CITY OF
BAINBRIDGE ISLAND

CLIMATE CHANGE
ADVISORY COMMITTEE
SPECIAL MEETING
WEDNESDAY, FEBRUARY 6, 2019
6:15 – 7:45 PM
CITY HALL
COUNCIL CONFERENCE ROOM
280 MADISON AVENUE NORTH
BAINBRIDGE ISLAND, WA 98110

AGENDA

Members:	Gary Lagerloef	Nora Ferm Nickum	Deborah Rudnick
	Derik Broekhoff	David McCaughey	James Rufo-Hill (Co-Chair)
	Lara Hansen (Co-Chair)	Michelle McClure	

Liaison: Councilmember Joe Deets

6:15 Call to Order / Roll Call / Accept or Modify Agenda / Conflict of Interest Disclosure

6:20 Approve January 2019 minutes

6:30 Public Comment

6:35 Draft CCAC Work Plan

7:05 Greenhouse Gas Emissions Inventory for PSCAA

7:35 Updates

7:45 Adjourn

CITY OF BAINBRIDGE ISLAND

CLIMATE CHANGE ADVISORY COMMITTE
JANUARY 16, 2018
CITY HALL
280 MADISON AVENUE NORTH
BAINBRIDGE ISLAND, WA 98110

MINUTES

Present: Committee members Derik Broekhoff, Michael Cox, Lara Hansen, Gary Lagerloef, David McCaughey, Michelle McClure, Nora Ferm Nickum, James Rufo-Hill; Council Liaison Joe Deets
Absent: Committee member Deborah Rudnick
Public: Randal Samstag, Gloria Sayler, Deborah Weinmann, Kelsey Hulse, Michael Pollock

1. Call to order
   - The meeting was called to order at 6:20 pm.

2. Approval of minutes
   - Minutes from the previous meeting (Dec. 17, 2018) were approved.

3. Public comment
   - No public comment.

4. Workplan
   - Continued discussion of draft workplan and assigning Committee leads to remaining items.
   - A high-level overview of the draft workplan will be presented to Council next month, while we continue to work on the implementation details for each item.
   - We will also work on assigning relative levels of prioritization for the items on the list.
   - Advisory committee members are not positioned to fully implement all of the items, but we aim to gather the necessary information and develop specific, actionable recommendations for Council.

5. Updates and other business
   - The Jan. 22 Council business meeting includes a discussion about the greenhouse gas inventory and the Committee recommendations related to optional items for the consulting contract. The Council packet with the proposed agreement will be posted online on Jan. 18.
   - Debbie Weinmann is a Western Washington University extension student studying policy, and she is interested in doing an internship on issues related to energy.
   - The next Climate and Energy Forum will be on Jan. 26, 10 am at Eagle Harbor Congregational Church.
   - In February, there will be an evening Climate and Energy Forum salon at the Good Egg.
   - At the next meeting, we will discuss the election of new co-chairs.

6. Meeting adjourned
   - The meeting was adjourned at 7:34 pm.

Co-Chair 01/16/19

Bainbridge Island Climate Change Advisory Committee: Draft 2019 Workplan (February 2nd, 2019)

This is the first draft of the 2019 CCAC workplan. Changes are certain to occur during the course of review. Do not cite or quote as this is a working document and is intended to generate discussion and comments.

Section 1: Background

The Bainbridge Island City Council established the Climate Change Advisory Committee (CCAC) in the fall of 2017. The CCAC was established to serve as a technical and planning advisory committee to the city council, city manager, and department of planning and community development staff on issues related to climate change as directed by the City Council.

More specifically, the CCAC was tasked with assisting the city in implementing the climate related goals and policies of the comprehensive plan[1] by undertaking several tasks as expeditiously as committee and city resources allow as outlined in Ordinance 2017-13[2].

[1] **Guiding Principle #7 Reduce greenhouse gas emissions and increase the Island's climate resilience.**
Guiding Policy 7.1 Mitigation: Participate with state, regional and local partners to reduce greenhouse gas emissions consistent with the 1990 benchmark and future year targets set forth in state law, educate the public about climate change and incentivize Island activities including land use patterns and building practices that reduce greenhouse gas emissions.
Guiding Policy 7.2 Adaptation: Minimize or ameliorate the impacts of climate change on our community and our Island's ecosystems through climate-informed policies, programs and development regulations.
Guiding Policy 7.3 Evaluate the climate vulnerabilities and implications of City actions and identify policies that alleviate those vulnerabilities. Consider the effects of shifting conditions (sea level rise, changing rainfall patterns, increasing temperatures and more extreme weather events) and the effects they cause (altered vegetation, changing water demands, economic shifts).

[2] **Tasks for CCAC**
1. Provide advice and/or recommendations to the city council or city staff, as appropriate, on methods of completing a baseline island-wide greenhouse gas (GHG) inventory for the city.
2. To the degree directed by the city council, assist with or manage the completion of a baseline island-wide GHG inventory.
3. Provide advice and/or recommendations to the city council or city staff, as appropriate, related to city GHG emission reduction targets.
4. Work with city staff, as appropriate, to complete and recommend to the city council a city climate action plan and implementation strategy.
5. Provide advice and /or recommendations to the city council or city staff, as appropriate, on how to measure progress toward meeting the city's GHG emission reduction targets and adaptation actions.
6. As directed by the city council, assist the city with participation in regional climate change efforts.
7. Provide education and outreach to the public regarding climate change and the work of the committee and the city relating to climate change.

Section 2: Proposed Targets

The CCAC believes that in order to achieve the comprehensive plans guiding principles for climate change and complete the specific tasks requested by the City Council, the CCAC needs to establish targets that can be measured and tracked over time. The CCAC is proposing targets in the following three areas:

1. Mitigation;
2. Adaptation; and
3. Citizen Engagement.

Table 1 provides a summary of the proposed targets. The CCAC believes these three categories are consistent with the guiding principles in the Comprehensive Plan and in the specific tasks that need to be completed in Ordinance 2017-13.

Table 1: Summary of Targets

Area	Target
Mitigation	
Overall	By 2035, Bainbridge Island would reduce its greenhouse gas emissionses by 80% from 2018 levels with interim targets of 25% by 2025 and 50% by 2030. By insert year, Bainbridge Island would reduce its anthropogenic greenhouse gass emissions by 100% from 2018 levels.
Greenhouse gas emissions	By June 2019 complete a greenhouse gas inventory for Island.
Energy Production	By 2035, Bainbridge Island will receive 100% of its electricity from clean, renewable energy sources with interim targets of 50% by 2025 and 75% by 2030.
Transportation	By 2035, Bainbridge Island will reduce its greenhouse gas emissions from transportation by 50% compared to 2018 levels with interim targets of 25% by 2025 and 40% by 2030. Or By 2035, 50% less per-capita travel by light duty vehicles by shifting to less GHG-intensive travel modes such as ride sharing, transit, walking and biking with an interim target of 30% less per-capita travel by light duty vehicles by 2030[3].
Buildings/Land Use	By 2021, develop mandatory green building standards for all City-owned buildings over 5000 square feet. By 2021, develop incentive programs to encourage green building in all residential and commercial buildings.
Waste Management	By 2035, reduce greenhouse gas emissions from solid waste and waste water management by 80% from 2018 levels with interim targets of 40% by 2025 and 60% by 2030.

[3] Getting to Zero. A Pathway to a Carbon Neutral Seattle. May 2011. http://www.seattle.gov/environment/climate-change/climate-planning/climate-action-plan

Commented [MOU1]: I'm not sure the targets below add up to this. We should do the calculation so that our recommendations achieve our desired target.

Commented [BS2]: This recognizes that reducing GHG from transportation maybe difficult. We could use carbon offsets if we wanted to try and reach net zero GHG emissions

Commented [BS3]: Current State legislation is for 100% clean energy by 2045.

Commented [MOU4]: What about propane? Where do we work toward its reductions?

Commented [BS5]: Should this be 1) net zero carbon emissions; 2) 100% renewables; 3) 100% clean energy; or 4) carbon neutrality/

Commented [MOU6]: This seems not ambitious enough, especially if the ferries are electrifying.

Commented [BS7]: I think we should engage the multi-modal committee and the mobility alliance to help come up with a target. I have proposed two targets one for GHG emission reductions and another on types of travel

Commented [MOU8]: We need to define this.

Commented [MOU9]: This seems like a low bar. Why not just require it as part of permitting? BI can create its own standard so there is no LEED or other costs to builders if that is seen as a deterrent.

Commented [BS10]: This needs much more discussion with Design review board, city, etc.

Do we want a mandatory program for private and commercial buildings?

Commented [BS11]: No idea if these are realistic targets.

Area	Target
Adaptation	
Overall	Minimize or ameliorate the impacts of climate change on our community and our Island's ecosystems through climate-informed policies, programs and development regulations.
Vulnerability Assessments ~~**Greenhouse gas emissions**~~	By December 2019, expand on the Bainbridge Island Climate Impact Assessment to complete mapped assessments of the threat to the island from: - Sea level rise~~By June 2019 complete a greenhouse gas inventory for Island.~~ - Alter precipitation and recharge potential - ?
~~**Vulnerability Assessments**~~	~~By December 2019 complete an initial assessment of the threat from sea level rise to the Island.~~
	By December 2020, COBI will adopt policy guidance/asset management strategy
Integration into City Operations	By 2020, include a process to evaluate all policies, programs, departmental activities, capital expenditures and permit decisions for potential vulnerability and possible hazard creation due to climate change.
Adaptation Commitment	By 2019, make a formal commitment to (Global Adaptation Week) on Bainbridge Island's intention to fully integrate climate change into city responsibilities, including evaluation of capital expenditures and permit decisions for potential vulnerability to climate change, and the intention to create a Climate Savvy Bainbridge Island.
Citizen Engagement	
Climate Change Education	By 2019, convene at least quarterly programs on issues relating to climate change and how the City is addressing this in their daily business.
Support on-going Island efforts	By 2019, establish formal collaborations with existing Island efforts by island organizations (e.g., non-profits, community groups). By 2020, create a multi-governmental task force to create a collaborative approach to implementing actions to achieve all City goal that includes other relevant entities on Bainbridge Island (e.g., BISD, BIFD, Parks and Rec, Kitsap Transit, Washington State Ferry/Washingotn Department of Transit, National Park Service)

Commented [BS12]: Need more specific targets. R

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Section 3: Mitigation

We are proposing targets for ~~four~~ five areas under mitigation:
1. Greenhouse gas emissions
2. Energy production;
2. Transportation;
3. Building/Land Use, and
4. Waste Management.

We have also identified specific actions to help us reach these targets for the four areas that include: 1) whether the action is a high, medium, or low priority; 2) description of the action; 3) a timeline to complete; 4) resources needed to accomplish; and 5) status for each action. This table will be updated every 6 months and presented to the City Council

Commented [BS13]: Need to discuss priorities for each one. I placed where I thought might fall.

Section 3.1: Greenhouse Gas Emissions

Target: By 2019, have accurate measures and tracking systems in place to facilitate the City's ability to achieve all other climate change goals.

Rational:

Table 2: Greenhouse Gas Emissions

Action	Priority	Timeline	Resources	Status
GHG Emissions				
Complete Island-wide GHG Inventory: Hire consultant to complete and Island-wide GHG emissions inventory	H	2019		
Work with High School on Annual update to GHG Inventory: Collaborate with BISD/BHS/Eagle Harbor High to add curriculum module that will include an annual GHG inventory by students	H			
Develop COBI internal carbon pricing program: COBI would incorporate a shadow price for carbon in evaluating all new capital and procurement decisions, and/or implement a carbon fee for operations, revenues from which could be invested in energy efficiency and clean energy projects at city facilities. Each department is given a carbon budget (as well as a financial budget) for the year.	M			

Section 3.2~~1~~: Energy Production

Target: By 2035, Bainbridge Island will receive 100% of its electricity from clean, renewable energy sources with interim targets of 50% by 2025 and 75% by 2030.

Rational: Currently the City of Bainbridge Island receives about XX? Of its electricity from clean, renewable energy sources. In Washington State electricity generation contributes about 20% of the States greenhouse gases[4]. Bainbridge Island is currently conducting a greenhouse gas inventory for the Island, but it is anticipated that the contribution from electrical generation maybe higher than the State average since a large percentage of electrical generation is from hydroelectricity. Bainbridge gets its electricity from Puget Sound Energy that has a fuel mix of over 60% fossil fuels. It is anticipated that Bainbridge Islands percent of greenhouse gases from electricity generation will be greater than the State average. The values from the inventory will be used as a baseline for evaluating potential reductions in emissions.

[4] https://ecology.wa.gov/Research-Data/Scientific-reports/Statewide-greenhouse-gas-inventory

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Commented [BS14]: Current State legislation is for 100% clean energy by 2045.

Commented [BS15]: Should this be 1) net zero carbon emissions; 2) 100% renewables; 3) 100% clean energy; or 4) carbon neutrality/

Commented [BS16]: I assume we know this

The Washington State legislator is considering establishing a goal of achieving 100% clean energy from electricity generators by 2045[5]. Across the U.S. over 90 cities, more than ten counties and two states, have already adopted ambitious 100% clean energy goals. Six cities in the U.S.--Aspen, Burlington, Georgetown, Greensburg, Rock port, and Kodiak Island--have already hit their targets[6].

The urgency to achieve 100% electricity from clean, renewable energy sources is highlighted in a 2018 report from the Intergovernmental Panel on Climate Change[7] that indicated in order to keep global temperatures below 1.5 degrees Celsius compared to post-industrial levels will require net zero global carbon emissions by 2050. We believe Bainbridge Island should strive to meet these targets in order to do our part to keep global temperatures below 1.5 degrees Celsius compared to post-industrial levels. Table 2 provides specific actions that we propose to assist to meet the energy production target in three areas:

- Energy delivery
- Energy conservation and energy efficiency; and
- Local renewable energy sources

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Table 3~~2~~: Energy Production

Action	Priority	Timeline	Resources	Status
Energy Delivery				
Ensure energy delivered to Bainbridge Island is from renewable, lowest GHG emissions sources: Develop an RFP and criteria for the renewal of our island electric utility provider franchise agreement that requires delivery of 100% lowest carbon, renewable energy to all consumers on Bainbridge Island that is additive to the fuel mix of the energy provider (unless they are already 100% renewable carriers with excess product to sell).	High			
Energy Conservation and Efficiency				
Incentivize reduction in propane use: Generation, transportation and combustion of propane results in GHG emissions and has air quality impacts. Develop strategies to decrease Island use of propane.	High			

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[5] SB-5116- 2019-20. https://app.leg.wa.gov/billsummary?BillNumber=5116&Initiative=false&Year=2019

[6] https://www.sierraclub.org/ready-for-100/commitments

[7] IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. https://www.ipcc.ch/sr15/

Action	Priority	Timeline	Resources	Status
Limit GHG emissions from buildings: Require that all new and re-development minimizes GHG emissions by 1) maximizing energy efficiency and 2) increasing renewable generation either on site or at a community renewable energy investment site. This will decrease our total grid demand decreasing the need to expand our energy delivery infrastructure (which is costly) and decrease greenhouse gas emissions from a mixed grid.	High			
Island renewable energy				
Create community renewable energy project sites: Not all sites on Bainbridge Island are suitable for renewable energy generation, but local renewable generation is part of building our resilience while decreasing our GHG emissions. Giving community members the opportunity to invest in and benefit from local generation (including financially through benefit from selling electrons into the grid) can increase local generation for those sited where it is not a functional option, and protect local tree canopy in those locations.	High			
Develop Local Micro-grids: Harness local renewable energy production into local micro-grids to increase our resilience including increasing reliability.	Medium			

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Commented [BS17]: This could go under land use and buildings?

Section 3.2: Transportation

Target: By 2035, reduce greenhouse gas emissions from transportation Island-wide by 50% compared to 2018 levels with interim targets of 25% by 2025 and 40% by 2030.

Or

By 2050, 50% less per-capita travel by light duty vehicles by shifting to less GHG-intensive travel modes such as ride sharing, transit, walking and biking with an interim target of 30% less per-capita travel by light duty vehicles by 2030[8].

[8] Getting to Zero. A Pathway to a Carbon Neutral Seattle. May 2011. http://www.seattle.gov/environment/climate-change/climate-planning/climate-action-plan

Rationale: In Washington State, transportation is estimated to produce almost 43%[9] of greenhouse gases. Bainbridge Island is currently conducting a greenhouse gas inventory for the Island, but it is anticipated that the contribution from transportation will be similar to the State wide percent of emissions. The values from the Inventory will be used as a baseline for evaluating potential reductions in emissions.

Table 3 provides specific actions that we propose to assist to meet the transportation target in three areas:

- Public transportation;
- Electric vehicles; and
- Non-motorized transportation

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Table 43: Transportation

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Action	Priority	Timeline	Resources	Status
Public Transportation				
Develop better understanding of park and rides: How well are these understood? Are they organic? Are they planned? Do we have a map of park and rides?	H			
Electric Vehicles				
Support and incentivize electrification of transportation on island: In order to reduce GHG emissions and improve local air quality, create incentives to move our island transportation fleet toward electrification. private car owners (perhaps reduce local car tabs for electric vehicles).	H			
Encourage School District/COBI/Parks to move towards electric fleets: Encourage the school district, parks, and COBI to move towards electrification of their fleet and battery storage. Some examples can be found at https://driveevfleets.org/ of ideas from other cities.	H			
Support Washington State Ferries Efforts towards electrification: Electrification is already underway at the WSF. City ~~can~~ supports ~~their~~ efforts to use VW funds to make this conversion, and ask WSF to consider lower rates for electric cars as it also provide health benefits their deck hands.	H			

[9] https://ecology.wa.gov/Research-Data/Scientific-reports/Statewide-greenhouse-gas-inventory

Action	Priority	Timeline	Resources	Status
Explore Options with Kitsap Transit to move towards electrification of their fleet: Meet with Kitsap Transit to learn of their plans for fleet electrification ~~of their fleet~~ and how they could increase the use of electric buses.	H			
Develop strategies to encourage use of electric vehicles: Develop strategies to develop electric vehicle infrastructure and access for high density housing. Evaluate how many electric cars on the Island and explore innovate ways to use cars during low production time.	M			
Explore the use of electric vehicles with UPS/Fedex/USPS: Meet with the deliver companies to determine if they have pilot programs with electrification or if we could work with them to develop a pilot program. Also, we could prompt anti-idling with them.	M			
Non-Motorized				
Work with the Council, Multi-modal Committee, and Mobility Alliance on possible second levy for non-motorized transportation: Work with all the groups to provide support on efforts to advance non-motorized transportation on the Island and increase island non-autocentric transit paths.	H			
Introduce hierarchy of transit concept for adoption by council: In the spirit of transit equity and community safety (while working to reduce greenhouse gas emissions), consider the most vulnerable, then design and implement transit to support pedestrians, bicycles, mass transit and individual cars, in that order.	H			
Anti-idling ordinance: Explore providing full coverage of sidewalks, bike paths (both off road when possible) in Winslow and all service centers, off road non-motorized transit paths between all service centers and Winslow (eventually between each other as well). Highly dependent on levy.	M			

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Section 3.3: Buildings and Land-Use

Target: By 2021, develop mandatory green building standards for all City-owned buildings over 5000 square feet. By 2021, develop incentive programs to encourage green building in all residential and commercial buildings.

Rationale: In Washington State, residential, commercial, and industrial buildings are estimate to provide almost 21% of greenhouse gases[10]. Bainbridge Island is currently conducting a greenhouse gas inventory for the Island, but it is anticipated that the contribution from transportation will be similar to the State wide percent of emissions. The values from the greenhouse inventory will be used as a baseline for evaluating potential reductions in emissions.

Table 54: Buildings and Land Use

Action	Priority	Timeline	Resources	Status
Buildings				
Support development of mandatory Green Building standards for all City-owned buildings over 5000 square feet: Work with Design Review board, city staff, and others to develop a mandatory green building program.	H			
Support development of incentive programs for residential and commercial development: Programs could include reducing plan check and building permit fees and expedited permit review for those projects that pursue some minimum green building standards.,	H			
Land Use				
Create Island-wide land use plan that reflects mitigation and adaptation goals: Develop guidelines to encourage siting of projects to reduce greenhouse gas emissions: This could include where to develop to decrease GHG emissions (e.g., decrease miles driven), maintain open space services (e.g., water recharge, water filtration, air filtration, temperature amelioration), increase permeable surfaces (built and natural), manage for change, etc.	H			

[10] https://ecology.wa.gov/Research-Data/Scientific-reports/Statewide-greenhouse-gas-inventory

Commented [MOU18]: Why not all buildings?

Commented [MOU19]: Why not code requirements?

Commented [BS20]: This needs much more discussion with Design review board, city, etc.

Do we want a mandatory program for private and commercial buildings?

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Section 3.4: Waste Management

Target: By 2035, reduce greenhouse gas emissions from solid waste and waste water management by 80% from 2018 levels with interim targets of 40% by 2025 and 60% by 2030.

Rationale: In Washington State, solid waste and wastewater management contribute about 4% of total greenhouse gases[11]. Bainbridge Island is currently conducting a greenhouse gas inventory for the Island, but it is anticipated that the contribution from solid waste and wastewater management will be similar to the State-wide percent of emissions. The values from the greenhouse inventory will be used as a baseline for evaluating potential reductions in emissions.

Table 6~~5~~: Waste Management

Action	Priority	Timeline	Resources	Status
Increase use of greenwaste bins for household and commercial food waste: City would develop food waste diversion program for households and commercial businesses to greenwaste bins for compost or energy production to eliminate landfilling of food waste which causes methane emissions	H			

[11] https://ecology.wa.gov/Research-Data/Scientific-reports/Statewide-greenhouse-gas-inventory

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Commented [BS21]: No idea if these are realistic targets.

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Section 4: Adaptation

Adaptation target: Minimize or ameliorate the impacts of climate change on our community and our Island's ecosystems through climate-informed policies, programs and development regulations.

Rationale for targets:

Actions to achieve targets: In order to achieve these targets we believe action is needed in two main areas:

- ~~Greenhouse gas emissions;~~
- Vulnerability assessments; and
- Integration of adaptation into all City business in order to decrease long-term costs and increase long-term effectiveness of City actions

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For each of these areas we identify actions as either: 1) high, medium, or low priority; 2) describe the action; 3) provide a timeline to complete; 4) identify any resources needed to accomplish; and 5) provide a status for each action. This table will be updated every 6 months and presented to the City Council.

Table 76: ~~: GHG Emissions~~/Vulnerability Assessment/Integration

Action	Priority	Timeline	Resources	Status
~~GHG Emissions~~				
~~Complete Island-wide GHG Inventory~~: ~~Hire consultant to complete and Island-wide GHG emissions inventory~~	~~H~~			
~~Work with High School on Annual update to GHG Inventory~~: ~~Collaborate with BISD/BHS/Eagle Harbor High to add curriculum module that will include an annual GHG inventory by students~~	~~H~~			
~~Develop COBI internal carbon pricing program:~~ ~~COBI would incorporate a shadow price for carbon in evaluating all new capital and procurement decisions, and/or implement a carbon fee for operations, revenues from which could be invested in energy efficiency and clean energy projects at city facilities. Each department is given a carbon budget (as well as a financial budget) for the year.~~	~~M~~			
Vulnerability Assessments				
Evaluate vulnerability of City assets to climate change~~sea level rise~~: Starting with sea level rise, evaluate the vulnerability of COBI assets including roads	H			

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Action	Priority	Timeline	Resources	Status
(motorized ~~and~~ & non-), other infrastructure (sewage treatment, water, buildings), and marine access.				
Hold community discussions around vulnerable sites: ~~Work with~~ City to host community conversations ~~about~~ with vulnerable sites and how to adapt to those changes.	H			
Integration				
Evaluate projects for vulnerability to climate change: Create a pathway for new COBI projects to be shared with the CCAC (or city staff ~~other city body~~) for evaluation of their vulnerability to climate change, such that design and siting can be best informed for long-term success.	H	2019		
Develop program to evaluate all permits and developments for vulnerability to climate change: All permits and non-COBI public fund expenditures should be evaluated for their vulnerability to climate change and a determination of how to proceed based on this assessment in order to ensure better long-term outcomes in the face of factors such as sea level rise, altered precipitation patterns, increasing temperatures and other climate related hazards.	H	2019		

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Section 5: Citizen Engagement

Adaptation target:

Rationale for targets:

For each of these areas we identify actions as either: 1) high, medium, or low priority; 2) describe the action; 3) provide a timeline to complete; 4) identify any resources needed to accomplish; and 5) provide a status for each action. This table will be updated every 6 months and presented to the City Council.

Table 8: Citizen Engagement

Action	Priority	Timeline	Resources	Status
Create Climate Change Week: Council proclamation to designate a week each year for city and community evaluation of the progress made on meeting our community commitments and goals relating to reducing our contribution and vulnerability to climate change.	H			
Support Community events on climate change: Participate in on-going information forums such as the Climate and Energy Forum and the Movies that Matter	H			

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Puget Sound Clean Air Agency

Greenhouse Gas Emissions Inventory

REVISED JUNE 2018

Prepared for the Puget Sound Clean Air Agency

CASCADIA
CONSULTING GROUP

Table of Contents

Executive Summary

As a growing area with robust industries and thriving communities, the Puget Sound region has a responsibility to address the threats of climate change. Quantifying sources of greenhouse gases is a fundamental step toward reducing greenhouse gas (GHG) emissions and tracking progress toward emission reduction goals.

In 2005, the Puget Sound Clean Air Agency (PSCAA) conducted the first comprehensive greenhouse gas inventory of its four-county area, which includes King, Pierce, Snohomish, and Kitsap counties. This report provides a 2015 update of community emissions within the agency's jurisdictions.

The inventory has been updated to follow the latest accepted greenhouse gas emission accounting protocols and datasets. The *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* ("U.S. Community Protocol") has emerged as a consistent, U.S.-specific framework for quantifying GHG emissions at the community level. This 2015 inventory for the Puget Sound Clean Air Agency follows the Community Protocol and includes emissions from transportation and building energy use, water and wastewater treatment and conveyance, land use change, and solid waste transport and disposal.

2015 Inventory Findings

The 2015 PSCAA greenhouse gas inventory revealed the following key findings:

- Greenhouse gas emissions in 2015 totaled 34.4 million megagrams (Mg)—or million metric tons (MT)—of carbon dioxide equivalent (CO_2e) in PSCAA's four-county area.
- In 2015, the average resident within the PSCAA's jurisdiction emitted 8.8 $MgCO_2e$.
- In 2015, the largest sources of community greenhouse gas emissions were the built environment (commercial, residential, and industrial sectors; 57%) and transportation (on-road vehicles, air travel, freight rail, marine vessels, and off-road vehicles; 38%).
- Passenger vehicles comprise the largest share of transportation emissions (74%), followed by freight and service vehicles (14%).
- Emissions from solid waste (2%), wastewater (1%), and agriculture (1%) were minimal in the Puget Sound region in 2015—typical of community GHG inventories.
- The largest source of other emissions was from residential land development (approximately 93,000 $MgCO_2e$).

Figure 1. Sources of greenhouse gas emissions for the PSCAA area in 2015, in million $MgCO_2e$ (total = 34.4 million $MgCO_2e$).

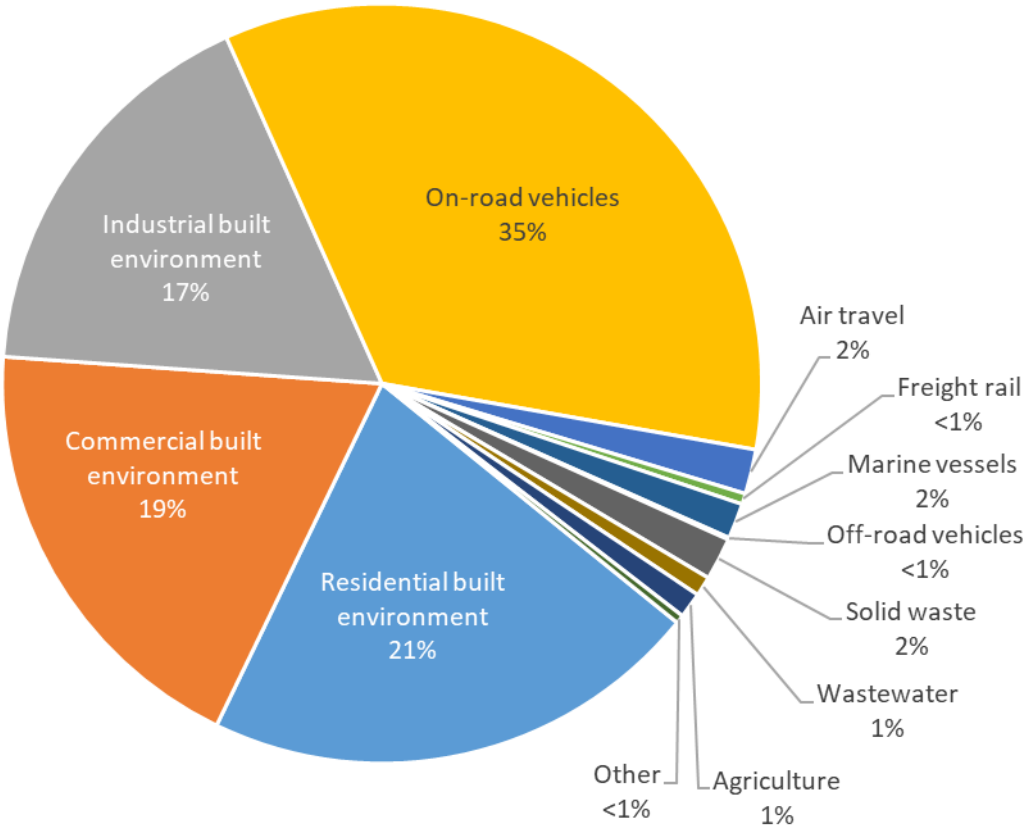
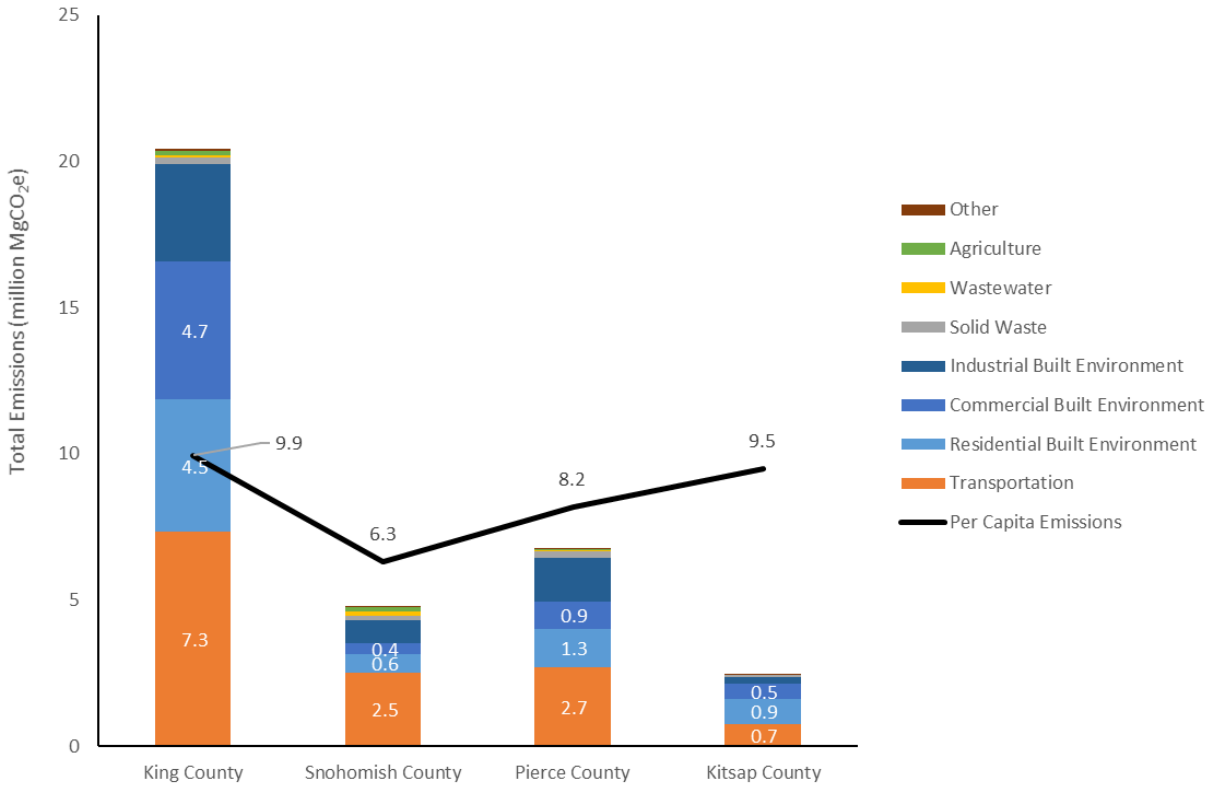


Figure 2. 2015 greenhouse gas emissions in the PSCAA area, by county.



Acronyms

BOD	Biochemical oxygen demand (a measure of the effectiveness of wastewater treatment plants)
EIA	United States Energy Information Association
EPA	United States Environmental Protection Agency
CNG	Compressed natural gas
CO_2e	Carbon dioxide equivalents
GHG	Greenhouse gas, limited to CO_2, CH_4, N_2O, and fugitive gases in this inventory
LPG	Liquefied petroleum gas
MOVES	Motor Vehicle Emission Simulator model, a model developed by U.S. EPA to quantify emissions from mobile sources
NONROAD	A tool developed by U.S. EPA to quantify non-road mobile emissions
PSCAA	Puget Sound Clean Air Agency
PSE	Puget Sound Energy
PSRC	Puget Sound Regional Council
SCL	Seattle City Light
SPU	Seattle Public Utilities
TCR	The Climate Registry
USDA	United States Department of Agriculture
WARM	Waste Reduction Model, a model developed by EPA to quantify solid waste emissions
WSDOT	Washington Department of Transportation
VMT	Vehicle Miles Traveled

Introduction and Context

Greenhouse gas inventories allow communities to account for sources and quantities of GHG emissions generated by community activities. This inventory includes both "in-boundary" emission *sources*—any physical process inside the jurisdictional boundary that releases GHG emissions—and *activities* resulting in GHG emissions. For example, it includes emissions associated with the in-county production of food and goods, regardless of where those goods are consumed, such as from a manufacturer located within King County that produces goods for export.

Greenhouse gas inventories provide insights about different emission footprints of a community. To the extent possible, this inventory quantifies emissions that result from *activities* of the community, regardless of geographic location. For example, emissions from solid waste disposal include landfill emissions from waste produced by City of Seattle residents but transported to a landfill in Oregon.

This report quantifies emissions associated with the following community activities within each county:

- **Transportation**, including from vehicle, air, marine, and rail travel.
- **Building, industrial, and equipment energy use**, including natural gas, electricity, and oil.
- **Refrigeration and electricity conveyance**.
- **Solid waste transport and disposal**, including emissions from landfilling and composting of waste disposed by residents and businesses within PSCAA counties, regardless of where that waste is ultimately transported.
- **Water and wastewater treatment and conveyance**.
- **Agriculture and land use change,** including livestock, soil and manure management, and land clearing from development.

In 2008, PSCAA conducted a comprehensive emissions inventory for the 2005 calendar year. The 2005 inventory included emissions of many different pollutants, including carbon monoxide (CO), nitrous oxides (NOx), fine particulate matter ($PM_{2.5}$), volatile organic compounds (VOC), sulfur oxides (SO_x), and carbon dioxide (CO_2). Table 1 below summarizes greenhouse gas emissions that were included in the 2005 inventory and this 2015 inventory update. In some cases, the quantification of emissions in these sectors is not comprehensive due to data availability limitations.

Table 1. Activities included in 2005 and 2015 greenhouse gas inventories.

	Included in inventory?	
Sector	2005	2015
Transportation		
On-road vehicles	✓	✓
Airport travel and ground support equipment	✓	✓
Rail transport and maintenance equipment	✓	✓
Commercial and recreational marine vessels	✓	✓
Miscellaneous non-road vehicles and equipment	✓	✓

Sector	Included in inventory? 2005	2015
Stationary combustion		
Petroleum-based fuel consumption (distillate oil, natural gas, propane)	✓	✓
Indoor and outdoor wood burning	✓	
Forest management and wildfires	✓	
Other GHG sources		
Livestock and land use	✓	✓
Non-energy use fuel	✓	✓
Other processes releasing GHGs		
Cement production	✓	✓
Steel production	✓	✓
Dry cleaning	✓	
SF_6 from power distribution	✓	✓
Surgical wards	✓	
Greenhouse gas sinks		
Forest carbon sequestration	✓	
Electricity production and consumption		
Electric power production	✓	
Electric power consumption	✓	✓

This inventory report provides a 2015 update of GHG emissions in the PSCAA jurisdictions. Because the 2015 update follows a different protocol than was used for the previous PSCAA inventory, emissions and resultant trends should not be compared between these two inventories.

Roadmap of this Report

This report is organized into the following sections:

- **Results:** A summary of inventory outcomes, trends, and key findings.
- **Data Sources:** Detail on reports, databases, and other information sources used to arrive at activity and emissions factor data.
- **Methodology:** An overview of the approaches, assumptions, and calculations used to quantify emissions values for each sector.
- **Data Source Limitations:** A list of key data sources that were not available at the time of this inventory update.
- **Conclusion:** Summary statements on the inventory process, project outcomes, and implications for future progress tracking and action planning.

Results

The 2015 inventory and methodological updates revealed the following key findings:

- Greenhouse gas emissions in 2015 totaled 34.4 million megagrams (Mg), or million metric tons (MT), of carbon dioxide equivalent (CO_2e) in PSCAA's four-county area.
- In 2015, the average resident within the PSCAA's jurisdiction emitted 8.8 $MgCO_2e$.
- In 2015, the largest sources of community greenhouse gas emissions were the built environment (commercial, residential, and industrial sectors; 57%) and transportation (on-road vehicles, air travel, freight rail, marine vessels, and off-road vehicles; 38%).
- Passenger vehicles comprise the largest share of transportation emissions (74%), followed by freight and service vehicles (14%).
- Emissions from solid waste (2%), wastewater (1%), and agriculture (1%) were minimal in the Puget Sound region in 2015—typical of community GHG inventories.
- The largest source of other emissions was emissions from residential land development (approximately 93,000 $MgCO_2e$).

Figure 3. Sources of greenhouse gas emissions for PSCAA counties in 2015, in million $MgCO_2e$ (total =34.4 million $MgCO_2e$).

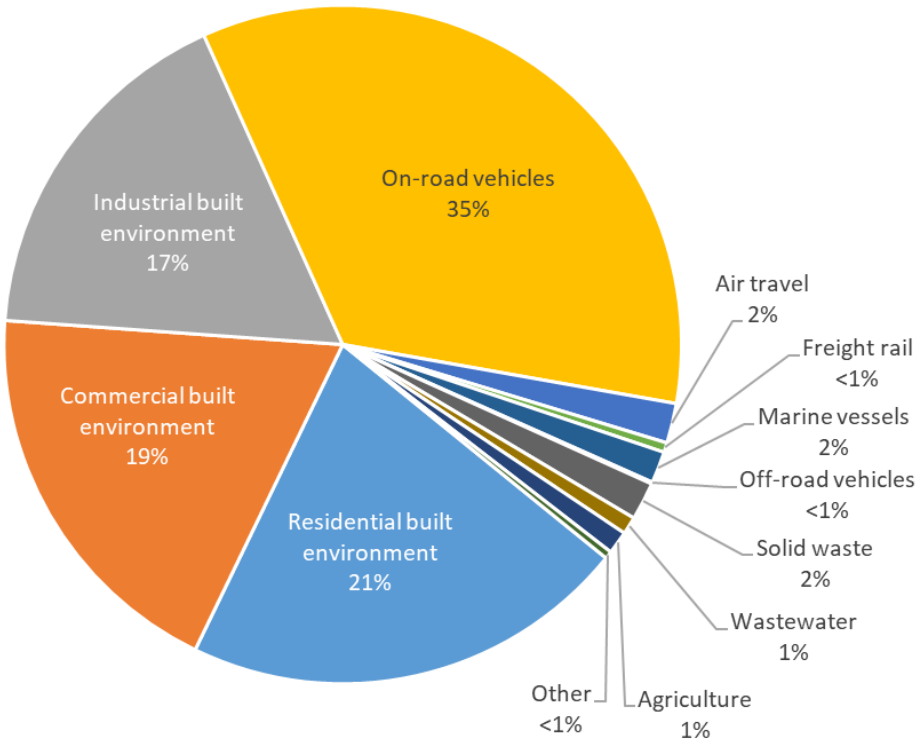


Figure 4. 2015 greenhouse gas emissions in the PSCAA area, by county.

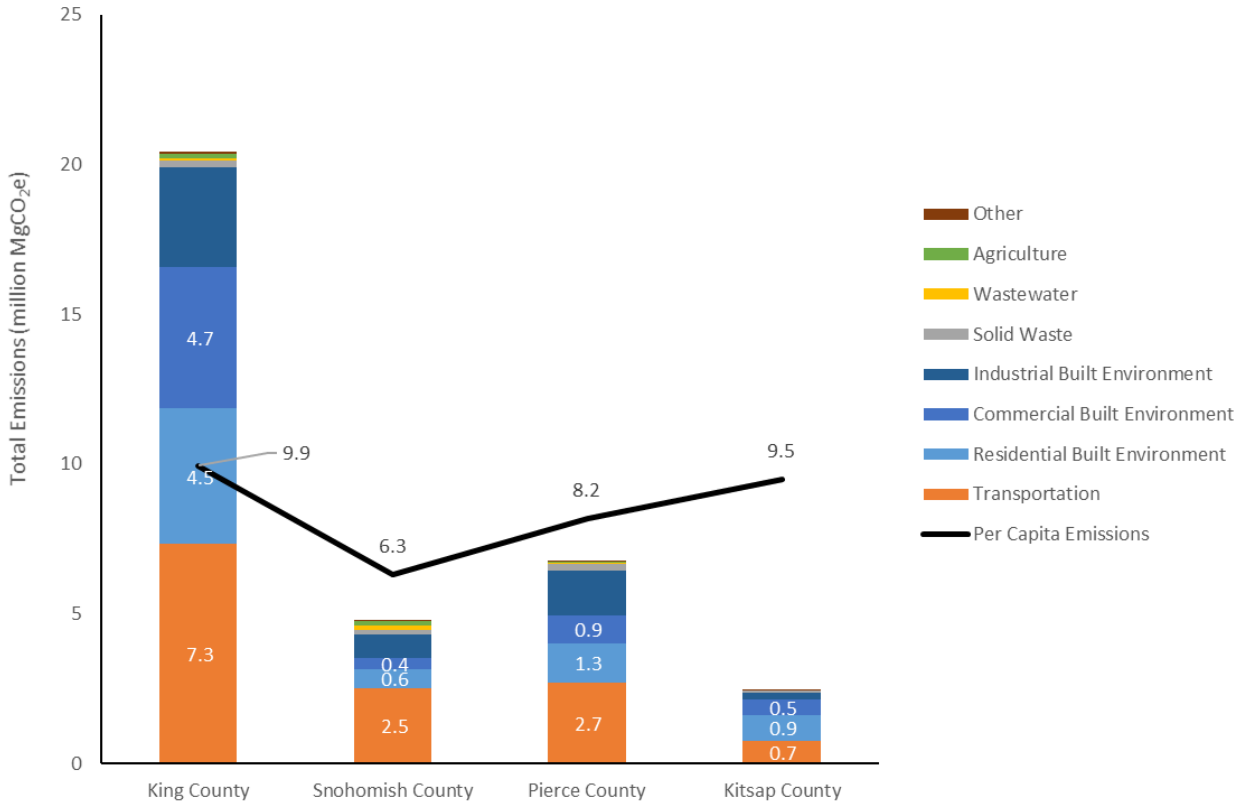


Figure 5. Proportional contributions to 2015 county GHG emissions.

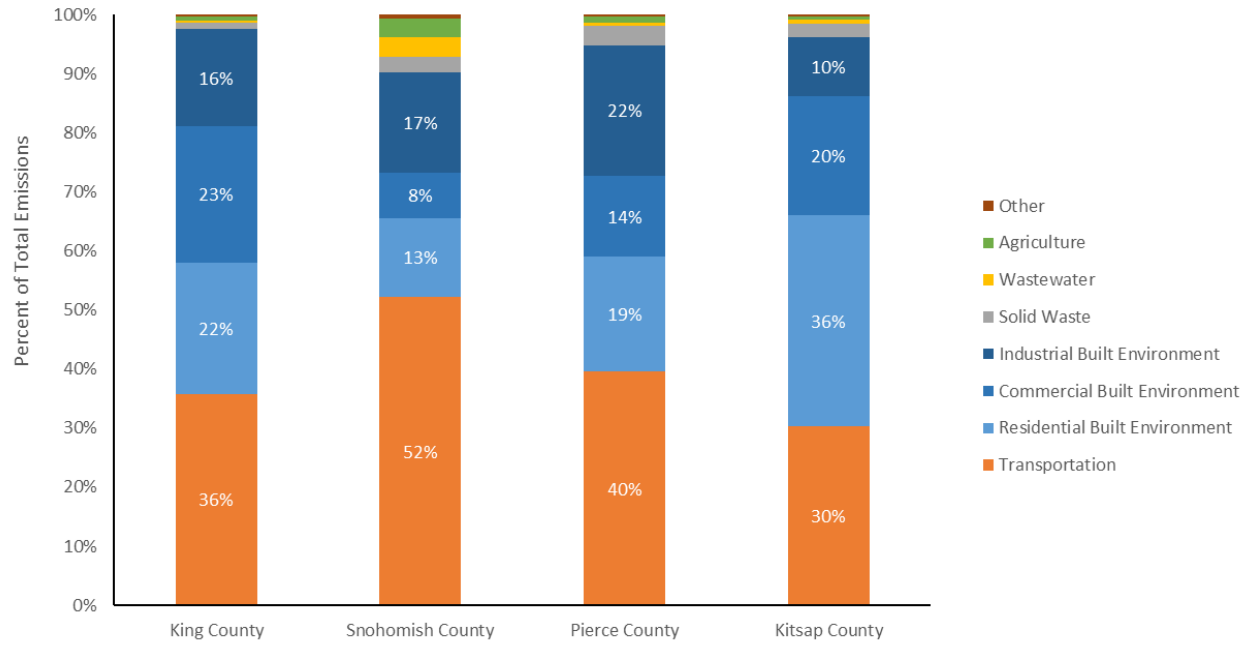


Table 2. PSCAA GHG emissions in 2015, by county and sector ($MgCO_2e$).

GHG Emissions by Sector ($MgCO_2e$)	King	Snohomish	Pierce	Kitsap	Total
Built Environment	**12,602,600**	**1,821,100**	**3,744,900**	**1,614,000**	**19,782,600**
Residential	**4,524,400**	**639,400**	**1,312,800**	**874,700**	**7,351,300**
Electricity	2,597,100	94,900	713,400	630,100	4,035,500
Natural Gas	1,567,600	453,100	482,500	205,100	2,708,300
Petroleum (Heating)	132,100	13,100	37,300	16,200	198,700
Petroleum (Non-road equipment)	227,600	78,300	79,600	23,300	408,800
Commercial	**4,737,100**	**365,300**	**928,800**	**496,300**	**6,527,500**
Electricity	2,955,800	65,700	479,500	347,400	3,848,400
Natural Gas (Heat and Other)	1,147,400	220,000	358,800	63,000	1,789,200
Natural Gas (Equipment)	18,700	3,200	18,000	800	40,700
Petroleum (Heat and Other)	254,600	42,800	53,800	76,800	428,000
Petroleum (Equipment)	212,500	33,600	18,700	8,300	273,100
Steam	148,100	-	-	-	148,100
Industrial	**3,341,100**	**816,400**	**1,503,300**	**243,000**	**5,903,800**
Electricity	611,600	15,400	220,100	4,800	851,900
Process emissions	351,100	-	101,500	-	452,600
Stationary combustion	1,323,900	403,700	746,800	100,400	2,574,800
Fugitive gas	1,054,500	397,300	434,900	137,800	2,024,500
Transportation and Other Mobile Sources	**7,318,300**	**2,499,500**	**2,683,700**	**745,400**	**13,246,900**
On-road vehicles	**6,349,800**	**2,359,200**	**2,521,000**	**654,800**	**11,884,800**
Passenger vehicles	5,142,700	1,985,000	2,128,600	582,300	9,838,600
Freight and service vehicles	1,048,600	338,500	371,900	65,800	1,824,800
Transit vehicles	158,500	35,700	20,500	6,700	221,400
Freight and passenger rail	**81,000**	**30,000**	**47,300**	**-**	**158,300**
Marine vessels	**220,600**	**102,700**	**108,400**	**88,100**	**519,800**
Off-road vehicles and other mobile equipment	**12,300**	**7,600**	**7,000**	**2,500**	**29,400**
Air travel	**654,600**	*	*	*	**654,600**
Solid Waste	**225,600**	**120,900**	**219,100**	**56,600**	**622,200**
Generation and disposal of solid waste	225,600	120,900	219,100	56,600	622,200
Water and Wastewater	**73,300**	**159,300**	**45,000**	**17,700**	**295,300**
Potable water process emissions	900	400	3,800	1,200	6,300
Wastewater process emissions	72,400	158,900	41,200	16,500	289,000
Agriculture	**145,500**	**154,000**	**63,700**	**12,800**	**376,000**
Domesticated animal production	78,700	64,900	28,100	4,800	176,500
Manure decomposition and treatment	66,800	89,100	35,600	8,000	199,500
Supplementary Emission Sectors	**58,800**	**31,500**	**24,000**	**8,500**	**122,800**
Soil management	9,400	13,900	5,500	1,200	30,000
Residential development	49,400	17,600	18,500	7,300	92,800
Total Emissions	**20,423,200**	**4,785,900**	**6,776,600**	**2,453,800**	**34,439,500**

** Data on jet fuel use from small regional airports are difficult to obtain and estimated to contribute less than 1% of all county emissions. Therefore, only commercial airport emissions from Seattle-Tacoma and King County International airports are included in this inventory.*

Table 3. 2015 per-capita GHG emissions for PSCAA region, by county and sector ($MgCO_2e$/resident).

Per Capita GHG Emissions by Sector ($MgCO_2e$/resident)	King	Snohomish	Pierce	Kitsap	Four-County Area
Built Environment	**6.1**	**2.4**	**4.5**	**6.3**	**5.1**
Residential	**2.2**	**0.8**	**1.6**	**3.4**	**1.9**
Electricity	1.3	0.1	0.9	2.4	1.0
Natural Gas	0.8	0.6	0.6	0.8	0.7
Petroleum (Heating)	<0.1	<0.1	<0.1	<0.1	<0.1
Petroleum (Non-road equipment)	0.1	0.1	<0.1	<0.1	0.1
Commercial	**2.3**	**0.5**	**1.1**	**1.9**	**1.7**
Electricity	1.4	<0.1	0.6	1.3	1.0
Natural Gas (Heat and Other)	0.6	0.3	0.4	0.2	0.5
Natural Gas (Equipment)	<0.1	<0.1	<0.1	<0.1	<0.1
Petroleum (Heat and Other)	0.1	<0.1	<0.1	0.3	0.1
Petroleum (Equipment)	0.1	<0.1	<0.1	<0.1	<0.1
Steam	<0.1	<0.1	<0.1	<0.1	<0.1
Industrial	**1.6**	**1.1**	**1.8**	**0.9**	**1.5**
Electricity	0.3	<0.1	0.3	<0.1	0.2
Process emissions	0.2	<0.1	0.1	<0.1	0.1
Stationary combustion	0.6	0.5	0.9	0.4	0.7
Fugitive gas	0.5	0.5	0.5	0.5	0.5
Transportation and Other Mobile Sources	**3.6**	**3.3**	**3.2**	**2.9**	**3.4**
On-road vehicles	**3.1**	**3.1**	**3.0**	**2.5**	**3.0**
Passenger vehicles	2.5	2.6	2.6	2.3	2.5
Freight and service vehicles	0.5	0.4	0.4	0.3	0.5
Transit vehicles	<0.1	<0.1	<0.1	<0.1	<0.1
Freight and passenger rail	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Marine vessels	**0.1**	**0.1**	**0.1**	**0.3**	**0.1**
Off-road vehicles and other mobile equipment	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Commercial airport	**0.3**	*	*	*	**0.2**
Solid Waste	**0.1**	**0.2**	**0.3**	**0.2**	**0.2**
Generation and disposal of solid waste	0.1	0.2	0.3	0.2	0.2
Water and Wastewater	**<0.1**	**0.2**	**<0.1**	**<0.1**	**<0.1**
Potable water process emissions	<0.1	<0.1	<0.1	<0.1	<0.1
Wastewater process emissions	<0.1	0.2	<0.1	<0.1	<0.1
Agriculture	**<0.1**	**0.2**	**<0.1**	**<0.1**	**<0.1**
Domesticated animal production	<0.1	<0.1	<0.1	<0.1	<0.1
Manure decomposition and treatment	<0.1	0.1	<0.1	<0.1	<0.1
Supplementary Emission Sectors	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Soil management	<0.1	<0.1	<0.1	<0.1	<0.1
Residential development	<0.1	<0.1	<0.1	<0.1	<0.1
Total Emissions	**9.9**	**6.3**	**8.2**	**9.5**	**8.8**

** Data on jet fuel use from small regional airports are difficult to obtain and estimated to contribute less than 1% of all county emissions. Therefore, only commercial airport emissions from Seattle-Tacoma and King County International Airports are included in this inventory.*

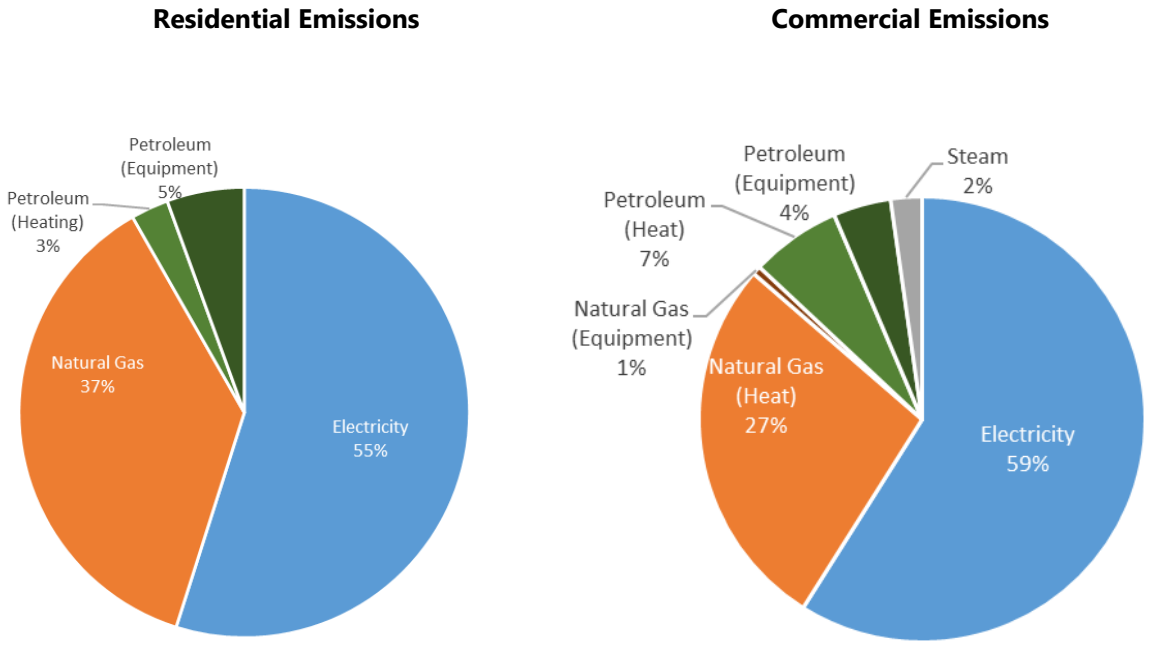
Residential and Commercial Built Environment

Emissions from the built environment resulted in the following key trends and findings:

- In 2015, the built environment accounted for 57% of communitywide emissions. Emissions from commercial and residential buildings accounted for most of those emissions (70%) and 40% of all emissions.
- Electricity consumption—especially within residential and commercial sectors—comprised the largest share of built environment emissions, followed by natural gas consumption (see Figure 6).

After electricity and natural gas, petroleum-based fuels are the third-largest source of emissions for the residential and commercial built environment. In the residential sector, petroleum-based fuels are used for equipment (i.e., lawn, garden, and recreational) and account for more emissions than heating oil.

Figure 6. Sources of residential (left) and commercial (right) GHG emissions in 2015.



PSCAA region's electricity is also connected to the regional grid. To put these counties' emissions in context, a sensitivity analysis was run per the recommendations of the U.S. Community Protocol to compare the utility-specific emissions profile with that of the regional grid. Results are shown in Figure 8. In general, the utility-specific emissions profiles generated fewer GHG emissions than the regional eGRID emission factor.

The utilities serving a county play a large role in driving GHG emissions. We weighted utility-specific emission factors by electricity consumption within each county to arrive at "weighted emission factors." This analysis demonstrates the relative influence of each utility on the county's overall emissions profile.

Table 4. Emission factors ($MgCO_2e$/MWh) of PSCAA-area electric utilities as compared to the regional average.

Public Utility	County	Utility-Specific Emission Factor	Performance ratio to NWPP 2014 eGRID
Puget Sound Energy	King, Pierce, and Kitsap	0.483	1.16
Seattle City Light	King	0.024	0.06
Snohomish PUD	Snohomish	0.026	0.06
Tacoma Power	Pierce	0.031	0.08
Peninsula Light	Pierce	0.032	0.08
Lakeview Power and Light	Pierce	0.027	0.07
Average		**0.10**	**0.25**

Table 5. Electricity consumption by utility company per county first as kWh, then as a percentage. Each county received a weighted emissions factor as a function of the emission factors of that county's utilities and the power each utility generated.

	King	Snohomish	Pierce	Kitsap	Total
Electricity Consumption (kWh)					-
Puget Sound Energy	12,299,969,803		2,317,638,248	1,938,616,472	**16,556,224,523**
Seattle City Light	9,521,275,614				**9,521,275,614**
Snohomish PUD		6,474,983,000			**6,474,983,000**
Tacoma Power			4,592,605,000		**4,592,605,000**
Peninsula Light			585,060,000		**585,060,000**
Lakeview Power and Light			262,975,000		**262,975,000**
TOTAL	**21,821,245,417**	**6,474,983,000**	**7,758,278,248**	**1,938,616,472**	**37,993,123,137**
Proportion within County					
Puget Sound Energy	56%		30%	100%	
Seattle City Light	44%				
Snohomish PUD		100%			
Tacoma Power			59%		
Peninsula Light			8%		
Lakeview Power and Light			3%		
TOTAL	**100%**	**100%**	**100%**	**100%**	
Emissions Factor x Proportion					
Puget Sound Energy	0.27		0.14	0.48	**0.48**
Seattle City Light	0.01				**0.03**
Snohomish PUD		0.03			**0.03**
Tacoma Power			0.02		**0.03**
Peninsula Light			0.002		**0.03**
Lakeview Power and Light			0.001		**0.03**
WEIGHTED EMISSIONS FACTOR	**0.28**	**0.03**	**0.17**	**0.48**	

Table 6. Reported fuel mix of PSCAA-area electric utilities in 2015 (Source: Washington State Department of Commerce).

	Puget Sound Energy	Seattle City Light	Snohomish PUD	Tacoma Power	Peninsula Light	Lakeview Power and Light	Regional Average
Hydro	28.65%	87.33%	86.71%	88.64%	83.52%	86.30%	76.86%
Coal	36.65%	2.37%	2.26%	2.71%	2.76%	2.35%	8.18%
Natural gas	29.66%	0.85%	0.83%	0.98%	1.01%	0.86%	5.70%
Petroleum	0.10%	0.02%	0.02%	0.02%	0.02%	0.02%	0.03%
Nuclear	0.59%	4.74%	9.79%	6.11%	9.82%	10.18%	6.87%
Wind	3.90%	3.10%	0.12%	1.30%	2.57%	0.00%	1.83%
Biomass	0.32%	0.41%	0.21%	0.18%	0.23%	0.22%	0.26%
Landfill	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
Cogeneration	0.00%	1.14%	0.00%	0.00%	0.00%	0.00%	0.19%
Solar	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Waste	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Geothermal	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Other	0.13%	0.04%	0.06%	0.06%	0.07%	0.07%	0.07%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 7. Residential emissions, by source and county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Electricity	2,597,076	94,911	713,354	630,065	**4,035,407**
Natural gas heating	1,567,570	453,130	482,505	205,059	**2,708,264**
Petroleum heating	132,141	13,096	37,261	16,249	**198,747**
Lawn and garden	227,600	78,300	79,600	23,300	**408,800**
Total	**4,524,388**	**639,437**	**1,312,720**	**874,673**	**7,351,218**

Table 8. Commercial emissions, by source and county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Electricity	2,955,818	65,669	479,489	347,354	**3,848,330**
Natural gas heating	1,147,441	219,961	358,811	62,968	**1,789,181**
Petroleum heating	254,615	42,789	53,751	76,796	**427,952**
Steam	148,193	-	-	-	**148,193**
Commercial equipment	361,710	100,621	99,037	96,287	**657,655**
Airport equipment	42,673	7,577	6,768	9,626	**66,643**
Total	**4,910,450**	**436,617**	**997,855**	**593,032**	**6,937,954**

Figure 7. Utility-specific 2015 electricity emissions factors for PSCAA-area electricity utilities.

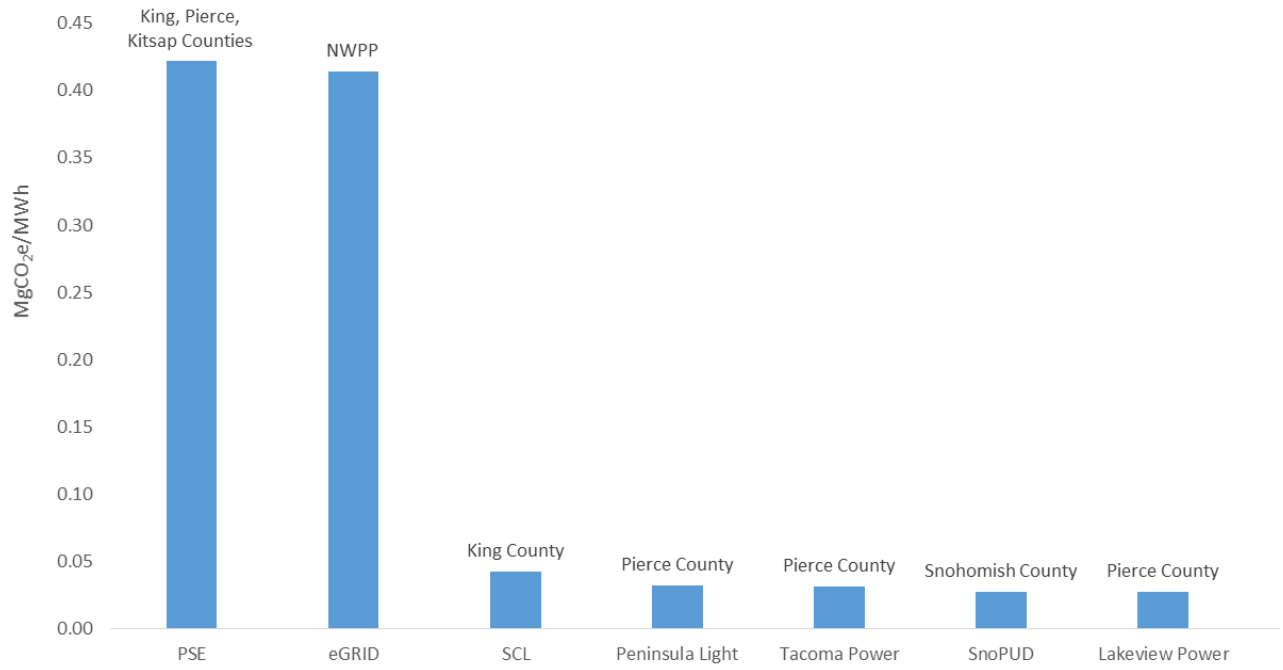
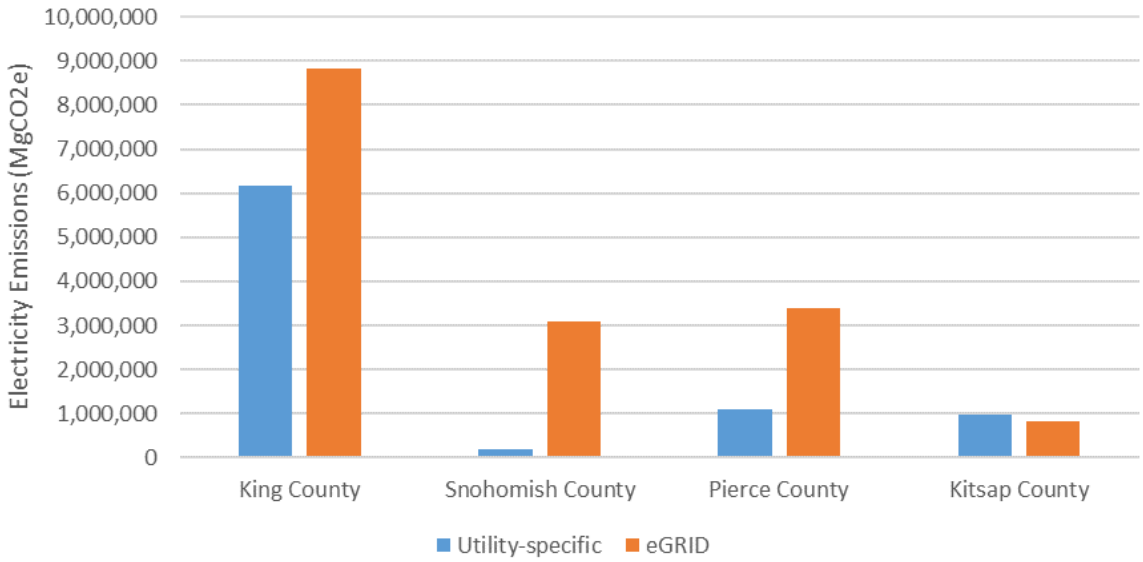


Figure 8. Comparison of utility-specific and eGRID-derived 2015 electricity emissions for PSCAA four-county area.[1]



[1] eGRID emission factor is for 2014 (2015 was not available at time of inventory).

Transportation

Transportation accounted for 38% of GHG emissions in 2015 and was the largest source of emissions after the built environment. Most transportation emissions in 2015 stemmed from passenger vehicles (74%), followed by emissions from freight and service vehicles (14%; Figure 9). King County was the largest contributor of transportation emissions (55% of the four counties). Average per-capita transportation emissions for the four counties was 3.4 $MgCO_2e$ per resident. King County had the highest per-capita emissions at 3.6 $MgCO_2e$ per resident, largely due to air emissions associated with Seattle-Tacoma International Airport. Among passenger vehicles, single-occupancy vehicles made up the overwhelming majority of vehicle miles traveled (Table 9) and emissions (Table 10).

Figure 9. PSCAA 2015 transportation GHG emissions, by sector (total = 13.2 million $MgCO_2e$).

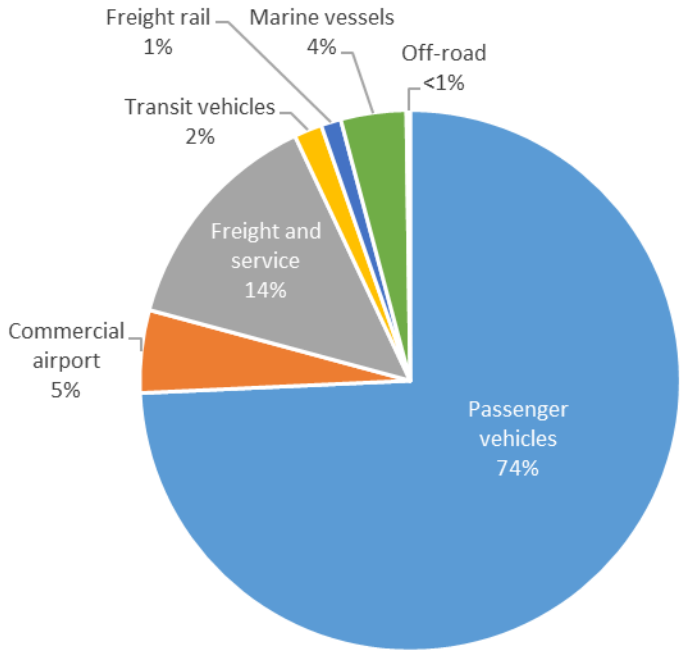


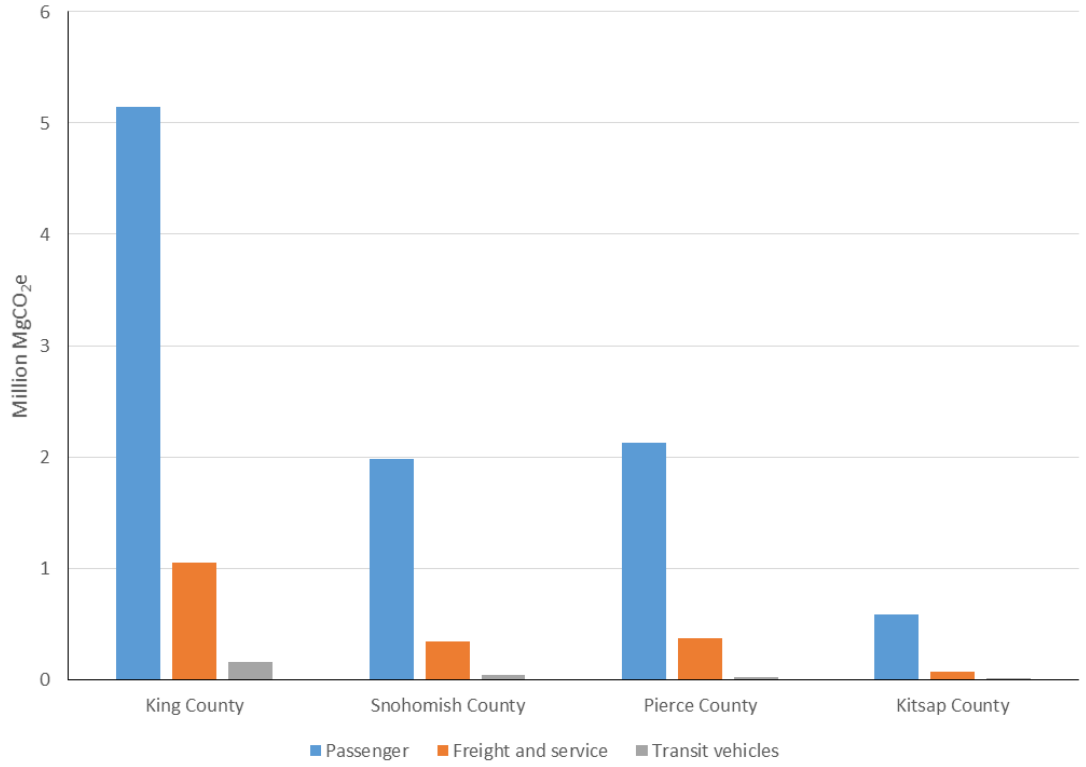
Table 9. Vehicle miles traveled in 2015, by sector and county.

		King	Snohomish	Pierce	Kitsap	Total
On-road						
	SOV	29,644,649	11,254,696	12,197,783	3,333,263	**56,430,391**
	HOV2	7,589,916	2,892,267	2,893,469	773,590	**14,149,242**
	HOV3	3,641,455	1,379,466	1,378,380	348,555	**6,747,855**
	Medium truck	2,265,886	665,337	736,193	198,918	**3,866,334**
	Heavy truck	1,151,381	390,594	420,556	46,855	**2,009,386**
Total		**44,293,287**	**16,582,361**	**17,626,380**	**4,701,181**	**83,203,209**

Table 10. Transportation emissions, by sector and county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
On-road					
SOV	3,497,118	1,340,724	1,468,071	399,083	**6,704,997**
HOV2	891,143	346,841	353,175	93,878	**1,685,037**
HOV3	427,321	165,860	168,688	42,381	**804,251**
Passenger start emissions	327,075	131,561	138,691	46,975	**644,303**
Transit	158,508	35,658	20,481	6,734	**221,381**
Medium truck	452,715	138,642	154,098	42,326	**787,781**
Heavy truck	595,853	199,836	217,774	23,479	**1,036,942**
Marine					
Recreational vessels	31,185	9,682	13,938	9,560	**64,365**
Ocean-going vessels	64,248	4,469	48,112	36,800	**153,628**
Harbor vessels	125,208	88,503	46,350	41,736	**301,796**
Freight & passenger rail	81,001	29,972	47,260	-	**158,233**
Off-road	12,346	7,639	7,011	2,466	**29,461**
Commercial airport	654,619	-	-	-	**654,619**
Total Transportation	**7,318,340**	**2,499,388**	**2,683,648**	**745,418**	**13,246,794**

Figure 10. On-road transportation emissions, by county and vehicle type.



Industry

Industrial emissions resulted in the following key trends and findings:

- Industrial GHG emissions made up 17% of 2015 emissions in PSCAA counties.
- Industrial emissions are dominated by stationary combustion of natural gas and distillate oil among large industrial operations such as military bases and manufacturing facilities, while fugitive gas emissions from refrigerants represent the second-largest emissions source (Figure 11).
- Only Pierce and King counties have significant industrial process emissions, largely from manufacturing of products such as steel, glass, lime, paper, and cement. Kitsap and Snohomish counties have no large industrial process facilities that are required to report air emissions.

Figure 11. Sources of industrial emissions for PSCAA in 2015 (total = 5.9 million $MgCO_2e$).

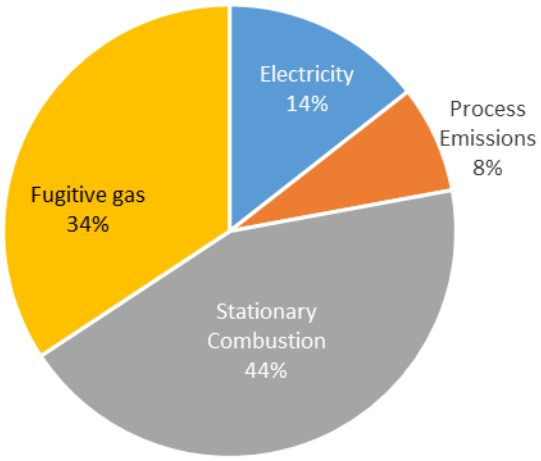


Table 11. Industrial emissions, by source and county ($MgCO_2e$).

Sub-sector	King	Snohomish	Pierce	Kitsap	Total
Electricity	611,614	15,412	220,136	4,755	**851,916**
Process Emissions					**-**
Steel	2,787	-	-	-	**2,787**
Glass	37,204	-	-	-	**37,204**
Cement	311,094	-	-	-	**311,094**
Lime	-	-	49,895	-	**49,895**
Pulp	-	-	51,640	-	**51,640**
Stationary Combustion					**-**
Natural Gas	158,105	116,714	363,499	16,320	**654,637**
Petroleum	60,248	26,412	16,173	3,898	**106,731**
Coal	135,832	-	-	-	**135,832**

Sub-sector	King	Snohomish	Pierce	Kitsap	Total
Tire-derived Fuel	10,037	-	-	-	**10,037**
Small Equipment	1,464,358	404,333	399,065	401,942	**2,669,698**
Fugitive Gas					
Ozone-depleting Substances	1,047,925	393,560	431,232	134,130	**2,006,847**
Switchgear Insulation	6,588	3,701	3,701	3,701	**17,692**
Total emissions	**3,845,793**	**960,132**	**1,535,341**	**564,746**	**6,906,012**

Table 12. Number of establishments inventoried, by county.

Sub-sector	King	Snohomish	Pierce	Kitsap	Total
Process Emissions					
Steel	2	0	0	0	**2**
Glass	4	0	0	0	**4**
Cement	2	0	0	0	**2**
Lime	0	0	1	0	**1**
Pulp	0	0	1	0	**1**

Solid Waste

Emissions from solid waste disposal made up 2% of total emissions in the PSCAA four-county area. These estimates do not include the carbon sequestration benefits of solid waste disposal—only the gross GHG emissions. King County had the largest solid waste emissions overall. All four counties had similar per-capita solid waste emissions, ranging from 0.1 $MgCO_2e$/capita to 0.3 $MgCO_2e$/capita; see Table 3).

Table 13. Solid waste emissions in 2015, by source and county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Landfill					
Transportation	31,525	9,171	15,107	4,361	**60,164**
Landfill Emissions Commitment	165,408	111,684	198,486	52,284	**527,863**
Carbon Sequestration	(365,655)	(164,298)	(228,053)	(65,309)	**(823,315)**
Compost					
Transportation	6,805		1,227		**8,032**
Fugitive Emissions	21,876		4,235		**26,111**
Soil Carbon Storage	(81,658)		(14,720)		**(96,378)**
Total gross emissions	**225,614**	**120,855**	**219,056**	**56,645**	**622,170**

Water and Wastewater

All four counties use a combination of treatment plants and septic systems to treat human waste. Treatment processes vary in their emissions profiles per volume of waste treated. For example, lagoon systems emit more GHG emissions than other treatment process. Overall, however, greenhouse gas emissions within this sector are minor compared to other sources, making up only 1% of all community emissions.

Sources of potable water vary across the four-county area. While King and Snohomish counties largely use surface water sources (100% and 97%, respectively), Kitsap and Pierce counties draw more from groundwater (approximately 63% and 30%, respectively). Emissions from the extraction, conveyance,

treatment, and distribution of water varies by these sources. Emissions are also dependent on the number of people served in a community and the fuel mix of the energy source. Many households and communities use small, private well systems—especially in Kitsap county. Energy use from these systems are accounted for in the residential energy rather than potable water sections of the inventory.

Because energy use associated with potable water treatment, conveyance, and consumption are already included in the commercial and industrial energy use sections of the inventory, calculation of potable water emissions is for reporting purposes only and are not added to the total emissions values. Direct methane and nitrous oxide emissions from the wastewater treatment process are included in the emission totals, however.

Table 14. Wastewater emissions, by source and county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Wastewater Treatment Plants	25,365	136,485	9,504	992	**172,346**
Septic	47,031	22,460	31,682	15,549	**116,723**
Total emissions	**72,397**	**158,945**	**41,186**	**16,541**	**289,069**

Table 15. Number of wastewater treatment facilities and population served, by county.

	King	Snohomish	Pierce	Kitsap	Total
Population Served by Treatment Plants	1,635,643	404,120	1,104,994	73,907	**3,218,664**
Facility Count	3	10	8	5	**26**

Table 16. Emissions from extraction, conveyance, treatment, and distribution of potable water ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Extraction	0	1	650	<1	**651**
Conveyance	114	57	438	179	**787**
Treatment	217	108	583	156	**1,064**
Distribution	558	278	2,149	877	**3,862**
Total	**889**	**444**	**3,819**	**1,211**	**6,363**

Table 17. Number of potable water utilities and population served, by county.

	King	Snohomish	Pierce	Kitsap	Total
Population Served	1,300,000	600,000	352,000	87,808	**2,339,808**
Facility Count	2	4	3	2	**11**

Agriculture and Land Use Change

Agriculture accounts for only about 1% of GHG emissions in the PSCAA area. Emissions are primarily derived from enteric digestion and manure from cattle (Table 18 and Table 19). Although row-crop agriculture is present in all four counties, nitrous oxide runoff and volatilization in row-crop systems are low relative to other agricultural emission sources (Table 20). King and Snohomish counties contribute the most livestock-based emissions. King County contributes more than twice the land use development-related GHG emissions compared to the three other counties (Table 21).

Table 18. Enteric methane emissions by agricultural animals ($MgCO_2e$).

Fugitive emissions	King	Snohomish	Pierce	Kitsap	Total
Cows	75,089	62,925	26,078	3,862	**167,954**
Chickens	-	-	-	-	**-**
All other	3,574	1,980	1,978	935	**8,467**

Total	**78,663**	**64,905**	**28,056**	**4,797**	**176,422**

Table 19. Manure emissions by agricultural animals ($MgCO_2e$).

Manure emissions	King	Snohomish	Pierce	Kitsap	Total
Cows	49,657	71,208	25,145	3,562	**149,572**
Chickens	284	8,838	1,334	119	**10,574**
All other	16,894	9,067	9,111	4,296	**39,368**
Total	**66,836**	**89,113**	**35,590**	**7,976**	**199,514**

Table 20. Nitrous oxide emissions from agricultural soil management ($MgCO_2e$).

Cropland	King	Snohomish	Pierce	Kitsap	Total
Volatilization and deposition	7,797	11,538	4,572	1,003	**24,909**
Surface leaching and run-off	1,569	2,321	920	202	**5,011**
Total	**9,366**	**13,859**	**5,492**	**1,204**	**29,920**

Table 21. Residential development emissions and land area, by county ($MgCO_2e$).

	King	Snohomish	Pierce	Kitsap	Total
Number of permits					
<0.25 acres	3,689	749	955	374	**5,767**
0.25 to 1 acre	424	119	192	122	**857**
>1 acre	177	241	206	163	**787**
Acreage of parcels					
<0.25 acres	406	89	119	10	**623**
0.25 to 1 acre	178	73	87	69	**407**
>1 acre	784	1,140	662	602	**3,188**
Acres cleared	542	193	202	81	**1,018**
Total emissions	**49,384**	**17,644**	**18,457**	**7,349**	**92,834**

Data Sources

This greenhouse inventory quantifies the release of GHG emissions from activities within PSCAA jurisdictions' geographic boundary, including from transportation, buildings, industrial processes, waste, water use, and agriculture. It also includes emissions generated outside of the community but attributable to in-boundary activities (for example, electricity consumption). Adjustments made to data, as needed, are described in the next section, Methodology.

Conducting the inventory involved acquiring the following data, summarized in Table 22 and detailed in the following sections:

- **Activity data** that quantify levels of activity that generate GHG emissions, such as vehicle miles traveled and kilowatt-hour (kWh) of electricity consumed.
- **Emission factors** that translate activity levels into emissions (e.g., $MgCO_2e$ per kWh).

Table 22. Key data sources for PSCAA's 2015 communitywide greenhouse gas inventory.

Sector	Activity	Emission Factors
Transportation (Road)	• Daily vehicle miles traveled (Puget Sound Regional Council)	• U.S. EPA MOVES2014a model
Transportation (Marine)	• Puget Sound Maritime Air Emissions Inventory (Starcrest Consulting Group, LLC, 2018)	• Puget Sound Maritime Air Emissions Inventory (Starcrest Consulting Group, LLC, 2018)
Buildings and Industry (Electricity)	• kWh consumption (local electric utilities)	• Utility fuel mix (Washington State Department of Commerce, 2017) • SCL-reported emission factors (The Climate Registry, 2015)
Buildings and Industry (Natural Gas and Oil)	• Gas use (PSE, Cascade Natural Gas) • Oil use (U.S. Energy Information Administration, 2015)	• Carbon content of natural gas and oil (U.S. Environmental Protection Agency, 2017)
Fugitive Gases	• Nationally reported EPA value for refrigerants • Switchgear insulation (SF_6) reported by utility	• U.S. EPA (U.S. Environmental Protection Agency, 2017)
Solid Waste	• Tons disposed and composted by county residents and businesses	• EPA WARM v14 model
Wastewater	• Wastewater treatment rates from facilities • Septic rates (Washington State Department of Health, 2014)	• National wastewater factors (ICLEI USA, 2013)
Water	• Service quantity provided by utilities	• Electricity provider emission factors
Agriculture	• Acres of cropland and number of livestock (U.S. Department of Agriculture, 2014)	• Emissions per animal or per acre (U.S. Environmental Protection Agency, 2017)
Land Use Change	• Acres of land cleared for development as deduced from building permit data (County Assessor's offices)	• Assumed existing carbon stocks (assessment based on U.S. Forest Service data) • Assumed lot clearing by lot size (assessment based on observations in King County)

Transportation

- **Vehicle miles traveled (VMT)** were obtained from Puget Sound Regional Council (PSRC) and accounted for all mileage within the county boundary, regardless of trip origin or destination. The PSRC applied emission factors from the U.S. EPA MOVES2014a model and modified those factors to reflect regional vehicle fleet age and fuel composition. PSRC data reported overall GHG emissions for passenger vehicles (cars, motorcycles, light trucks), medium trucks, and heavy trucks.
- We acquired **fuel consumption** data for transit agencies—including King County Metro, Sound Transit, Community Transit, and Kitsap Transit—from the National Transit Database of the Federal Transit Administration.
- We referenced the Puget Sound Maritime Air Emissions Inventory report to estimate 2015 **freight rail and marine** emissions.
- Emissions from **other non-road equipment** were obtained through U.S. EPA NONROAD modeling of individual counties.
- **Air emissions** were calculated using activity data from the 2008 Seattle-Tacoma International Airport Activity Report and fuel data from the King County International Airport.

Buildings and Energy

- Data on **electricity** and **natural gas** use were provided by the local energy utilities, including Lakeview Power, Peninsula Light, Puget Sound Energy (PSE), Seattle City Light (SCL), Snohomish PUD (SnoPUD), and Tacoma Power. For Kitsap County, natural gas use statistics were modeled based on regional trends because we were not able to obtain data from Cascade Natural Gas.
- We calculated **electric utility emissions factors** using the 2015 Washington State Electric Utility Fuel Mix Disclosure Report conducted by the Washington State Department of Commerce, with the exception of SCL, which reports emissions factors through The Climate Registry (TCR).
- We obtained data on residential, commercial, and industrial **heating oil** from the Energy Information Administration.
- The EPA NONROAD 2008 model was applied to **residential equipment emissions,** such as from lawnmowers.
- We obtained **commercial steam energy** data from PSCAA, which provided data from Enwave, a Seattle steam company that heats approximately 200 commercial downtown buildings.
- Additional **commercial nonroad sources** were calculated using the EPA NONROAD 2008 model. These nonroad sources encompass fuel used for commercial landscaping and non-flight equipment at airports.

Industry

- **Industrial process** emissions from large sources—including emissions from cement, steel, and glass manufacturing—were provided by the PSCAA.

- Data on fugitive emissions from **ozone-depleting substitutes** were derived from nationally reported values from the U.S. EPA. These values were scaled to the PSCAA counties based on county populations.
- Emissions of **SF_6** from switchgear insulation used by electric utilities were derived from the individual utilities.

Solid Waste

- We used waste composition data from the 2009 Washington Statewide Waste Characterization Study from the Washington State Department of Ecology, along with emissions factors from the U.S. EPA WARM v14 model, to calculate emissions from **waste disposal and composting**. Where available, waste tonnages and composition data were obtained directly from the County.

Wastewater

- Wastewater emission calculations required data from PSCAA-area **wastewater treatment plants**, provided by facility engineers and publicly available documents.

Potable Water

- **Potable water** emissions required data on water use, publicly available from local water utilities, and energy use estimates provided by the U.S. Community Protocol.

Agriculture

- The USDA provides data on animal quantities by county. The EPA provides national-level **animal enteric and manure** emission factors and state-level emissions factors for cattle.

Land Use

- Each county's Assessor's office publicly provides county-specific land use data, which we used to calculate the emissions associated with **new development** in 2015.

Methodology

This 2015 inventory was conducted in adherence with the U.S. Community Protocol. See the text box below for more information on this protocol and how it compares to other available protocols.

The U.S. Community Protocol

The U.S. Community Protocol was built to provide easily applicable and accurate community-level estimates of GHG emissions. This protocol provides a consistent framework in which to compare protocols from a geographic boundary across time. The U.S. Community Protocol was designed for community-scale GHG accounting, making it a valuable tool for counties and cities and an appropriate choice for the Puget Sound Clean Air Agency. The U.S. Community Protocol is widely used and well understood by municipalities.

This inventory follows the U.S. Community Protocol methodology, created by Local Governments for Sustainability (ICLEI) in 2013. The U.S. Community Protocol requires, at a minimum, reporting of the following five activities: 1) Use of electricity by the community, 2) Use of fuel in residential and commercial stationary combustion equipment, 3) On-road passenger and freight motor vehicle travel, 4) Use of energy in potable water and wastewater treatment and distribution, and 5) Generation of solid waste by the community. Other protocols, such as the Global Protocol for Community-scale GHG Emissions (GPC) are also commonly used. Whereas the GPC focuses primarily on the reporting and categorical requirements of an inventory, the U.S. Community Protocol provides specific methodologies, and often emission factors, to calculate different emissions sources.

The GPC also requires reporting of carbon "sinks," which represent net absorption of greenhouse gases from the atmosphere. The U.S. Community Protocol does not include sinks. By not accounting for sinks, the U.S. Community Protocol can over-represent the net GHG emissions and allows for some societal goods, such as waste composting, to be perceived negatively. However, other sinks, such as a landfilling, could be perceived positively as a GHG sink, even though increased landfilling of waste is generally not considered a societal good.

Table 23. Brief methodological outline of the 2015 inventory.

Sector	Methodology Overview
Transportation (Road)	• Emissions calculated by PSRC as a function of VMT, fuel mix, fleet age, and U.S. EPA MOVES2014a emission factors. • Transit emissions based on Federal Transit Administration National Transit Database reported fuel use and standard EPA emissions factors.
Transportation (Air)	• For Sea-Tac Airport, scaled reported 2008 fuel consumption to 2015 by number of landings. Attributed to individual counties based on county population and employment statistics. • King County International Airport fuel use for cargo was attributed to King County.
Transportation (Marine)	• Emissions as reported in the Puget Sound Maritime Air Emissions Inventory and scaled to 2015 based on cargo or population, as relevant.
Transportation (Rail)	• Emissions as reported in the Puget Sound Maritime Air Emissions Inventory and scaled to 2015 based on cargo. • Included 2015 light rail emissions for Sound Transit as reported by Sound Transit.
Buildings and Industry (Electricity)	• Calculated the sum of billed consumption and line loss and multiplied the sum by utility-specific emission factors. • Utility emission factors based on reported fuel mix in 2015 Washington State Electric Utility Fuel Mix Disclosure Report. • Utilized the TCR-based emission factor for Seattle City Light (The Climate Registry, 2015).
Buildings and Industry (Natural Gas and Oil)	• Applied U.S. Community Protocol emissions factors to utility-reported natural gas and distillate oil consumption statistics. • Applied IPCC and King County-derived emissions calculations to industrial process data reported to PSCAA unless emissions were reported to the U.S. EPA, in which case U.S. EPA emission values were used. • Applied the U.S. EPA MOVES 2014 NONROAD model for nonroad equipment emissions.
Fugitive gases	• National values for ozone-depleting substance substitutes scaled to region by population (U.S. Environmental Protection Agency, 2017). • Electric utility-reported SF_6 emissions from switchgear insulation.
Waste	• Waste characterization data applied to U.S. EPA WARM v14 emission factors. • Includes composting emissions.
Wastewater	• Wastewater treatment facility service population multiplied by gas production estimates per U.S. Community Protocol methodology and assumptions. • Includes biogas emissions, BOD_5 emissions, and emissions from septic systems.
Potable Water	• Included within electricity sector, but also called out as a separate line item. • Utility reported water consumption—scaled to county population, if necessary—and multiplied by national energy use factors for extraction, conveyance, treatment, and distribution.
Agriculture	• Livestock population multiplied by national emissions intensities for enteric and manure-derived methane and nitrous oxide emissions. • County farm acreage multiplied by national soil emissions factors for agricultural soil management emissions.
Land Use Change	• New building permits multiplied by estimated land clearing and resulting emissions.

Transportation (Road)

On-road transportation emissions were quantified for cars and light trucks, vanpool, buses, and trucks.

On-road passenger vehicle and freight emissions were calculated by PSRC. PSRC used vehicle miles traveled (VMT) modeling data and NONROAD emission factors. PSRC scaled emission factors by county-level data on fuel mix, fleet age, and vehicle type. For cars and light trucks, running emissions are provided for three categories: SOV, HOV2, and HOV3. Start emissions are provided for cars and light trucks combined. For medium and heavy trucks, both running and start emissions are provided.

Transit (bus and vanpool) fuel use data were obtained primarily from the Federal Transit Administration National Transit Database, with the exception of King County Metro, which provided fuel use and electricity use directly. Where bus routes cross jurisdiction boundaries, we estimated county-specific attributions using geographic distributions of routes (e.g., 75% of Sound Transit bus fuel use was attributed to King County).

Light rail emissions were included in the "rail" section, detailed below.

Transportation (Air)

Emissions associated with **air travel** were calculated for jet fuel use. and, if available, for ground support equipment. Because ground support equipment is classified as "commercial equipment," its emissions are not included in the transportation section of this inventory.

For **Seattle-Tacoma International Airport** ("Sea-Tac"), we included all landing and takeoff emissions from the airport. We obtained jet fuel supplied at Sea-Tac for 2015. We then applied standard jet fuel emission factors from the U.S. EPA Inventory of Greenhouse Gas Emissions and Sinks report (U.S. Environmental Protection Agency, 2017). We used a standard landing-takeoff factor, assuming that 10% of all fuel consumed by aircraft are used during landing and takeoff, and are thus part of the airport's emissions profile.

For **King County International Airport**, we obtained data for aviation and jet fuel dispensed on site in 2015. We applied emissions factors for those fuels from the U.S. EPA Inventory of Greenhouse Gas Emissions and Sinks report (U.S. Environmental Protection Agency, 2017).

Consumption-based Air Travel Emissions

Another approach to quantifying air travel emissions involves estimating total air emissions associated with resident and business air travel into and out of an airport, regardless of whether the fuel was combusted within or outside the county's air space. To be consistent with the calculation approach used for other transportation modes (e.g., on-road vehicles, marine vessels), we calculated air travel emissions in this section as the total emissions resulting from jet fuel burned during landing and takeoff for all planes flying into and out of Sea-Tac and King County International airports (regardless of who was traveling).

The alternative methodology—which takes more of a consumption-based approach to quantifying air travel emissions—was also employed and is summarized below. For this approach, we allocated airshed emissions fractions to individual counties based on respective population and employment statistics. This approach means that counties with more residents and business travelers are assigned a greater proportion of travel-related emissions at Sea-Tac airport. We obtained jet fuel supplied at Sea-Tac for 2015, and then applied emissions factors from the U.S. EPA Inventory of Greenhouse Gas Emissions and Sinks report (U.S. Environmental Protection Agency, 2015) to arrive at air travel emissions associated with Sea-Tac.

	King	Snohomish	Pierce	Kitsap	Total
Air travel emissions ($MgCO_2e$)	2,539,181	787,214	884,070	268,162	4,478,627

Transportation (Rail & Marine)

On- and off-terminal rail locomotive emissions were derived primarily from the Puget Sound Maritime Air Emissions Inventory (Starcrest Consulting Group, LLC, 2018), which provides rail emissions information by county and port. Total emissions data included emissions associated with on-terminal line hauling, on-terminal switching, off-terminal port-related locomotives, and other off-terminal locomotive emissions within the counties.[2] Due to data availability limitations, the inventory did not include line-haul locomotive emissions associated with the Port of Everett.

Light rail electricity use data were obtained from directly from Sound Transit.

Marine emissions were quantified from three sources: 1) recreational vessels, 2) ocean-going vessels (OGV) maneuvering and hoteling at ports, and 4) harbor vessels. Where relevant, we scaled 2016 inventory values for these sources to 2015 values by port tonnage or county population.

[2] Other off-terminal locomotive emissions within counties were extrapolated from the 2005 Puget Sound Maritime Air Emissions Inventory, as this information was not included in recent inventory reports.

Buildings and Industry (Electricity)

We quantified emissions associated with **electricity** consumption in the residential, commercial, and industrial sectors. Per the U.S. Community Protocol, emissions attributable to both billed electricity use and line loss were included.

Electric **utility emission factors** were calculated based on fuel mixes as reported in the 2015 Washington State Electric Utility Fuel Mix Disclosure Report. The one exception was Seattle City Light, which reports to The Climate Registry (TCR) following a rigorous and third-party-audited methodology. Per the recommendations of the U.S. Community Protocol, the new inventory uses TCR's reported SCL emissions factor (The Climate Registry, 2015). To ensure consistency with the SCL emission factor, we applied the TCR methodology to Washington State fuel mix disclosure data to arrive at final utility-specific emissions factors for each electric utility in the four-county region.

The U.S. Community Protocol recommends using third-party verified utility-specific emissions factors, if available. If not available, then the protocol recommends calculating a utility-specific emissions factor, and comparing that factor to that of the regional grid, known as U.S. EPA's eGRID factor. Because the only Puget Sound electricity utility with third-party verified emissions factors is Seattle City Light, we also conducted a sensitivity analysis using the eGRID emissions factor associated with the Puget Sound subregion (NWPP).

Buildings and Industry (Natural Gas and Oil)

Households burn petroleum-based fuels for space heating, water heating, and cooking. These fuels include natural gas, propane, and distillate fuel oil. Small industrial and commercial establishments burn petroleum-based fuels for space heating and other operations. Few, if any, residential, commercial, and industrial sectors in the four-county area burn coal or residual oil—we therefore did not include these fuels in the inventory.

We used the 2015 **natural gas** energy usage report by customer type (e.g., commercial, industrial, or residential) provided by PSE. Because Cascade Natural Gas Company consumption data for Kitsap County were not available at the time of this inventory, we modeled natural gas consumption by Kitsap County residential, commercial, and industrial customers based on PSE consumption and Kitsap population statistics.

We used the 2015 **distillate fuel oil** sales by end use (e.g., commercial, industrial, residential) for Washington state (U.S. Department of Energy, 2016) and calculated residential use for each county using the occupied housing units with oil-based heat reported in the 2015 American Community Survey estimates (U.S. Census Bureau). For this analysis, we assumed that residential fuel consumption is directly proportional to households using fuel. For commercial oil use, we assumed that commercial fuel consumption is directly proportional to employment. PSCAA provided data on commercial point sources of natural gas (e.g., steam plants) and distillate oil.

Non-road mobile engines include airport ground support equipment, locomotives, vessels, boats, and other miscellaneous mobile engines not used on public roadways. These engines can run on gasoline, diesel, LPG, CNG, or electricity. The inventory uses industrial small equipment emission factors from the U.S. EPA NONROAD model 2014 and data on fuel consumption provided by PSCAA. As detailed in Table 24 below, the emissions were grouped by sector: commercial (commercial and airport ground support), residential (lawn, garden, and recreational), and industrial small equipment (agriculture, construction, mining, industrial, and logging).

Table 24. Examples of non-road mobile engines

Terrestrial recreation	Golf carts, all-terrain vehicles, dirt-bikes, specialty vehicles
Construction	Bulldozers, pavers, excavators, drills, surfacers, compactors, rammers, signals
Industrial	Aerial lifts, forklifts, sweepers, scrubbers, material handlers
Lawn and garden	Lawn mowers, trimmers, blowers, chippers, lawn tractors, aerators, chainsaws
Agricultural	Tractors, combines, swathers, sprayers, balers, tillers
Commercial	Generators, pumps, compressors, welders, pressure washers
Logging	Shredders, chain saws, fellers, bunchers, debarkers
Airport ground support	Tractors, loaders, service trucks, deicers, forklifts, carts

We scaled down a national EPA **fugitive gas** value for ozone-depleting substance substitutes by county populations to calculate emissions from this source (U.S. Environmental Protection Agency, 2017). Data on switchgear insulation gas emissions (SF_6)—another fugitive gas—were obtained from publicly availability utility emissions reports.

Solid Waste

To quantify GHG emissions from the **transfer and disposal of solid waste**, we applied emission factors from the U.S. EPA WARM v14 model to estimates of waste disposal and composition. We calculated emissions from two sources: 1) transportation to landfill and 2) landfill emissions commitment. Commitment includes all future-year landfill emissions from waste being disposed in 2015 (this is standard practice in solid waste GHG emission accounting). Where known, we customized WARM emission factors to include county-specific travel distances and landfill gas capture estimations. We also included emissions from **commercial composting** using U.S. EPA WARM v14 emissions factors.

We obtained waste composition data using estimates from the Washington State Department of Ecology's 2009 Washington Statewide Waste Characterization Study and, where possible, directly from the counties. Landfill tonnages were acquired directly from the counties. Composting tonnages were gathered directly from the utility, county, or municipal government, as available.

In addition to emissions, the U.S. EPA WARM v14 model also calculates **landfill carbon sequestration**—the GHG emissions avoided from putting waste into the landfill as opposed to letting it decompose naturally. Carbon sequestration is not typically included in greenhouse gas emission inventories and thus is not included in this inventory report.

Potable Water

This inventory attributes GHG emissions to processes of **extraction, conveyance, treatment, and distribution of potable water**. The total gallons of potable water provided daily and the proportion of groundwater to surface water sources were acquired from each service provider. Water from residential wells is included in the buildings category.

National water use emission factors within the U.S. Community Protocol were multiplied by the quantity of water involved in each of the following processes to determine energy use: 1) quantity of water extracted from groundwater sources, 2) total quantity of water conveyed, 3) quantity of surface water treated, and 4) total quantity of water distributed. Energy use was then summed and multiplied by the PSE emission factor to derive emissions related to potable water.

Because energy use associated with these processes is already included in the commercial and industrial energy use sections of the inventory, calculation of potable water emissions is for reporting purposes only and are not added to the total emissions values.

Wastewater

The U.S. Community Protocol lays out specific methodologies for calculating GHG emissions from **wastewater treatment facilities** based on how wastewater is treated. We applied these equations to known wastewater treatment facilities in the four-county area. Facility-specific information on treatment processes and loads were obtained from publicly available reports, webpages, and facility representatives.

We also included emissions from **septic systems**. We quantified emissions from septic systems by applying estimates of the number septic system households from the Washington State Department of Health (Washington State Department of Health, 2014) to the U.S. Community Protocol methodology.

Agriculture

For agriculture-related emissions, we quantified enteric emissions from livestock, methane, and nitrous oxide emissions from manure management and nitrous oxide emissions from soil management. These data were largely gathered from USDA's 2012 Census of Agriculture (United States Department of Agriculture, 2014).

Land Use

The Assessor's office from each county (King, Kitsap, Pierce, and Snohomish) supplied data on **new residential construction** (i.e., building permits) and associated lot sizes. We used carbon storage and land clearing assumptions based on King County's 2008 GHG inventory to model emissions from residential land use changes (Stockholm Environment Institute, 2012).

Data Source Limitations

Key data sources that were not available for this inventory include the following:

- **Port data for Everett:** The 2016 Puget Sound Maritime Air Emissions Inventory does not include line-haul locomotive emissions for the Port of Everett due to data availability limitations.
- **Naval base emissions:** Emissions from naval marine vessels are not included in this inventory due to insufficient data availability. Kitsap County has a rail line for military use only, for which emissions were not accounted.
- **Cascade Natural Gas:** We were not able to obtain 2015 natural gas consumption statistics from Cascade Natural Gas in Kitsap County. Natural gas consumption was estimated based on served population size and residential, commercial, and industrial population consumption rates in King County.
- **Peninsula Light and Lakeview Light and Power:** We were not able to obtain retailed electricity data directly from these two Pierce County utilities. We were able to acquire overall retailed electricity and residential retailed electricity from the Washington Department of Commerce. We separated commercial and industrial electrical consumption using the ratio of commercial to industrial retailed electricity by Tacoma Power, the immediately geographically adjacent utility.
- **Small airport fuel use.** Obtaining jet fuel use amounts from smaller regional airports would require contacting each airport fuel source individually. Due to the challenge in obtaining reliable numbers from these entities, as well as the relatively small amount compared to other emissions categories (estimated <1% of total emissions), we did not include fuel use from smaller regional airports.
- **Wastewater treatment plants:** Whenever possible, treatment managers, engineers, or staff were contacted regarding treatment processes. When staff were not reachable or data were not provided, treatment was assumed to not include nitrification/denitrification per the U.S. Community Protocol recommendations.
- **Mink farms:** Data on the number of minks farmed by county in Washington is not published due to privacy concerns. Minks were estimated by dividing the number of minks in the state by the number of farms. Where biological data on enteric and manure emissions were lacking, goat emission factors were used as a substitute. Emissions associated with minks were small.

Conclusion and Future Considerations

This inventory provides a snapshot of 2015 GHG emissions in PSCAA's four-county area: King, Kitsap, Pierce, and Snohomish counties. These counties are diverse in their populations, economies, and natural resources, but the challenges they face are similar. Rising temperatures, population growth, and shifting market demands will alter the counties' carbon footprints and ability to address climate change through meaningful and measurable greenhouse gas emission reductions. Through this effort of identifying key emissions sources and benchmarking progress, PSCAA and its counties will have the foundational information needed to develop and implement targeted and strategic actions for meeting greenhouse gas reduction goals.

References

Coven, J. F., Morgenstern, T., Mallory, S., Erickson, P., Down, A., & Broekhoff, D. (2014). *Seattle Community Greenhouse Gas Emissions Inventory*.

ICLEI USA. (2013). *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*.

King County. (2017, May). *Assessments Data Download*. Retrieved from King County Department of Assessments: http://info.kingcounty.gov/assessor/DataDownload/default.aspx

King County. (2017, May). *Documents- Waste monitoring and surveys*. Retrieved from Solid Waste Division: https://your.kingcounty.gov/solidwaste/about/waste_documents.asp

King County. (2017, May). *Wastewater Program*. Retrieved from Publuic Health- Seattle and King County: http://www.kingcounty.gov/depts/health/environmental-health/piping/onsite-sewage-systems.aspx

Seattle Public Utilities. (2012). *2013 Water System Plan*.

Starcrest Consulting Group, LLC. (2018). *2016 Puget Sound Maritime Air Emissions Inventory*.

Stockholm Environment Institute. (2012). *Greenhouse Gas Emissions in King County*. King County, Washington.

The Climate Registry. (2015, May). *CRIS Public Reports*. Retrieved from The Climate Registry: https://www.theclimateregistry.org/our-members/cris-public-reports/

U.S. Department of Agriculture. (2014). Washington State and County Data. In *2012 Census of Agriculture* (Vol. 1).

U.S. Energy Information Administration. (2015, May). *Sales of Distillate Fuel Oil by End Use*. Retrieved from Petroleum and Other Liquids: https://www.eia.gov/dnav/pet/pet_cons_821dst_dcu_swa_a.htm

U.S. Environmental Protection Agency. (2008). *Inventory of U.S. Greenhouse Gas Emissions and Sinks:1990-2006*.

U.S. Environmental Protection Agency. (2017). *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2015*.

United States Department of Agriculture. (2014). 2012 Census of Agriculture. In *Washington State and County Data*.

Washington State Department of Commerce. (2017). *2015 Fuel Mix Disclosure Data*.

Washington State Department of Health. (2014). Puget Sound Septic Financing Assessing.

Washington State Department of Health. (2014). *Puget Sound Septic Financing Assessment.*

Washington State Department of Transportation. (2015). *Washington State Ferries FY2015 Route Statements.*