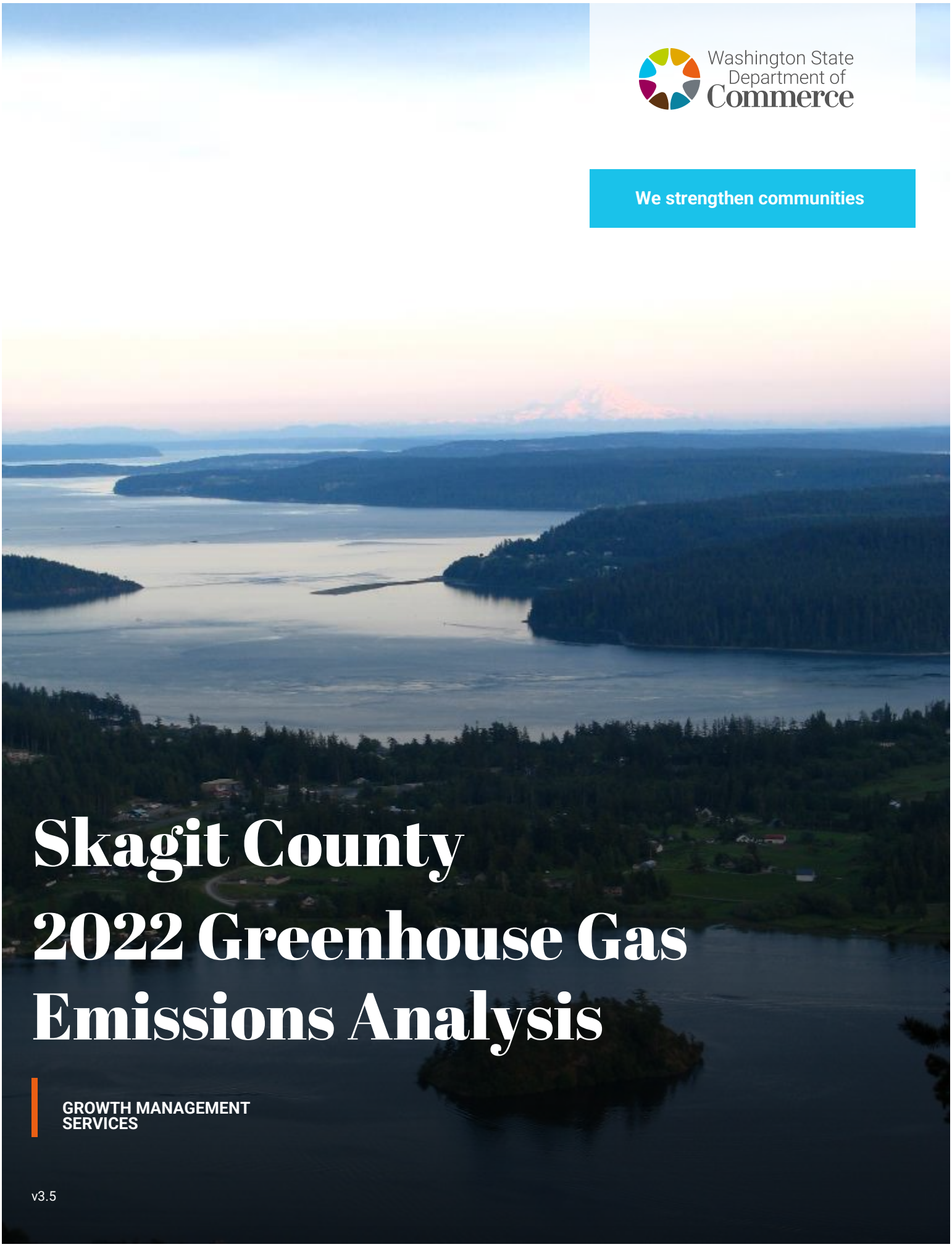


Washington State Department of Commerce

We strengthen communities

Skagit County 2022 Greenhouse Gas Emissions Analysis

GROWTH MANAGEMENT SERVICES

v3.5

Acknowledgements

Washington State Department of Commerce
Sarah Fox, Climate & Ecosystem Section Manager

Michael Burnham, Climate & Ecosystem Policy Team Manager

Pranjali Rai, Senior Planner

Consultant Team
Cascadia Consulting Group

WSP

Fehr & Peers

Kim Lungren Associates

FUNDED BY WASHINGTON'S CLIMATE COMMITMENT ACT

1011 Plum St. SE
P.O. Box 42525
Olympia, WA 98504-2525

www.commerce.wa.gov

For people with disabilities, this report is available on request in other formats. To submit a request, please call 7-1-1 and ask to be connected to 360-725-4000.

Contents

Executive Summary

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, 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 Skagit County, as well as projected future emissions and GHG emission reduction strategies. Skagit 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.

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 Skagit County community produced an estimated 6,078,127 metric tons of carbon dioxide equivalent ($MTCO_2e$), which equates to approximately 46.3 $MTCO_2e$ per capita. Figure 1 and Figure 2 show the breakdown of 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.

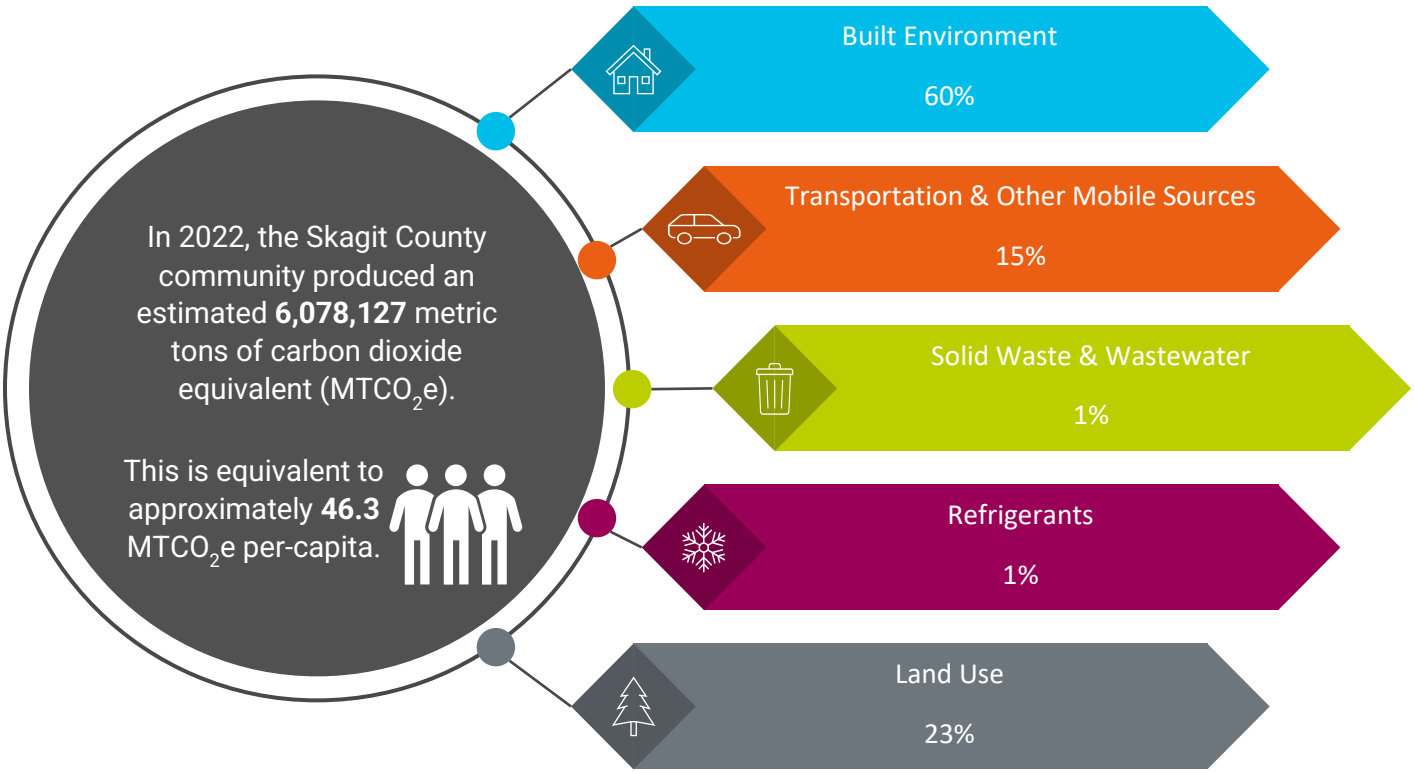
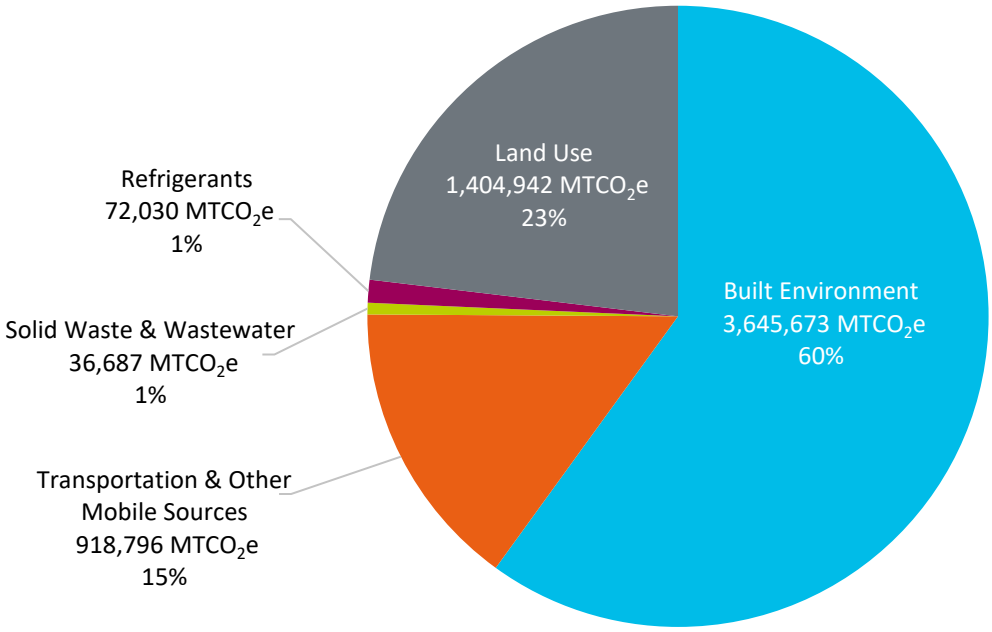


FIGURE 2. 2022 COMMUNITYWIDE GHG EMISSIONS PROFILE ($MTCO_2E$).



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, Skagit County's operations produced an estimated 18,251 $MTCO_2e$. Figure 3 and Figure 4 show 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 3. 2022 COUNTY OPERATIONS GHG EMISSIONS PROFILE BY SOURCE.

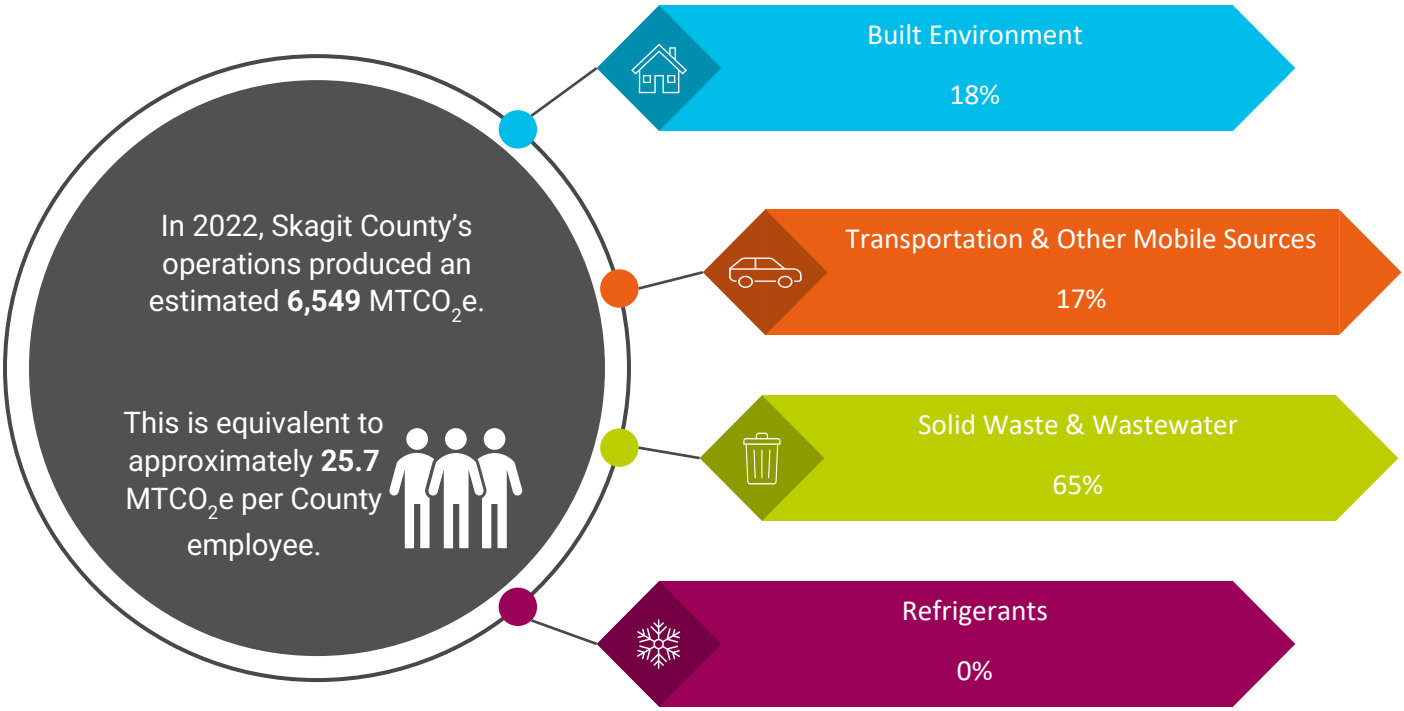
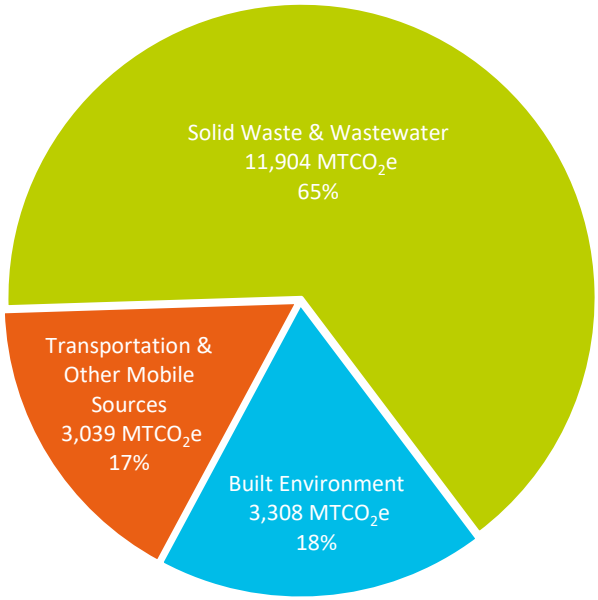


FIGURE 4. 2022 COUNTY OPERATIONS GHG EMISSIONS PROFILE ($MTCO_2E$).

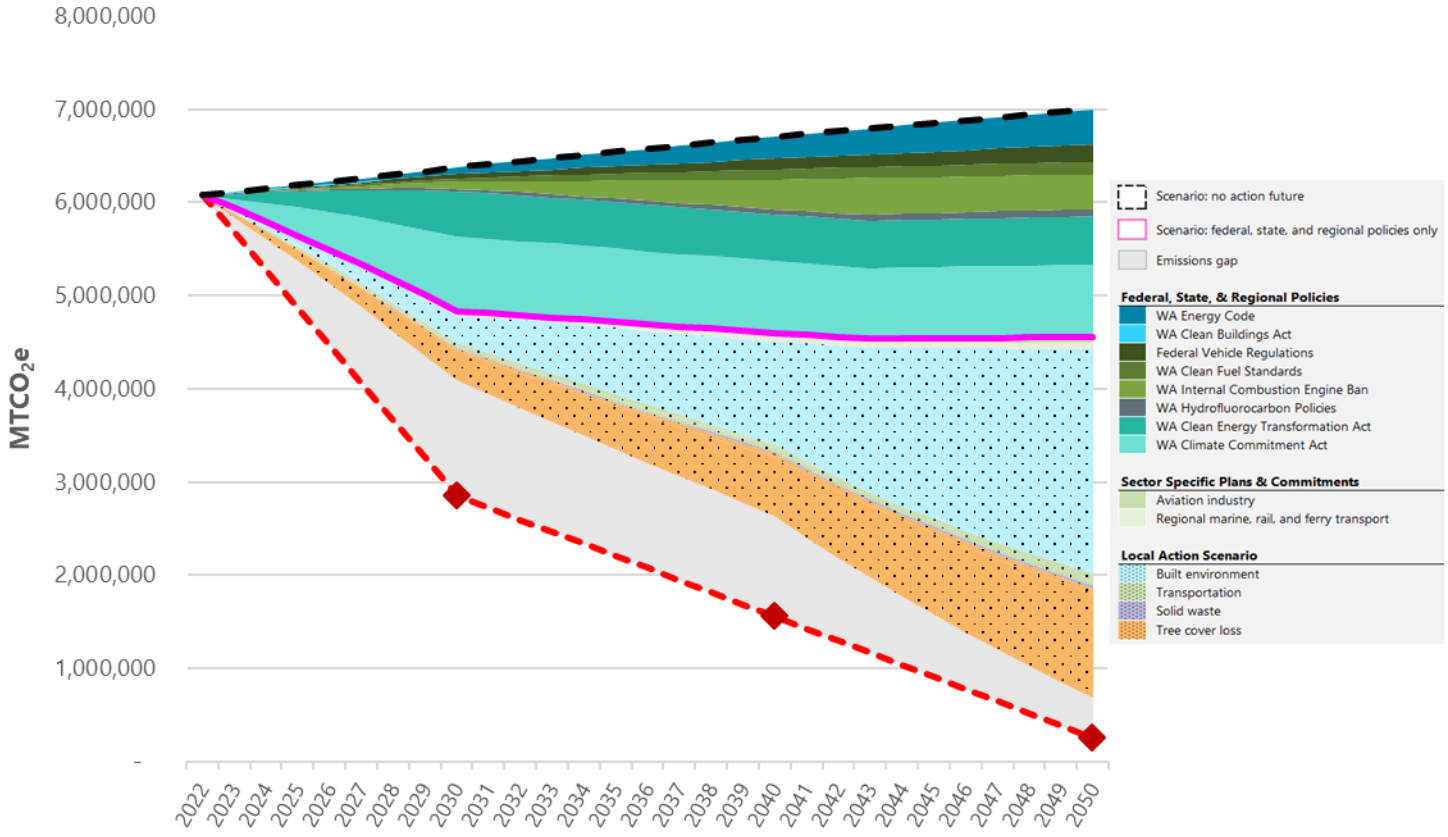


Future Emissions Projections & Local Strategies

A forecasting analysis of Skagit County's communitywide emissions from 2022 to 2050 revealed the following 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, Skagit County's emissions will grow 35% by 2050 (compared to a 1990 baseline), as depicted by the dotted black line in Figure 5.
- Adjusted business-as-usual (ABAU), which models estimated emissions reductions from existing federal, state, and regional policies. This scenario estimates a 12% reduction in communitywide emissions by 2050 (compared to a 1990 baseline), as depicted by the pink line in Figure 5.
- 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 a 79% total reduction in communitywide emissions by 2050 (compared to a 1990 baseline), as shown by the local action scenario reductions in Figure 5.

FIGURE 5. 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 Skagit County. As presented in the local action scenario, key GHG emission reduction strategies for focus in Skagit County's comprehensive plan update include:

- Decarbonize and reduce energy consumption in new and existing residential and commercial buildings through 1) transition from fossil fuels such as natural gas to low-carbon building energy sources such as renewable electricity and 2) energy efficient building design and retrofits. Local action to transition to renewable building energy sources would reduce Skagit County's built environment emissions, which made up 60% 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 Skagit County's communitywide on-road emissions from passenger vehicles, which made up 8% 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 Skagit County's passenger and freight vehicle on-road emissions, which made up 11% 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 Skagit County would reduce land use emissions, which made up 23% 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 industrial gas manufacturing. These industrial process emissions made up 20% of Skagit 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 Skagit County, as well as projected future emissions and GHG emission reduction strategies.

Methodology

In determining the methodology used to complete Skagit 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:

- Skagit County's communitywide inventory was performed using guidance from both ICLEI's U.S. Community Protocol for Accounting and Reporting of GHG Emissions (USCP)[1] and The Greenhouse Gas Protocol's Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC)[2]. These protocols are the industry standards for quantifying GHG emissions from community activities.[3]
- Skagit 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).[4] This protocol outlines a standardized method for local governments to estimate operational emissions.

Skagit 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] U.S. Community Protocol | ICLEI USA
[2] Global Protocol for Community-Scale GHG Inventories (GPC) | GHG Protocol.
[3] 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.
[4] 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.

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 Public transit	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 Skagit 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 Skagit County community produced an estimated 6,078,127 $MTCO_2e$. This total equates to approximately 46.3 $MTCO_2e$ per-capita. The community's largest sources of emissions were built environment, contributing 60% of total emissions, and land use contributing 23%. Figure 6 and Table 2 summarize 2022 communitywide emissions by sector and source. Table 2 also identifies "core emissions," 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 include emissions from electricity, natural gas, on-road vehicles, solid waste generation and disposal, and wastewater treatment processes.

FIGURE 6. 2022 COMMUNITYWIDE EMISSIONS PROFILE ($MTCO_2E$).

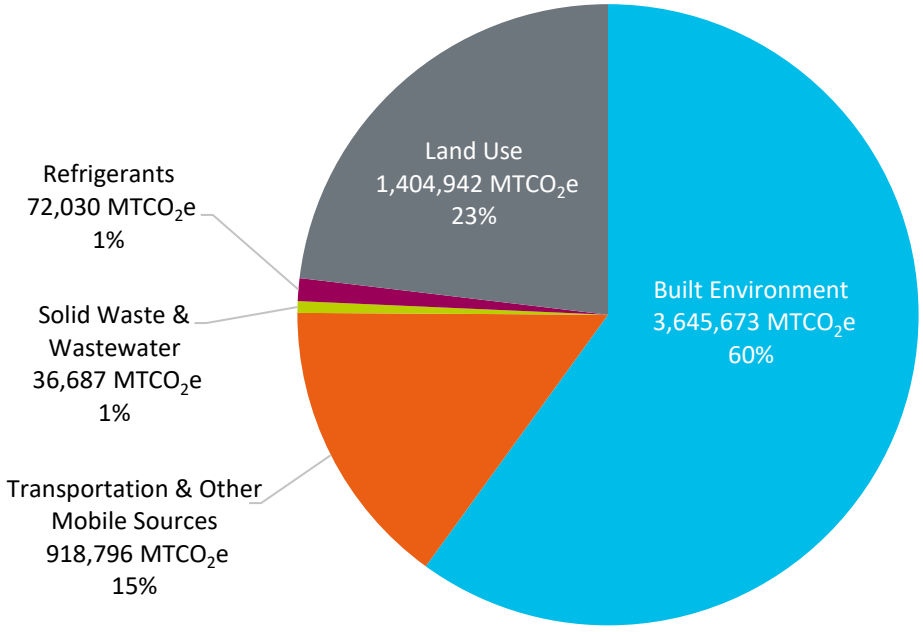
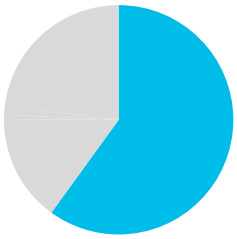


TABLE 2. TOTAL AND PER-CAPITA COMMUNITYWIDE GHG EMISSIONS, BY SECTOR ($MTCO_2E$ AND %).

GHG Emissions Sector	Total Emissions ($MTCO_2e$)	Per-capita Emissions ($MTCO_2e$)	Percent of Emissions (%)
Built Environment			
Electricity	**459,959**	**3.5**	**8%**
Residential	225,041	1.7	4%
Commercial	191,498	1.5	3%
Industrial	43,419	0.3	<1%
Natural Gas	**1,916,026**	**14.6**	**32%**
Residential	109,295	0.8	2%
Commercial	62,194	0.5	1%
Industrial	1,744,538	13.3	29%
Propane	**32,957**	**0.3**	**<1%**
Residential	28,327	0.2	<1%
Commercial	4,630	<0.1	<1%
Fuel Oil	**34,474**	**0.3**	**<1%**
Residential	2,206	<0.1	<1%
Commercial	32,268	0.2	<1%
Industrial Processes	**1,202,257**	**9.2**	**20%**
Transportation & Other Mobile Sources			
On-Road Vehicles	**691,726**	**5.3**	**11%**
Passenger vehicles	490,348	3.7	8%
Freight & service vehicles	198,053	1.5	3%
Public Transit	**3,325**	**<0.1**	**<1%**
Off-Road Equipment	**75,398**	**0.6**	**1%**
Aviation	**95,616**	**0.7**	**2%**
Marine & Rail	**56,056**	**0.4**	**<1%**
Solid Waste & Wastewater			
Solid Waste Generation & Disposal	**29,915**	**0.2**	**<1%**
Landfill	26,587	0.2	<1%
Compost	3,328	<0.1	<1%
Wastewater Processes	**6,771**	**<0.1**	**<1%**
Refrigerants			
Refrigerants	**72,030**	**0.5**	**1%**
Land Use			
Agriculture	**162,920**	**1.2**	**3%**
Tree Cover Loss	**1,242,022**	**9.5**	**20%**
Total Emissions	**6,078,127**	**46.3**	**100%**
Core Emissions	***3,104,398***	***23.7***	***51%***

Built Environment

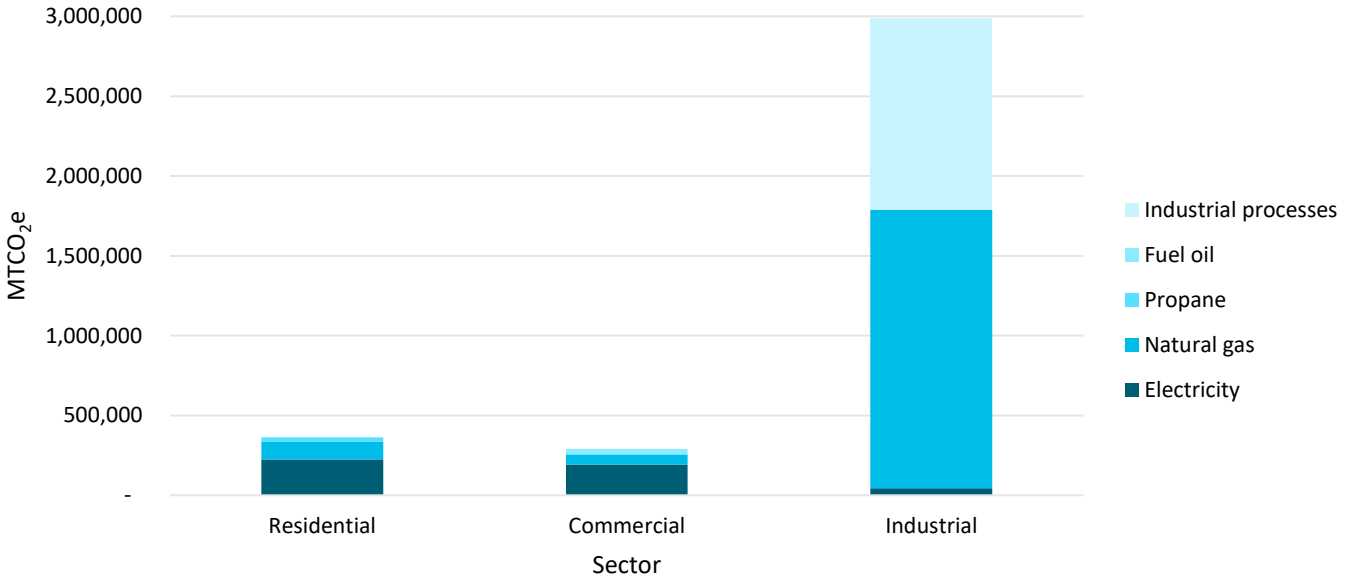


The built environment sector made up 60% of Skagit County's 2022 communitywide emissions, contributing 3,645,673 $MTCO_2e$. This sector includes emissions from the use of electricity, natural gas, propane, and fuel oil to heat, cool, and power buildings, as well as direct emissions from industrial processes within the county.

Figure 7 below summarizes Skagit County's 2022 emissions from the built environment, by sector and source. An estimated 8% and 32% of Skagit County's total communitywide emissions stemmed from electricity and natural gas consumption, respectively. Propane and fuel oil consumption contributed <1% and <1%, respectively, and 20% of communitywide emissions were produced by industrial processes within Skagit 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, Skagit County's electricity emissions were approximately 355,918 $MTCO_2e$, compared to 459,959 $MTCO_2e$ when estimated using a utility-specific approach.

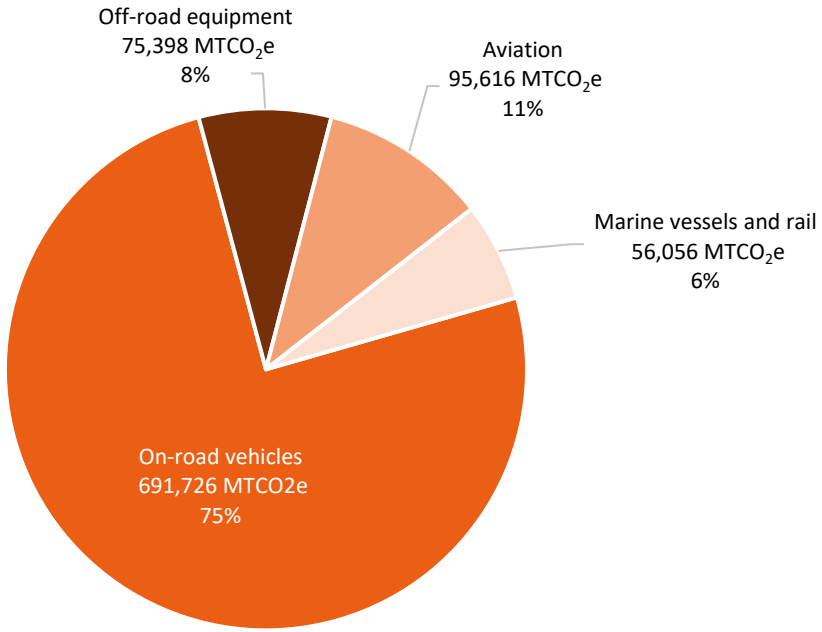
FIGURE 7. BUILT ENVIRONMENT GHG EMISSIONS, BY SECTOR AND SOURCE.



Transportation

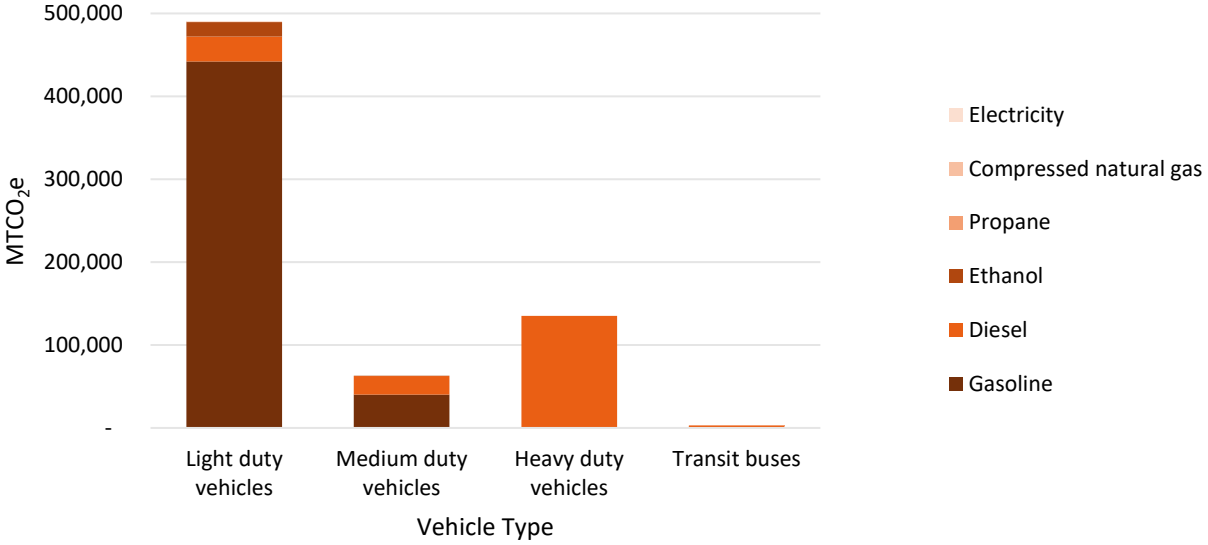
The transportation sector made up 15% of Skagit County's 2022 communitywide emissions, emitting an estimated 918,796 $MTCO_2e$. This sector includes emissions from the use of on-road vehicles and off-road equipment, as well as emissions from marine, rail, and air travel, shown in Figure 8 below.

FIGURE 8. TRANSPORTATION EMISSIONS, BY SOURCE.



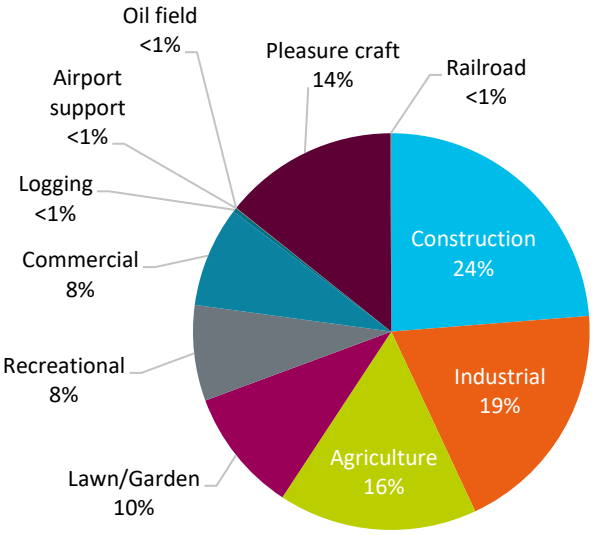
On-road vehicle emissions include those from passenger vehicles, freight and service trucks, and transit vehicles within the county boundary, and made up 75% of Skagit County's 2022 transportation emissions. On-road emissions by vehicle and fuel type are shown in Figure 9.

FIGURE 9. ON-ROAD TRANSPORTATION EMISSIONS, BY VEHICLE AND FUEL TYPE.



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 75,398 $MTCO_2e$, making up 1% of communitywide emissions. The largest source of off-road emissions was construction, producing 24% of all off-road vehicle and equipment emissions.

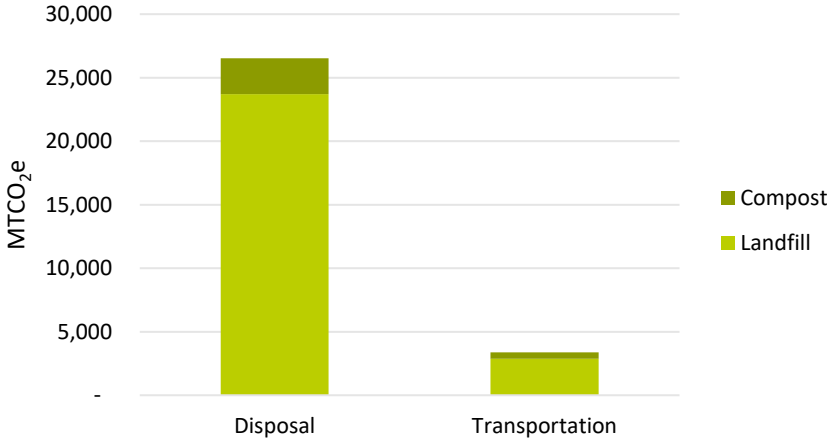
FIGURE 10. OFF-ROAD EMISSIONS, BY SECTOR.



Solid Waste & Wastewater

The solid waste and wastewater sector made up 1% of Skagit County's 2022 communitywide emissions, contributing an estimated 36,687 $MTCO_2e$. 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 Skagit County.

FIGURE 11. EMISSIONS FROM SOLID WASTE GENERATION, BY ACTIVITY AND WASTE TYPE.



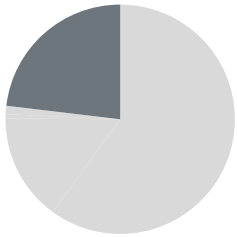
Emissions from wastewater are generated by the biological processing of organic wastewater at treatment facilities, as well as from septic systems within the community. In 2022, emissions from wastewater made up <1% of communitywide emissions. Wastewater treatment plants within Skagit County also produce 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 1% of Skagit County's 2022 communitywide emissions, contributing an estimated 72,030 $MTCO_2e$. 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 23% of Skagit County's 2022 communitywide emissions, contributing approximately 1,404,942 $MTCO_2e$. 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. Skagit County had approximately 68,346 acres of agricultural cropland in 2022.

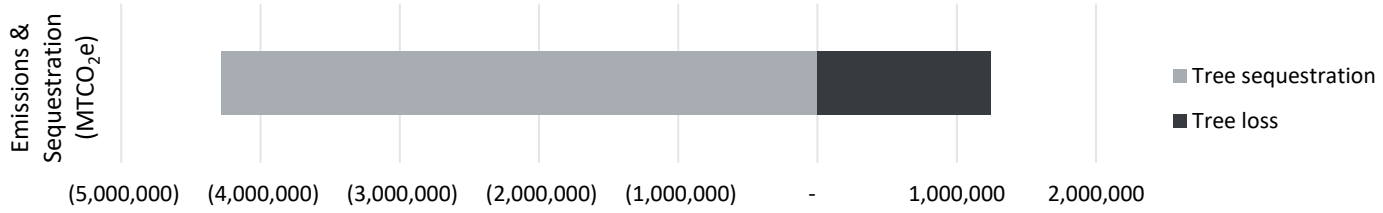
In 2022, the largest emitter of agricultural emissions in Skagit County was dairy cows, producing 51% of agriculture emissions.

Emissions from land use also include emissions from tree cover loss within Skagit 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 1,242,022 $MTCO_2e$.

Tree Carbon Sequestration

Trees and forests in Skagit County sequestered approximately 4,283,975 $MTCO_2e$ 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 12 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 should not be netted with sequestration; Figure 12 below provides a sense of scale for comparison purposes only. 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 Skagit County, see Appendix D.

FIGURE 12. 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, Skagit County's operations produced an estimated 18,251 $MTCO_2e$. The County's largest sources of emissions occurred from solid waste & wastewater, contributing 65% of total County operations emissions, and built environment, contributing 18%. County operations emissions in 2022 made up .3% of Skagit County's 2022 communitywide emissions. Figure 13 depicts Skagit County's 2022 operational emissions by sector and source.

FIGURE 13. COUNTY OPERATIONS EMISSIONS PROFILE ($MTCO_2E$).

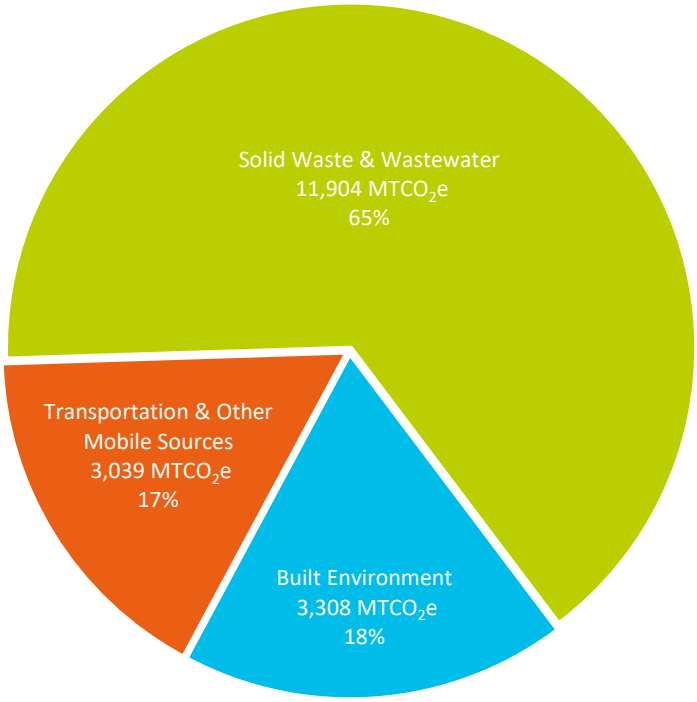
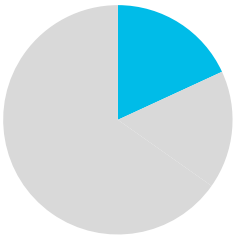


TABLE 3. 2022 TOTAL AND PER-CAPITA COUNTY OPERATIONS GHG EMISSIONS, BY SECTOR ($MTCO_2E$ AND %).

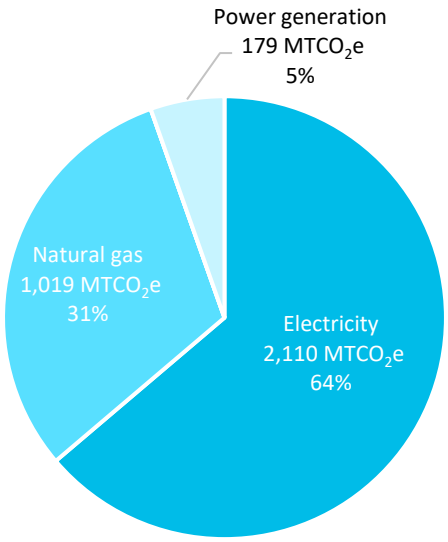
GHG Emissions Sector	Total Emissions ($MTCO_2e$)	Per-employee Emissions ($MTCO_2e$)	Percent of Emissions (%)
Built Environment			
Electricity	**2,100**	**3.0**	**12%**
Natural Gas	**1,019**	**1.4**	**6%**
Propane	**11**	**<0.1**	**<.1%**
Fuel Oil	**N/A**	**N/A**	**0%**
Power Generation	**179**	**0.3**	**1%**
Transportation & Other Mobile Sources			
Fleet Vehicles & Equipment	**3,039**	**4.3**	**17%**
On-road fleet vehicles	1,022	1.4	6%
Off-road fleet equipment	2,017	2.8	11%
Employee Commute	**N/A**	**N/A**	**0%**
Business Travel	**N/A**	**N/A**	**0%**
Solid Waste & Wastewater			
Solid Waste Generation & Disposal	**11,894**	**16.7**	**65%**
Landfilled waste	420	0.6	2%
Composted waste	N/A	N/A	0%
County-owned landfills	11,474	16.1	63%
Wastewater Processes	**10**	**<0.1**	**<.1%**
Refrigerants			
Refrigerants	**N/A**	**N/A**	**0%**
Stationary refrigerants	N/A	N/A	0%
Mobile refrigerants	N/A	N/A	0%
Total Emissions	**18,251**	**25.7**	**100%**

Built Environment



The built environment sector, which includes emissions from all County-owned and operated facilities, made up 18% of Skagit County's 2022 operational emissions, contributing approximately 3,308 $MTCO_2e$. This sector includes emissions from the use of electricity, natural gas, propane, and fuel oil to heat, cool, and power County facilities, as well as diesel generators used for backup power. The breakdown of government operations emissions by fuel type is shown in Figure 14.

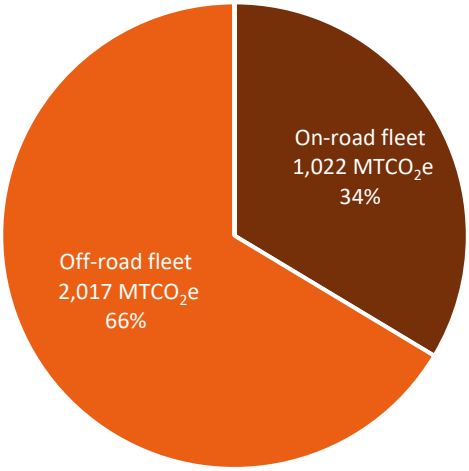
FIGURE 14. GOVERNMENT OPERATIONS BUILT ENVIRONMENT EMISSIONS, BY FUEL TYPE.



Transportation

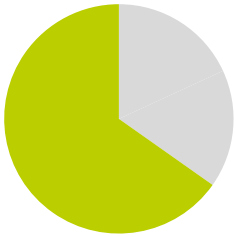
County operations transportation emissions stem from the operation of County fleet vehicles and equipment, County employee commuting, and County staff business travel (as data are available). Emissions from this sector made up 17% of Skagit County's 2022 operational emissions (approximately 3,039 $MTCO_2e$). A breakdown of Skagit County operations transportation emissions are shown below in Figure 15.

FIGURE 15. GOVERNMENT OPERATIONS TRANSPORTATION EMISSIONS, BY SOURCE.



Solid Waste & Wastewater

The solid waste and wastewater sector made up 65% of Skagit County's 2022 operational emissions, contributing approximately 11,904 $MTCO_2e$. 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 0% of Skagit County's 2022 operational emissions (0 $MTCO_2e$). 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 Skagit County. Specifically, the analysis forecasted Skagit 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 projected population[5] and economic growth[6].[7]
- 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.

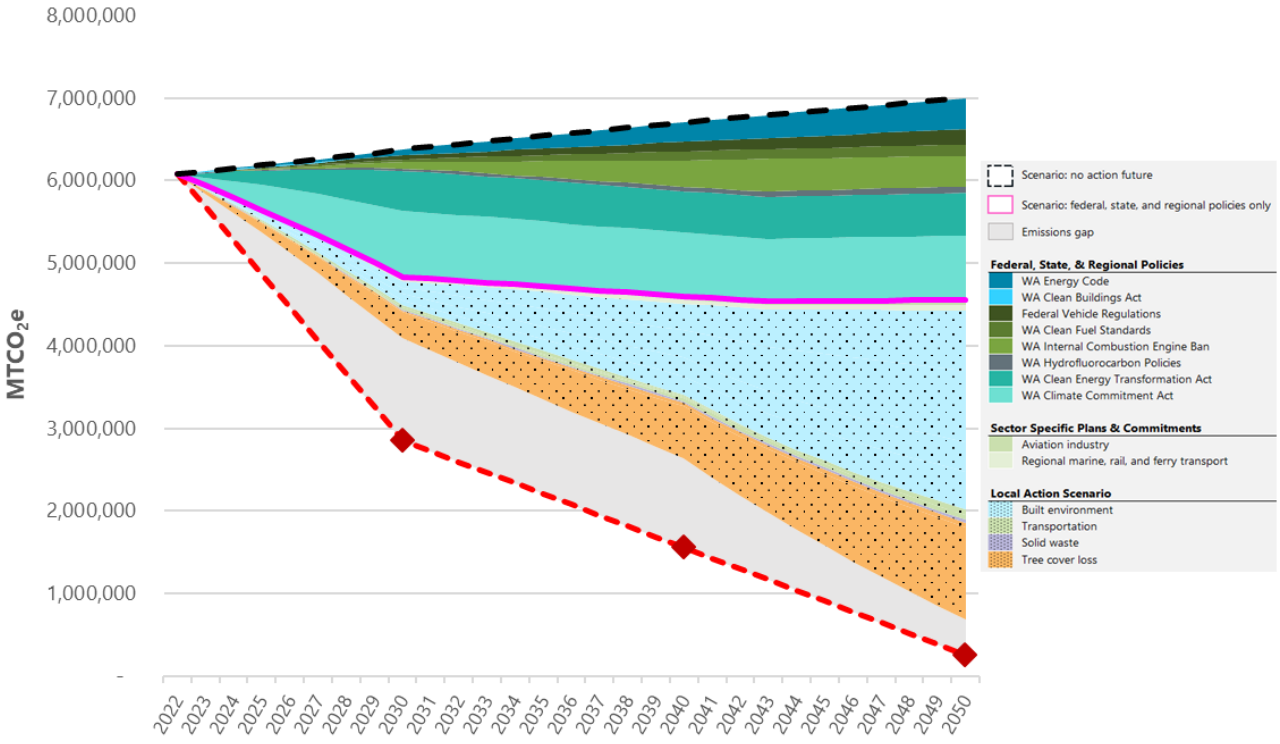
Findings Summary

The 2022-2050 forecast and scenario analysis revealed the following key findings, as summarized in Figure 16:

- BAU: 35% increase by 2050 compared to 1990.
- ABAU: 12% decrease by 2050 compared to 1990.
- Local Action: 79% decrease by 2050 compared to 1990.

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

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



[5] Washington Office of Financial Management (OFM) Growth Management Act population projections, "Middle" scenario.
[6] Future employment estimated using expected OFM population growth percentages.
[7] 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 Skagit County's Comprehensive Plan update.

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 modeled based on estimated population and economic growth. Population and economic growth estimates can be found in Table 4. Overall, the BAU projects a 35% growth in emissions by 2050.

TABLE 4. DEMOGRAPHIC PROJECTIONS FOR SKAGIT COUNTY.

Demographic	2022	2030	2040	2050
Population	131,250	142,805	155,142	166,281
Employment	51,542	56,080	60,924	65,299

Adjusted-Business-as-Usual Scenario

The ABAU estimates emissions reductions resulting from established federal, state, and regional policies. Together, implementation of identified policies results in an estimated 12% reduction in communitywide GHG emissions by 2050 compared to 1990 levels.

The ABAU scenario included consideration of the following federal, state, and regional policies. Additional information regarding policy interpretation and assumptions are provided in Appendix B.

- Washington State Energy Code (SB 5854)
- Washington Clean Buildings Act (HB 1257)
- Federal Vehicle Regulations (CAFE)
- WA Clean Fuel Standard (HB 1091)
- WA Internal Combustion Engine Ban (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 5 below summarizes the local action scenario and associated reductions.

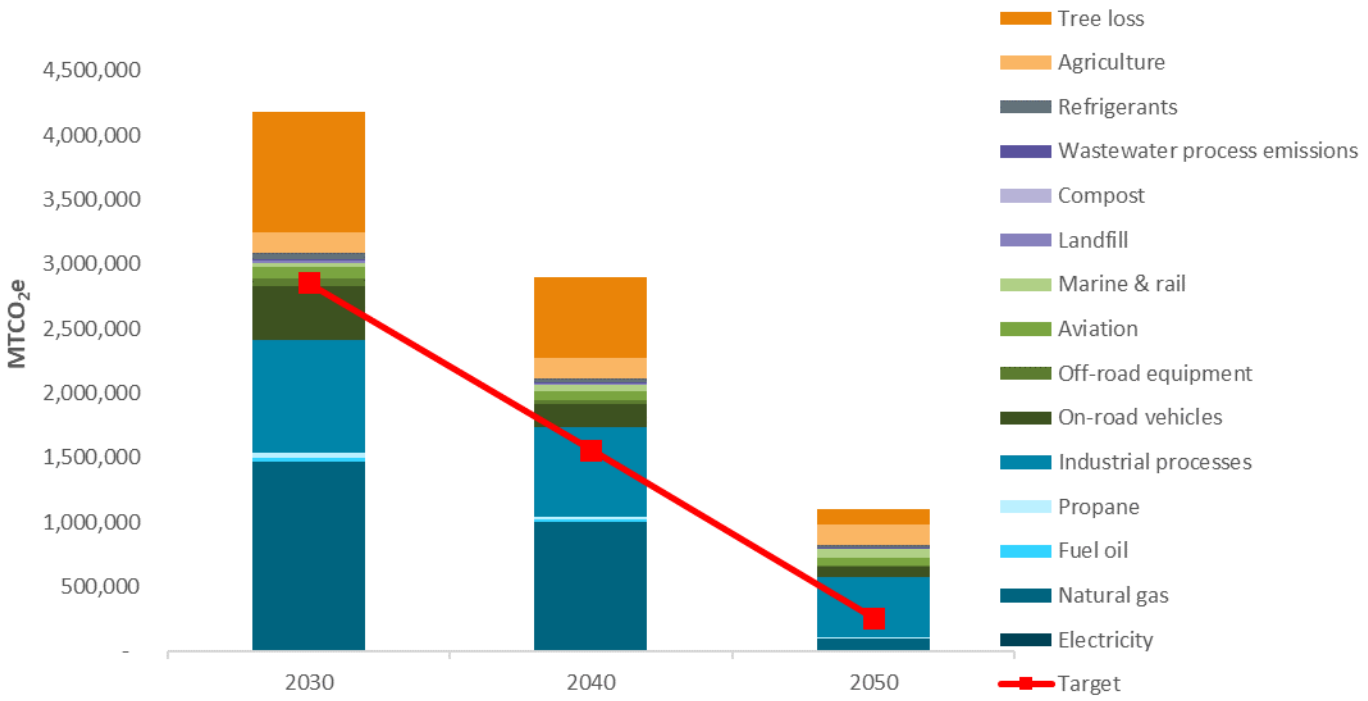
TABLE 5. LOCAL ACTION SCENARIO AND GHG EMISSION REDUCTIONS ($MTCO_2E$).

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%	4,068,794	11%
Reduce energy use in existing buildings (% reduction in energy use)	45%	3,690,337	18%
Electrify existing buildings (% fossil fuel use converted to elect.)	95%	3,572,138	20%
Reduce industrial emissions (% reduction in emissions)	50%	3,964,980	11%
Reduce passenger vehicle travel (% reduction in VMT)	20%	4,425,737	1%
Electrify passenger vehicles (% new vehicles sold that are EV)	100%	4,425,737	<1%
Electrify freight/service vehicles (% new vehicles sold that are EV)	80%	4,360,645	1%
Decarbonize offroad equipment (% reduction in emissions)	95%	4,362,214	1%
Divert C&D materials (% of C&D waste diverted)	85%	4,396,058	1%
Divert other recyclable and compostable materials (% reduction in waste to landfill)	95%		
Improve soil management (% reduction in emissions)	75%	4,364,135	2%
Reduce tree loss (% reduction in tree loss)	90%	3,307,917	33%
Total Emission Reductions		**44,938,692**	**100%**

Remaining Emissions

In 2050, the largest sources of remaining emissions under the local action scenario are industrial processes (42%), agriculture (15%), and tree loss (11%). The makeup of remaining emissions is depicted in Figure 17 below.

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



Local Policy Options

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

- Decarbonize and reduce energy consumption in new and existing residential and commercial buildings through 1) transition from fossil fuels such as natural gas to low-carbon building energy sources such as renewable electricity and 2) energy efficient building design and retrofits. Local action to transition to renewable building energy sources would reduce Skagit County's built environment emissions, which made up 60% 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 Skagit County's communitywide on-road emissions from passenger vehicles, which made up 8% 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 Skagit County's passenger and freight vehicle on-road emissions, which made up 11% 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 Skagit County would reduce land use emissions, which made up 23% 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 industrial gas manufacturing. These industrial process emissions made up 20% of Skagit County's 2022 communitywide emissions.

Appendix A: GHG Inventory Methodology

Methodology and Data Sources

Calculating Skagit County's GHG emissions inventories involved identifying and applying emissions factors to activity data, summarized in Table 6 and detailed in the following sections:

- 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).

TABLE 6. KEY APPROACHES AND DATA SOURCES FOR COUNTY GHG EMISSIONS INVENTORIES.

Sector	Activity Data	Emissions Factors (EFs)
Transportation		
On-road vehicles	Two approaches: 1) Vehicle miles traveled data from Washington State Department of Transportation (WSDOT) Highway Performance Monitoring System (HPMS) 2) Origin-destination vehicle miles traveled estimates from StreetLight	U.S. Environmental Protection Agency (EPA) Emission Factors Hub[8] 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)
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)
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)

[8] EPA Emission Factors Hub

Sector	Activity Data	Emissions Factors (EFs)
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	N/A - data reported in terms of 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	

Transportation

On-Road

On-road emissions were developed using 2022 vehicle-miles-traveled (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.

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.

Clark County:

Portland International Airport (PDX) is not located in Clark County; however, many residents of Clark County utilize PDX for air travel. PDX provided passenger survey data that identified the percentage of departing passengers whose home is Clark County. These data were used to attribute a portion of the airport's 2022 fuel consumption data to Clark County.

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.

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"[9]. Other defaults 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 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 metered facility energy consumption (e.g., electricity, natural gas) were excluded.

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

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 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.

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.

Transportation

On-Road

- No notable limitations of approach or data sources.

Off-Road

- No notable limitations of approach or data sources.

Public Transit

- No notable limitations of approach or data sources.

Aviation

- No data received for Concrete Municipal Airport.
- Allocated emissions from Seattle-Tacoma International Airport by population using passenger survey data.

Marine

- National Emissions Inventory data were used for this analysis, which was last updated in 2020.

Rail

- National Emissions Inventory data were used for this analysis, which was last updated in 2020.

Building Energy

Electricity

- No notable limitations of approach or data sources.

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.

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.

Solid Waste and Wastewater

Solid Waste Generation and Disposal

- Landfill: Data from the City of Anacortes were not split between residential and commercial, so the WA state average breakdown by sector was applied as a proxy.
- Compost: No notable limitations of approach or data sources.

Wastewater Treatment Processes

- No notable limitations of approach or data sources.

Septic Systems

- No notable limitations of approach or data sources.

Refrigerants

- No notable limitations of approach or data sources.

Land Use

Agriculture

- No notable limitations of approach or data sources.

Tree 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 in Skagit County is provided in Appendix D.

Sensitivity to Local Conditions

Not all inventory values are based on locally derived data. Table 7 below summarizes some of the limitations and sensitivities of data used in the inventory.

TABLE 7. 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
Transportation				
On-road		✓		
Off-road		✓		
Public transit		✓		
Aviation		✓		
Marine & rail		✓		
Built Environment				
Electricity	✓			
Natural gas	✓			
Fuel oil			✓	
Propane			✓	
Industrial processes	✓			
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 Internal Combustion Engine Ban (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 Internal Combustion Engine Ban (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 ICE ban, 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 Skagit County's Climate Element. These draft policies are drawn from the Department of Commerce's Climate Menu of Measures.[10]

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. 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.

33% of Skagit 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.

[10] 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.

40% of Skagit 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.

33% of Skagit 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.
- Phase out natural gas use in existing publicly owned facilities by **[insert target date]** and retrofit with electric heat pumps. 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: 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.

40% of Skagit 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.

20% of Skagit 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.

8% of Skagit 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.

8% of Skagit 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 Skagit 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 Skagit County's 2022 communitywide emissions

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

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

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

<1% of Skagit 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.

2% of Skagit 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.

1% of Skagit 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.

20% of Skagit 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 70% of Skagit 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

This page has been intentionally left blank.

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2016 to 2019

Skagit 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. Skagit 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 1,242,022 t CO2e per year.

- Over the period 2016 to 2019, the Net GHG balance of forests and trees was -3,041,953 t CO2e per year.

- Roughly 69% of Skagit County's total land base of 455,973 hectares (1,126,733 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 13 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -4,283,975 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Skagit 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. Skagit 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	-3,910,114	
Forest Disturbances		343,134
Non-Forest to Forest	-187,525	
Forest to Settlement		2,794
Forest to Grassland		593,346
Forest to other non-forest lands		29,899
Trees outside of forests	-186,336	272,851
Harvested Wood Products	0	
TOTAL	-4,283,975	1,242,022
Net GHG balance	**-3,041,953**	

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). Skagit County’s total land base is approximately 455,973 hectares (1,126,733 acres), with nearly 6% Settlement (i.e. developed areas of varying intensity), around 68.7% forest, 12.2% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 4.8% cropland, 2.7% wetland and 5.5% other land.

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

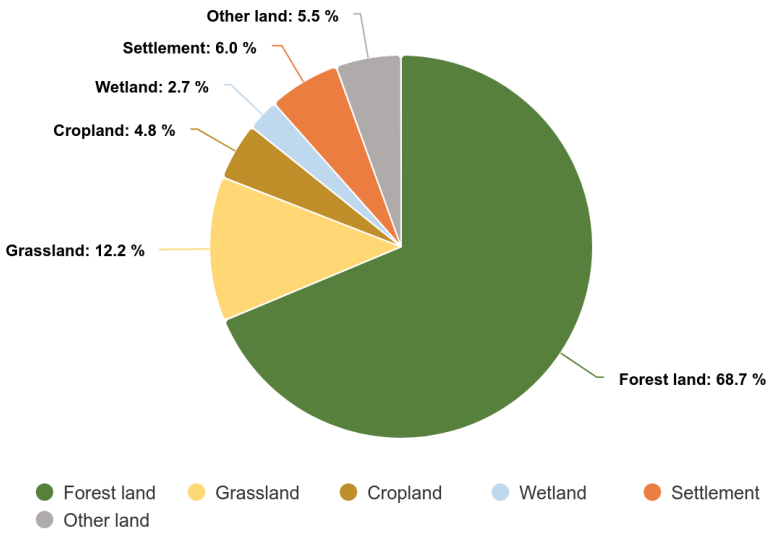
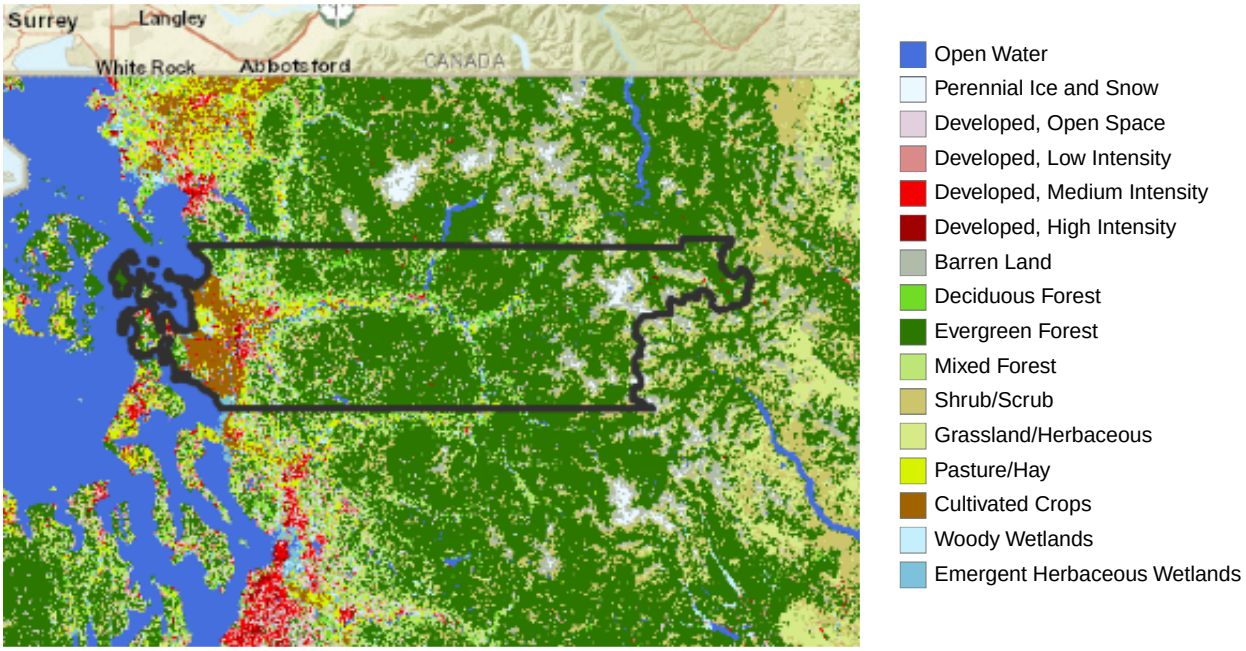


Figure 2. Land cover in Skagit from the National Land Cover Database, 2019



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 4,088 hectares (10,102 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 13,838 hectares (34,193 acres) of forest land, largely from Grassland.

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

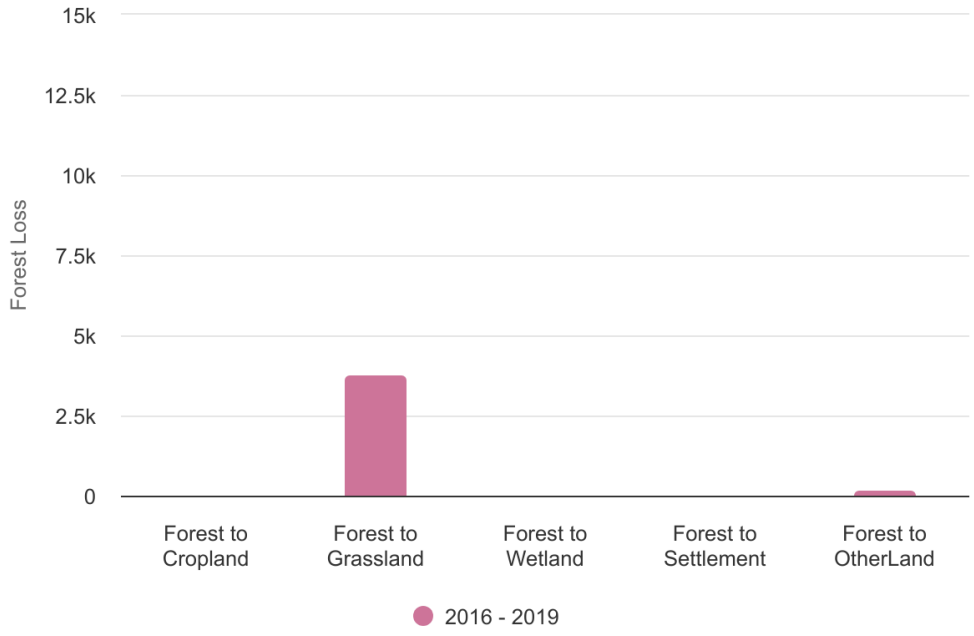
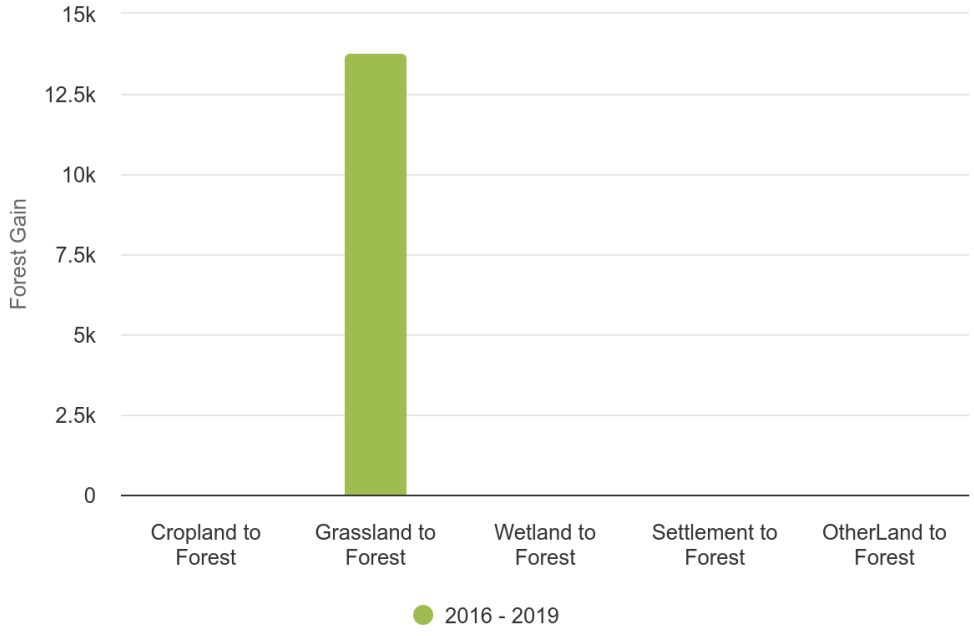


Figure 4. Gain of forest from other land use types between 2016 and 2019 (ha)



Forest Disturbances

Over the inventory period 2016 to 2019, forest disturbance from insects was the most significant in Skagit County, affecting 15031.1 hectares (37142.6 acres), followed by harvests, which affected 2558.5 hectares (6322.2 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, Skagit County had an average of 18,005 hectares (44,490 acres) of tree canopy outside forests. Between 2011 and 2016, 775 hectares per year of tree canopy were lost, for a total of 3,876 hectares (9,579 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)

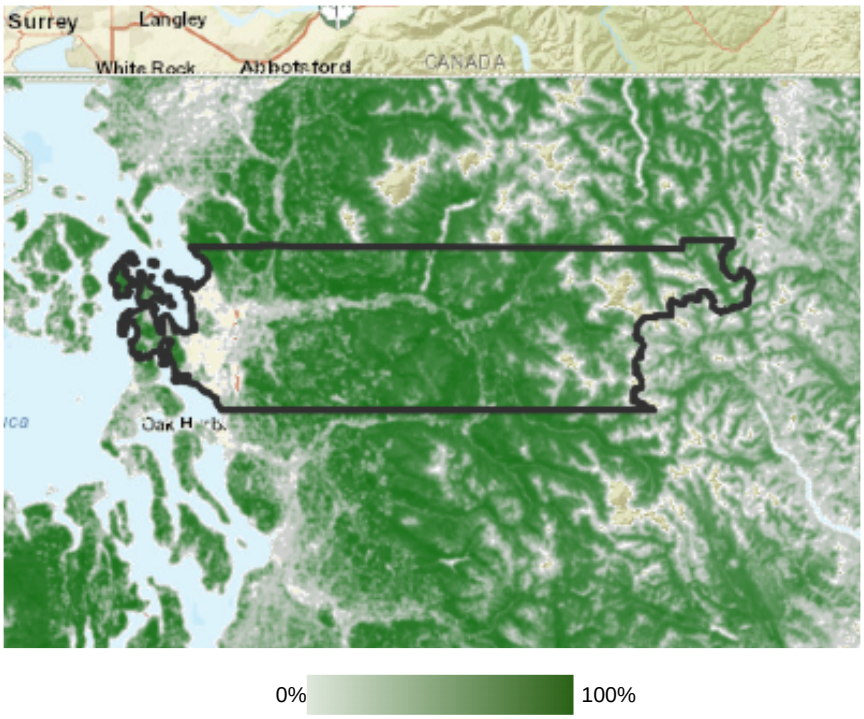


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Skagit County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). "Other"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

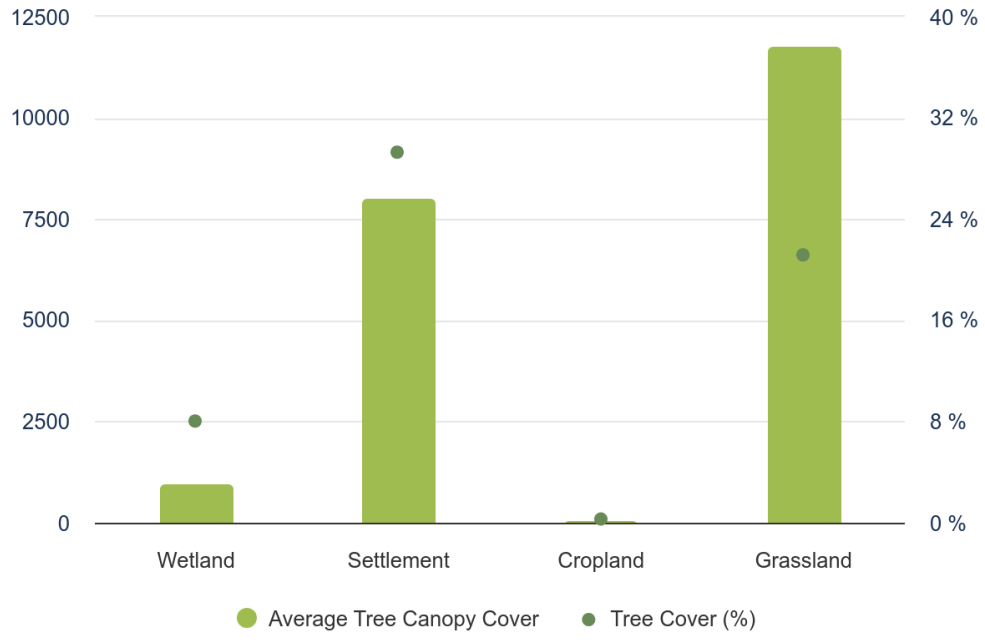
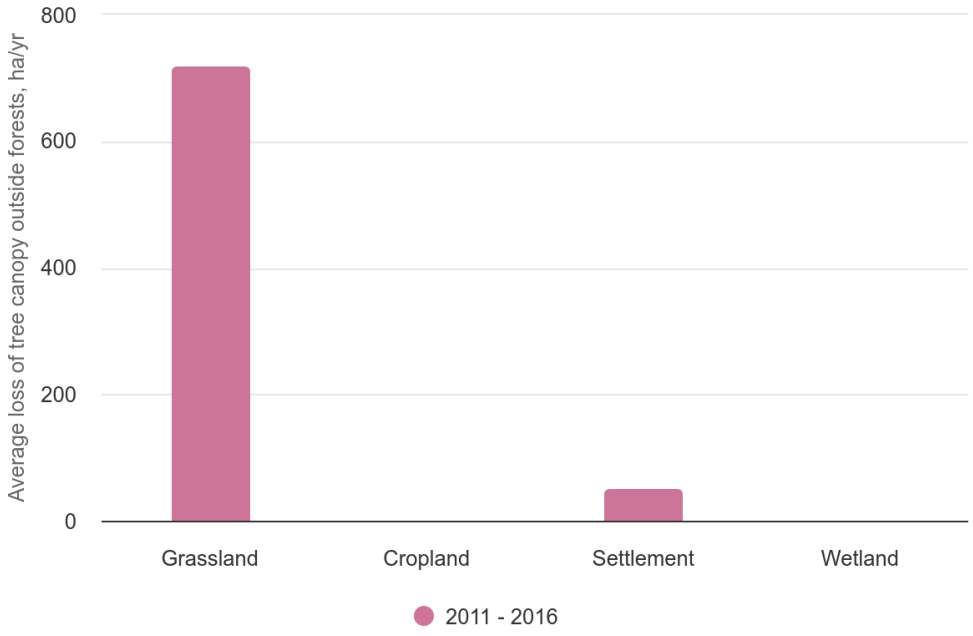


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Skagit County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



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	13,754	0	0.1	0	0	4	114	6	9	0	2	3	3	0.2	3	0	13,898
Evergreen Forest	0	250,378	0.2	0	0.1	13	3,033	274	37	0	4	0.1	0.3	0	219	0	253,959
Mixed Forest	0	0.2	28,967	0.1	0	18	273	44	3	0.1	3	1	0.9	0	4	0	29,316
Woody Wetlands	0	0	0	6,352	2	0	0.2	0	7	6	0	0	0	0	0	0	6,367
Cultivated Crops	0	0	0	0.3	21,922	21	0	0	0.4	13	1	0.6	0.2	0.5	2	0	21,961
Pasture/Hay	0.7	2	3	2	57	14,655	0.6	0.5	6	0	2	2	2	0.7	3	0	14,737
Grassland/Herbaceous	0.1	16	3	0	0	43	7,940	5,304	9	0	0.4	0.5	0.3	0.9	407	0	13,724
Shrub/Scrub	365	12,677	739	0	0	2	64	23,722	7	0	0.4	0	0	0	387	0	37,964
Open Water	0	0.2	0	0	0	0	6	0.4	6,284	97	0.3	0	0	0	7	0	6,394
Emergent Herbaceous Wetlands	0	0	0	15	11	4	0.2	0	66	5,771	0	0	0	0	0	0	5,867
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	12,468	23	62	8	0	0	12,560
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	8,287	21	25	0	0	8,333
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	4,814	8	0	0	4,821
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	1,760	0	0	1,760
Barren Land	0.5	13	0.7	0	0	0	67	40	64	0.5	0	0	0	0	18,583	0	18,769
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,510	5,510
Total	**14,120**	**263,086**	**29,714**	**6,369**	**21,992**	**14,759**	**11,497**	**29,393**	**6,491**	**5,887**	**12,482**	**8,317**	**4,904**	**1,803**	**19,617**	**5,510**	**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	299,451	2	3,779	62	19	227	**303,540**
Cropland	0.3	21,922	21	13	2	2	**21,961**
Grassland	13,808	57	51,732	22	10	797	**66,426**
Wetland	15	11	10	12,217	0.3	7	**12,261**
Settlement	0	0	0	0	27,474	0	**27,474**
Other Land	14	0	107	64	0	24,093	**24,278**
Total	**313,289**	**21,992**	**55,649**	**12,378**	**27,505**	**25,127**	**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	42.33	
To Grassland	128.34	
To Settlement	123.17	
To Wetland	104.50	
To Other	78.99	
Reforestation (Non-Forest to Forest)		-3.69
Forest Remaining Forest		
Undisturbed		-3.78
Disturbed		
Fire	0	
Insect/Disease	-6.72	
Harvest/Other	149.10	
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 Skagit 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.