CITY OF BEND

2021 COMMUNITY GREENHOUSE GAS INVENTORY

December 2022

Prepared by Good Company

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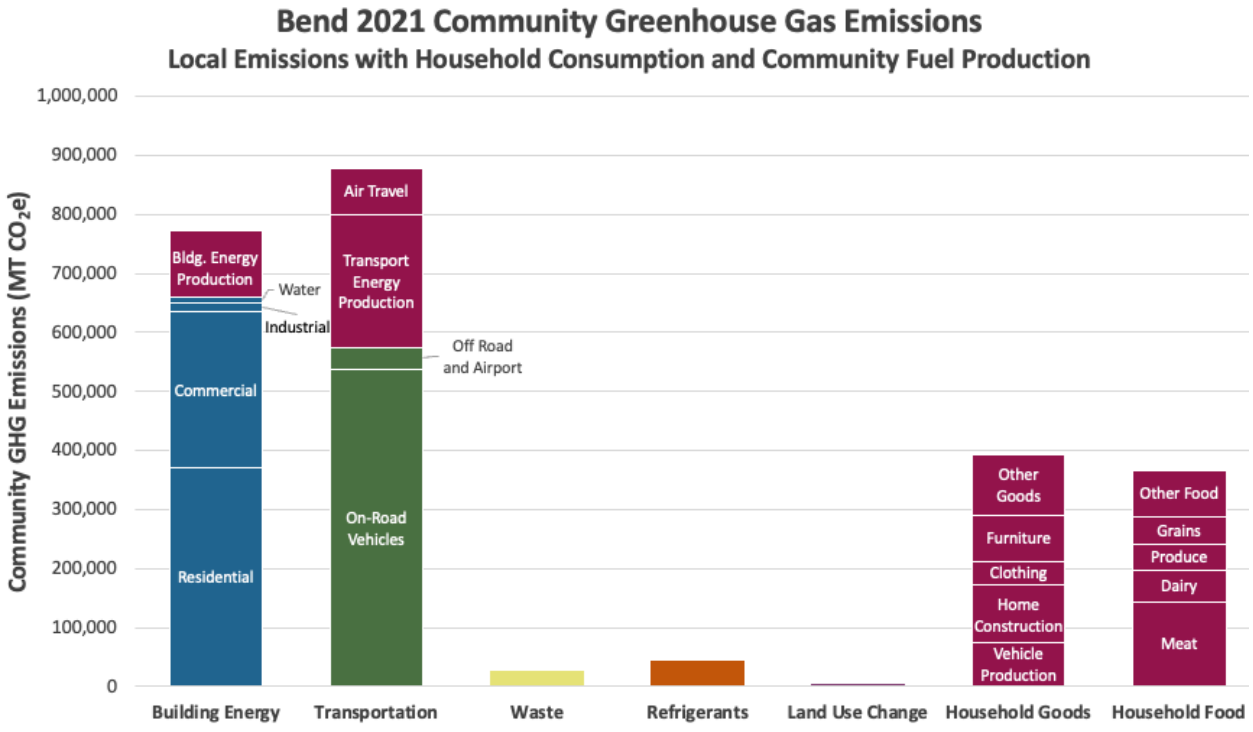
I. EXECUTIVE SUMMARY

This Greenhouse Gas (GHG) Inventory provides an update to the previous 2016 GHG Inventory as part of Bend's community emissions tracking system to measure progress toward the Community Climate Action Plan (C-CAP). As part of the climate action work, Bend has implemented two **climate targets: 40% GHG emissions reduction from 2016 by 2030** and **70% reduction from 2016 by 2050**.

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 **building energy use (50%)** and **transportation (44%)**. For buildings, electricity is the largest source of emissions (73%); followed by natural gas (24%); and other fuels (3%). Smaller local sources of emissions include **refrigerant loss from buildings and vehicles (3%)** and **waste disposal (2%).** Lastly, **land use development emissions (<.5%)** were included – a newly available emissions source since 2016. See Figure 1.
- Beyond local emissions, the inventory also considers imported emissions from the production and **consumption of imported goods, food, and energy products**. When included, these emissions more than double Bend's community emissions. The largest sources include consumption of meat, clothing, furniture, construction materials, air travel, and upstream energy production.
- This report also forecasts Bend's future community emissions through 2050 based on existing climate policy. These policies are **expected to reduce local emissions by 64% in 2050 compared to 2016 – below the target of 70% reduction.**

Figure 1: Bend's 2021 Community GHG Emissions. Local emissions (primary colors) with imported emissions (magenta) *Note: this report uses market-based accounting for electricity.*



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 global climate changes that have 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 to avoid the worst potential climate impacts on human communities and economies. According to IPCC, we need a decrease of around 45% in net emissions (compared to 2010) by 2040 and to reach net-zero by 2050 or sooner. The commonly referenced international goal to mitigate the worst climate impacts is to limit global average temperature increases to no more than 1.5-2°C relative to temperatures at the start of the industrial revolution. As of 2018, we have already passed the halfway point as 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 adopted its Climate Action Resolution (Resolution 3044), launching their climate action work, including conducting regular community greenhouse gas (GHG) inventories starting with a 2016 inventory to establish a baseline measurement, and recurring update inventories to measure progress against the *Bend Community Climate Action Plan*. 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's 2021 Community Greenhouse Gas (GHG) Emissions Inventory** and builds upon the results of the previously conducted FY 2016 inventory. A community emissions inventory considers many sources of emissions generated by the activities of residents, businesses, and government operations within a geographic boundary, including:

Building 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 as well as 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 building energy, transportation emissions are generated at the tailpipe.

Refrigerants are potent gases lost from transportation and building cooling systems. Refrigerants are powerful global warming gases. Therefore, relatively small losses have a large climate impact.

Waste disposal in landfills and wastewater treatment produces methane, of which a fraction leaks out to the atmosphere having a negative climate impact.

Land Use emissions are generated when land that had previously been a carbon sink or storage (such as forest) gets converted into another land type (such as development) that does not store or sequester carbon.

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, transport, and distribute 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 Building Energy and Transportation.

III. INVENTORY BOUNDARIES

Geographic Boundary: City of Bend Urban Growth Boundary (UGB)

Time frame: Calendar year 2021

Protocol: Greenhouse Gas Protocol's *Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)*. The GPC is focused on Sector-based Emissions, also known as "local" sources of emissions. Bend's inventory also includes an estimate of the "imported" emissions embodied in community consumption of fuels, consumer goods, construction materials, food, and air travel. Emissions sectors and applicable sub-sectors included in the GPC are shown in Figure 2. See Appendix B for more details.

Scope 1	GHG emissions from sources located within the city boundary.
Scope 2	GHG emissions occurring because of the use of grid-supplied electricity within the City's geographic boundary. *This inventory uses market-based accounting.*
Scope 3	All other GHG emissions that occur outside the city boundary because of activities taking places within the City's geographic boundary.

Figure 2: Crosswalk of emissions sectors and Scope categories.

Emissions Sector / Sub-Sector	Included in Inventory	Scope 1	Scope 2	Scope 3
Building Energy				
Residential Buildings	•	✓	✓	
Commercial Buildings and Facilities	•	✓	✓	
Industrial Facilities	•	✓	✓	
Water and Wastewater Facilities	•	✓	✓	
Fugitive Emissions from Natural Gas Systems	•	✓		
Energy Generation Supplied to the Grid	•	✓		
Agriculture, Forestry, and Fishing	NO			
Fugitive Emissions from Coal Production	NO			
Transportation				
On-Road Passenger and Commercial Vehicles	•	✓	✓	✓
On-Road Freight Vehicles	•	✓	✓	✓
On-Road Transit Vehicles	•	✓	✓	✓
Off-Road Vehicles and Equipment	•	✓	✓	✓
Local Aviation	•	✓		
Waterborn Navigation	NO			
Waste				
Solid Waste Generated in City	•			✓
Wastewater Generated in City	•	✓		
Biological Treatment of Waste Generated in City	•			✓
Industrial Process and Product Use				
Refrigerants	•	✓		
Industrial Processes	NO			
Agriculture, Forestry, and Land Use				
Land Use Change	•	✓		
Livestock	NO			
Other Agriculture	NO			
Imported Emissions Sources				
Household Consumption of Goods and Services	•			✓
Upstream Energy Production	•			✓

NE = Emissions occur but are not reported or estimated - see justification in exclusions
NO = Activity or process does not occur within City

IV. INVENTORY RESULTS

LOCAL EMISSIONS

The Bend community generated **1.3 million MT CO_2e** of local, sector-based emissions. For sense of scale, this quantity of emissions is equivalent to the carbon sequestered annually by over 1.5 million acres of average U.S. forest – a land area about 66 times the size of the City of Bend.

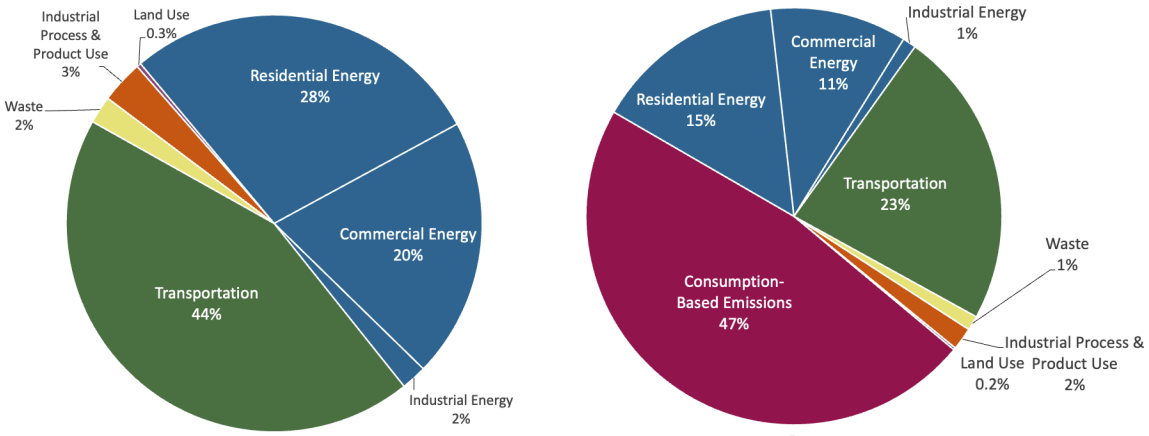
Bend's local emissions are similar in many ways to other communities around Oregon. These emissions are shown in Figure 3 on the left and come primarily from **transportation** gasoline and diesel combustion in vehicles to transport people and goods (green segment) and **building energy** combustion of natural gas and electricity use in buildings (blue segments) as well as emissions from **waste**, including landfill disposal of community solid waste and wastewater treatment (yellow). Emissions from **industrial processes and product** use include refrigerant gas loss from buildings and vehicles (orange). There is also a small segment of **land use change** emissions that came from development of green space.

IMPORTED EMISSIONS FROM HOUSEHOLD CONSUMPTION AND UPSTREAM ENERGY

In addition to accounting for local 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 imported emissions total an additional **1.2 million MT CO_2e**. The right side of Figure 3 compares the scale of local emissions versus emissions from household consumption and upstream fuels production[1].

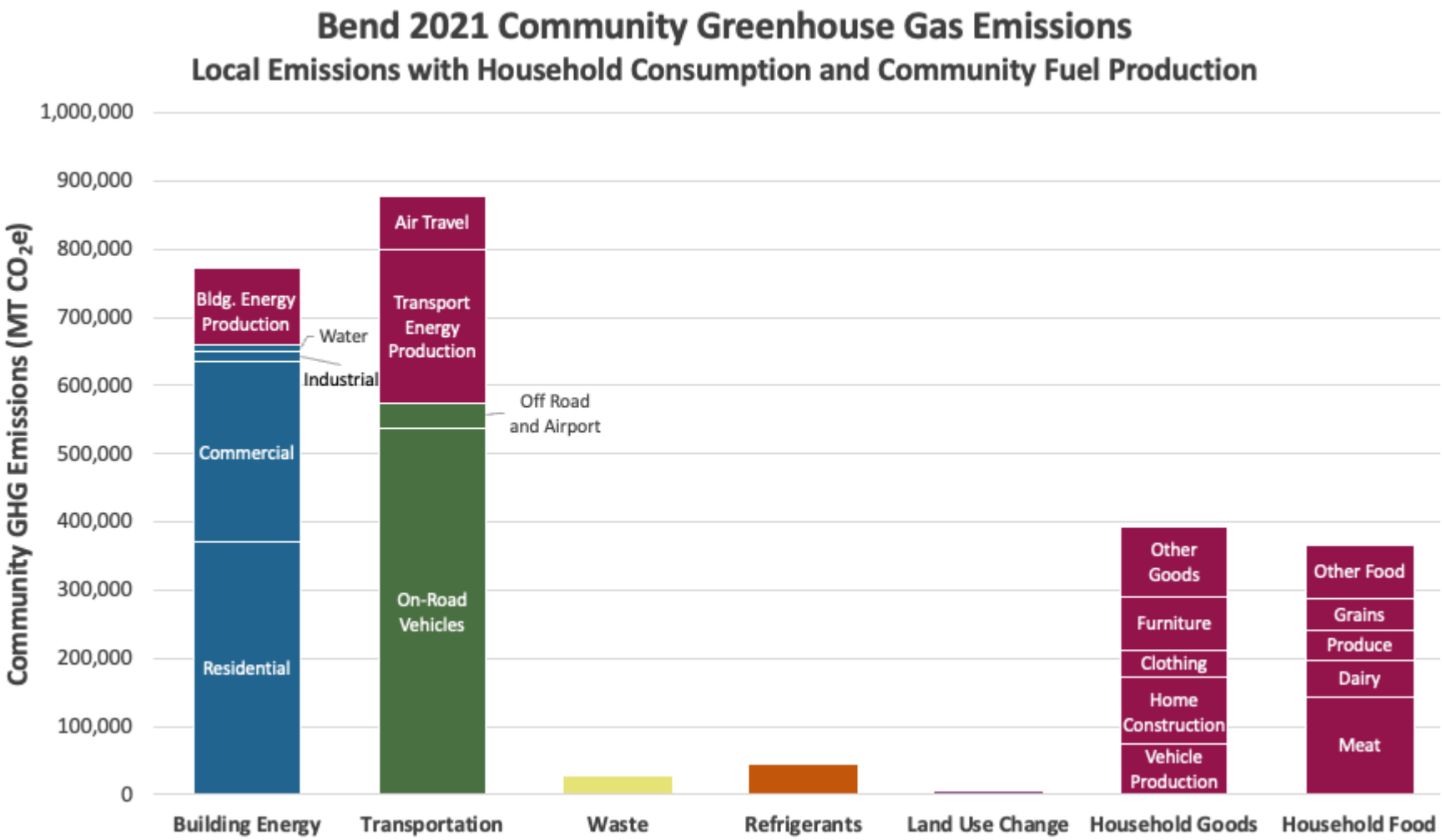
Household consumption of imported goods, food, and services is a significant source of community emissions. Within this category, emissions from the production of meat, furniture, clothing, and vehicles; home construction; and services produced outside of the city, such as health care and education. While the consumption of these goods and services represents a significant source of emissions, the production of these goods and services is occurring outside of the City of Bend. Therefore, these are considered imported emissions and the community has less control over these emissions. That said – the community does control demand for various types of products which presents opportunities to mitigate imported emissions.

Figure 3: Bend's 2021 Local GHG Emissions (left) and Local + Imported GHG Emissions (right)



[1] Local emissions account for "tailpipe" emissions from the combustion of fuels. There are also imported "upstream" emissions that account for the energy and process emissions during extraction and refinement of fuels.

Figure 4: Detailed summary of local emissions by sector (primary colors) with imported emissions from household consumption of goods, food, and energy and air travel (magenta).



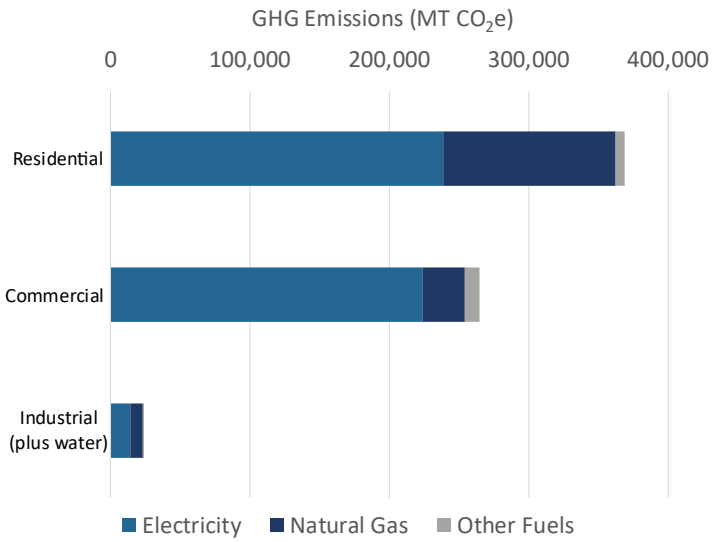
Note: Figure 4 presents market-based emissions for electricity. Location-based emissions details are included in Appendix A. Other Goods include electronics, toys, personal care products, cleaning products, printed reading materials, paper, office supplies, and medical supplies.

DETAILED RESULTS

Building Energy

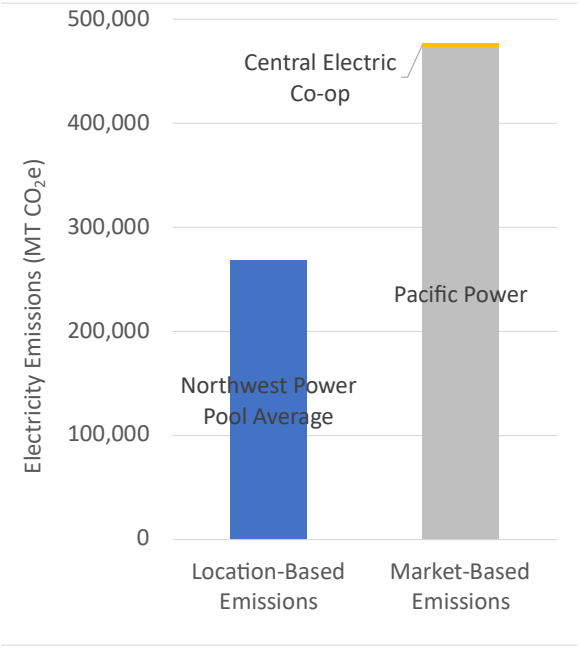
Electricity and natural gas use by the residential and commercial sectors are the largest source of local emissions with **over 650,000 MT CO_2e**. In Bend, residential homes have a larger emissions impact than commercial businesses, and industrial energy use is small by comparison. By energy type, electricity had the largest impact (73% of total building energy); followed by natural gas (24%); and other fuels (3%). Figure 5 shows building energy emissions broken down by sub-sector and energy type.

Figure 5: Comparison of stationary energy use, by sub-sector and energy type.



This report uses ***market-based accounting for electricity emissions,*** which are based on the GHG intensity of electricity contracts with local utilities. Bend's market-based emissions are much larger than emissions using the location-based method (as shown in Figure 6). Pacific Power's electricity generation from coal in 2021 is the major driver of this difference. Conversely, Central Electric Co-op (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 2021, Pacific Power's residential, commercial, and industrial customers voluntarily purchased 15% zero GHG renewable electricity which decreases Bend's market-based emissions. Location-based accounting emissions are available in Appendix A.

Figure 6: Comparison of location-based and market-based electricity emissions



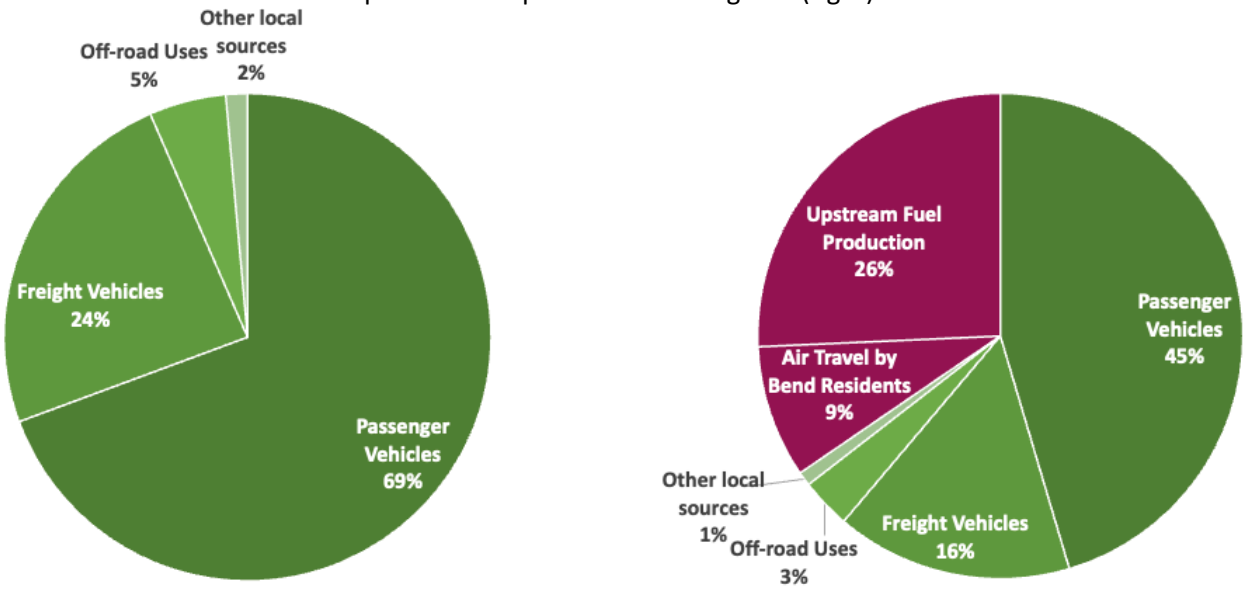
Transportation

The transportation sector is Bend's second leading source of emissions **nearly 575,000 MT CO_2e**. Local, on-road transportation of passengers makes up the overwhelming majority of these emissions (as shown in Figure 7). On-road emissions originate largely from residential-owned passenger vehicles combusting gasoline (E10). Freight vehicles also contribute a significant share of emissions, primarily combusting diesel (B5).

Off road equipment, which is dominated by construction equipment but also includes recreational vehicles, emit about 5% of local emissions. Other local sources include Bend airport aviation fuel use (making up just over 1% of transportation emissions) and transit, airport ground transportation, and electric vehicles each making up <0.1% of the total emissions.

In addition to local emissions, there are also imported emissions from air travel by Bend households, and upstream emissions from gasoline and diesel fuel production – for more information, see *Imported Emissions from Consumption of Goods, Food, and Air Travel* on page 10. Unlike local transportation emissions which are primarily calculated from fuel sales, air travel emissions are estimated based on household income data. While Bend does have a small municipal airport, these emissions are from Bend residents departing from any airport, regardless of airport location.

Figure 7: Bend's 2021 local transportation GHG emissions in green (left) and local + imported GHG emissions with air travel and upstream fuel production in magenta (right)



Solid Waste & Wastewater

Solid Waste and Wastewater emissions total **less than 30,000 MT CO_2e** – about 2% of local emissions. Local haulers send landfilled waste to Knott Landfill and local composting facilities. These landfill emissions are estimated to total roughly 27,000 MT CO_2e.

Wastewater is processed by the City of Bend, and 6,370 septic systems are located in the city. Total wastewater process emissions are estimated to total about 1,200 MT CO_2e.

Refrigerants

Refrigerant emissions are fugitive emissions; unintentional emissions, leaks, or discharges of gases and vapors from pressurized cooling and refrigeration systems that have a large climate impact, ranging from a few hundred to over 20,000 times the Global Warming Potential of an equivalent weight of carbon dioxide depending on the gas.

Refrigerant loss from residential and commercial buildings and vehicle air conditioning and refrigeration equipment are the only local source of Industrial Process and Product Use emissions. These sources are estimated using state per capita data, downscaling from emissions reported in the State of Oregon's most recent GHG Inventory, and are estimated at about **43,000 MT CO_2e**. Within the State of Oregon, sources of residential, commercial, and transportation refrigerant emissions (in DEQ's inventory as High Global Warming Potential gases) have grown by 21% since 2009.

Land Use Changes

Land use change emissions come from converting land that stores carbon into land that stores less or no carbon. This could come from converting forest into farmland or, in the City of Bend's case, it comes from developing previously undeveloped space. In 2021, 443 acres were converted within the City of Bend from undeveloped spaced to developed space, resulting in roughly **4,000 MT CO_2e** of emissions.

Imported Emissions from Consumption of Goods, Food, and Air Travel

Bend's inventory goes beyond protocol requirements to include known large sources of Other Scope 3 Emissions, described in this report as **Imported emissions** – household consumption of goods and services; air travel; and upstream emissions for production of fuels used by the community. For 2021, these emissions totaled **nearly 1.2 million MT CO_2e.**

Imported emissions are not currently included in the protocol due to limitations related to accurately accounting for these emissions over time at the community level.[2] While these accounting limitations are real, the scale of consumption-based emissions is large enough to warrant inclusion in community climate action work. 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 increased by 10% between 2010 and 2015.

This category includes emissions from the production of imported food, furniture, clothing, vehicles, home building materials, and more consumed by Bend residents that are produced outside of the community. While household consumption represents a significant source of emissions, these products, and therefore emissions, are imported and so 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 imported emissions that are considered in this inventory include: production of goods and food, all of the upstream emissions associated with energy and fuel production and transport, and air travel by Bend residents, regardless of where that travel originates. Figure 8 provides details and shows that the largest sources of imported emissions include transportation and building fuels, meat and other foods, construction materials, air travel, and furniture.

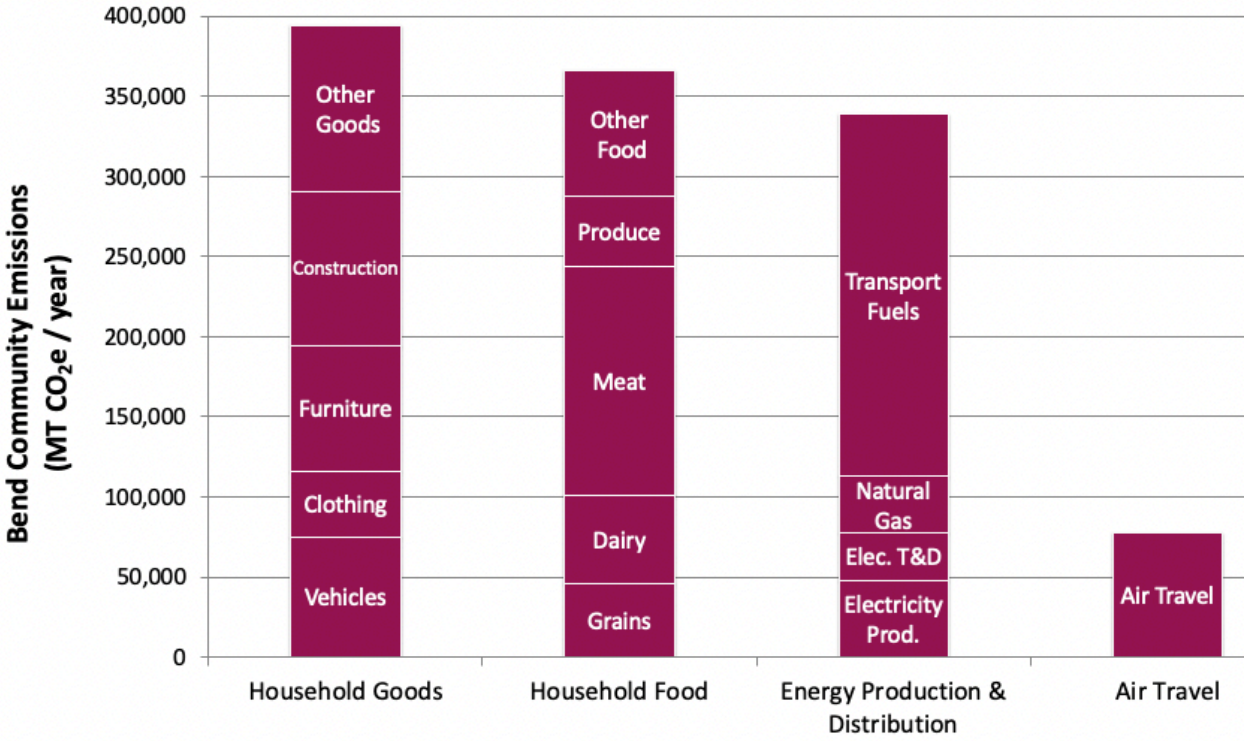
[2] The GPC authors; C40 Cities; and Oregon Department of Environmental Quality are all currently working to develop tools that will allow for more accurate community tracking of these emissions in the future

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 & Distribution): 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, and diesel.

Figure 8: Bend's Scope 3 emissions by category



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.

V. EMISSIONS FORECAST TO 2050

In order to effectively plan for community GHG mitigation actions, it is useful to conduct an emissions forecast which considers long-term emissions trends based on existing local, state, and federal policies and programs, utility projections, and population growth based on projected population growth from Portland State University's Population Research Center.

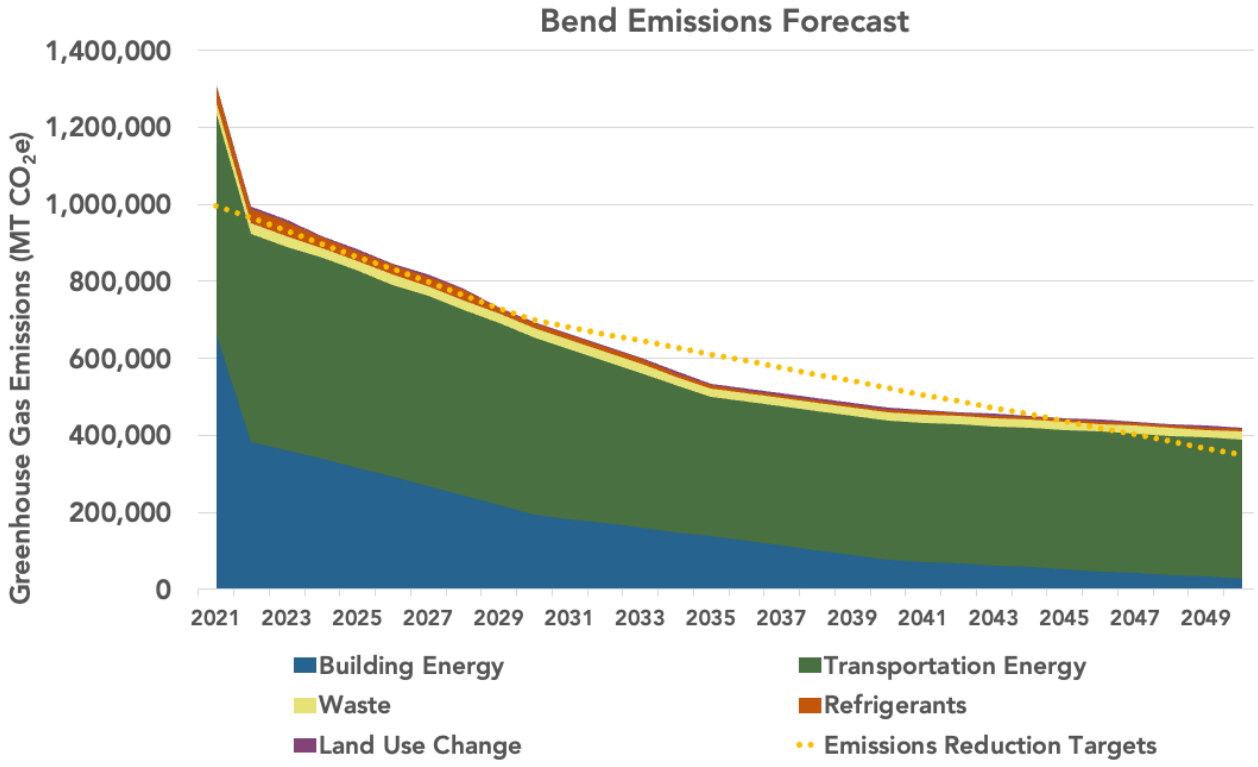
Figure 9 below shows the following emissions scenarios:

- **Bend's Emissions Targets:** The orange dotted line represents Bend's GHG emissions targets of 40% reduction in emissions compared to a 2016 baseline by 2030, and 70% reduction in emissions by 2050.
- **Existing Policy Forecast:** The stacked areas show the emissions reductions expected from existing local, state, utility, and federal policies.

The policies modeled in the forecast have significant GHG reduction impacts, particularly in the building and transportation energy sectors. If implemented as planned and/or required by law, these policies are forecast to reduce emissions by 40% compared to 2016 community emissions by 2030 **and 64% by 2050 – exactly meeting the 2030 target but just short of the 70% reduction by 2050 target**. The largest sources of forecasted emissions reductions come from Oregon's Renewable Portfolio Standards for electricity and Clean Fuel Program for natural gas. Oregon's Clean Fuel Program is also expected to reduce transportation emissions.

This forecast is based on **best estimates from available data and perfect implementation** from the policies described. **Actual emissions may be different and highlights the importance of working with energy distributors and stakeholders to create the desired outcomes.**

Figure 9: Estimated future emissions reduction based on existing policies.



Policies considered in the Existing Policy Forecast scenario include:

Building energy

- Oregon's Clean Energy Targets and Renewable Portfolio Standard (Pacific Power electricity only)
    - Zero-emissions electricity by 2040 for Pacific Power with intermediate targets (80% reduction by 2030, 90% reduction by 2035)
- PacifiCorp's Integrated Resource Plan
    - Assumed efficiencies and growth in electricity consumption
- Oregon Climate Protection Program
    - 90% reduction in natural gas and other fossil fuels by 2050

This modeling includes required reductions in electricity emissions intensity, expected growth in electricity use, and required reductions in total fossil fuel suppliers (for building energy emissions). The steep drop for 2022 is due to a linear decrease assumption for all applicable building energy emissions. It is unknown what the exact emissions from building energy will be each year, particularly electricity emissions intensity.

Transportation energy

- Oregon Clean Fuels Program
    - Assumed 37% emissions reduction by 2035 for all gasoline and diesel blends

While many factors and policies will shape transportation emissions, the Oregon Clean Fuels Program is the most comprehensive and robust, and models required reductions in Oregon, primarily from gasoline and diesel importers. The transition to widespread Electric Vehicles through the adopted Advanced Clean Cars II rule for electric and zero-emissions vehicles will also undoubtedly change transportation emissions in the future, but the exact impacts are unknown and therefore not modeled in the forecast.

Waste

- Oregon SB263 for Waste reductions
    - Assumes a diversion rate of 15% below 2016 by 2025, and 40% by 2050.

This state policy aims to reduce food waste along with other recyclable and reusable materials, which will in turn reduce landfill emissions.

Refrigerants

- American Innovation and Manufacturing (AIM) Act for Refrigerants
    - A phased step-down in production and consumption of refrigerants: 10% by 2022, 40% by 2024, 70% by 2029, 80% by 2034, and 85% by 2036.

This federal policy will limit the production and sale of high-GWP refrigerant gases, known as Hydrofluorocarbons (HFCs).

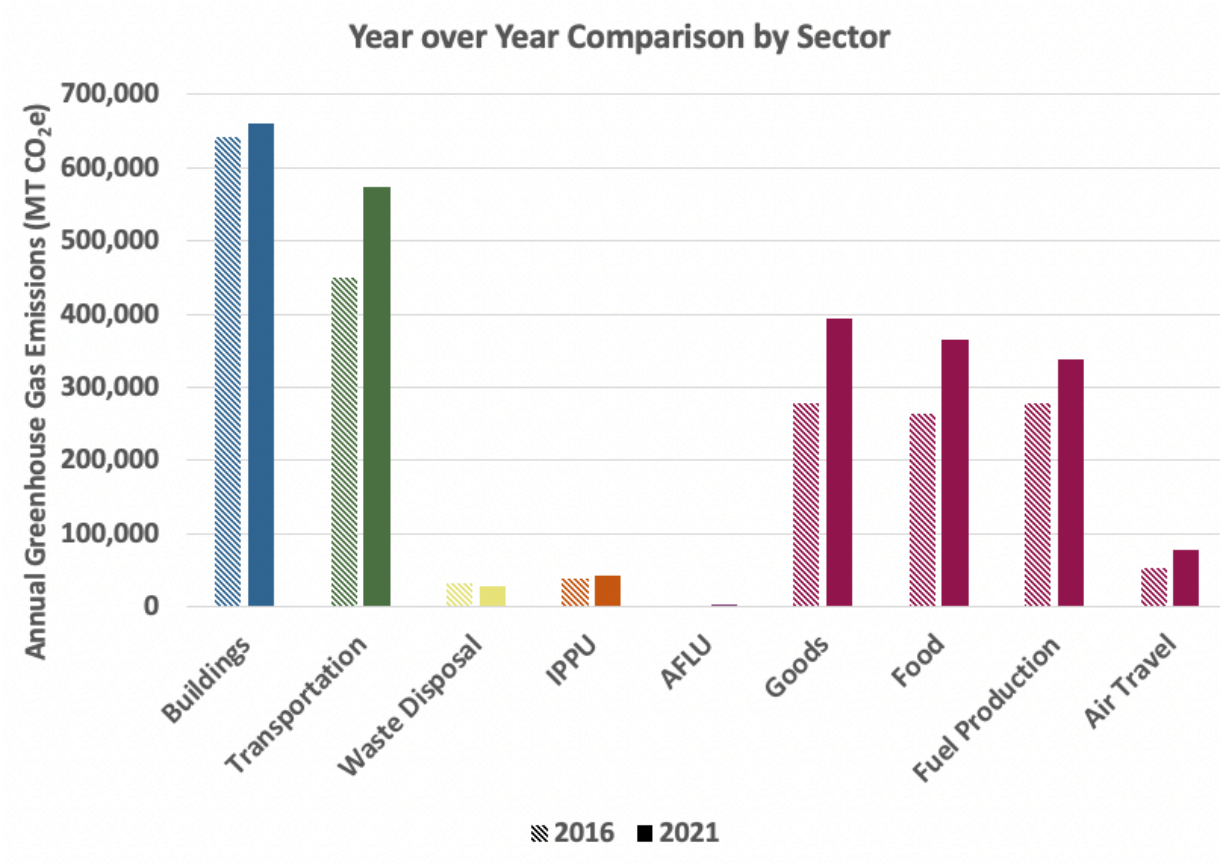
Land Use Change

Not modeled due to insufficient data and a very small emissions source.

VI. 2016 UPDATES AND COMPARISON

Figure 10 shows a year over year comparison total community emissions, using updated values for the 2016 inventory. New data was available to improve the 2016 inventory, primarily with fuel sales data from Oregon Department of Transportation. Additionally, market-based accounting was selected for reporting as it's most compatible with community targets and forecasting. For these reasons, the 2016 GHG inventory was redone. Notable changes, context, and 2021 comparisons are described below.

Figure 10: Comparison of Bend's community emissions from 2016 to 2021



NOTABLE CHANGES FROM PREVIOUS DATA AVAILABILITY TO CURRENT:

- **All data was recollected** for calendar year 2016 instead of fiscal year 2016, as available.
- **All data was recalculated** using Good Company's Carbon Calculator for Communities (G3C-Community) with updated emissions factors for all fuels as available.
- **All electricity emissions were recalculated** to show market-based electricity accounting, per best practices when combined with community climate targets, reflecting local utilities and market purchases (including renewables, e.g. RECs).
- **Transportation emissions data changed** from community VMT modeling to fuel sales reporting from Oregon Department of Transportation (except airport and transit emissions). This data is preferred for multiple reasons, primarily due to the quality, consistency, and availability of data over time. However, ODOT reporting has improved over the years, and it is unknown if 2016 fuel quantities are lower due to lower sales or incomplete data.
- **Land use change data** was previously unavailable and is included for 2021.

Table 1: Emissions in 2016 versus 2021

Inventory Year	Building Energy MT CO_2e	Transportation MT CO_2e	Waste Disposal MT CO_2e	Refrigerants MT CO_2e	Land Use Change MT CO_2e
2016	641,490	449,307	33,603	39,370	n/a
2021	660,446	574,586	28,016	43,440	4,329
% Difference	+3%	+28%*	-17%	+10%	n/a

Inventory Year	Goods Production MT CO_2e	Food Production MT CO_2e	Fuel Production MT CO_2e	Air Travel MT CO_2e
2016	278,523	263,569	279,364	52,570
2021	393,802	365,624	338,460	77,561
% Difference	+41%	+39%	+21%	+48%

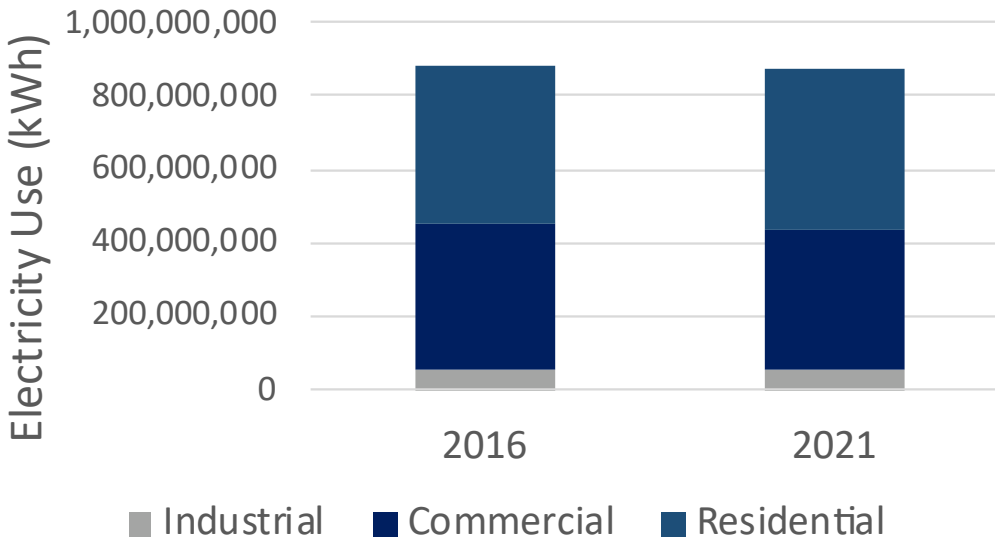
Inventory Year	Local Emissions Total MT CO_2e	Per capita MT CO_2e	Imported Emissions Total MT CO_2e	Per capita MT CO_2e	Community Total MT CO_2e	Per capita MT CO_2e
2016	1,163,771	**13.9**	874,025	**10.5**	2,037,796	**24.4**
2021	1,310,817	**12.8**	1,175,447	**11.5**	2,486,264	**24.4**
% Difference	+13%	**-8%**	+35%	**+10%**	+22%	**-0.2%**

* Fuel sales data is not confirmed to be complete for 2016, but is the most accurate available. It is unknown if 2016 fuel quantities are lower due to lower sales or incomplete data. The largest increase in fuel sales was for diesel blends.

BUILDING ENERGY CHANGES

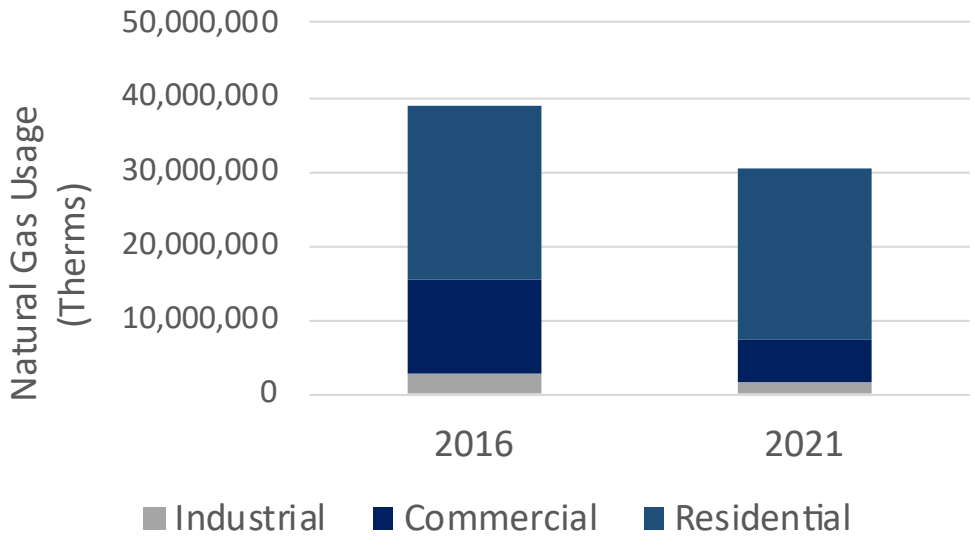
Total community electricity use decreased by 1.5% between 2016 and 2021, with residential sector use increasing by 1.3% during the period and commercial sector use decreasing by 5.7% (see Figure 11). Industrial electricity use increased by 11.2%, but this was a relatively small part of the overall usage.

Figure 11: Bend electricity use (in MWh), by sub-sector for 2016 and 2021



Total community natural gas use decreased by 21.3% between 2016 and 2021, with residential sector use decreasing by 0.5%, the commercial sector decreasing by 55.4% (accounting for the bulk of the savings), and industrial use decreasing by 40.5% (see Figure 12).

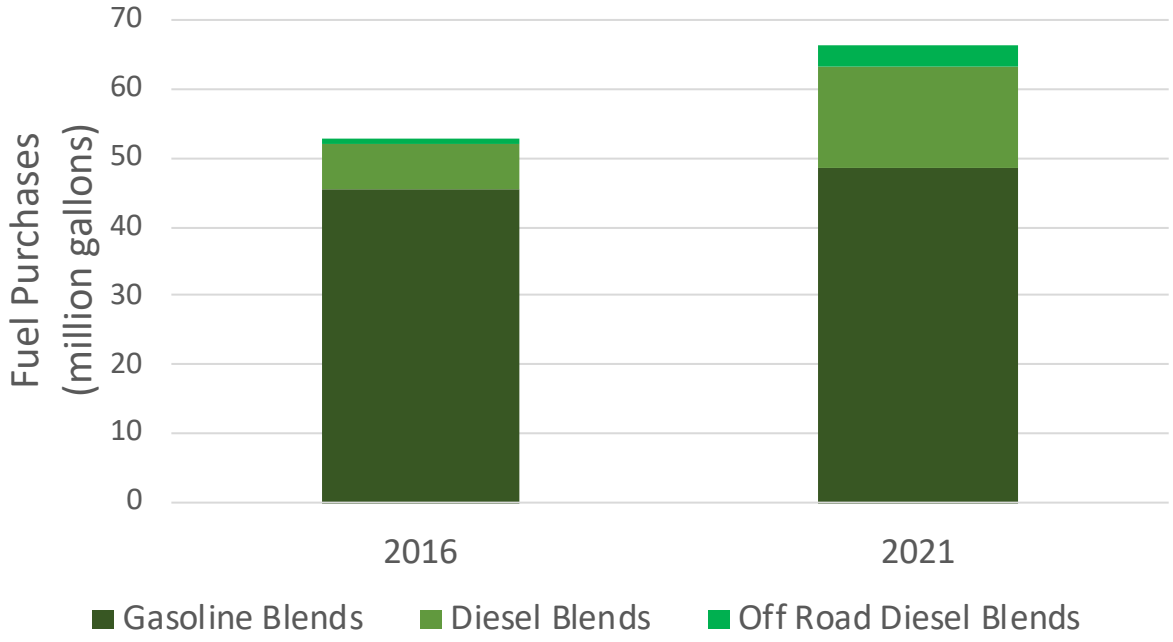
Figure 12: Bend natural gas use (in therms), by sub-sector for 2016 and 2021



TRANSPORTATION ENERGY CHANGES

All fuel sales increased between 2016 and 2021, but the growth was especially notable in diesel fuel. Gasoline purchases increased by 7%, less than population growth (18%), but on-road diesel increased by 125%, while off road uses increased by 284%. Diesel therefore accounts for almost all the increase in vehicle fuel emissions, but as noted in Table 1, 2016 fuel data is likely to be incomplete.

Figure 13: Bend fuel purchases (in million gallons) from 2016 to 2021



APPENDIX A: SUMMARY OF DATA

Figure 14: Summary Table of Bend 2021 Community Emissions

**See page 8 for a discussion of location-based and market-based electricity emissions*

Emissions Sector / Sub-Sector	2021 Emissions (MT CO_2e)		Notes
	Location-based	Market-based	
Building Energy	**451,696**	**660,446**	
Residential Buildings			*Location-Based accounting is based on the carbon intensity (CI) of regional electric grid, Market based accounting is based on the CI for local utilities and customer purchases of green energy.*
Electricity	*143,232*	*238,894*	
Natural Gas	*123,129*		
Other Fuels	*6,310*		*Incluces propane and fuel oil use*
Commercial Buildings and Facilites			
Electricity	*111,966*	*224,013*	
Natural Gas	*30,212*		
Other Fuels	*10,183*		*Includes propane and fuel oil use*
Industrial Facilities			
Electricity	*8,739*	*5,920*	
Natural Gas	*8,456*		
Water and Wastewater Energy	*8,097*	*11,957*	*Includes electricity, fuel oil, and propane*
Fugitive Emissions from Natural Gas Systems	*1,371*		
Transportation	**574,368**	**574,586**	
On-Road Passenger and Commercial Vehicles	*398,584*	*398,801*	*Includes gasoline and electric vehicles*
On-Road Freight Vehicles	*138,351*		*Diesel vehicles*
Known off-road uses	*29,355*		
Transit	*543*		
Bend Airport	*7,537*		*Local airport emissions only*
Waste	**28,016**		
Solid Waste Generated in City	*26,847*		
Wastewater Generated in City	*167*		*Process emissions only - energy use included in Stationary*
Biological Treatment of Waste	*1,002*		
Industrial Process and Product Use	**43,440**		
Refrigerants	*43,440*		
Agriculture, Forestry, and Land Use	**4,329**		
Land Use Change	*4,329*		
Imported Emissions Sources	**1,139,478**	**1,175,447**	
Household Consumption			
Goods	*393,802*		*Includes production emissions for imported construction materials, clothing, furniture, vehicles, and other goods*
Food	*365,624*		
Air Travel	*77,561*		*Air travel by residents regardless of airport*
Upstream Energy Production			
Transportation Fuels	*225,531*		
Natural Gas	*35,357*		
Electricity	*41,604*	*77,572*	*Includes Fuel Production and Transmission & Distribution loss*
Local Emissions	**1,101,849**	**1,310,816**	
Per Capita	**10.8**	**12.8**	
Local + Imported Total Emissions	**2,241,327**	**2,486,263.2**	
Per Capita	**22.0**	**24.4**	

APPENDIX B: METHODOLOGY OVERVIEW

The inventory accounted for all seven Kyoto gases, but only four were relevant: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons (HFC). It is important to note that the data available for the two inventory years was not identical; for example, the 2016 inventory included a more detailed breakdown of transportation emissions, while the 2021 inventory included emissions from land use conversion. Some 2016 data points were updated accordingly, primarily transportation fuel sales instead of VMT modeling.

Notable changes from previous data availability to current:

- **All data was recollected** for calendar year 2016 instead of fiscal year 2016, as available.
- **All data was recalculated** using Good Company's Carbon Calculator for Communities (G3C-Community) with updated emissions factors for all fuels as available.
- **All electricity emissions were recalculated** to show market-based electricity accounting, per best practices when combined with community climate targets, reflecting local utilities and market purchases (including renewables, e.g. RECs).
- **Transportation emissions data changed** from community VMT modeling to fuel sales reporting from Oregon Department of Transportation (except airport and transit emissions). This data is preferred for multiple reasons, primarily due to the quality, consistency, and availability of data over time. However, ODOT reporting has improved over the years, and it is unknown if 2016 fuel quantities are lower due to lower sales or incomplete data.
- **Land use change data** was previously unavailable and is included for 2021.

Protocols and Tools

This inventory follows Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC) 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.

All community GHG emissions presented in this report are represented in metric tons of carbon dioxide equivalent (MT CO_2e). Quantities of individual GHGs are accounted include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs, CFCs, PFCs, and sulfur hexafluoride (SF_6) as applicable 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).

G3C-Community and Audit Trail

Good Company's carbon calculator tool *G3C – Community* was used for emissions calculations. Emissions are documented in the Inventory Audit Trail. G3C – Community is an Excel-based calculator that documents all activity data; emissions factors; and emissions calculations used in the inventory. The audit trail catalogs all data, calculation, and resource files used to complete the inventory. These resources are highly detailed and will allow for those conducting future inventories to fully understand and replicate the methods used in this inventory.

Data Collection

Good Company worked with Cassie Lacy, Project Manager for the City of Bend to collect the data required to calculate emissions. City, County, and State staff members as well as utilities that serve the Bend community graciously provided data and expertise.

Table 2: Summary of Inventory Exclusions

Emissions Sector / Sub-Sector	Justification for Exclusion
Stationary Energy	
Agriculture, Forestry, and Fishing	No significant activity identified within City.
Fugitive Emissions from Coal Production	Not occurring.
Industrial propane and fuel oil	Data not available.
Transportation	
Waterborn Transportation	Included elsewhere; no significant activity identified within City but would be part of fuel sales reported.
Rail	Data not available.
IPPU	
Industrial Processes	No significant activity identified within City, per EPA FLIGHT database and Oregon DEQ reporting facilities.
AFLU	
Agriculture and Livestock	No significant activity identified within City.
Forestry	No significant activity identified within City.