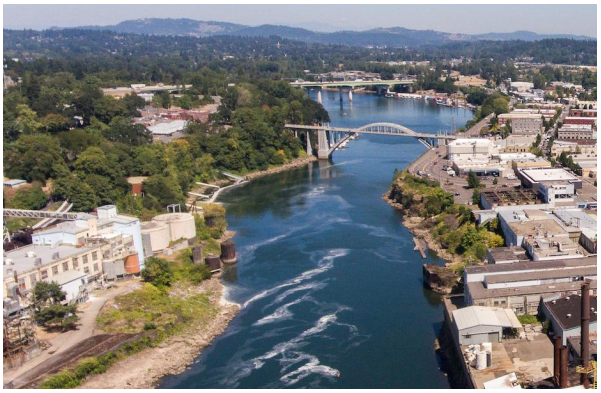
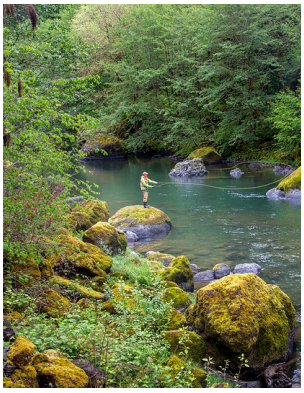
Clackamas County | Oregon Community Greenhouse Gas Inventory for 2018





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This report was prepared by:

Good Company
65 Centennial Loop
Eugene, Oregon 97401
541.341.4663
goodcompany.com

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Clackamas County Willamette River view near Oregon City Arch Bridge, Clackamas County
Plugged-in Electric Vehicle Charging, Noya Fields Photography
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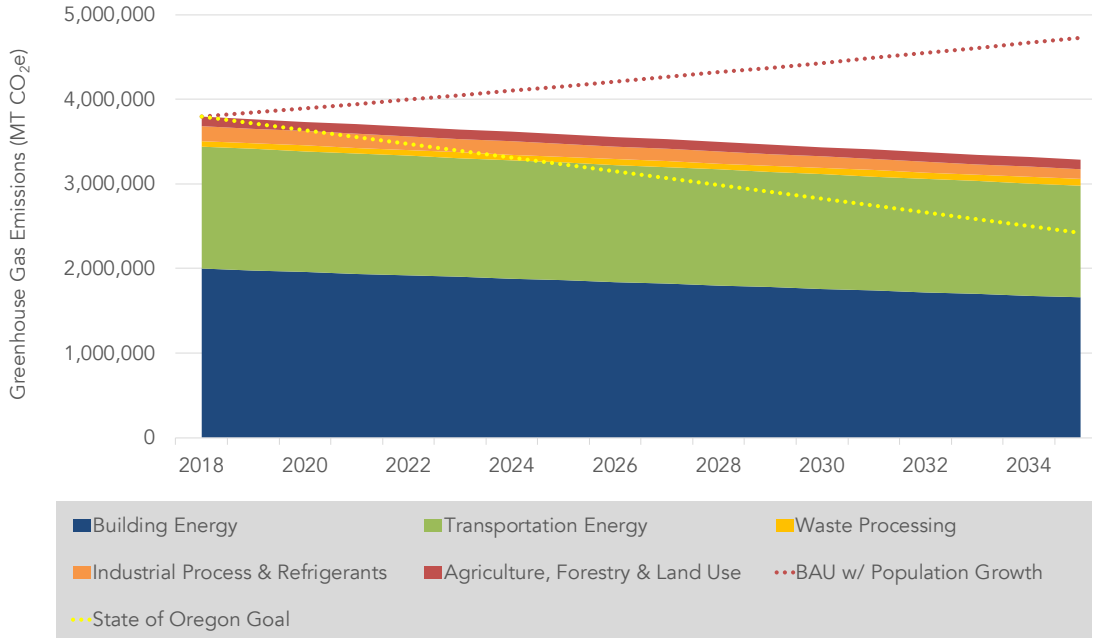
I. EXECUTIVE SUMMARY

Clackamas County completed a Community Greenhouse Gas (GHG) Inventory to better understand local sources of GHG emissions (i.e. climate pollution) to inform development of a community climate action plan (CAP) and to establish a community emissions tracking system to measure progress as the 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 County's geographic boundary.

- During 2018, Clackamas County's largest sources of local emissions included energy use by buildings (53% of total) and transportation (38%). For buildings, electricity was the largest source of emissions (62%); followed by natural gas (34%); and other fuels (4%). Smaller local sources of emissions included refrigerant loss and industrial processes (4%), agricultural animal emissions (3%) and waste disposal (2%).
- **Figure 1** details the community's 2018 emission sources and forecasts these sources to 2035. The dotted red line shows 2018 emissions rates with projected community population growth to 2035 (1.3% annually[1]), or a business as usual (BAU) forecast. The stacked, colored areas show the emissions benefit of existing State and Federal policies compared to a BAU forecast. In fact, existing policies are anticipated to decrease emissions by 33% in 2035 compared to a BAU scenario (see Figure 11 for more details).
- The yellow line in **Figure 1** illustrates the reduction pathway required to meet the State of Oregon's current climate goals, which aim to reduce our state's carbon pollution by 80% by 2050 from 1990 emissions levels.[2] As can be seen, existing policies alone will not be enough to meet these goals, which highlights the need for additional local, regional, state, and federal climate action.

Figure 1: Clackamas County 2018 Community Emissions Forecast



[1] Portland State University (2017). Coordinated Population Forecast for Clackamas County, its Urban Growth Boundaries (UGB), and Area Outside UGBs 2017-2067.
[2] Oregon Executive Order 20-04. See https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf.

II. INTRODUCTION

Human activity in the form of consumption of fossil fuels is the primary cause of planetary warming and changes in climate that have occurred over the past few decades and accelerated in recent years. The best available evidence indicates that human-caused greenhouse gas emissions (GHGs) must be reduced significantly by 2030 to avoid to avoid "severe, pervasive and irreversible impacts for people and ecosystems."[3] We are already observing physical changes to Oregon's climate, including hotter temperatures, drought, wildfire smoke and less mountain snow. Understanding the areas of greatest risk gives us the opportunity to act rather than react to these changing conditions and helps us be as resilient as possible. The most common international goal to mitigate the worst climate impacts are aligned with the Paris Climate Accord which seeks to limit global average temperature increases to well below 2°C (3.6°F) relative to temperatures at the start of the industrial revolution and to strive for limiting temperature to 1.5°C. As of 2018, we've already passed the halfway point: average temperatures have increased by more than 1°C (1.8°F) since the Industrial Revolution and are on track to increase to 1.5°C (2.7°F) by 2040.

It's with this understanding and urgency that Clackamas County commissioned this community greenhouse gas (GHG) inventory. The Clackamas County 2018 Community GHG Inventory includes the following emissions sources:

Building Energy use by residential, commercial, and industrial buildings and facilities represents a large source of community emissions. These emissions come from combustion of natural gas for water and building heat, and from electricity generated from fossil fuels for use in Clackamas County. Additionally, a fraction of natural gas is lost during local distribution, releasing methane, a potent greenhouse gas pollutant.

Transportation energy, 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 by combustion of gasoline, diesel, natural gas, or from electricity generation for electric vehicles.

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

Industrial Process & Product Use (Refrigerant Loss) Emissions from refrigerants are lost from transportation and building cooling systems. Refrigerants are powerful global warming gases. Therefore, relatively small losses have a large climate impact.

Agriculture & Forestry generate emissions from agricultural activity (e.g. animal waste and agricultural inputs) and community land use change (e.g. development of forest or grasslands).

Consumption-based Emissions are generated outside of the community during the production of goods, food, fuels and service products consumed by residents within Clackamas County. *Note: Consumption-based emissions presented in this inventory are **estimated** and therefore the results have a greater level of uncertainty compared to other sources of emissions.*

[3] Intergovernmental Panel on Climate (2014). Assessment Report 5 Synthesis Report: Climate Change 2014. http://www.ipcc.ch/report/ar5/syr/

III. INVENTORY BOUNDARIES

Clackamas County's community inventory follows Greenhouse Gas Protocol's *Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)*.[4] The GPC is focused on accounting for sector-based emissions, which can be thought of as local sources of emissions. The Clackamas County inventory also includes an estimate of the emissions embodied in local consumption of consumer goods, construction materials, and food, to inform community climate action planning on a known, large emissions source often excluded from inventories.

Figure 2: Clackamas County geographic boundary.

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. The greenhouse gas inventory presented in this report is based on calendar year 2018 data for the Clackamas County geographic boundary. The share of emissions is also estimated for the 15 incorporated cities in the county. This inventory considers all seven recognized greenhouse gases, but only five are relevant for Clackamas County – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC) and sulfur hexafluoride (SF_6). All gases are reported in terms of carbon dioxide equivalent (CO_2e), or the amount of carbon dioxide it would take to create the same warming effect.

As described above, GHG emissions are often organized by sector (e.g. buildings, transportation, industry, etc.) Another way to organize them is by their origin location, either within a community or outside – these are referred to as 'scopes.' Scope categories as outlined below distinguish between those emissions that occur within the geographic boundaries (Scope 1) from those that occur outside the boundaries, but that are driven by activity from within (Scope 2 and Scope 3). Emissions sectors and sub-sectors included in the GPC are shown in Table 1 (next page). These are compared to emissions included in the 2018 community inventory by scope category.

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

[4]GPC has become the recommended or required standard for international reporting to CDP's Cities Survey and the Global Covenant of Mayors for Climate & Energy. While Clackamas County does not currently participate in these endeavors, the Clackamas County 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.

Table 1: Crosswalk of Emission and Scope Categories.

Emissions Sector / Sub-Sector	Included in Inventory	Scope 1	Scope 2	Scope 3
Stationary Energy				
Residential Buildings	•	✓	✓	
Commercial Buildings and Facilities	•	✓	✓	
Industrial Facilities	•	✓	✓	
Energy Generation Supplied to the Grid	•	✓		
Agriculture, Forestry, and Fishing	NE	✓	✓	
Fugitive Emissions from Natural Gas Systems	•	✓		
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	•	✓		
Aviation	NE	✓		
Waterborn Navigation	•	✓	✓	
Waste				
Solid Waste	•	✓		✓
Wastewater Treatment	•	✓		✓
Biological Treatment of Waste	•	✓		✓
Incineration of Waste	•			✓
Industrial Process and Product Use				
Product Use (refrigerants)	•	✓		
Industrial Processes	•	✓		
Agriculture, Forestry, and Land Use				
Livestock	•	✓		
Land	NE	✓		
Other Agriculture	NE	✓		
Other Scope 3 Emissions Sources				
Household Consumption	•			✓
Air Travel	•			✓
Upstream Energy Production	•			✓

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

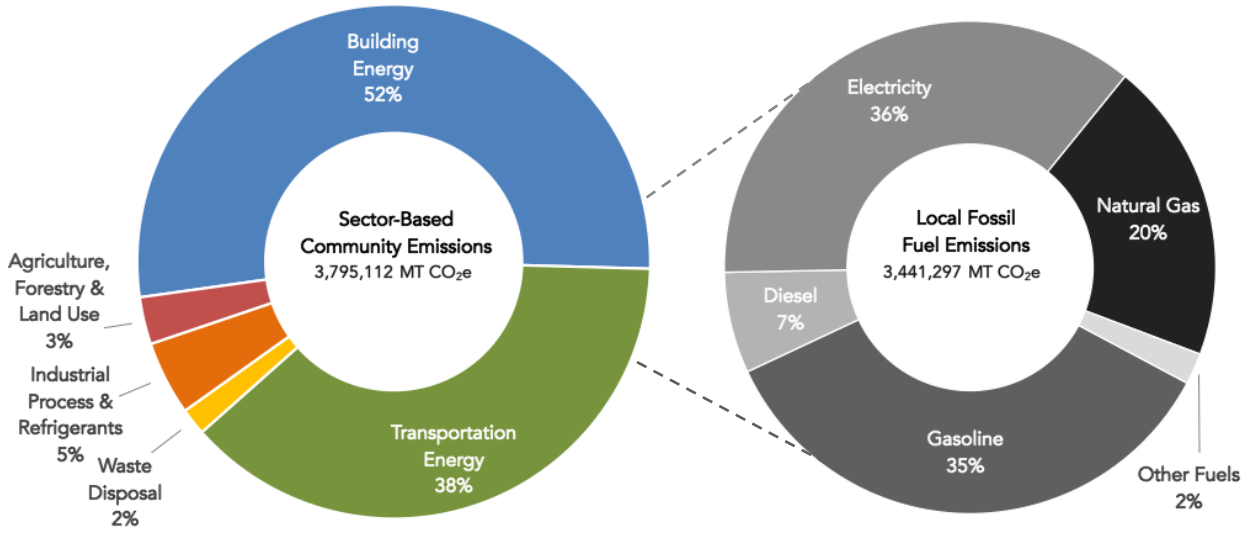
IV. INVENTORY RESULTS

LOCAL EMISSIONS (SECTOR-BASED EMISSIONS)

The Clackamas County community generated 3,795,112 MT CO_2e of local emissions – about 9.1 MT CO_2e per resident. This is less than the U.S. average of 16.5 and considerably greater than global average of 5.0.[5] Protocols refer to local emissions as sector-based emissions. Those emissions are generated close to home and are most often under the community's direct control. This quantity of GHGs is equivalent to the carbon sequestered by nearly 5 million acres of average U.S. forest – a land area about 4 times the size of Clackamas County.

Clackamas County's local emissions[6] are shown on the left side of **Figure 3** and come primarily from electricity use and combustion of natural gas by buildings and other facilities (**blue segments**) as well as gasoline and diesel combustion in vehicles (**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**). Note that all emissions from **buildings** and **transportation** are from fossil fuels; only **waste**, **refrigerants**, and **agriculture** are non-fossil fuel emissions. About 90% of Clackamas County's local emissions are from fossil fuel combustion. The right side of **Figure 3** details fossil fuel use.

Figure 3: 2018 Community Local Emissions and Fossil Fuel Details. All fossil fuel emissions are from building and transportation energy sources.
Note – Figure 3 presents market-based accounting for electricity emissions (see page 12 for more detail).

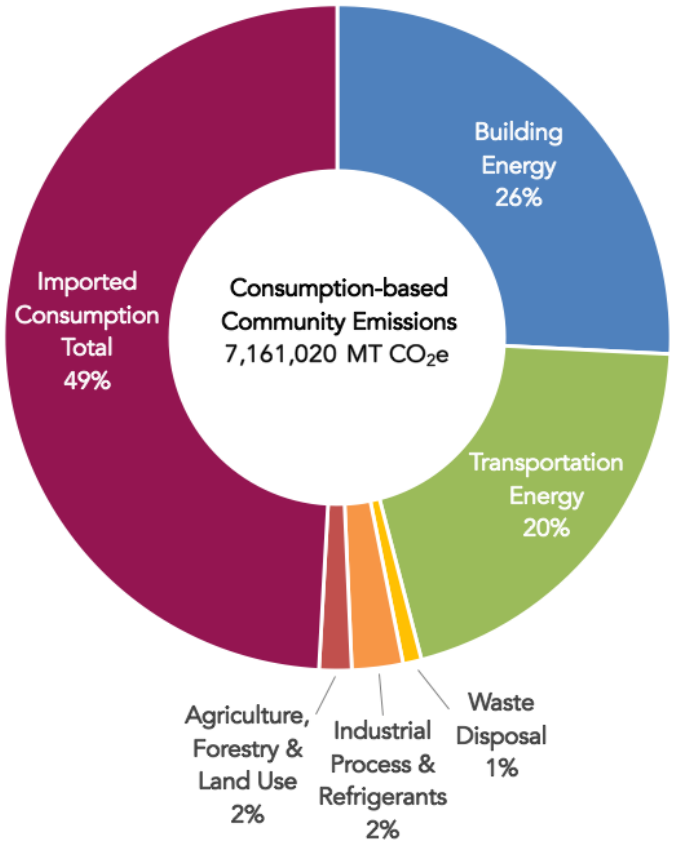


[5] Data from World Bank. For details visit https://data.worldbank.org/indicator/EN.ATM.CO2E.PC.
[6] Local emissions inventories include emissions within the County's boundaries, from energy and fuel use by homes, businesses, and vehicles as well as all emissions from electricity generation, landfilling solid waste and wastewater treatment regardless of the location of the facility. These emissions sources correspond with BASIC+ reporting in the Global Protocols for Community-Scale GHG Inventories.

CONSUMPTION-BASED EMISSIONS

In addition to accounting for local emissions, the inventory also estimates imported **consumption-based emissions**, which are generated outside of Clackamas County to produce the imported goods, food, and services consumed by Clackamas County households. Consumption-based emissions total about 3,500,000 MT CO_2e in addition to sources of sector-based emissions. **Figure 4** compares the scale of local, sector-based emissions to imported emissions from household consumption of goods, food, air travel, and production and transport of the fuels combusted in the County.[7]

Figure 4: Comparison of Local Emissions to Consumption-based Emissions.



Within goods, the largest purchasing categories include building materials, furniture, and vehicles & parts. Within food, the largest emissions are from the production of meats, especially beef and lamb products. Upstream emissions from fuel production and air travel from flights taken by county residents (departing from airports outside of the County) are also significant sources of Clackamas County consumption-based emissions. Upstream fuel emissions are from energy used and various process emissions that occur during production and transport of energy products combusted in Clackamas County and accounted for in Clackamas County local emissions. For more details on these emissions see the related section on page 15. **Figure 5** offers another graphic comparison of sources of local and consumption-based emissions.

[7] Sector-based emissions are calculated using local activity data collected for the inventory year and are considered highly accurate. See Appendix B for details. Imported consumption-based emissions are *estimated* using average factors from State of Oregon's consumption-based model and therefore have a higher level of uncertainty.

Figure 5: Clackamas County Community GHG Emissions by Local (Sector-based) and Consumption-based Emissions Sources.

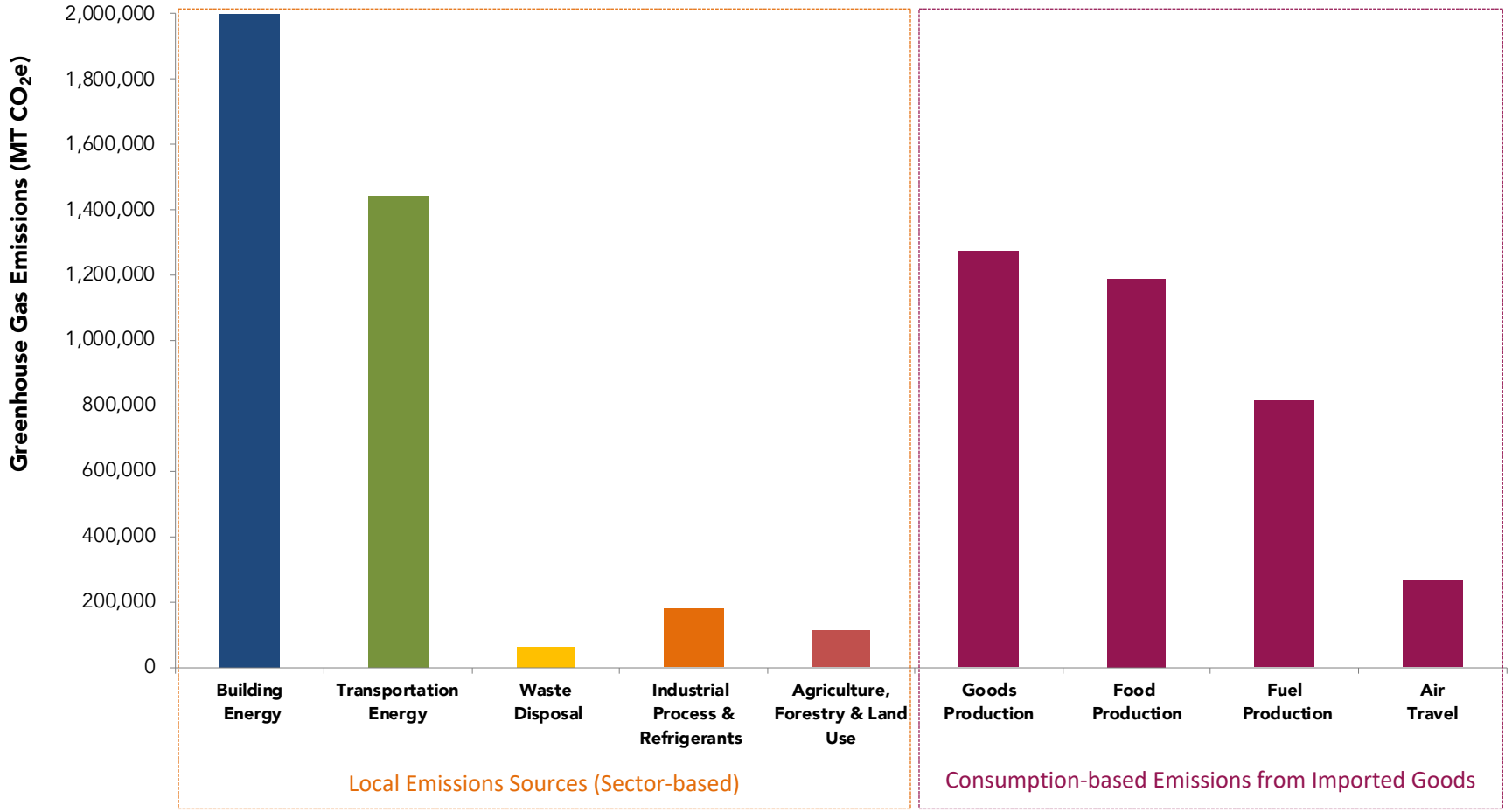


Table 2: Summary Table of Clackamas County 2018 Community GHG Emissions.

Emissions Sector / Sub-Sector	2018 Emissions		Per capita	
	Market-based	Location-based	Market-based	Location-based
Stationary Energy (27%)	**2,017,424**	**1,865,782**	**4.8**	**4.5**
Residential Buildings				
Electricity	576,497	551,058	1.4	1.3
Natural Gas	324,235		0.8	
Other Fuels	29,745		0.1	
Commercial Buildings and Industrial Facilities				
Electricity	656,628	533,524	1.6	1.3
Natural Gas	359,130		0.9	
Other Fuels	40,533		0.1	
Fugitive Emissions from Natural Gas Systems	17,644		0.0	
Fugitive Sulfur Hexafluoride	1,128		0.0	
Potable Water Treatment Energy	6,502	4,806	0.0	0.0
Wastewater Treatment Energy	5,382	3,979	0.0	0.0
Transportation (20%)	**1,442,645**	**1,442,500**	**3.5**	**3.5**
On-Road Passenger Vehicles	1,138,834		2.7	
On-Road Freight & Commercial Vehicles	204,937		0.5	
On-Road Transit Vehicles	8,533		0.0	
Off-Road Vehicles and Equipment	74,264		0.2	
Rail	15,902	15,767	0.0	0.0
Recreational Marine	137		0.0	
Ferry	38	28	0.0	0.0
Waste (1%)	**64,205**		**0.2**	
Solid Waste Landfill and Compost	49,324		0.1	
Wastewater Treatment & Septic Systems	14,831		0.0	
Incineration of Waste	50		0.0	
Industrial Process and Product Use (2%)	**158,399**		**0.4**	
Refrigerants	158,399		0.4	
Agriculture, Forestry, and Land Use (2%)	**112,439**		**0.3**	
Livestock	112,439		0.3	
Land	NE			
Other Agriculture	NE			
Consumption-based & Upstream Emissions (48%)	**3,542,276**	**3,517,696**	**8.5**	**8.5**
Household Consumption				
Goods	1,271,850		3.1	
Food	1,187,346		2.9	
Upstream Energy Production	815,429	790,849	2.0	1.9
Air Travel	267,650		0.6	
Sequestration & Offsets	**-1,404,037**		**-3.4**	
Purchased Offsets	-7,037		0.0	
Local Carbon Storage	-1,397,000		-3.4	
Local Emissions	3,795,112	3,643,324	9.1	8.8
Local + Consumption	7,337,388	7,161,020	17.6	17.2

*See page 12 for a discussion of location-based and market-based electricity accounting emissions. See page 19 section titled, Summary of Exclusions for sub-sectors that are not included. *Sector percentages are based on the market-based accounting Local + Consumption total.*

County-Wide GHG Emissions by Incorporated and Unincorporated Areas

Table 3 uses county-wide GHG emissions and population to calculate average per capita emissions (MT CO_2e / average county resident). This per capita average is then multiplied by populations for cities within Clackamas County as well as the unincorporated population to estimated emissions for these distinct communities in the county. This table presents estimates of these emissions only and not an accurate community-level account.

This inventory project was motivated in part by the desire to provide cities and unincorporated areas with an estimate of emissions at local scales. It is possible that some communities vary in emissions per capita due to differences in consumption, travel, or building energy use. Data to provide accurate accounting for cities and unincorporated communities was requested in the course of this inventory but was unavailable for most data sources. Thus, while actual emissions per capita may differ between communities in Clackamas County, and the relative contribution from different sectors may vary too, data was not available that could describe variability. The only exception was PGE electricity account, where PGE was able to provide this level of detail. Canby Utility Board reported electricity is also known to be exclusive to Canby. Additional details for building energy use between cities vs unincorporated are presented in the Buildings section in **Figure 8**.

Table 3: Summary Table of Clackamas County 2018 Estimated GHG Emissions by City.

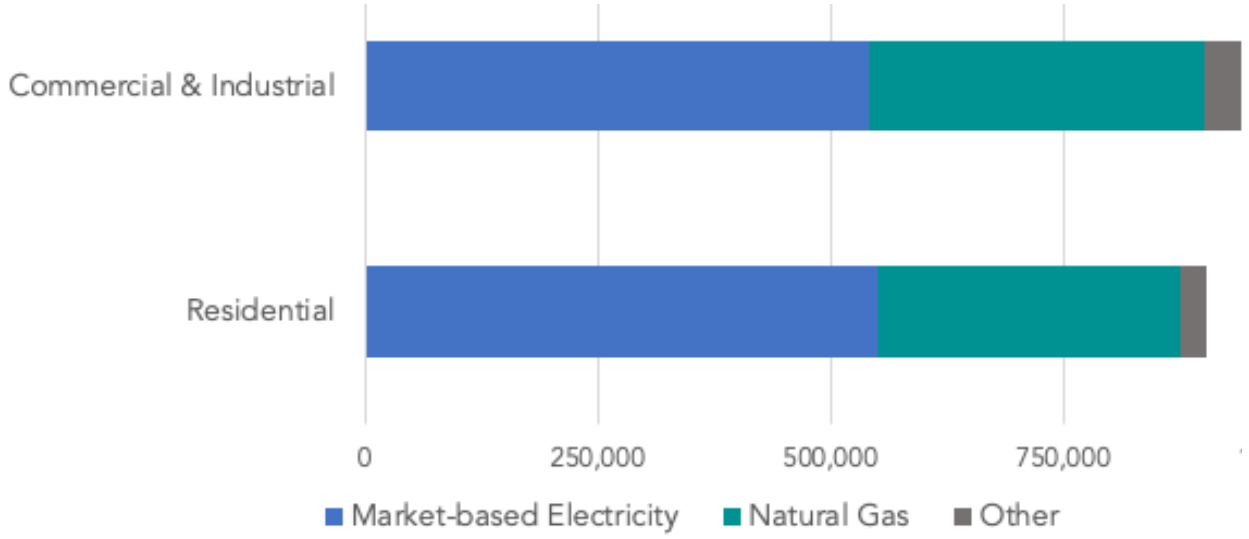
City	2018 Population	2018 GHG Emissions (estimated)
Barlow	135	1,231
Canby	16,800	153,237
Estacada	3,400	31,012
Gladstone	11,880	108,360
Happy Valley	20,945	191,044
Johnson City	615	5,610
Lake Oswego	38,215	348,567
Milwaukie	20,525	187,213
Molalla	9,625	87,792
Oregon City	34,860	317,966
Rivergrove	372	3,393
Sandy	10,990	100,242
Tualatin	27,602	251,764
West Linn	25,830	235,601
Wilsonville	25,250	230,311
Unincorporated	169,031	1,541,769
County-Wide Totals	416,075	3,795,112
County-Wide Average per Capita GHGs		9.1

DETAILED RESULTS FOR SECTORS & SIGNIFICANT EMISSIONS

Buildings

Electricity and natural gas use by the residential and commercial sectors are large sources of local emissions. Clackamas County commercial and industrial uses have a slightly larger impact in Clackamas County than residential uses. By energy type, electricity had the largest impact (59% of total building emissions); followed by natural gas (37%); and other fuels (4%). **Figure 6** shows building energy emissions broken down by sub-sector and energy type.

Figure 6: Comparison of Building Energy Emissions by Sub-sector and Energy Type, (MT CO_2e).



The Community Inventory Protocol (GPC) requires that communities report electricity emissions using two accounting methods; 1) location-based, and 2) market-based. ***Market-based accounting*** is based on the GHG intensity of electricity contracts with local utilities[8] and is used in most of the figures presented in this report as the GPC protocols recommended methodology to track progress towards goals over time. ***Location-based electricity accounting emissions*** are calculated using the regional electricity grid's (Northwest Power Pool, NWPP) GHG intensity and represent the average impacts of electricity use and efficiency efforts.

PGE provides about 95% of the county's electricity supply with the remainder supplied by Canby Utility board. PGE's utility-specific emissions intensity is greater than Canby Utility Board and the NWPP regional grid average (0.395 MT CO_2e/MWh vs. 0.290 respectively). As can be seen in **Figure 7** this difference is the driver in market-based emissions being larger than location-based for the Clackamas community. PGE's electricity generation from owned and jointly-owned power

[8] Market-based electricity accounting is commonly used for target and goal tracking and is useful to assess and manage GHGs associated with electricity generation and supply. Location-based electricity accounting offers a means of assessing the average impacts of electricity use on the regional electricity grid. It also highlights benefits for energy efficiency actions, particularly in communities served by utilities with very low GHG electricity. That is, the less electricity used in the community, the more low-GHG electricity there is available for export to communities with more GHG intensive electricity sources.

plants are largely served by natural gas, as well as coal, hydroelectricity, and wind. Canby Utility Board is served by Bonneville Power Administration's low-GHG hydroelectricity.

The market-based electricity accounting method also accounts for community participation in utility green power programs. In 2018, PGE's and Canby Utility Board's customers voluntarily purchased Renewable Energy Credits (RECs) equal to about 9% of demand, which decreases Clackamas County market-based electricity accounting emissions. In addition, about 1% of community demand is generated within the county through residential and commercial PV solar installations.

Figure 7: Comparison of Location-based to Market-based Electricity Emissions.

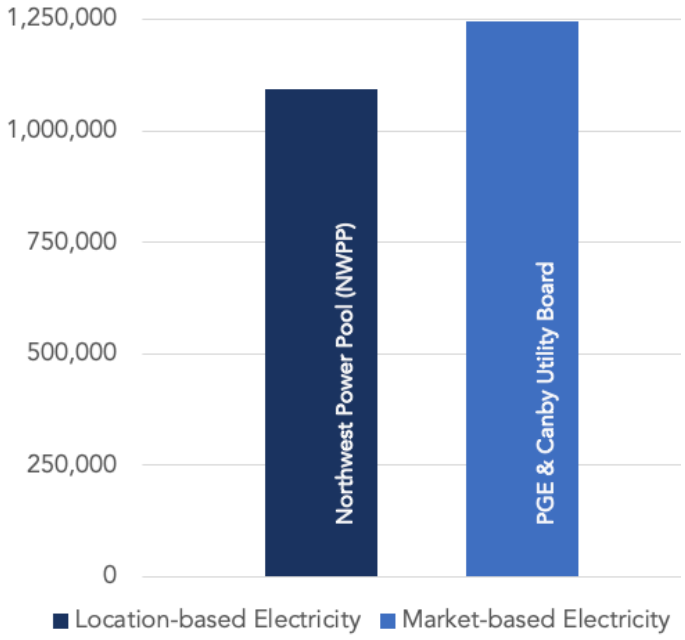
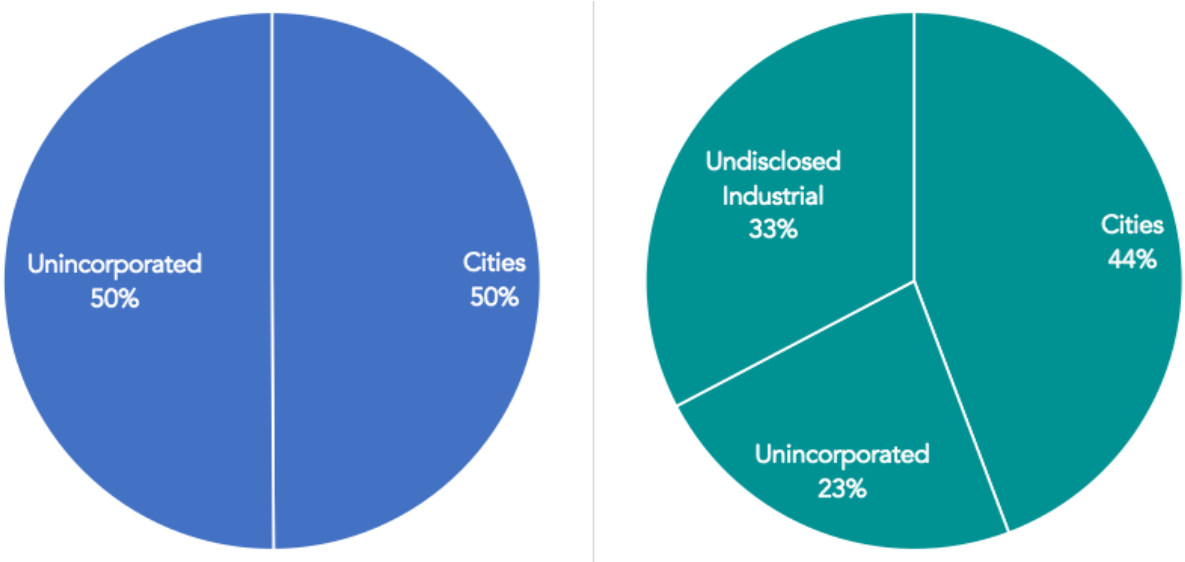


Figure 8 compares building electricity use and natural gas use by incorporated and unincorporated areas. As can be seen, electricity use is equally split between the two while natural gas use is mostly by cities and large industrial users.

Figure 8: Clackamas County Electricity Use, % of kWh Consumed (left) and Natural Gas[9] (right).



[9] Northwest Natural Gas did not provide incorporated / unincorporated data splits for industrial customers and natural gas transport (i.e. gas transported via NWN pipes for users within Clackamas County by a supplier other than NWN) due to customer privacy concerns.

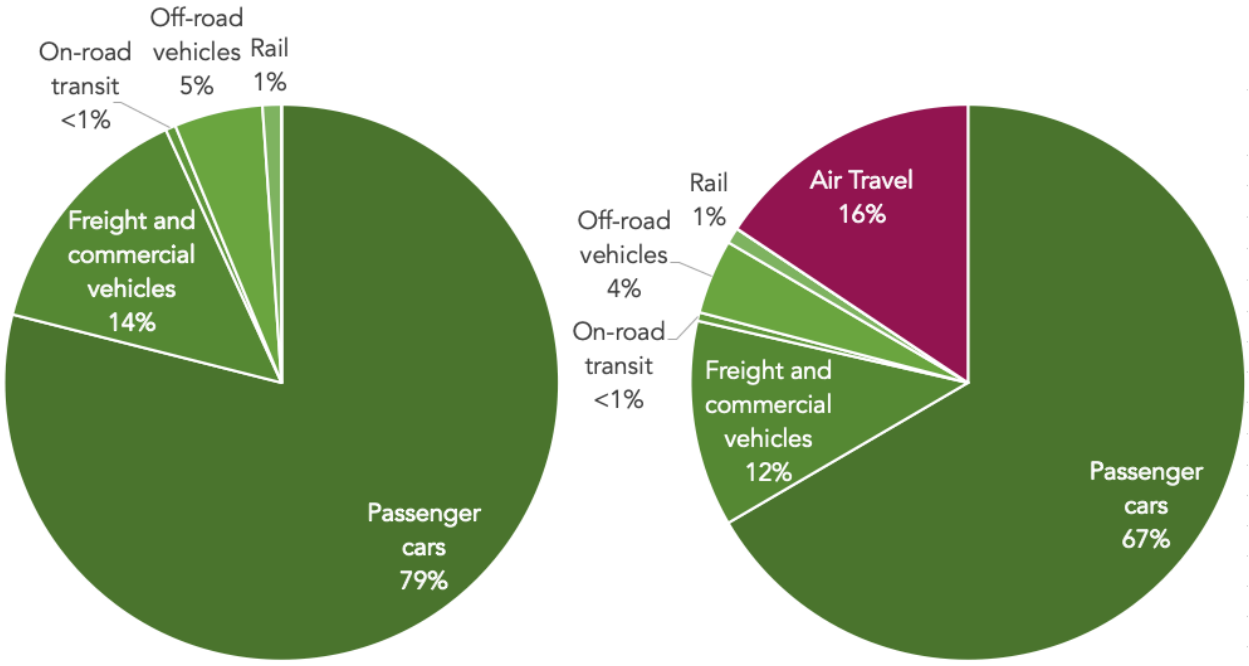
Two smaller sources of reported emissions include fugitive natural gas (i.e. methane loss) from Northwest Natural's distribution system in Clackamas County (~18,000 MT CO_2e) and fugitive loss of SF_6 from PGE's local electricity distribution system (~1,000 MT CO_2e). Related to fugitive natural gas, Northwest Natural's reported distribution loss rate is *less than half* of GHG inventory protocol's default rate for this source (NWN's reported is 0.14% while the protocol default is 0.3%). Additional upstream emissions from natural gas production (energy use and process emissions at the point of extraction and during transport) are included in Consumption-based emissions.

Transportation

On-road passenger vehicles are Clackamas County's leading source of transportation-related local emissions and represent 79% of transportation emissions. See **Figure 9**. These emissions originate from residential-owned passenger cars and trucks, which primarily use E10 gasoline. The next largest category is freight & commercial vehicles at 14%, including local & heavy-duty freight and service providers such as electricians, plumbers, etc. operating within the boundary. The next category is off-road (e.g. construction) sources at 5% of emissions. Passenger and freight rail, transit, and marine transportation all represent around 1% or less of transportation emissions.

Air travel is not considered a source of local emissions for Clackamas County as there are no commercial airports within the county's geographic boundary (other than very small private facilities). Air travel services used by Clackamas County residents for flights departing outside the county are included as part of Clackamas County **consumption-based emissions**. As is shown in **Figure 9**, GHGs from air travel services (**magenta**) are a significant source of emissions in addition to local transportation emissions (**green**).

Figure 9: Transportation Emissions by Vehicle Category, Comparing Local Emissions (all **green**, left) and Local Emissions with Scope 3 Air Travel (with **magenta**, right).



Waste

Waste in Clackamas County includes process methane and nitrous oxide emissions from landfill disposal of mixed solid waste (MSW); composting of organic wastes (e.g. yard waste); wastewater emissions at wastewater treatment plants; and emissions from residential septic systems. Disposal of solid waste, specifically the landfilling of MSW, is the largest source of waste emissions (77%) with the remainder from wastewater (23%). Landfill emissions are calculated based on waste composition as reported in Oregon Department of Environmental Quality's 2017.

Industrial Process & Product Use (IPPU)

Emissions from product use in Clackamas County, the only source of emissions reported for the IPPU sector, includes fugitive loss of refrigerants from buildings and vehicle sources. These sources are estimated for Clackamas County using State per capita data, downscaling from emissions reported in the State of Oregon's 2015 GHG Inventory, and are estimated at 158,399 MT CO_2e. In Oregon, sources of refrigerant emissions have grown significantly over the past 10 years.

No large industrial process emissions sources were identified within Clackamas County using the U.S. Environmental Protection Agency's Facility-Level Information on Greenhouse Gases Tool (FLIGHT). There are industrial facilities within Clackamas County, but none that exceed the EPA's mandatory reporting threshold of greater than 25,000 MT CO_2e annually.

Agriculture, Forestry, & Land Use (AFLU)

Agricultural emissions, and specifically, methane emissions from livestock are the only source included in the Clackamas County inventory (112,439 MT CO_2e). A wide variety of livestock are raised within the County and these emissions come from enteric fermentation by ruminant animals and manure management.

Two other sources of emissions are expected to be significant within the County, including the application of soil inputs (e.g. nitrogen fertilizers) and the conversion of greenspace to developed land, but data was not available to support emissions calculations. See Appendix B for additional details for excluded emissions sources.

Consumption-based Emissions from Imported Goods, Food and Air Travel

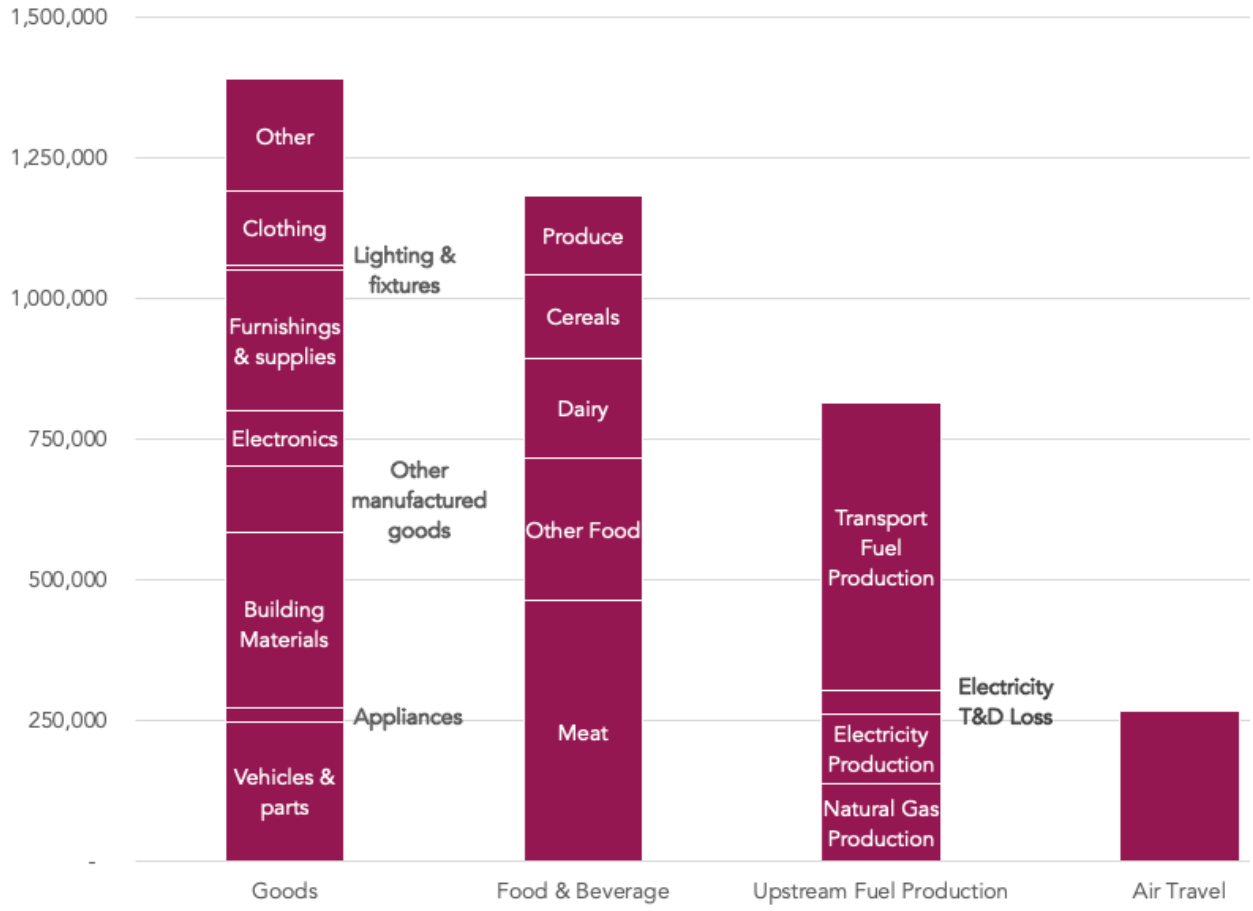
Clackamas County's inventory goes beyond GPC protocol requirements to highlight known large sources of consumption-based emissions. These emissions are considered Scope 3 in GHG inventory accounting. This means the community has less ownership and control over management of these emissions as compared to sources of local emissions. These consumption-based emissions will be in another community's local accounting. That said – these emissions are included in the inventory because they are large; it follows State of Oregon inventory practices; and because local opportunities exist to reduce these emissions locally.

The following consumption-based emissions categories are considered.

- **Household Goods:** Emissions from extraction, manufacture, and transportation of raw materials into final products such as building materials, automobile, furniture, clothing, and other goods.
- **Household Food:** Emissions from agriculture (energy for irrigation, production of fertilizers, methane emissions from livestock, etc.), transportation of raw materials, and finished products emissions. Categories included are grains, dairy, meat, produce, and other foods.
- **Upstream 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.
- **Air Travel:** Emissions associated with air travel by the community from airports outside the community's geographic boundary.

Some of the largest purchasing categories include food, building materials, furniture, and vehicles & parts. Within food, the largest emissions are from meats, specifically beef and lamb products. Upstream emission for transportation fuel production and air travel from flights taken by county residents (departing from airports outside of the county) are also significant sources of Clackamas County consumption-based emissions. Upstream emissions are emissions from energy used and various processes that occur during production and transport of energy products combusted in Clackamas County and accounted for in Clackamas County local emissions.

Figure 10: Detailed results of Consumption-based Emissions (MT CO_2e)



Negative Emissions (Carbon Sequestration and Purchased Carbon Offsets)

When considering what to do with information about greenhouse gases the county is emitting or causing to be emitted, there are different categories of action. The primary and essential action is to reduce emissions from fossil fuels. The combustion of fossil fuels release carbon into the atmosphere that has been stored for millions of years in the earth (as coal, petroleum and natural gas) and without human intervention would continue to be locked away. Greenhouse gas inventories and climate action plans (CAP) are focused on understanding and implementing actions to reduce sources of these emissions.

But there are complementary actions that may be taken, particularly when we consider opportunities within a County's geographic boundary, through either local carbon storage in community land use (i.e. forests and soils) or by community purchase of carbon offset credits. These actions can be thought of as "negative emissions" or sequestration actions, and are needed to reduce carbon dioxide that is already in the atmosphere. Negative emissions may be pursued by communities by managing local natural resources for greater carbon storage (e.g. forests and soil) or participating in community-wide purchased carbon offset programs (e.g. Northwest Natural Gas' Smart Energy program). These types of actions are a complement to reducing fossil fuel and other man-made greenhouse gas emissions. But these actions cannot act as a substitute as the current rate of fossil fuel combustion far outpaces the availability of natural resources to sequester fossil fuel carbon.

Negative emissions accounting methodology is not currently included in community GHG inventory protocol. Further, the protocol explicitly states that local sequestration and purchased offsets may not be used calculate a net reduction in community emissions. That said – this category is included as current best practice given the recent emergence of net-zero climate goals and the potential scale of land use opportunities within Clackamas County's forest and agricultural resources.

Clackamas County land area is approximately 1.2 million acres with more than 600,000 acres of forests and over 150,000 acres of agricultural land. Clackamas County's forested land gained significant additional carbon storage during 2018. It is estimated that additional carbon storage by Clackamas County in 2018 totals over 1.4 million MT CO_2e, or about 2.3 MT CO_2e per acre.[10] This value is the net gain in carbon storage for the inventory year, not the *total* carbon storage for Clackamas forest lands. Storage will fluctuate from year to year depending on a variety of factors including the impact of wildfires. This scale illustrates that future management towards maximizing vegetative and soil carbon storage may offer a significant climate action opportunity for the Clackamas Community. This not only demonstrates the opportunity for additional carbon sequestration, but the importance of keeping this large carbon storage source intact and undisturbed.

In addition to local carbon storage, about 1% of the natural gas used in Clackamas County is compensated for by community members who participate in Northwest Natural's innovative Smart Energy program (approximately 7,000 MT CO_2e). This program allows customers to purchase carbon offsets from The Climate Trust on their bill to offset GHGs from natural gas use.

[10] Additional storage for 2018 is estimated using information presented to Oregon's Global Warming Commission by the Forestry Task Force in a presentation titled The Forest Carbon Picture in Oregon: *A Key Role in the State's Carbon Footprint and Performance (May 2018).*

V. COMMUNITY EMISSIONS FORECAST

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

Figure 11 (next page) is a complement to the information provided in **Figure 1**, which shows how community emissions will change over time in a BAU scenario with population growth compared to the forecast effect of existing State and Federal policies. **Figure 11** shows similar information but focuses on the effect of various policies (as wedges) to illustrate the scale of corresponding reductions by sector. The figure includes:

- **Population BAU:** The **red** dotted line in Figure 11 represents 2018 community emissions rates and increases them by population forecasts for Clackamas County through 2035.
- **State of Oregon Goals:** The **yellow** dotted line represents emissions reduction pathway required to meet the State of Oregon's Climate Goal.
- **Existing Policy BAU:** The wedges in Figure 11 shows the emissions reductions expected from existing regional, state, and federal policies by sector.

Policies considered in the Existing Policy BAU scenario include:

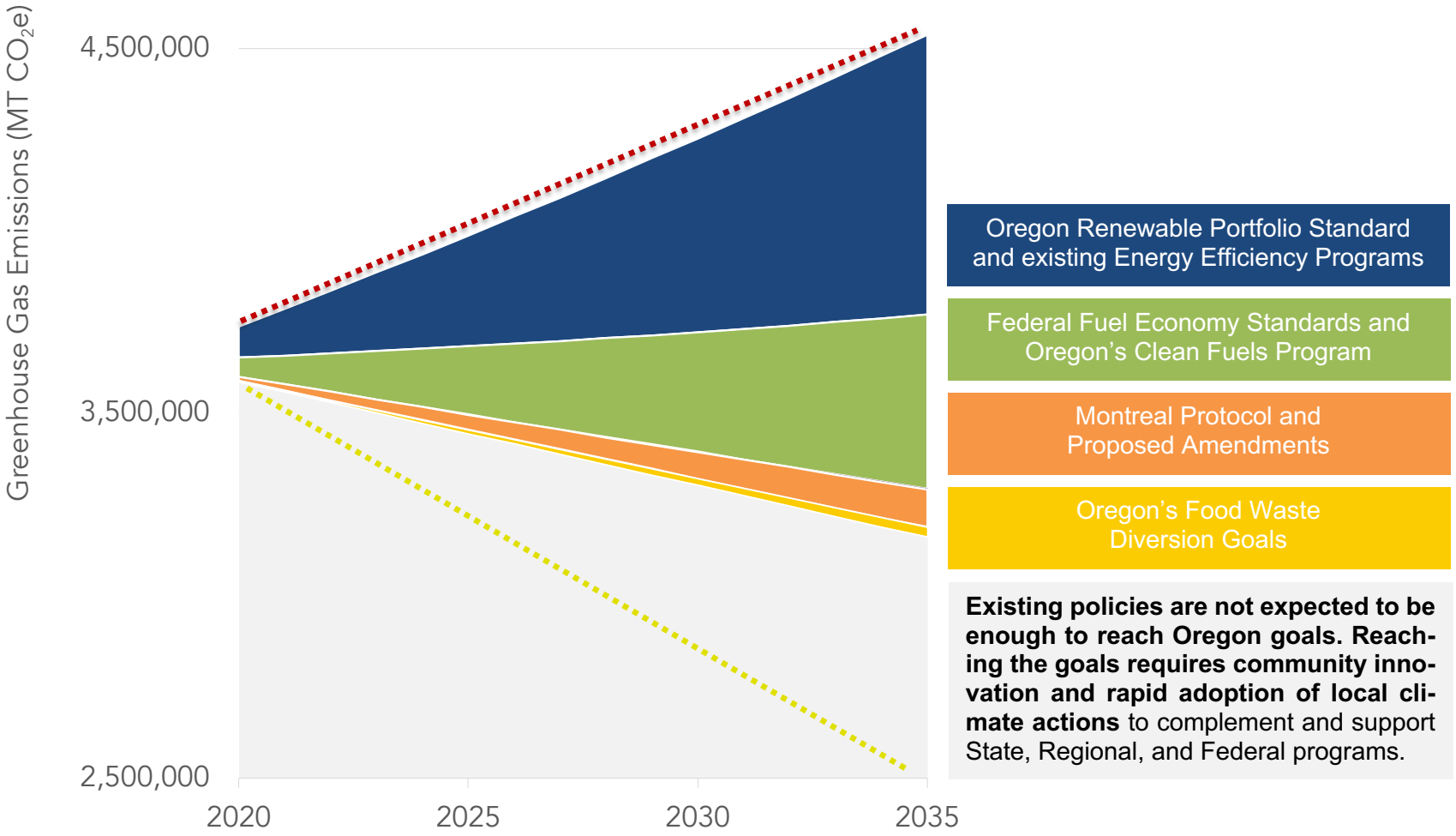
- Oregon's Renewable Portfolio Standard (RPS)[11]
- Energy Trust of Oregon's Programs[12]
- Federal Fuel Economy Standards (CAFE)[13]
- Oregon's Clean Fuels Program
- Montreal Protocol and Amendments
- Oregon SB263 (food waste recovery)[14]

These policies are forecasted to reduce emissions 33% compared to the BAU scenario in 2035. The largest sources of emissions reductions come from Oregon's Renewable Portfolio Standard and the Federal light-duty fuel economy standards. This forecast shows, as other forecasts have,[15] that existing policies are likely not enough to reach Oregon's existing climate goals, much less the more aggressive goals of the Paris Accord.

More aggressive policies to systemically reduce energy use and emissions intensity from our energy systems are required, as is participation and support from the public at large to rapidly adopt commercially viable climate targets to support and ensure success of climate policies.

[11] PGE provided a forecast of annual average emissions factors for the IRP's preferred portfolio scenario.
[12] Load forecast based on PGE's 2019 Integrated Resource Plan, preferred scenario.
[13] On-road transportation forecast based on reductions reported in Oregon Global Warming Commission's 2018 *Report to the Legislature*. OGWC modeling assumed to account for both increasing fuel economy and reductions associated with Oregon's Clean Fuels Program.
[14] Forecast based on 25% food waste diversion requirements in SB263. EPA's waste reduction model (WARM) used to estimate emissions reductions.
[15] Oregon Global Warming Commission 2018 Biennial Report to the Legislature. Accessed 5/20 online at https://www.keeporegoncool.org/reports.

Figure 11: Estimated Future Emissions Reduction Based on Population Growth and Existing Policies Relative to State Goals.



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 accounting emissions and ICLEI's US Community Protocol for guidance on calculation of consumption-based emissions (i.e., other Scope 3 as defined by GPC protocol).

Good Company's carbon calculator tool *G3C – Community* was used for emissions calculations. Emissions are documented in the CY 2018 GHG 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 the 2018 inventory.

All community GHG emissions presented in this report are represented in metric tons of carbon dioxide equivalent (MT CO_2e). The gases considered in the analysis are consistent with protocol and include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), Chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) per the Kyoto Protocol. All GHG calculations use 100-year 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 the Sustainability & Solid Waste Program at Clackamas County (Sarah Allison and Eben Polk) to collect the 2018 data required to calculate emissions. City staff along with other local and regional government staff as well as private businesses that serve the Clackamas County community graciously provided time, data and expertise. Data and emissions factors are described in Appendix A.

SUMMARY OF INVENTORY EXCLUSIONS

Emissions Sector / Sub-Sector	Justification for Exclusion
Stationary energy: Agriculture, Forestry, and Fishing	Data splits not available for these sub-sectors, but will be included in the inventory for consumption of natural gas and electricity within the County geographic boundary. Estimates of off-road fuel use are included in the transportation sector.
Stationary energy: Emissions from Coal Production	No activity identified within boundary.
Transportation: aviation	Emissions estimated to be very small, with no commercial airports.
Agriculture, Forestry, and Land Use: Land use	Clackamas County includes significant unincorporated land area that is undisturbed and currently storing carbon in the trees and soil. As land is cleared for development there is the potential to lose significant quantities of stored carbon and therefore should be included in a community GHG inventory. Data related to the development of this unincorporated land was not readily available

	for this inventory but should be re-considered in future years' inventories given the scale of forest carbon storage in Clackamas County and projected population growth. The data required would be land area converted (reported in acres) from either forest or grassland to developed.
Agriculture, Forestry, and Land Use: Other agriculture	Application of Soil Amendments – Data was not identified to estimate emissions from the application of soil amendments in Clackamas County agriculture (e.g. conventional nitrogen fertilizers). Given that agriculture is a significant economic sector in Clackamas this emissions source should be reconsidered in future inventories. The data required would include the weight and type of soil amendments applied. This data may also be estimated using information about dominant crop types and average annual soil amendments required for these crop types.

SUGGESTIONS FOR FUTURE INVENTORIES

- **Frequency of community inventories.** A first-time inventory can take significant time and resources to complete, as relationships with external partners are built and needed data collection systems are established. Future year inventories leverage those systems to reduce the time required to complete the inventory. An appropriate frequency for community invitatories is between 2 – 5 years. Annual inventories may be too frequent while a duration longer than 5 years may result in system decay. In 5-years' time, memories fade, files are purged from servers, and staff change organizational roles. We've sought to address the loss of memory and files in the 2018 inventory by providing detailed inventory audit trail, but recommend it is utilized by staff within the next few years to ensure system efficiencies and relationships are maintained to support future inventories.
- **City-level reporting.** At the onset of data collection, the intent was to collect county-wide data in addition to data for each incorporated city. This proved to be challenging for most external data providers with the exception of the electric utilities. This reporting request does not align with existing data systems and therefore requires significant labor on the part of external partners to provide these data details. Some external parties also reported privacy concerns for their large customers. To provide this reporting for the 2018 inventory we allocated county-wide emissions based on cities' and unincorporated populations. This approach provides a sense-of-scale estimate but should be used with caution as specific community context was not accounted for accurately.

APPENDIX A: GLOSSARY OF TERMS

GHG

Short for greenhouse gases. Emission of greenhouse gases are the cause of current climate change. An inventory of GHGs measures gases in units of CO_2e. A GHG inventory is also known as a carbon footprint.

GHGP/GPC/Protocol

This type of inventory follows a set protocol, the GHG Protocol (GHGP) standard for cities known as Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). This protocol determines what is included within a set boundary and categorizes emissions by sector. See Sector-based inventory for more information.

GWP

Short for global warming potential. This refers to the potency of emissions to trap heat in the atmosphere. Carbon dioxide has a GWP of 1, and other GHG gases are more potent and expressed as a multiple of carbon dioxide. For example, methane has a GWP of 34, meaning one molecule of it has 34 times the effect of one molecule of carbon dioxide.

Consumption-based Emissions (Other Scope 3)

Emissions from consumption of imported goods and services, also known as Other Scope 3 Emissions per GPC protocol, include emissions from upstream fuel production and household consumption, such as food, household goods, and air travel.

IPCC AR5

The United Nations Intergovernmental Panel on Climate Change (IPCC) releases Assessment Reports providing an overview of the state of knowledge concerning climate change science. The fifth report, AR5, is the most recent version released in 2014.

KWh

Short for kilowatt hour. Kilowatt hours are a standard unit for electricity consumption, and a measure of electrical energy equivalent to a power consumption of 1,000 watts for 1 hour.

Sector-based Greenhouse Gas Inventory (i.e., Local Emissions)

This refers to preparing an inventory that is broken down by various sectors of the community that have common GHG characteristics. In this report, sector-based emissions are called **local emissions**. This type of inventory follows a set protocol (GPC) determining what is included in each sector, as discussed in Section IV Methodology Overview. Mainly, sector-based emissions include emissions from building energy and vehicles along with local sources of GHGs from waste (regardless of landfill site) and uncontrolled loss of methane and refrigerant gases. Note that emissions from household consumption of goods and services are not included in sector-based inventories. The sectors applicable to this inventory are discussed on page 8 and include:

Buildings: emissions from energy used or produced in a fixed location, e.g. electricity, natural gas, heating fuel oil (mainly building energy).

Transportation: emissions from vehicles and mobile equipment.

Waste: landfilled waste emissions and wastewater treatment emissions.

Process Emissions & Product Use: refrigerants and other fugitive gases from industrial processes and natural gas transportation.

Agriculture, Forestry & Land Use: emissions from agriculture (e.g. animal waste and agricultural inputs) and community land use change (e.g. development of forest or grasslands).

Location-based Electricity Emissions Accounting

Refers to GHG intensity of the regional electricity grid, representing the average impacts of electricity use and efficiency efforts across the region. Contrast with Market-based Electricity Emissions Accounting. See discussion on Page 16.

Market-based Electricity Emissions Accounting

Refers to the GHG intensity of electricity contracts with local utilities, in the case Snohomish County Public Utility District. Contrast with Location-based Electricity Emissions Accounting. See discussion on Page 16.

MT

Short for Metric Ton (~2,200 lbs.). International standards call for metric tons as the typical standardized unit.

MT CO_2e

Metric Tons of carbon dioxide equivalent – a unit of measure. Most greenhouse gases are more potent in warming the atmosphere than carbon dioxide. In order to calculate and compare emissions easily, all gases are calculated and combined into a carbon dioxide equivalent, typically measured in metric tons.

Scope (as in Scope 1, Scope 2, Scope 3)

Scopes are one method to define the source of emissions. Scope categories distinguish between emissions that occur within a geographic boundary (scope 1), from electricity generation serving the community (scope 2), and emissions that occur outside the boundary, but that are driven by activity within the boundary (scope 3). Scopes are discussed on pages 19 and 20 and are another way to frame emissions included in other inventory methods.

Therm

Common reporting unit of natural gas that represents 100,000 British thermal units. A therm is roughly equivalent to 100 cubic feet of natural gas.

APPENDIX B: SUMMARY OF DATA AND EMISSIONS FACTORS

Description of Data and Emissions Factors	
Population information was obtained from the US Census Bureau. Per capita GHG emissions were obtained by dividing the 2018 local emissions by the 2018 estimated population. Emissions for the County's cities are estimated using county-wide emissions and city populations.	
Emissions Category	**Category Description**
Stationary Energy (Buildings)	
Residential Energy	*These categories include direct emissions from natural gas, fuel oil, and propane combustion by the residential, commercial, and industrial sub-sectors within the county's geographic boundaries. Also includes the emissions from grid electricity use by the same sub-sectors for the same geographic boundaries.*
Commercial Energy	
Industrial Energy	
Electricity and natural gas data provided by electric utilities, Portland General Electric and Canby Utility Board, and natural gas utility, Northwest Natural. Electricity and gas data included information on retail sales; participation in renewable electricity and carbon offset programs; and local electricity generation from privately owned residential and commercial PV solar installations. This utility data is considered highly accurate. Residential and commercial fuel oil and propane use was estimated using state-level per capita fuel usage data downscaled by Clackamas County's 2018 population. Emissions factors for natural gas, fuel oil, and propane are from U.S. EPA's emissions factors hub and The Climate Registry's 2018 Default Emissions Factors and are considered highly accurate. Electricity location-based emissions factors are taken from EPA eGRID 2018 data for the Northwest Power Pool (NWPP) sub-region. Market-based electricity accounting emissions factors for PGE and Canby Utility Board are taken from Oregon Department of Environmental Quality's report titled, *2010 – 2017 Greenhouse Gas Emissions from Electricity Use*. Online at https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx.	
Fugitive Natural Gas System Emissions	*Fugitive loss of natural gas from the local product distribution system.*
Northwest Natural Gas reported a 0.14% system leakage rate for Clackamas County. Note that the NWN reported rate is less than half of the protocol default proxy value of 0.3%.	
Fugitive SF_6	
Portland General Electric reported the weight of sulfur hexafluoride (SF_6) fugitively lost during 2018.	
Transportation	
On-Road Energy	*Direct emissions from gasoline and diesel for passenger & freight transportation.*
Staff at Portland Metro used the Regional Transportation Model to calculate average daily 2015 Clackamas County transportation greenhouse gas emissions using two calculation methods; 1) Network-based, and 2) Matrix-based. Results were used as received and no adjustments were made to account for different data years. The **network-based** calculation provides emissions that correspond to all on-road vehicle miles traveled within the County geographic boundary regardless of origins and destinations. The **matrix-based** calculation method provides emissions that correspond to all on-road vehicle miles traveled with trip ends in the County regardless of the trip origin or destination. Portland Metro staff recommends utilizing the Matrix-based calculation data as the approach used by many other Oregon jurisdictions; it is the preferred method community GHG inventory protocols; and it is the more appropriate way to identify those emissions most directly associated with households and businesses within the geography in question and most likely to be impacted by any policies that might be enacted. On-road emissions are modeled and are considered highly to moderately accurate.	
Transit	*Direct emissions from gasoline and diesel for passenger transit transportation.*
Data was collected for five transit providers in Clackamas County, which provided fuel volume data by fuel type. Transit types included bus, light rail, commuter rail, and paratransit. Data was available for the	

following agencies: TriMet; Clackamas County Mt. Hood Express; SMART (Wilsonville); Canby CAT; South County Transportation District (Molalla). Data requests were also sent to Sandy Area Metro. Data received is considered highly accurate.	
Water Transportation	*Direct emissions from gasoline and diesel sold to recreational marine vehicles and indirect emissions from electricity used by ferry.*
Data was collected for Canby Electric Ferry, which provided fuel kWh of electricity and utility name. Data is considered highly accurate. Diesel and gasoline fuel sales at the recreational marina were provided as an annual estimate and considered moderately accurate.	
Rail – Passenger & Freight	*Direct emissions from gasoline and diesel for passenger and freight transportation.*
For passenger and freight rail calculations, rail distance data was acquired from the U.S. Bureau of Transportation Statistics. Activity data estimates from ODOT and Amtrak were used to identify activity in Clackamas County. For Amtrak passenger rail, Amtrak's route-specific published data for ridership along Amtrak routes through Clackamas County was used to calculate passenger-miles which was then multiplied by EPA's rail emissions factor. Amtrak publishes annual reports, allowing for more accurate and convenient reporting. For freight rail, annual gross ton miles were multiplied by EPA's rail product transport emissions factor. Unlike Amtrak, ODOT does not publish annual reports, relying on older reports from 2010. This sub-sector required significant estimation of activity data and therefore is considered as having mid-to-low accuracy.	
Off Road	*Direct emissions from gasoline and diesel for off-road vehicles such as construction equipment, etc.*
A high-quality, annually available data source for off-road is not available for Clackamas County. To provide an estimate for the 2018 inventory Good Company used the U.S. Department of Transportation, Federal Highway Administration's report titled Off-highway and Public-use Gasoline Consumption (2015). This report used EPA's NonRoad model to estimate off-road fuel use for each of the United States. Oregon values in this report are downscaled on a per capita basis to estimate non-road fuel use in Clackamas County. Note: Oregon Department of Environmental Quality is developing an inventory of off-road equipment. This resource may be useful in future inventories for this emissions source. This sub-sector required significant estimation of activity data and therefore is considered as having mid-to-low accuracy.	
Waste	
Landfill Solid Waste	*Fugitive methane emissions from mixed solid waste generated in the community and disposed of at outside the City.*
Activity data for Rossman's Landfill, Coffin Butte Landfill, Wasco County Landfill, Columbia Ridge Landfill was taken from the Oregon DEQ's registered facilities database, a reliable, recurring data source. Self-haul tons and waste sent to Covanta Waste-to-Energy plant were also reported by the County. Emissions calculation methodology follows IPCC's first order decay model and is designated by EPA as EE-6 calculations. Landfill emissions are scaled down per capita using the ratio of Clackamas County to the metro's tri-county population. Population data is provided by the US Census Bureau. This activity data is considered highly accurate.	
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 currently accounted for in GPC methodology.*
Compost facility data for two private facilities were available from DEQ using 2017 reporting; 2018 data was not available. This activity data is considered highly accurate.	

Wastewater Treatment Process Emissions	*Fugitive nitrous oxide emissions from discharge of treated effluent (wastewater).*
Wastewater treatment plant process emissions for biogas combustion and effluent discharge are calculated using data provided by Clackamas County staff and external agencies. Data was collected for the following wastewater treatment plants: Canby, Tri-County, Kellogg Creek, and Hoodland. The following were calculated for facilities as appropriate depending on their operations. For biogas combustion data included square cubic feet per day of biogas and the percent methane in the biogas. For effluent discharge the data included kilograms of nitrogen discharged per day. Emissions calculations for nitrification / denitrification are based on community population data from Portland State University's Population Research Center. This activity data is considered highly accurate.	
Septic Systems	*Direct emissions from the combustion of biosolids (wastewater).*
Septic fugitive emissions are estimated using number of parcels in the county not served by centralized sewer service. The number of systems is multiplied by Clackamas County's average household size to estimated population served by septic. Average emissions factors for residential septic systems are provided by the U.S. Community GHG Protocol. This activity is considered highly accurate.	
Industrial Process and Product Use	
Refrigerant Loss	*Fugitive loss of refrigerants from building and vehicle air conditioning systems.*
County-specific data for fugitive refrigerant loss is not readily available and would be very time consuming to collect. Therefore, activity data for fugitive refrigerant loss is estimated using Oregon state-level data attributed to our community on a per capita basis. Activity data for state-level fugitive emissions from refrigerants, aerosols, and fire suppression systems is reported in the Oregon Department of Environmental Quality's (ODEQ's) Oregon Greenhouse Gas Inventory. Oregon's GHG inventory includes refrigerant loss for the residential & commercial, transportation, and industrial sub-sectors. Refrigerant loss is aggregated for a variety of refrigerant types and reported by ODEQ in units of CO_2e. The industrial subsector was not included because there are no significant industrial sources of fugitive refrigerant emissions in Clackamas County, per the EPA's Facility-Level Information on Greenhouse Gas Tool (FLIGHT). Refrigerant activity data is estimated from State of Oregon totals and therefore is considered as having mid-level accuracy.	
Agriculture, Forestry, and Land Use	
Livestock Methane	*Fugitive methane emissions from livestock enteric fermentation and manure management.*
Activity data for livestock taken from USDA's 2017 census of agriculture for Clackamas County. Emissions factors (per head of livestock for various breeds) are taken from ICLEI's U.S. Community Protocol, Appendix G. Activity data is considered highly accurate.	
Other Scope 3 (consumption emissions)	
Goods	*Upstream energy and process emissions raw material extraction, manufacturing, and out-of-state transportation of goods.*
Food	*Upstream energy and process emissions from the growing, processing and transportation of foods.*
Services	*Upstream energy emissions from air travel by community members from airports outside of the community's geographic boundaries.*

Accurate data on quantities and suppliers for the goods and food consumed by Clackamas County community households is not readily available. Therefore, the State of Oregon's 2015 consumption-based inventory was used to estimate these sources of emissions. State of Oregon CBEI results were downscaled for Clackamas County using US Census Bureau data on households' income and number of households within various income brackets. Note that ODEQ conducts the Oregon CBEI every 5 years and therefore this methodology may not be used to estimate emissions on an annual basis. Given inventory year and that Clackamas data is estimated from a large and complicated economic model this activity data is considered as having mid-to-low accuracy.	
Upstream 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 Community.*
Data for gasoline, diesel, natural gas and electricity use is same as previously described. Lifecycle emissions factors for the various fuel types are provided by Oregon Department of Environmental Quality's Clean Fuels program carbon intensity scores. Upstream fuel and energy emissions are calculated as the difference between direct tailpipe emissions (reported under Transportation) and total lifecycle emissions. Activity data for electricity and natural gas is considered highly accurate while transportation fuel use is considered moderately accurate. Upstream emissions factors are for regulatory purposes and therefore a considered highly accurate.	
Negative Emissions	
Local Carbon Storage	*Additional carbon storage in the inventory year by local forest and soil resources.*
Total acres of Federal forestland in Clackamas County is reported in Clackamas County's 2018 Forestry Management Plan. Total land area in Clackamas is 1.2 million acres with 51% being Federal Forest Lands. Methodology and Emissions Factors: Acres of forest land are multiplied by the net-sequestration per acre as reported by to the Oregon Global Warming Commission by the Forest Advisory Task Force in a 2018 presentation titled, The Forest Carbon Picture in Oregon: A Key Role in the State's Carbon Footprint and Performance. This presentation includes net-carbon sequestration for Western Cascade forests as well as the total land area, which are used to calculate a net-sequestration per acre value for 2018 which is applied to Clackamas County's forested land area to estimate the additional annual sequestration value for forested land. Activity data for Clackamas County is estimated using State of Oregon data for Western Cascade forests and therefore is considered moderately accurate.	
Purchased Carbon Offsets	*Community purchase of verified carbon offsets (e.g. offsets purchased by the community-at-large from participation in NWN's Clear Energy program).*
Carbon offsets purchased by account holders were provided by the natural gas utility as therm-equivalents, which was then converted to MT CO_2e using G3C Community. This activity data is considered highly accurate.	