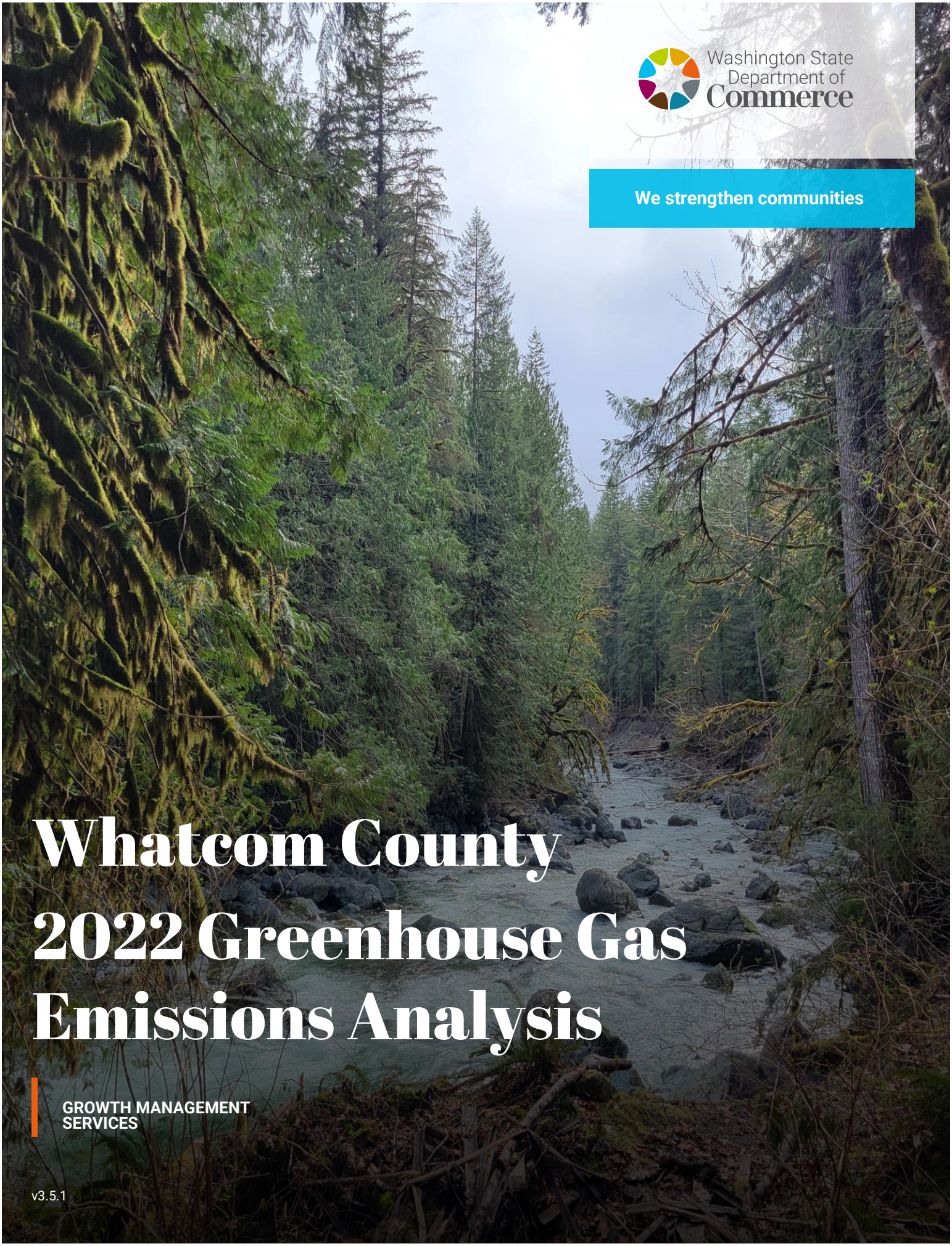

Washington State Department of Commerce

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Whatcom County 2022 Greenhouse Gas Emissions Analysis

GROWTH MANAGEMENT SERVICES

v3.5.1

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Table of Contents

Executive Summary

To better understand current and future greenhouse gas (GHG) emissions in Washington and support local comprehensive planning, the Washington Department of Commerce (Commerce) funded an 11-county GHG emissions inventory and scenario planning effort. HB 1181, signed into law in 2023, requires Washington cities and counties to incorporate a Climate Element into Comprehensive Plans to build resilience and reduce GHG emissions. For 11 counties and the cities within, development of a greenhouse gas emissions sub-element is mandatory for inclusion in the jurisdiction's next Comprehensive Plan update. This GHG analysis effort aims to support local comprehensive planning, as identifying current and future emissions is a critical step in understanding where the state's largest sources of emissions are occurring and where there are opportunities for emissions reduction. This report provides a summary of 2022 communitywide and county government operations emissions for Whatcom County, as well as projected future emissions and GHG emission reduction strategies. Whatcom County's communitywide and operational emissions were quantified for the 2022 calendar year, representing the most recent year with complete data at the time of this study.

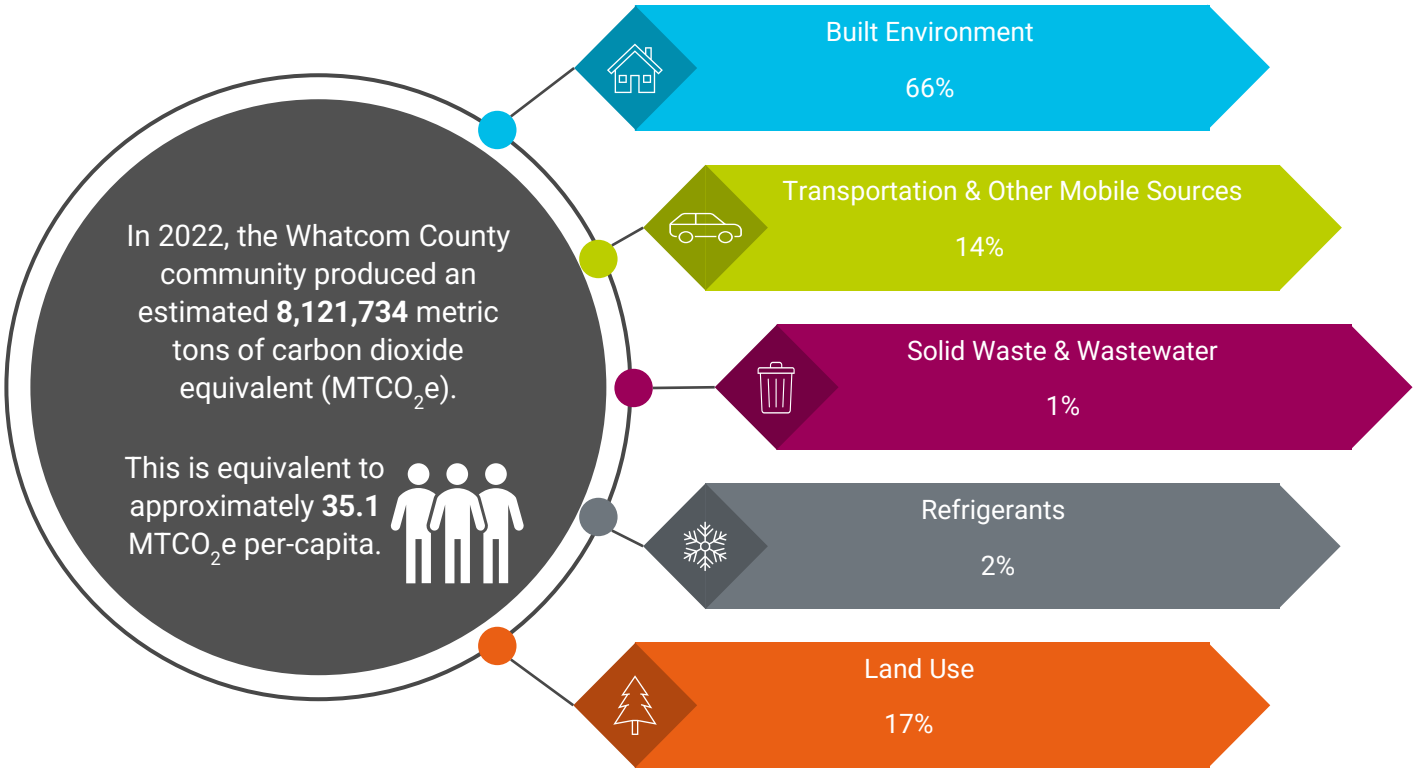
This inventory reports both the county's total emissions (includes direct and indirect emissions from industry, agriculture, and other sectors) and its "core" emissions (includes sectors over which county governments often have the most influence through local policy mechanisms such as local codes/regulations). We recommend that the county use its core emissions as a starting point for shaping comprehensive plan policies. We also recommend that the county also consider policies that address emissions from non-core sectors to support co-benefits such as clean air and water, improve resilience, and provide beneficial opportunities such as local food systems.

2022 Greenhouse Gas Emissions Profile

Communitywide

The communitywide emissions inventory quantifies emissions produced by activity from county residents, businesses, schools, and visitors, including from buildings, transportation, land use, and solid waste generation and disposal. In 2022, the Whatcom County community produced an estimated total of 8,121,734 metric tons of carbon dioxide equivalent ($MTCO_2e$), which equates to approximately 35.1 $MTCO_2e$ per capita. Figure 1 shows the breakdown of total 2022 communitywide emissions, including emissions from the built environment, transportation, solid waste and wastewater treatment, refrigerant usage, and land use.

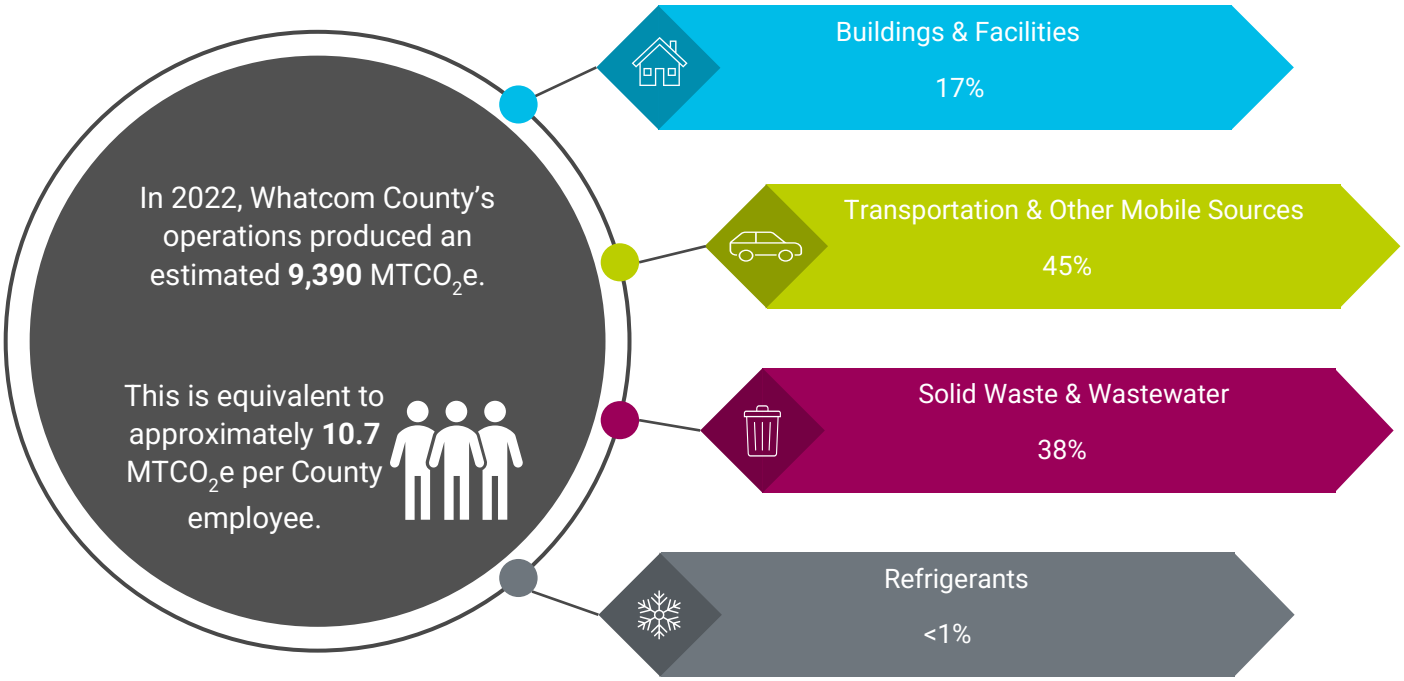
FIGURE 1. 2022 COMMUNITYWIDE GHG EMISSIONS PROFILE BY SOURCE.



County Operations

The county operations emissions inventory reports emissions that are produced by county government activities and facilities, including from county facilities, fleet vehicles, employee commuting, and waste generation and disposal. In 2022, Whatcom County's operations produced an estimated 9,390 $MTCO_2e$. Figure 2 shows the breakdown of 2022 county operations emissions, including emissions from county facilities, transportation (fleet vehicles, employee commuting, and business travel), solid waste and wastewater treatment, and refrigerant usage.

FIGURE 2. 2022 COUNTY OPERATIONS GHG EMISSIONS PROFILE BY SOURCE.

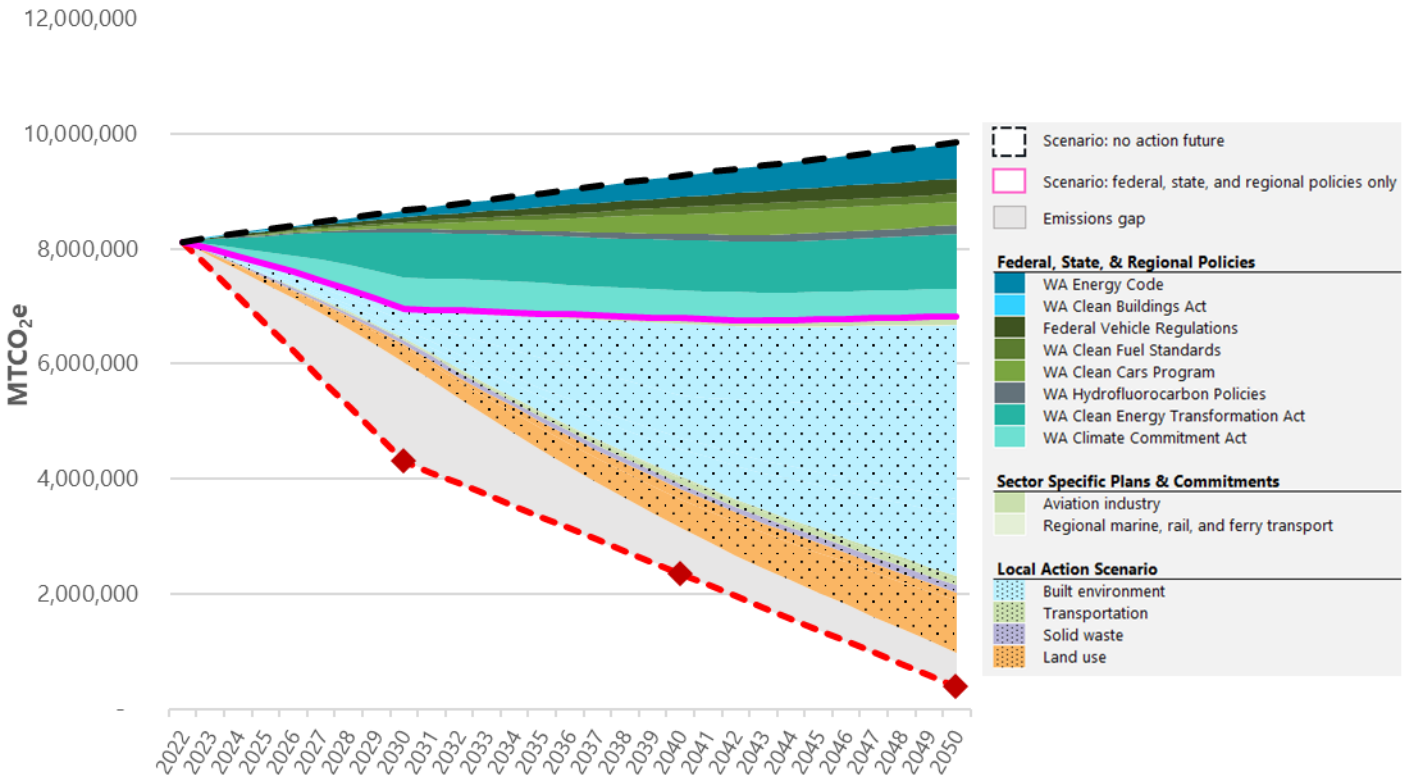


Future Emissions Projections & Local Strategies

A forecasting analysis of Whatcom County's communitywide emissions from 2022 to 2050 revealed the following total emissions projections under three scenarios compared to Washington state greenhouse gas emission reduction targets (45% by 2030, 70% by 2040, and 95% by 2050, compared to a 1990 baseline):

- Business-as-usual (BAU), which assumes no action is taken to reduce GHG emissions. Under this scenario, Whatcom County's emissions will grow 26% by 2050 (compared to a 1990 baseline), as depicted by the dotted black line in Figure 3.
- Adjusted business-as-usual (ABAU), which models estimated emissions reductions from existing federal, state, and regional policies. This scenario estimates a 13% reduction in communitywide emissions by 2050 (compared to a 1990 baseline), as depicted by the pink line in Figure 3.
- Local action scenario, which models estimated emission reductions from local climate actions such as reducing building energy consumption or transitioning to electric vehicles: Combined with the ABAU, this scenario estimates an 87% total reduction in communitywide emissions by 2050 (compared to a 1990 baseline), as shown by the local action scenario reductions in Figure 3.

FIGURE 3. FORECASTED GHG EMISSIONS AND REDUCTIONS ($MTCO_2E$).



These analyses of current and projected future GHG emissions provide insight into local policy options for reducing GHG emissions in Whatcom County. As presented in the local action scenario, key GHG emission reduction strategies for focus in Whatcom County's comprehensive plan update include:

- Reduce energy consumption in new and existing residential and commercial buildings through: 1) supporting clean building energy sources and 2) energy efficient building design and retrofits. Local action to transition to renewable building energy sources would reduce Whatcom County's built environment emissions, which made up 66% of 2022 communitywide emissions.
- Reduce passenger vehicle travel within the county, including through changes to land use, transportation infrastructure (transit, walking, bicycling), and commuting options/modes. A reduction in passenger VMT would reduce Whatcom County's communitywide on-road emissions from passenger vehicles, which made up 6% of 2022 emissions.
- Facilitate the transition to electric vehicles through expansion of reliable EV charging infrastructure and public education on options and available incentives/rebates. Local action to support transitioning passenger and freight vehicles to electric would reduce Whatcom County's passenger and freight vehicle on-road emissions, which made up 9% of 2022 communitywide emissions.
- Limit tree loss and support low-carbon land practices such as sustainable forestry, agriculture, and livestock management. Reducing tree loss emissions and emissions from agricultural practices in Whatcom County would reduce land use emissions, which made up 17% of 2022 communitywide emissions.
- Work with local industries to support transition to low-carbon industrial processes, including for high-carbon industries such as petroleum refining and aluminum refining and production. These industrial process emissions made up 16% of Whatcom County's 2022 communitywide emissions.

Introduction

To better understand current and future greenhouse gas (GHG) emissions in Washington and support local comprehensive planning, WA Department of Commerce (Commerce) funded an 11-county GHG emissions inventory and scenario planning effort. HB 1181, signed into law in 2023, requires Washington cities and counties to incorporate a Climate Element into Comprehensive Plans to build resilience and reduce GHG emissions. For 11 counties and the cities within, development of a greenhouse gas emissions sub-element is mandatory for inclusion in the jurisdiction's next Comprehensive Plan update. This GHG analysis effort aims to support local comprehensive planning for these counties, as identifying current and future emissions is a critical step in understanding where the state's largest sources of emissions are occurring and where there are opportunities for emissions reduction. This report provides a summary of 2022 communitywide and county government operations emissions for Whatcom County, as well as projected future emissions and GHG emission reduction strategies.[1]

Methodology

In determining the methodology used to complete Whatcom County's GHG analyses, the project team used the following guiding principles:

- Replicability and transparency, to ensure that analyses can be conducted in future years.
- Consistency, both across counties and with past county GHG analyses, where applicable.
- Accuracy, including through inclusion of all relevant sectors, use of locally specific data, and alignment with industry best practices.

GHG Emissions Inventories

The following protocols were referenced to complete the GHG emission inventories:

- Whatcom County's communitywide inventory was performed using guidance from both ICLEI's U.S. Community Protocol for Accounting and Reporting of GHG Emissions (USCP)[2] and The Greenhouse Gas Protocol's Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC)[3]. These protocols are the industry standards for quantifying GHG emissions from community activities.[4]
- Whatcom County's operational inventory was performed using guidance from ICLEI's Local Government Operations Protocol for the Quantification and Reporting of GHG Emissions Inventories (LGOP).[5] This protocol outlines a standardized method for local governments to estimate operational emissions.

Whatcom County's communitywide and operational emissions were quantified for the 2022 calendar year, chosen as the most recent year with complete data at the time of this study. All analyses were performed in Microsoft Excel.

---

[1] The GHG emissions estimates shown in this report are intended to support development of Whatcom County's Climate Element. The county may reference additional and/or more locally-specific analyses to support a comprehensive understanding of its GHG emissions context.
[2] U.S. Community Protocol | ICLEI USA
[3] Global Protocol for Community-Scale GHG Inventories (GPC) | GHG Protocol.
[4] These two protocols have different geographic specificities (e.g., the GPC is more global, while the U.S. Community Protocol has more of a U.S. focus). Both share the same basic GHG accounting principles.
[5] Local Government Operations (LGO) Protocol | ICLEI USA

Emissions Sources

The GHG emissions inventories, forecast, and scenario analysis included emissions sources listed in Table 1, as applicable. These sources are recommended by protocols and aligned with industry best practices.

The table below also identifies communitywide "core emissions" sources, which are emissions produced by sectors most commonly included in community greenhouse gas inventories and over which county governments often have the most influence (e.g., through local policy mechanisms such as local codes/regulations). Core emissions included in this inventory, indicated in **bold** in the table below, include emissions from electricity, natural gas, on-road vehicles, solid waste generation and disposal, and wastewater treatment processes. While agriculture, tree loss, and some other emissions sources are not included in the core emissions scenario, Commerce still strongly encourages local jurisdictions to consider comprehensive plan policies to address emissions from these sources. Such policies will support co-benefits such as clean air and water, improve resilience, and provide beneficial opportunities such as local food systems.

TABLE 1. EMISSIONS SOURCES FOR THE 2022 COMMUNITYWIDE AND COUNTY OPERATIONS GHG ANALYSES.

Sector	Communitywide	County Operations
Buildings	**Electricity** **Natural gas** Propane Fuel oil Industrial processes	Electricity Natural gas Propane Fuel oil
Transportation	**On-road vehicles** Off-road equipment Aviation	County fleet vehicles & equipment County employee commute County business travel
Solid Waste	**Landfilled waste generation & disposal** **Compost generation & disposal**	Landfilled waste generation & disposal Compost generation & disposal County landfills
Wastewater	**Treatment processes** **Septic systems**	Treatment processes
Land Use	Agriculture Forests & land use change	N/A
Refrigerants	Refrigerants	Refrigerants

Detailed methodologies and data considerations for each emissions source are provided in Appendix A.

Forecast & Scenario Planning

The interactive communitywide GHG emissions forecasting and scenario planning analysis estimated emissions from 2022 to 2050 under the following three scenarios:

- Business-as-usual (BAU), which assumes no action is taken to reduce GHG emissions.
- Adjusted business-as-usual (ABAU), which models estimated emissions reductions from existing federal, state, and regional policies.
- Additional local action needed to achieve state GHG emission reduction targets.

This analysis was conducted in a user-friendly tool based in Microsoft Excel, which allows for custom user-defined inputs and real-time scenario planning to inform GHG emission reduction policy development.

Local Policy Options

Outputs from Whatcom County's GHG emissions inventories, forecast, and scenario analysis supported development of county-specific local policy options. These options were developed through consultation with county staff and included detailed review of county emissions sources.

GHG Emissions Inventory Findings

Communitywide Inventory

In 2022, the Whatcom County community produced an estimated 8,121,734 $MTCO_2e$, 1,916,847 $MTCO_2e$ of which are from core emissions sources. This total equates to approximately 35.1 and 8.3 $MTCO_2e$ per-capita for the total and core emissions sources, respectively. Accounting for all emissions sources, the community's largest sources of emissions were from built environment (buildings), contributing 66% of total emissions, and land use contributing 17%. Figure 4 and Table 2 summarize 2022 communitywide emissions by sector and source.

Note that the on-road vehicle emissions listed in Figure 4 and Table 2 utilize vehicle miles traveled (VMT) data from WSDOT's Highway Performance Monitoring System (HPMS). For additional context, the "Transportation" section on page 15 discusses alternative methods for estimating VMT in Whatcom County.

FIGURE 4. 2022 COMMUNITYWIDE EMISSIONS PROFILE ($MTCO_2E$).

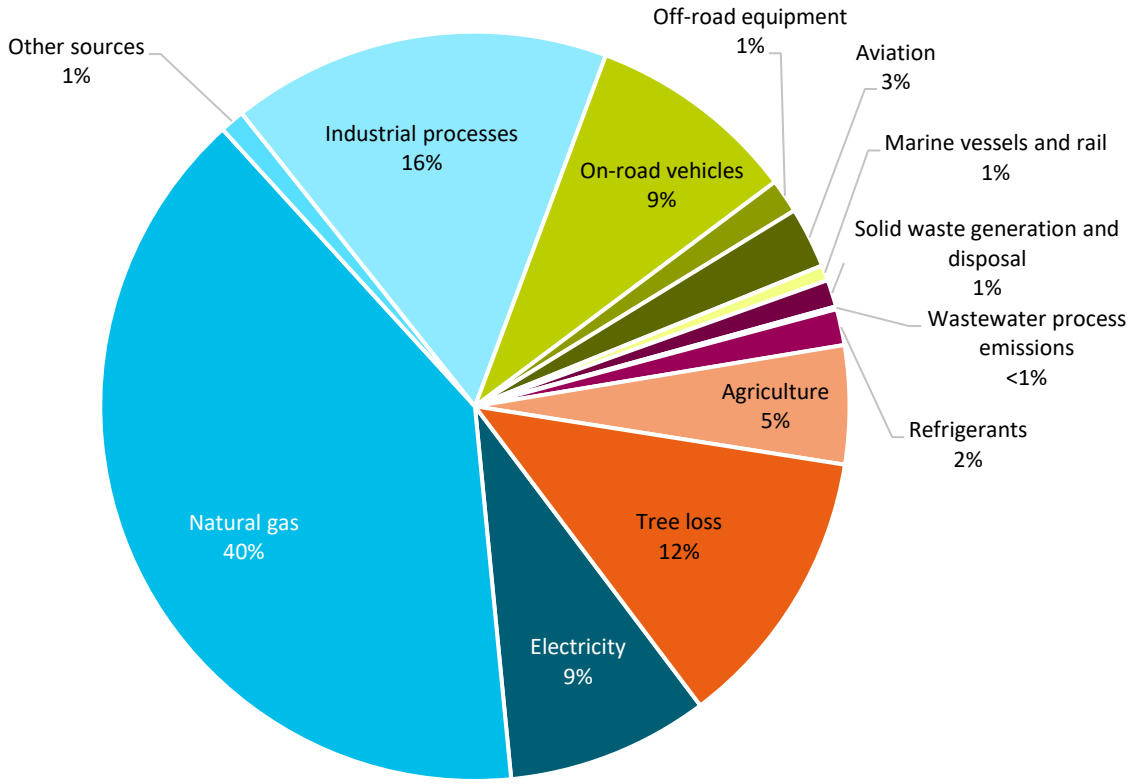


TABLE 2. TOTAL AND PER-CAPITA COMMUNITYWIDE GHG EMISSIONS, BY SECTOR ($MTCO_2E$ AND %).

GHG Emissions Sector	Total Emissions ($MTCO_2e$)	Per-capita Emissions ($MTCO_2e$)	Percent of Emissions (%)
Built Environment			
Electricity	**709,148**	**3.1**	**9%**
Residential	373,306	1.6	5%
Commercial	273,483	1.2	3%
Industrial	62,359	0.3	<1%
Natural Gas	**3,231,190**	**13.9**	**40%**
Residential	249,994	1.1	3%
Commercial	176,752	0.8	2%
Industrial	2,804,444	12.1	35%
Propane	**66,582**	**0.3**	**<1%**
Residential	55,494	0.2	<1%
Commercial	11,088	<0.1	<1%
Fuel Oil	**19,787**	**<0.1**	**<1%**
Residential	2,997	<0.1	<1%
Commercial	16,790	<0.1	<1%
Industrial Processes	**1,330,442**	**5.7**	**16%**
Transportation & Other Mobile Sources			
On-Road Vehicles	**738,587**	**3.2**	**9%**
Passenger vehicles	519,598	2.2	6%
Freight & service vehicles	213,241	0.9	3%
Public transit	5,747	<0.1	<1%
Off-Road Equipment	**119,478**	**0.5**	**1%**
Aviation	**212,901**	**0.9**	**3%**
Marine & Rail	**54,014**	**0.2**	**<1%**
Solid Waste & Wastewater			
Solid Waste Generation & Disposal	**94,845**	**0.4**	**1%**
Landfill	94,845	0.4	1%
Compost	N/A	N/A	0%
Wastewater Processes	**9,881**	**<0.1**	**<1%**
Refrigerants			
Refrigerants	**126,483**	**0.5**	**2%**
Land Use			
Agriculture	**415,205**	**1.8**	**5%**
Tree Cover Loss	**993,191**	**4.3**	**12%**
Total Emissions	**8,121,734**	**35.1**	**100%**
Core Emissions	***1,916,847***	***8.3***	***24%***

TABLE 2. CORE COMMUNITYWIDE AND PER-CAPITA GHG EMISSIONS, BY SECTOR ($MTCO_2E$ AND %).

GHG Emissions Sector	Total Emissions ($MTCO_2e$)	Per-capita Emissions ($MTCO_2e$)	Percent of Emissions (%)
Built Environment			
Electricity	**646,789**	**2.8**	34%
Residential	373,306	1.6	19%
Commercial	273,483	1.2	14%
Natural Gas	**426,746**	**1.8**	**22%**
Residential	249,994	1.1	13%
Commercial	176,752	0.8	9%
Transportation & Other Mobile Sources			
On-Road Vehicles	**738,587**	**3.2**	**39%**
Passenger vehicles	519,598	2.2	27%
Freight & service vehicles	213,241	0.9	11%
Public transit	5,747	<0.1	<1%
Solid Waste & Wastewater			
Solid Waste Generation & Disposal	**94,845**	**0.4**	**5%**
Landfill	94,845	0.4	**5%**
Compost	N/A	N/A	**N/A**
Wastewater Processes	**9,881**	**<0.1**	**<1%**
Core Emissions	**1,916,847**	**8.3**	**24%**

The sections below provide a more detailed summary of GHG emissions inventory findings within each sector. Values are presented using the total emissions (i.e., not "core" emissions) framework.

Built Environment

The built environment sector made up 66% of Whatcom County's 2022 total communitywide emissions, contributing 5,357,149 $MTCO_2e$. This sector includes emissions from the use of electricity, natural gas, propane, and fuel oil to heat, cool, and power buildings, as well as direct emissions from industrial processes within the county.

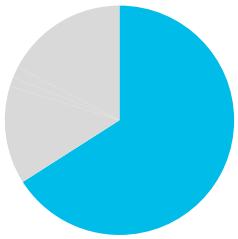
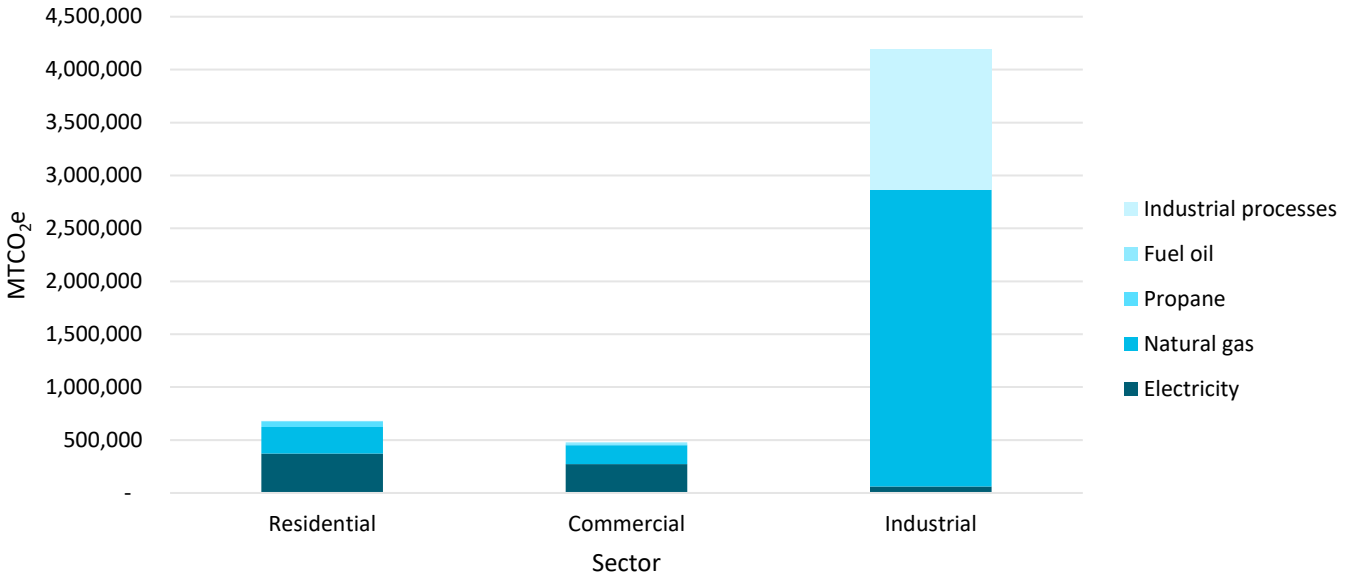


Figure 5 below summarizes Whatcom County's 2022 emissions from the built environment, by sector and source. An estimated 9% and 40% of Whatcom County's total communitywide emissions stemmed from electricity and natural gas consumption, respectively. Propane and fuel oil consumption contributed <1% and <1%, respectively, and 16% of communitywide emissions were produced by industrial processes within Whatcom County.

Emissions calculated from electricity were calculated using utility-specific emission factors sourced from the WA Department of Ecology. For informational purposes, emissions from electricity were also calculated using the regional electric grid emissions factor, sourced from the EPA Emissions & Generation Resource Integrated

Database (eGRID). When calculated using this location-based method, Whatcom County's electricity emissions were approximately 641,320 $MTCO_2e$, compared to 709,148 $MTCO_2e$ when estimated using a utility-specific approach.

FIGURE 5. BUILT ENVIRONMENT GHG EMISSIONS, BY SECTOR AND SOURCE.



Transportation

The transportation sector made up 14% of Whatcom County's 2022 total communitywide emissions, emitting an estimated 1,124,979 $MTCO_2e$. This sector includes emissions from the use of on-road vehicles and off-road equipment, as well as emissions from marine, rail, and air travel, shown in Figure 6 below.

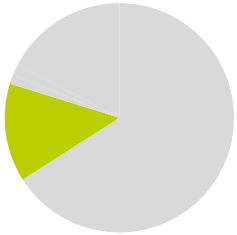
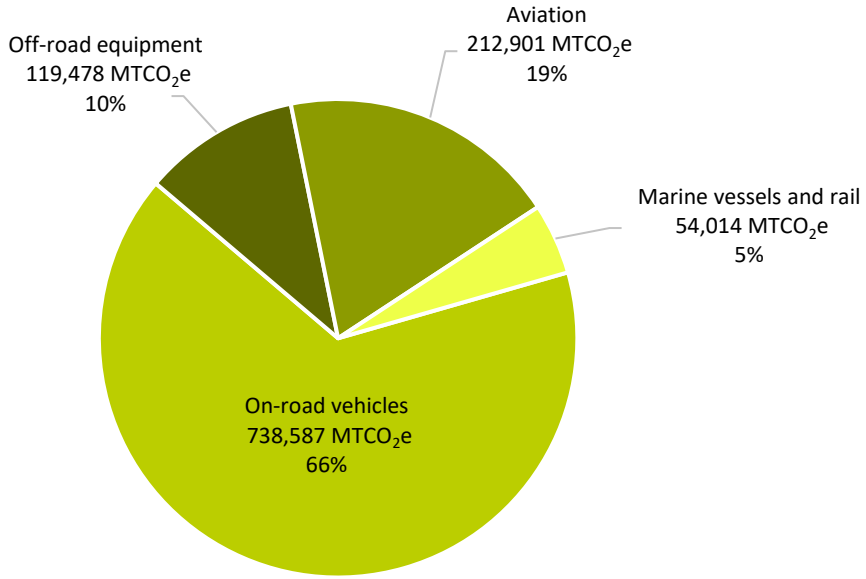
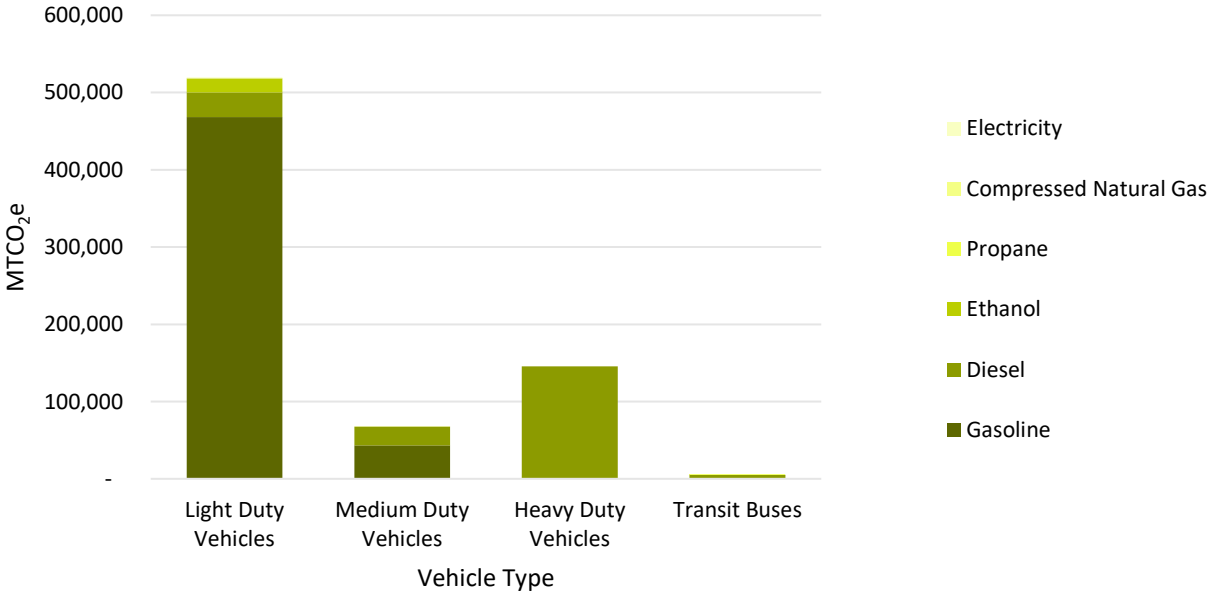


FIGURE 6. TRANSPORTATION EMISSIONS, BY SOURCE.



On-road vehicle emissions include those from passenger vehicles, freight and service trucks, and transit vehicles within the county boundary, and made up 66% of Whatcom County's 2022 total transportation emissions. On-road emissions by vehicle and fuel type are shown in Figure 7.

FIGURE 7. ON-ROAD TRANSPORTATION EMISSIONS, BY VEHICLE AND FUEL TYPE.



On-Road Vehicles

The GHG emissions inventory presented in this report is consistent with state law requirements to use data provided by Washington State Department of Transportation (WSDOT) and uses estimates of total vehicle miles traveled (VMT) within the Whatcom County geographic boundary. This estimate sums the vehicle miles driven on all public roadways within the county. The total VMT is then divided by the county's population to calculate a 'VMT per capita' value. In this context, "per capita" refers to the resident population of Whatcom County. As a result, the 'VMT per capita' value represents the total segment-level VMT within the county relative to its residential population, regardless of whether the miles were generated by residents, visitors, or pass-through traffic, or the purpose of the travel. Based on this approach, we estimate the per-capita VMT in Whatcom County in 2022 to be approximately 16 vehicle miles per day.

It is important to note that this reported 'VMT per capita' metric from WSDOT is not the same as 'VMT generated per resident.' It has limited value in explaining individual travel behavior and does not account for travel behavior outside of the county, such as trips made by residents and employees commuting to or from Whatcom County for work.

To better understand the travel behavior of Whatcom County residents and employees, we have used a third-party VMT data source that provides home-based VMT estimates. Home-based VMT refers to the total number of miles driven by automobile trips originating from a person's home. This data allows us to answer specific questions about community travel patterns, such as, "How many vehicle miles are driven to and from work each day by employees working in the county?" Additionally, this data can be used to develop targeted VMT reduction strategies, such as reducing single-occupancy vehicle commutes for large employers. For Whatcom County in 2022, this data source provides the following average daily VMT metrics:

23 home-based VMT per resident

Home-Based VMT per Resident

14 home-based work VMT per employee

Home-Based Work (HBW) VMT

Home-based VMT measures the amount of vehicle-miles-traveled for all trips that either start or end at home by a resident living in the county.

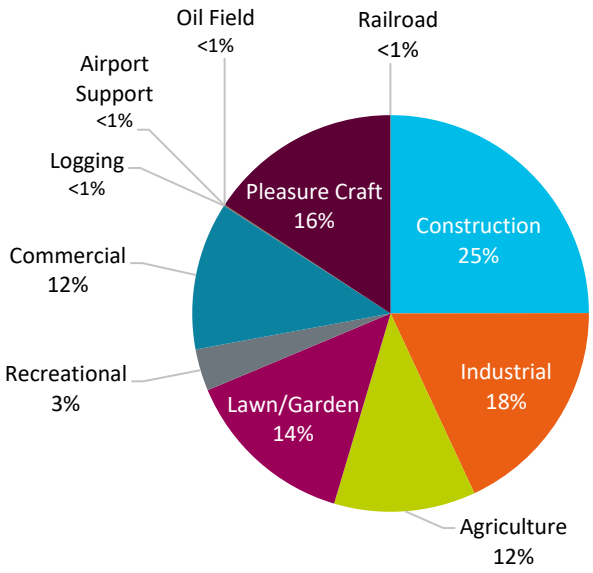
Home-based work (HBW) VMT measures the vehicle-miles-traveled for commute trips (trip either starts/ends at home and starts/ends at work) by an employee working in the county.

Off-Road Vehicles & Equipment

In addition to on-road vehicles, emissions from the following off-road equipment categories were included in this inventory: recreational, construction, industrial, lawn/garden, agriculture, commercial, logging, airport support, oil field, pleasure craft, and railroad. Off-road vehicles and equipment produced 119,478 $MTCO_2e$,

making up 1% of communitywide emissions. The largest source of off-road emissions was construction, producing 25% of all off-road vehicle and equipment emissions.

FIGURE 8. OFF-ROAD EMISSIONS, BY SECTOR.



Solid Waste & Wastewater

The solid waste and wastewater sector made up 1% of Whatcom County's total 2022 communitywide emissions, contributing an estimated 104,726 $MTCO_2e$. This sector includes emissions from the generation and disposal of solid waste and commercially processed compost (if available), as well as the treatment of wastewater produced within Whatcom County.

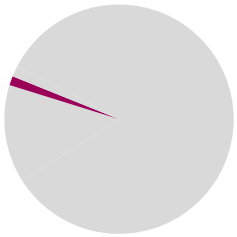
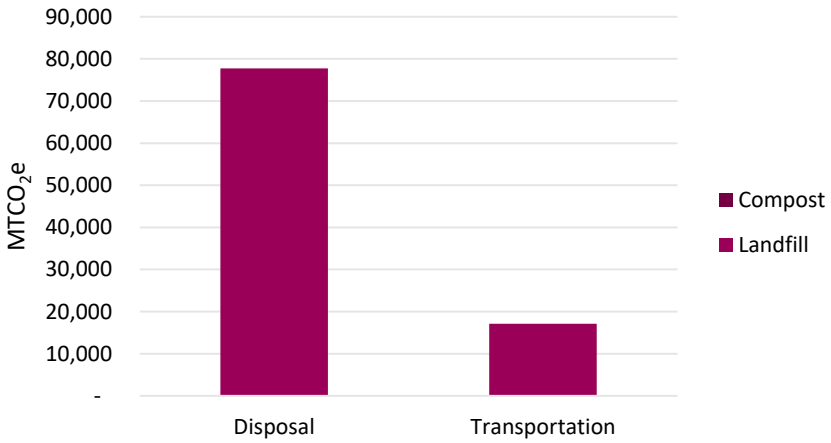
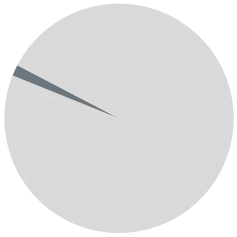


FIGURE 9. EMISSIONS FROM SOLID WASTE GENERATION, BY ACTIVITY AND WASTE TYPE.



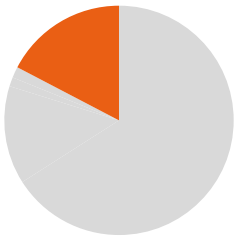
Emissions from wastewater are generated by the biological processing of organic wastewater at treatment facilities, as well as from septic systems within the community. In 2022, emissions from wastewater made up <1% of total communitywide emissions. Wastewater treatment plants within Whatcom County also produce emissions through energy used to power wastewater treatment processes; these emissions are accounted for in the commercial energy sector to avoid double-counting between sectors.

Refrigerants



Refrigerant emissions accounted for 2% of Whatcom County's 2022 total communitywide emissions, contributing an estimated 126,483 $MTCO_2e$. The refrigerant sector includes emissions from the use and leakage of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and CO_2 from ozone depleting substances (ODSs). Due to local data limitations, refrigerants emissions in this inventory are downscaled from national-level data to the county level based on population.

Land Use



Land use emissions made up 17% of Whatcom County's 2022 total communitywide emissions, contributing approximately 1,408,396 $MTCO_2e$. The land use sector includes emissions from agricultural activities such as soil management, digestive processes in livestock (enteric fermentation), and manure management, in addition to emissions from land use changes and tree loss. Whatcom County had approximately 64,682 acres of agricultural cropland in 2022.

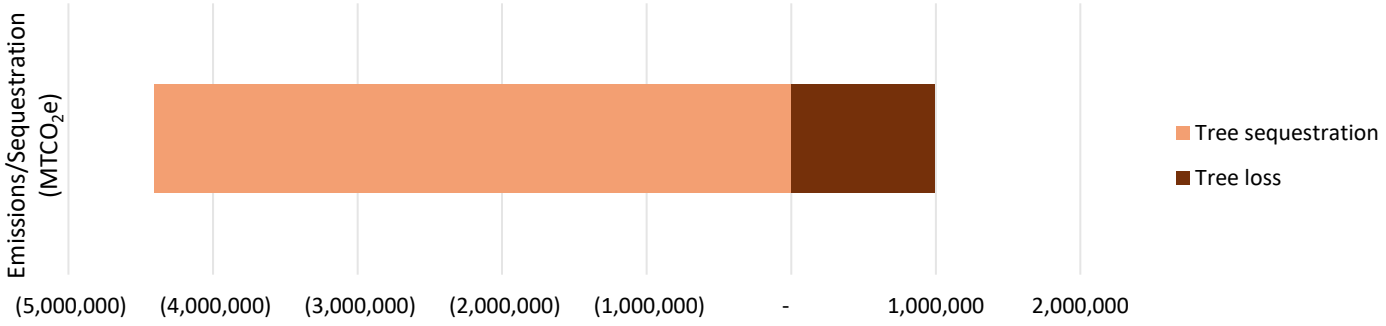
In 2022, the largest emitter of agricultural emissions in Whatcom County was dairy cows, producing 71% of agriculture emissions.

Emissions from land use also include emissions from tree cover loss within Whatcom County, stemming from forest management and activities that result in conversion of tree-covered land into settlements, grasslands, or other non-forested land types. In 2022, changes to tree cover resulted in the generation of approximately 993,191 $MTCO_2e$. Note that emissions from tree loss consider emissions from all lands within the county's boundary, regardless of ownership, which can include state and federally owned and managed lands.

Tree Carbon Sequestration

Trees and forests in Whatcom County sequestered approximately 4,405,414 $MTCO_2e$ from the atmosphere in 2022. Carbon sequestration refers to the removal of carbon dioxide from the atmosphere. This sequestration estimate is derived from remote sensing data and accounts for tree characteristics, including tree types, age, and health. Figure 10 below compares estimated GHG emissions from tree cover loss to GHG removals from tree carbon sequestration in 2022. Causes of tree loss include conversion from forest to other land uses; deforestation/harvesting; reduction in urban tree canopy; and degradation from insects, fire, and diseases. Emissions from tree cover loss are not netted with sequestration in this inventory to present a complete picture of gross GHG emissions and to support identification of reduction opportunities. Note that these tree loss emissions estimates do not consider loss of future carbon sequestration potential. For additional information regarding emissions from tree cover loss and carbon sequestration in Whatcom County, see Appendix D.

FIGURE 10. TREE COVER GHG EMISSIONS AND SEQUESTRATION.



County Operations Inventory

The county operations emissions inventory summarizes GHG emissions produced by county government activities, including from county-owned and operated facilities. In 2022, Whatcom County's operations produced an estimated 9,390 $MTCO_2e$. The county's largest sources of emissions occurred from transportation & other mobile sources, contributing 45% of total county operations emissions, and solid waste & wastewater, contributing 38%. County operations emissions in 2022 made up 0.12% of Whatcom County's 2022 communitywide emissions. Figure 11 depicts Whatcom County's 2022 operational emissions by sector and source.

FIGURE 11. COUNTY OPERATIONS EMISSIONS PROFILE ($MTCO_2E$).

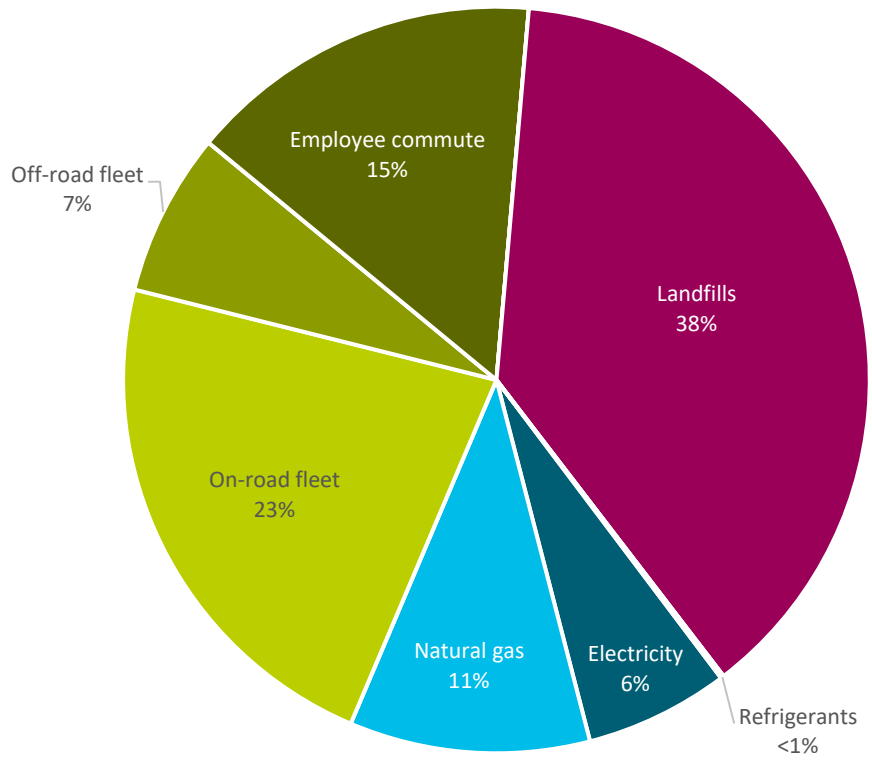


TABLE 3. 2022 TOTAL AND PER-CAPITA COUNTY OPERATIONS GHG EMISSIONS, BY SECTOR ($MTCO_2E$ AND %).

GHG Emissions Sector	Total Emissions ($MTCO_2e$)	Per-employee Emissions ($MTCO_2e$)	Percent of Emissions (%)
Built Environment			
Electricity	**586**	**0.7**	**6%**
Natural Gas	**978**	**1.1**	**10%**
Propane	**N/A**	**N/A**	**0%**
Fuel Oil	**N/A**	**N/A**	**0%**
Power Generation	**N/A**	**N/A**	**0%**
Transportation & Other Mobile Sources			
Fleet Vehicles & Equipment	**2,778**	**3.2**	**30%**
On-road fleet vehicles	2,114	2.4	23%
Off-road fleet equipment	664	0.8	7%
Employee Commute	**1,447**	**1.7**	**15%**
Business Travel	**N/A**	**N/A**	**0%**
Solid Waste & Wastewater			
Solid Waste Generation & Disposal	**3,587**	**4.1**	**38%**
Landfilled waste	N/A	N/A	0%
Composted waste	N/A	N/A	0%
County-owned landfills	3,587	4.1	38%
Wastewater Processes	**N/A**	**N/A**	**0%**
Refrigerants			
Refrigerants	**13**	**<0.1**	**<.1%**
Stationary refrigerants	N/A	N/A	0%
Mobile refrigerants	13	<0.1	<.1%
Total Emissions	**9,390**	**10.7**	**100%**

Built Environment

The built environment sector, which includes emissions from all county-owned and operated facilities, made up 17% of Whatcom County's 2022 operational emissions, contributing approximately 1,565 $MTCO_2e$. This sector includes emissions from the use of electricity, natural gas, propane, and fuel oil to heat, cool, and power county government facilities, as well as diesel generators used for backup power. The breakdown of government operations emissions by fuel type is shown in Figure 12.

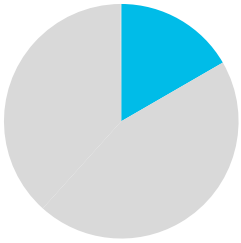
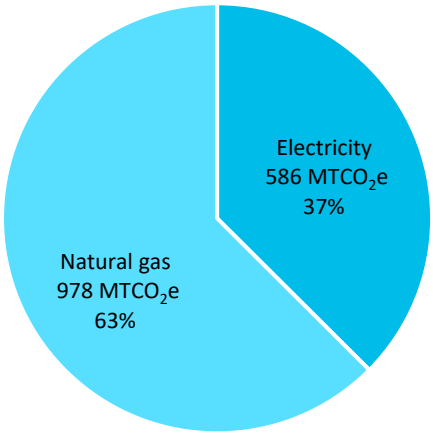


FIGURE 12. GOVERNMENT OPERATIONS BUILT ENVIRONMENT EMISSIONS, BY FUEL TYPE.



Transportation

County operations transportation emissions stem from the operation of county fleet vehicles and equipment, county employee commuting, and county staff business travel (as data are available). Emissions from this sector made up 45% of Whatcom county's 2022 operational emissions (approximately 4,226 $MTCO_2e$). A breakdown of Whatcom County operations transportation emissions are shown below in Figure 13.

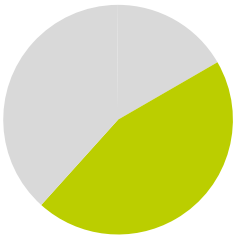
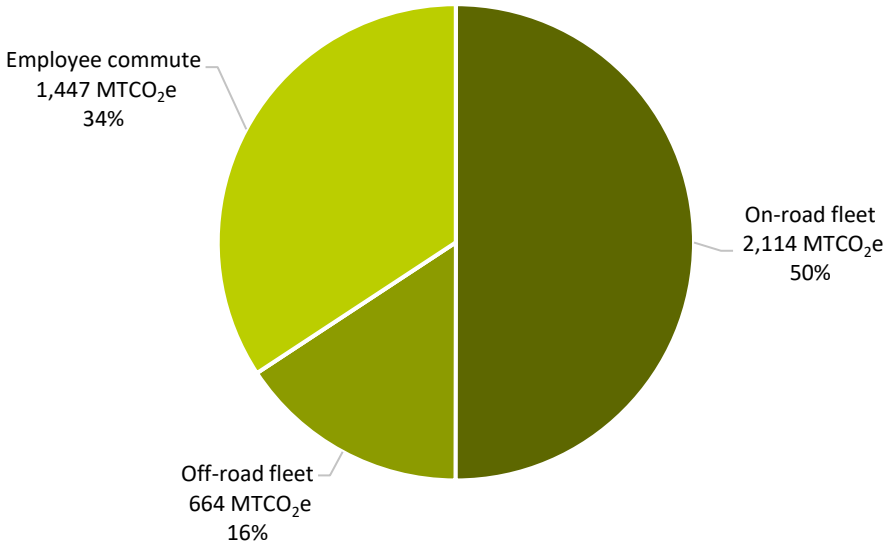


FIGURE 13. GOVERNMENT OPERATIONS TRANSPORTATION EMISSIONS, BY SOURCE.



Solid Waste & Wastewater

The solid waste and wastewater sector made up 38% of Whatcom County's 2022 operational emissions, contributing approximately 3,587 $MTCO_2e$. This sector includes emissions from the county government's generation and disposal of solid waste, emissions from county-owned landfills (as applicable), energy used to convey water to county facilities, and process emissions from any county-owned wastewater facilities. Note that some of these sources may have been excluded due to data availability limitations.

Refrigerants

The refrigerant sector made up an estimated <1% of Whatcom County's 2022 operational emissions (13 $MTCO_2e$). This sector includes emissions from the use, leakage, and disposal of stationary refrigerants in county facilities, as well as mobile refrigerant use in county fleet vehicles and equipment.

Future Emissions Forecast & Scenario Analysis

Results from the 2022 communitywide GHG inventory were used to forecast future emissions and emission reduction scenarios for Whatcom County. Specifically, the analysis[6] forecasted Whatcom County's communitywide GHG emissions to 2050 under three scenarios, detailed in the sections below:

- Business-as-usual (BAU), which assumes no action is taken and assumes the projected population[7] and economic growth. [8] [9]
- Adjusted business-as-usual (ABAU), which models estimated emissions reduction from existing federal, state, and regional policies.
- Additional local action, which models estimated emissions reduction from local strategies such as VMT reduction and building energy efficiency.

In addition to these scenarios which consider all of Whatcom County's emissions, a "core emissions" forecast is shown below, which represents projected emissions only for the "core" emission sources included in the communitywide inventory. Core emissions that were included in this inventory include emissions from electricity, natural gas, on-road vehicles, solid waste generation and disposal, and wastewater treatment processes. These emissions are produced by sectors that are commonly included in community greenhouse gas inventories and which county governments often have the most influence.

Findings Summary

A summary of key findings from the 2022-2050 forecast and scenario analysis is provided in Table 4 below for both the core and all emissions sources.

TABLE 4. EMISSIONS FORECAST FOR 2050, UNDER THREE SCENARIOS (% CHANGE COMPARED TO 1990 BASELINE).

Scenario	Core Emissions	All Emissions
Business-as-Usual	+38%	+26%
Adjusted Business-as-Usual	-60%	-13%
Local Action	-94%	-87%

Emission levels for 1990 were estimated based on state-level emissions trends between 1990 and 2022.

[6] The forecast scenarios shown in this report are shown as examples of potential emission reduction pathways and may not reflect the scenarios represented in Whatcom County's Climate Element or associated analyses.
[7] Washington Office of Financial Management (OFM) Growth Management Act population projections, "Middle" scenario.
[8] Future employment estimated using expected OFM population growth percentages.
[9] Please note that the growth forecasts used in this analysis were selected in order to achieve consistency between Washington counties, and may not reflect the growth forecast used in Whatcom County's Comprehensive Plan update.

FIGURE 14. FORECASTED GHG EMISSIONS AND REDUCTIONS UNDER THREE SCENARIOS - CORE EMISSIONS.

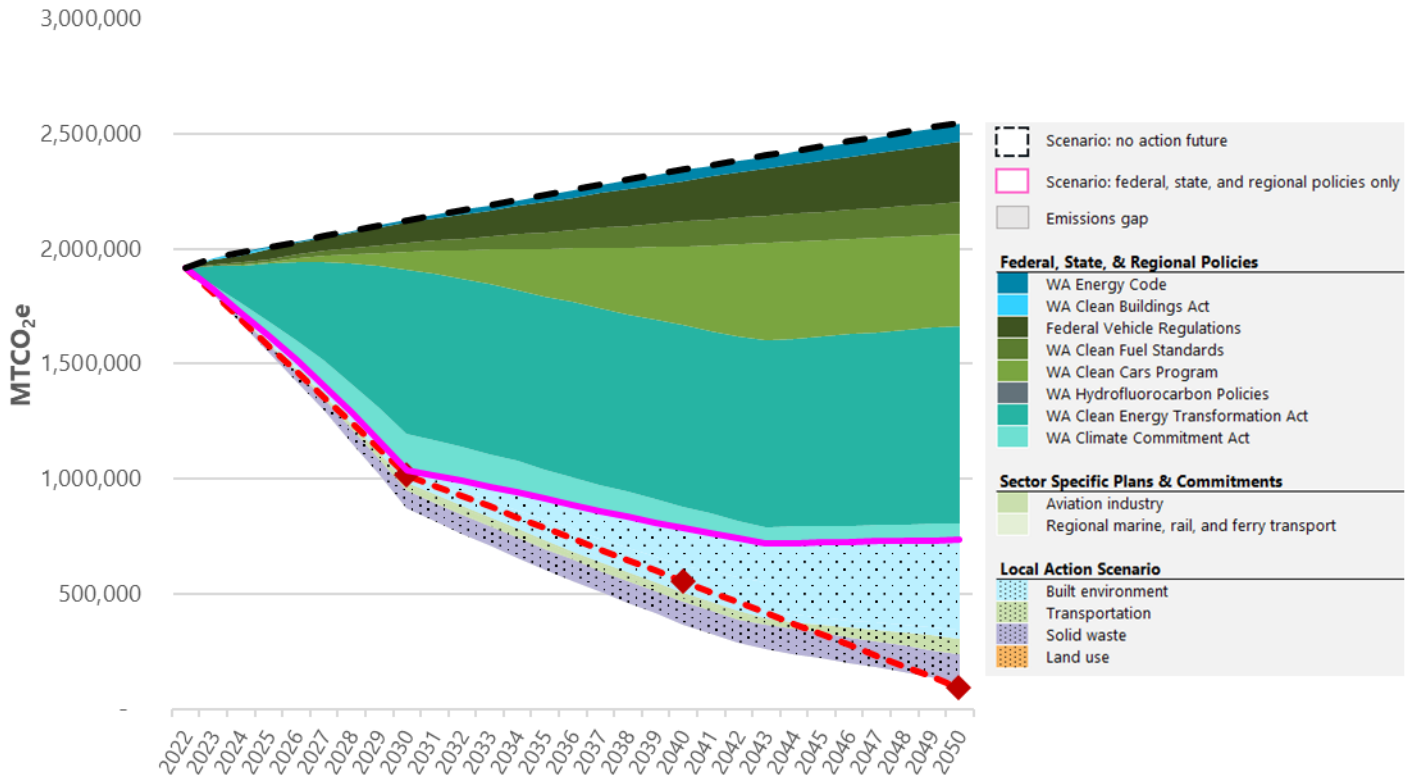
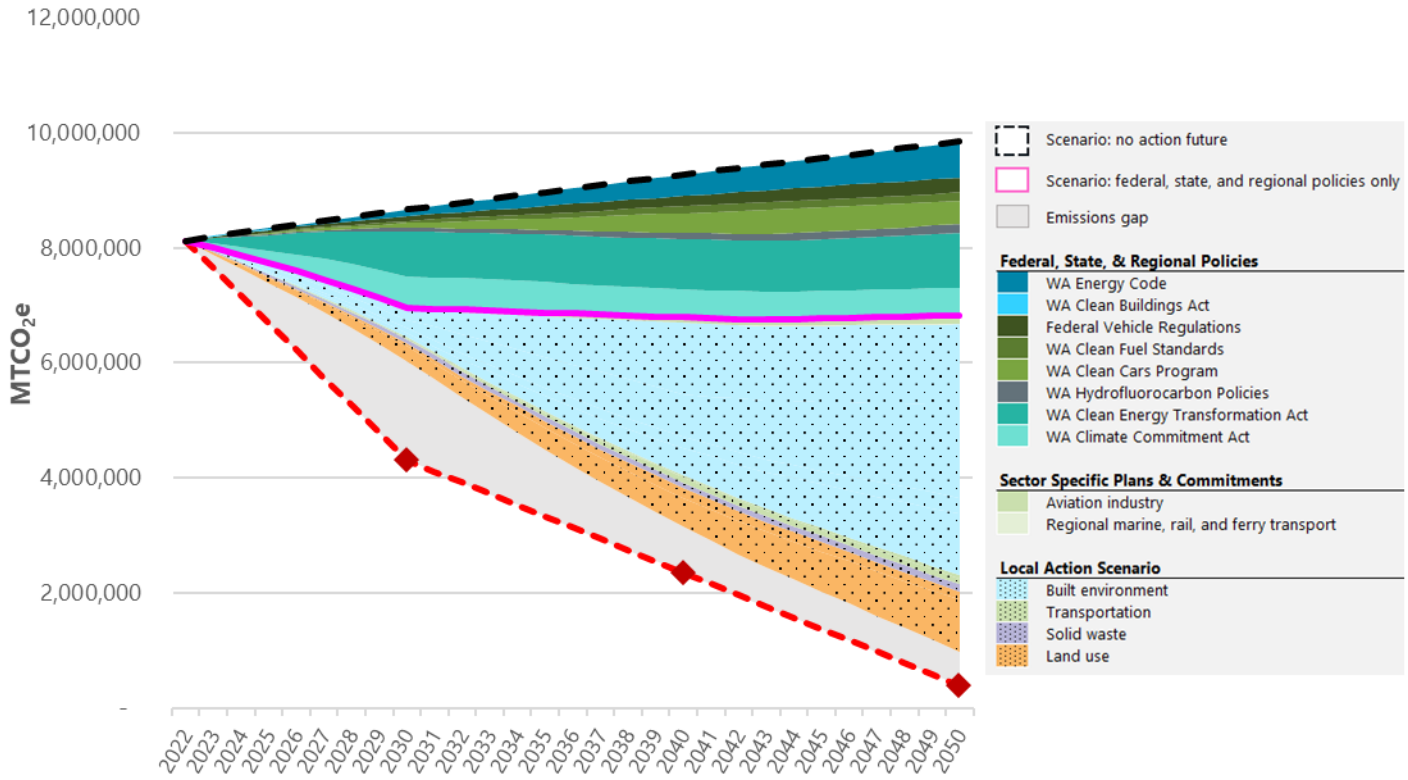


FIGURE 15. FORECASTED GHG EMISSIONS AND REDUCTIONS UNDER THREE SCENARIOS - ALL EMISSIONS.



The following sections provide a detailed summary of each scenario, including underlying assumptions and policy-specific findings.

Business-as-Usual Scenario

The BAU projects emissions based on a "no-action future" that assumes no federal, state, regional, or local policies or actions influence future emissions. Future emissions under the BAU are based on estimated population and economic growth. Population and economic growth estimates can be found in Table 5.

- Total Emission Forecast: The BAU projects a 26% growth in total emissions by 2050.
- Core Emission Forecast: The BAU projects a 38% growth in core emissions by 2050.

TABLE 5. DEMOGRAPHIC PROJECTIONS FOR WHATCOM COUNTY.

Demographic	2022	2030	2040	2050
Population	231,650	254,158	280,275	304,836
Employment	123,937	135,979	149,952	163,093

Adjusted-Business-as-Usual Scenario

The ABAU estimates emissions reductions resulting from established federal, state, and regional policies. Together, the implementation of identified policies results in an estimated 13% reduction in communitywide GHG emissions by 2050 compared to 1990 levels.

The ABAU scenario considered the following federal, state, and regional policies. Appendix B provides additional information regarding policy interpretation and assumptions.

- Washington State Energy Code (SB 5854)
- Washington Clean Buildings Act (HB 1257)
- Federal Vehicle Regulations (CAFE)
- WA Clean Fuel Standard (HB 1091)
- WA Clean Cars Program (SB 5974)
- WA Hydrofluorocarbon Policies (HB 1112 & HB 1050)
- WA Clean Energy Transformation Act (CETA)
- WA Climate Commitment Act (E2SSB 5126)

Note that to avoid double-counting, the analysis sequentially models each policy, so the order of modeling influences a policy's indicated GHG emission reductions.

Local Action Scenario

The local action scenario models additional emissions reductions from county-level local strategies, such as land use policies to encourage transportation mode shift and building energy efficiency. The intention of this scenario is to support identification and prioritization of local policies for inclusion in a GHG emission reduction sub-element. The local action scenario, which represents just one of many potential paths to achieving GHG emission reductions, provides a pathway toward achieving the state's GHG emission reduction target (95% reduction in GHG emissions by 2050 compared to a 1990 baseline). Note that several of these strategies may address emission sources that are expected to be reduced through existing federal, state, and regional legislation, which may make local strategies appear less impactful. Table 6 and Table 7 below summarize the local action scenario and associated reductions.

TABLE 6. LOCAL ACTION SCENARIO AND GHG EMISSION REDUCTIONS ($MTCO_2E$) - CORE EMISSIONS.

Local Strategy	2050 Value	Cumulative emissions reduction to 2050 ($MTCO_2e$)	Proportion of local strategy reductions (%)
Electrify new buildings (% fossil fuel use converted to elect.)	100%	541,224	6%
Reduce energy use in existing buildings (% reduction in energy use)	45%	2,795,718	31%
Electrify existing buildings (% fossil fuel use converted to elect.)	95%	2,364,223	26%
Reduce passenger vehicle travel (% reduction in per-capita VMT)	20%	177,372	2%
Electrify passenger vehicles (% new vehicles sold that are EV)	100%	286,830	3%
Electrify freight/service vehicles (% new vehicles sold that are EV)	80%	502,307	6%
Electrify transit vehicles (% new vehicles sold that are EV)	90%	59,319	<1%
Divert C&D materials (% of C&D waste diverted)	85%	2,372,979	26%
Divert other recyclable and compostable materials (% reduction in waste to landfill)	95%		
Total Emission Reductions		**9,099,972**	**100%**

TABLE 7. LOCAL ACTION SCENARIO AND GHG EMISSION REDUCTIONS ($MTCO_2E$) - ALL EMISSIONS.

Local Strategy	2050 Value	Cumulative emissions reduction to 2050 ($MTCO_2e$)	Proportion of local strategy reductions (%)
Electrify new buildings (% fossil fuel use converted to elect.)	100%	4,314,228	6%
Reduce energy use in existing buildings (% reduction in energy use)	45%	21,491,556	29%
Electrify existing buildings (% fossil fuel use converted to elect.)	95%	18,429,709	24%
Reduce industrial emissions (% reduction in emissions)	50%	10,979,037	15%
Reduce passenger vehicle travel (% reduction in VMT)	20%	177,345	<1%
Electrify passenger vehicles (% new vehicles sold that are EV)	100%	287,200	<1%
Electrify freight/service vehicles (% new vehicles sold that are EV)	80%	502,317	<1%
Electrify transit vehicles (% new vehicles sold that are EV)	90%	59,331	<1%
Decarbonize offroad equipment (% reduction in emissions)	95%	1,540,230	2%
Divert C&D materials (% of C&D waste diverted)	85%	2,372,979	3%
Divert other recyclable and compostable materials (% reduction in waste to landfill)	95%		
Improve soil management (% reduction in emissions)	75%	3,023,879	4%
Reduce tree loss (% reduction in tree loss)	90%	12,116,930	16%
Total Emission Reductions		**75,294,742**	**100%**

Remaining Emissions

In 2050, the largest sources of remaining emissions under the local action scenario are agriculture (38%), natural gas (16%), and aviation (13%). Under the "Core" forecast's local action scenario, the largest sources of remaining emissions in 2050 are on-road vehicles (66%), natural gas (19%), and wastewater process emissions (11%). The makeup of remaining emissions is depicted in Figure 16 and Figure 17 below.

FIGURE 16. FORECASTED GHG EMISSIONS AND REDUCTIONS UNDER THREE SCENARIOS ($MTCO_2E$) - CORE EMISSIONS.

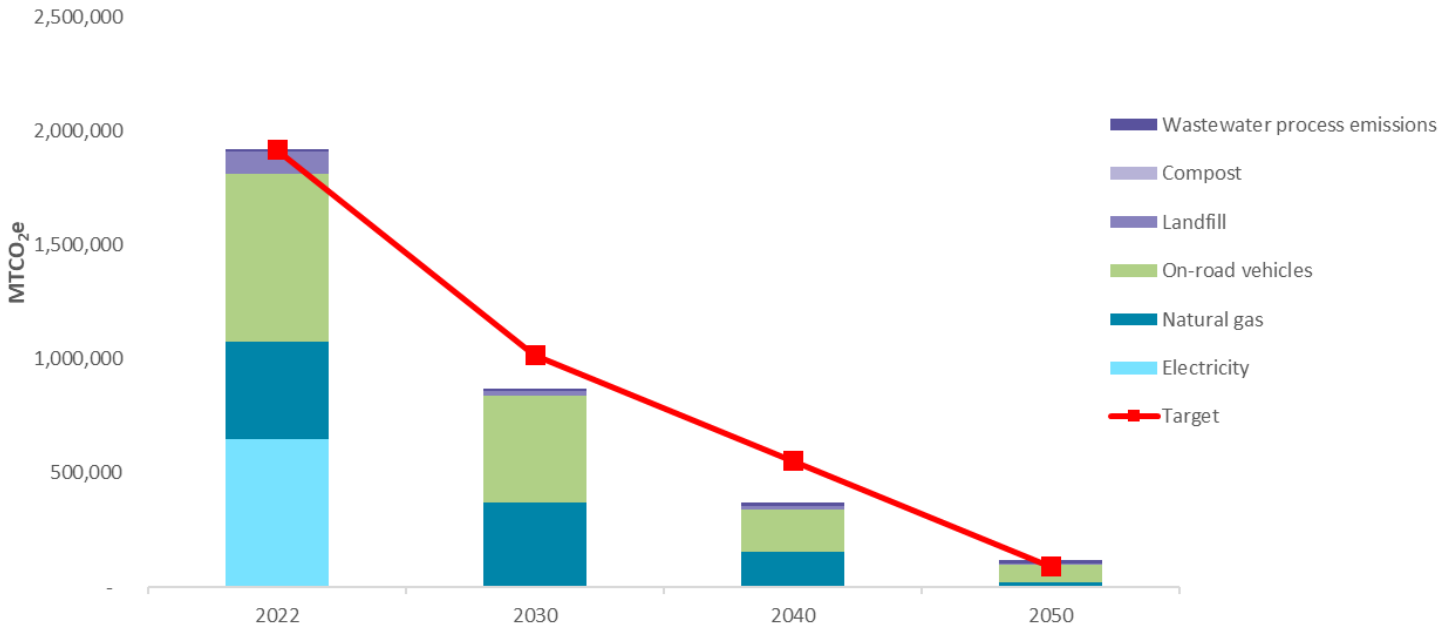
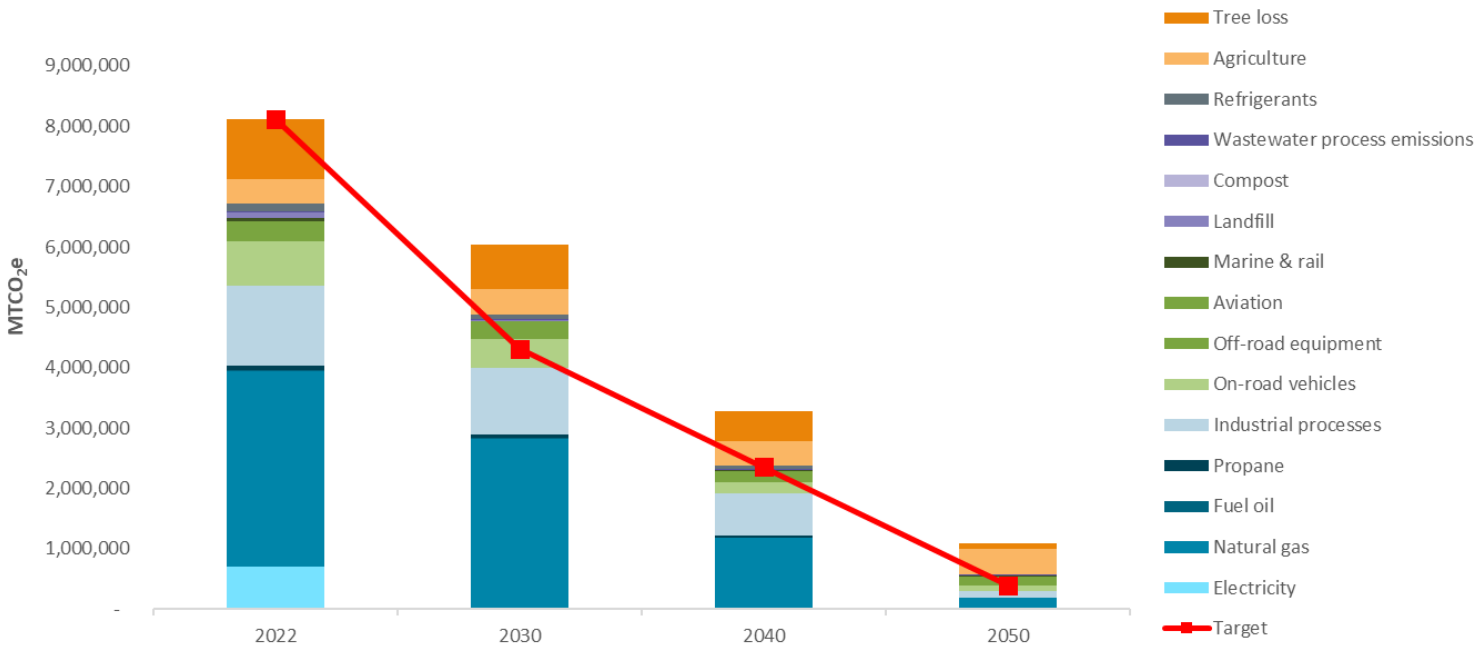


FIGURE 17. FORECASTED GHG EMISSIONS AND REDUCTIONS UNDER THREE SCENARIOS ($MTCO_2E$) - ALL EMISSIONS.



Local Policy Options

These analyses of current and projected future GHG emissions provide insight into local policy options for reducing GHG emissions in Whatcom County. As presented in the local action scenario, key GHG emission reduction strategies for focus in Whatcom County's comprehensive plan update include:

- Reduce energy consumption in new and existing residential and commercial buildings through: 1) supporting clean building energy sources and 2) energy efficient building design and retrofits. Local action to transition to renewable building energy sources would reduce Whatcom County's built environment emissions, which made up 66% of 2022 communitywide emissions.
- Reduce passenger vehicle travel within the county, including through changes to land use, transportation infrastructure (transit, walking, bicycling), and commuting options/modes. A reduction in passenger VMT would reduce Whatcom County's communitywide on-road emissions from passenger vehicles, which made up 6% of 2022 emissions.
- Facilitate the transition to electric vehicles through expansion of reliable EV charging infrastructure and public education on options and available incentives/rebates. Local action to support transitioning passenger and freight vehicles to electric would reduce Whatcom County's passenger and freight vehicle on-road emissions, which made up 9% of 2022 communitywide emissions.
- Limit tree loss and support low-carbon land practices such as sustainable forestry, agriculture, and livestock management. Reducing tree loss emissions and emissions from agricultural practices in Whatcom County would reduce land use emissions, which made up 17% of 2022 communitywide emissions.
- Work with local industries to support transition to low-carbon industrial processes, including for high-carbon industries such as petroleum refining and aluminum refining and production. These industrial process emissions made up 16% of Whatcom County's 2022 communitywide emissions.

Appendix A: GHG Inventory Methodology

Emissions Sectors

Communitywide

The communitywide GHG emissions inventory included the sectors depicted in Table 8 below. Some of the sectors are classified as "core" emissions sources; Table 8 identifies these core emissions sources and the rationale for their classification. Core emissions sources also align with the five basic emissions generating activities that are required for community inventories per the U.S. Community Protocol for Accounting and Reporting of GHG Emissions[10]. While agriculture, tree loss, and some other emissions sources are not included in the core emissions scenario, Commerce still strongly encourages local jurisdictions to consider comprehensive plan policies to address emissions from these sources. Such policies will support co-benefits such as clean air and water, improve resilience, and provide beneficial opportunities such as local food systems.

TABLE 8. COMMUNITYWIDE GHG EMISSIONS INVENTORY SECTORS.

Sector	Core?	Required?	Rationale
Built Environment			
Electricity	**Yes**	✓	Local governments can often influence electricity use in local buildings through local building codes, financial incentives, minimum regulatory requirements, technical assistance, and other programs.
Natural gas	**Yes**	✓	Local governments can often influence use of fuels in stationary combustion applications (e.g., furnaces) in local buildings through local building codes, financial incentives, minimum regulatory requirements, technical assistance, and other programs. *Note: Be advised that I-2066, approved by Washington voters in November 2024, prevents counties, cities, and towns from adopting policies that prohibit, penalize, or discourage natural gas heating in buildings and appliances and equipment within buildings. Check with your jurisdiction's legal counsel about impacts to your jurisdiction.*
Fuel oil & propane	No		Often a smaller emissions source; less confident in local specificity of the data (estimated using downscaled state-level data).
Industrial processes	No		Local governments have less direct control over large industrial sources; they are regulated at the state and federal level.
Transportation			
On-road vehicles	**Yes**	✓	Local governments can influence transportation emissions through land use and urban design regulations and through transportation infrastructure investments.
Off-road equipment	No		Often a smaller emissions source; local governments have less influence over off road equipment fuel usage.
Aviation	No		Local governments have less influence over aviation fuel mix and passenger air travel behavior.
Marine & rail	No		Often a smaller emissions source; local governments have less influence over marine/rail activity and fuels.
On-road vehicles	**Yes**	✓	Local governments can influence transportation emissions through land use and urban design regulations and through transportation infrastructure investments.
Solid Waste & Wastewater			
Solid waste generation & disposal	**Yes**	✓	Local governments can influence the amount of solid waste generated and sent to various disposal methods through their administration of municipal solid waste, recycling and composting services.
Compost generation & disposal	**Yes**		Local governments can influence the amount of solid waste generated and sent to various disposal methods through their administration of municipal solid waste, recycling and composting services.

[10] U.S. Community Protocol | ICLEI USA

Sector	Core?	Required?	Rationale
Wastewater treatment processes and septic systems	**Yes**		Local governments can influence community water use through local building codes, promoting and/or providing incentives to foster conservation and efficiency, and other programs and services.
Refrigerants			
Refrigerants	No		Often a smaller emissions source; less confident in local specificity of the data (estimated using downscaled national-level data).
Land Use			
Agriculture	No		Local governments have less influence over agricultural management practices; less confident in local specificity of the data (management practices are assumed based on national trends).
Tree loss and tree carbon sequestration	No		Local governments have less influence over management of forests and other natural resources owned by private entities and state and federal agencies; data represent an average over a 3+ year time period so may not reflect current trends.

County Operations

The county government operations GHG emissions inventory sought to include the sectors depicted in Table 9 below. These sectors represent Scope 1, 2, and 3 emissions sources, which are defined as follows:

- Scope 1: All direct GHG emissions sources
- Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.
- Scope 3: All other indirect emissions not covered in Scope 2.

Depending on data availability, not all sectors may have been included in Whatcom County's county operations GHG inventory. The Local Government Operations Protocol notes that local governments should, at a minimum, quantify and report all Scope 1 and 2 emissions, and reporting of Scope 3 emissions is optional.

TABLE 9. COUNTY OPERATIONS GHG EMISSIONS INVENTORY SECTORS.

Sector	Scope	Description
Built Environment		
Electricity	2	Amount of electricity (in kWh) consumed by County-owned buildings and facilities, including any County-owned utilities and streetlights/traffic signals, as well as the amount of electricity (in kWh) consumed by any green program enrollment.
Natural gas	2	Amount of natural gas (in therms) consumed by County-owned buildings and facilities.
Other fuels	1	Amount of propane and fuel oil (in gallons) consumed by County-owned buildings and facilities, including any City-owned utilities.
Power generation	1	Fuel type and amount consumed by County generators.
Transportation		
County vehicles & equipment	1	Vehicle fleet inventory includes on-road and off-road fleet and equipment.
Employee Commute	3	Employees commuting passenger miles travelled by transit type (e.g. car, bus, ferry).
Business Travel	3	Business travel miles by mode (e.g. passenger vehicle, train, or air travel).
Solid Waste & Wastewater		
Solid waste & Compost	1	Total solid waste generated by County operations during inventory year (in tons) by waste stream (e.g. landfill, recycling, compost). If tonnage is unavailable, please provide the number of bins per waste type, estimated fullness per bin, and pickup frequency.
County landfills	1	Landfill characteristics owned/operated by the County (ex. Waste in place, open year, close year, etc.).

Sector	Scope	Description
Wastewater treatment processes	2	Wastewater generation data from wastewater treatment plants.
Water conveyance	2	Amount of electricity (in kWh) consumed for water conveyance.
Refrigerants		
Stationary refrigerants	1	The total amount of refrigerants (in lbs.) used to fill or refill refrigeration equipment.
Mobile refrigerants	1	The total amount of refrigerants (in lbs.) used to fill or refill fleet air conditioning.

Methodology and Data Sources

Calculating Whatcom County's GHG emissions inventories involved identifying and applying emissions factors to activity data:

- Activity data quantify levels of activity that generate GHG emissions, such as vehicle miles traveled and kWh of electricity consumed.
- Emission factors (EFs) translate activity levels into emissions (e.g., $MTCO_2e$ per kWh).

The tables and sector sections below provide an overview of methodologies for each emissions sector in the communitywide and County government operations inventories. Any deviations or data limitations specific to Whatcom County are noted in the "Approach and Data Limitations" section on page 42.

TABLE 10. COMMUNITY GHG INVENTORY: KEY APPROACHES AND DATA SOURCES.

Sector	Activity Data	Emissions Factors (EFs)
Built Environment		
Electricity	County-wide consumption provided by utilities	1) Utility-specific emission factors (from Department of Ecology Clean Fuel Standard program utility-specific electricity calculations) 2) Emissions & Generation Resource Integrated Database (eGRID) EFs (for informational purposes only)
Natural gas	County-wide consumption provided by utilities	1) Utility-specific emission factors, where available 2) U.S. EPA EF Hub average EFs (where utility-specific EFs were not available)
Fuel oil	WA fuel oil consumption by sector from U.S. Energy Information Administration (EIA)	U.S. EPA EF Hub average EFs
Propane	WA propane consumption by sector from U.S. EIA	U.S. EPA EF Hub average EFs
Industrial processes	EPA Facility Level Information on Greenhouse Gases Tool (FLIGHT)	N/A - data reported in emissions
Transportation		
On-road vehicles	Two approaches[11]: 1) Vehicle miles traveled data from Washington State Department of Transportation (WSDOT) Highway Performance Monitoring System (HPMS) 2) Vehicle miles traveled estimates from StreetLight for home-based resident vehicle trips and work-based employee vehicle trips	U.S. Environmental Protection Agency (EPA) Emission Factors Hub[12] vehicle EFs (by vehicle & fuel type)
Off-road equipment	EPA Motor Vehicle Emission Simulator (MOVES) model outputs, by county	N/A (data reported in emissions)

[11] See more information regarding these two approaches in the "Transportation" section below.
[12] EPA Emission Factors Hub

Sector	Activity Data	Emissions Factors (EFs)
Public transit	Reported transit vehicle miles traveled by fuel type for each transit agency from the National Transit Database (NTD)	U.S. EPA Emission Factors Hub vehicle EFs (by vehicle & fuel type)
Aviation	Two approaches, depending on data availability: 1) Volume of fuel (jet-A and aviation gasoline) loaded onto all planes departing from airports within county; volume of all fuel used in helicopters, light aircraft operating within county boundaries (e.g., police, sightseeing, training) 2) Number of landing and takeoff cycles that could be used to estimate fuel based on similar airports Emissions from Seattle-Tacoma International Airport (SEA) and Portland International Airport (PDX) were attributed to individual counties using Approach 1 (described above), in combination with passenger survey data, population, and household income data from the U.S. Census.	U.S. EPA EF Hub average emission factors, by fuel type
Marine	US EPA National Emissions Inventory (NEI) estimates by county (for commercial marine vessels)	N/A (data reported in emissions)
Rail	U.S. EPA National Emissions Inventory (NEI) by county (for freight and passenger rail use)	N/A (data reported in emissions)
Solid Waste & Wastewater		
Solid waste generation & disposal	County-wide tonnage and local waste characterization data, as available. Where local waste characterization data were unavailable, Department of Ecology regional characterizations were used.	EPA Waste Reduction Model (WARM) EFs, customized for landfill attributes
Compost generation & disposal	County-wide tonnage and WA state organics characterization study	EPA WARM EFs
Wastewater treatment processes	Wastewater treatment data by wastewater treatment facilities (including gallons processed)	U.S. Community Protocol default EFs, customized for wastewater treatment facility process specifications (unless a treatment facility provided customized emission calculations)
Septic systems	Number of reported septic systems	U.S. Community Protocol default EFs
Refrigerants		
Refrigerants	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022	N/A - reported in terms of emissions
Land Use		
Agriculture	County-specific acres of cropland and number of livestock (from U.S. Department of Agriculture Census of Agriculture)	U.S. Community Protocol defaults by animal / management scenario
Tree cover	ICLEI Land Emissions and Removals Calculator - reported in terms of emissions	

TABLE 11. COUNTY GOVERNMENT OPERATIONS GHG INVENTORY: KEY APPROACHES AND DATA SOURCES.

Sector	Activity Data	Emissions Factors (EFs)
Built Environment		
Electricity	Consumption by County facilities	Utility-specific emission factors (from Department of Ecology Clean Fuel Standard program utility-specific electricity calculations)
Natural gas	Consumption by County facilities	Utility-specific emission factors
Other fuels	Consumption by County facilities	U.S. EPA EF Hub average EFs
Power generation	Consumption by County facilities	U.S. EPA EF Hub average EFs
Transportation		
County fleet vehicles & equipment	Fuel consumption data for County vehicles and equipment	US Environmental Protection Agency (EPA) Emission Factor Hub vehicle EFs (by vehicle & fuel type)
Employee commute	Total employees commuting passenger miles travelled	N/A
Business travel	Total employee business travel miles travelled	N/A
Solid Waste & Wastewater		
Solid waste & compost	Estimated tonnage based on waste hauler invoices (container size and pickup frequency) Assumed waste characterization consistent with community commercial sector	EPA Waste Reduction Model (WARM) EFs, customized for landfill attributes
County landfills	Tons of waste in place	Reported emissions from EPA FLIGHT dataset
Wastewater treatment	Wastewater treatment data by wastewater treatment facilities (including gallons processed)	U.S. Community Protocol default EFs, customized for wastewater treatment facility process specifications (unless a treatment facility provided customized emission calculations)
Water conveyance	Energy consumption by County facilities	Utility-specific emission factors
Refrigerants		
Stationary refrigerants	County-reported refrigerant use	IPCC Sixth Assessment Report (AR6) Global Warming Potentials (GWP)
Mobile refrigerants	County-reported refrigerant use	IPCC Sixth Assessment Report (AR6) Global Warming Potentials (GWP)

Communitywide

Building Energy

Electricity

Emissions from electricity consumption were determined using the amount of electricity consumed in 2022 within each county, multiplied by utility- and year-specific emission factors. Residential, commercial, and industrial electricity consumption data were procured directly from the utilities that provide service to each county. Emissions from electricity transmission and distribution (T&D) were included in the utility-specific emission factors used for these inventories, provided by the WA Department of Ecology.

Natural Gas

Emissions from natural gas consumption were determined by multiplying the natural gas consumed in 2022 within each county by utility- and year-specific emission factors (as available). Residential, commercial, and industrial natural gas consumption data were procured directly from the utilities that provide service to each county. Emissions from natural gas leakage were calculated using utility-specific leakage rates if available, or

using a default leakage rate from the Environmental Defense Fund's "User Guide for Natural Gas Leakage Rate Modeling Tool"[13]. Other default values necessary to calculate fugitive emissions from natural gas were provided by ClearPath, ICLEI's greenhouse gas inventory software platform.

Propane & Fuel Oil
Residential propane and fuel oil emissions were calculated using 2021 U.S. EIA residential and commercial propane and fuel oil consumption data for the state of Washington. Data for 2022 were not available at the time of this analysis, so 2021 data were scaled to 2022 using trends in fuel consumption over the past several years. Statewide total residential fuel sales were allocated to counties using U.S. Census American Community Survey (ACS) home heating fuel data. Commercial propane and fuel oil emissions were calculated using WA commercial fuel consumption estimates downscaled by the number of commercial employees within each county as compared to total state employment. Employment data were collected from the WA Employment Security Department, which provides data on the number of employees across industries. Propane and fuel oil emissions were both calculated using U.S. EPA emissions factors. Industrial propane and fuel oil were not calculated due to potential overlap with the industrial process emissions sector (see below).

Industrial Processes
Emissions from industrial processes in 2022 were obtained from EPA's Facility Level Information on Greenhouse Gases Tool (FLIGHT). Data was available for download by county for large facilities (>25,000 $MTCO_2e$) required to report annual data about GHG emissions to EPA as part of the Greenhouse Gas Reporting Program. To avoid double counting with other inventory sectors such as solid waste and buildings, EPA FLIGHT data from landfill facilities and facility energy consumption (e.g., natural gas) were excluded.

Transportation

On-Road
Three methodologies were used to estimate vehicle-miles-traveled (VMT), but only the first VMT approach was used to calculate on-road emissions:

- Vehicle miles traveled estimates from the county's regional travel demand model
- Vehicle miles traveled data from Washington State Department of Transportation (WSDOT) Highway Performance Monitoring System (HPMS)
- Vehicle miles traveled estimates from StreetLight for home-based resident vehicle trips and work-based employee vehicle trips

On-road GHG emissions were estimated using 2022 VMT activity data from WSDOT's Highway Performance Monitoring System (HPMS), which provides estimated annual VMT for all public roadways in each county. VMT for each county was split into light, medium, and heavy-duty VMT based on WSDOT HPMS statewide freight percentages. For medium- and heavy-duty freight emissions, VMT was multiplied by fuel- and vehicle-specific emissions factors from the 2022 EPA Emission Factors Hub. For light-duty vehicles, 2022 vehicle registration data from each county was used to estimate VMT by fuel type, which was then multiplied by fuel-specific emissions factors from the EPA Emission Factors Hub. The vehicle registration data was also used to create a weighted emissions factor for light-duty gasoline vehicles, based on the split between passenger vehicles and light trucks in each county.

[13] U.S. Natural Gas Leakage Model User Guide | EDF

Using the regional travel demand model for VMT estimates is an effective approach for estimating on-road emissions because it provides an estimate of vehicle activity within a jurisdiction's boundaries, aligning with the geographic-based approach used in GHG emissions inventories for other sectors. Compared to HPMS estimates, the travel model can be better calibrated to local conditions, incorporating jurisdiction-specific roadway characteristics, land use patterns, and travel behavior. Also, many jurisdictions have relied on travel model VMT data in past inventories, offering methodological consistency over time.

Using HPMS data is an alternative for obtaining VMT activity data for jurisdictions that do not have a travel demand model calibrated to current conditions. HPMS estimates VMT using traffic counts on public roadways. These counts are expanded using statistical sampling and road segment characteristics (e.g., functional class, urban/rural designation) to estimate total VMT across all public roads within each county. While HPMS data offers a consistent, annually reported dataset and is useful for producing jurisdiction-level VMT estimates, it has less explanatory power compared to travel demand models, which incorporate land use, network connectivity, and regional behavior patterns.

Both the travel demand model and HPMS data focus on VMT occurring within and passing through the area, rather than the VMT generated by the area itself (even if that VMT passes outside of the area boundary). While travel demand models can estimate VMT generated by an area, it is a more complex calculation than the geographic boundary-based approach. Understanding VMT generated by the area offers valuable context for developing targeted reduction strategies, as it reflects the driving activity of residents and workers within the jurisdiction while excluding pass-through traffic on interstates and major roadways. Many local VMT reduction strategies, such as providing transit passes, aim to influence the travel behavior of residents and workers, making person-level VMT data particularly useful for policy development. While geographic-boundary based approaches for VMT provide a consistent and reliable estimate of VMT and associated GHG emissions, person-level VMT data can complement this by offering deeper insights to support effective VMT reduction goals.

To supplement the VMT data, estimates for home-based VMT per resident and home-based work VMT per employee were provided by StreetLight Data for each county. The methodology involves several steps using Location-Based Services (LBS) data to create a detailed and accurate metric. First, StreetLight data analyzes all vehicle trips that either start or end within the selected geography. These trips are then assigned to residents or employees based on inferred home and work locations. The trips are further classified by purpose, such as home-to-work or home-to-other trips. Average trip lengths are then calculated for each category. The VMT estimates are obtained by multiplying the average trip length by the vehicle volumes for each trip category, and these estimates are normalized for residents and employees. More information regarding this methodology can be found in Appendix E.

Off-Road

Off-road emissions were acquired from EPA's Motor Vehicle Emissions Simulator (MOVES) model version 4.0. Using county-level defaults, the MOVES nonroad module was used to output 2022 daily emissions for all available off-road sectors, including agriculture, airport support, commercial, construction, industrial, lawn and garden, logging, oil field, pleasure craft, railroad, recreational, and underground mining. The equipment included in these sectors included self-propelled vehicles, such as construction equipment, as well as handheld equipment like chainsaws. MOVES output was provided for by weekday and weekend day for each month. The results were multiplied by the appropriate number of weekdays and weekend days in 2022 to determine annual emissions. The model produces CH_4 and CO_2 emissions per sector for gasoline, LPG, CNG, and diesel.

Public Transit
Transit emissions were based on annual fuel use and vehicle-miles-traveled data for each transit agency, obtained from the National Transit Database report for 2022. Annual fuel use was multiplied by standard fuel- and vehicle-specific emissions factors from the EPA Emission Factors Hub.

Aviation
Aviation emissions were based on the fuel used by aircraft at each airport. Gallons of jet fuel and aviation gasoline were multiplied by standard fuel-specific emission factors from the EPA Emission Factors Hub. Emissions from regional and municipal airports were assigned to the county in which the airport is located.

King, Kitsap, Pierce, Thurston, Skagit, Snohomish, and Whatcom County:

Emissions from Seattle-Tacoma International Airport (SEA) were allocated to the surrounding counties to acknowledge that many travelers are residents of locations other than King County, where the airport is located. To attribute fuel consumption to the Puget Sound counties, total jet fuel used in 2022 was multiplied by the percentage of passengers whose journey began or ended at SEA—rather than connecting through SEA—based on passenger survey data provided by the airport. Using passenger survey data that identified the percentage of passengers who were from King County, a portion of this fuel was attributed to King County. To ensure consistency with the Puget Sound Regional Emissions Analysis (PSREA) 2019 inventory approach, the remaining fuel allocated to the Puget Sound region was then attributed to Kitsap, Pierce, Thurston, and Snohomish counties based on an income-weighted per-capita fuel consumption average. This income-weighted per-capita consumption metric was then used to estimate commercial aviation-related GHG emissions for Skagit and Whatcom counties. All fuel consumption estimates were then multiplied by fuel-specific emission factors to estimate GHG emissions.

Marine
Emissions from marine sources were estimated for commercial marine vessels. Pleasure craft were reported as off-road vehicles/equipment. Emissions from commercial marine vessels were obtained from EPA's National Emissions Inventory (NEI) 2020 NEI Data Retrieval Tool, by county. In the absence of 2022 data or scaling factors related to commercial activity, it was assumed that 2022 emissions were equivalent to 2020 emissions.

NEI commercial marine data includes emissions from the Washington State Ferry (WSF) system. WSF has begun implementation of its System Electrification Plan, which is projected to decrease fleetwide GHG emissions by 75% by 2040. To understand the contribution of ferry vessel emissions to the total commercial marine vessel sector, emissions from WSF vessels were determined by scaling the emissions reported in the 2016 Puget Sound Maritime Emissions Inventory by fuel use in 2016 and 2022 (these calculations were performed for informational purposes only).

Rail
Emissions from freight and passenger rail were obtained from EPA's National Emissions Inventory 2020 NEI Data Retrieval Tool, by county. In the absence of 2022 data or scaling factors related to commercial activity, it was assumed that 2022 emissions were equivalent to 2020 emissions.

Solid Waste and Wastewater

Solid Waste Generation and Disposal
Emissions from the generation and disposal of landfilled solid waste were estimated by multiplying the tons of waste generated in 2022 by material-specific emissions factors derived from the U.S. EPA WARM v16 model. If

locally specific solid waste tonnage data were not attainable, WA Department of Ecology "Solid Waste Disposal Annual Summary, Recoverable and Non-Recoverable Wastes generated in Washington State, 1994-2021" tonnage data were scaled by population to estimate county-level waste generation. Waste and compost generation data were obtained from local waste haulers that serve each county, as available. Waste composition data, when available, were obtained directly from county staff. If recent waste characterization studies were unavailable, regional data from the WA Statewide 2020 Waste Characterization Study were used. These characterization data were translated into U.S. EPA WARM categories to estimate emissions by material type, and EFs were applied to estimate methane emissions based on the landfill's unique characteristics and methane capture scenario. Emissions from transportation of waste to landfills were estimated using estimated travel distance (from Google Maps) and default EFs from the U.S. Community Protocol.

Wastewater Treatment Processes
Emissions from the treatment of wastewater produced by each county were estimated based on reported 2022 data from wastewater treatment plants. Emissions were estimated based on the type of treatment processes at a given plant—such as the use of anaerobic digestion or the use of nitrification/denitrification—as well as the population served. Based on the data reported by each facility, emissions were calculated using U.S. Community Protocol default equations. Where facilities were unable to directly provide the necessary data to estimate process emissions, the treatment plant service area was used to estimate population served and emissions were estimated using data from U.S. EPA compliance reports for that wastewater treatment facility.

Septic Systems
To determine emissions from septic systems, the estimated population served by septic systems was estimated using the 1) number of septic systems within each county and 2) average population per household in that county as of 2022 (as reported by the U.S. Census). Emissions were then estimated using default equations from the U.S. Community Protocol.

Refrigerants

Emissions from refrigerant use were obtained from U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2022. Total refrigerant emissions were downscaled to each county based on the U.S.-to-county population ratio.

Land Use

Agriculture
Agricultural emissions were calculated following the U.S. Community Protocol methodology. Agricultural emissions stem from livestock enteric fermentation, manure management, and soil. For these calculations, the U.S. EPA Inventory Annexes provided values for the following: livestock enteric fermentation emissions factors, distribution of waste management systems, typical animal mass, daily and annual volatile solid production rates, maximum CH_4 producing capacity per pound of manure, methane conversion factors based on manure management system, daily excreted nitrogen rates, nitrous oxide emissions factors, nitrogen lost through volatilization, and nitrogen lost through runoff and leaching. The U.S. Community Protocol Appendix G provided values for volatilization and runoff/leaching emissions factors. Data on the number of animals in each county was sourced from the USDA 2022 Census of Agriculture. The U.S. EPA Inventory and Inventory Annexes provided nationwide values for direct and indirect N_2O emissions from soils, and the total U.S. cropland acreage was provided by the 2022 USDA Census of Agriculture. This national data was used to create an emissions factor for soil, which was applied to the acres of cropland in each county.

Tree Loss & Carbon Sequestration
ICLEI's Land Emissions and Removals Navigator (LEARN) tool was used to estimate GHG emissions from tree cover loss and carbon sequestration from tree cover gain and maintenance within county boundaries. The LEARN tool uses the National Land Cover Database (NLCD), produced by the United States Geological Survey (USGS) as the land cover database for this analysis. The LEARN tool requires a minimum of a 3-year analysis timeframe, which was divided by three to determine an average annual value. At the time of this analysis, the tool was available through 2019; therefore, a 2016-2019 timeframe was analyzed. Default factors used to calculate emissions for the "Trees Outside Forests" category are based on data for Seattle, Washington (the tool allows for customization to major metropolitan areas; the only available Washington option is for Seattle). More information regarding this methodology can be found in Appendix D: Tree Canopy GHG Emissions & Sequestration Summary Report.

County Government Operations

Built Environment

Facility Electricity
Emissions from electricity consumption were determined by multiplying the amount of electricity consumed in 2022 within each county-owned and/or -managed facility by utility- and year-specific emission factors. Emissions from electricity transmission and distribution (T&D) were included in the utility-specific emission factors used for these inventories, provided by the WA Department of Ecology.

Facility Natural Gas
Emissions from natural gas consumption were determined by multiplying the natural gas consumed in 2022 within each county-owned and/or -managed facility by utility- and year-specific emission factors. Emissions from natural gas leakage were calculated using utility-specific leakage rates if available or using a default leakage rate from the Environmental Defense Fund's *User Guide for Natural Gas Leakage Rate Modeling Tool*.[14] Other default values necessary to calculate fugitive emissions from natural gas were provided by ClearPath, ICLEI's greenhouse gas inventory software platform.

Other Facility Energy Sources
Emissions from other facility fuel sources, including propane, fuel oil, and diesel, were calculated by multiplying the amount of fuel consumed within each county-owned and/or managed facility by default U.S. EPA emissions factors.

Transportation

On-Road Fleet Vehicles
GHG emissions from on-road county fleet vehicles were estimated by multiplying either fleet vehicle 1) fuel consumption or 2) miles traveled by fuel- and vehicle-specific emissions factors from the 2022 EPA Emission Factors Hub. Vehicle miles traveled data were translated to fuel consumption using average miles per gallon (mpg) estimates from the U.S. Department of Transportation Federal Highway Administration's (FHWA) "Annual Vehicle Distance Traveled in Miles and Related Data - 2022" dataset.

[14] U.S. Natural Gas Leakage Model User Guide | EDF

Off-Road Fleet Vehicles
GHG emissions from off-road county fleet vehicles were estimated by multiplying off-road fleet vehicle fuel consumption by fuel-specific emissions factors from the 2022 EPA Emission Factors Hub.

Transit Fleet
GHG emissions from county-owned and/or operated transit fleet vehicles were estimated using emissions estimates from the transit agency.

Employee Commute
GHG emissions from county employee commuting were estimated using available commuting data, such as from employee surveys or Washington State Commute Trip Reduction program reporting.

Business Travel
GHG emissions from county employee business travel were estimated by multiplying standard emissions factors from the EPA Emissions Factors Hub by county-reported mileage data for ground and air travel.

Solid Waste and Wastewater

Solid Waste Generation and Disposal
Emissions from county government generation and disposal of landfilled solid waste were estimated by multiplying estimated total tons of waste generated in 2022 from county owned and/or managed facilities by material-specific emissions factors derived from the U.S. EPA WARM v16 model.

If local waste characterization studies were unavailable, regional data from the WA Statewide 2020 Waste Characterization Study were used. These characterization data were translated into U.S. EPA WARM categories to estimate emissions by material type, and emission factors were applied to estimate methane emissions based on the landfill's unique characteristics and methane capture scenario. Emissions from transportation of waste to landfills were estimated using estimated travel distance from county to landfill (Google Maps) and default emission factors from the U.S. Community Protocol.

Landfills
Emissions from county owned and/or operated landfills were estimated using EPA's Facility Level Information on Greenhouse Gases Tool (FLIGHT). Data was available for download by county for large facilities (>25,000 $MTCO_2e$) required to report annual data about GHG emissions to EPA as part of the Greenhouse Gas Reporting Program.

Wastewater Treatment Processes
Emissions county-owned and/or operated wastewater treatment facilities were estimated using reported emissions values from wastewater treatment facilities.

Water Conveyance
Emissions from county-owned and/or operated water conveyance systems (e.g., pump stations) were estimated using county- or utility-reported energy consumption (electricity, natural gas) and multiplying by respective emissions factors, consistent with the approach used for county facility energy consumption.

Refrigerants
Emissions from the leakage of both mobile and stationary refrigerants within county-owned and/or operated facilities and vehicles were estimated using county-provided data on refrigerant use and/or recharge. These use estimates were converted to greenhouse gas emissions estimates using standard global warming

potentials (GWPs) from The GHG Protocol, which are based on findings from the IPCC Sixth Assessment Report (AR6).[15]

[15] IPCC Global Warming Potential (GWP) values relative to CO2 | GHG Protocol

Approach and Data Limitations

While the GHG inventories sought to include the most accurate, locally-specific data available, in some cases data availability was limited and scaling or approximations were necessary. Notable limitations in the data and resulting approaches are summarized below.

Communitywide

Transportation

On-Road Vehicles

- Estimated VMT was split into light, medium, and heavy-duty VMT based on WSDOT HPMS statewide freight percentages. These allocations could deviate from county-level freight percentages.
- Estimated VMT was split into vehicle fuel types based on county-level vehicle registration data (internal combustion engine vs. electric) and state-level data (non-EV fuel type allocation for gasoline, diesel, CNG, and ethanol).

Off-Road Vehicles

- No notable limitations of approach or data sources.

Public Transit

- No notable limitations of approach or data sources.

Aviation

- Allocated emissions from Seattle-Tacoma International Airport by population using passenger survey data.
- Did not include emissions from Whatcom County resident use of Vancouver International Airport (YVR).

Marine

- County-level National Emissions Inventory (NEI) data were used for this analysis, which was last updated in 2020.

Rail

- County-level National Emissions Inventory (NEI) data were used for this analysis, which was last updated in 2020.

Building Energy

Electricity & Natural Gas

- No notable limitations of approach or data sources.

Propane & Fuel Oil

- At the time of the analysis, 2022 EIA data were unavailable; 2021 data were used as a proxy, forecasting to 2022 based on past trends. Downscaled state-level consumption data using US Census home heating information and WA employee counts.
- Industrial propane and fuel oil are not included due to limited ability to confidently scale state data to county level.

Industrial Processes

- Emissions from U.S. EPA FLIGHT reporting were used to avoid potential double counting, due to lack of data granularity within WA Department of Ecology reporting (Ecology data does not distinguish emissions by fuel type or application).

- Excluded landfill and stationary combustion emissions to minimize double counting with solid waste and building energy emissions estimates.

Solid Waste and Wastewater

Solid Waste Generation and Disposal

- Landfill: Local waste disposal data from haulers not available at the time of this analysis; landfilled waste tonnage was estimated using disposed solid waste by landfill data for Whatcom County from WA State Department of Ecology for 2021. These data are based on annual reports from all disposal facilities in Washington state. A local waste characterization study was not available; used WA Department of Ecology 2020 Statewide Waste Characterization Study, Northwest waste generation area estimates.
- Compost: Data were unavailable; emissions from compost were excluded from this analysis.

Wastewater Treatment Processes

- No data received from the following wastewater treatment facilities: Lummi Kwina, Sandy Point, Gooseberry Point, Newhalem, Lighthouse Point, and Lynden. Volume data for these facilities were estimated using publicly available data (e.g., US EPA Enforcement and Compliance History Online, or "ECHO").

Septic Systems

- No notable limitations of approach or data sources.

Refrigerants

- National-level refrigerant emissions data were scaled to the county-level based on population.

Land Use

Agriculture

- Emissions estimates are not sensitive to local management practices; assume per-unit (e.g., acre, animal) emissions based on national averages.

Tree Loss & Carbon Sequestration

- The most recent year of data available within the LEARN tool at the time of this analysis was 2019, so the tree cover analysis was performed using 2016-2019 to satisfy the tool's three-year analysis time period requirement. The National Land Cover Database (NLCD) used for the LEARN tool's analysis is updated approximately every 2-3 years. Additional information regarding emissions from tree cover loss and carbon sequestration is provided in Appendix D.
- Analysis includes all land use changes within county geographic boundary, regardless of ownership. In some cases, a large proportion of lands within county boundary could be federal- or state- owned or managed lands.

County Government Operations

Built Environment

Facility Electricity & Natural Gas

- No notable limitations of approach or data sources.

Other Facility Energy Sources

- Emissions from this sector are not included in the inventory, data was unavailable at the time of analysis.

Transportation

On-Road & Off-Road Fleet Vehicles

- No notable limitations of approach or data sources.

Transit Fleet

- No notable limitations of approach or data sources.

Employee Commute

- No notable limitations of approach or data sources.

Business Travel

- Emissions from this sector are not included in the inventory, data was unavailable at the time of analysis.

Solid Waste & Wastewater

Solid Waste Generation & Disposal

- Emissions from this sector are not included in the inventory, data was unavailable at the time of analysis.

Landfills

- No notable limitations of approach or data sources.

Wastewater Treatment Processes

- No notable limitations of approach or data sources.

Water Conveyance

- Emissions from this sector are not included in the inventory, data was unavailable at the time of analysis.

Refrigerants

- No notable limitations of approach or data sources.

Sensitivity to Local Conditions

Not all inventory values are based on locally derived data. Table 12 below summarizes some of the limitations and sensitivities of data used in the communitywide GHG emissions inventory. Generally, GHG estimations in the county government operations GHG inventory reflect locally derived data.

TABLE 12. SUMMARY OF DATA SENSITIVITY TO LOCAL CONDITIONS.

Sector	Values are sensitive to local conditions	Values are sensitive to local conditions, with some exceptions	Values are based on scaled regional/state data	Values are based on scaled national data
Built Environment				
Electricity	✓			
Natural gas	✓			
Fuel oil			✓	
Propane			✓	
Industrial processes	✓			
Transportation				
On-road		✓		
Off-road		✓		
Public transit		✓		
Aviation		✓		
Marine & rail		✓		
Solid Waste and Wastewater				
Solid waste generation & disposal		✓		
Wastewater treatment processes	✓			
Refrigerants				
Refrigerants				✓
Land Use				
Agriculture		✓		
Tree loss	✓			

Appendix B. Emissions Forecast & Scenario Analysis Methodology

Adjusted Business-As-Usual Assumptions

The adjusted business-as-usual (ABAU) scenario included consideration of the following federal, state, and regional policies:

- Washington State Energy Code (SB 5854)
- Washington Clean Buildings Act (HB 1257)
- Federal Vehicle Regulations (CAFE)
- WA Clean Fuel Standard (HB 1091)
- WA Clean Cars Program (SB 5974)
- WA Hydrofluorocarbon Policies (HB 1112 & HB 1050)
- WA Clean Energy Transformation Act (CETA)
- WA Climate Commitment Act (E2SSB 5126)

Additional information regarding policy interpretation and assumptions are provided below.

WA Energy Code (SB 5854)

Interpretation: SB 5854 requires residential and nonresidential construction permitted under the 2031 state energy code to achieve a 70% reduction in annual net energy consumption (compared to a 2006 baseline). State energy codes will be adopted from 2013-2031 to incrementally move towards achieving the 70% reduction by 2031.

Modeling Assumptions: New construction in 2031 and beyond will consume 70% less energy than the 2006 baseline. Scaled 2022 data to 2006 to use a 2006 baseline for this policy analysis. Assumed this baseline applies to all jurisdictions. Using 2022 energy consumption rates, modeled a straight-line reduction in energy consumption rate from 2022 to 2031 to achieve the 70% reduction from baseline (in new buildings only). Assume that any additional energy consumption under BAU compared to 2022 is from new buildings.
All new commercial buildings must use electric heat pumps for space heating and electric water heating for 50% of water (reflects updates to the 2021 WA State Energy Code).

- Assume commercial water heating accounts for 9% of building energy use; assume space heating accounts for 23% of building energy use (total = 32%; Source: EIA 2015).
- Assume 75% of current commercial buildings use fossil fuel space/water heating.

WA Clean Buildings Act (HB 1257)

Interpretation: Requires all new and existing commercial buildings over 50,000 square feet to reduce their energy use intensity by 15%, compared to the 2009–2018 average.

- Buildings greater than 220,000 square feet must comply by June 1, 2026
- Buildings greater than 90,000 square feet must comply by June 1, 2027
- Buildings greater than 50,000 square feet must comply by June 1, 2028

Modeling Assumptions: Using 2022 county level commercial energy consumption data, calculated energy consumed per sq ft of commercial building space to arrive at average energy use intensity (EUI: energy

consumed per sq ft). Scaled 2022 data to 2019 as a proxy for 2009-2018 baseline. Modeled a straight-line reduction in energy use intensity (up to 15%) for Bins 1–3 below for 2023 through respective compliance dates.

- Bin 1: >220K sq ft
- Bin 2: > 90K sq ft
- Bin 3: > 50K sq ft
- Bin 4: 50K sq ft and under (rule does not apply)

Federal Vehicle Regulations (CAFE)

Interpretation: Corporate Average Fuel Economy (CAFE) standards are regulated by the DOT and supported by the EPA, calculates average fuel economy levels for manufacturers and sets related GHG standards. Passenger cars and light trucks require an industry-wide fleet average of approximately 49 mpg for passenger cars and light trucks in model year 2026, increasing fuel efficiency 8% annually for model years 2024–2025 and 10% annually for model year 2026. This will also increase the estimated fleetwide average by nearly 10 miles per gallon for model year 2026, relative to model year 2021.

Modeling Assumptions: Based on PSRC Vision 2050 modeling, scaling 2022 data to 2018 for these assumptions, assumed the following changes in vehicle emissions intensity (g CO_2e/mile):

- Light duty vehicles: 33% reduction from 2018 to 2050.
- Heavy duty vehicles: 26% reduction from 2018 to 2050.

WA Clean Fuel Standard (HB 1091)

Interpretation: The Clean Fuel Standard requires a 20% reduction in the carbon intensity of transportation fuels by 2038, compared to a 2017 baseline level. Reductions in carbon intensity may be achieved through cleaner fuels or by purchasing clean fuel credits from cleaner producers such as those providing electricity as fuel. Boats, trains, aircraft, and military vehicles & equipment are excluded.

Modeling Assumptions: Model assumes the 2022 transportation fuel emissions factors are applicable for 2017–2023 (2017 is policy baseline year). Overall, policy calls for 20% reduction in carbon intensity of transportation fuels by 2038.

EV/fuel contributions: Since there are concerns with WA's short-term ability to scale up low carbon fuels, for 2030 the split of clean fuel/EV is closer to 35%/65%, compared to 50%/50% by 2038.

Therefore, compared to baseline, we modeled the following for fuel carbon intensities:

- 3.5% reduction in per-gallon gasoline & diesel vehicle (passenger, heavy duty, transit) emissions from cleaner fuels (NOT EVs) by 2030.
- 10% reduction in per-gallon gasoline & diesel vehicle (passenger, heavy duty, transit) emissions from cleaner fuels (NOT EVs) by 2040.
- Maintain 10% reduction levels to 2050.

Given ICE ban, compared to baseline, we will model the following for EV use:

- 6.5% transition of gasoline/diesel passenger vehicles to EV by 2030.
- 10% transition of gasoline/diesel passenger vehicles to EV by 2040.
- Maintain 10% reduction levels to 2050.

WA Clean Cars Program (SB 5974)

Interpretation: Establishes a target that, "all publicly owned and privately owned passenger and light duty vehicles of model year 2030 or later that are sold, purchased, or registered in Washington state be electric vehicles."

Modeling Assumptions: As part of Move Ahead Washington program, WA would ban sale of gasoline/diesel ICE passenger vehicles starting in 2030. For this policy, assuming a 15-year vehicle turnover rate, with the following proportion of new sales EV (a conservative estimate given that the ICE ban is currently a goal and lacks a clear accountability mechanism):

- 25% by 2026
- 65% by 2030
- 100% by 2035
- Maintained by 100% thereafter

WA Hydrofluorocarbon Policies (HB 1112 & HB 1050)

Interpretation: HB 1112 requires that new equipment be manufactured without HFCs or using refrigerants with a lower global warming potential (GWP) in a phased approach through 2024. Equipment covered by the law are being phased in each year, starting with 2020, and penalties apply for non-compliance. In 2021, HB 1050 applied Clean Air Act provisions for ozone depleting substances to HFCs and extended restrictions on higher GWP HFCs to new equipment such as ice rinks and stationary air conditioning.

Modeling Assumptions: Aligned model assumptions with state modeling, scaling 2022 data to 2019 to align with modeling.

WA Clean Energy Transformation Act (CETA)

Interpretation: CETA applies to all electric utilities serving retail customers in Washington and sets specific milestones: By 2025, utilities must eliminate coal-fired electricity from their state portfolios; by 2030, utilities must be greenhouse gas neutral, with flexibility to use limited amounts of electricity from natural gas if it is offset by other actions; by 2045, utilities must supply Washington customers with electricity that is 100% renewable or non-emitting, with no provision for offsets.

Modeling Assumptions: Electricity will be GHG neutral (electricity emissions factor equals zero) in 2030 and beyond with a straight-line emissions factor reduction from 2022 to 2030. For utilities that rely on coal for electricity generation, additionally model straight-line reduction to 0% coal by December 31, 2025. Assume coal is replaced by renewables. This action impacts electricity emissions factors (reduces emissions per unit of energy consumed).

WA Climate Commitment Act (E2SSB 5126)

Interpretation: The Climate Commitment Act (known as Cap and Invest) places an economy-wide cap on carbon to meet state GHG reduction targets and remain consistent with best available science, while minimizing the use of offsets to meet those targets. Every polluting facility covered under the program needs to hold one allowance for every ton of greenhouse gas that it emits. Based on an environmental justice review, 35–40% of investments must be made in overburdened communities to reduce health disparities and create environmental benefits, with an additional 10% allocated for tribal programs and projects.

Modeling Assumptions: State estimates that CCA will account for 26.2 million $MTCO_2e$ in statewide reductions by 2030. 2018 total emissions = 99.57 million $MTCO_2e$. Scaled 2022 data to 2018 to obtain a proxy baseline.

Key regulated CCA sectors relevant to the geographic inventory include:

- Natural gas (however, this sector will receive directly allocated no-cost allowances).
- Industrial processes (however, Emissions-Intensive Trade-Exposed facilities will receive directly allocated no-cost allowances).
- Transportation fuels (however, already covered to some extent by Clean Fuels Standard).

Therefore, assume the following for CCA:

- Assume CETA addresses emissions reductions in electricity sector.
- Apply -10% emissions factor adjustment to natural gas (assuming increase in hydrogen or RNG in fuel mix) to 2030.
- Apply -15% emissions reduction estimate (consider applying a reduction factor) to industrial process emissions to 2030.
- Apply -23.5% fuel emissions factor reduction estimate (consider applying a reduction factor) to transportation emissions to 2030 and -30% to 2040 (includes reductions from CFS).

Appendix C: GHG Emission Reduction Policies

This appendix contains examples of greenhouse gas emission reduction policies that could be included within Whatcom County's Climate Element. These draft policies are drawn from the Department of Commerce's Climate Menu of Measures.[16]

How to read these policies:

The list of model goals and policies (measures) below aligns with recommended GHG-reduction strategies from the Emissions Forecast and Scenario Analysis Tool. Local governments may choose to use these optional measures as written, adapt them to fit local context, or supplement them. Counties may not have direct control or influence to enact all example policies presented below; policies can be tailored to reflect a jurisdiction's available "levers" and/or appropriate role(s) in achieving a policy's intended outcomes. Please access details related to listed measures using the factsheet links. These factsheets provide information on the HB1181 requirements satisfied by the measures, as well as information about the measures' co-benefits, equity and justice potential, and related policies that can be used to inform policy development and evaluation for adoption.

Built Environment

Strategy: Electrify new buildings.

41% of Whatcom County's 2022 communitywide emissions

Goal: ***Ensure that buildings use renewable energy, conservation, and efficiency technologies and practices to reduce greenhouse gas emissions.*** Click to open factsheet

- Require additional net-zero greenhouse gas emission features of all new residential and commercial structures. Click to open factsheet
- Maximize renewable energy sources for the supply of electricity and heat to new and existing buildings. Click to open factsheet
- Require all publicly owned buildings to be powered completely by renewable energy by **[insert target date]**. Click to open factsheet
- Incentivize green building certification to improve energy and environmental performance. Click to open factsheet.

Goal: Maximize solar access of site design, where practicable, for new solar-ready residential and commercial buildings. Click to open factsheet.

- Direct solar development onto lands identified as having “least conflict” through the Least-Conflict Solar Siting process on the Columbia Plateau. Click to open factsheet.
- Require solar panels on buildings with large rooftops, as well as within or over parking areas. Click to open factsheet.

[16] Climate Menu of Measures

Goal: Ensure that the local economy is resilient to climate disruptions and fosters business opportunities associated with climate mitigation and adaptation. Click to open factsheet.

- Facilitate the development of community-owned, small-scale renewable energy generation projects. Click to open factsheet.

Strategy: Reduce energy use in existing buildings.

50% of Whatcom County's 2022 communitywide emissions

Goal: Foster higher-intensity land uses in mixed-use urban villages and transit corridors. Click to open factsheet.

- Adjust single-family home impact fees and system development charges so those homes with larger impacts on utilities pay more. Click to open factsheet.

Goal: ***Ensure that buildings use renewable energy, conservation, and efficiency technologies and practices to reduce greenhouse gas emissions.*** Click to open factsheet.

- Retrofit buildings for energy efficiency. Click to open factsheet.
- Incentivize green building certification to improve energy and environmental performance. Click to open factsheet.

Goal: Prioritize the adaptive reuse of buildings, recognizing the emission-reduction benefits of retaining existing buildings. Click to open factsheet.

- Prioritize the preservation and weatherization of housing in overburdened communities, particularly at higher densities, to reduce emissions and increase resilience. Click to open factsheet.

Strategy: Electrify existing buildings.

41% of Whatcom County's 2022 communitywide emissions

Goal: ***Ensure that buildings use renewable energy, conservation, and efficiency technologies and practices to reduce greenhouse gas emissions.*** Click to open factsheet.

- Maximize renewable energy sources for the supply of electricity and heat to new and existing buildings. Click to open factsheet.
- Develop local microgrid solar and battery storage facilities in low-impact sites. Click to open factsheet.
- Incentivize green building certification to improve energy and environmental performance. Click to open factsheet.
- Phase out natural gas use in existing publicly owned facilities by **[insert target date]** and retrofit with electric heat pumps. Click to open factsheet. *Note: Be advised that I-2066, approved by Washington voters in November 2024, prevents counties, cities, and towns from adopting this policy and other policies that prohibit, penalize or discourage natural gas heating in buildings and appliances and equipment within buildings. Check with your jurisdiction's legal counsel about impacts to your* jurisdiction.

Require all publicly owned buildings to be powered completely by renewable energy by **[insert target date]**. Click to open factsheet. *Note: Be advised that I-2066, approved by Washington voters in November 2024, prevents counties, cities, and towns from adopting this policy and other policies that prohibit, penalize or discourage natural gas heating in buildings and appliances and equipment within buildings. Check with your jurisdiction's legal counsel about impacts to your jurisdiction.*

Goal: Ensure that energy infrastructure — including generation and transmission — is able to accommodate renewable energy opportunities and to withstand and recover quickly from the impacts of extreme weather and other natural hazards worsened by climate change Click to open factsheet.

- Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations. Click to open factsheet.

Goal: Ensure that the local economy is resilient to climate disruptions and fosters business opportunities associated with climate mitigation and adaptation. Click to open factsheet.

- Facilitate the development of community-owned, small-scale renewable energy generation projects. Click to open factsheet.

Strategy: Increase local solar.

50% of Whatcom County's 2022 communitywide emissions

Goal: Ensure that buildings use renewable energy, conservation, and efficiency technologies and practices to reduce greenhouse gas emissions. Click to open factsheet.

- Maximize renewable energy sources for the supply of electricity and heat to new and existing buildings. Click to open factsheet.
- Develop local microgrid solar and battery storage facilities in low-impact sites. Click to open factsheet
- Require all publicly owned buildings to be powered completely by renewable energy by **[insert target date]**. Click to open factsheet.

Goal: Maximize solar access of site design, where practicable, for new solar-ready residential and commercial buildings. Click to open factsheet.

- Direct solar development onto lands identified as having "least conflict" through the Least-Conflict Solar Siting process on the Columbia Plateau. Click to open factsheet.
- Require solar panels on buildings with large rooftops, as well as within or over parking areas. Click to open factsheet.

Goal: Ensure that energy infrastructure — including generation and transmission — is able to accommodate renewable energy opportunities and to withstand and recover quickly from the impacts of extreme weather and other natural hazards worsened by climate change. Click to open factsheet.

- Install distributed renewable energy generation and battery infrastructure at public facilities to store renewable electricity generated on site and provide emergency power that ensures continuity of operations. Click to open factsheet.

Goal: Ensure that the local economy is resilient to climate disruptions and fosters business opportunities associated with climate mitigation and adaptation. Click to open factsheet.

- Facilitate the development of community-owned, small-scale renewable energy generation projects. Click to open factsheet.

Strategy: Reduce industrial emissions.

16% of Whatcom County's 2022 communitywide emissions

Goal: Establish land use patterns that increase the resilience of the built environment, ecosystems, and communities to climate change. Click to open factsheet.

- Prohibit the expansion of polluting industries in overburdened communities via local zoning and development regulations. Click to open factsheet.

Transportation & Other Mobile Sources

Strategy: Reduce passenger vehicle travel.

6% of Whatcom County's 2022 communitywide emissions

Goal: Convert public fleets to zero-emission vehicles by [insert target date] and develop supporting infrastructure and programs (e.g., charging stations and dedicated lanes for electric cars and buses). Click to open factsheet.

- Prioritize and promote public transit expansion and use through coordination of land use and transportation planning. Click to open factsheet.
- Implement multimodal transportation planning to reduce single-occupancy vehicle dependence and greenhouse gas emissions. Click to open factsheet.

Goal: Reduce vehicle miles traveled to achieve greenhouse gas reduction goals. Click to open factsheet.

- Implement travel demand management (TDM) programs and strategies. Click to open factsheet.
- Increase multimodal capacity in coordination with the location of higher-density housing and commercial centers. Click to open factsheet.
- Create a safe, well-connected, and attractive bicycle and pedestrian transportation network to encourage active transportation. Click to open factsheet.
- Prioritize, develop, and maintain mobility hubs in transportation-efficient locations — especially in overburdened communities experiencing a scarcity of transportation alternatives. Click to open factsheet.
- Provide vehicle licensing fee subsidies to low-income drivers who present proof of transit pass use over the previous year to encourage mode shift. Click to open factsheet.

- Integrate "Complete Streets" principles into the roadway designs of residential developments. Click to open factsheet.
- Facilitate the siting of complimentary destinations such as commercial-employment centers, schools or education centers, and residential developments. Click to open factsheet.
- Establish micromobility centers wherever plausible (e.g., hubs for shared bikes and scooters). Click to open factsheet.
- Address active transportation and other multimodal types of transportation options in concurrency programs – both in assessment and mitigation. Click to open factsheet.
- Prioritize permitting for transit-oriented development (TOD) proposals. Click to open factsheet.
- Improve transit speed, frequency, coverage, and reliability. Click to open factsheet.
- Establish a green belt of parks to support connectivity and non-motorized travel between houses, schools, and businesses across a community. Click to open factsheet.

Goal: Use demand-based methods to reflect the actual cost of existing parking. Click to open factsheet.

- Eliminate parking minimum requirements, and establish parking maximums. Click to open factsheet.
- Reduce parking requirements where there are multimodal options available. Click to open factsheet.

Goal: Foster higher-intensity land uses in mixed-use urban villages and transit corridors. Click to open factsheet.

- Ensure public transit stops and stations are located at or near (e.g., within 600 ft.) dense commercial and employment areas. Click to open factsheet.
- Limit parking spaces near transit-oriented development to encourage use of transit and decrease single-occupancy vehicle travel. Click to open factsheet.
- Prioritize infill development through zoning and permitting process. Click to open factsheet.
- Establish form-based codes where appropriate to better integrate higher-density development. Click to open factsheet.
- Increase residential densities near (within 600 feet) high-use transit stations and centers. Click to open factsheet.

Goal: Increase housing diversity and supply within urban growth areas to reduce greenhouse gas emissions and support environmental justice. Click to open factsheet.

- Increase or remove density limits in areas well-served by transit and other services within the urban growth area. Click to open factsheet.
- Allow middle housing types, such as duplexes, triplexes, and ADUs, on all residential lots. Click to open factsheet.
- Amend SEPA exemptions to allow residential infill development projects outright. Click to open factsheet.
- Establish minimum residential densities within urban growth areas. Click to open factsheet.
- Plan for and invest in capital facilities to accommodate infill development. Click to open factsheet.
- Allow or encourage micro-housing units. Click to open factsheet.
- Develop and implement inclusionary zoning to support greater income diversity in housing types. Click to open factsheet.

Goal: Establish land use patterns that increase the resilience of the built environment, ecosystems, and communities to climate change. Click to open factsheet.

- Implement complimentary, mixed land uses versus traditional zoning, such as locating business districts, parks and schools in neighborhoods to promote cycling and walking and reduce driving. Click to open factsheet.

Strategy: Electrify passenger vehicles.

6% of Whatcom County's 2022 communitywide emissions

Goal: Convert public fleets to zero-emission vehicles by [insert target date] and develop supporting infrastructure and programs (e.g., charging stations and dedicated lanes for electric cars and buses). Click to open factsheet.

- Provide low-income residents subsidies to purchase or lease electric vehicles and bicycles. Click to open factsheet.

Goal: Expand electric vehicle infrastructure. Click to open factsheet.

- Require electric vehicle charging infrastructure in all new and retrofitted buildings. Click to open factsheet.

Goal: Improve the efficiency of transportation system to reduce greenhouse gas emissions. Click to open factsheet.

- Develop dedicated electric-vehicle (EV) lanes on local roads and highways. Click to open factsheet.

Strategy: Electrify freight/service vehicles.

3% of Whatcom County's 2022 communitywide emissions

Goal: Expand electric vehicle infrastructure. Click to open factsheet.

- Require electric vehicle charging infrastructure in all new and retrofitted buildings. Click to open factsheet.

Goal: Improve the efficiency of transportation system to reduce greenhouse gas emissions. Click to open factsheet.

- Develop dedicated electric-vehicle (EV) lanes on local roads and highways. Click to open factsheet.

Strategy: Decarbonize off-road equipment.

1% of Whatcom County's 2022 communitywide emissions

Goal: Reduce GHG emissions in rural areas of the county. Click to open factsheet.

- Phase out the use of gas-powered landscaping equipment. Click to open factsheet.

Strategy: Divert construction and demolition (C&D) materials.

<1% of Whatcom County's 2022 communitywide emissions

Goal: Ensure that the community is able to reduce, reuse, and recycle waste materials sustainably. Click to open factsheet.

- Develop a program that will enable recycling of all construction and demolition debris by **[insert target date]**. Click to open factsheet.
- Recycle all paper, food, textile, and metal waste by **[insert target date]**. Click to open factsheet.
- Minimize carbon emission impacts of building demolition with best available recycling strategies. Click to open factsheet.
- Develop a local pollution surcharge for large producers of air pollutants, wastewater, and solid waste. Click to open factsheet.
- Require methane capture processes from wastewater treatment facilities. Click to open factsheet.

Goal: Develop targeted campaigns for recycling material with highest GHG reduction impact (e.g., paper, metal, food waste). Click to open factsheet.

- Incentivize recycling of construction and demolition debris. Click to open factsheet.
- Create and sustain a business technical assistance program to increase recycling and reduce waste. Click to open factsheet.
- Use recycled materials in the construction of transportation and other infrastructure facilities. Click to open factsheet.

Goal: Ensure that the local economy is resilient to climate disruptions and fosters business opportunities associated with climate mitigation and adaptation. Click to open factsheet.

- Promote local industrial development to support a circular economy that increases demand for reused and recycled materials and reduces demand for new raw materials and their embodied carbon emissions. Click to open factsheet.

Strategy: Divert other recyclable and compostable materials.

5% of Whatcom County's 2022 communitywide emissions

Goal: Develop targeted campaigns for recycling material with highest GHG reduction impact (e.g., paper, metal, food waste). Click to open factsheet.

- Create and sustain a business technical assistance program to increase recycling and reduce waste. Click to open factsheet.

Goal: Ensure that the local economy is resilient to climate disruptions and fosters business opportunities associated with climate mitigation and adaptation. Click to open factsheet.

- Promote local industrial development to support a circular economy that increases demand for reused and recycled materials and reduces demand for new raw materials and their embodied carbon emissions. Click to open factsheet.

Goal: Ensure that the community is able to reduce, reuse, and recycle waste materials sustainably. Click to open factsheet.

- Develop a program that will enable recycling of all construction and demolition debris by **[insert target date]**. Click to open factsheet.
- Increase staff and facility capacity for composting programs to divert **[insert percentage]** of community organic waste from entering landfills. Click to open factsheet.
- Reduce municipal solid waste disposed of in landfills by **[insert percentage]** by **[insert target date]**. Click to open factsheet.
- Recycle all paper, food, textile, and metal waste by **[insert target date]**. Click to open factsheet.
- Develop a local pollution surcharge for large producers of air pollutants, wastewater, and solid waste. Click to open factsheet.

Land Use

Strategy: Improve soil management.

2% of Whatcom County's 2022 communitywide emissions

Goal: Support long-term local and regional agriculture that sequesters carbon. Click to open factsheet.

- Facilitate and enable regenerative agriculture and regenerative ocean farming where practicable. Click to open factsheet.
- Designate a percentage of agricultural land that shall be maintained and managed for sequestering carbon and curtailing vehicle miles traveled. Click to open factsheet.

Goal: Reduce GHG emissions in rural areas of the county. Click to open factsheet.

- Require methane collection on dairy farms and other agricultural operations that utilize waste ponds. Click to open factsheet.
- Promote the sale and use of agricultural supplies, pesticides, fertilizers, and fuels that are not derived from fossil fuels. Click to open factsheet.

Strategy: Reduce tree loss.

12% of Whatcom County's 2022 communitywide emissions

Goal: Increase tree canopy cover to boost carbon sequestration, reduce heat islands, and improve air quality, prioritizing overburdened communities. Click to open factsheet.

- Improve and expand urban forest management to maximize or conserve carbon storage. Click to open factsheet.
- Maximize tree canopy coverage in surface parking lots. Click to open factsheet.

- Maintain small forestland ownership and publicly owned forest properties with carbon sequestration as the goal. Click to open factsheet.

Strategy: Protect land carbon sinks (including agricultural lands, wetlands, and grasslands).

2022 annual sequestration amount was equivalent to 54% of Whatcom County's 2022 communitywide emissions.

Goal: Support long-term local and regional agriculture that sequesters carbon. Click to open factsheet.

- Maximize conservation and carbon sequestration through alignment of Conservation Futures, Transfer of Development Rights (TDR), and Open Space Program strategies with the Climate Commitment Act. Click to open factsheet.

Goal: Increase tree canopy cover to boost carbon sequestration, reduce heat islands, and improve air quality, prioritizing overburdened communities. Click to open factsheet.

- Improve and expand urban forest management to maximize or conserve carbon storage. Click to open factsheet.
- Maximize tree canopy coverage in surface parking lots. Click to open factsheet.
- Maintain and manage natural lands (forests, grasslands, wetlands) to maintain or increase their carbon concentrations and avoid conversion of carbon-rich ecosystems. Click to open factsheet.
- Maintain small forestland ownership and publicly owned forest properties with carbon sequestration as the goal. Click to open factsheet.

Goal: Protect and restore coastal ecosystems to increase the resilience of species, habitats, and communities to climate change. Click to open factsheet.

- Identify, protect, and restore submerged aquatic vegetation (eelgrass, kelp, etc.) that provides aquatic habitat, "blue" carbon storage, and other ecosystem services. Click to open factsheet.

Goal: Preserve land for long-term agricultural use, recreation, open spaces, and other uses consistent with rural character. Click to open factsheet.

- Preserve land outside of the unincorporated UGA for long-term agricultural use, recreation, open spaces, forestry, mineral resources, and other uses consistent with rural character. Click to open factsheet.
- Require open space set-asides (such as parks) for new development. Click to open factsheet.

Appendix D: Tree Canopy GHG Emissions & Sequestration Summary Report

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Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019
Whatcom County, Washington

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Whatcom County, Washington has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2016 to 2019, emissions from forests and trees were 993,191 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -3,412,223 t CO2e per year.

- Roughly 62% of Whatcom County's total land base of 561,258 hectares (1,386,897 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 8.6 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -4,405,414 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Whatcom County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Whatcom county's GHG fluxes from forests and trees for inventory period 2016 – 2019, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
Undisturbed Forest	-4,072,399	
Forest Disturbances		291,052
Non-Forest to Forest	-147,571	
Forest to Settlement		24,212
Forest to Grassland		434,044
Forest to other non-forest lands		64,833
Trees outside of forests	-185,443	179,050
Harvested Wood Products	0	
TOTAL	-4,405,414	993,191
Net GHG balance	**-3,412,223**	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Whatcom County’s total land base is approximately 561,258 hectares (1,386,897 acres), with nearly 5.2% Settlement (i.e. developed areas of varying intensity), around 62.2% forest, 18% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 2.9% cropland, 3.5% wetland and 8.2% other land.

Figure 1. Land cover in Whatcom from the National Land Cover Database, 2019

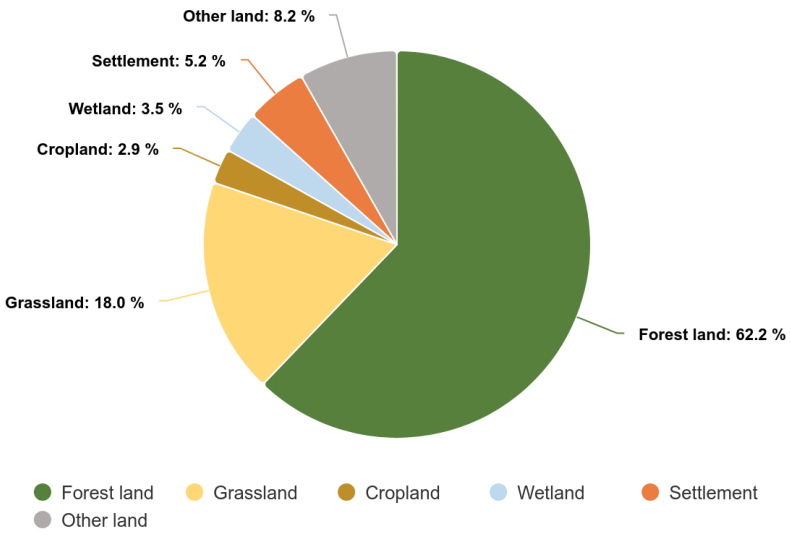
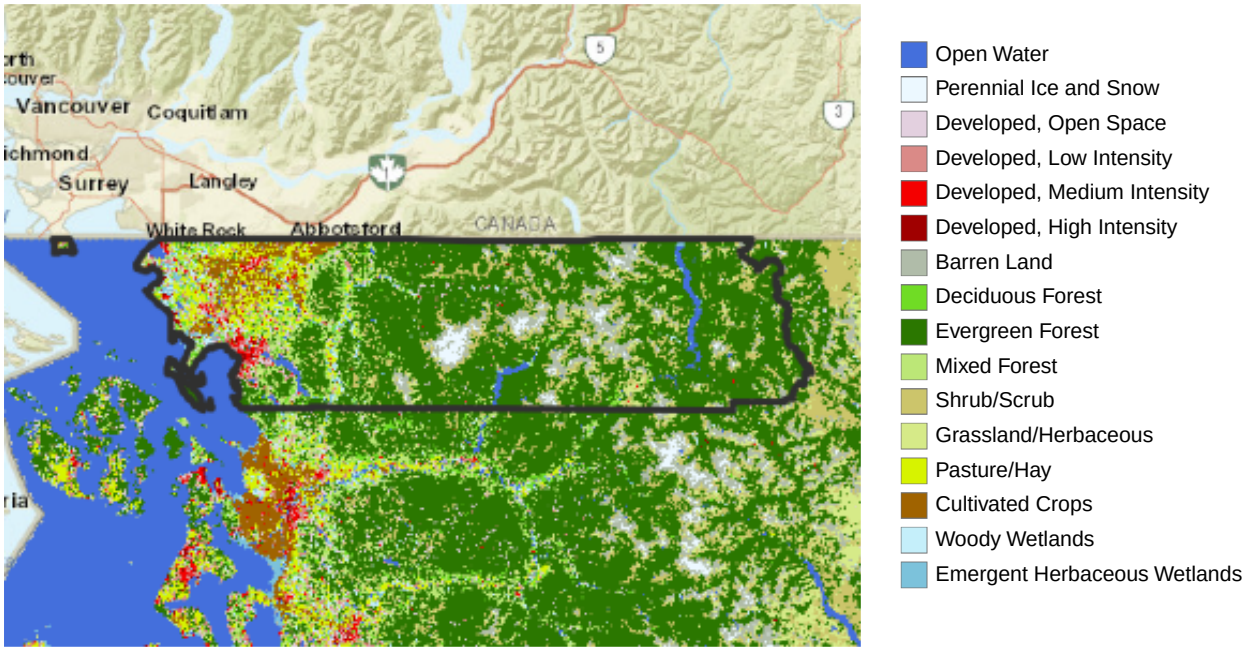


Figure 2. Land cover in Whatcom from the National Land Cover Database, 2019



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2016 and 2019, the county lost around 3,915 hectares (9,674 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 11,029 hectares (27,254 acres) of forest land, largely from Grassland.

Figure 3. Loss of forest to other land use types between 2016 and 2019 (ha)

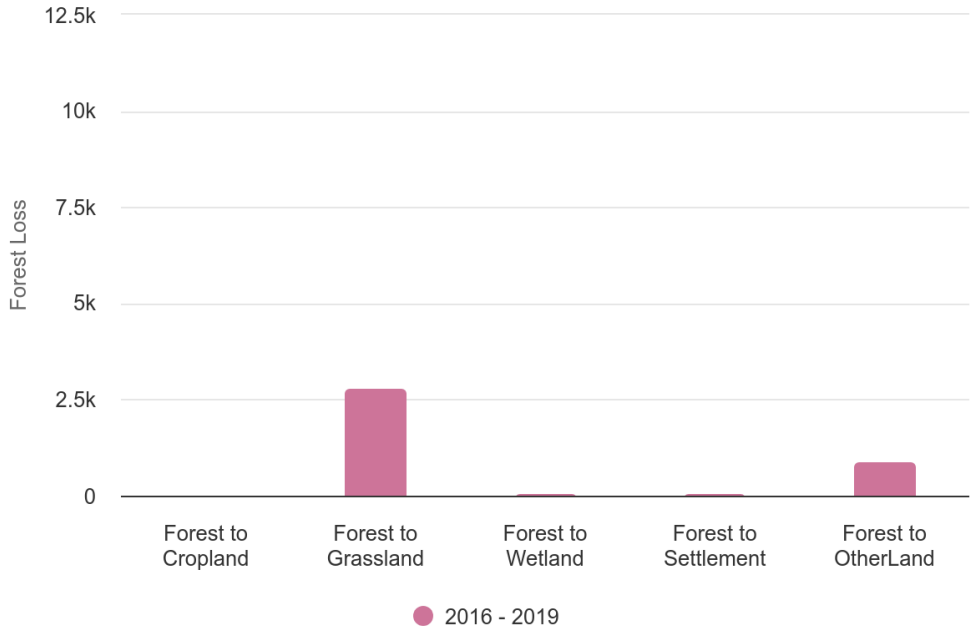
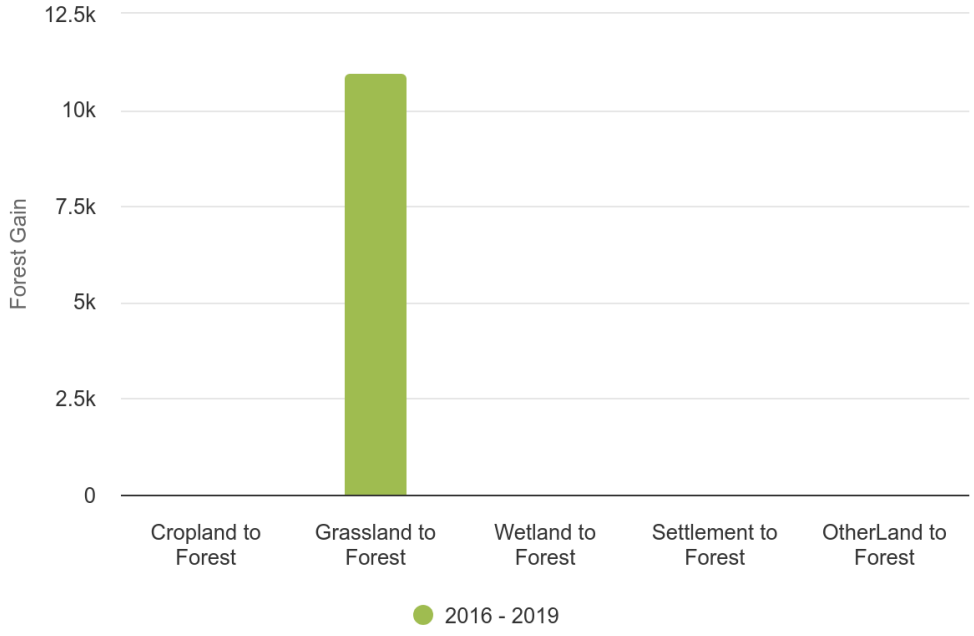


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from insects was the most significant in Whatcom County, affecting 14129.3 hectares (34914.2 acres), followed by harvests, which affected 2143.6 hectares (5296.9 acres) and fires, which affected 0 hectares (0.0 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data is only available for the years 2011 and 2016. Over this time period, Whatcom County had an average of 17,918 hectares (44,276 acres) of tree canopy outside forests. Between 2011 and 2016, 509 hectares per year of tree canopy were lost, for a total of 2,544 hectares (6,286 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Whatcom County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). “Other” category not shown due to very low area.

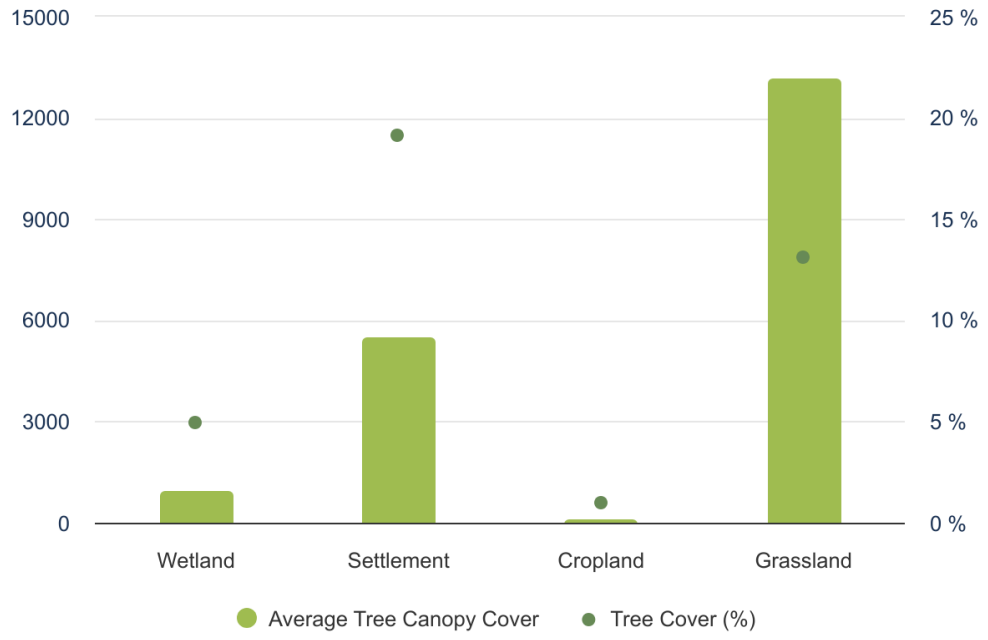
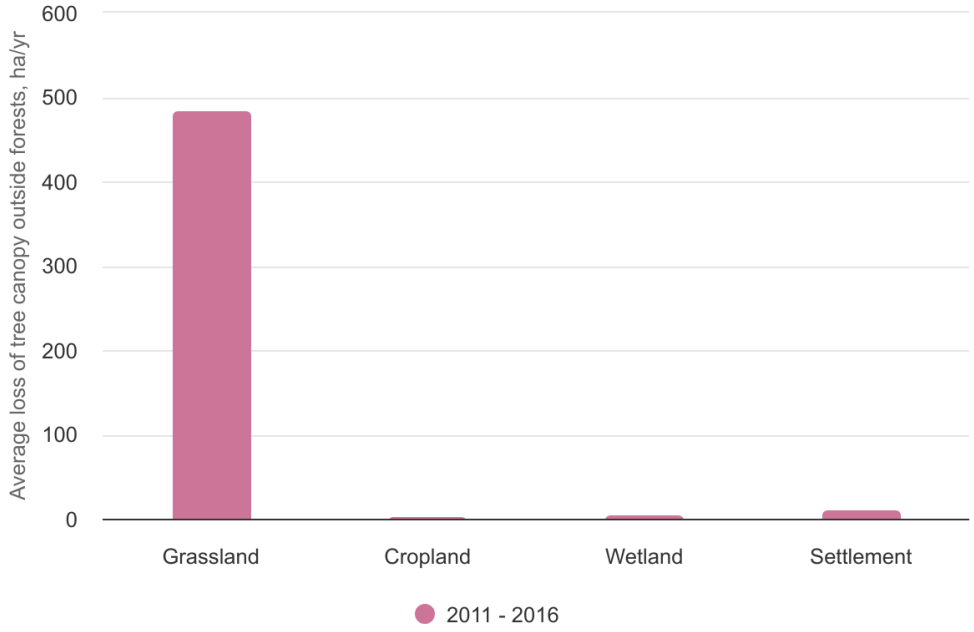


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Whatcom County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2016 to 2019. All areas are in hectares.

2019: Top 2016: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	12,601	0	0	0	0	0.6	79	24	2	0	7	2	2	0.2	6	0	12,722
Evergreen Forest	0.1	292,332	0	0	0	16	1,921	445	23	0.1	57	2	1	0.4	908	0	295,706
Mixed Forest	0	0.3	23,941	0	4	5	249	54	4	0	17	4	2	0.2	0.6	0	24,279
Woody Wetlands	0	0	0	9,007	25	12	0	0	7	32	3	0.6	0.5	2	0	0	9,088
Cultivated Crops	0	0	0	0	16,267	129	0	0.1	3	0	5	4	9	9	2	0	16,427
Pasture/Hay	0.5	0.9	0.5	1	20	28,400	0.3	0.5	15	6	27	13	11	4	2	0	28,503
Grassland/Herbaceous	0.1	18	2	0	0	21	16,965	3,916	6	0	3	2	2	0.7	673	0	21,608
Shrub/Scrub	551	9,995	428	0	0	1	91	48,563	8	0	3	0.5	0.4	0	600	0	60,240
Open Water	0	0.3	0	0	0	0	0	0	11,975	447	0	0.1	0.2	0	33	0	12,455
Emergent Herbaceous Wetlands	0	0	0	17	51	19	0.2	0	67	6,924	3	1	0.6	1	0	0	7,085
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	9,830	14	74	13	0	0	9,930
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	11,129	29	23	0	0	11,182
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	5,492	6	0	0	5,498
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	2,167	0	0	2,167
Barren Land	1	13	0.4	0	0	0	76	73	182	0	0.2	0	0	0.1	35,368	0	35,714
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,519	8,519
Total	**13,153**	**302,359**	**24,372**	**9,026**	**16,366**	**28,603**	**19,382**	**53,075**	**12,292**	**7,408**	**9,953**	**11,172**	**5,623**	**2,227**	**37,591**	**8,519**	**0**

Table 3. Simplified land cover change matrix for 2016 to 2019.All areas are in hectares.

2019: Top 2016: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	337,881	28	2,806	68	98	915	**341,796**
Cropland	0	16,267	129	3	26	2	**16,427**
Grassland	10,997	20	97,958	36	66	1,274	**110,351**
Wetland	18	51	19	19,412	6	33	**19,540**
Settlement	0	0	0	0	28,777	0	**28,777**
Other Land	15	0	149	182	0.3	43,887	**44,233**
Total	**348,910**	**16,366**	**101,061**	**19,700**	**28,975**	**46,110**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	75.47	
To Grassland	126.45	
To Settlement	201.38	
To Wetland	114.68	
To Other	47.12	
Reforestation (Non-Forest to Forest)		-3.65
Forest Remaining Forest		
Undisturbed		-3.46
Disturbed		
Fire	0	
Insect/Disease	-6.73	
Harvest/Other	155.35	
Trees Outside Forest		
Tree canopy loss	95.90	
Canopy maintained/gained		-2.82

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Whatcom County, the change in the harvested wood pool over the inventory period 2016 to 2019 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.