CITY OF GRESHAM OREGON

Gresham, Oregon

Community Greenhouse Gas Inventory

Acknowledgements

Project team

- Alex Logue
- Allison Don
- Carly Rice
- David Berniker
- Gregg Hayward
- Jay Higgins
- Meghan Borato
- Nick Isbister
- Shannon Martin
- Steve Fancher
- Tina Osterink
- Toby Hazelbaker
- Torrey Lindbo
- Tim Lynch

Project Manager and community contact:

Shannon Martin, Solid Waste & Sustainability Manager
City of Gresham
shannon.martin@greshamoregon.gov

Additional project staff assisting in data collection:

- Keri Handaly
- Ken Koblitz
- Tina Osterink
- Alan Johnston
- Jacob Corum

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Consulting team

Good Company, a sustainability consulting firm based in Eugene, OR conducted the analysis for the City of Gresham. Aaron Toneys and Claudia Denton of Good Company provided data gathering assistance to City staff and facilitated the use of Good Company's Carbon Calculator for Communities (G3C – Community), a proprietary GHG inventory tool, to conduct analysis. They are the primary authors of this report.

Table of Contents

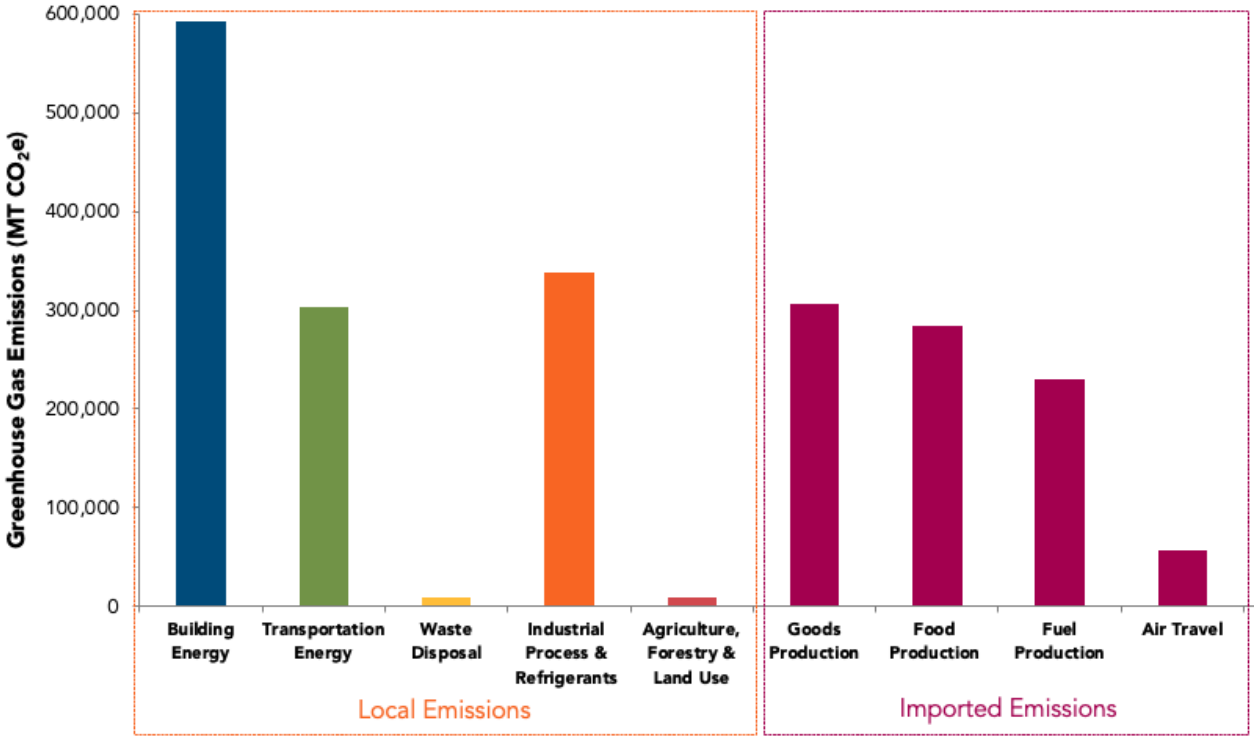
Executive Summary

City of Gresham completed a Community Greenhouse Gas (GHG) Inventory to better understand sources of GHG emissions (i.e. climate pollution) to inform development of a community Climate Action Plan (CAP). The inventory follows internationally recognized community GHG inventory protocols and accounts for all significant sources of GHG emissions driven by activities taking place within the City's geographic boundary. Beyond protocol requirements, the inventory also measures consumption-based emissions from imported goods and food, air travel, as well as negative emissions, including forest sequestration and the purchase of carbon offsets.

Summary of Findings

- During 2019, local emissions totaled over **1.25 million Metric Tons of carbon dioxide equivalent (MT CO_2e)**. The largest sectors were energy use by buildings (primarily natural gas and electricity use, 47%), industrial processes and refrigerants (27%), and transportation (primarily gasoline combustion, 24% local emissions). Waste disposal and land use change each accounted for 1% of local emissions.
- Imported emissions from household consumption and production of fuel and energy sold in Gresham totaled **nearly 880,000 MT CO_2e** and include upstream emissions from production of goods (35%), food (32%), fuel production (26%), and air travel (7%).
- All emissions combined total **over 2.1 million MT CO_2e**, or **19.5 MT CO_2e** per resident.

Figure 1: City of Gresham's 2019 Community Greenhouse Gas Emissions



Introduction

Human activity in the form of combustion 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.[1] The best available evidence indicates that human-caused greenhouse gas emissions (GHGs) must be reduced by about 45% from 2010 levels by 2030[2] to avoid "severe, pervasive and irreversible impacts for people and ecosystems."[1] We are already observing physical changes to Oregon's climate, including hotter temperatures, drought, wildfire smoke and less mountain snow[3]. 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[1]. It's with this understanding and urgency that the City of Gresham commissioned this community greenhouse gas (GHG) inventory to inform development of a community Climate Action Plan.

The City of Gresham 2019 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. Small quantities of combusted propane and other fuels are also included. 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, other liquid and gas fuels, or from electricity generation for electric vehicles.

Waste disposal in landfills and other facilities and **wastewater** treatment from treatment plants and septic tanks produce methane, of which a fraction leaks out to the atmosphere.

Industrial Process & Refrigerants release a variety of potent greenhouse gases into the atmosphere, including Chlorofluorocarbons (CFCs), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF_6) and Nitrogen Trifluoride (NF_3). Some of these gases are refrigerants from building and vehicle air conditioning and refrigeration equipment, while other gases have specific industrial

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

[2] Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments, https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/

[3] Mote, P.W., J. Abatzoglou, K.D. Dello, K. Hegewisch, and D.E. Rupp, 2019: Fourth Oregon Climate Assessment Report. Oregon Climate Change Research Institute. occri.net/ocar4.

uses. These gases typically have very high global warming potential; therefore, relatively small losses have a large climate impact.

Agriculture, Forestry, & Land Use generate emissions from agricultural activity (e.g. animal waste and agricultural inputs), forestry activities, 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. 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.*

Inventory Boundaries & Methodology (What's Included?)

Protocol and Inventory Boundaries

This 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 we refer to here as local sources of emissions. This inventory also includes an estimate of the emissions embodied in local consumption of consumer goods (referred to here as imported emissions), construction materials, and food, to inform community climate action strategies on a known, large emissions source often excluded from inventories.

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 2019 data for the City of Gresham geographic boundary. This inventory considers all seven recognized greenhouse gases, and all of them are relevant for Gresham – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3). 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.

Scopes

As described above, GHG emissions are often organized by sector (e.g. buildings, transportation, waste, etc.). Another way to organize them is by their location of origin, 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

[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. The GPC may be downloaded at https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities.

in the GPC are shown in Table 1 (next page). These are compared to emissions included in the 2019 community inventory by scope category.

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

Table 1: Crosswalk of Emission 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	•	✓	✓	
Energy Generation Supplied to the Grid	NO			
Agriculture, Forestry, and Fishing	NO			
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	•	✓		
Railway	•		IE	
Aviation	NO			
Waterborne Navigation	•	IE		
Waste & Wastewater				
Solid Waste	•	NE		✓
Wastewater Treatment	•	✓		
Biological Treatment of Waste	•			✓
Incineration of Waste	•			✓
Industrial Process and Refrigerants				
Product Use (refrigerants)	•	✓		
Industrial Processes	•	✓		
Agriculture, Forestry, and Land Use				
Livestock	NO			
Land	•	✓		
Other Agriculture	NO			
Other Scope 3 Emissions Sources				
Household Consumption	•			✓
Air Travel	•			✓
Upstream Energy Production	•			✓
Negative Emissions				
Purchased carbon offsets	•	✓		
Local carbon storage (annual growth)	•	✓		

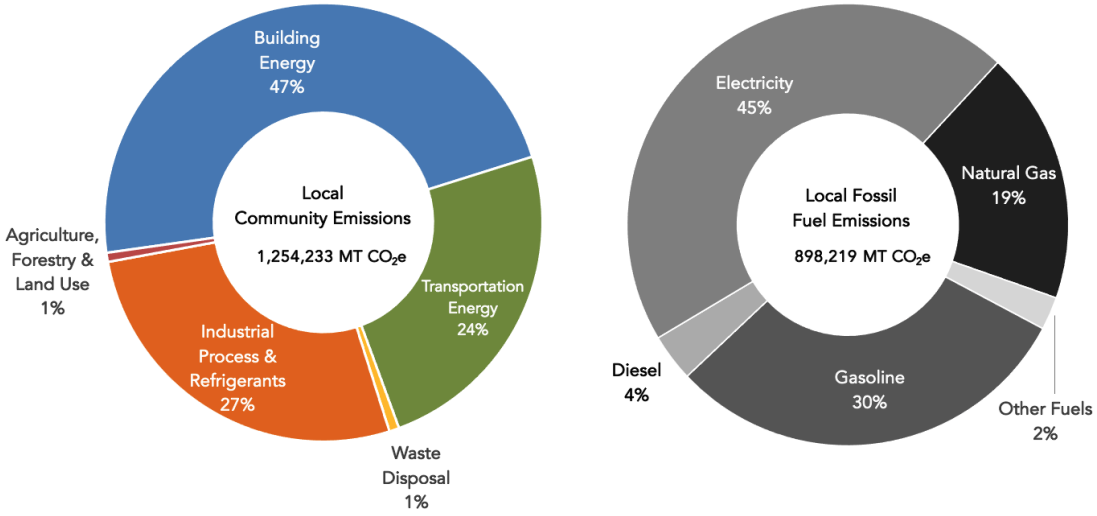
NE = Emissions occur but are not reported or estimated – see justification in exclusions
IE = Included Elsewhere as part of another data set where a split is not available
NO = Activity or process does not occur within boundary

High-Level Inventory Results

Local Emissions

The Gresham community generated over **1.25 million MT CO_2e** of local emissions – about **11.5 MT CO_2e** per resident. **This is less than the U.S. average of 15.2 and considerably greater than global average of 4.5**.[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 over 1.5 million acres of average U.S. forest[6] – a land area about 100 times the size of Gresham.**

Figure 2: 2019 Local Community Emissions and Fossil Fuel Details. In Gresham, fossil fuel emissions come from Building Energy and Transportation Energy sources only. *Note: All figures present market-based[7] accounting for electricity emissions unless otherwise noted.*



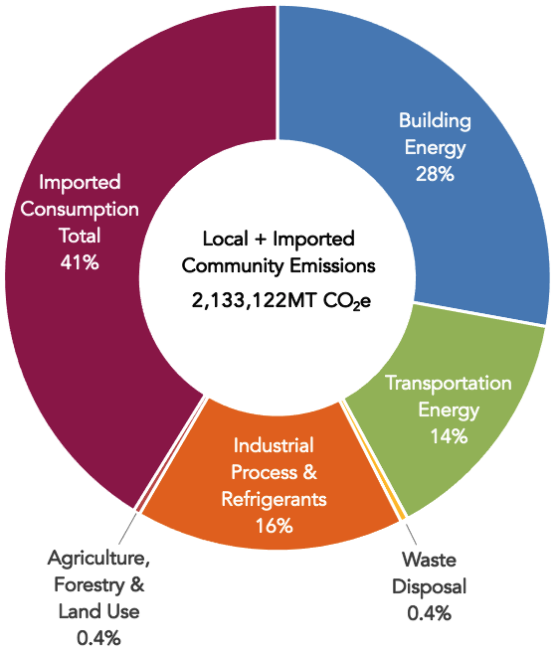
Gresham's local emissions are shown on the left side of **Figure 2** and come primarily from Building Energy, such as electricity use and combustion of natural gas by buildings and other facilities (**blue segments**), Industrial Process & Refrigerant, such as federally reported special industrial emissions and refrigerant gas loss from buildings and vehicles (**orange**), and transportation sources, mainly gasoline and diesel combustion in vehicles (**green segment**). Emissions from waste include landfill disposal of community solid waste and wastewater treatment (**yellow**). In Gresham, emissions from Agriculture, Forestry, and Land Use only come from land use development of greenspace (**red**). The right side of **Figure 2** details fossil fuel use. Note that all emissions from **buildings** and **transportation** are from **fossil fuels** (**72% of total**); **waste**, **industrial process and refrigerants**, and **land use** are non-fossil fuel emissions.

[5] Data from World Bank. For details visit https://data.worldbank.org/indicator/EN.ATM.CO2E.PC
[6] US EPA GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator
[7] See Appendix B page 24 for information about market-based vs. location-based accounting.

Imported Emissions

In addition to accounting for local emissions, the inventory also estimates **imported (consumption-based) emissions**, which are generated outside of Gresham to produce and provide the imported **goods, food, services, air travel,** and **production and transport of fuels** consumed by local households. Imported emissions total **about 880,000 MT CO_2e** in addition to sources of local emissions. **This quantity of GHGs is equivalent to the carbon sequestered by nearly 1.1 million acres of average U.S. forest[8]. Figure 3** compares the scale of local, sector-based emissions to imported emissions from household consumption.

Figure 3: 2019 Community Local + Imported Emissions



Within goods, the largest purchasing categories include vehicles & parts, appliances, and construction materials. Within **food**, the largest emissions are from the production of meats, particularly beef and lamb products.

Upstream emissions from **fuel production** (gasoline, diesel, electricity, and natural gas) and **air travel** from flights taken by residents (regardless of airport location) are also significant sources of consumption-based emissions. For more details on these emissions see **Figure 9** and the related section on page 17.

Total emissions

Local and imported emissions combine for a total **over 2.1 million MT CO_2e**, or **19.5 MT CO_2e** per resident. **This quantity of GHGs is roughly equivalent to the carbon sequestered by 2.6 million acres of average U.S. forest.** There are **negative emissions** sources as well, from voluntary purchase of **carbon offsets** from Northwest Natural Gas customers (**over 2,000 MT CO_2e**) as well as annual additional **sequestration** from growth in local forests – **over 7,000 MT CO_2e**. Note that the net benefit from PGE customers' purchase of Renewable Energy Credits are already accounted for in the building energy sector (market-based accounting) and reduced emissions by **nearly 51,000 MT CO_2e**.

Figure 4 and **Table 2** on the following pages detail and compare local emissions, imported emissions, and negative emissions.

[8] US EPA GHG Equivalencies Calculator https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Figure 4: Gresham 2019 Community GHG Emissions by local emissions, imported emissions from consumption, and negative emissions from carbon storage and offsets.

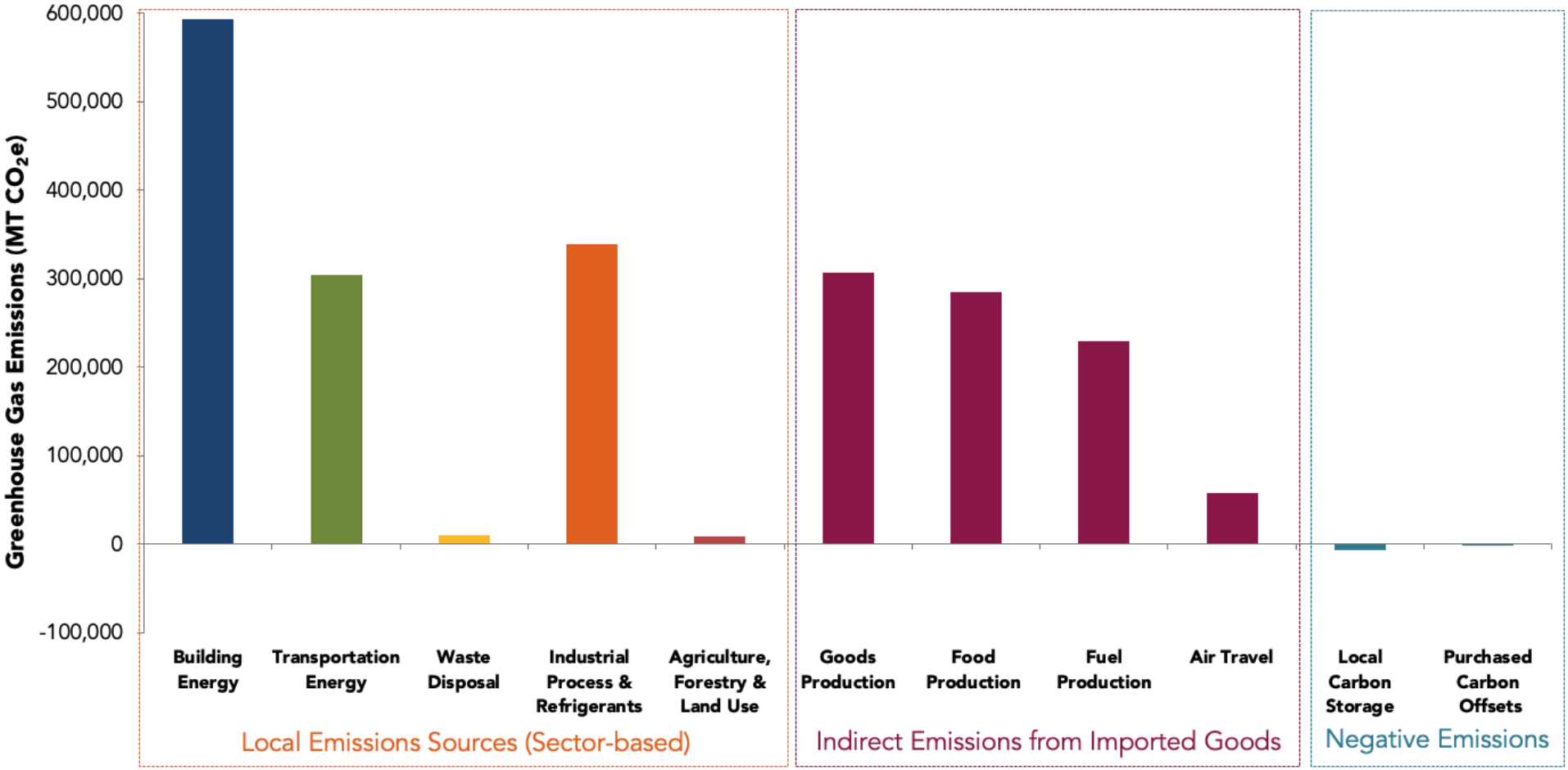


Table 2: Summary Table of Gresham 2019 Community GHG Emissions*

Emissions Sector / Sub-Sector		2019 Emissions		Per capita	
		Market-based	Location-based	Market-based	Location-based
Building Energy	**28%**	**594,257**	**546,226**	**5.4**	**5.0**
Residential Buildings					
Electricity		123,962	125,667	1.1	1.1
Natural Gas		78,404		0.7	
Other Fuels		8,135		0.1	
Commercial Buildings and Industrial Facilities					
Electricity		281,809	230,891	2.6	2.1
Natural Gas		87,584		0.8	
Other Fuels		11,165		0.1	
Fugitive Emissions from Natural Gas Systems		1,987		0.02	
Known Potable Water Treatment & Delivery Energy		483	377	0.004	0.003
Wastewater Treatment & Conveyance Energy		729	2,016	0.01	0.02
Transportation	**14%**	**303,961**	**303,634**	**2.8**	**2.8**
On-Road Passenger Vehicles		272,770	272,442	2.5	2.5
On-Road Freight & Commercial Vehicles		25,377		0.2	
On-Road Transit Vehicles		4,806		0.04	
Off-Road Vehicles and Equipment		1,008		0.01	
Rail		IE			
Recreational Marine		IE			
Waste	**0.4%**	**9,178**		**0.1**	
Solid Waste		7,384		0.1	
Compost		697		0.01	
Wastewater Treatment & Septic Systems		860		0.01	
Incineration of Waste		238		0.002	
Industrial Process and Refrigerants	**16%**	**338,448**		**3.1**	
Industrial Processes		291,352		2.7	
Refrigerants		47,096		0.4	
Agriculture, Forestry, and Land Use	**0.4%**	**8,388**		**0.1**	
Land Use Conversion		8,388		0.1	
Imported Emissions	**41%**	**878,889**	**868,682**	**8.0**	**7.9**
Household Consumption					
Goods		307,051		2.8	
Food		284,415		2.6	
Fuel Production		229,765	219,558	2.1	2.0
Air Travel		57,658		0.5	
Negative Emissions		**-9,407**		**-0.1**	
Purchased Offsets		-2,188		-0.02	
Local Carbon Storage		-7,219		-0.1	
Local Emissions		**1,254,233**	**1,205,873**	**11.5**	**11.0**
Local + Imported		**2,133,122**	**2,074,556**	**19.5**	**19.0**

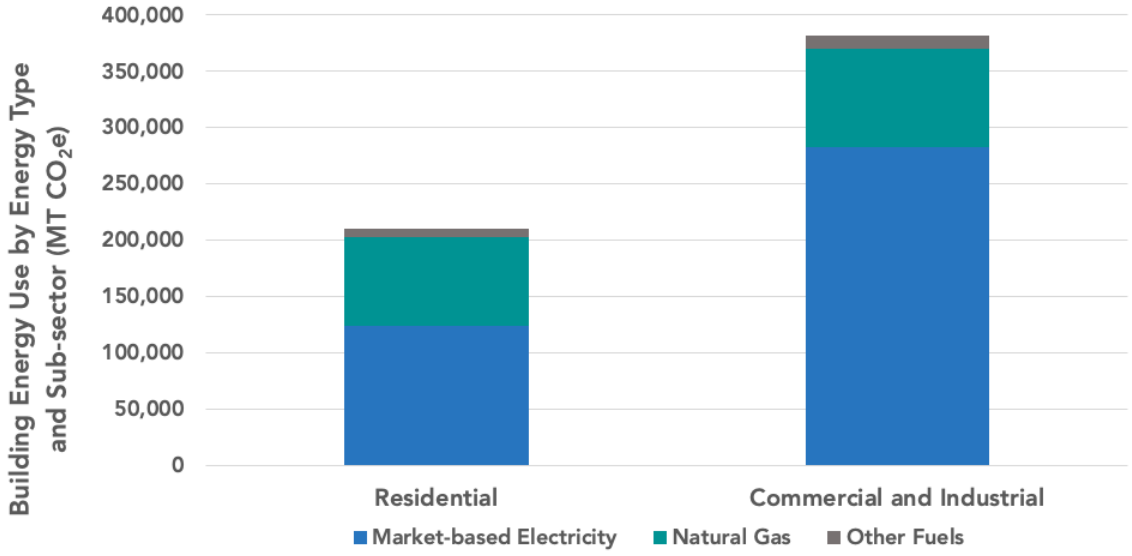
**Sector percentages are based on the market-based accounting Local + Imported total. Per GHG Protocol, negative emissions are not subtracted (or "netted") from totals.*

Inventory Highlights

Building Energy

Energy used in buildings is Gresham's largest source of local GHG emissions accounting for **47%** of local emissions. These emissions come from a mix of electricity, natural gas use, and other stationary combusted fuels totaling nearly **595,000 MT CO_2e**.[9] Gresham's commercial and industrial uses have nearly twice the impact of residential uses. By energy type, electricity had the largest impact (69% of total building emissions); followed by natural gas (28%); and other fuels (3%). **Figure 5** shows emissions broken down by sub-sector and energy type. Fugitive natural gas escaping from local distribution systems were reported by the utility and accounts for 0.3% of total building emissions and are not visible in the graphic.

Figure 5: Building Energy Use breakdown



Portland General Electric (PGE) is the local utility supplying electricity to the Gresham community. Each electric utility has its own specific emissions factor (MT CO_2e emitted per kilowatt-hour [kWh] of electricity) which is dependent on the utility's power generation supply contracts. The market-based electricity accounting method uses these utility-specific factors and accounts for voluntary community participation in utility-sponsored green power programs.

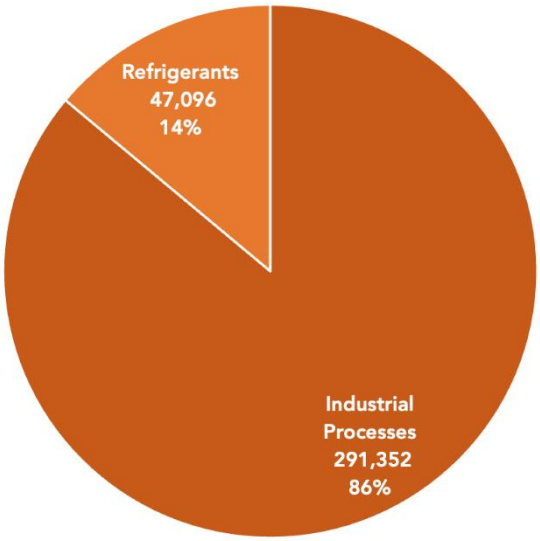
In 2019, PGE's residential and businesses customers in Gresham purchased renewable energy in the form of Renewable Energy Credits (RECs) equal to about 11% of demand, which decreased market-based electricity accounting emissions by 50,719 MT CO_2e.

[9] All emissions estimates use market-based accounting for electricity unless otherwise noted. Market-based electric accounting totals **406,984 MT CO_2e** from electricity, while location-based accounting totals **358,952 MT CO_2e**. See Appendix B page 24 for information about market-based vs. location-based accounting.

Industrial Process & Refrigerants

Industrial Process and Refrigerant Emissions are fugitive gases from specialized industrial uses or refrigeration systems. These gases – CFCs, HFCs, PFCs, SF_6, and NF_3 – have a large climate impact, up to 23,500 times the Global Warming Potential of an equivalent weight of CO_2 depending on the gas.

Figure 6: 2019 Emissions from Industrial Process & Refrigerant sources (MT CO_2e)



Industrial process emissions sources were identified for three facilities within Gresham using the U.S. Environmental Protection Agency's Facility-Level Information on Greenhouse Gases Tool (FLIGHT)[10] and Oregon Department of Environmental Quality Reported greenhouse gas emissions for facilities with air quality permits[11]. These emissions total over **290,000 MT CO_2e**[12] for 2019 and were the second largest source of local emissions. The majority of these emissions (86%) are process emissions from industrial manufacturing facilities operating within Gresham. Note that building energy emissions (e.g. combusted fuels) are not included in Industrial Process emissions and are excluded here.

A smaller source of emissions is fugitive loss of refrigerants from residential and commercial buildings and vehicle air conditioning and refrigeration equipment. These sources are estimated for Gresham using state per capita data, downscaling from emissions reported in the State of Oregon's 2015 GHG Inventory, and are estimated at about **47,000 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[13].

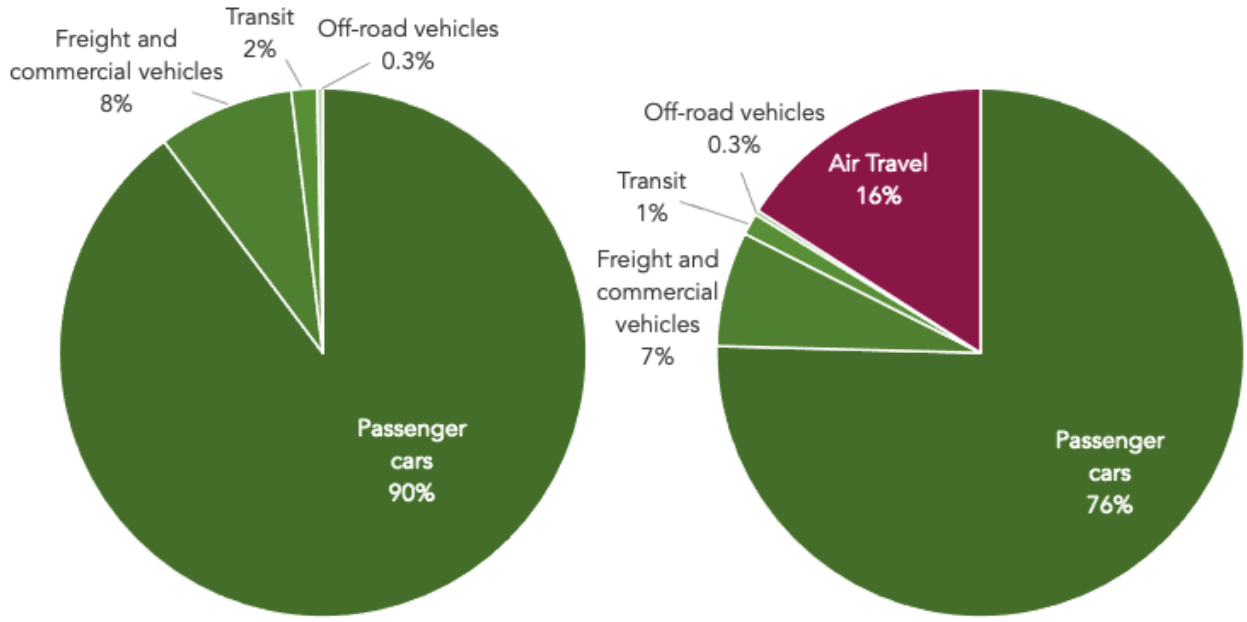
[10] Available at https://ghgdata.epa.gov/ghgp/main.do
[11] Available at https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx
[12] These facilities are monitored by EPA's FLIGHT and/or Oregon DEQ due to the significant climate impacts. EPA's FLIGHT database values will vary from this analysis, as the online tool uses IPCC AR4 GWP values, and this GHG Inventory uses updated IPCC AR5 GWP values in line with the most recent science. Oregon DEQ also reports AR4 GWP values, but individual gas data was not available to convert into AR5 GWP value totals. Applicable Industrial Process emissions data for two large Industrial processors was calculated from EPA FLIGHT. Applicable Industrial Process emissions data for another large Industrial company was requested from Oregon DEQ. Building energy was excluded.
[13] Oregon Greenhouse Gas Sector-Based Inventory https://www.oregon.gov/deq/aq/programs/Pages/GHG-Inventory.aspx

Transportation

Transportation emissions are the third largest source of local emission for Gresham, totaling over **300,000 MT CO_2e**. On-road passenger vehicles were the leading source of local transportation emissions and are responsible for **90%** of local transportation emissions. These emissions originate from gasoline sales, primarily used by private use cars and trucks but may include a small percentage of non-road uses such as small boats. The next largest category is diesel sales, primarily used by freight & commercial vehicles at **8%**; the majority of these emissions are expected to be from on-road vehicles but may also include non-road equipment. Additionally, emissions from TriMet's public transit services were estimated to be 2%, and known off-road (e.g. construction, agriculture and forestry) sources at 0.3% of emissions. See **Figure 7**.

Gresham does not have an airport within the geographic boundary so there are no local air travel emissions, but many residents do travel by airplane which is part of the community's **consumption-based emissions**. As is shown in **Figure 7**, emissions from air travel (**magenta**) are a significant source of emissions in addition to local transportation emissions (**green**). Consumption-based air travel is estimated at just under **58,000 MT CO_2e**.

Figure 7: Transportation Emissions. Magenta is Consumption-based.



Solid Waste & Wastewater

Solid Waste and Wastewater emissions total less than **10,000 MT CO_2e** – about 1% of local emissions. Gresham haulers send landfilled waste to Arlington Landfill, Wasco Landfill, Covanta Waste-to-Energy, and a small amount to unknown destinations. These landfill emissions are estimated to total roughly **7,500 MT CO_2e**. In addition to landfilled waste, organics are sent to composting facilities or for fuel purposes. Composted food scraps and yard waste are estimated to total **less than 700 MT CO_2e**. Vance Pit is the only waste site located inside Gresham. Data was not readily available for this site, however, emissions are expected to minimal as the site is small, not open for new waste, and not required to be regulated by state or federal agencies.

Wastewater is processed by City of Gresham facilities and is included in the analysis. A small number of septic systems are also present in the city. Total wastewater process emissions, including septic, are estimated to total **about 850 MT CO_2e**.

Agriculture, Forestry, & Land Use

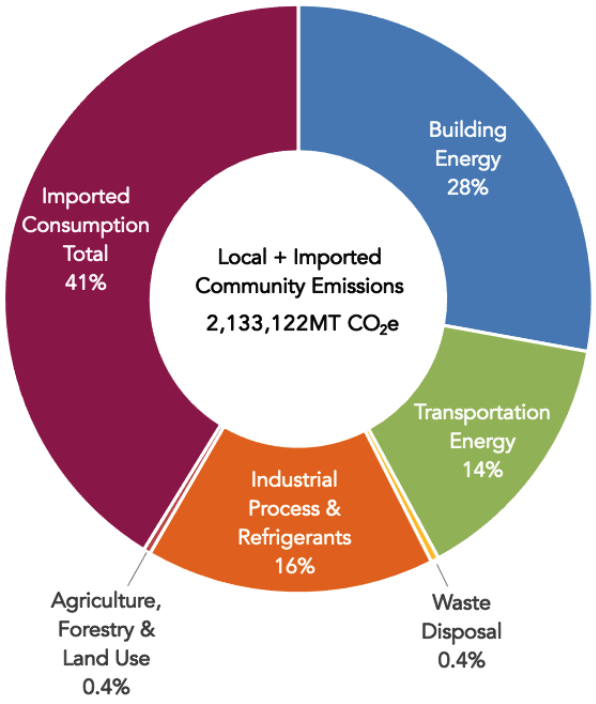
Applicable AFLU emissions include land use conversion from greenspace to development. This source of emissions considers the carbon stored in existing vegetation that is lost to the atmosphere during site clearing for construction and development. This data was compiled by City staff and is estimated to total nearly **8,500 MT CO_2e.**

Imported Emissions

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

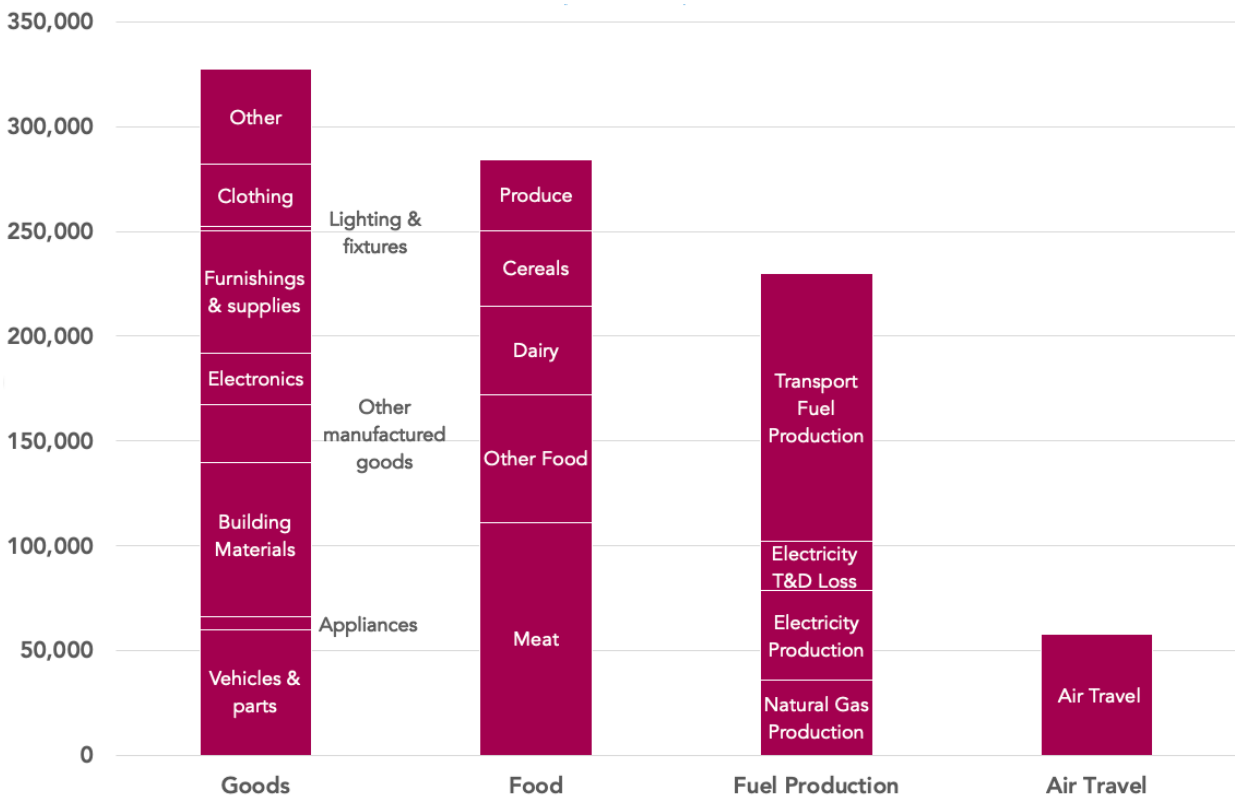
Gresham's inventory goes beyond GPC protocol requirements to highlight the known large sources of imported emissions from consumption activities. These emissions are considered Other Scope 3 in GPC protocol. This means the community has less control over management of these emissions as compared to sources 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, they are caused by local demand, it follows State of Oregon inventory practices, and because opportunities exist to reduce these emissions locally. These emissions were estimated at nearly 880,000 MT CO_2e and make up 41% of total **emissions (Figure 8).**

Figure 8: 2019 Community Local + Imported Emissions



Consumption of imported **goods** is the largest source for Gresham's imported emissions at **35% of imported emissions**. The largest contributors to this category include building materials, vehicle parts, and furnishings and supplies (**Figure 9**). The next largest category is **food** and beverage, where largest emissions are from meats, specifically beef and lamb products. Upstream **fuel production**, specifically gasoline production, is another large source, which goes hand-in-hand with passenger transportation being a large local emissions source. **Air travel** is also a significant source of Gresham consumption-based emissions. Note that these air travel emissions are from air travel trips taken by residents regardless of airport location and are not based on Portland airport fuel use alone.

Figure 9: Community 2019 Imported Emissions by Category



Category Descriptions:

- **Goods:** Emissions from extraction, manufacture, and transportation of raw materials into final products such as building materials, automobile, furniture, clothing, and other goods.
- **Food & Beverage:** 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 produce, cereals, dairy, meat, 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, and diesel (not available for propane and fuel oil).
- **Air Travel:** Emissions associated with air travel by the community regardless of the airport's location.

Negative Emissions

Negative emissions are from carbon sequestered by additional growth in vegetation within Gresham's city limits and purchased carbon offsets. When considering what to do with information about greenhouse gases the community 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 are focused on understanding and implementing actions to reduce sources of these emissions.

But there are complementary actions that may be taken through either local carbon storage in community land use (i.e. forests and soils) or by community purchase of carbon offset credits. 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 to 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 forest and agricultural resources.

Gresham's land area is approximately 14,720 acres with only 2,500 acres of tree canopy, sequestering an additional 7,219 MT CO_2e in 2019. This value is the net gain in carbon storage for the inventory year, not the total carbon storage for the tree canopy.

In addition to local carbon storage, a small portion of natural gas used in Gresham is compensated for by community members who participate in Northwest Natural's Smart Energy program (reported by the utility as 2,188 MT CO_2e). This program allows customers to purchase carbon offsets from The Climate Trust on their bill to offset emissions from their natural gas use.

Note that the net benefit from PGE customers' purchase of Renewable Energy Credits is already accounted for in the building energy sector (market-based accounting) and reduced emissions by nearly 51,000 MT CO_2e.

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 and communities 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 28, meaning one molecule has 28 times the effect of one molecule of carbon dioxide (IPCC AR5 values).

Imported Emissions

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.

Local Emissions

Known as sector-based emissions per GPC protocol. This refers to preparing an inventory that is broken down by various sectors of the community that have common GHG characteristics. This type of inventory follows a set protocol (GPC) determining what is included in each sector. Mainly, sector-based emissions include emissions from building energy and vehicles along with local sources of GHGs from waste, uncontrolled loss of industrial and refrigerant gases, and land uses. Note that emissions from household consumption of goods and services are not included in sector-based inventories. Standard sectors include:

- **Building Energy:** emissions from energy used or produced in a fixed location, e.g. electricity, natural gas, propane, and fuel oil. The GPC term is stationary energy.
- **Transportation:** emissions from vehicles and mobile equipment.
- **Waste:** landfilled waste emissions and wastewater treatment emissions.

- **Industrial Process & Refrigerants:** community use of refrigerants and fugitive high-GWP gases from industrial processes. The GPC term is Industrial Process & Product Use.
- **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), as applicable to the community.

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.

Market-based Electricity Emissions Accounting

Refers to the GHG intensity of electricity contracts with local utilities. Contrast with Location-based Electricity Emissions Accounting.

MT

Short for Metric Ton (~2,200 lbs.). This is a common unit by international standards.

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).

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: Methodology & Protocols

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 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. *G3C – Community* is an Excel-based calculator that documents all activity data; emissions factors; and emissions calculations used in the inventory. An inventory Audit Trail (included in *G3C – Community*) is used to catalog all data, calculation, and resource files collected for or created 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.

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), Sulfur Hexafluoride (SF_6), and Nitrogen Trifluoride (NF_3) 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) when available.

Data Collection

Good Company worked with City of Gresham staff to collect the data required to calculate emissions. Gresham staff along with other local and regional government staff as well as private entities that serve the community graciously provided time, data and expertise. Data and emissions factors are described in Appendix C.

Inventory Exclusions

Table 3: Summary of Inventory Exclusions

NE = Emissions occur but are not reported or estimated
IE = Included Elsewhere as part of another data set where a split is not available
NO = Activity or process does not occur within boundary

Emissions Sector / Sub-Sector	Key	Justification for Exclusion
Building energy: Potable Water Treatment and Deliver Energy	IE	Gresham is served mainly from the City of Portland through the Bull Run and groundwater systems. The City also has a partnership with the Rockwood Water People's Utility District to provide groundwater during times of high demand. Electricity data was not provided by Rockwood Water but is included in commercial/industrial electricity consumption. Known electricity use for City of Portland Bull Run is identified in **Table 2**.
Building energy: Energy Generation	NO	No significant activity identified within Gresham's geographic boundary. Some local community solar is likely but expected to be de minimis.

Supplied to the Grid		
Building energy: Agriculture, Forestry, and Fishing	NO	No activity identified within Gresham's geographic boundary.
Building energy: Fugitive emissions from Coal Production	NO	No activity identified within Gresham's geographic boundary.
Transportation: Rail	NE/IE	A short strip of freight rail track is located inside Gresham. Data was not available, and emissions are expected to be de minimis. Further, the majority of transportation emissions are based on fuel sale data, of which no fuel is sold for rail uses. A short section of TriMet light rail is located inside Gresham. The community's share of transit emissions, including light rail, are included in on-road transit emissions.
Transportation: Aviation	NO	Aviation emissions within the GPC are specific to air travel that is confined to the Community's geographic boundary; no such activity identified within Gresham's geographic boundary. That said – the community's air travel emissions for flights that extend beyond the community's boundaries are estimated and included as an Other Scope 3 emissions source. These emissions represent an estimate of air travel emissions by community residents for transboundary trips outside of the community's geographic boundary.
Transportation: Waterborne navigation	IE	Several small marinas, primarily for houseboats, are located inside the geographic boundary along the Columbia River. Fuel use is expected to be de minimis with data collection not readily available but should be included in fuel sales used to calculate on road transportation emissions.
Waste: Scope 1 landfilled solid waste	NE	Vance Pit is a small, closed landfill – data was not available and emissions are expected to be de minimis. This facility is not monitored by the EPA or Oregon DEQ.
Agriculture, Forestry, and Land Use: Livestock	NO	No livestock activity identified within Gresham's geographic boundary.
Agriculture, Forestry, and Land Use: Other agriculture	NO	No industrial-scale agriculture activity identified within Gresham's geographic boundary.

Electricity

Activity data was collected from Portland General Electric (PGE). Data was collected directly from the utility, including percentage of RECs purchased. A split for commercial and industrial uses was not available.

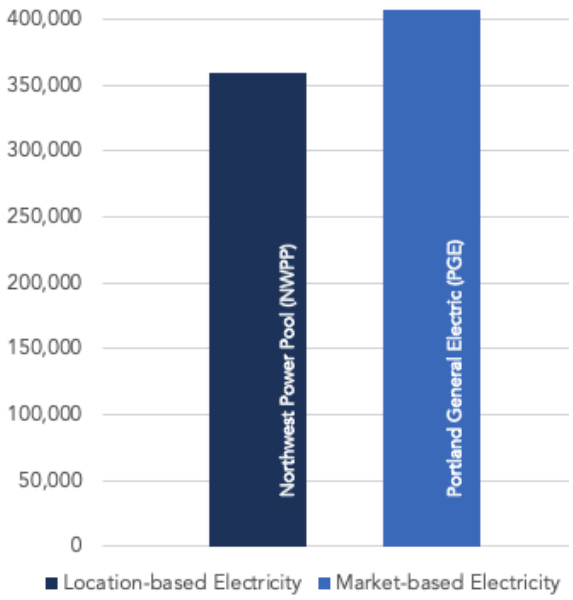
The Community Inventory Protocol (GPC) requires that communities report electricity emissions using two accounting methods: location-based and market-based.[14] **Market-based accounting** is based on the GHG intensity of electricity contracts with local utilities and is used in most of the figures presented in this

[14] For details visit http://www.ghgprotocol.org/scope_2_guidance.

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.

- **Location-based method** (or regional grid) multiplies an organization's electricity use by the average emissions intensity of a specific regional electricity grid that is published by the Environmental Protection Agency (eGRID 2019). Note that over time there may be differences in emissions results for inventory years due to the use of an updated eGRID emissions factor (typically released every 1-2 years). Location-based electricity accounting offers a means of assessing the average impacts of electricity use on the regional electricity grid.

Figure 10: Electricity emissions using both accounting methods



- **Market-based method** (or utility-specific) represents emissions specific to the utility and takes into account community purchase of renewable energy certificates. 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. 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.

Appendix C: Summary of Data and Emissions Factors

Emissions Category	Category Description
Building Energy (Stationary Energy in GPC Protocol)	
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 geographic boundary. Also includes the emissions from grid electricity used by the same sub-sectors for the same geographic boundary.*
Commercial Energy	
Industrial Energy	
Electricity and natural gas data provided by Portland General Electric and Northwest Natural Gas. Electricity and gas data included information on retail sales and participation in renewable electricity and carbon offset programs. Residential and commercial fuel oil and propane use was estimated using state-level per capita 2019 fuel usage data downscaled by Gresham's 2019 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. Location-based electricity emissions factors are taken from EPA eGRID 2019 data for the Northwest Power Pool (NWPP) sub-region. Market-based electricity accounting emissions factors for electric utilities are taken from Oregon Department of Environmental Quality's report titled, *2010 – 2019 Greenhouse Gas Emissions from Electricity Use*. Available online at https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx. Utility data is considered highly accurate; non-utility data (e.g. fuel oil and propane) is considered to have medium accuracy.	
Fugitive Natural Gas System Emissions	*Fugitive loss of natural gas from the local product distribution system.*
Northwest Natural Gas reported a 0.12% system leakage rate. Note that the NWN reported rate is less than half of the protocol default proxy value of 0.3%. This data is considered highly accurate.	
Transportation	
On-Road Energy	*Direct emissions from gasoline and diesel for passenger & freight transportation.*
Fuel sales data for gasoline, diesel, propane, and CNG was provided by the ODOT Fuels Tax Group. This data is considered highly accurate.	
Transit	*Direct emissions from gasoline and diesel (on-road) and electricity (light rail) for passenger transit transportation.*
Emissions data was collected from TriMet Transit District's Operational GHG inventory. These emissions were estimated and downscaled by Gresham's population to TriMet's service territory. Data received from TriMet is considered highly accurate; however, the estimate based on population is considered moderately accurate.	

Rail – Passenger & Freight	*Direct emissions from gasoline and diesel for passenger and freight transportation within the geographic boundary.*
Light rail emissions are included in transit emissions. No Amtrak or other passenger rail activity occurring in the boundary. A short strip of freight rail track is located inside Gresham. Data was not available, and emissions are expected to be de minimis. Further, the majority of transportation emissions are based on fuel sale data, of which no fuel is sold for rail uses.	
Off-Road	*Direct emissions from gasoline and diesel for off-road vehicles such as construction equipment, etc.*
Fuel sales data for dyed diesel and biodiesel was provided by the ODOT Fuels Tax Group. This data is considered highly accurate.	
Waste	
Landfill Solid Waste	*Fugitive methane emissions from mixed solid waste generated in the community regardless of disposal location.*
Gresham has multiple destination landfills. For waste landfilled at Wasco and Arlington landfills, EPA reported 2019 emissions were downscaled based on reported short tons from Gresham customers. This methodology follows IPCC's first order decay model and is designated by EPA as EE-6 calculations. This activity data is considered highly accurate. For waste sent to Covanta Waste-to-Energy incineration plant, EPA reported 2019 emissions for an *estimated* quantity of waste processed by Covanta were downscaled based on reported short tons from Gresham customers. Covanta total emissions and short tons of waste by Gresham's customers are considered highly accurate, but without total short tons of processed waste for 2019 by Covanta, this data is considered medium to high accuracy. A small portion of waste by Gresham customers have unknown destination landfills. For this waste, the Methane Commitment method combined with Oregon DEQ 2016 Waste Composition data for (Portland) Metro was used to estimate emissions. This is considered medium to high accuracy.	
Composting Organic Waste	*Fugitive methane and nitrous oxide emissions from composting of organic wastes (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 data was available in short tons from City staff for 2019. Compost is processed outside of Gresham, by Dirt Hugger and Recology Aumsville. 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 the City of Gresham Wastewater staff. For biogas combustion data included square cubic feet per day of biogas and the percent methane in the biogas.

For Nitrogen effluent discharge, data was not available and was estimated using ICLEI U.S. Community GHG Protocol methodology and service population. Emissions calculations for nitrification / denitrification are based on service population.

This activity data is considered medium-to-highly accurate.

Septic Systems	*Direct emissions from the combustion of biosolids (wastewater).*

Septic fugitive emissions are estimated using number of residents in the community not served by centralized sewer service. Average emissions factors for residential septic systems are provided by the U.S. Community GHG Protocol. This activity is considered highly accurate.

Industrial Process & Refrigerants (Industrial Process & Product Use in GPC protocol)

Refrigerants (Product Use in GPC protocol)	*Fugitive loss of refrigerants and other high GWP gases from building and vehicle air conditioning systems.*

Fugitive refrigerant loss and other non-industrial high GWP gas emissions are estimated using Oregon state-level data attributed to the 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 (as High Global Warming Potential [HGWP] sources) in quantities of CO_2e. Data used is from Oregon's GHG inventory includes HGWPs for the residential & commercial and transportation sub-sector (industrial emissions calculated separately, see Industrial Processes below). High GWP gas emissions are estimated from State of Oregon totals and therefore are considered as having mid-level accuracy.

Industrial Processes	*Fugitive loss of industrial high GWP gases from industrial processes. Stationary building emissions (fuel combustion, etc.) are not included and are part of Building Emissions.*

Three applicable facilities inside the boundary were identified by the EPA FLIGHT tool and/or Oregon DEQ's air quality monitoring reports. These industrial facilities are required to report significant air quality and/or climate emissions.

EPA reports include specific gases and quantities with clear separation of building energy emissions. Pre-calculated values used IPCC AR4 GWP values and were re-calculated to reflect more accurate IPCC AR5 GWP values. Building energy emission were excluded to avoid double counting.

Oregon DEQ reports total emissions in CO_2e and do not list specific high GWP gases or quantities, nor a split between Industrial Process and building energy emissions. Oregon DEQ was contacted with a request for an Industrial Process split which was provided. Emissions were reported using AR4 GWP values and were not possible to re-calculate using AR5 values. Other DEQ reported facilities either emitted biogenic emissions or 100% building energy emissions and were not included.

This data is considered highly accurate.	
Agriculture, Forestry, and Land Use	
Land Use	*Emissions from vegetation lost during land uses development (vegetated land to impermeable surfaces).*
Acres of total vacant land developed in 2019 inside City limits were provided by City staff. The online tool i-Tree Landscape was used to supplement this data and estimate Gresham's average carbon storage per acre of non-impervious land. This carbon-storage rate was multiplied by the acreage lost to development. This data is considered medium to high accuracy.	
Imported 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 all airports regardless of location.*
Accurate data on quantities and suppliers for the goods and food consumed by community households is not readily available. Therefore, the State of Oregon's 2015 consumption-based emissions inventory (CBEI) was used to estimate these sources of emissions. State of Oregon CBEI results were downscaled for Gresham 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. Air travel is based on U.S. Census Data and Oregon's version of the UC Berkeley Household Cool Climate Calculator. Given inventory year and that 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 because the precise feedstocks for biofuels sold within the community is not readily available. Upstream emissions can vary significantly for biofuels depending on feedstocks and therefore calculated emissions are considered moderately	

accurate. Upstream emissions factors are for regulatory purposes and are therefore considered highly accurate.	
Negative Emissions	
Local Carbon Storage	*Additional carbon storage in the inventory year by local forest resources.*
The online tool i-Tree Landscape was used to find the quantity of local tree canopy in Gresham and the associated average, annual, additional CO_2e sequestration. This data is considered medium to high accuracy.	
Purchased Carbon Offsets	*Community purchase of verified carbon offsets.*
Carbon offsets purchased by Northwest Natural Gas account holders' participation in NWN's Clear Energy program were provided by the utility as therm-equivalents and MT CO_2e. This activity data is considered highly accurate.	