Transportation		
On-Road Energy	Direct emissions from gasoline and diesel for passenger and freight transportation.	Vehicle miles traveled and greenhouse gas emissions are estimated by Oregon Department of Transportation staff using the GreenSTEP model. Emissions factors for gasoline and diesel and calculation methodology are considered highly accurate. Data source 1 is considered more accurate and therefore used to report results.
Transit	Direct emissions from gasoline and diesel for passenger and transit transportation.	Fuel volume data provided by Cascade East Transit staff. Default fuel emissions factors are programmed into ClearPath.
Bend Air Port	Direct emissions from jet kerosene and aviation gasoline for local air travel.	Fuel volume data provided by City staff. Default composting emissions factors are programmed into ClearPath.
Rail Freight	Direct emissions from gasoline and diesel for passenger and freight transportation.	Fuel volume estimate using gross ton miles provided by BNSF for local transportation planning and BNSF reported fuel use per ton mile. Fuel volume data provided by Cascade East Transit staff. Default fuel emissions factors are programmed into ClearPath.
Industrial Process and Product Use		
Refrigerant Loss (buildings and vehicles)	Fugitive loss of refrigerants from building and vehicle air conditioning systems.	Actual data on refrigerant loss is not available at the local level. State-level data from Oregon's 2013 GHG inventory is down-scaled by population to estimate emissions. Emissions factors are taken from The Climate Registry's 2015 Default Emissions Factors.
Waste		
Landfill Solid Waste	Fugitive methane emissions from mixed solid waste generated in the Bend community and disposed of at Knott Landfill. Its important to note that Knott Landfill is modern landfill that collects landfill gas (LFG) and generates electricity. Even using best practices, achieving 100% LFG collection is difficult and therefore solid waste landfill disposal produces GHG emissions.	Deschutes County provided total shorts tons of material transferred to Knott Landfill. Fugitive methane from Knott was taken from the Environmental Protection Agency's Facility Level Information on Greenhouse Gas Emissions Tool (FLIGHT) which reports emissions (MT CO2e) using the First Order Decay Model and IPCC's AR4 GWP for methane. Methane GWP was adjusted with AR5 values for input into ClearPath. Total Knott Landfill emissions
Composting Organic Waste	Fugitive methane and nitrous oxide emissions from composting of organic wastes (wood, yard debris, and food). It should be noted that while composting does produce emissions they are significantly less than if the same material were landfilled. Also land-application of compost increases soil carbon sequestration. That benefit is not accounted for in GPC methodology.	Deschutes County provided total shorts tons of material transferred to Deschutes Recycling / Composting center. Total County waste weights were down-scaled per capita for City of Bend. Default composting emissions factors are programmed into ClearPath.
Wastewater	Fugitive nitrous oxide emissions from nitrification / denitrification process and from discharge of treated effluent and carbon dioxide and methane emissions from combustion of biogas. Fugitive methane emissions from septic systems.	City staff provided values for nitrogen discharged in plant effluent, as well as annual biogas production volumes. Bend's 2016 population, used to estimate nitrification/denitrification emissions, is from Portland State University's 2016 Oregon Population Report. City staff provided data on the community population served by septic systems. Default composting emissions factors are programmed into ClearPath.
Household Consumption-Based Emissions		
Goods	Upstream energy and process emissions raw material extraction, manufacturing, and out-of-state transportation of goods.	Accurate data on quantities consumed and suppliers for the goods and food consumed by Bend community households is not readily available. Therefore Oregon's Carbon Calculator and US Census Bureau data on distribution of households by household income were used to estimate emissions.
Food	Upstream energy and process emissions from the growing, processing and transportation of foods.	
Energy (Fuel Production)	Upstream energy and process emission from the production and distribution of natural gas, gasoline, diesel and electricity consumed either directly or indirectly by the Bend Community.	Data for gasoline, diesel, natural gas and electricity use is same as previously described. Lifecycle emissions factors for the various energy types are provided by Oregon Department of Environmental Quality's reported carbon intensity values for Oregon's Clean Fuels Program.