

CLACKAMAS COUNTY BOARD OF COUNTY COMMISSIONERS

Policy Session Worksheet

Presentation Date: 6/9/20 **Approximate Start Time:** 1:30 pm **Approximate Length:** 60 min.

Presentation Title: Community Greenhouse Gas Inventory

Department: Transportation & Development – Sustainability & Solid Waste Program

Presenters: Eben Polk, Sustainability Supervisor; Cheryl Bell, DTD Assistant Director; Sarah Allison, Sustainability Analyst; Dr. Sarah Present, Public Health Officer

Other Invitees: Dan Johnson, *DTD Director*, Clackamas Climate Exchange Members: Karen Buehrig, *DTD*, Nancy Bush, *Disaster Management*, Greg Geist, *WES*, Rick Gruen, *BCS*, Chris Lyons, *PGA*, Jon Legarza, *BCS*, Ellen Rogalin, *PGA*, Jay Wilson, *Disaster Management*, Samantha Wolf, *BCS*; Aaron Toney, *Good Company*

WHAT ACTION ARE YOU REQUESTING FROM THE BOARD?

- No action. Informational only.

EXECUTIVE SUMMARY:

The purpose of this policy session is to introduce the Board to the community-wide greenhouse gas (GHG) inventory, which will be a foundational document for the climate action plan.

Overview

The Board has directed staff to develop a comprehensive and inclusive climate action plan building off the 2008 Action Plan for a Sustainable Clackamas County and supporting the 2017 climate resolution [Resolution Number 2017-85] adopted by the Board of Commissioners. In February of 2020, the Board adopted a related Performance Clackamas goal:

By January 2022, a Climate Action Plan is adopted for our community with specific recommendations to reach the goal of being carbon neutral by 2050.

In October 2019 Sustainability and Solid Waste contracted with Good Company to develop a community-wide GHG inventory as a foundational document for the climate action plan. A GHG inventory measures a community's or an organization's carbon footprint, or contribution to climate change, through emissions of greenhouse gases like carbon dioxide and methane. They are a standard and important tool used to develop climate action plans. These studies estimate GHGs produced by specific activities in the community, and therefore help prioritize actions to reduce those emissions. Slides for this policy session are provided as Attachment A, and the full report is provided as Attachment B.

In the context of the Performance Clackamas system, the GHG inventory is a *metric* we track (carbon emissions). Once we know where we are (baseline) we can chart a pathway to where we want to be (BCC goal). Thus, we should expect a GHG inventory to be a recurring process.

Role of the Inventory in the Climate Action Plan

In reviewing the GHG inventory, it is important to have context on how this information fits into the overall climate action planning process.

Community-level GHG inventories are a standard foundation for developing climate action plans (CAP). The information contained in the inventory will be used by our consultant to understand

our community's baseline carbon emissions, and to help the consultant determine potential actions and strategies to reduce our climate impact and meet the 2050 carbon neutrality goal.

While the inventory contains important information about our community's energy use and emissions, this document in itself does not determine actions or next steps. In addition to the reduction of GHGs, other important considerations for developing and prioritizing actions include feasibility, community engagement, and how different actions can benefit community health, resiliency and prosperity.

As the Board looks ahead to the CAP process, key decision points will be presented as the consultant embarks on development of the plan. Today's policy session is informational, to provide the Board with a general understanding of the results of the community GHG inventory, how an inventory is conducted, and context for the climate action planning process ahead.

Community Greenhouse Gas Inventory Results

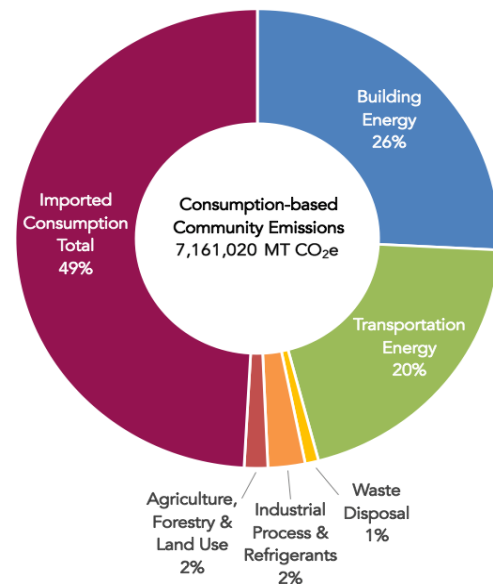
The community greenhouse gas inventory calculates the total GHG emissions for the entirety of Clackamas County, based upon 2018 data. These emissions come from many types of activities, including:

- Powering, heating and cooling buildings
- Transportation
- Waste
- Industrial processes and refrigeration
- Goods and services purchased by the community, but made elsewhere

GHG emissions include six gasses: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. To simplify reporting, all other gasses are reported as metric tons of carbon dioxide equivalent (MT CO₂e). This conversion is done by measuring the global warming potential for each gas, and then expressing this as the amount of carbon dioxide that would generate the same level of warming. MT CO₂e and carbon footprint are used as a shorthand for all GHGs in this inventory.

Figures 1 and 2 show that the county's total emissions in 2018 were 7,161,020 MT CO₂e. Of that total, 3,795,112 MT CO₂e (9.1 per capita MT CO₂e) is considered "local" i.e. not from imported goods and services. These emissions include both cities and the unincorporated county. By understanding where these emissions come from, the County can take appropriate steps to reduce our contribution to climate change.

Figure 1



Building Energy

The emissions from this category come from the electricity, natural gas, and small amounts of other fuels such as propane to power, heat, and cool buildings. These emissions are roughly evenly split between commercial/industrial and residential buildings. Electricity is the largest contributor, and is split evenly between incorporated and unincorporated areas.

Transportation

Transportation emissions come from tailpipe emissions of fossil fuel vehicles, and the electricity used for electric vehicles. The vast majority of transportation emissions (79%) came from passenger cars. Air travel is captured under Consumption-based Emissions.

Waste Disposal

Emissions from waste sent to landfills and wastewater produced 1% of the county's total emissions.

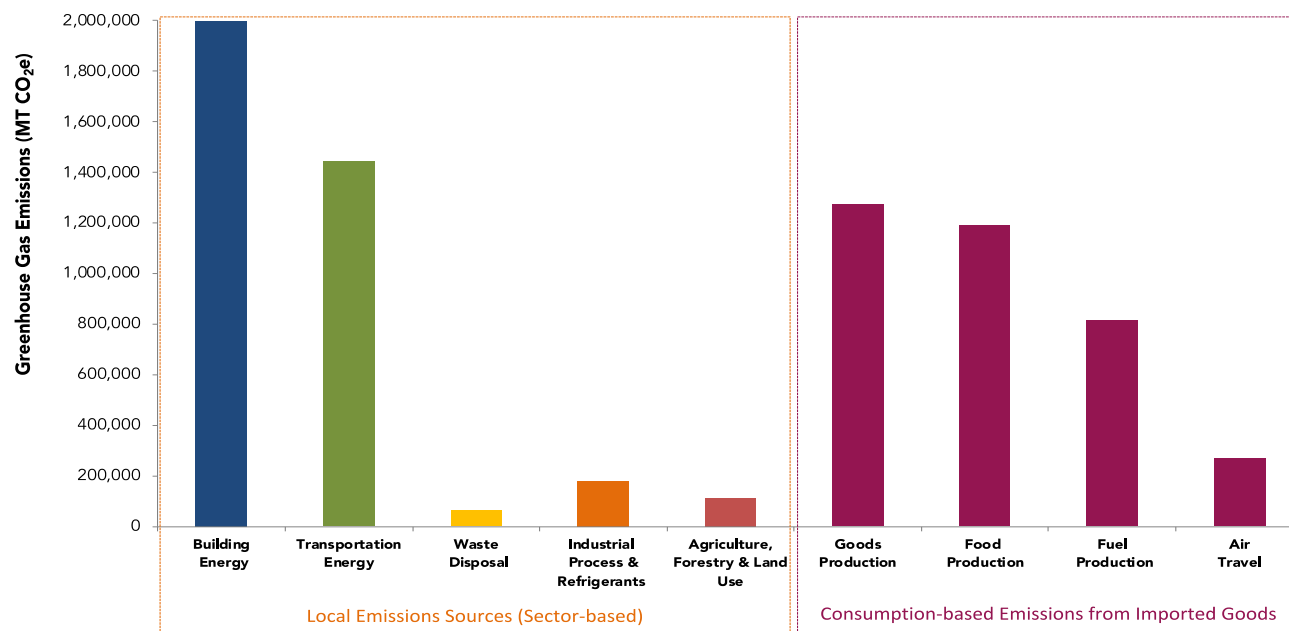
Industrial Process & Refrigerants

Industrial processes and refrigeration were a similarly small source of emissions at 2%. No industrial facilities in Clackamas County meet the EPA's mandatory reporting threshold of greater than 25,000 MT CO₂e annually.

Agriculture, Forestry & Land Use

This category includes methane emissions from livestock raised within Clackamas County. It does not include emissions from tractors and other equipment that would fall into the category of off-road transportation. Future inventories may also consider soil amendments and development of open greenspace if the data are available.

Figure 2



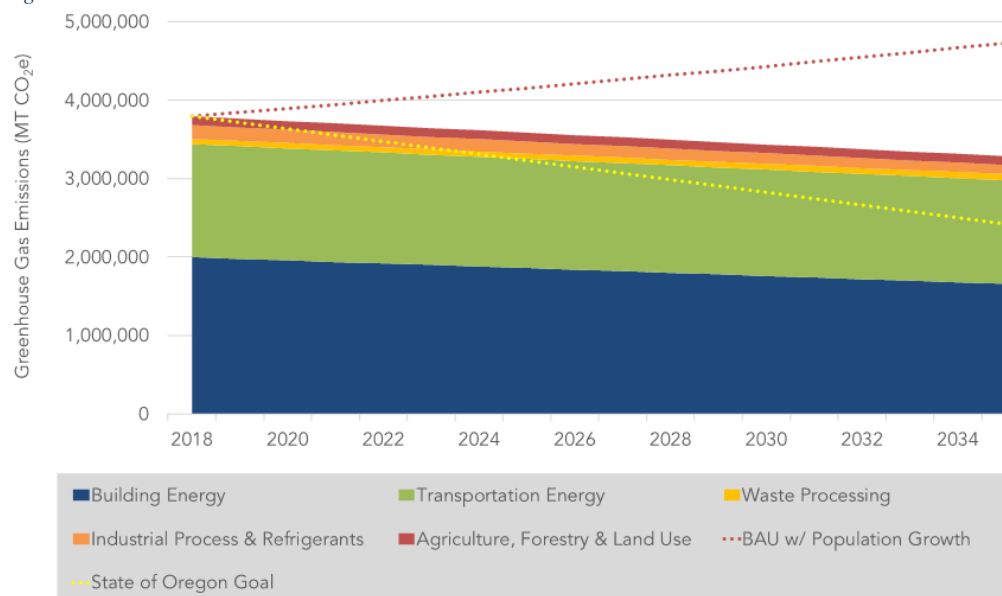
Consumption-based Emissions

Almost half of the county's total emissions come from purchases of goods and services that are produced outside of the county. These figures are estimated based on household income and the State of Oregon's assessment of purchasing patterns. These emissions fall into four main categories:

- 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 of 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.

Emissions Forecast

Figure 3



*BAU= Business as usual (shown by the red line), depicts GHG emission growth if current pre-COVID-19 level emissions increase with population growth

**State of Oregon goal (shown by the yellow line) is by 2050 to reduce the state's carbon pollution by 80% from 1990 emission levels

The GHG inventory is a “snapshot” of a specific year, but it is useful to consider how the emissions are expected to change over time. Figure 3 shows the emissions forecast (not including consumption-based emissions) from 2018 to 2034. The colored bars show the anticipated reduction in emissions over time caused by policies such as Oregon’s Renewable Portfolio Standard (making electricity generation cleaner) and the Clean Fuels Program (encouraging electric vehicles). These policies will make a positive difference when compared to the red dotted line, which shows business as usual if the current pre-COVID-19 level of emissions increased with population growth. Existing policies are not sufficient, however, to meet either the State of Oregon’s goal (shown in the yellow dotted line) or the County’s goal of carbon neutral by 2050.

This forecast showing the effect of state policies highlights our ability to preview the contribution of potential climate actions toward the County’s goal, and to benchmark future inventories to measure our progress.

Breakdown of Data

When originally scoping this inventory as a community study, the initial intent was for the report to provide both a countywide understanding of greenhouse gas emissions, and to dive further into the data to inventory emissions by jurisdiction. The aim of this level of detail was to provide cities within the county access to data for their use related to their own climate work. Because of limited data availability, the city-level results are approximations only, based on the countywide average per capita GHG emissions and city populations. While this limits the accuracy of city-level estimates, the overall analysis provides a good foundation for cities and the county in understanding opportunities to reduce our carbon footprint, and actions that also offer benefits for community health, livability, and affordability.

Next Steps

While issuance of the request for proposals (RFP) for development of the climate action plan was delayed due to the COVID-19 response, work on this effort has resumed, with this request posting to the public on May 28, 2020. The procurement will be open for bidding for six weeks,

then we will begin the process of selecting a consultant to assist the County in developing our plan.

Since the development of the project's scope of work we have seen the onset and impact of the COVID-19 pandemic. While the primary focus of the County has appropriately been on responding to the public health emergency, safely reopening the economy, and building resiliency for this ongoing disruption, there are also many ways that climate action intersects with the COVID-19 response and recovery that are important to consider.

As the climate action plan is developed, we will be including in the scope of work consideration of the pandemic and COVID-19's impact on climate change. In this, it is important to recognize that while some of the behavior changes needed to respond to COVID-19 have had the unintended consequence of reducing GHG emissions, the overall pandemic response is not the kind of climate action we want to support. Effective climate action will enhance the wellbeing of the community, and contribute to the long-term resilience of the county. The climate action plan will look at how COVID-19 recovery can also incorporate climate considerations, along with other pre-existing goals of the community, to restore the economy in a way that supports the wellbeing of the community now and into the future.

FINANCIAL IMPLICATIONS (current year and ongoing):

Is this item in your current budget? YES NO

What is the cost? - already incurred: \$32,095

What is the funding source? - Sustainability and Solid Waste Fund

STRATEGIC PLAN ALIGNMENT:

- **How does this item align with your Department's Strategic Business Plan goals?**

The community greenhouse gas inventory is a foundational document for the forthcoming climate action plan, which will impact all County departments' future strategic business plans and goals. Therefore, while the issue of this planning session does align with DTD's Strategic Business Plan goals and the goals of many other departments including Public Health, the larger alignment with the County's Performance Clackamas goals is more relevant to this policy session.

- **How does this item align with the County's Performance Clackamas goals?**

Performance Clackamas includes a climate-specific goal:

By January 2022, a Climate Action Plan is adopted for our community with specific recommendations to reach the goal of being carbon neutral by 2050.

The community greenhouse gas inventory will serve as a key document to support the development of meaningful actions to achieve this goal, as contained within the climate action plan.

LEGAL/POLICY REQUIREMENTS:

In the 2017 resolution on climate the Board of Commissioners resolved to "renew its commitment to policies and practices, both within county government and throughout the community, that respond to the need to combat and adapt to climate change, for the sake of the future of our residents and our economy."

A number of other policies and plans speak to climate issues that involve the County's participation or leadership. For example, the Oregon Legislature required Metro to develop a strategy to reduce greenhouse gas pollution from the transportation sector in our region, which culminated in the regional Climate Smart Strategy in 2015. Our new Regional Waste Plan incorporates goals and actions to reduce GHG emissions from our consumption and discard of materials. The County's Public Health Modernization process explicitly includes climate-related health issues.

PUBLIC/GOVERNMENTAL PARTICIPATION:

This document is a technical analysis and does not include public/governmental participation beyond data collection. However, decisions about the actions to take based on this information will be determined through the climate action plan development process. This will involve extensive participation by various departments within the County, other agency partners, and the community; therefore, broad engagement will be key in developing and implementing the overall climate action plan.

PGA has been included in the pre-work associated with this effort, and will continue to work with staff and the consultants in developing and implementing engagement strategies.

OPTIONS:

No options. This session is informational only.

RECOMMENDATION:

N/A

ATTACHMENTS:

- Attachment A. Policy Session Presentation Slides
- Attachment B. Community Greenhouse Gas Inventory Report

SUBMITTED BY:

Division Director/Head Approval _____

Department Director/Head Approval *Dan Johnson*

County Administrator Approval _____

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| For information on this issue or copies of attachments, please contact Sarah Allison @ 503-742-4462 |
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Clackamas County Community Greenhouse Gas Inventory

June 9, 2020

Policy Session for the Board of County Commissioners

Climate Action Plan Milestone

- The Community Greenhouse Gas (GHG) Inventory is a major foundation for the climate action plan
- It is a standard element of climate action plans
- It is the first step we've taken beyond internal assessment and action



Introduction

- The GHG inventory will be used repeatedly throughout the CAP process.
- Today, we just want to familiarize you with the tool, knowing that we will dig into specific areas in greater detail as we move forward.
- The solutions to these challenges will come from analysis and community engagement. Any ideas for solutions that we have right now will need to be further developed through that process.
- There are no decision points today.



Inventory Boundaries

- **Geographic boundary:** Clackamas County
- **Time period:** 2018
- **Emissions sources:**
 - *Buildings*
 - *Transportation*
 - *Waste*
 - *Industry and Refrigerants*
 - *Household consumption of goods and food*
 - *Air travel (from airports outside boundary)*
 - *Upstream energy production*



What does the Inventory measure?

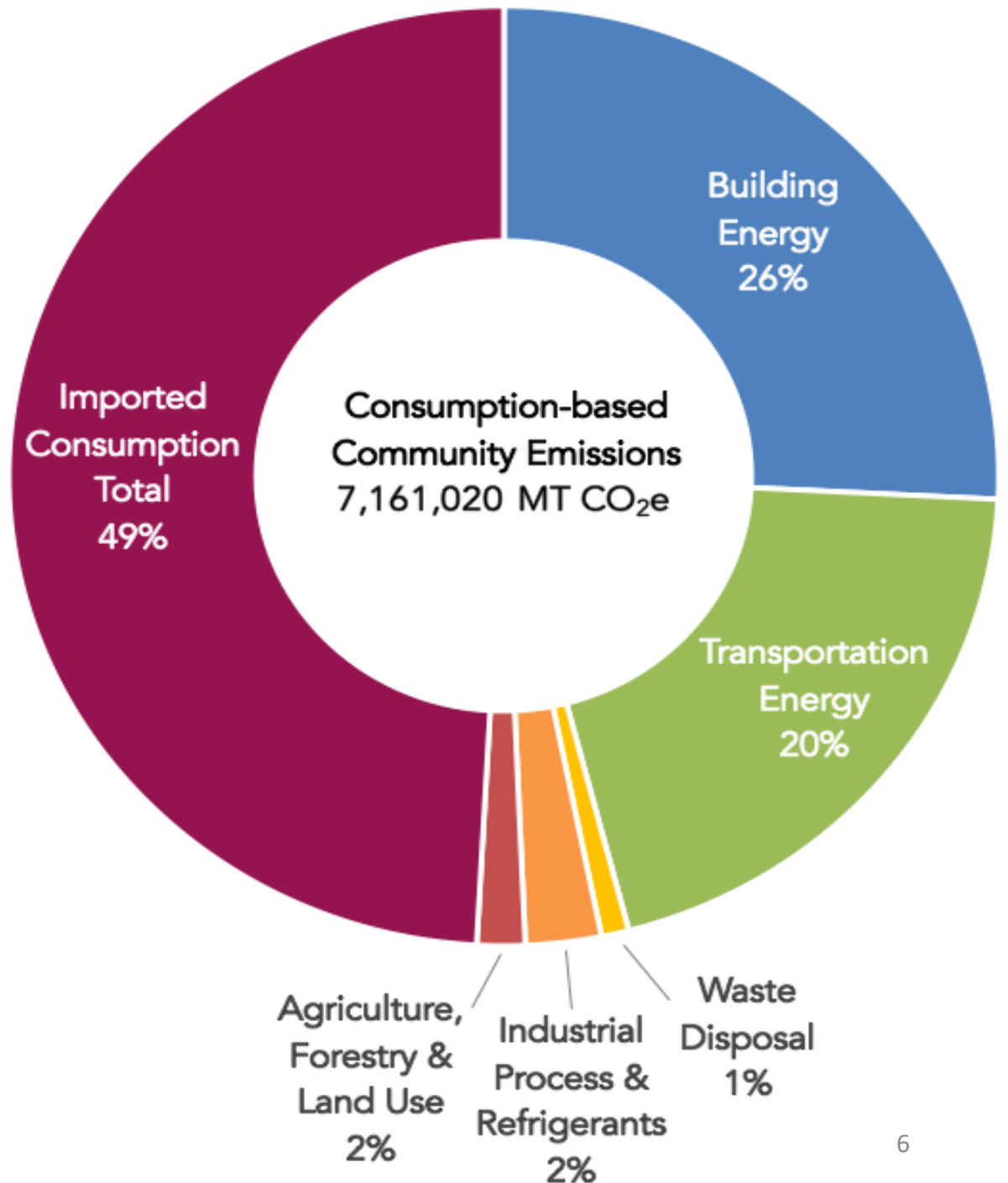
- GHG inventory measures the weight of GHGs
- For defined geographic and time boundaries
- Convert all gases into metric tons of carbon dioxide equivalent (MT CO₂e) using GWP

| Greenhouse Gases | Chemical Formula | Global Warming Potential (100 year) |
|-------------------------|--|--|
| Carbon dioxide | CO ₂ | 1 |
| Methane | CH ₄ | 28 |
| Nitrous oxide | N ₂ O | 265 |
| Hydrofluorocarbons | C _x H _y F _z | 12 - 12,000 |

Source: IPCC 5th Assessment Report, 2014

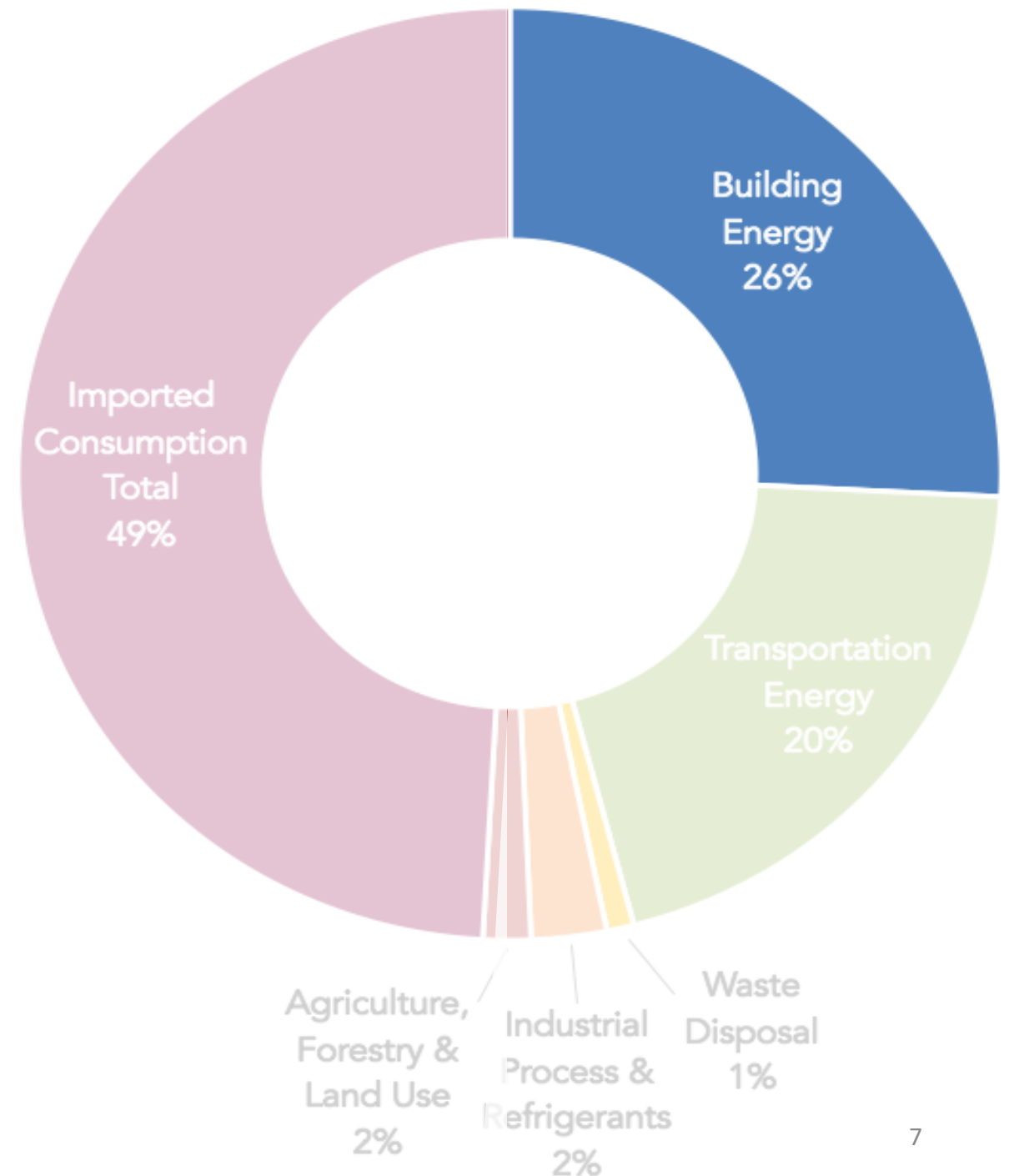
GHG Inventory Results

- Total emissions – 7,161,020 MT CO₂e
- Without imported emissions - 3,795,112 MT CO₂e
- Per Capita
 - Clackamas County - 9.1
 - US average – 16.5
 - Global average – 5.0
- Most meaningful benchmark is against self over time



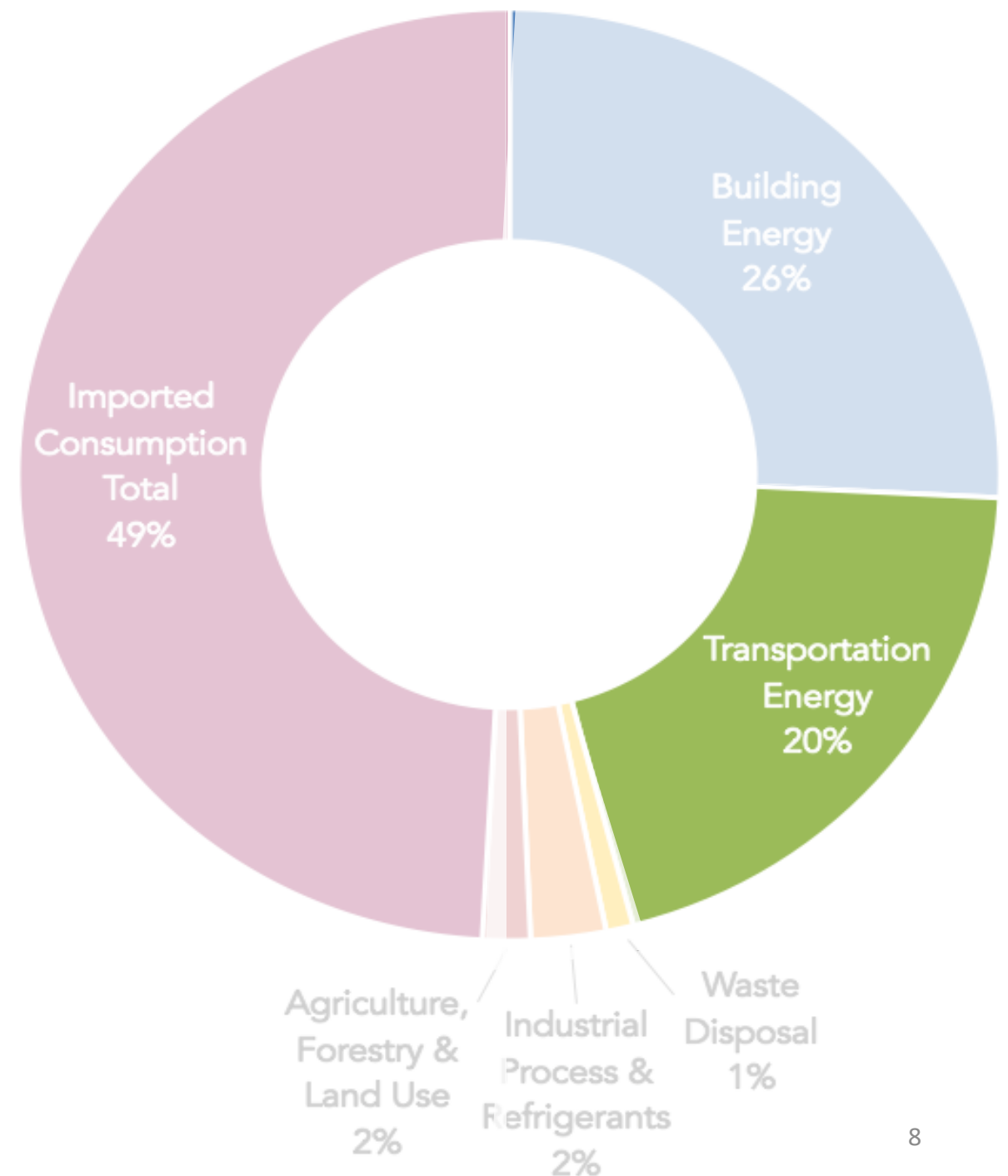
Building Energy

- Residential, commercial and industrial use of electricity, natural gas, and incidental other fuels for power



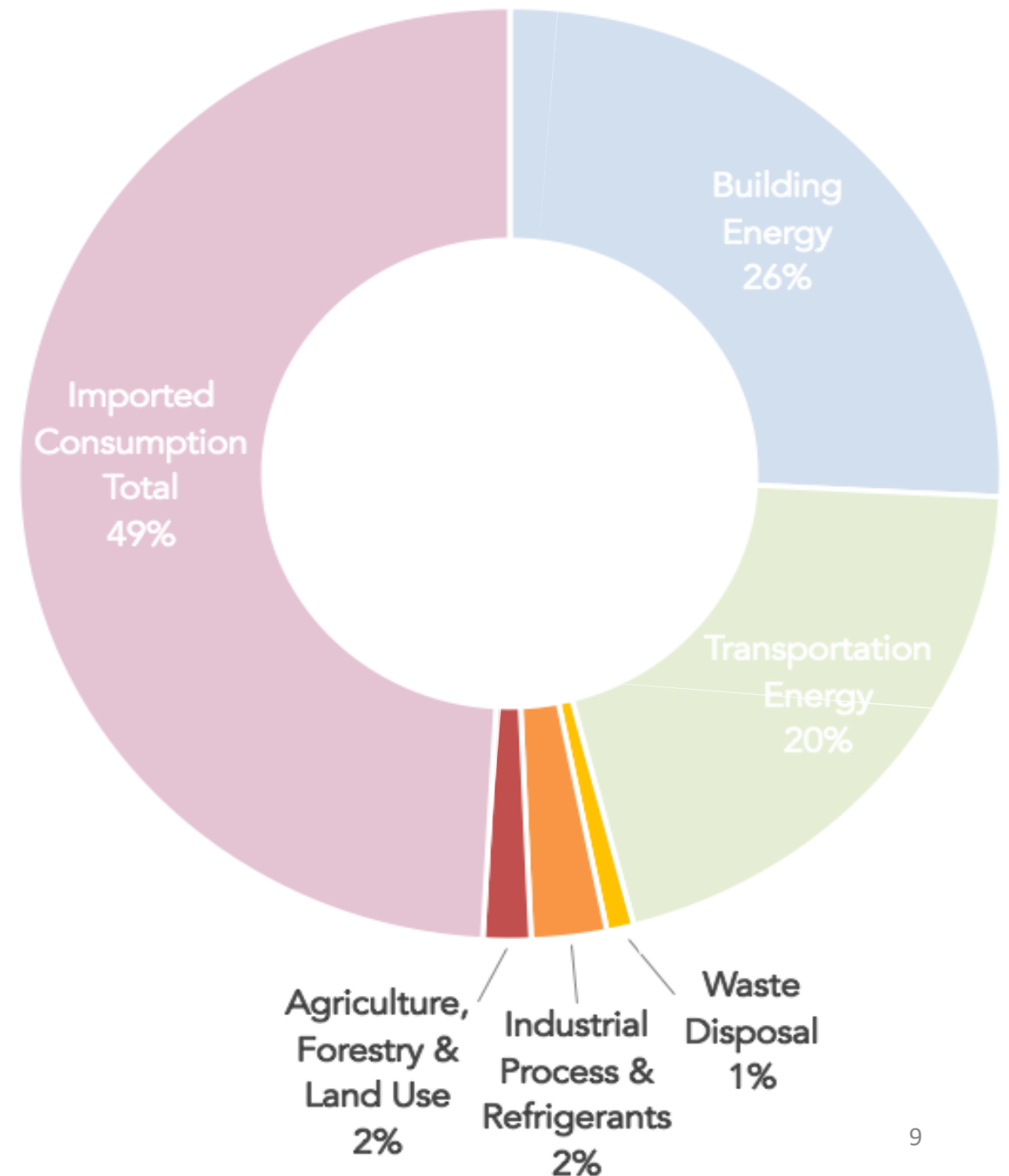
Transportation Energy

- Tailpipe emissions from on and off-road transportation



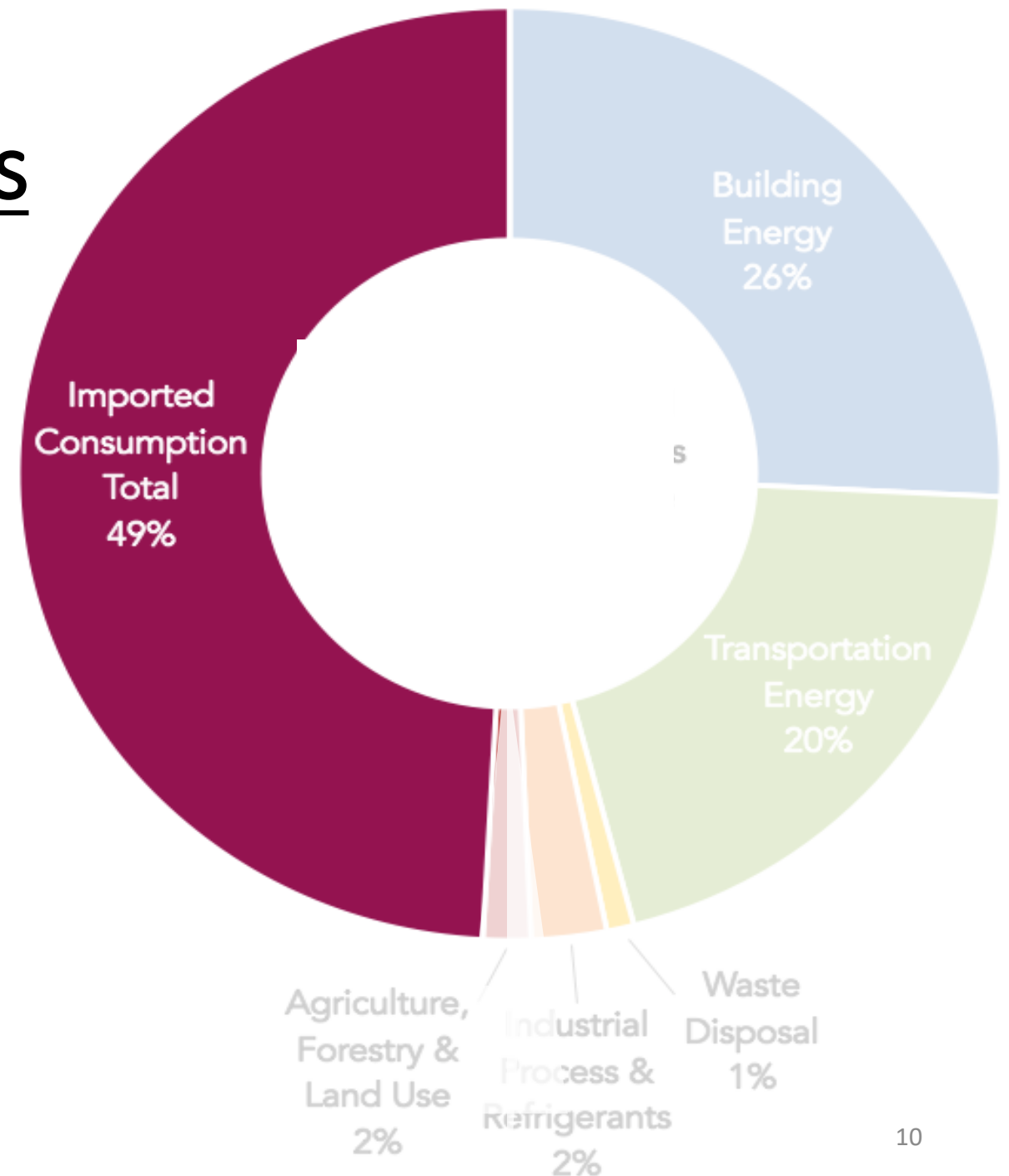
Small Contributors

- Waste Disposal, Industrial Processes, Refrigerants, Agriculture, Forestry and Land Use produce 5% of emissions

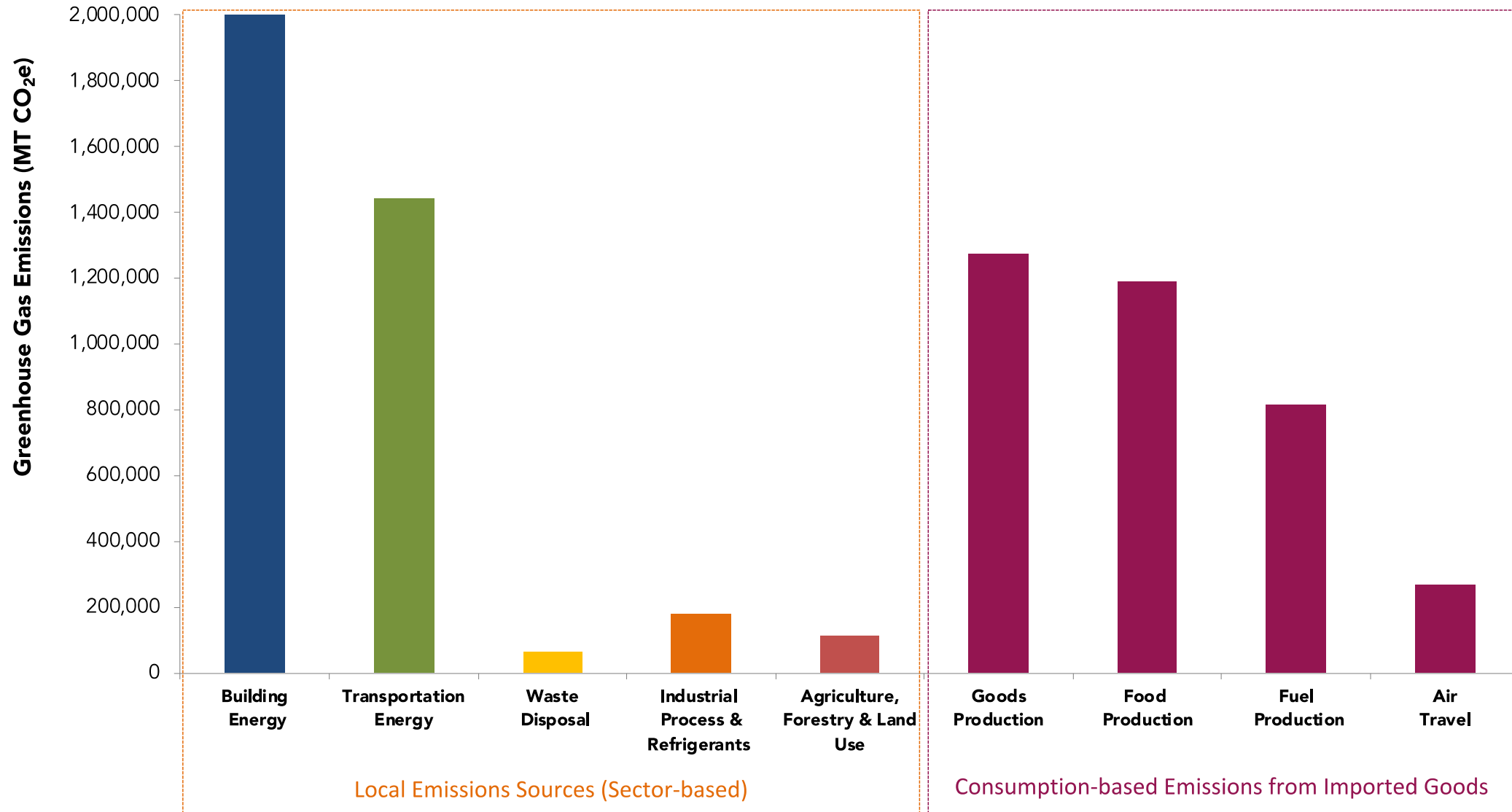


Consumption Emissions

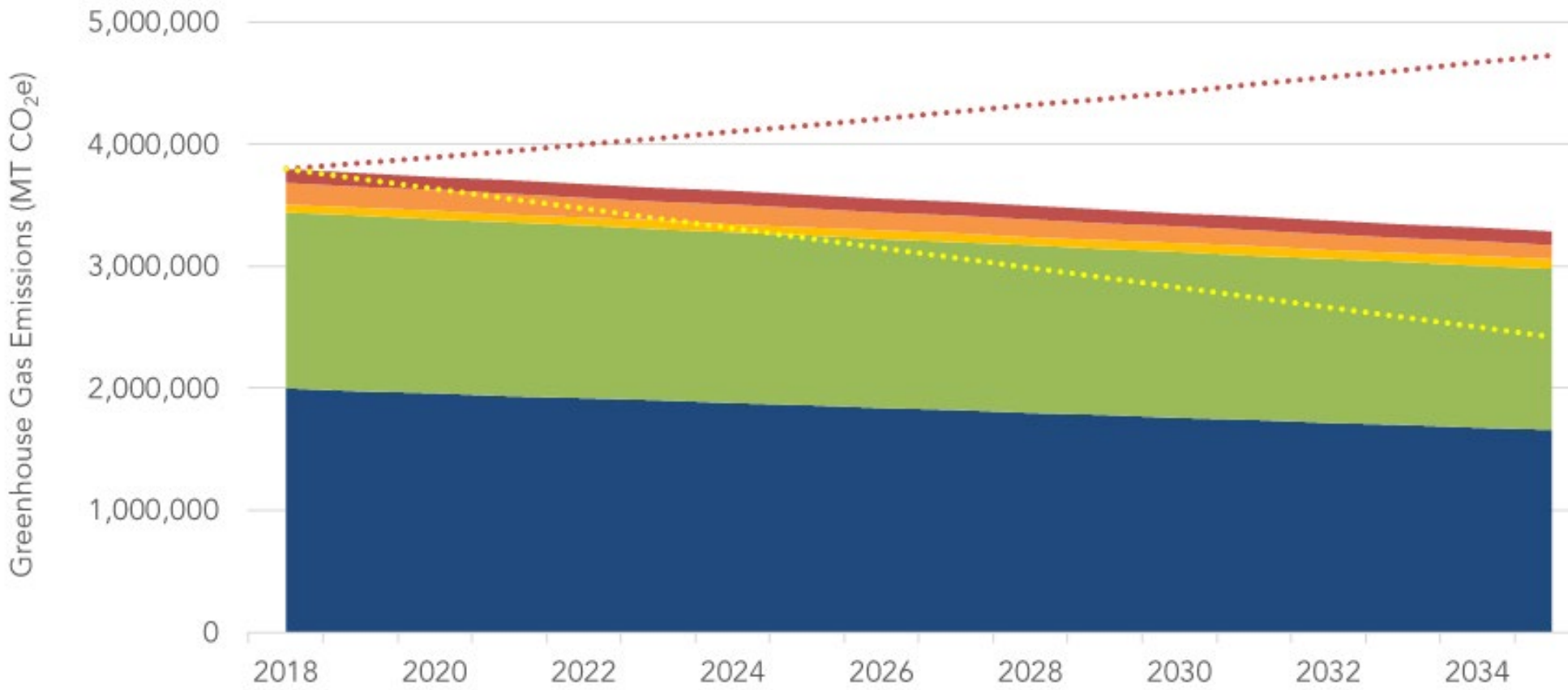
- This category accounts for emissions that are generated outside of the county, but because of county consumption of goods and services.



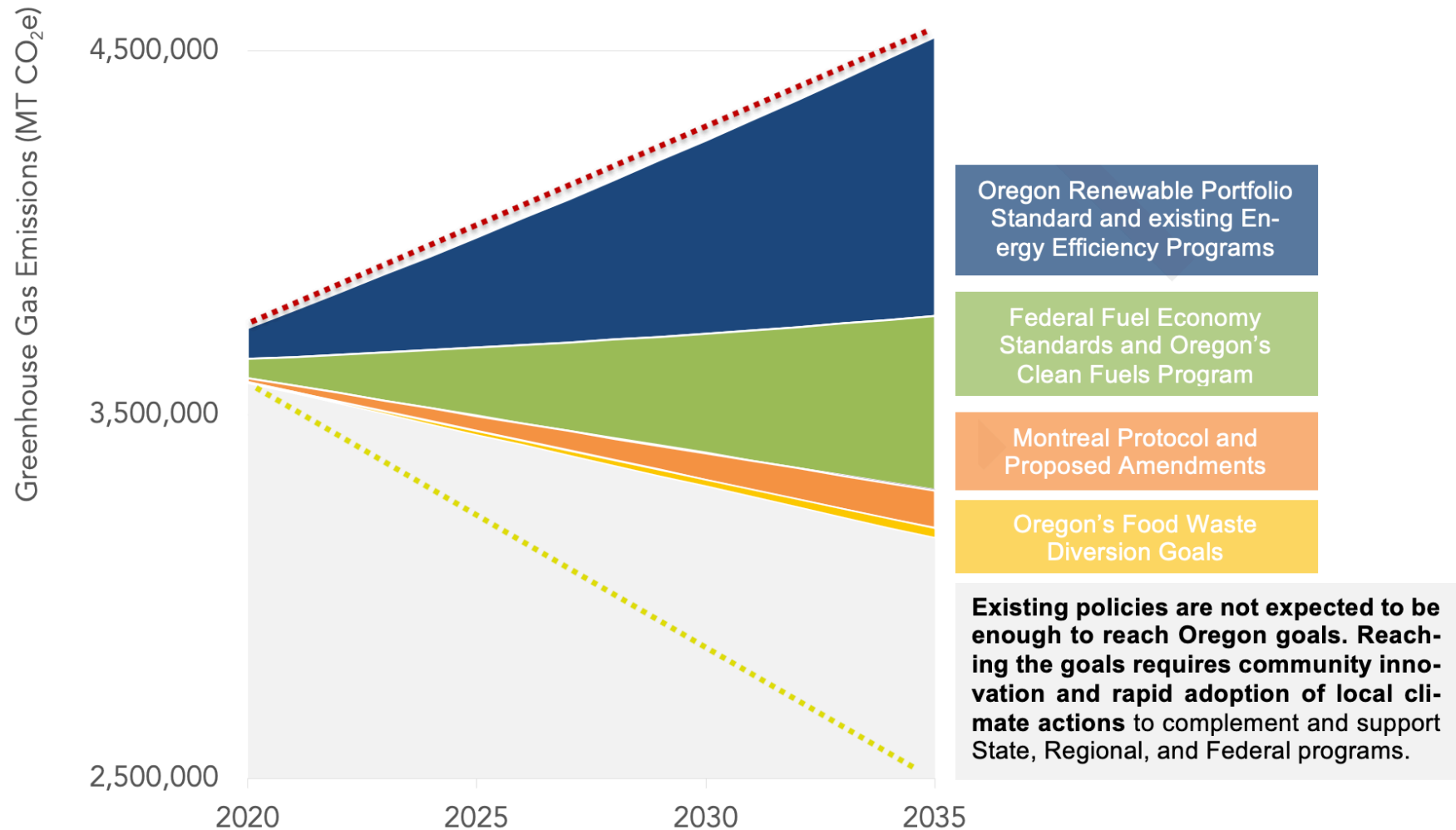
Results



Emissions Forecast



Existing Policy Reductions



Next Steps

- The climate action plan (CAP) request for proposals (RFP) posted on May 28.
- The CAP process will take COVID-19 into consideration.
- Some COVID-19 responses may be viable climate actions, but only in the context of supporting community wellbeing.
- These climate considerations are essential to the long-term viability of recovery decisions being made in the coming months.



Highlights

- Largest sources of community emissions include:
 - Building use of electricity and natural gas
 - Transportation's use of gasoline
 - Consumption of building materials, furniture, clothing, meat, and dairy
- Existing policies are forecast to deliver significant emissions reductions compared to BAU, but more is required to meet State of Oregon Goals
- Future Tracking – Good Company's GHG inventory deliverables (G3C-Community calculator, Audit Trail, and staff training) are designed to support future tracking towards GHG reduction goals

An aerial photograph of a river flowing through a city. The river is the central focus, with white rapids visible in the lower half. Two bridges cross the river: a large concrete arch bridge in the middle ground and a smaller bridge further upstream. The city buildings are visible on both banks, with a dense forested area in the background. The word "Questions?" is overlaid in large black text on the left side of the image.

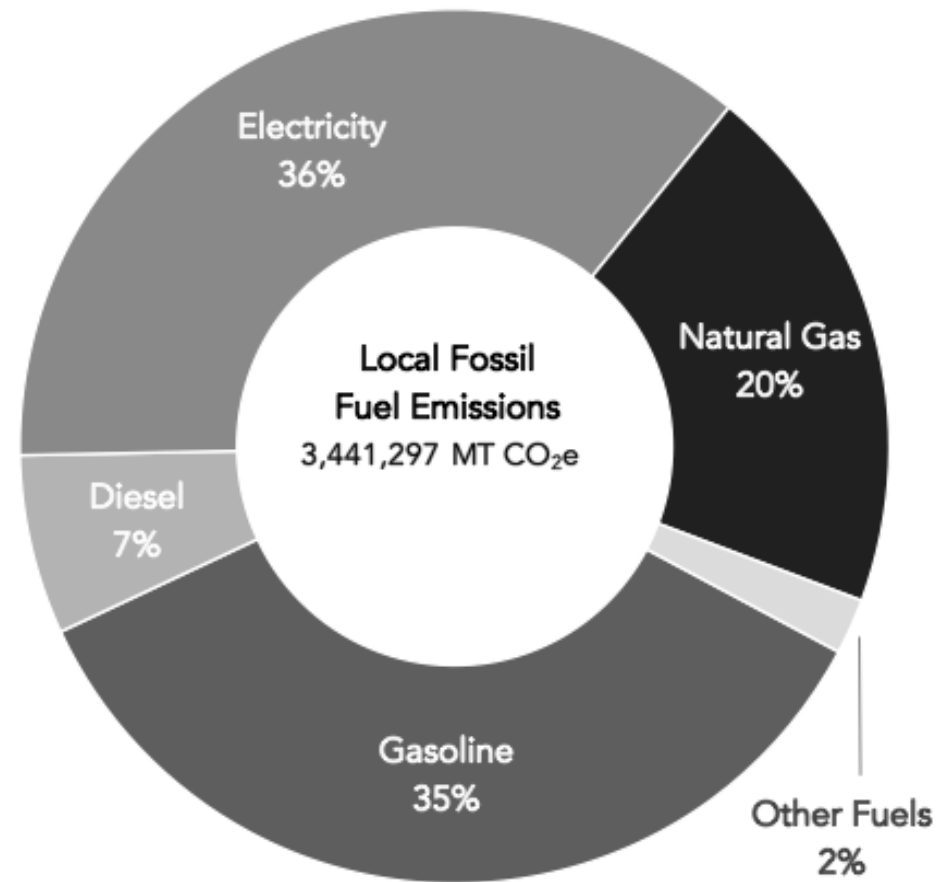
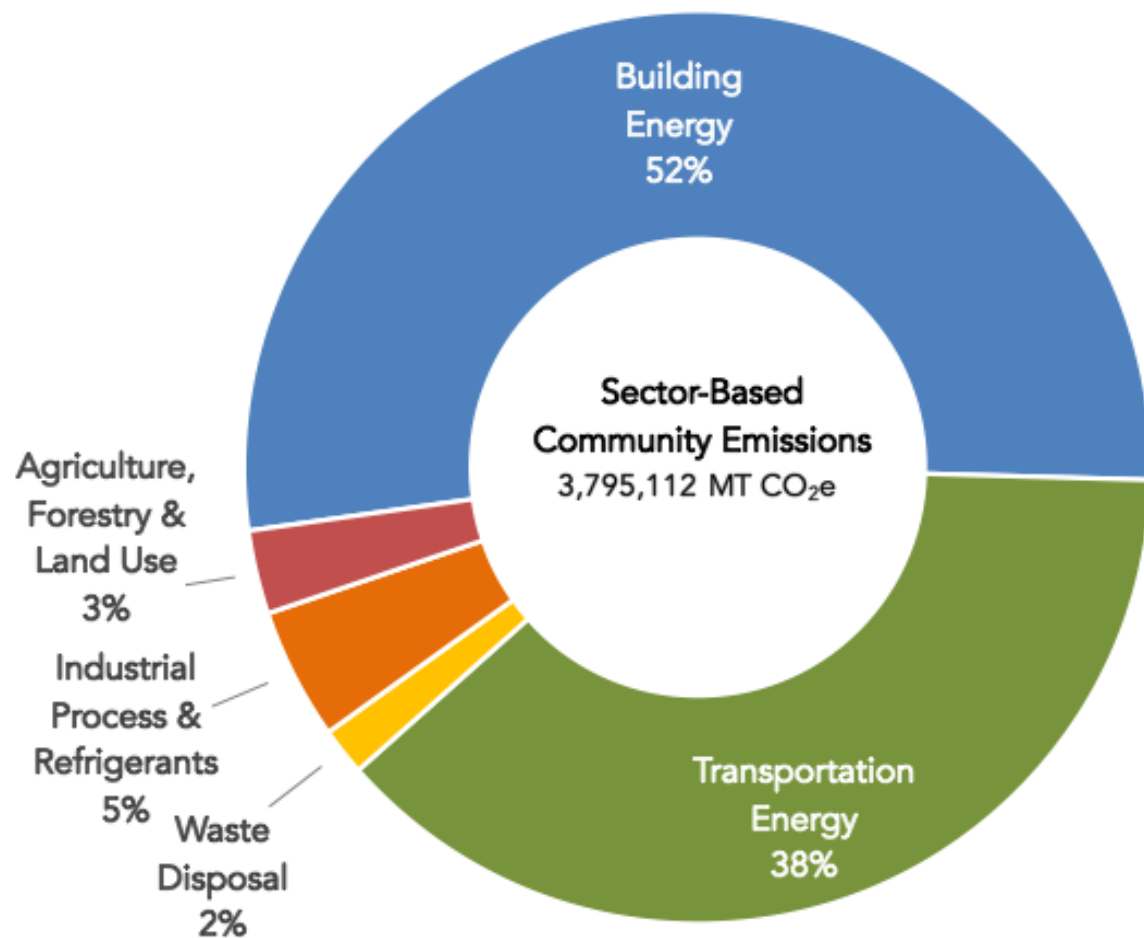
Questions?

Additional Details

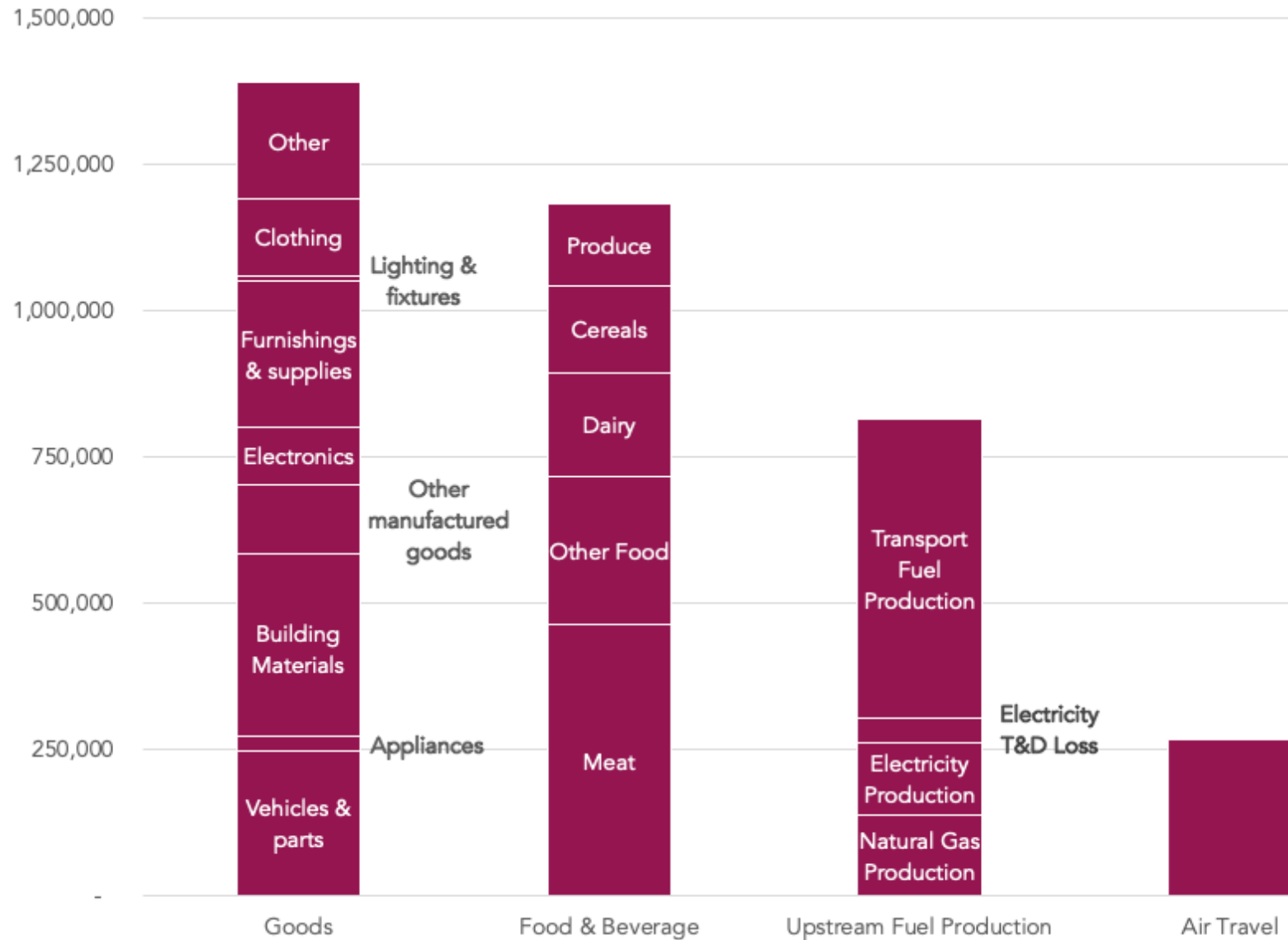
- Local Use of Fossil Fuels
- Household Consumption Details
- Fuels in Building Emissions
- Electricity and Natural Gas by Location
- Transportation Details
- Oregon Emissions Trends



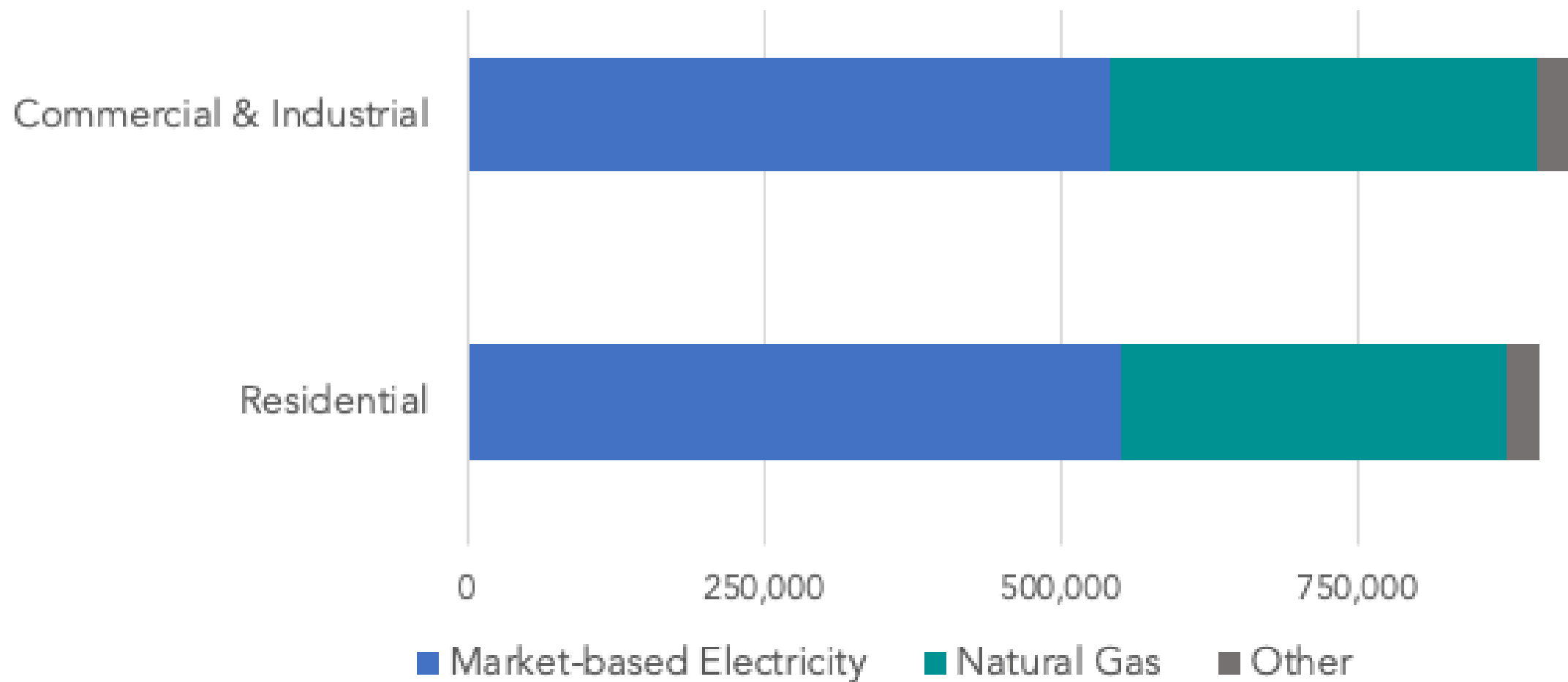
Local Use of Fossil Fuels



Household Consumption Details

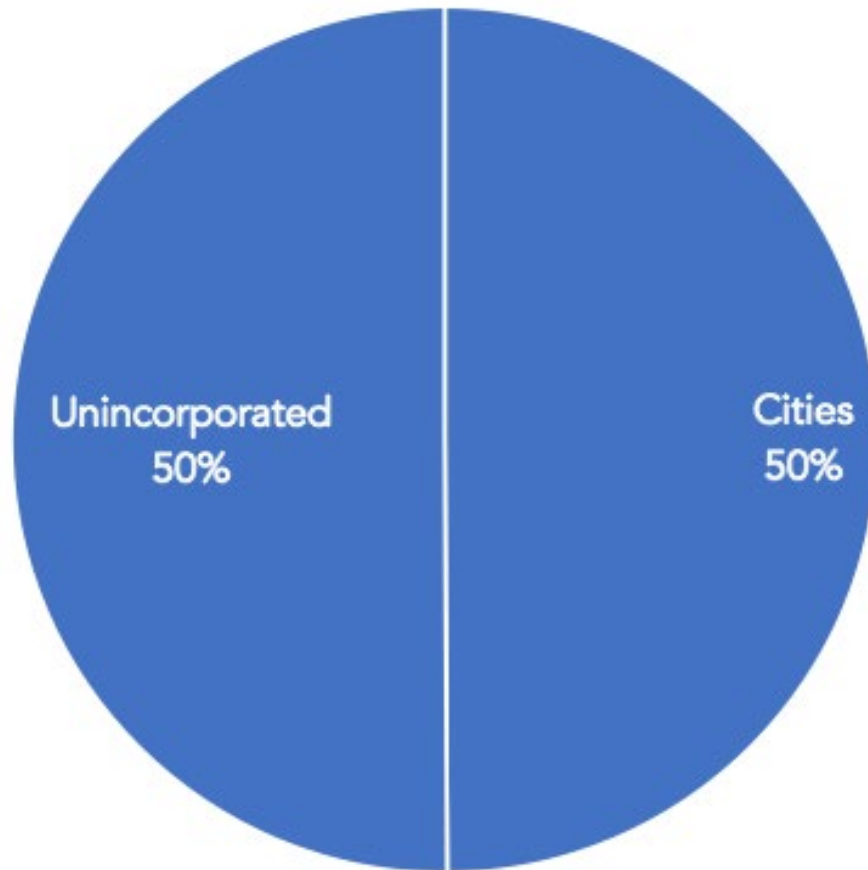


Fuels in Building Emissions

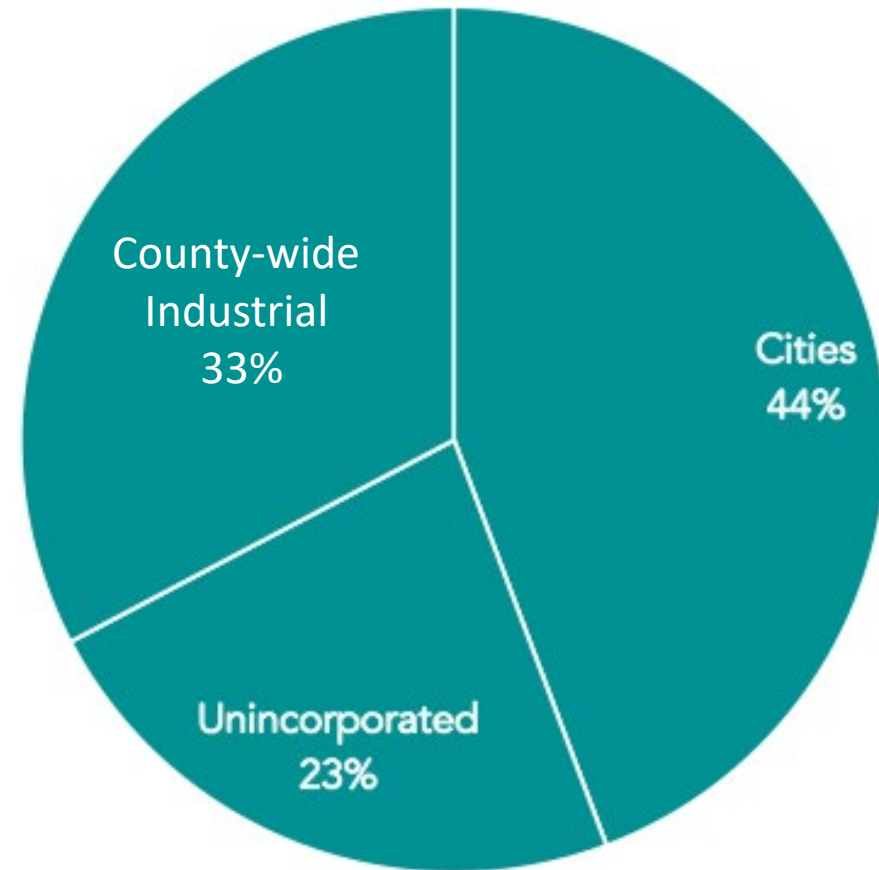


Electricity and Natural Gas by Location

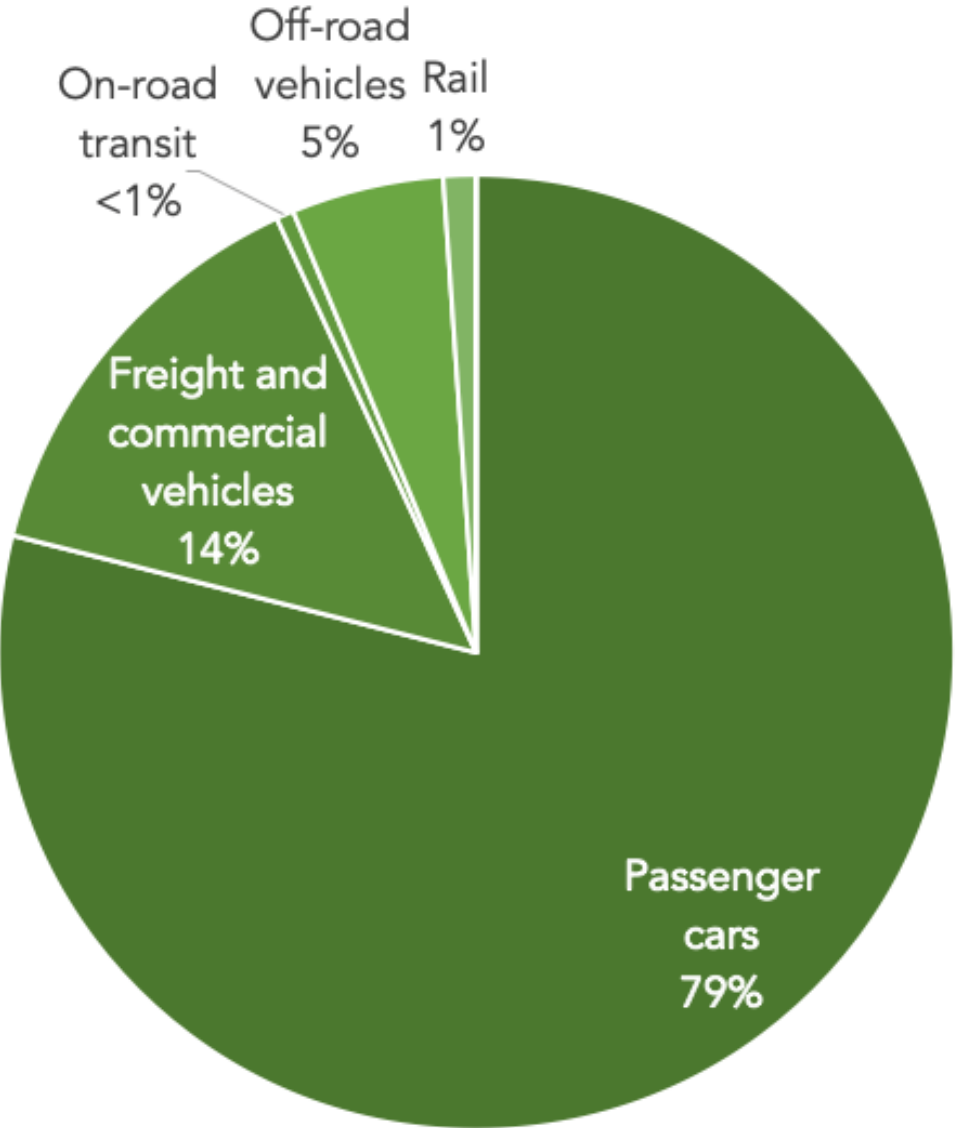
Electricity Emissions



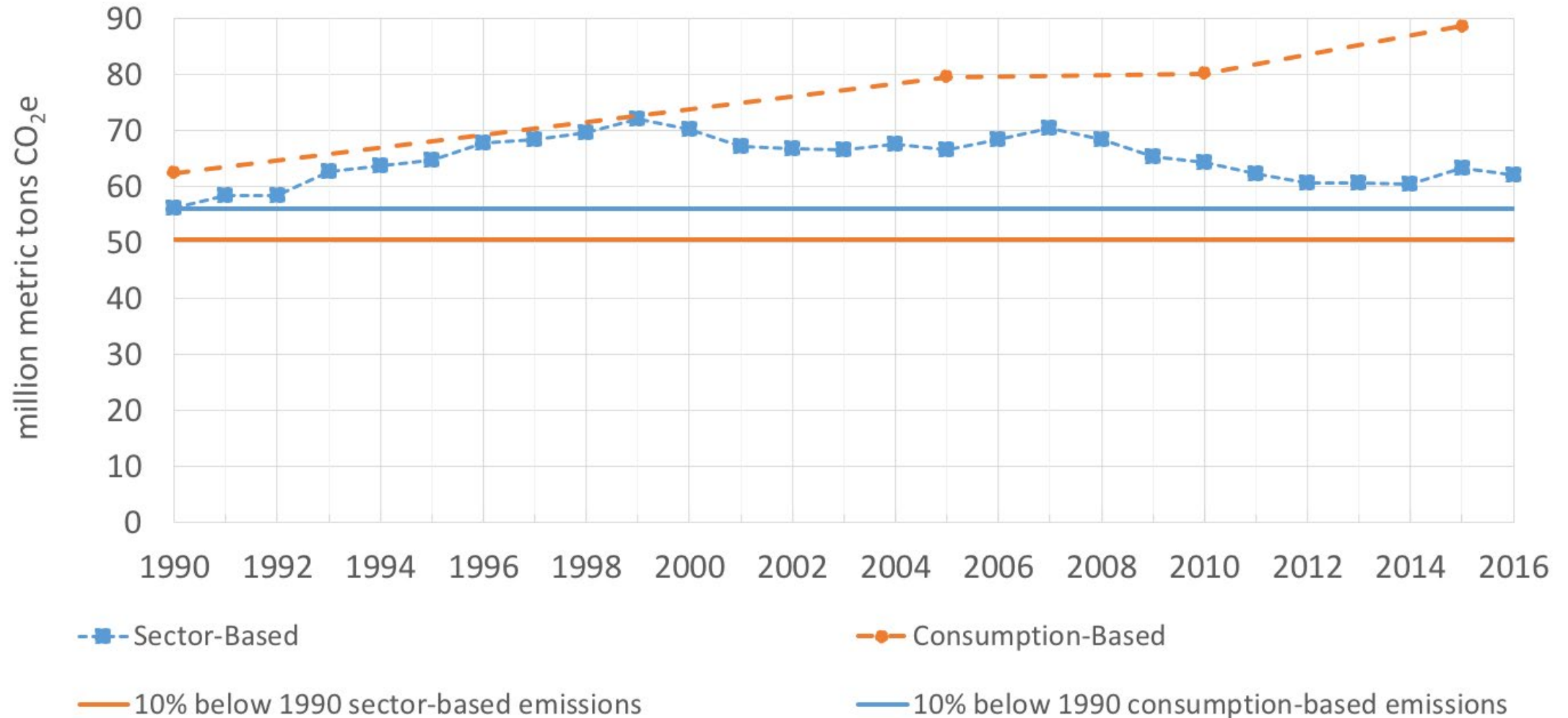
Natural Gas Emissions



Transportation Details

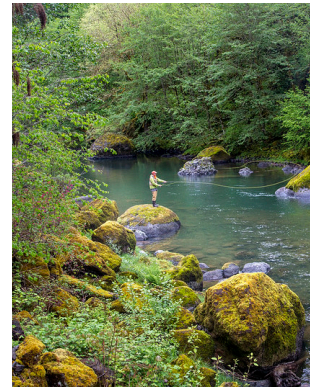
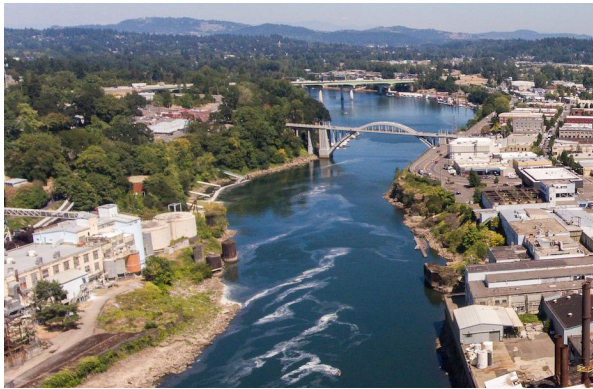


Oregon Emissions Trends





Clackamas County | Oregon Community Greenhouse Gas Inventory for 2018



May 2020

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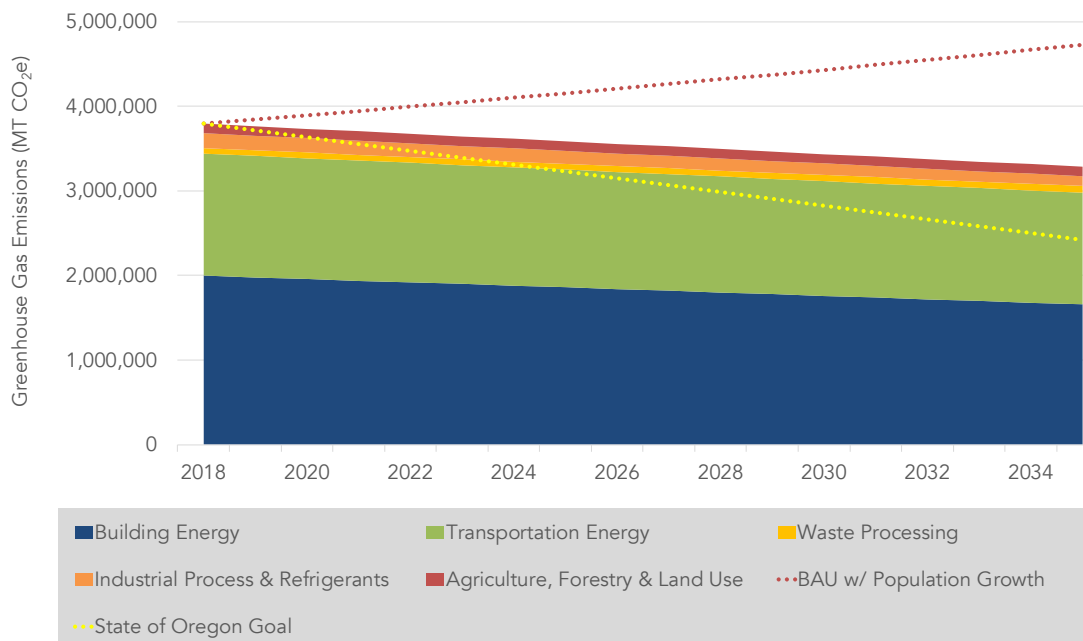
*Clackamas County Willamette River view near Oregon City Arch Bridge, Clackamas County
Plugged-in Electric Vehicle Charging, Noya Fields Photography
Fly Fishing on the Molalla River, Oregon Bureau of Land Management*

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% annually¹), 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.

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 (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC) and sulfur hexafluoride (SF₆). All gases are reported in terms of carbon dioxide equivalent (CO₂e), or the amount of carbon dioxide it would take to create the same warming effect.

Figure 2: Clackamas County geographic boundary.



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. |

⁴GPC 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

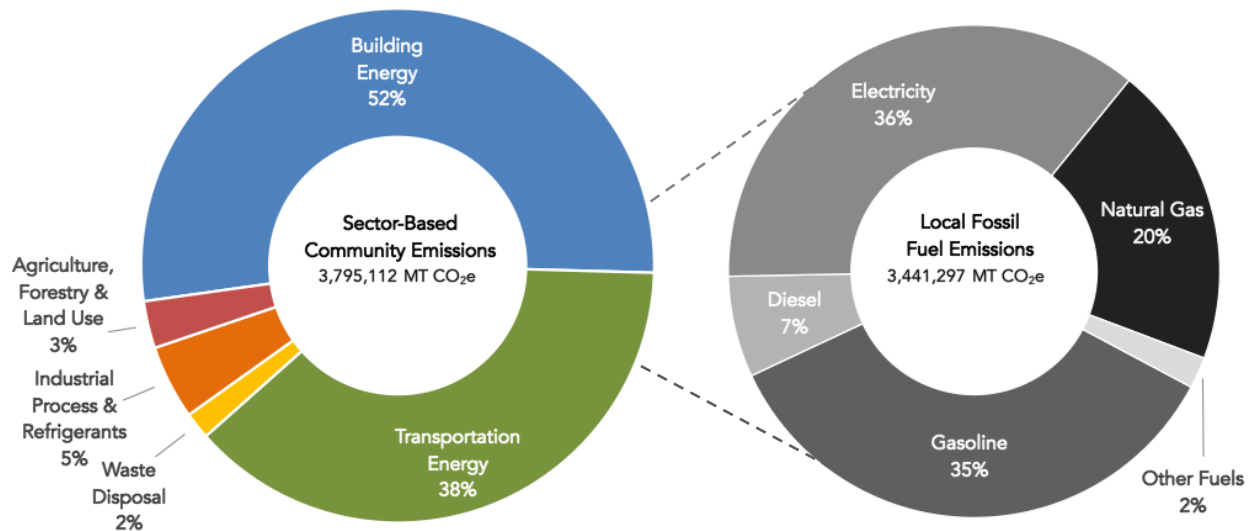
LOCAL EMISSIONS (SECTOR-BASED EMISSIONS)

The Clackamas County community generated 3,795,112 MT CO₂e of local emissions – about 9.1 MT CO₂e 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 emissions⁶ 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>.

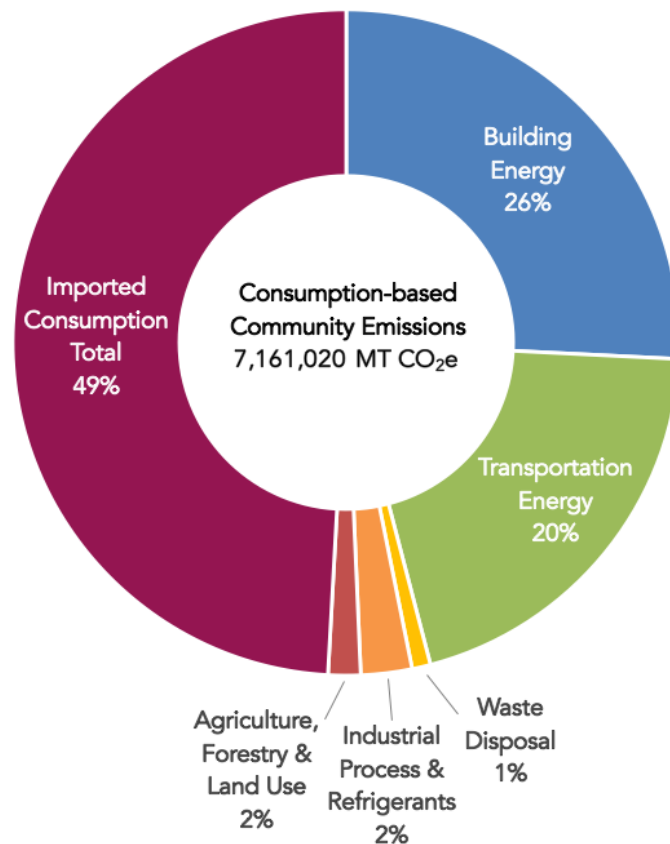
⁶Local emissions inventories include emissions within the County’s boundaries, from energy and fuel use by homes, businesses, and vehicles as well as all emissions from electricity generation, landfilling solid waste and wastewater treatment regardless of the location of the facility. These emissions 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 CO₂e 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

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.

Figure 4: Comparison of Local Emissions to 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.

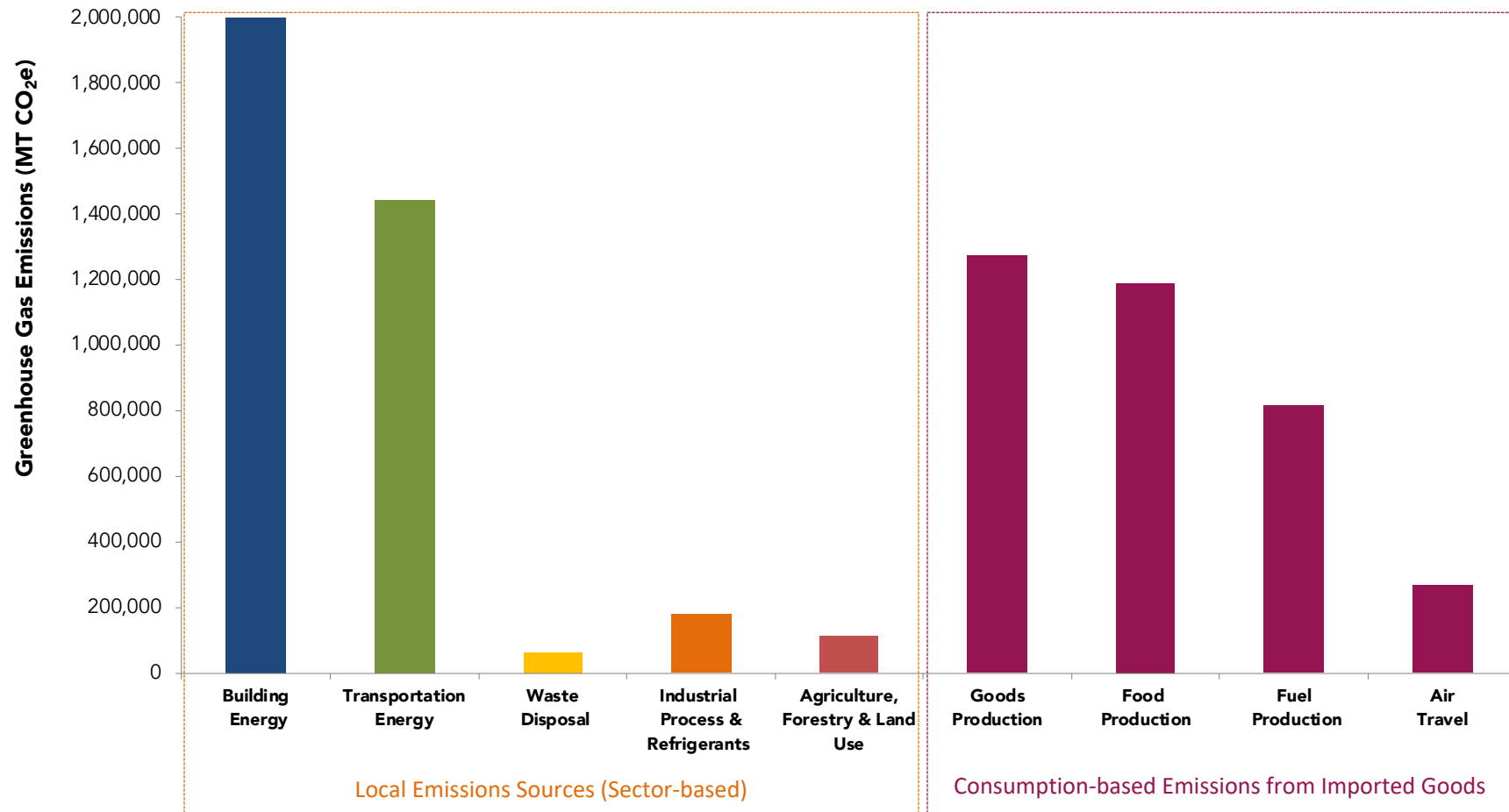


Table 2: Summary Table of Clackamas County 2018 Community GHG Emissions.

| 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 CO₂e / 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.

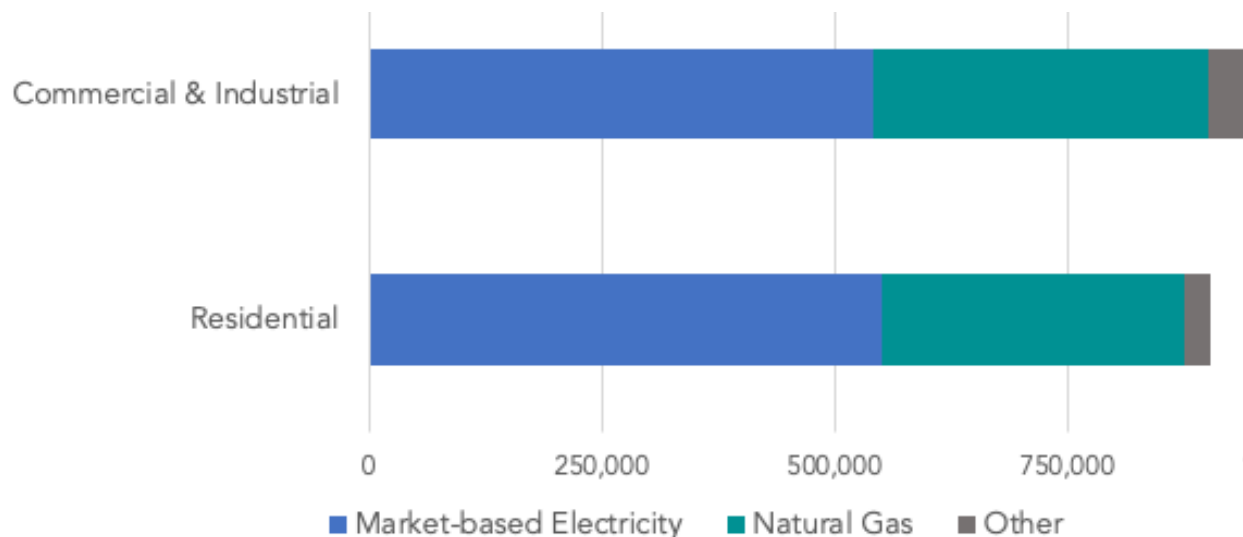
| City | 2018 Population | 2018 GHG Emissions (estimated) |
|--|-----------------|--------------------------------|
| Barlow | 135 | 1,231 |
| Canby | 16,800 | 153,237 |
| Estacada | 3,400 | 31,012 |
| Gladstone | 11,880 | 108,360 |
| Happy Valley | 20,945 | 191,044 |
| Johnson City | 615 | 5,610 |
| 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 CO₂e).



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 utilities⁸ 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 CO₂e/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.

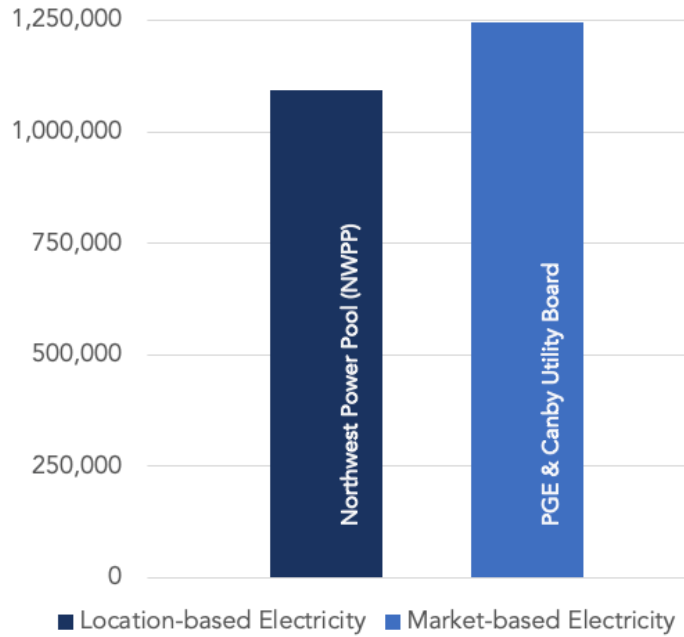
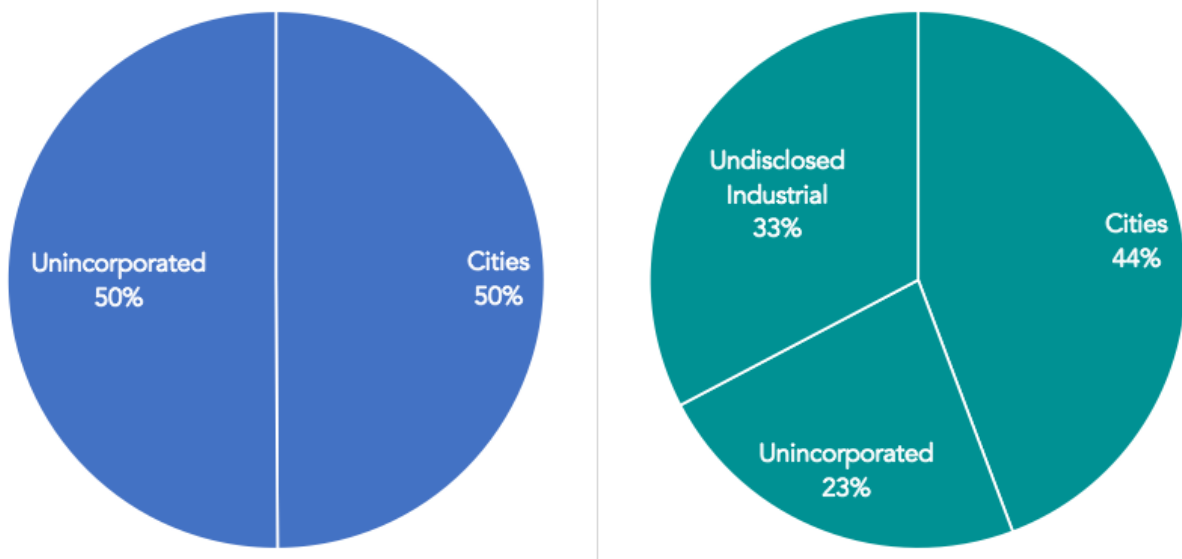


Figure 8 compares building electricity use and natural gas use by incorporated and unincorporated areas. As can be seen, electricity use is equally split between the two while natural gas use is mostly by cities and large industrial users.

Figure 8: Clackamas County Electricity Use, % of kWh Consumed (left) and Natural Gas⁹ (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.

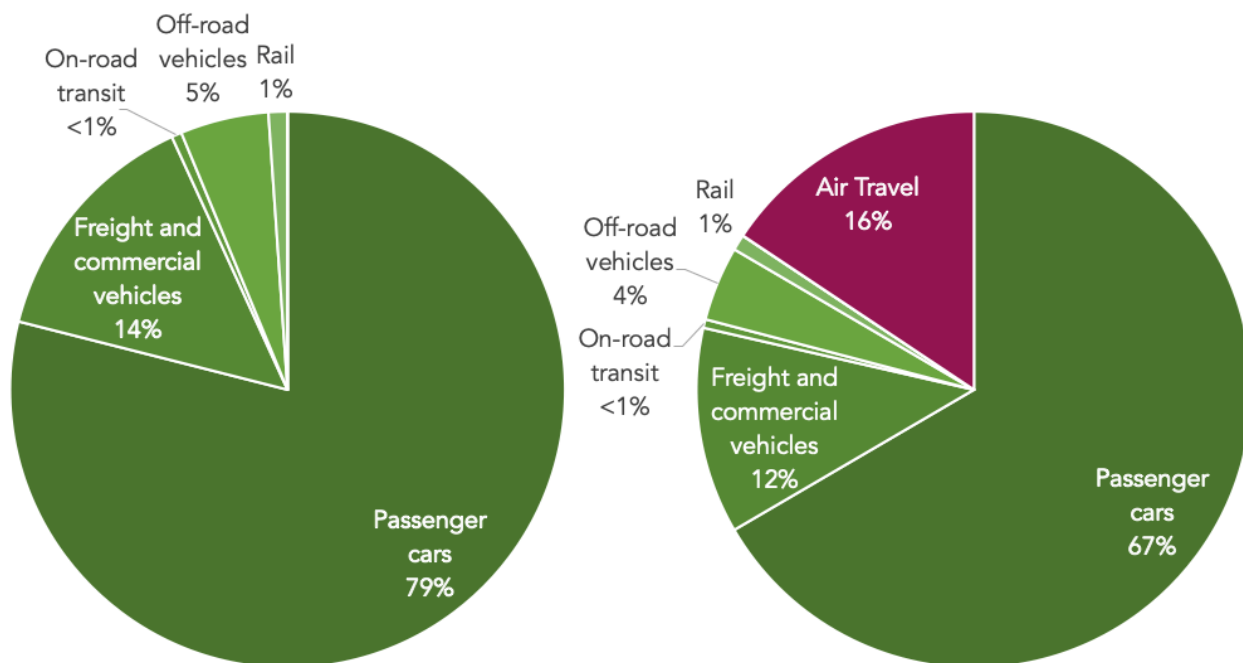
Two smaller sources of reported emissions include fugitive natural gas (i.e. methane loss) from Northwest Natural’s distribution system in Clackamas County (~18,000 MT CO₂e) and fugitive loss of SF₆ from PGE’s local electricity distribution system (~1,000 MT CO₂e). Related to fugitive natural gas, Northwest 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 CO₂e. 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 CO₂e 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 CO₂e). 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

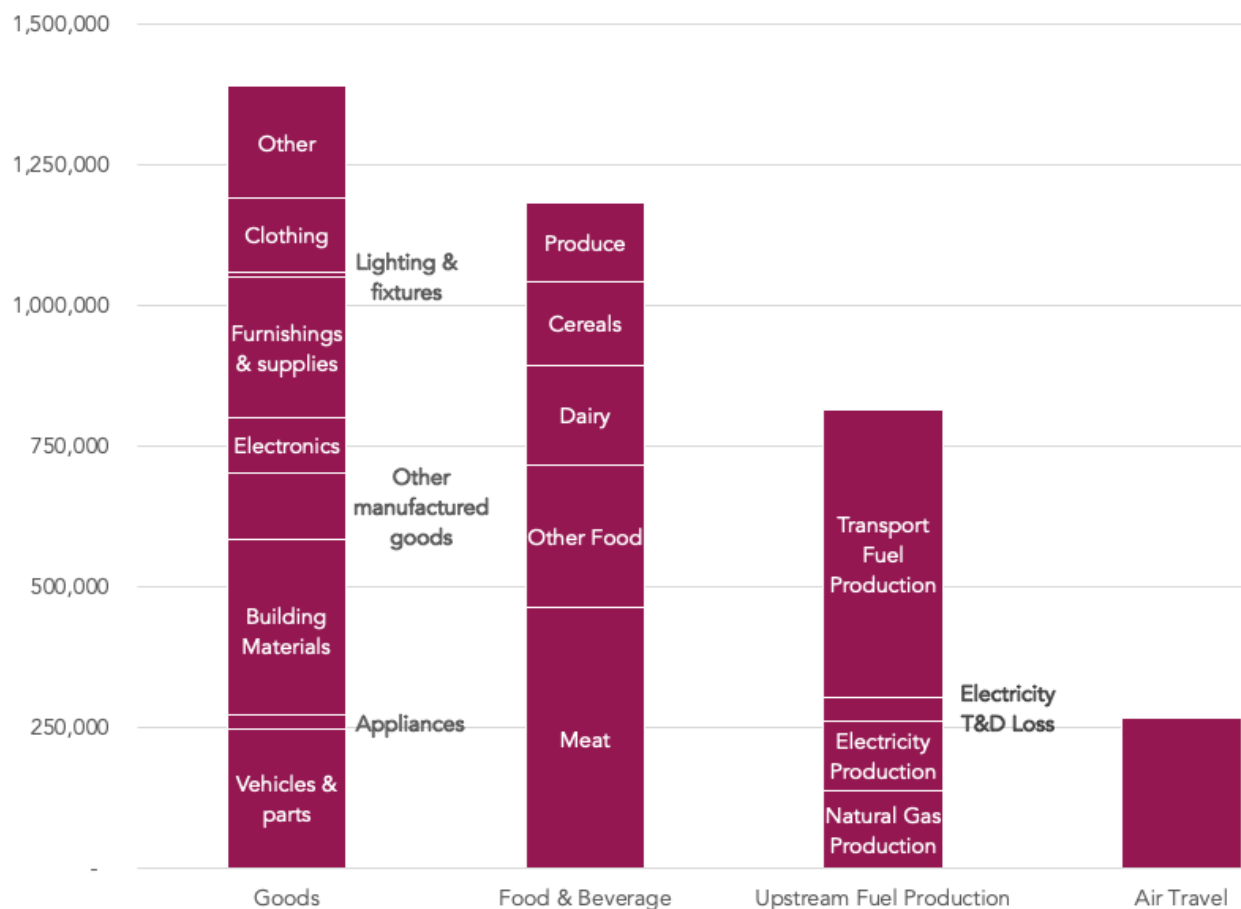
Clackamas County's inventory goes beyond GPC protocol requirements to highlight known large sources of consumption-based emissions. These emissions are considered Scope 3 in GHG inventory accounting. This means the community has less ownership and control over management of these emissions as compared 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 CO₂e)



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 CO₂e, or about 2.3 MT CO₂e 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 CO₂e). 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 Programs¹²
- 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.

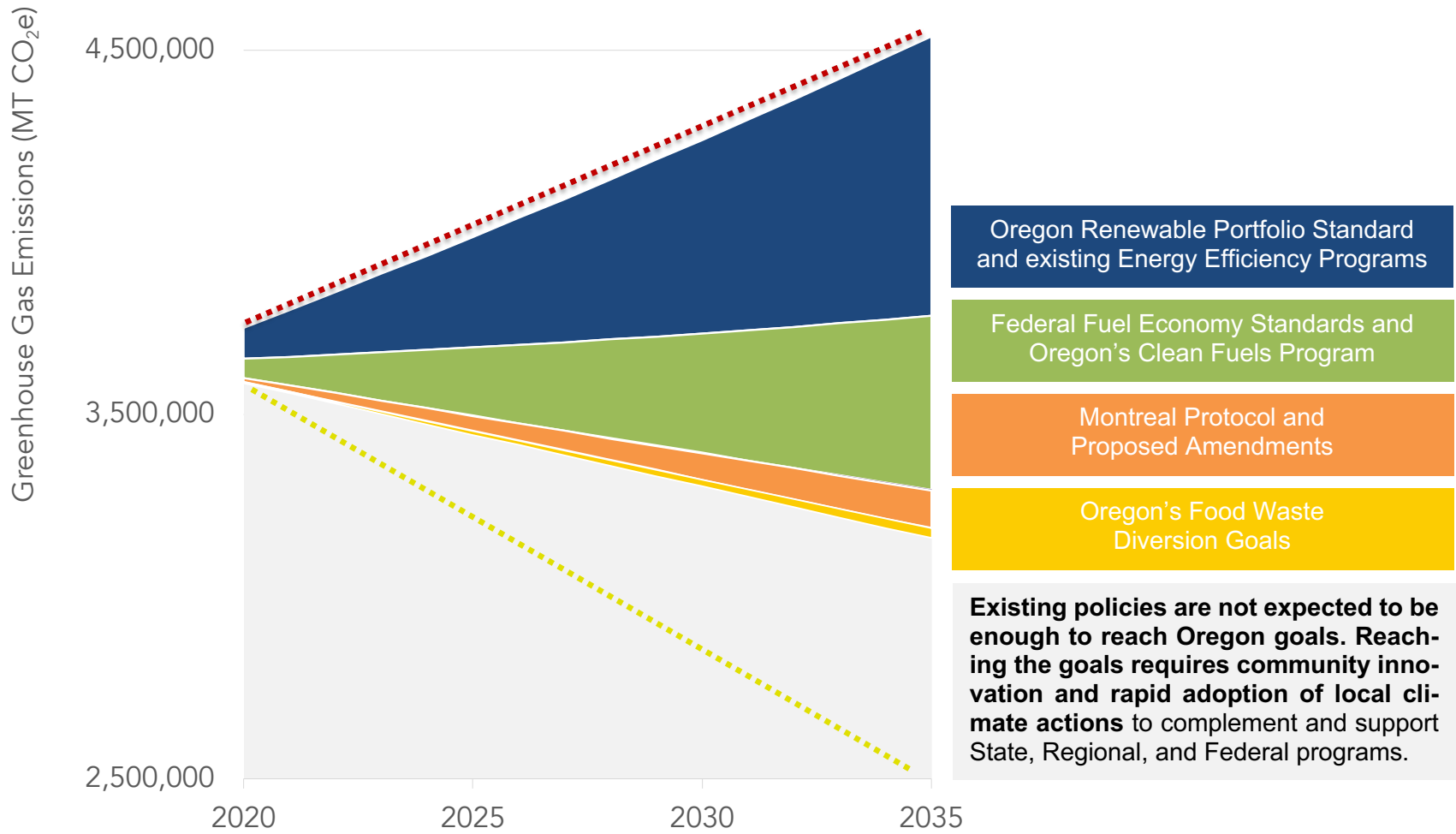
¹² Load forecast based on PGE's 2019 Integrated Resource Plan, preferred scenario.

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 CO₂e). The gases considered in the analysis are consistent with protocol and include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), Chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆) 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 re-considered 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 inventories 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 CO₂e. 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 CO₂e

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 | <i>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.</i> |
| 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, <i>2010 – 2017 Greenhouse Gas Emissions from Electricity Use</i> . Online at https://www.oregon.gov/deq/air/programs/Pages/GHG-Emissions.aspx . | |
| Fugitive Natural Gas System Emissions | <i>Fugitive loss of natural gas from the local product distribution system.</i> |
| 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 SF₆ | |
| Portland General Electric reported the weight of sulfur hexafluoride (SF ₆) fugitively lost during 2018. | |
| Transportation | |
| On-Road Energy | <i>Direct emissions from gasoline and diesel for passenger & freight transportation.</i> |
| 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 | <i>Direct emissions from gasoline and diesel for passenger transit transportation.</i> |
| 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 | |

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| <p>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.</p> | |
| Water Transportation | <p><i>Direct emissions from gasoline and diesel sold to recreational marine vehicles and indirect emissions from electricity used by ferry.</i></p> |
| <p>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.</p> | |
| Rail – Passenger & Freight | <p><i>Direct emissions from gasoline and diesel for passenger and freight transportation.</i></p> |
| <p>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.</p> | |
| Off Road | <p><i>Direct emissions from gasoline and diesel for off-road vehicles such as construction equipment, etc.</i></p> |
| <p>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.</p> | |
| Waste | |
| Landfill Solid Waste | <p><i>Fugitive methane emissions from mixed solid waste generated in the community and disposed of at outside the City.</i></p> |
| <p>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.</p> | |
| Composting Organic Waste | <p><i>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.</i></p> |
| <p>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.</p> | |

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| Wastewater Treatment Process Emissions | <i>Fugitive nitrous oxide emissions from discharge of treated effluent (wastewater).</i> |
| <p>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.</p> | |
| Septic Systems | <i>Direct emissions from the combustion of biosolids (wastewater).</i> |
| <p>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.</p> | |
| Industrial Process and Product Use | |
| Refrigerant Loss | <i>Fugitive loss of refrigerants from building and vehicle air conditioning systems.</i> |
| <p>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 CO₂e. The industrial sub-sector 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.</p> | |
| Agriculture, Forestry, and Land Use | |
| Livestock Methane | <i>Fugitive methane emissions from livestock enteric fermentation and manure management.</i> |
| <p>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.</p> | |
| Other Scope 3 (consumption emissions) | |
| Goods | <i>Upstream energy and process emissions raw material extraction, manufacturing, and out-of-state transportation of goods.</i> |
| Food | <i>Upstream energy and process emissions from the growing, processing and transportation of foods.</i> |
| Services | <i>Upstream energy emissions from air travel by community members from airports outside of the community's geographic boundaries.</i> |

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| <p>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.</p> | |
| Upstream Fuel Production | <i>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.</i> |
| <p>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.</p> | |
| Negative Emissions | |
| Local Carbon Storage | <i>Additional carbon storage in the inventory year by local forest and soil resources.</i> |
| <p>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.</p> | |
| Purchased Carbon Offsets | <i>Community purchase of verified carbon offsets (e.g. offsets purchased by the community-at-large from participation in NWN's Clear Energy program).</i> |
| <p>Carbon offsets purchased by account holders were provided by the natural gas utility as therm-equivalents, which was then converted to MT CO₂e using G3C Community. This activity data is considered highly accurate.</p> | |