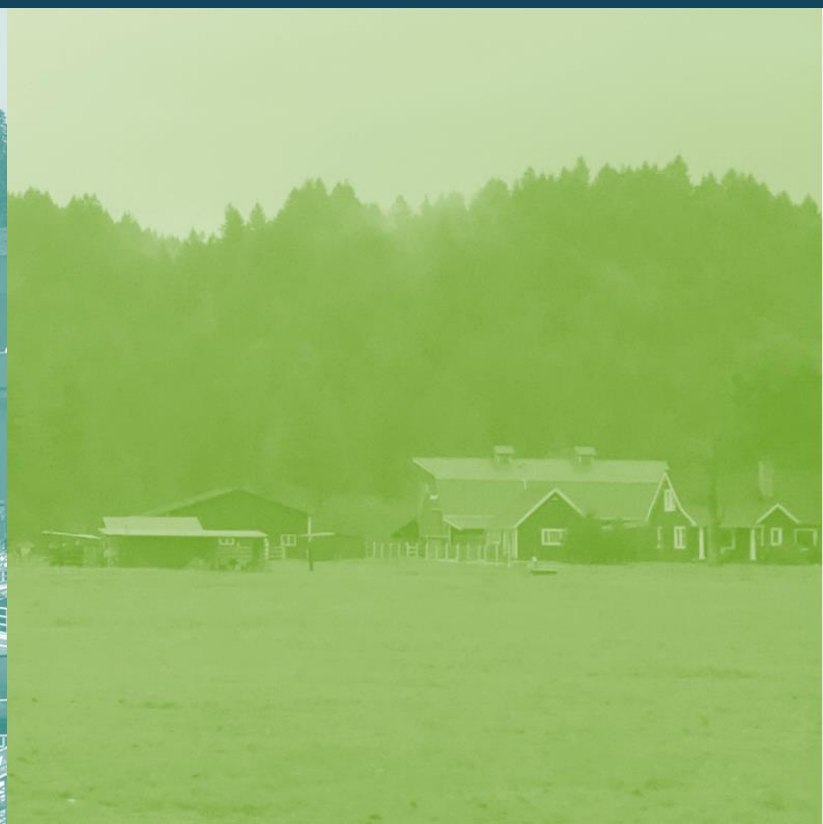
2021
Greenhouse Gas Emissions Inventory for Thurston County

October 2022



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Acknowledgements

Thurston Regional Planning Council would like to thank the Thurston Climate Action Team — especially the work of Tom Crawford and Dave Bradley — for their work on the 2010 through 2020 Thurston County greenhouse gas emissions inventories. Special thanks to Dave Bradley for providing TRPC with technical assistance and for reviewing the 2021 Thurston County Greenhouse Gas Emissions Inventory.

This inventory was funded by Thurston County and the cities of Lacey, Olympia, and Tumwater.

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EXECUTIVE SUMMARY

In 2019, Thurston Regional Planning Council, Thurston County, and the cities of Lacey, Olympia, and Tumwater committed to reducing climate-warming greenhouse gas emissions. The following targets were adopted:

- Achieve 45 percent reduction of 2015 levels by 2030
- Achieve 85 percent reduction of 2015 levels by 2050

Meeting these targets requires monitoring emissions across Thurston County. Since 2010, the Thurston Climate Action Team (TCAT) has completed a greenhouse gas emissions inventory for Thurston County. This report extends the TCAT inventory to 2021 and incorporates changes identified by TCAT and the Thurston Climate Mitigation Plan.

Total 2021 greenhouse gas emissions in Thurston County are estimated at 2.9 million metric tons CO2e (MTCO2e) — about 9.8 MTCO2e per person. After several years of increasing emissions, 2020 and 2021 emissions were below the 2015 baseline. **However, emissions are still not on track to meet the 2030 and 2050 targets** (Figure 1)**.**

The buildings and energy sector — emissions due to heating and powering homes and businesses — remains the largest source of emissions (54 percent of total, Figure 2). Transportation is the second largest sector, accounting for 36 percent of emissions. The remaining sectors included in the inventory — water and waste, agriculture, and hydrofluorocarbons – together account for approximately 10 percent of the total.

The region has seen some success. Combined emissions from the buildings and energy and transportation sectors decreased by over 150,000 MTCO2e since 2015 (Figure 4). While some of the decrease was due to cleaner sources of electricity and improved vehicle efficiency, increased telework due to the COVID-19 pandemic also contributed. Future inventories will show whether these decreases in emissions can be sustained.

This greenhouse gas emissions inventory is a “geographic-plus” inventory, meaning it includes emissions associated with activities occurring within the Thurston region “plus” emissions associated with producing the electricity used in the region, even though that electricity is generated outside the Thurston region. The inventory does not include emissions due to the goods and services consumed by Thurston County residents (i.e., it is not a consumption-based emissions inventory).

The accuracy and comprehensiveness of this greenhouse gas emissions inventory are limited by the quality and availability of data. This report includes notes on data limitations. As new or improved data sources are identified, they will be added to the inventory.

Figure 1: Total Emissions and Thurston Climate Mitigation Plan Emission Reduction Targets

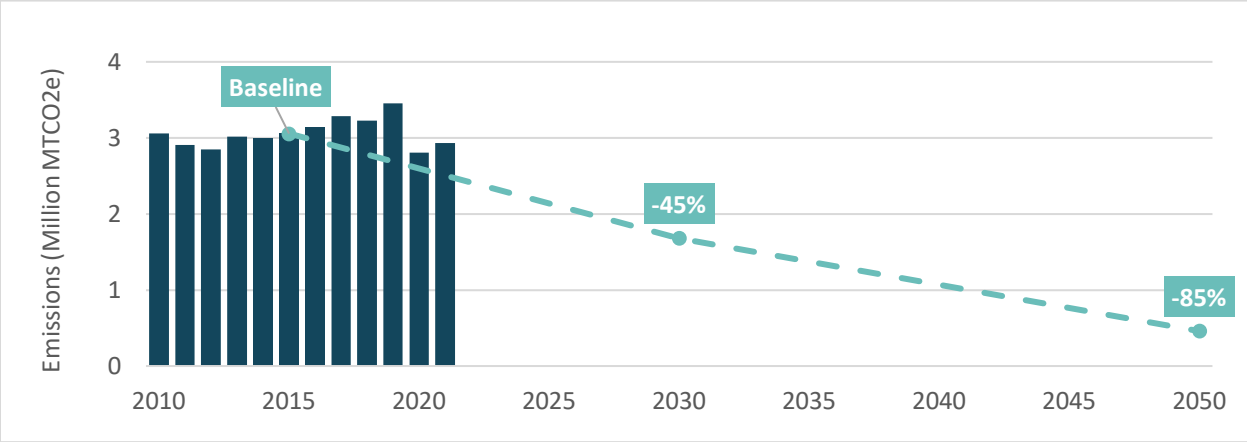


Figure 2: 2021 Emissions by Sector

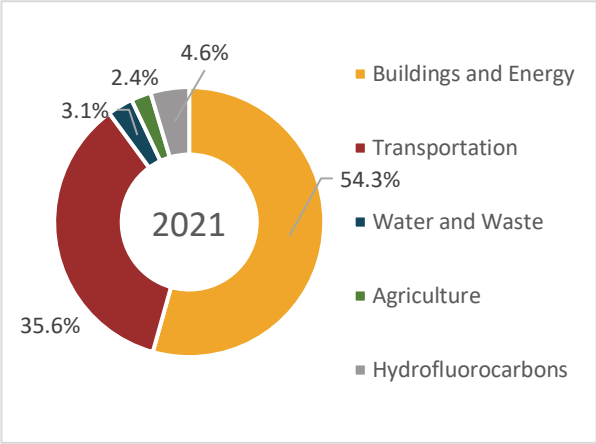


Figure 3: Per Capita Emissions

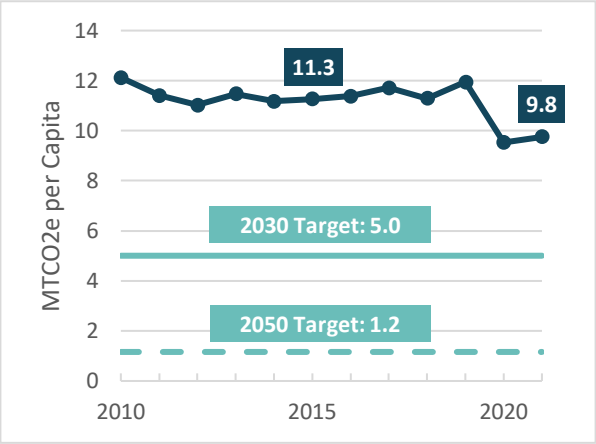
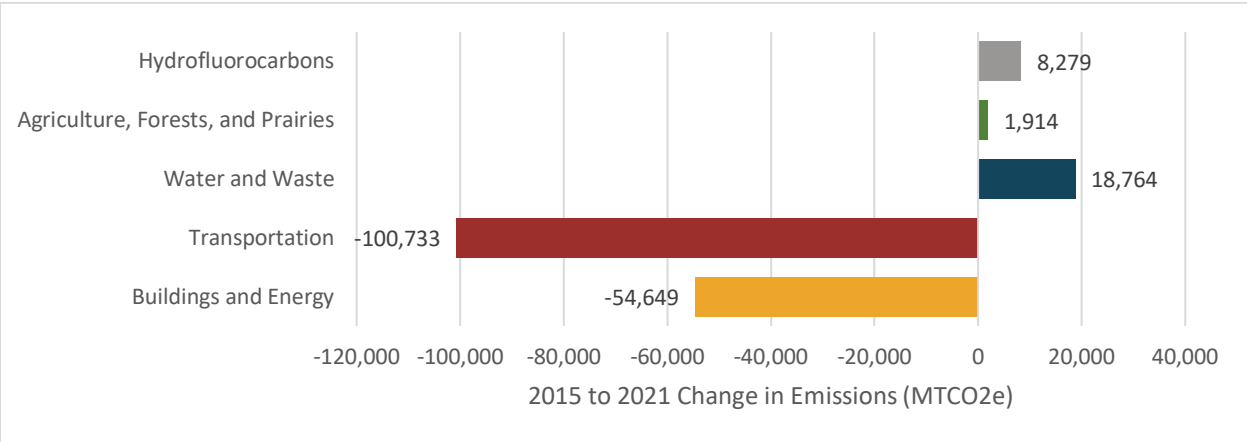


Figure 4: Change of Sector Emissions from 2015 to 2021



INTRODUCTION

Increasing emissions of carbon dioxide and other greenhouse gases are changing the Thurston region's climate in ways that will impact both human and natural systems. In general, we can expect to experience hotter, drier summers and warmer, wetter winters. These changes are anticipated to worsen existing hazards—like floods, landslides, and wildfires—and introduce new threats—like invasive plants, insects, and infectious diseases.

To ensure that our community significantly reduces local contributions to climate change, Thurston Regional Planning Council (TRPC), Thurston County, and the cities of Lacey, Olympia, and Tumwater have adopted the following greenhouse gas emissions reduction targets:

- 45% reduction below 2015 levels by 2030, and
- 85% below 2015 levels by 2050.

To reach these targets, policymakers and the public need information on the amount and source of greenhouse gas emissions to understand if we are meeting our targets and evaluate which strategies are most effective. For this reason, the Thurston Climate Mitigation Plan (TCMP) includes the following action (Action G4.1, TRPC 2020):

> ***Emissions inventory.*** *Prepare and publish an annual emissions inventory that tracks greenhouse gas emissions by jurisdiction and source category. Review and update emissions inventory methodology as necessary to address improvements to data or methodologies, improve consistency, incorporate changes to state or federal policies, or report on issues of local interest.*

The Thurston region has a long history of inventorying its greenhouse gas emissions. The region's first greenhouse gas emissions inventory was developed by the Thurston Climate Action Team (TCAT), a local nonprofit dedicated to addressing the climate threat in Thurston County. TCAT updated the inventory annually, covering the years of 2010 through 2019.

In 2022, the four TCMP partner jurisdictions contracted with TRPC to complete the greenhouse gas emissions inventory. Over the course of 2022, TRPC worked with TCAT to transition the inventory. This report provides a summary of greenhouse gas emissions in the Thurston Region between 2010 and 2021.

METHODOLOGY AND SCOPE

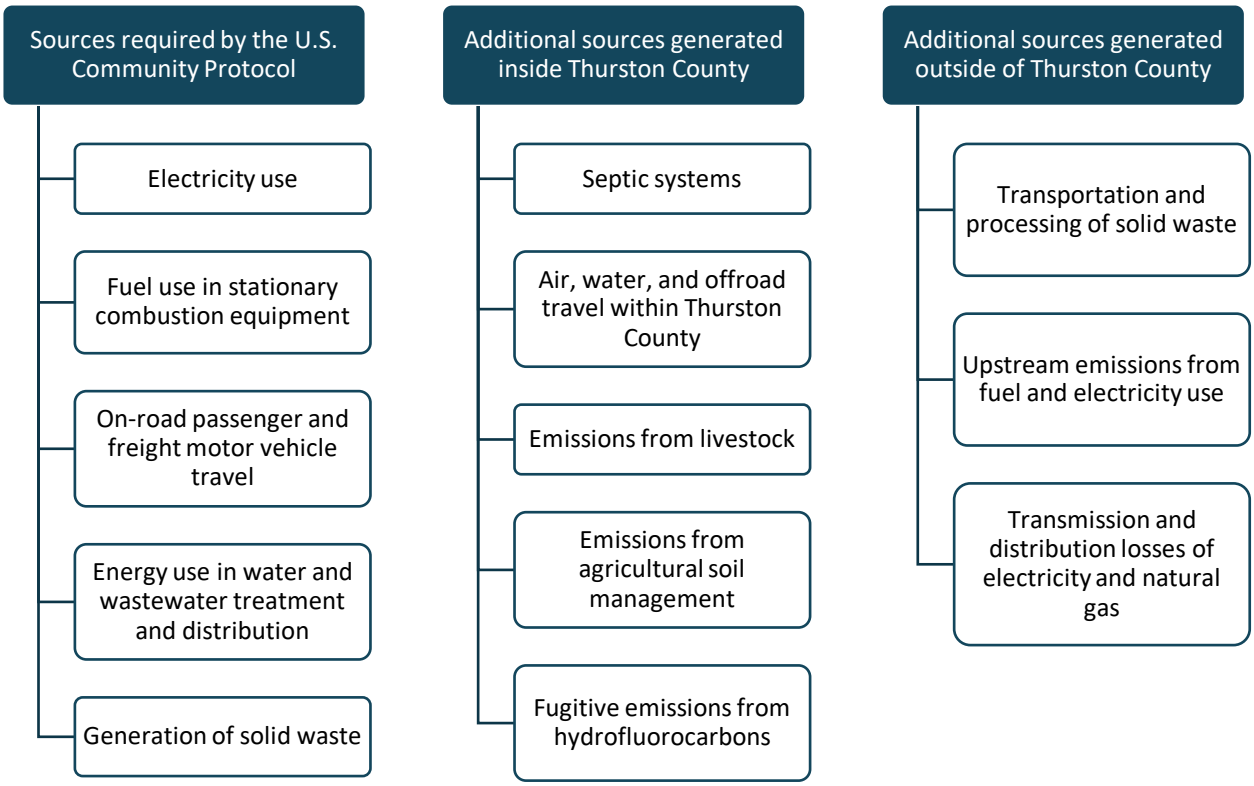
This report provides a geographic-plus inventory that estimates greenhouse gas emissions associated with activities occurring within the Thurston region plus emissions associated with producing the electricity used in the region, even though that electricity is generated outside the Thurston region. This inventory also includes emissions associated with the transportation and disposal of solid waste generated by residents and businesses even though local solid waste is currently disposed at a landfill located outside Thurston County.

This inventory — like the previous TCAT inventories — was prepared in accordance with the requirements and procedures established by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions prepared by ICLEI (ICLEI 2019). The protocol provides internationally accepted methods that facilitate comparisons with emission inventories prepared by other cities and counties.

What emissions sources are included?

The U.S. Community Protocol requires five basic emissions generating activities be included in emissions inventory reports. Beyond these required sources, this report includes other significant emissions generating activities where data was available. Included sources are listed below:

Figure 5: Emissions sources included in the inventory, separated by source location and required status



This inventory reports greenhouse gas emissions in metric tons of carbon dioxide equivalents (MTCO2e), a standard unit for reporting greenhouse gas emissions that standardizes the warming potential of different greenhouse gases. The U.S. Community Protocol addresses six different greenhouse gases associated with climate change:

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF6)

Each greenhouse gas has a different global warming potential — based on how well it traps heat and its lifespan in the atmosphere — which can be compared to that of carbon dioxide. This report uses the 100-year global warming potential of each gas from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment.

How should this inventory be used?

TRPC recommends that this inventory be used to compare year-over-year changes in greenhouse gas emissions data in Thurston County to identify the largest contributors of emissions in our region and sectors where we have seen the most change in emissions. The inventory should be compared to other jurisdictions with caution, first ensuring that a consistent methodology is being used for each sector.

Organization of the Inventory

The greenhouse gas emissions inventory is organized around the following sectors:

Buildings and Energy: Emissions from residential, commercial, and industrial buildings and outdoor lighting

Transportation: Emissions from onroad vehicles (passenger vehicles, commercial trucks, and heavy-duty vehicles) and offroad vehicles and equipment

Water and Waste: Emissions from solid waste management, composting, wastewater treatment plants, and on-site septic systems

Agriculture, Forests, and Prairies: Emissions from livestock (enteric fermentation and manure management) and agricultural soil management

Hydrofluorocarbons: Emissions from unintentional leakage or discharge of industrial chemicals used primarily for cooling, refrigeration, and fire suppression

Changes from Previous Inventories

Action G4.3 of the TCMP states:

> ***Other emission sources and sinks.*** *Expand sources and sectors in future emissions inventories to inform future regulatory policy to reduce greenhouse gas emissions.*

Several improvements to the inventory have been identified, both to improve its accuracy and scope. TCAT identified a number of improvements in its 2019 inventory (TCAT 2021). In addition, Cascadia Consulting Group provided a list of recommendations (Cascadia 2019) in their review of TCAT's inventory as part of the early phases of the TCMP. Some overarching changes include entering the inventory into ClearPath — to help with quality control and review — and using the most recent greenhouse gas global warming potential factors from the IPCC Fifth Assessment. Other changes are noted within each sector of this report.

Limitations

This inventory is intended to quantify greenhouse gas emissions in Thurston County as comprehensively and accurately as possible. Some emissions included in the inventory rely on low-accuracy data, for example using assumptions based state and national averages. Some known sources of emissions have been omitted if there are no reliable data available and the expected emissions make up a small percent of the total. Omitted sources of emissions are noted throughout this report.

Consumption-Based Emissions

This inventory does not include emissions related to the goods and services that Thurston County residents consume. Consumption-based emission inventories require detailed data on household spending and the carbon footprint of the goods and services they consumed, and emissions from goods and services generated and consumed in the same area may be overestimated. TRPC estimates that Thurston County households consume about 48 MTCO2e per year using data provided by the University of California Berkeley's Cool Climate tool (U.C. Berkeley CoolClimate Network 2013). Total countywide consumption is estimated at 5.6 million MTCO2e per year, nearly double the estimated 3 million MTCO2e emitted in 2021 calculated using the geographic-plus methodology in this report.

INVENTORY RESULTS

Buildings and Energy

Figure 6: Buildings and Energy Emissions by Source

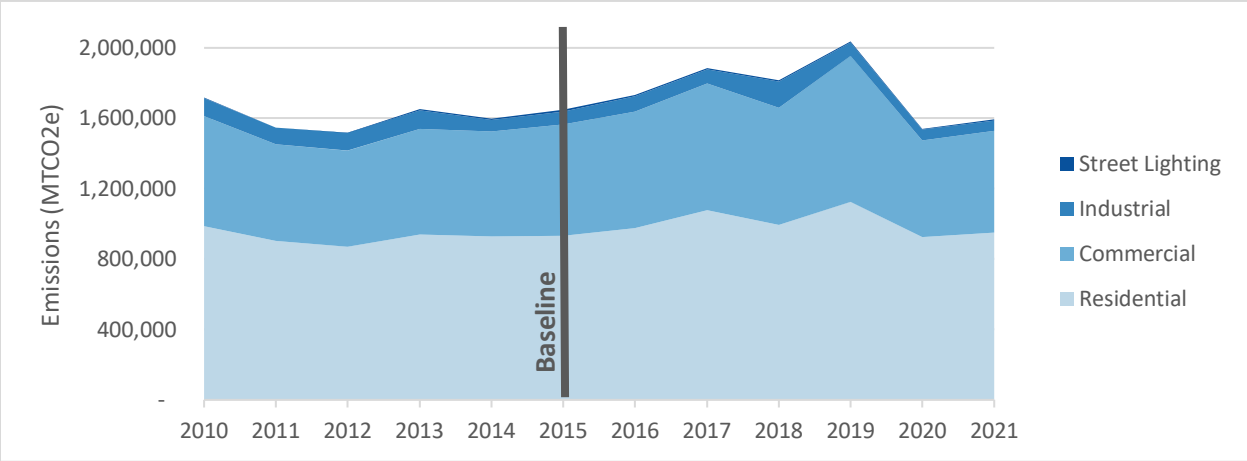


Figure 7: 2021 Buildings and Energy Emissions by Source

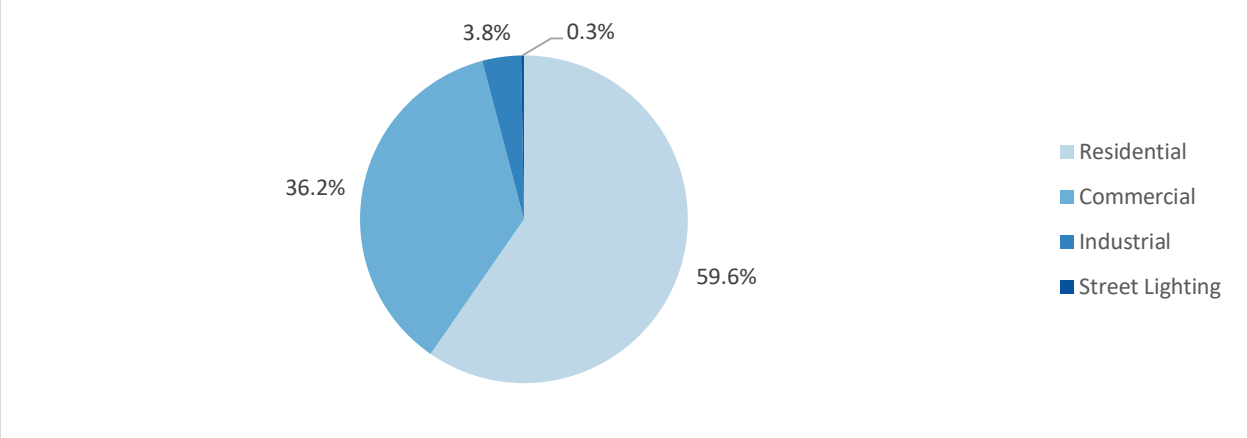


Table 1: Buildings and Energy Emissions by Source (MTCO2e)

Emissions Source	2015	2021	Change	Percent Change
Residential	933,310	950,072	16,762	1.8%
… Electricity	699,775	665,017	-34,758	-5.0%
… Natural Gas	189,571	229,780	40,209	21.2%
… Other (Wood, Oil, LPG)	43,964	55,275	11,311	25.7%
Commercial	631,943	577,335	-54,609	-8.6%
… Electricity	535,396	465,360	-70,036	-13.1%
… Natural Gas	96,548	111,975	15,428	16.0%
Industrial	74,090	61,049	-13,041	-17.6%
… Electricity	67,396	55,712	-11,684	-17.3%
… Natural Gas	6,694	5,337	-1,357	-20.3%
Street Lighting	8,117	4,355	-3,762	-46.3%
Total	**1,647,460**	**1,592,811**	**-54,649**	**-3.3%**

Explanation

The buildings and energy sector is the largest contributor of greenhouse gas emissions in Thurston County. As of 2021, the buildings and energy sector accounts for 54.3 percent of emissions included in the inventory. Since 2015, buildings and energy emissions have decreased by 3.3 percent.

The buildings and energy sector includes the following emission sources:

- Electricity and natural gas used to power and heat residential, commercial, and industrial buildings
- Liquid petroleum gas (LPG), distillate fuel oil, and wood used by residential customers
- Electricity used in street lighting
- Production of electricity, natural gas, LPG, and distillate fuel oil, also known as upstream emissions
- Distribution of and leaks from electricity and natural gas use, also known as process and fugitive emissions

Emissions from residential sources make up the largest portion of building and energy emissions, accounting for 59.6 percent of 2021 buildings and energy emissions. Within the residential sector, 70.0 percent of emissions resulted from electricity use. Electricity use makes up larger portions of commercial and industrial emissions, at 80.6 percent and 91.3 percent respectively.

Since 2015, residential emissions have risen (1.8 percent increase) while commercial and industrial emissions have decreased (8.6 percent and 17.6 percent decreases respectively). While electricity usage within the region has risen since 2015 (Figure 8), decreases in emissions intensity of electricity have kept emissions resulting from electricity from rising.

Within the buildings and energy sector, 12.2 percent of total emissions resulting from electricity use are considered upstream emissions, or emissions resulting from the production of the electricity, and 4.4 percent of total electricity emissions can be attributed to distribution. Upstream emissions resulting from the production of natural gas account for 17.6 percent of total natural gas emissions, and distribution and leaks account for 2.5 percent of total natural gas emissions.

Methodology Changes in 2022

This inventory followed the same methodology as the 2019 TCAT inventory to calculate buildings and energy emissions.

Limitations and Improvements

Commercial and industrial energy sources other than electricity and natural gas. Commercial and industrial buildings using energy sources other than natural gas and electricity — such as oil, LPG, or wood — are not included in the inventory. Large emitters in this category are required to report their emissions to EPA (EPA 2020). Examples include pulp and paper mills, glass recyclers, or concrete producers. Since none are found in Thurston County, this is not believed to be a significant source of emissions.

Puget Sound Energy emissions factor. At the time of publication, Puget Sound Energy (PSE) has not released a 2021 Greenhouse Gas Emissions Inventory, which is used to determine the carbon intensity of PSE's electricity. This report uses the 2020 PSE emissions factor as a proxy. As PSE's fuel mix has

become less dependent on coal each year, using the 2020 emissions factor for 2021 emissions may overestimate emissions associated with electricity use.

Figure 8: Electricity Usage in Thurston County

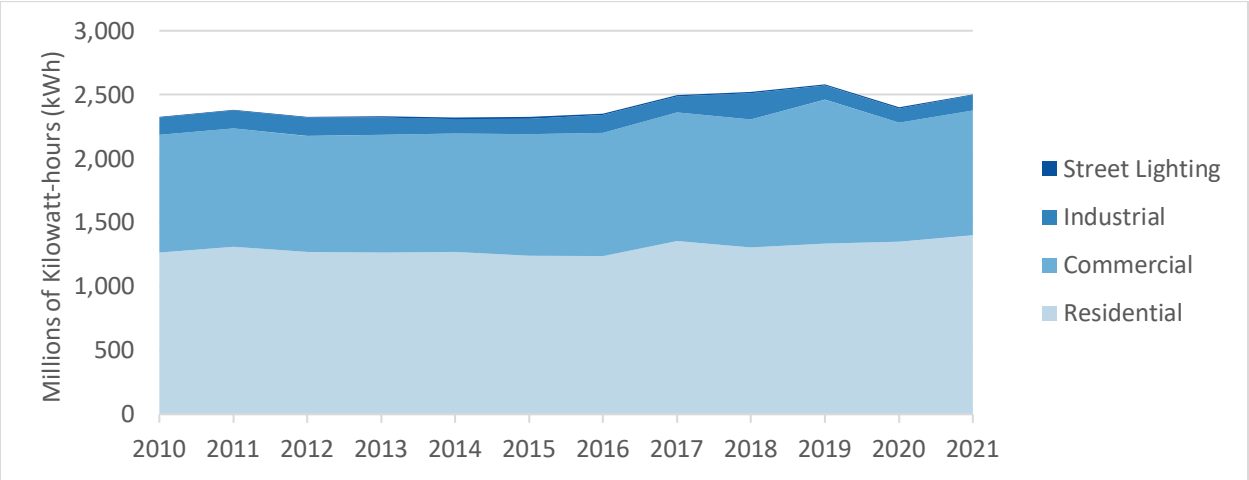
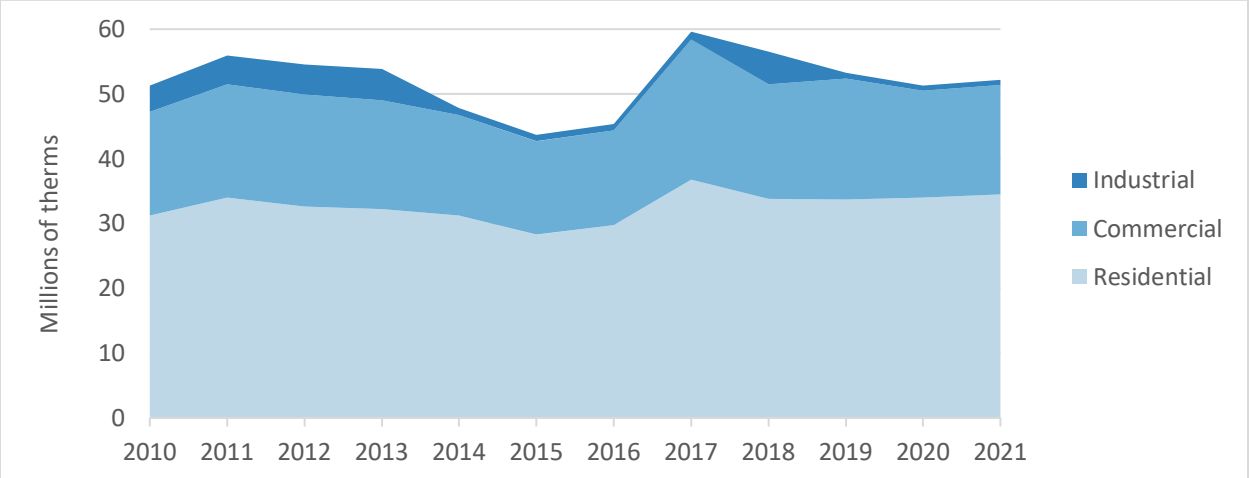


Figure 9: Natural Gas Usage in Thurston County



Transportation

Figure 10: Transportation Emissions by Source

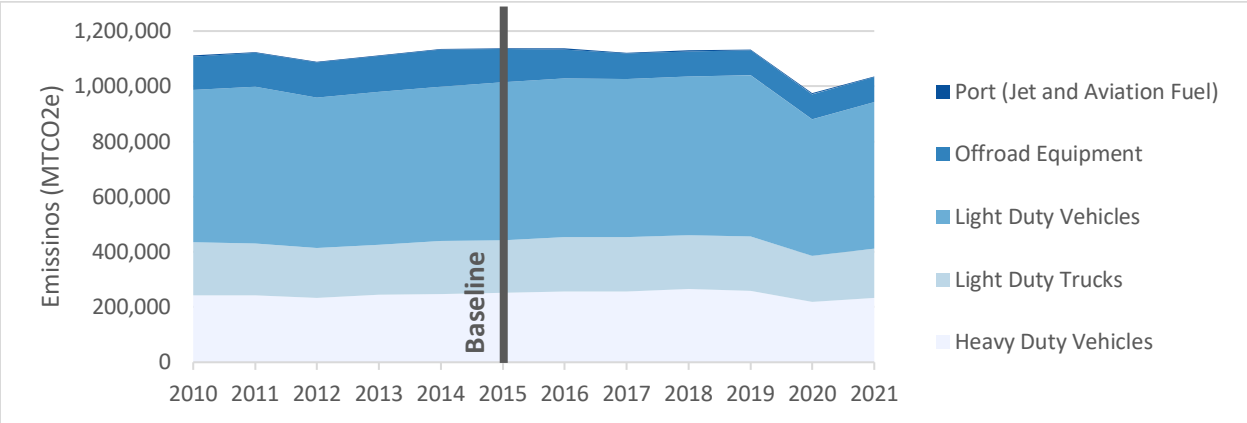


Figure 11: 2021 Transportation Emissions by Source

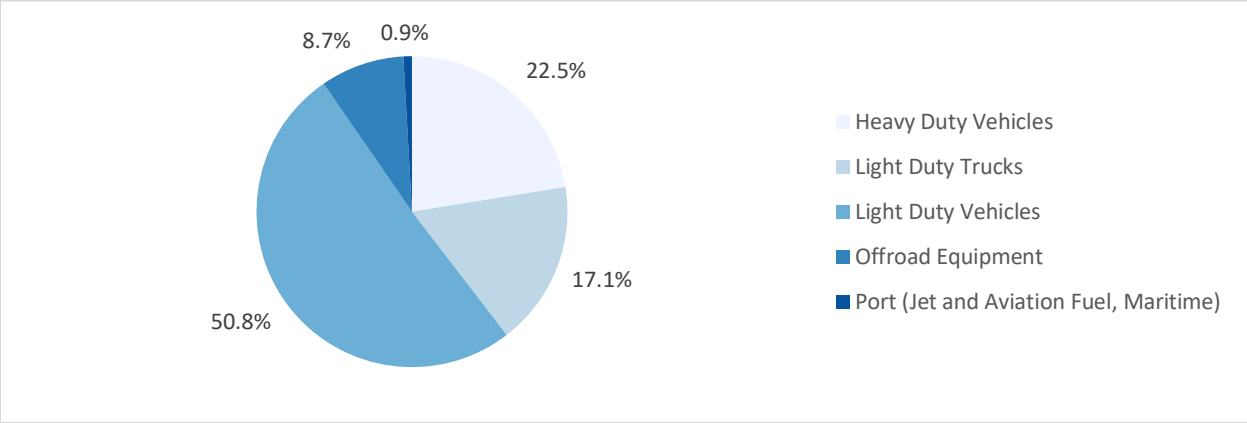


Table 2: Transportation Emissions by Source (MTCO2e)

Emissions Source	2015	2021	Change	Percent Change
Onroad Gas Vehicles	762,092	733,839	-28,253	-3.7%
… Heavy Duty Gas Vehicles	10,888	36,666	25,778	236.8%
… Light Duty Gas Trucks	182,398	170,637	-11,761	-6.4%
… Gas Passenger Vehicles	563,635	521,956	-41,679	-7.4%
… Motorcycles	5,171	4,580	-591	-11.4%
Onroad Diesel Vehicles	252,836	208,019	-44,817	-17.7%
… Heavy Duty Diesel Vehicles	240,782	197,399	-43,383	-18.0%
… Light Duty Diesel Trucks	8,795	7,773	-1,022	-11.6%
… Diesel Passenger Vehicles	3,259	2,847	-412	-12.6%
Offroad Equipment	120,225	91,102	-29,122	-24.2%
Olympia Regional Airport	2,396	3,483	1,088	45.4%
… Jet Fuel	1,924	2,454	530	27.5%
… Aviation fuel	471	1,029	558	118.3%
Port of Olympia Maritime	5,334	5,706	372	7.0%
Total	**1,142,882**	**1,042,150**	**-100,733**	**-8.8%**

Explanation

The transportation sector is the second-largest contributor of greenhouse gas emissions in Thurston County. Transportation accounts for 35.6 percent of emissions included in the inventory. Since 2015, transportation emissions have decreased by 8.8 percent.

The transportation sector includes the following emission sources:

- Vehicles traveling on Thurston County roadways (excluding through travel). This includes passenger vehicles, trucks, transit buses, and other vehicle types.
- Offroad equipment, such as construction equipment, lawn and garden equipment
- Jet and aviation fuel use at the Olympia Regional Airport
- Port of Olympia maritime emissions, including ocean-going vessels, commercial harbor vessels, recreational vessels, cargo-handling equipment, locomotives, heavy-duty vehicles, and fleet vehicles

Onroad vehicles are by far the largest source of transportation emissions, accounting for 90.4 percent of transportation emissions inventoried. Gas-fueled onroad vehicles account for 70.4 percent of emissions while diesel-fueled onroad vehicles account for 20.0 percent. Of all transportation emission sources inventoried, diesel-fueled onroad vehicles saw the greatest reduction between 2015 and 2021, decreasing by over 44,000 MTCO2e (17.7 percent decrease). The largest source of increased emissions from onroad vehicles is heavy duty gas vehicles, which saw an increase of 25,778 MTCO2e (236.8 percent).

While total onroad transportation emissions have decreased overall since 2015, the long term-trend is unclear. Prior to 2020, onroad transportation emissions had been gradually increasing by about 0.6 percent per year before abruptly decreasing in 2020 by 15.3 percent, in large part due to the COVID-19 pandemic, and increasing 7.0 percent in 2021.

Two transportation emission sources increased between 2015 and 2021: jet and aviation fuel at the Olympia Regional Airport and Port of Olympia maritime emissions (45.4 percent and 7.0 percent increases respectively). However, these two sources account for just one percent of all transportation emissions inventoried.

Methodology Changes in 2022

- Emissions from jet and aviation fuel used at the Olympia Regional Airport were added.
- Maritime emissions from Port of Olympia were added.

Limitations and Improvements

Transportation outside of Thurston County. Onroad transportation emissions only include vehicles traveling on roadways in Thurston County. Travel by Thurston County residents and businesses outside of Thurston County is not included in the inventory. This is consistent with vehicle miles traveled data provided by the state Dept. of Transportation. In addition, emissions from vehicles passing through Thurston County are not included.

Upstream emissions. Emissions due to extracting and producing diesel and gasoline fuel are not included in the inventory.

Air travel. Air travel by Thurston County residents — other than fuel used at the Olympia Airport — is not included in the inventory. Air travel is a significant source of greenhouse gas emissions worldwide, however there is not reliable data on air travel habits of Thurston County residents. Air travel is often included in a consumption-based greenhouse gas emissions inventory.

Rail Travel. Emissions from rail transport — both passenger and freight — are not included. Rail is not believed to be a significant source of emissions. Most rail transport in Thurston County is through travel. There is limited local data on emissions from rail transport.

Electric vehicle emissions. As of September 2022, approximately 1.5% of registered vehicles in Thurston County are fully electric vehicles (Figure 12). Because they are powered with electricity from homes and buildings, emissions from electric vehicles are included in the buildings and energy sector. Future inventories may be able to include electric vehicle emissions in the transportation sector if ICLEI, the Dept. of Ecology, or other sources recommended a methodology.

Transit. Although they are not called out specifically, emissions from transit vehicles are included in the onroad emissions estimates. After a sharp decline in 2020, transit boardings increased in 2021. Increasing transit boardings should cause a decrease in overall transportation emissions.

Figure 12: Electric Vehicle Registrations in Thurston County

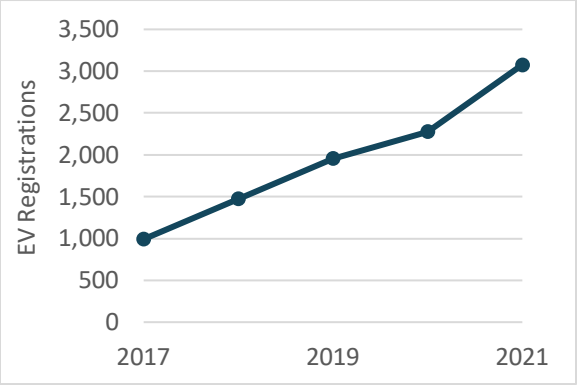
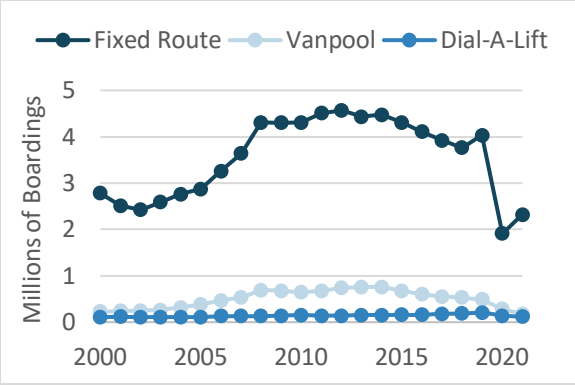


Figure 13: Intercity Transit Boardings



Water and Waste

Figure 14: Water and Waste Emissions by Source

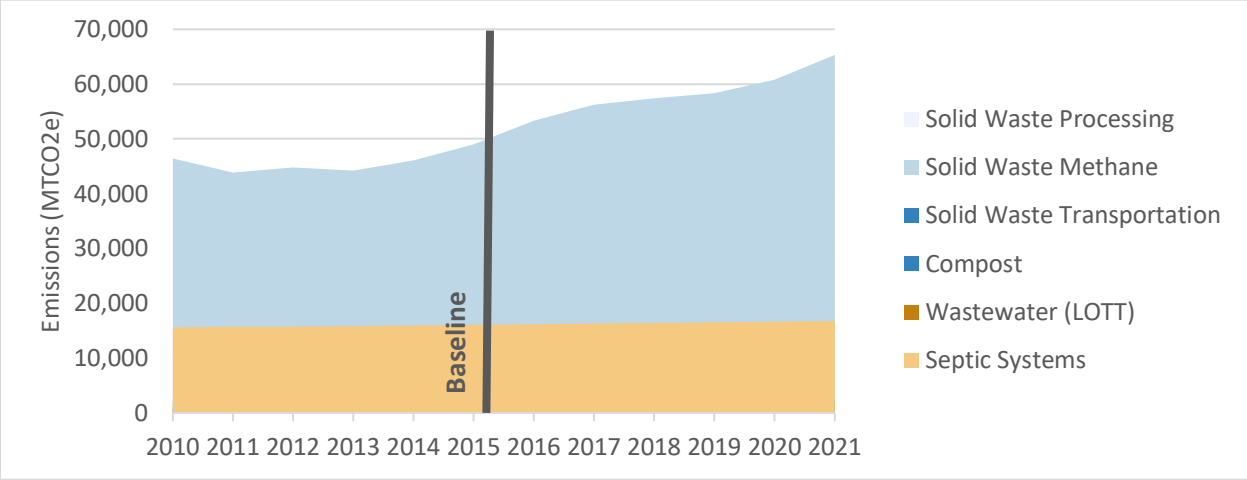


Figure 15: 2021 Water and Waste Emissions by Source

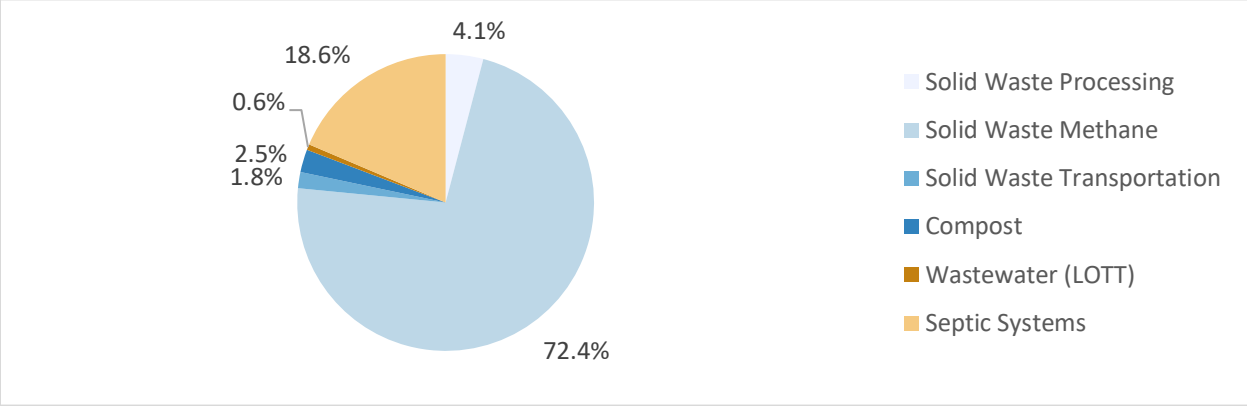


Table 3: Water and Waste Emissions by Source (MTCO2e)

Emissions Source	2015	2021	Change	Percent Change
Solid Waste	52,996	70,605	17,609	33.2%
… Methane	49,009	65,326	16,317	33.3%
… Rail transport out of county	813	1,048	235	28.9%
… Truck transport out of county	402	536	134	33.3%
… Processing	2,771	3,694	923	33.3%
Compost	1,761	2,240	479	27.2%
Wastewater (LOTT)	544	559	15	2.8%
… Digester	11	8	-3	-27.3%
… Methanol	108	122	14	13.0%
… Process	315	327	12	3.8%
… Effluent Fugitives	110	102	-8	-7.3%
Septic Systems	16,112	16,773	661	4.1%
Total	**71,413**	**90,176**	**18,764**	**26.3%**

Explanation

The water and waste sector is the second-smallest contributor of greenhouse gas emissions in Thurston County. As of 2021, this sector accounts for 3.1 percent of emissions included in the inventory. Since 2015, water and waste emissions have increased by 26.3 percent.

The water and waste sector includes the following emission sources:

- Processing of solid waste
- Truck and rail transport of solid waste outside Thurston County
- Methane emissions from solid waste disposed at landfills, including future emissions as waste decays.
- Composting of organic waste
- Wastewater (LOTT)
    - Combustion of digester gas
    - Use of fossil fuel derived methanol
    - Fugitive emissions from effluent discharges to Puget Sound
    - Process emissions from nitrification and denitrification
- Fugitive emissions from septic tanks

Emissions from electricity and natural gas consumption by waste and water treatment facilities are included in the buildings and energy sector.

Thurston County's solid waste is disposed at the Roosevelt Regional Landfill in Klickitat County. Roosevelt uses innovative methane capture systems that divert 90-95 percent of methane emissions. Emissions that are not captured account for 72.4 percent of water and waste emissions and have increased 33.2 percent since 2015. All solid waste emissions sources have increased by at least 28 percent from 2015 to 2021, and this uptake in emissions parallels the increased tonnage of solid waste produced by Thurston residents each year (Figure 16).

Wastewater and septic emissions make up 4.1 and 18.6 percent of water and waste emissions respectively. While both sources have increased since 2015, they have seen more moderate increases (2.8 and 4.1 percent respectively).

The only water and waste emissions sources that decreased since 2015 are the combustion of digester gas and fugitive emissions from effluent discharges, two of the four sources that make up LOTT's wastewater emissions. Combined, the decreases from these two sources totaled only 11 MTCO2e.

Methodology Changes in 2022

This inventory followed the same methodology as the 2019 Thurston County inventory to calculate water and waste emissions.

Limitations and Improvements

Wastewater treatment facilities outside of LOTT. The inventory does not include emissions from six wastewater treatment facilities in the county due to the lack of readily available data on treatment processes. These facilities include the City of Tenino, City of Yelm, and four facilities operated by Thurston County (Boston Harbor, Grand Mound, Olympic View, and Tamoshan). TRPC estimates that these facilities serve no more than five percent of the county population.

Solid waste disposed out-of-county. It is not known if a significant amount of Thurston County's solid waste is disposed of at sites other than WARC, and if so, how much. Emissions generated by this activity are not included in the inventory.

Biosolids. Emissions and carbon removals due to the use of biosolids at LOTT are included as an indirect source emissions and removals in LOTT's greenhouse gas inventory. LOTT's 2021 inventory estimates that the use of biosolids in 2021 resulted in the removal of 349 MTCO2e from the atmosphere (LOTT 2022). Future inventories should explore incorporating emissions removals from the use of biosolids in wastewater treatment.

Collection and pickup of solid waste. This sector only includes emissions related to transporting waste from the Thurston County border to the Roosevelt Regional Landfill. Emissions due to household or business garbage pickup, or transport from WARC to the Roosevelt Regional Landfill with Thurston County are included with onroad transportation emissions.

Figure 16: Solid Waste generated in Thurston County

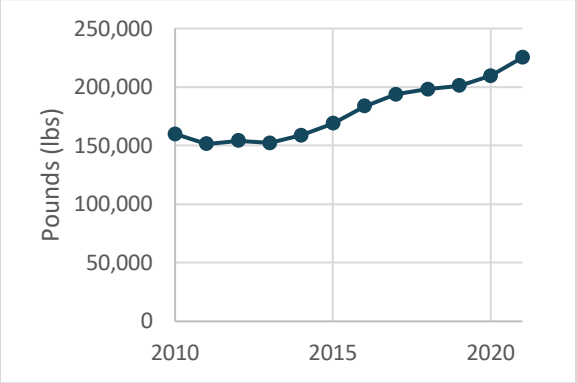
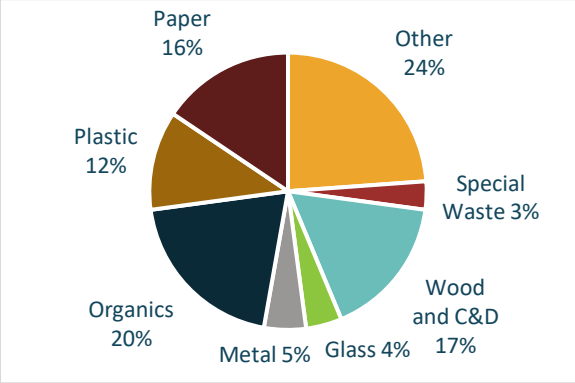


Figure 17: Thurston County Waste Composition



Agriculture, Forests, and Prairies

Figure 18: Agriculture Emissions by Source

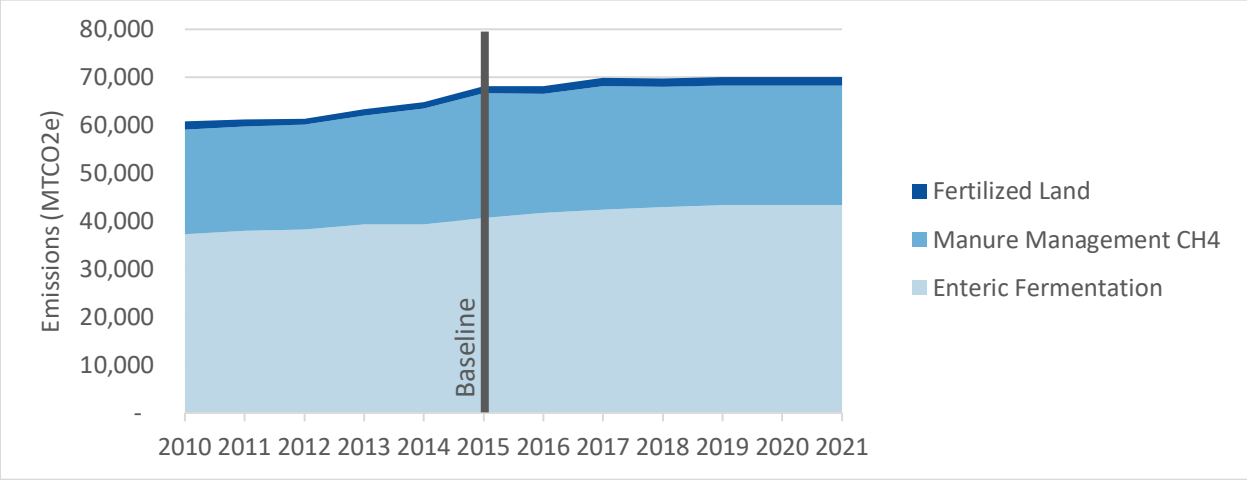


Figure 19: 2021 Agriculture Emissions by Source

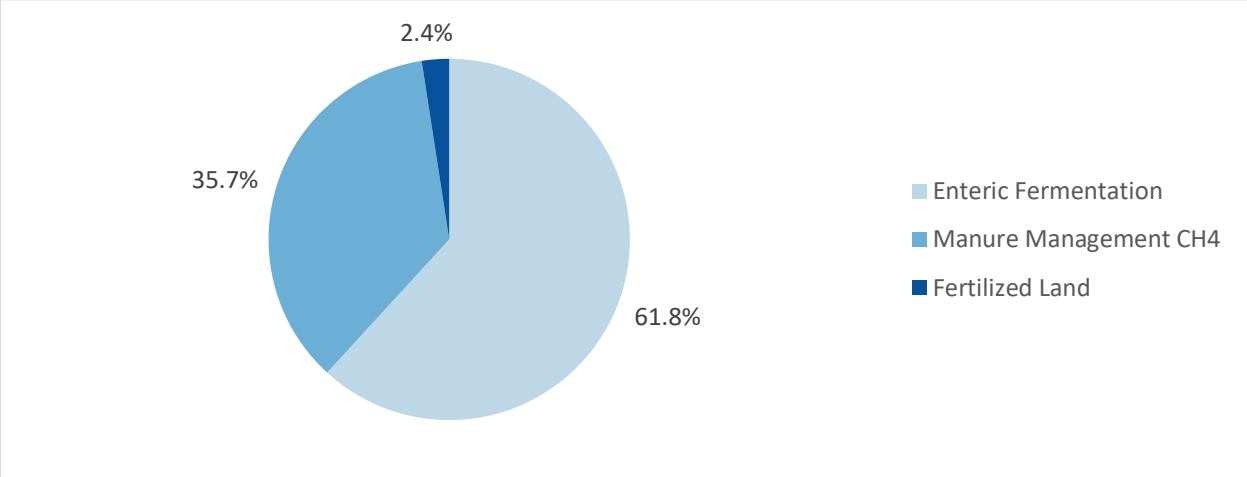


Table 4: Agriculture Emissions by Source (MTCO2e)

Emissions Source	2015	2021	Change	Percent Change
Enteric Fermentation	40,607	43,294	2,686	6.6%
Manure Management Methane (CH4)	26,037	25,040	-997	-3.8%
Fertilized Land	1,485	1,709	224	15.1%
Total	**68,130**	**70,043**	**1,914**	**2.8%**

Explanation

The agriculture, forests, and prairies sector is the smallest contributor of greenhouse gas emissions in Thurston County. As of 2021, this sector accounts for 2.4 percent of emissions included in the inventory. The current inventory only includes emissions from agriculture (see "Limitations and improvements"), which have increased 2.8 percent since 2015.

The agriculture, forests, and prairies sector includes the following emission sources:

- Enteric fermentation—part of the digestive process in animals that produces methane as a byproduct—of cattle, goats, horses, sheep, and swine
- Methane from manure management of cattle, goats, horses, poultry, sheep, and swine
- Emissions from agricultural soils due to fertilizer use

Out of the three main sources included, fertilizer use is the smallest contributor to emissions (2.4 percent in 2021) while enteric fermentation makes up the largest share of emissions at 61.8 percent. While emissions have increased overall since 2015, the increase is relatively low.

Cattle are responsible for the greatest share of both enteric fermentation and manure management emissions, and emissions from cattle have risen in both categories. All other species have seen decreases in emissions due to enteric fermentation and manure management since 2015. The number of cattle in Thurston County has risen since 2010, while all other species have decreased or stayed constant in population.

Emissions from fertilized land have increased 15.1 percent since 2015, resulting from the increased number of fertilized acres in Thurston County.

Methodology Changes in 2022

- Nitrous oxide (N2O) emissions from manure management are not included. Nitrous oxide emissions from manure management are not believed to be a significant source of emissions, and there is limited local data available. In the last inventory, 94.3 percent of manure management emissions were a result of methane production (TCAT 2021).
- Manure management emissions from goats, horses, and sheep have been added.

Limitations and Improvements

Manure management practices in Thurston County. Manure management emissions are greatly impacted by the management practice used. Thurston County does not have a record of manure management practices used by local dairies, and this inventory uses the distribution of manure management practices statewide as a proxy.

Limited data availability. All sources reported in this sector use the USDA Census of Agriculture to estimate activity data. The Census of Agriculture is conducted every five years, and the last year of data available is 2017. This inventory assumes that livestock counts and fertilized acres remained constant during 2017 – 2021.

Emissions due to fertilizer use. While several types of fertilizer generate greenhouse gas emissions, this inventory includes only emissions attributable to conventionally fertilized acres, or land that is treated with commercial fertilizers. Future inventories should seek to incorporate emissions from other fertilizer use.

Forests and Prairies[1]

Soil and vegetation have the potential to sequester carbon, or remove and store carbon dioxide, from the atmosphere. This inventory does not include carbon removals from sequestration in overall emissions estimates, and the estimates provided below are intended for informational purposes only. In 2019, ICLEI released the Land Emissions and Removals Navigator (LEARN) tool, a resource for measuring greenhouse gas emissions due to seven types of land cover classes. The tool is compliant with the U.S. Community Protocol (ICLEI 2021).

The LEARN tool estimates that 926,857 MTCO2e were sequestered per year over the 2006-2016 time period (Table 5). This ten-year average serves as a baseline of net sequestration due to forests, trees, and forest cover change in the Thurston Region. Figure 20 shows the change in sequestration compared to the baseline. For most time periods, there was a decrease in sequestration compared to baseline (indicated by positive values) with only the 2011-2013 time period seeing an increase in sequestration (negative values).

However, there is significant uncertainty in these estimates, especially in urban areas where the resolution of data used in the LEARN tool is not high enough to track changes in tree cover. There are also limited data on the area of native prairies in Thurston County and their carbon sequestration potential. Future inventories should explore better methods to estimate carbon sequestration due to land cover change, including changes in urban forests and native prairies.

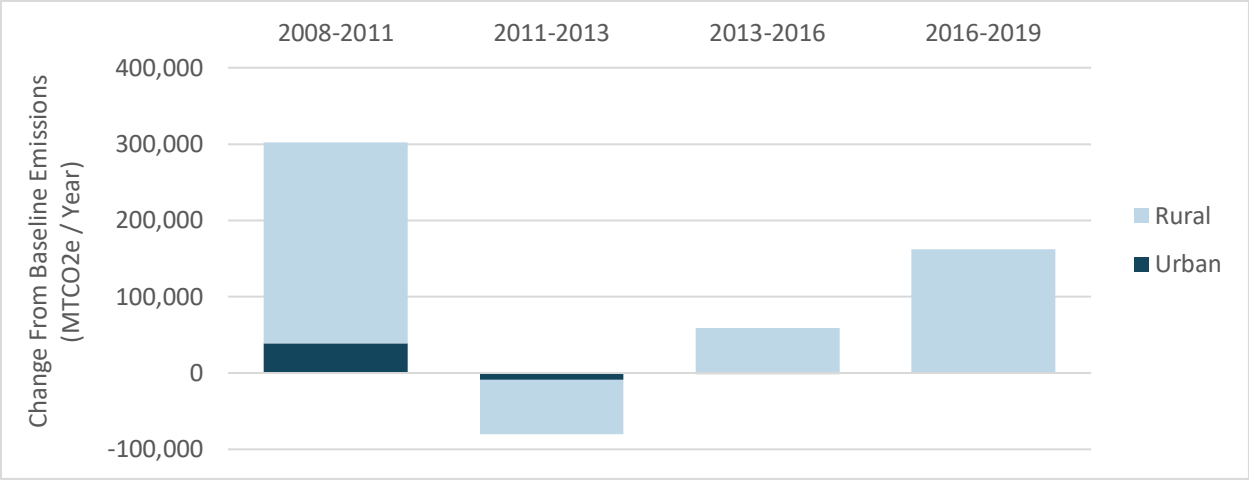
Table 5: Sequestration Due to Land Cover Changes Using ICLEI LEARN Tool (MTCO2e / Year)

Land Cover Change Class	2006-2016 Baseline	2008-2011	2011-2013	2013-2016	2016-2019
Undisturbed Forest	-996,786	-1,170,711	-1,215,911	-1,178,325	-1,268,533
Forest Disturbances	71,945	65,128	93,338	63,508	266,632
Non-Forest to Forest	-184,637	-40,459	-61,160	-100,392	-194,168
Forest to Settlement	17,568	29,327	5,462	17,450	11,547
Forest to Grassland	328,043	444,100	332,642	377,945	337,251
Forest to other non-forest lands	2,241	47,787	7,523	9,232	6,571
Trees outside of forests (A)	-165,231	N/A	-168,764	-58,106	76,151
Harvested Wood Products (B)	N/A	N/A	N/A	N/A	N/A
Net GHG Balance	**-926,857**	**-624,828**	**-1,006,870**	**-868,687**	**-764,548**

Note: Negative values indicate carbon sequestration. A) Data only available for 2006-2016. B) Not calculated due to lack of data.

[1] This section was revised in January 2023 after ICLEI notified LEARN users of an error in estimating emissions due to trees outside of forests.

Figure 20: Net Emissions Due to Land Cover Change (Change from Baseline Emissions)



Note: Compared to net emissions of -926,857 MTCO2e over a ten-year baseline (2006-2016). Negative values indicate net sequestration. Estimated using ICLEI LEARN tool.

Hydrofluorocarbons

Figure 21: Hydrofluorocarbon Emissions by Source

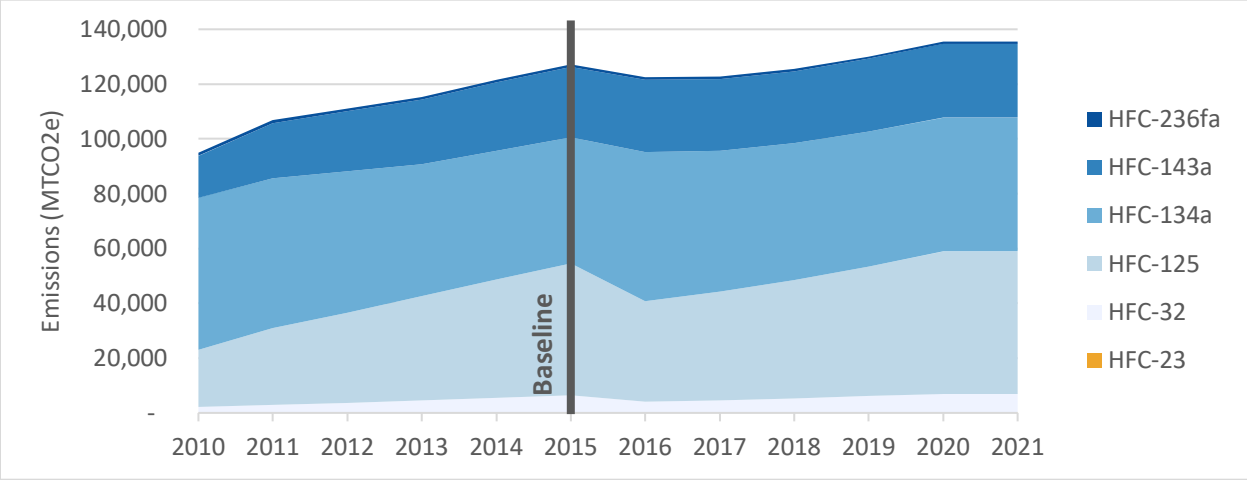


Figure 22: 2021 Hydrofluorocarbon Emissions by Source

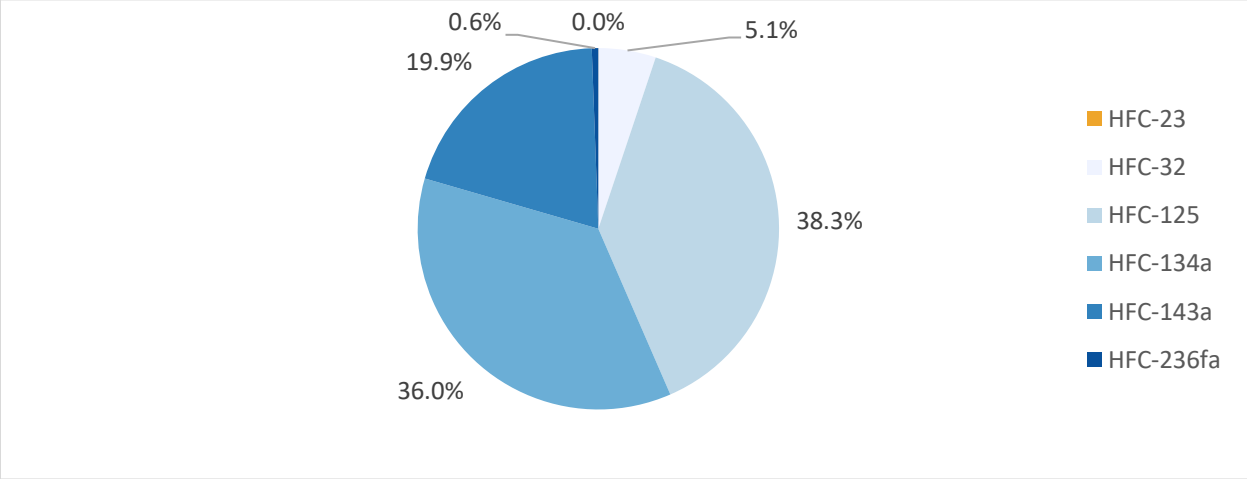


Table 6: Hydrofluorocarbon Emissions by Source (MTCO2e)

Emissions Source	2015	2021	Change	Percent Change
HFC-23	32	22	-10	-29.8%
HFC-32	6,416	6,951	535	8.3%
HFC-125	48,075	51,946	3,871	8.1%
HFC-134a	45,969	48,806	2,838	6.2%
HFC-143a	25,819	27,012	1,192	4.6%
HFC-236fa	933	786	-147	-15.8%
Total	**127,244**	**135,522**	**8,279**	**6.5%**

Explanation

Hydrofluorocarbons (HFCs) are a group of industrial chemicals used primarily for cooling, refrigeration, and fire suppression. Many HFCs are also powerful greenhouse gases, and while they are mostly contained in equipment, unintentional leakage or discharge of these chemicals causes greenhouse gas emissions.

The hydrofluorocarbons sector includes the following emission sources:

- Emissions from leakage or discharge of HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a, and HFC-236fa

Hydrofluorocarbon emissions make up 4.6 percent of 2021 total emissions. Within the hydrofluorocarbon sector, 38.3 percent of emissions resulted from HFC-125, which is used in fire suppression systems. The second largest source of hydrofluorocarbon emissions is HFC-134a, which is used in refrigeration and air conditioning systems and as a propellant for some aerosols.

Since 2015, hydrofluorocarbon emissions have risen 6.5 percent. The majority of HFCs tracked for this report saw increases in emissions, with the exception of HFC-23 and HFC-236fa. The U.S. Environmental Protection Agency regulates HFCs, and has implemented a regulation that as of October 1, 2022, no more than 0.1 percent of HFC-23 created on a facility line may be emitted (40 CFR 84.27).

Methodology Changes in 2022

- Emissions from HFCs were not included in the previous inventories due to limited data availability and opportunities for local government intervention to reduce these emissions. Cascadia Consulting Group recommended including emissions from these sources in future inventories (Cascadia 2019).

Limitations and Improvements

Lack of Local Data. There is no local data that captures leaks of HFCs from refrigerants and fire suppression systems. The emissions included above were calculated using a population adjustment to national emissions. This methodology has a large margin of error and does not capture regional variations in how Washington State or Thurston County residents generate hydrofluorocarbon emissions.

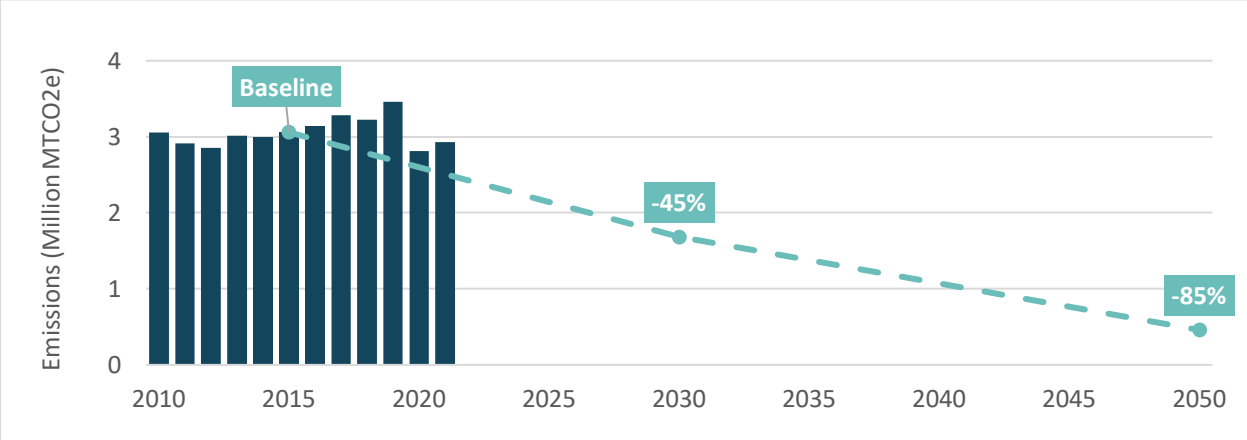
State action around HFCs. In 2022, the Washington Legislature passed HB 1050, a bill to increase the regulation of HFCs. The bill directs the Department of Ecology to set a maximum global warming potential threshold for HFCs used in new stationary air conditioning equipment, new and existing stationary refrigeration equipment, and in ice rinks; create a program to manage emissions from large air conditioning and refrigeration equipment; and recommend how to safely manage and dispose of refrigerants. The bill also directs the State Building Code Council to develop standards allowing substitutes for HFCs that have lower global warming potentials. This action should help lower emissions from HFCs in Washington state but will not be reflected in the emissions estimates unless a local data source is used.

SUMMARY

While Thurston County has achieved a 4.1 percent reduction in greenhouse gas emissions from 2015-2021, the region is not on track to meet the 2030 or 2050 emission reduction targets. The Thurston Climate Mitigation Plan established the following regional greenhouse gas emission reduction targets:

- 45% reduction below 2015 levels by 2030
- 85% reduction below 2015 levels by 2050

Figure 23: Total Emissions and Thurston Climate Mitigation Plan Emission Reduction Targets



The greatest contributors to regional emissions are the buildings and energy and transportation sectors. In 2021, these sectors made up 54.3 and 35.6 percent of total emissions respectively. Since 2015, emissions from the water and waste; agriculture, forests, and prairies; and hydrofluorocarbon sectors have all risen. Though it is important to reduce emissions in all areas, the bulk of emissions are not coming from these sectors.

Figure 24: Change of Sector Emissions from 2015 to 2021

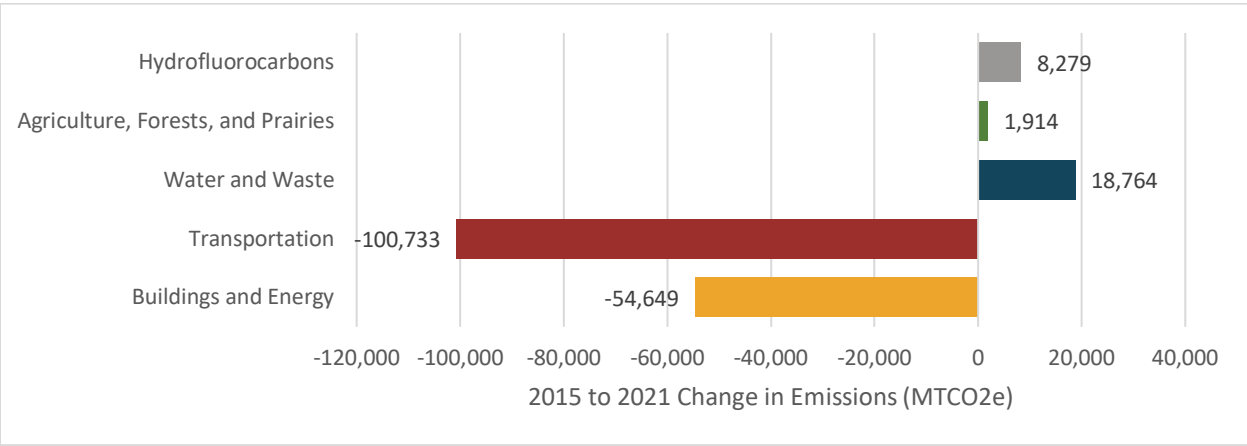


Figure 25: 2021 Emissions by Sector

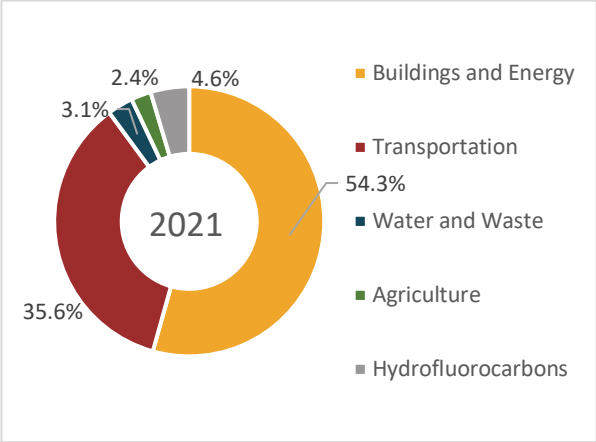
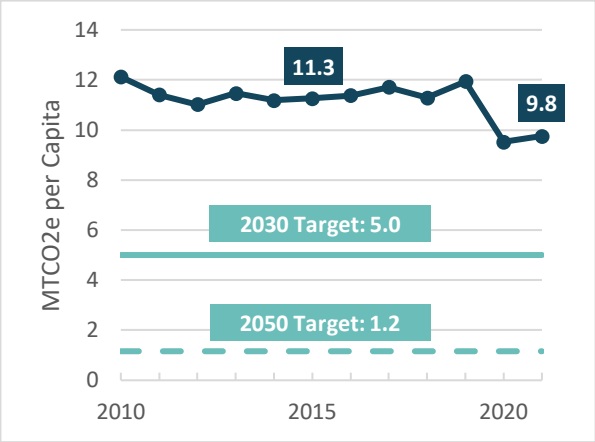


Figure 26: Per capita emissions (MTCO2e)



Per capita emissions dropped 13.4 percent from 2015 to 2021. The Thurston region is projected to expand to a population of approximately 395,300 in 2050, and meeting the 2050 emissions target will require that per capita emissions drop to only 1.2 MTCO2e per person annually.

Understanding Emissions Trends

Several factors help to explain the differences in emissions from 2015 to 2021. The following trends are based on the activity data and emissions factors shown in Appendix II, and did not come from an attribution model or analysis. Large drivers in emissions changes include:

- Decreased travel due to an uptake in telework. In 2020, the COVID-19 pandemic significantly shifted how and where people work. U.S. Census's American Community Survey estimated that in 2015, 4.8 of Thurston workers teleworked. This figure jumped to 23.4 percent in 2021.
- Lower carbon intensity of electricity. In 2021, 40.6 percent of total emissions can be attributed to electricity. Washington State's Clean Energy Transformation Act requires that electric utilities in Washington must phase out coal by 2025 and source all electricity from renewable or non-emitting sources by 2050. Puget Sound Energy has been continually working to meet these standards, and their fuel mix becomes less carbon intensive each year. Though electricity usage in the Thurston region has increased since 2015 (Figure 8), emissions from electricity have not.
- Increased amounts of solid waste. The largest source of emissions within the waste and water sector is methane emitted from solid waste at landfills. From 2015 to 2021, methane emissions from solid waste at landfills increased 33.3 percent. This trend is a result of the growing amount of solid waste produced by Thurston residents, which has increased every year since 2013 (Figure 16).

Improvements for Future Inventories

As climate action in Thurston County continues, it will be important to maintain and improve an annual greenhouse gas inventory. Suggestions to improve the accuracy of a Thurston greenhouse gas inventory include:

- Include emissions from air travel outside of Olympia Regional Airport (ORA). While this report includes emissions from aviation gas and jet fuel used at ORA, emissions from commercial travel are not included. ORA does not provide commercial air service and most Thurston residents use SeaTac for air travel.
- Factor electric vehicles into onroad transportation emissions. At the time of publication, neither ICLEI nor the Dept. of Ecology have outlined a methodology to exclude miles travelled from electric vehicles from onroad transportation emissions. As a result, this inventory overestimates onroad transportation emissions as all miles travelled are attributed to gas or diesel vehicles. Electric vehicle adoption is consistently growing in the Thurston region and it will be important to understand the effects of this shift on regional emissions.
- Use regional emissions factors for manure management of livestock. Currently, there is no record of the manure management practices employed by Thurston County farms. Manure management practices greatly impact emissions from livestock, and this report uses the Washington State distribution of practices rather than local information. This method leads to less accurate results, and no way to see changes in emissions due to local action.
- Incorporate carbon sequestration and other land use emissions and removals. There are several methodologies that can be used to estimate carbon sequestration and emissions from different land covers and uses. These methods vary in accuracy and require consistent, detailed data of local land cover. Future inventories should strive to include land use emissions and removals to help inform local action around carbon sequestration and development regulations.

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APPENDIX I: GREENHOUSE GAS EMISSIONS BY YEAR

Metric Tons CO2e (MTCO2e)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Buildings and Energy												
Residential Electricity	711,902	608,912	601,963	673,733	673,638	699,775	726,311	775,267	714,115	833,854	642,300	665,017
Residential Natural Gas	210,187	228,357	219,198	216,559	209,864	189,571	198,647	244,603	224,650	224,081	226,282	229,780
Residential Other Fuels (Wood, Propane, Oil)	65,109	65,388	48,791	49,549	46,531	43,964	50,588	58,012	55,460	68,338	55,275	55,275
Commercial Electricity	517,514	431,482	430,755	488,092	489,593	535,396	563,704	576,015	549,110	705,003	441,399	465,360
Commercial Natural Gas	107,515	118,048	115,964	113,219	104,234	96,548	97,354	144,153	117,778	124,074	109,638	111,975
Industrial Electricity	76,692	63,403	67,848	72,681	60,062	67,396	82,232	72,269	114,406	69,258	54,080	55,712
Industrial Natural Gas	26,896	29,723	31,389	32,184	7,149	6,694	6,551	7,836	33,333	5,950	5,257	5,337
Street Lighting	2,485	1,957	2,020	5,267	6,770	8,117	6,613	5,765	5,365	6,026	4,236	4,355
Transportation												
Heavy Duty Gas Vehicles	8,899	10,110	10,002	10,376	10,654	10,888	36,967	37,830	39,026	40,026	34,273	36,666
Light Duty Gas Trucks	183,180	180,021	172,578	173,229	183,587	182,398	189,071	189,248	185,774	188,965	159,500	170,637
Light Duty Gas Vehicles	542,400	557,858	535,339	545,634	548,883	563,635	566,369	565,276	566,939	575,810	487,892	521,956
Motorcycles	4,982	5,076	5,553	5,384	5,317	5,171	5,308	5,298	5,122	5,053	4,281	4,580
Heavy Duty Diesel Vehicles	234,447	232,518	223,257	233,930	236,882	240,782	218,909	218,017	227,478	218,043	184,517	197,399
Light Duty Diesel Trucks	8,830	8,620	8,143	8,326	8,840	8,795	8,512	8,595	8,446	8,601	7,265	7,773
Light Duty Diesel Vehicles	3,129	3,208	3,083	3,147	3,171	3,259	3,056	3,077	3,088	3,139	2,661	2,847
Offroad Emissions	122,514	124,509	127,502	130,495	134,786	120,225	105,664	91,102	91,102	91,102	91,102	91,102
Port (Jet and Aviation Fuel)	3,088	2,666	2,743	2,504	2,491	2,396	2,794	2,754	3,000	2,816	2,666	3,483
Port (Maritime)	3,605	3,846	4,218	4,590	4,962	5,334	5,706	5,706	5,706	5,706	5,706	5,706
Water and Waste												
Solid Waste Processing	2,624	2,482	2,530	2,496	2,606	2,771	3,013	3,180	3,249	3,301	3,437	3,694
Solid Waste Methane	46,401	43,900	44,737	44,154	46,083	49,009	53,281	56,239	57,459	58,387	60,779	65,326
Solid Waste Transportation	1,130	1,092	1,102	1,092	1,130	1,215	1,327	1,379	1,421	1,446	1,474	1,584
Compost	2,304	1,968	1,968	1,729	1,828	1,761	1,836	1,793	1,838	2,111	2,280	2,240
Wastewater (LOTT)	530	525	623	567	538	544	530	668	645	639	600	559
Septic Systems	15,542	15,655	15,769	15,883	15,982	16,112	16,227	16,342	16,458	16,574	16,690	16,773
Agriculture												
Enteric Fermentation – Cattle	34,921	35,662	35,893	36,995	37,118	38,562	39,889	40,593	41,181	41,539	41,539	41,539
Enteric Fermentation – Goats	195	211	227	218	209	201	192	183	186	183	183	183
Enteric Fermentation – Horses	1,363	1,333	1,303	1,249	1,196	1,142	1,089	1,035	988	1,035	1,035	1,035
Enteric Fermentation – Sheep	451	434	417	415	406	370	342	316	297	329	329	329
Enteric Fermentation – Swine	342	339	402	380	363	333	199	207	207	207	207	207
Manure Management CH4 – Cattle	13,299	13,835	14,281	15,025	15,988	17,012	16,913	17,573	17,285	17,590	17,590	17,590
Manure Management CH4 – Goats	10	11	12	11	11	10	10	9	9	9	9	9
Manure Management CH4 – Horses	169	166	162	155	148	142	135	129	123	129	129	129
Manure Management CH4 – Poultry	8,203	7,642	7,349	7,453	7,896	8,726	7,722	8,001	7,701	7,222	7,222	7,222

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Manure Management CH4 – Sheep	12	12	11	11	11	10	9	8	8	9	9	9
Manure Management CH4 – Swine	109	110	139	136	140	137	79	81	81	82	82	82
Fertilized Land	1,772	1,460	1,148	1,260	1,373	1,485	1,597	1,709	1,709	1,709	1,709	1,709
Hydrofluorocarbons												
HFC-23	21	21	21	21	32	32	21	22	22	22	22	22
HFC-32	2,160	2,833	3,668	4,558	5,465	6,416	3,984	4,632	5,356	6,085	6,951	6,951
HFC-125	20,836	28,015	32,991	38,113	43,143	48,075	36,802	39,619	43,033	47,165	51,946	51,946
HFC-134a	55,479	54,852	51,528	48,129	47,069	45,969	54,446	51,400	49,966	49,345	48,806	48,806
HFC-143a	15,381	20,096	21,880	23,527	24,897	25,819	26,285	26,264	26,293	26,671	27,012	27,012
HFC-236fa	977	985	998	1,026	1,016	933	901	873	842	805	786	786

APPENDIX II: ACTIVITY DATA AND FACTOR SETS

Table Abbreviations:

USCP U.S. Community Protocol Version 1.2 (July 2019)
GPC Global Protocol for Community-Scale Greenhouse Gas Inventories: An Accounting and Reporting Standard for Cities Version 1.1
[A] Data not available. Last available year used
[B] Linear interpolation use for missing years

Population and Housing Estimates

Office of Financial Management
https://ofm.wa.gov/washington-data-research/population-demographics/population-estimates/april-1-official-population-estimates

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Population	252,264	254,999	258,517	262,682	267,616	271,409	276,016	280,399	285,842	289,597	294,793	300,500
Housing Units	108,182	109,201	110,327	111,749	113,188	114,291	115,657	116,955	118,560	119,781	121,438	122,700

Electricity Use

Accounting methods:

- USCP BE.2.1: Emissions from Electricity Use
- USCP BE.4.1.1: Electric Power Transmission and Distribution Losses
- USCP BE.5.2: Upstream Emissions from Electricity Use

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Residential Electricity	kWh	1,266,273,211	1,310,060,008	1,269,359,538	1,267,128,962	1,271,598,941	1,241,099,148	1,238,087,439	1,354,506,613	1,302,856,062	1,333,178,736	1,350,928,941	1,398,708,650
Commercial Electricity	kWh	920,512,299	928,324,061	908,332,627	880,721,762	924,184,162	949,560,852	960,903,366	1,006,383,157	1,001,815,210	1,127,169,042	928,381,668	978,775,906
Industrial Electricity	kWh	136,413,709	136,410,005	143,070,748	136,695,424	113,376,794	119,530,793	140,173,901	126,265,310	208,726,519	110,730,539	113,745,075	117,176,707
Street Lighting	kWh	4,419,884	4,210,561	4,260,253	9,906,493	12,778,793	14,395,639	11,273,368	10,072,911	9,788,499	9,634,585	8,908,731	9,160,220
Factor Sets													
Emissions factor CO2	lbs/MWh	1,024.10	861.46	883.09	976.72	985.93	1,025.78	1,103.18	1,073.56	1,042.26	1,166.10	869.64	[A]
Emissions factor CH4	lbs/GWh	64.25	50.96	44.26	57.66	59.86	56.19	59.81	60.23	54.55	60.98	62.94	[A]
Emissions factor N2O	lbs/GWh	15.82	15.21	14.69	15.27	15.54	16.53	15.13	14.66	13.39	12.79	8.89	[A]
WNPP Region Grid Loss	—	6.84%	6.84%	5.76%	5.76%	4.79%	4.79%	4.23%	4.23%	4.60%	5.10%	5.30%	[A]
PSE Fuel Mix % Coal	—	36.20%	31.72%	29.76%	31.29%	34.99%	36.65%	37.11%	37.58%	31.18%	31.98%	22.96%	[A]
PSE Fuel Mix % Natural Gas	—	21.62%	11.56%	15.55%	23.31%	19.93%	29.66%	21.72%	21.27%	17.24%	27.92%	27.04%	[A]
Upstream Emissions	Various	USCP Appendix C Table B.13											

Natural Gas Use

Accounting methods:

- USCP BE.1.1: Emissions from stationary fuel combustion
- USCP BE.5.1.1: Upstream emissions associated with stationary fuel use within a community

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Residential	Therms	31,268,416	33,971,581	32,609,000	32,216,327	31,220,371	28,309,121	29,785,238	36,765,774	33,766,679	33,681,053	34,011,857	34,537,738
Commercial	Therms	15,994,386	17,561,362	17,251,389	16,842,941	15,506,391	10,975,508	14,597,334	21,667,261	17,702,895	18,649,214	16,479,377	16,830,726
Industrial	Therms	4,007,880	4,429,061	4,677,417	4,795,796	1,065,303	1,001,325	983,864	1,179,723	5,018,711	895,810	791,566	803,608
Factor Sets													
Emissions per Btu	Various	USCP Appendix C Tables B.1 and B.3											
Upstream Emissions	Various	USCP Appendix C Table B.13											

Other Residential Heating Fuel Use

Accounting methods:

- USCP BE.1.2: Estimating fuel use in the residential sector

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Fuel oil heating homes	Housing Units	1556	1585	1456	1340	1140	991	792	711	691	732	621	[A]
LPG heating homes	Housing Units	6070	5892	5514	5057	4725	4693	4733	4755	4768	4896	4826	[A]
Wood heating homes	Housing Units	6038	6409	6589	6833	6426	6474	6414	6231	5865	5883	5898	[A]
Factor Sets													
Fuel oil	MMBtu / Unit	62.97	60.99	47.47	49.09	57.39	56.68	60.71	88.65	68.40	73.69	72.73	[A]
Hydrocarbon gas liquids	MMBtu / Unit	100.97	104.21	81.11	83.32	82.35	72.77	88.98	105.48	101.27	125.31	101.91	[A]
Wood	MMBtu / Unit	161.85	157.30	130.91	170.69	173.27	201.12	222.76	228.87	247.67	286.54	234.60	[A]
Emissions Per Btu	Various	USCP Appendix C Tables B.1, B.2, and B.3											
Upstream Emissions	Various	USCP Appendix C Table B.13											

Onroad Transportation

Accounting Methods

- USCP TR.1.B.2: CO2 Emissions from Passenger Vehicles
- USCP TR.1.B.3: CH4 and N2O Emissions from Passenger Vehicles

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity													
Vehicle Miles Traveled	Miles (thousands)	2,341,013	2,328,580	2,241,171	2,303,087	2,330,925	2,431,638	2,473,582	2,497,842	2,529,427	2,534,097	2,173,163	2,324,891
Factor Sets													
Heavy Duty Diesel	% of VMT	9.65%	9.09%	9.07%	9.24%	9.27%	9.09%	8.20%	8.18%	8.54%	8.28%	[A]	[A]
Heavy Duty Gas	% of VMT	0.42%	0.40%	0.41%	0.42%	0.42%	0.41%	1.38%	1.40%	1.43%	1.47%	[A]	[A]
Light Duty Diesel Trucks	% of VMT	0.85%	0.83%	0.81%	0.81%	0.85%	0.82%	0.78%	0.79%	0.78%	0.78%	[A]	[A]
Light Duty Diesel Vehicles	% of VMT	0.34%	0.35%	0.35%	0.35%	0.34%	0.35%	0.32%	0.32%	0.32%	0.32%	[A]	[A]
Light Duty Gas Trucks	% of VMT	20.15%	19.66%	19.32%	19.27%	20.14%	19.48%	19.95%	19.94%	19.73%	19.75%	[A]	[A]
Light Duty Gas Vehicles	% of VMT	67.96%	69.05%	69.32%	69.24%	68.31%	69.21%	68.72%	68.72%	68.58%	68.79%	[A]	[A]
Motorcycles	% of VMT	0.62%	0.63%	0.72%	0.68%	0.66%	0.63%	0.64%	0.64%	0.62%	0.60%	[A]	[A]
Gas Passenger Vehicle Fuel Economy	MPG	23.50	23.16	23.28	23.41	23.20	23.86	23.96	24.21	24.38	24.10	24.38	[A]
Gas Light Truck Fuel Economy	MPG	17.20	17.10	17.12	17.16	17.10	17.34	17.40	17.52	17.87	17.60	17.87	[A]
Gas Heavy Truck Fuel Economy	MPG	6.40	5.36	5.36	5.36	5.35	5.36	5.36	5.36	5.37	5.37	5.38	[A]
Gas Motorcycle Fuel Economy	MPG	23.50	23.16	23.28	23.41	23.20	23.86	23.96	24.21	24.38	24.10	24.38	[A]
Diesel Passenger Vehicle Fuel Economy	MPG	23.50	23.16	23.28	23.41	23.20	23.86	23.96	24.21	24.38	24.10	24.38	[A]
Diesel Light Truck Fuel Economy	MPG	17.20	17.10	17.12	17.16	17.10	17.34	17.40	17.52	17.87	17.60	17.87	[A]
Diesel Heavy Truck Fuel Economy	MPG	6.40	6.05	6.05	6.04	6.06	6.10	6.15	6.22	6.31	6.39	6.48	[A]
Gas Passenger Vehicle CH4 emissions	g/mi	0.0201	0.0248	0.0233	0.0220	0.0211	0.0203	0.0196	0.0191	0.0186	0.0183	0.0180	[A]
Gas Light Truck CH4 emissions	g/mi	0.0232	0.0315	0.0293	0.0272	0.0253	0.0237	0.0223	0.0211	0.0201	0.0193	0.0187	[A]
Gas Heavy Truck CH4 emissions	g/mi	0.0333	0.1658	0.1556	0.1411	0.1266	0.1159	0.1047	0.0957	0.0860	0.0785	0.0719	[A]
Gas Motorcycle CH4 emissions	g/mi	0.0201	0.0248	0.0233	0.0220	0.0211	0.0203	0.0196	0.0191	0.0186	0.0183	0.0180	[A]
Diesel Passenger Vehicle CH4 emissions	g/mi	0.0050	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	[A]
Diesel Light Truck CH4 emissions	g/mi	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	[A]
Diesel Heavy Truck CH4 emissions	g/mi	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	[A]
Gas Passenger Vehicle N2O emissions	g/mi	0.0174	0.0215	0.0193	0.0171	0.0152	0.0135	0.0119	0.0105	0.0093	0.0083	0.0074	[A]
Gas Light Truck N2O emissions	g/mi	0.0251	0.0375	0.0341	0.0306	0.0272	0.0243	0.0214	0.0189	0.0167	0.0148	0.0132	[A]
Gas Heavy Truck N2O emissions	g/mi	0.0134	0.0797	0.0795	0.0787	0.0778	0.0745	0.0726	0.0696	0.0664	0.0633	0.0611	[A]
Gas Motorcycle N2O emissions	g/mi	0.0174	0.0215	0.0193	0.0171	0.0152	0.0135	0.0119	0.0105	0.0093	0.0083	0.0074	[A]
Diesel Passenger Vehicle N2O emissions	g/mi	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	[A]
Diesel Light Truck N2O emissions	g/mi	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	[A]
Diesel Heavy Truck N2O emissions	g/mi	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	[A]
Diesel and gasoline CO2 emissions	Kg/gallon	USCP Appendix D Table TR.1.6											

Vehicle Pass-Through Rates

Percent of VMT associated with vehicles neither starting nor ending their trip in Thurston County

Vehicle Class	Percentage
Heavy Duty Diesel	35%
Heavy Duty Gas	35%
Light Duty Diesel Trucks	25%
Light Duty Diesel Vehicles	10%
Light Duty Gas Trucks	25%
Light Duty Gas Vehicles	10%
Motorcycles	10%

Port of Olympia Jet Fuel and Aviation Consumption

Accounting Method

- USCP TR.6.B.1: CO2e Emissions from Aircraft

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Jet A Fuel	Gallons	231,184	197,930	205,453	199,120	189,684	196,714	218,684	215,502	221,901	186,439	182,154	250,855
Aviation 100LL (low lead)	Gallons	99,079	87,538	87,867	66,665	76,202	56,533	78,502	77,437	99,419	118,923	106,053	123,437

Solid Waste and Compost

Accounting Methods

- GPS Reference Number III.2.1: Solid waste generated in the city that is treated biologically (Compost)
- USCP SW.4.1 Methane Emissions from Community-Generated Waste Sent to Landfills
- USCP SW.6: Truck waste transportation
- USCP TR.3.1: Fuel Consumed by Freight Rail (Line-Haul)

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Solid waste	Tons	159,984	151,361	154,248	152,206	158,888	168,977	183,704	193,905	198,110	201,310	209,557	225,236
Compost	Tons	33,086	28,264	28,264	24,839	26,255	25,295	26,373	25,744	26,392	30,316	32,742	32,176
Truck Transportation	Miles	17	17	17	17	17	17	17	17	17	17	17	17
Rail Transportation	Miles	220	220	220	220	220	220	220	220	220	220	220	220
Factor Sets													
Freight rail fuel consumption	Ton miles/gallon diesel	484	469	476	473	479	471	468	479	473	472	487	[A]

Waste Characterization Factor Set

Waste Type	Percentage
Newspaper	0.6%
Office Paper	6.4%
Corrugated Carboard	3.6%
Magazines / Third Class Mail	5.0%
Food Scraps	16.9%
Grass	1.0%
Leaves	1.0%
Branches	1.0%
Dimensional Lumber	11.1%

Water and Wastewater

Accounting Methods

- USCP WW.1.a, WW.2.a, WW.3: Combustion of Digester Gas (CO2, CH4, N2O)
- USCP WW.7: Process N2O Emissions
- USCP WW.9: Process CO2 Emissions from Methanol
- USCP WW.11(alt): Fugitive Methane Emissions from Septic Emissions
- USCP WW.12 Fugitive Nitrous Oxide Emissions from Effluent Discharge

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data													
Digester Gas Production	scf/day	138,369	163,673	158,161	172,050	158,624	161,922	167,657	178,341	162,517	172,163	140,706	140,945
Gas Composition	% CH4	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.68	0.68	0.68	0.57	0.57
Daily Methanol (CH3OH) Load	metric tons/day	0.25	0.17	0.3	0.15	0.16	0.24	0.23	0.2	0.19	0.19	0.23	0.27
N2O Effluent Fugitives (daily N load from discharge)	kg N/day	160.09	140.59	246.26	248.98	201.36	144.22	126.08	294.33	283.45	270.29	219.50	133.79
Industrial discharge multiplier		1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Population served by LOTT	People	123,380	126,801	125,112	128,602	130,261	135,634	137,551	147,739	143,661	145,318	138,647	148,436
Households on septic	Households	52,000	52,273	52,546	52,819	53,092	53,365	53,638	53,911	54,184	54,457	54,730	55,000
Average Household Size	Persons/Household	2.46	[B]	[B]	[B]	[B]	[B]	[B]	[B]	[B]	[B]	2.51	[A]

Agriculture

Accounting Methods

- USCP A.1 CH4 Emissions Due to Enteric Fermentation
- USCP A.2.1 Methane Emissions from Manure Management
- GPC Reference Number V.3

	Unit	2007	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Activity Data														
Cattle	Heads	17,225	[B]	[B]	16,631	[B]	[B]	[B]	[B]	18,203	[A]	[A]	[A]	[A]
Sheep	Heads	1,838	[B]	[B]	1,797	[B]	[B]	[B]	[B]	1,724	[A]	[A]	[A]	[A]
Goats	Heads	1,173	[B]	[B]	1,817	[B]	[B]	[B]	[B]	1,462	[A]	[A]	[A]	[A]
Hogs	Heads	777	[B]	[B]	644	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]
Poultry	Heads	1,509,090	[B]	[B]	1,402,243	[B]	[B]	[B]	[B]	1,433,800	[A]	[A]	[A]	[A]
Horses	Heads	3,229	[B]	[B]	2,895	[B]	[B]	[B]	[B]	2,300	[A]	[A]	[A]	[A]
Fertilized acres	Acres	9,121	[B]	[B]	3,866	[B]	[B]	[B]	[B]	5,755	[A]	[A]	[A]	[A]
Factor Sets														
Cattle enteric fermentation emissions	MTCO2e/head		2.07017	2.12908	2.15821	2.18321	2.15055	2.19424	2.22985	2.23001	2.26234	2.28200	[A]	[A]
Sheep enteric fermentation emissions	MTCO2e/head		0.24893	0.24068	0.23182	0.23298	0.22989	0.21077	0.19671	0.18345	0.17199	0.19110	[A]	[A]
Goat enteric fermentation emissions	MTCO2e/head		0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12500	0.12698	0.12500	[A]	[A]
Swine enteric fermentation emissions	MTCO2e/head		0.04902	0.05053	0.06250	0.05894	0.05642	0.05172	0.03084	0.03218	0.03218	0.03218	[A]	[A]
Horse enteric fermentation emissions	MTCO2e/head		0.45000	0.45000	0.45000	0.45000	0.45000	0.45000	0.45000	0.45000	0.42964	0.45000	[A]	[A]
Cattle manure management CH4 emissions	MTCO2e/head		0.78839	0.82599	0.85872	0.88666	0.92634	0.96803	0.94545	0.96538	0.94955	0.96633	[A]	[A]
Swine manure management CH4 emissions	MTCO2e/head		0.15668	0.16345	0.21528	0.21080	0.21727	0.21281	0.12336	0.12639	0.12557	0.12737	[A]	[A]
Poultry manure management CH4 emissions	MTCO2e/head		0.00568	0.00537	0.00524	0.00529	0.00558	0.00614	0.00541	0.00558	0.00537	0.00504	[A]	[A]
Sheep manure management CH4 emissions	MTCO2e/head		0.00660	0.00639	0.00615	0.00618	0.00610	0.00560	0.00522	0.00486	0.00456	0.00507	[A]	[A]
Goat manure management CH4 emissions	MTCO2e/head		0.00638	0.00638	0.00638	0.00638	0.00638	0.00638	0.00638	0.00638	0.00648	0.00638	[A]	[A]
Horse manure management CH4 emissions	MTCO2e/head		0.05588	0.05588	0.05588	0.05588	0.05588	0.05588	0.05588	0.05588	0.05335	0.05588	[A]	[A]
Emissions per fertilized acre	MTCO2e/acre		0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297

Hydrofluorocarbons

Accounting Methods

- GPC Reference Number IV.2

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Factor Sets													
HFC 23 emissions	mg/person	6.58	6.52	6.47	6.42	9.55	9.48	6.28	6.23	6.19	6.16	6.12	[A]
HFC 32 emissions	g/person	12.65	16.41	20.96	25.63	30.16	34.92	21.32	24.40	27.68	31.04	34.83	[A]
HFC 125 emissions	g/person	26.06	34.66	40.26	45.77	50.86	55.88	42.06	44.57	47.49	51.38	55.59	[A]
HFC 134a emissions	g/person	169.17	165.47	153.32	140.94	135.29	130.28	151.74	141.01	134.46	131.07	127.35	[A]
HFC 143a emissions	g/person	12.70	16.42	17.63	18.66	19.38	19.82	19.84	19.51	19.16	19.19	19.09	[A]
HFC 236fa emissions	mg/person	480.32	479.45	478.75	484.69	471.18	426.52	404.95	386.29	365.43	344.94	330.71	[A]

APPENDIX III: INVENTORY DATA SOURCES

Data	Source	Scope	Quality
Buildings and Energy			
Activity Data			
Residential, commercial, and industrial electricity consumption	Puget Sound Energy	County	High
Residential, commercial, and industrial natural gas consumption	Puget Sound Energy	County	High
Households heating with fuel oil	American Community Survey (5-Year Average)	County	Low
Households heating with liquid petroleum gas	American Community Survey (5-Year Average)	County	Low
Households heating with wood	American Community Survey (5-Year Average)	County	Low
Fuel oil consumption per household	Energy Information Administration	State	Medium
Liquid petroleum gas consumption per household	Energy Information Administration	State	Medium
Wood consumption per household	Energy Information Administration	State	Medium
Electricity transmission grid loss	EPA eGRID	NWPP Region	Medium
Factor Sets			
Emissions (CO2, CH4, N2O) per kWH electricity	Puget Sound Energy	PSE Service Area	High
Electricity generation fuel mix	Puget Sound Energy	PSE Service Area	High
Transportation			
Activity Data			
Vehicle miles traveled	WSDOT	County	Medium
Jet fuel and aviation gas consumption	Port of Olympia	Site	High
Port maritime emissions	Puget Sound Maritime Emissions Inventory	Site	Medium
Offroad transportation emissions	EPA National Emissions Inventory	County	Low
Factor Sets			
VMT per vehicle/fuel type	EPA State Inventory and Projection Tool	State	Low
Vehicle fuel economy and emissions	U.S. Energy Information Administration	National	Medium
Vehicle pass-through rates	Thurston Regional Planning Council	County	Low
Water and Waste			
Activity Data			
Landfill waste	Thurston County Waste and Recovery Center (WARC)	County	High
Compost	Thurston County Waste and Recovery Center (WARC)	County	High
Waste transportation (truck and rail miles traveled)	Thurston Regional Planning Council	Site	High
Wastewater treatment • Digester gas production • Digester gas composition • Daily methanol load • Daily N load from effluent • Population served by LOTT	LOTT	Site	High
Number of septic systems	Thurston County Environmental Health	County	Medium
Factor Sets			
Freight rail fuel consumption	USDOT Bureau of Transportation Statistics	National	Low

Data	Source	Scope	Quality
Waste Characterization	WARC 2014 Waste Characterization Study	County	Medium
Agriculture			
Activity Data			
Thurston County livestock counts	USDA Census of Agriculture	County	Low
Thurston County acres treated with fertilizer	USDA Census of Agriculture	County	Low
Factor Sets			
Enteric emissions per head livestock	EPA State Inventory and Projection Tool	State	Medium
Manure management per head livestock	EPA State Inventory and Projection Tool	State	Medium
Emissions per fertilized acre	EPA State Inventory and Projection Tool	State	Medium
Hydrofluorocarbons			
Activity Data			
Thurston County population	Office of Financial Management	County	High
Factor Sets			
HFC emissions per person	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2020)	National	Low