City of Salem, Oregon

2016 Consumption-Based Greenhouse Gas Inventory

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CITY OF Salem AT YOUR SERVICE

Prepared by verdis GROUP

Introduction

In the effort to address climate change by reducing greenhouse gas (GHG) emissions, it is critical to first measure where emissions are coming from. This baseline is known as a GHG inventory. For municipalities, there are two different kinds of GHG inventories: sector-based and consumption-based.

In 2019, a sector-based GHG inventory of Salem's emissions was completed using 2016 data. This inventory measured emissions that are generated within Salem's city limits from activities such as energy generation, transportation, waste and manufacturing.

To complement this sector-based inventory, Salem called for the creation of a consumption-based inventory. This inventory measures GHGs that are associated with the goods and services that are purchased and used by Salem residents. For every good or service used, GHG emissions may be produced from the production, transportation, wholesale or retail sales, consumer use, and eventual disposal of the purchased item or service.

For example, if a Salem resident purchases a new pair of athletic shoes, a sector-based GHG inventory would measure the emissions created by driving to the store to purchase the shoes and later disposing of the shoes. But a consumption-based inventory will also measure all the GHG emissions that went into manufacturing that pair of shoes overseas and shipping them to the store. In essence, the consumption-based GHG inventory measures the carbon footprint of residents' purchasing and use behaviors.

Key Terms

GHG - Greenhouse gas. Examples of greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases.

CO_2e - Carbon dioxide equivalent. This is a metric that describes different GHGs in a common unit. It signifies the amount of CO_2 which would have the equivalent global warming impact.

$MtCO_2e$ - Metric tons of carbon dioxide equivalent. This is the unit of measurement by which atmospheric GHGs are measured.

In North America and Europe, the emissions from a consumption-based emissions inventory are typically higher than a sector-based inventory, because they take into account a much larger web of activity that occurs outside of their geographic bounds.

Consumption-based emissions occur both within and outside of the geographic bounds of Salem, meaning some of the emissions that occur are already counted within the sector-based inventory. The methodology for the two inventories differs significantly, so caution should be taken when interpreting the results. The emissions from these inventories cannot be added together for a total footprint because some emissions overlap. Instead, the inventories complement each other as two methods for viewing Salem's carbon footprint.

Generally, government has less ability to directly impact consumption emissions through legislation, compared with sector-based inventories. That's because most consumer behavior is not regulated. Instead, consumption-based emissions can be reduced by individual consumer behavior. These behavior changes might include, for example, reducing meat consumption or driving fewer miles. For the average resident, making choices regarding consumption can be a tangible way to reduce greenhouse gas emissions, minimize the amount of material they send to the landfill, and eliminate unnecessary expenditures. Therefore, measuring and communicating consumption-based emissions can be an effective message for environmentally-conscious residents.

Methods

A consumption-based inventory requires two variables: per-capita expenditures across a range of consumer categories; and emission factors for each purchase, use, sale or disposal of those goods and services (a specified quantity of carbon dioxide equivalents per unit of each good or service).

Data on per-capita expenditures was provided by the Bureau of Economic Analysis (BEA). The BEA provided per capita consumer spending by state and year for multiple categories, which were combined into the 14 categories analyzed. Verdis Group then extrapolated the data from the state to the local level. Expenditure data varied by less than 1% between the State of Oregon and Salem.

The Salem metropolitan area includes the adjacent counties of Marion and Polk Counties as defined by the United States Office of Management and Budget according to published standards that are applied to Census Bureau data. The general concept of a metropolitan area is that of a core area containing a large population nucleus, together with adjacent communities having a high degree of economic and social integration with that core.

Emission factors were sourced from the Oregon's Greenhouse Gas Emissions through 2015 report and are a composite of multiple greenhouse gases that have been converted into carbon dioxide equivalents. For example, each metric ton of methane released into the atmosphere will have the same effect as 25 metric tons of carbon dioxide, so the quantity of methane released is multiplied by 25 to turn it into carbon dioxide equivalents.

Verdis Group sub-categorized the emissions into two categories: **Three-phase** (production & supply chain, transportation, and wholesale & retail) and **use and disposal**.

Since the source for emissions factors (noted above) was from 2015, but the target analysis year was 2016, Verdis Group wanted to confirm that the emissions per unit of activity were the same from one year to the next. The expected change between 2015 and 2016 emissions intensity was thus analyzed. It was determined that no significant change occurred over one year, and thus emission factors for 2015 were assumed for 2016.

These two pieces of data (dollars expended per resident and emissions per dollar) were used to calculate average emissions per category per resident for 2016.

Results

Verdis Group calculated that purchases of goods and services by residents of Salem were responsible for nearly 4.2 million metric tons of carbon dioxide equivalent ($MtCO_2e$) greenhouse gases in 2016. Each resident's use of goods and services (consumption) produced almost 20 $MtCO_2e$ in 2016 (Table 1). Vehicles and parts (29%) and food and beverages (22%) constituted over half of consumption-based emissions (Figure 1, Figure 3). Salem's consumption-based emissions were over 250% of sector-based emissions (Figure 4). This finding is in line with other North American and European cities, which typically have higher emissions in a consumption-based inventory than a sector-based inventory, as determined by a study completed by the C40 Cities Climate Leadership Group.

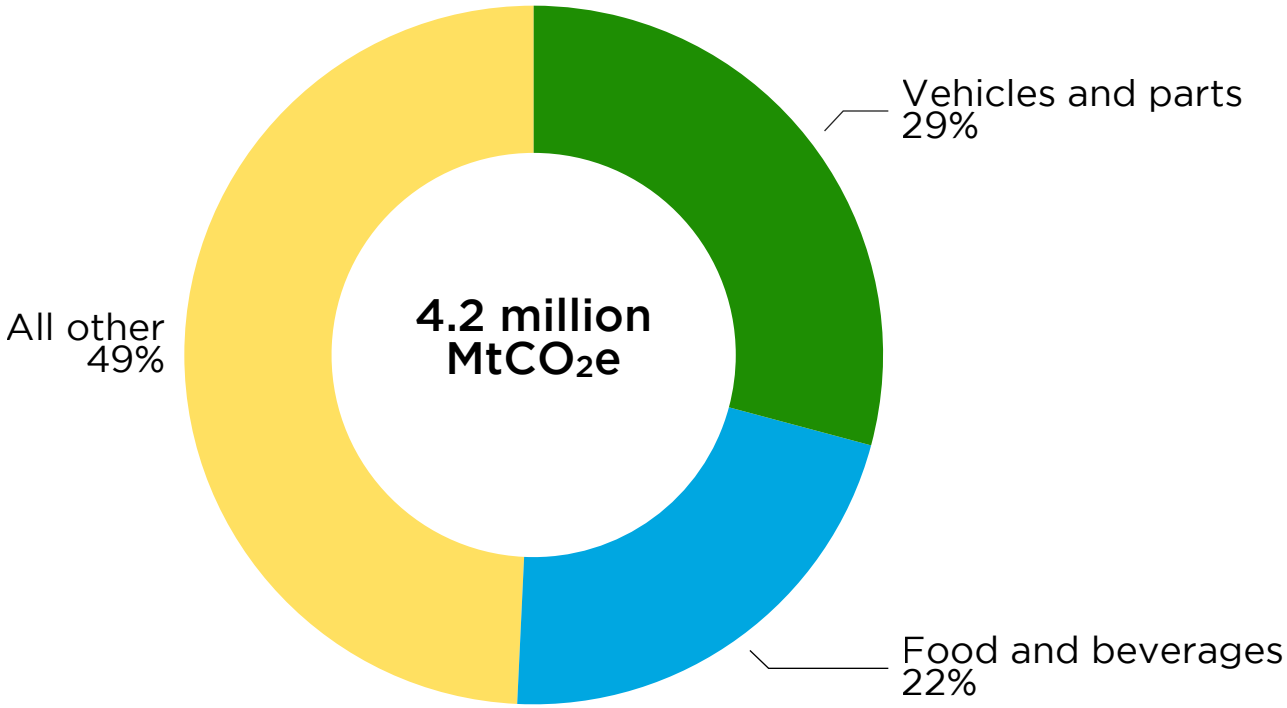

Figure 1. City of Salem consumption-based emissions for 2016.

Each resident's consumption produced almost **20 metric tons of CO_2e.**

Salem's consumption-based emissions were over **250%** greater than sector-based emissions.

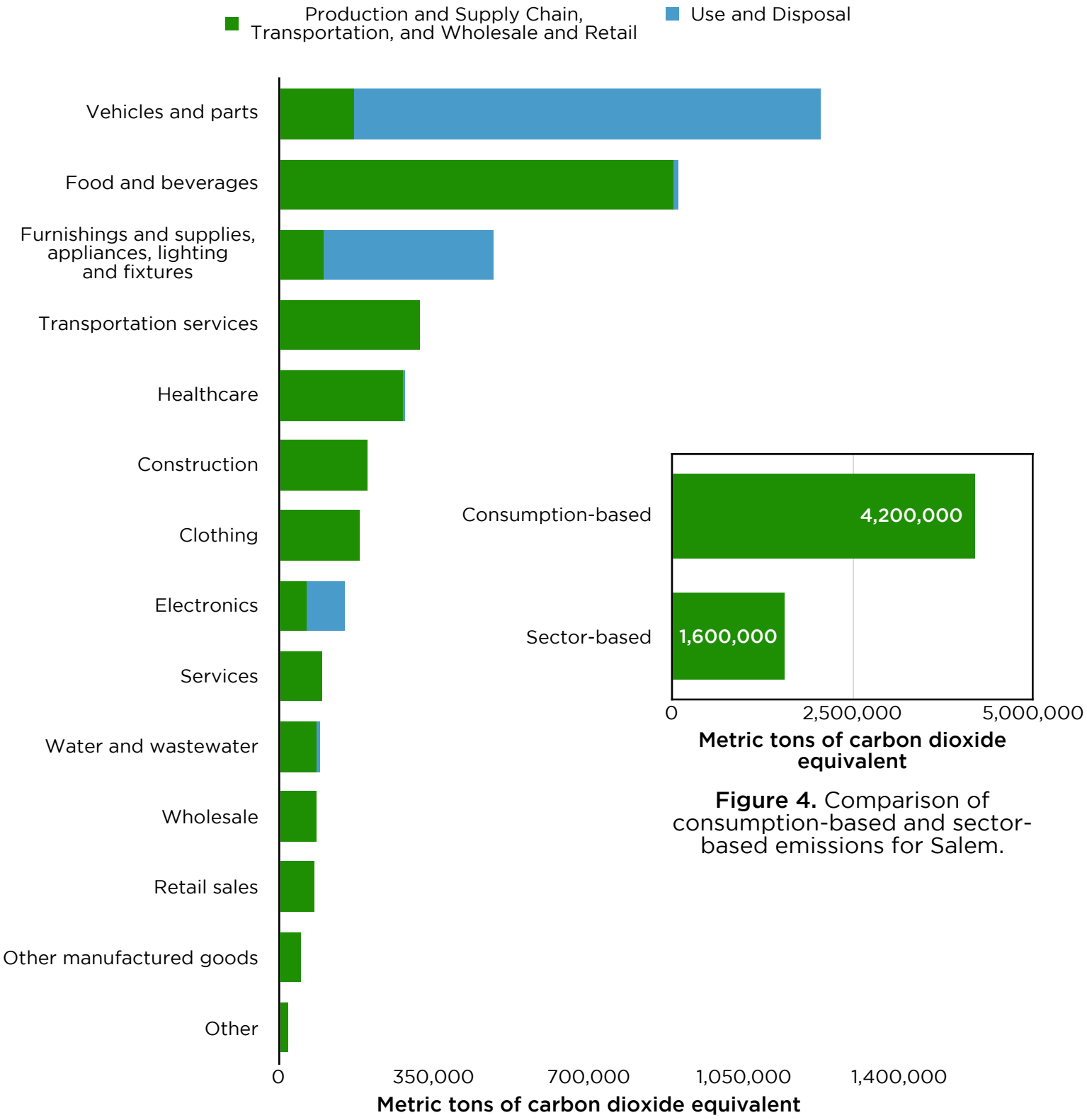

Figure 3. City of Salem consumption-based emissions by category for 2016.

Figure 4. Comparison of consumption-based and sector-based emissions for Salem.

Table 1. Sources of Salem's GHG emissions.

Source	$MtCO_2e$	$MtCO_2e$ Per Resident
Vehicles and parts	1,220,800	5.7
Food and beverages	903,600	4.2
Furnishings and supplies, appliances, lighting and fixtures	486,400	2.3
Transportation services	317,700	1.5
Healthcare	286,400	1.3
Construction	201,700	0.9
Clothing	184,600	0.9
Electronics	149,500	0.7
Services	97,600	0.5
Water and wastewater	92,700	0.4
Wholesale	88,200	0.4
Retails sales	82,500	0.4
Other manufactured goods	52,000	0.2
Other	22,100	0.1
Total	**4,185,700***	**19.7***

*Differences in total due to rounding

The vehicles and parts category is the largest source of consumption-based emissions in Salem. The primary reason for this is because of the GHG emissions released by the combustion of gasoline and diesel fuel in motor vehicles. This result should come as no surprise because mobile emissions, which includes motor vehicles and other sources, were responsible for 53% of all sector-based emissions in Salem and 28% of emissions nationally.

The consumption of food and beverages is the second-largest source of consumption-based emissions. Emissions from this category include those associated with meat consumption, especially beef, which has a large carbon footprint due to all the inputs associated with growing cattle feed, the methane released in manure and through a process of digestion known as rumination, and transporting product to stores. Food waste is another significant source because all of the emissions associated with producing, transporting, and storing food that is not eaten create needless GHG emissions.

Sector-Based vs. Consumption-Based Inventories

The City of Salem, Oregon, completed a sector-based greenhouse gas inventory of 2016 data in 2019. Sector-based inventories account for emissions that occur within the geographic bounds of a municipality (i.e., within City limits), typically with several exceptions (e.g. electricity produced outside of the boundary but consumed within, waste produced within but transported outside). Complementary to these efforts is a consumption-based inventory, which assesses emissions from the sourcing, production, retailing, use, and disposal of goods and services used by Salem residents regardless of where the goods and services were produced.

In some cases, emissions are counted in both inventories which can lead to double counting if emissions from the inventories are added together. The infographic (Figure 2) to the right lays out three scenarios involving commuting as an illustrative example of how these emissions would be accounted for in a consumption-based vs. sector-based inventory.

- In the first scenario, a Salem resident commutes to work outside the city limits. In this scenario, all emissions from the trip are included in the consumption-based inventory because the resident is from Salem. However, in the sector-based inventory, only emissions from driving within the city limits are counted.
- In the second scenario, a resident from another city commutes into Salem for work. No emissions are counted towards the consumption-based inventory because the individual does not live in Salem. However emissions from driving within the city limit are included in the sector-based inventory.
- In the third scenario, a resident of Salem lives and works within the city. Total trip emissions are included for both inventories but for different reasons: the consumption-based inventory because the individual is a resident of Salem, and the sector-based inventory because all activity takes place within the city limits.

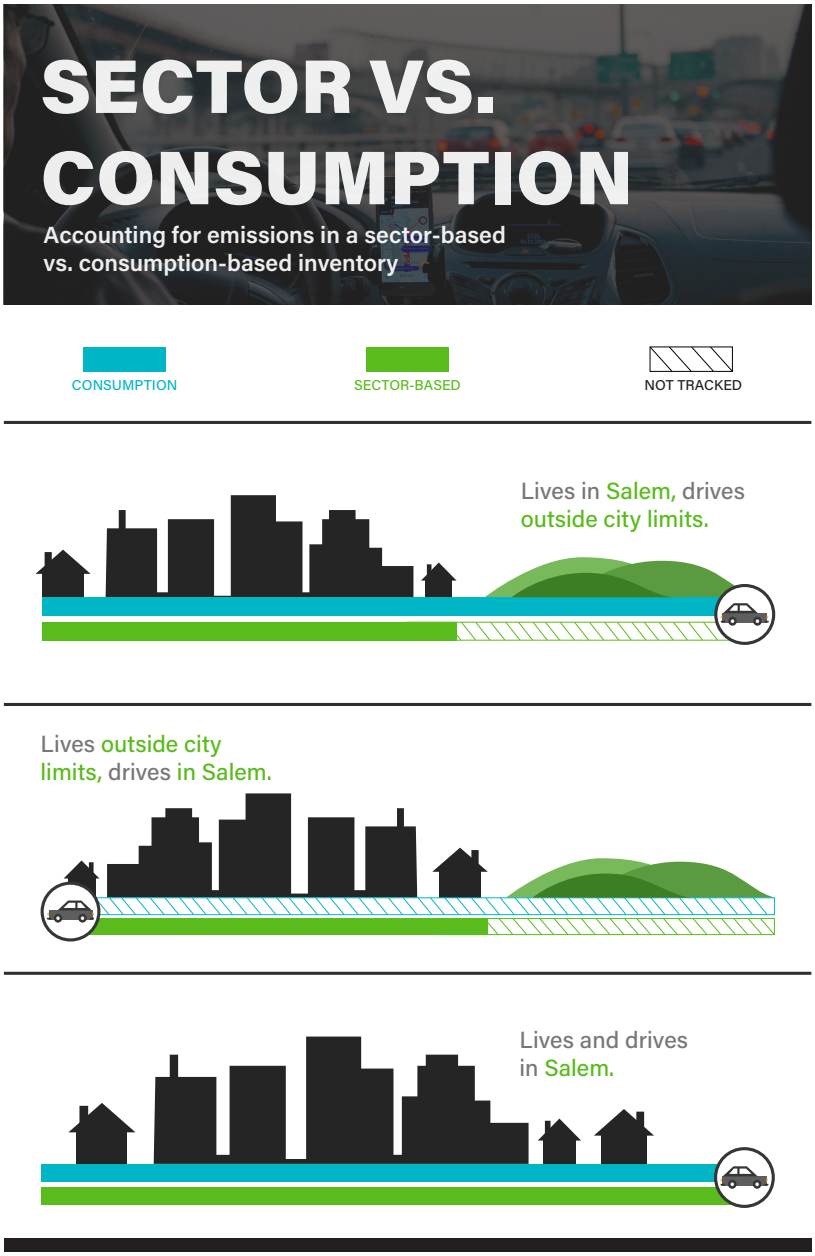

Figure 2. Three scenarios comparing how emissions are accounted for depending on whether the inventory is sector-based or consumption-based.

Goal-Setting

When goal-setting, the sector-based and consumption-based inventories should be treated separately. Goals need not be set for both inventories. It remains uncommon to set consumption-based goals because of the difficulty of measuring the effect of changes in consumer behavior and because municipalities have little control over the purchasing decisions of residents.

It is helpful to keep in mind that all consumption-based emissions are another location's sector-based emissions. For example, many of the products purchased in Salem were produced in China, where the production would be counted in sector-based inventories. Widespread goal-setting and rigorous actions to reduce sector-based emissions will lower consumption-based emissions.

Verdis Group recommends setting goals based on sector-based inventories due the challenges associated with directly impacting and measuring a reduction in GHG emissions in a consumption-based inventory.

What You Can Do

Individual choices can add up to make a big difference in reducing emissions. Here are some of the most impactful ways that you can reduce your carbon footprint:

Reduce the number of trips you make in a gasoline-powered car by carpooling, busing, biking, or walking instead.

If purchasing a new vehicle, purchase an electric vehicle or hybrid to reduce emissions per mile.

Reduce the amount of red meat you consume. Animal husbandry is a significant source of agricultural emissions. Beef cattle are the most emissions-intensive commonly consumed meat.

Reduce the number of airplane flights you take.

Reduce food waste by buying only what you need. Wasted food accounts for 6% of global emissions.