SECTION 2 | THE PORT'S MARITIME EMISSIONS

Where Do Port-related Air Pollutant and GHG Emissions Come From?

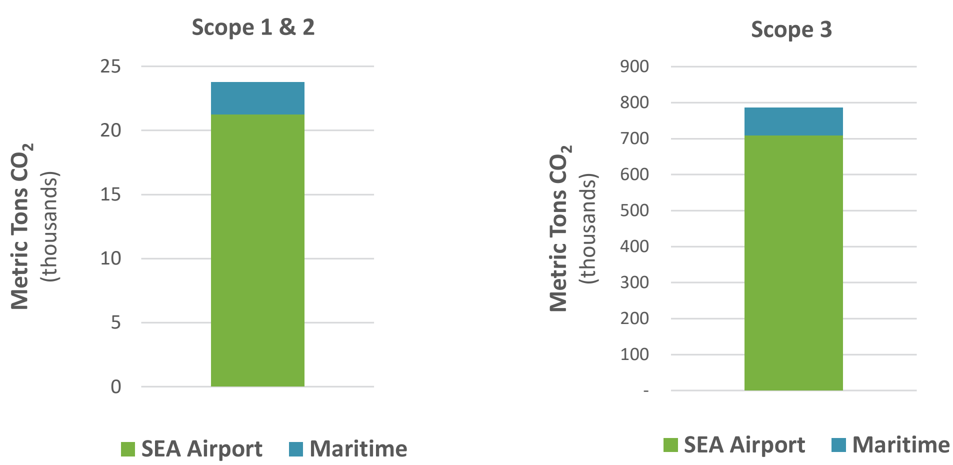
As hubs of transportation activity, ports move people and goods using vehicles, vessels, equipment, buildings, and facilities that are mostly powered by fossil fuels. These energy-intensive operations contribute to air pollutant and GHG emissions in the region. Diesel exhaust is a leading source of toxic air pollution in the region, and most vessels, locomotives, and trucks serving ports use diesel engines. For these reasons, DPM is used as the key indicator of maritime-related air pollution in this Plan.

The Port's lines of business include the cruise, grain, commercial fishing, recreational boating, and other maritime industries, which are the focus of this Plan. In addition, the Port also operates SEA Airport and is a partner in the NWSA which operates container cargo terminals in Elliott Bay. Emissions from SEA Airport and NWSA are not covered by this Plan, and the discussion below explains the relationship between these entities and their emissions.

Port of Seattle maritime emissions in context with SEA Airport emissions

Looking at the Port's total emissions profile, emissions are broken into those associated with Maritime and Aviation branches of the Port. The Port's maritime-related emissions (the focus of this Plan) are about 10 percent of the Port's total emissions. SEA Airport emissions are addressed separately in the Sustainable Airport Master Plan.[13]

Figure 2. Recent Port-wide GHG emissions: Port of Seattle Maritime and SEA Airport



The Port's maritime emissions (covered by this Plan) represent 11 percent of Scopes 1 and 2 emissions and 10 percent of Scope 3 emissions. The remaining emissions come from SEA Airport sources, which are not addressed in this Plan. Note that scope 1 and 2 emissions are for 2019. Scope 3 emissions shown are the latest available: 2018 (airport) and 2016 (maritime).

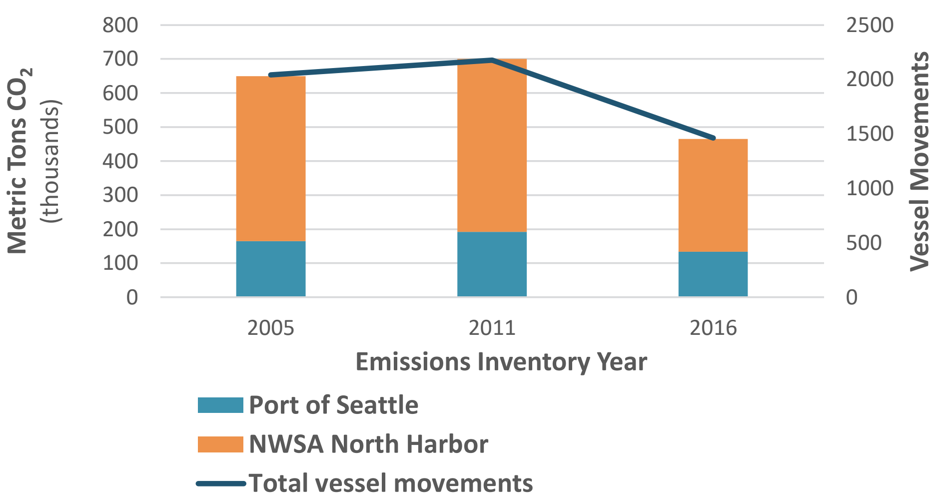
[13] Port of Seattle, *Sustainable Airport Master Plan (SAMP)*.

Port of Seattle maritime emissions in context with NWSA North Harbor emissions

The Port is a partner in The NWSA, a separate port development authority that manages the container cargo terminals in Elliott Bay (referred to as the NWSA North Harbor). Although the two ports have aligned goals through the 2020 Strategy and collaborate regularly, each port operates as a separate organization and plans and budgets for emission reduction efforts separately. NWSA developed its own implementation plan to address climate and air emissions from container cargo terminals in the North Harbor. NWSA North Harbor emission sources include container ships, harbor vessels, cargo-handling equipment used on container terminals, container trucks, and locomotives. Looking at both the Port and NWSA North Harbor gives a more complete picture of maritime emissions from Seattle-based ports.

GHG emissions from ocean-going vessels (OGV) and container trucks account for most of the maritime-related GHG emissions generated by the two seaports. NWSA operations contribute about two-thirds of Seattle-based maritime GHG emissions from OGV and harbor vessels, most of the emissions from rail and cargo-handling equipment, and all emissions from trucks. Absolute GHG gas emissions from the Port and NWSA North Harbor combined declined 27 percent from 2005 to 2016. Total vessel movements for the Port and NWSA's North Harbor declined 28 percent over the same period.[14]

Figure 3. Total GHG emissions from Port Maritime and NWSA North Harbor sources 2005 – 2016



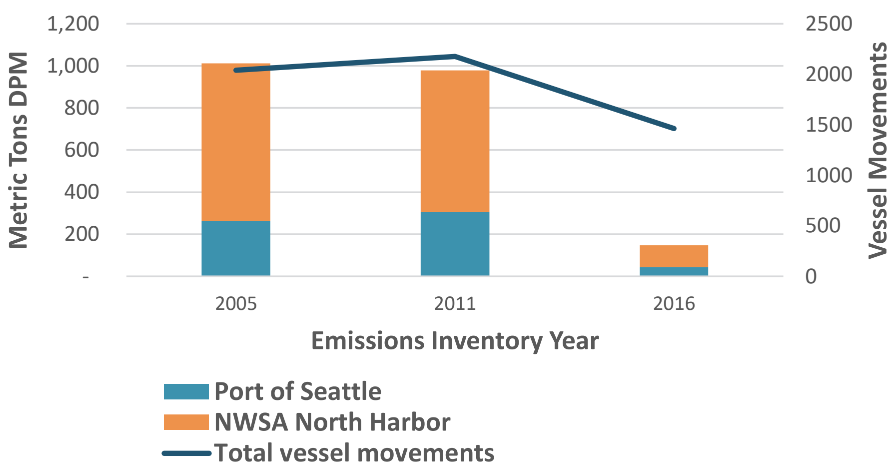
Port of Seattle maritime emissions account for about 25 percent of the two seaports' GHG emissions. The 2016 decline in GHG emissions mirrored a decline in total vessel movements, along with efficiency improvements that reduced fuel use.

[14] The number of vessel movements is used as an indicator of activity moving through the ports to capture activity from both marine cargo and cruise. Total vessel movements include individual vessel arrivals, shifts between berths or anchorages, and departures within Puget Sound.

DPM emissions can travel long distances, but concentrations are highest closest to the source; therefore, emissions occurring on or near port terminals are the most critical to protect the health of near-port communities. Local emissions were approximated by including OGV hoteling/maneuvering (near or at berth) and regional emissions of locomotives and container trucks; estimates of near-port emissions from these sources is not available. The two largest maritime-related sources of local DPM emissions are trucks and OGV.

Between 2005 and 2016, absolute emissions of local DPM in Seattle from the Port and NWSA North Harbor activities combined have declined 68 percent. This reflects a lower level of vessel movements in 2016 as well as widespread adoption of lower-sulfur fuels by ocean-going vessels, vehicles, and equipment over this period. Since then, the NWSA's Clean Truck Program has required container trucks to have newer engines that reduce DPM emissions by over 70 percent. The impact of this and other more recent emission reduction initiatives will not be measured until the release of the next inventory (anticipated for the year 2021).

Figure 4. Local DPM emissions from Port Maritime and NWSA North Harbor sources 2005 – 2016



Local emissions were approximated by including OGV hoteling/maneuvering (near or at berth) and regional emissions of locomotives and container trucks. (Estimates of neighborhood-scale emissions from these sources is not available.) In 2016, DPM emissions declined significantly due to a lower number of vessel movements, as well as use of cleaner fuels.

How are the Port's Maritime GHG and DPM Emissions Characterized?

The Port owns and operates some sources of GHG emissions, like fuel used in its fleet vehicles or energy used in its buildings, but does not own or directly control the ships, harbor craft, and rail locomotives that operate on Port properties and move people and cargo through the port. These sources account for most of the emissions in the Port's sphere of influence.

To characterize varying levels of control over emissions sources, GHG reporting protocols define three types of GHG emissions, referred to as "scopes."[15] The Port has set targets to reduce emissions within each scope and uses the scope designations to track progress.

[15] Greenhouse Gas Protocol, *Corporate Accounting and Reporting Standard*.

- **Scope 1 GHG emissions** are direct emissions from sources that are owned or controlled by the Port (such as fuel consumption by the Port's vehicle fleet).
- **Scope 2 GHG emissions** are indirect emissions from sources that are controlled by the Port (such as electricity purchased by the Port).
- **Scope 3 GHG emissions** are from sources not owned or directly controlled by the Port (such as emissions from tenant energy use, and fuel consumption by cruise and grain ships).

This Plan addresses all three scopes, but sorts emissions into two main categories which overlay the scope designations: **Port Maritime Administration** and **Maritime Activity.** This framework better reflects the Port's level of control for each emission source and provides a more logical alignment with how the Port structures emission reduction projects and programs. For example, some strategies to reduce building energy use apply to both Port-managed and tenant-managed spaces, even though they fall into different GHG emission scopes.

Table 3. Port Maritime emission sectors by level of control (GHG scope)

Category/Sector	Percent of Scopes 1 and 2 emissions	Percent of Scope 3 emissions	Percent of Total Emissions (2019)
Port Maritime Administration			
Building and Campus Energy – assigned to Port	53%		2%
Building and Campus Energy – assigned to Tenant	18%	1%	1%
Fleet Vehicles and Equipment	29%		1%
Employee Commuting		2%	2%
Solid Waste			<1%
Maritime Activity			
Ocean-going Vessels		77%	74%
Harbor Vessels		14%	14%
Cargo-handling Equipment		<1%	<1%
Trucks		<1%	<1%
Rail		6%	6%

Port Maritime Administration sectors produce Scopes 1, 2, and 3 GHG emissions

Port Maritime Administration sources stem from the Port's maritime and economic development operations, and include Port-owned buildings and campuses, Port-owned fleet vehicles and equipment, employee commuting, solid waste management, and staff business travel (business air travel has been rendered carbon neutral since 2016 through purchase of carbon offsets.) Port Maritime Administration sources made up 6 percent of the Port's total maritime-related GHG emissions in 2019. Port Maritime Administration sectors produce a mix of Scopes 1, 2, and 3 emissions but the Port has direct control or can influence these operations.

> **The Plan Focuses on These Port Maritime Administration Sectors:**
>
> - Building and Campus Energy
> - Fleet Vehicles and Equipment
> - Employee Commuting*
> - Solid Waste*
> - Habitat Restoration and Carbon Sequestration*
>
> *These sectors are outside the scope of the 2020 Strategy but are relevant to the Port's specific operations.

While the sectors named above emit GHGs, the Port's habitat restoration efforts may have the opposite effect by "sequestering" (capturing) carbon in vegetation, soil, sediments, and water. The Port does not currently quantify carbon sequestration of restored habitat and has not included carbon sequestration in the Plan's emission forecasts. However, carbon capture benefits may be quantifiable in the future and could contribute to the Port's net-zero carbon goals. Habitat restoration is an additional element that supports the Plan's vision. Furthermore, if global emissions continue to rise, carbon capture and storage strategies will continue to grow in importance to stem the effects of climate change.

Port Maritime Administration Emissions Sources




Maritime Activity sectors produce Scope 3 GHG emissions and DPM emissions

Maritime Activity sources include ships (referred to as ocean-going vessel or OGV), harbor vessels (tugs, commercial fishing vessels, recreational vessels), locomotives, trucks (including cruise-related buses and trucks supporting cruise and commercial fishing supply chain[16]), and cargo-handling equipment. These vessels, vehicles, and equipment are not Port-owned, but operate on and around Port properties, including cruise terminals, grain terminal, marinas, and industrial properties.

> **The Plan Focuses on These Maritime Activity Sectors:**
>
> - Waterside sectors:
>   - Ocean-going Vessels
>   - Harbor Vessels
> - Landside sectors:
>   - Cargo-handling Equipment
>   - Trucks*
>   - Rail
>
> *Non-container trucks, buses, and fishing-related trucks.

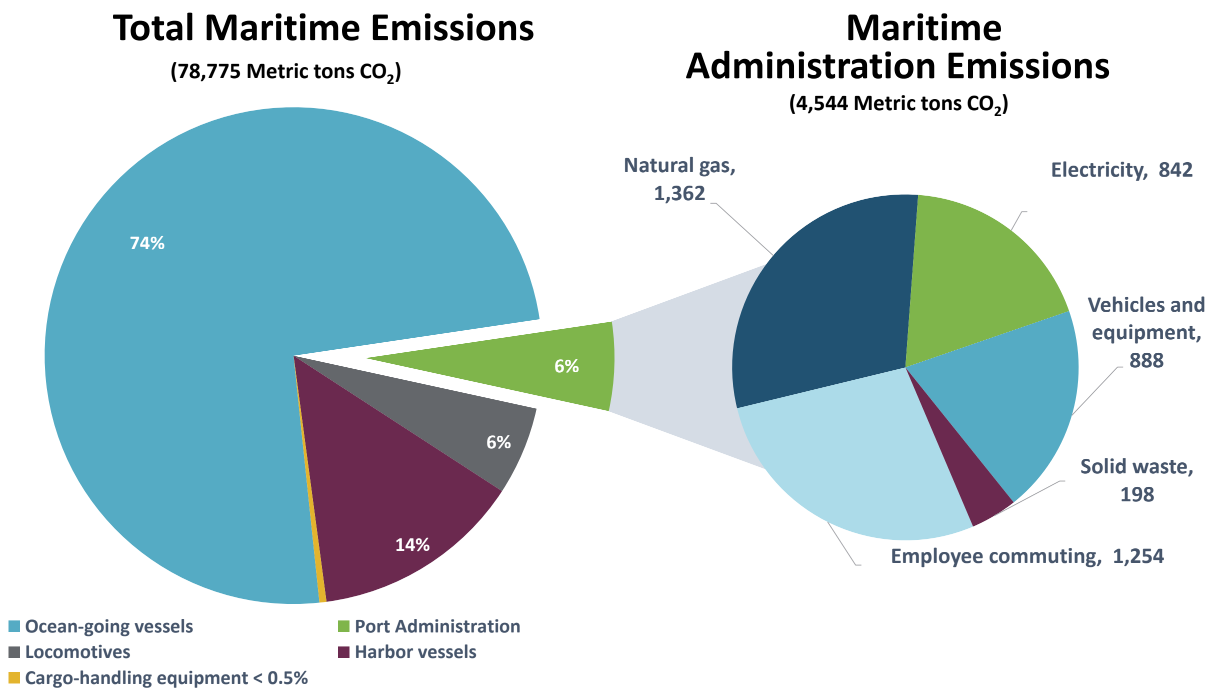
Because the Port has some influence, but not direct operational control, over Maritime Activity sectors, the associated GHG emissions are classified as Scope 3. The GHG from these activities combined made up 94 percent of the Port's maritime-related GHG emissions in 2019.

Maritime Activity Emissions Sources

[16] Truck sector emissions estimated for the Port in previous emissions inventories have included only emissions from buses that serve the cruise terminal. The Port aims to evaluate additional truck sources in future tracking and climate initiatives, such as medium- and heavy-duty trucks supporting the cruise and fishing industries but does not currently have data on how much these trucks contribute to emissions.

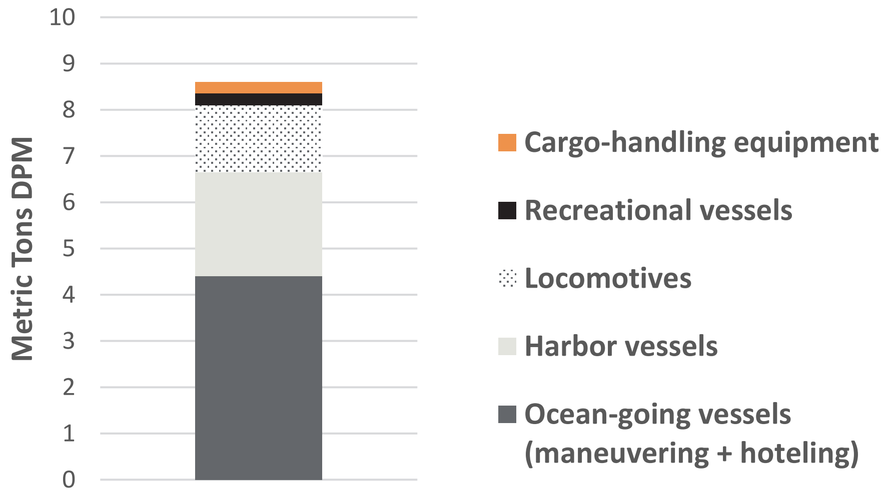
OGV contributed the largest share of air pollutant and GHG emissions compared to other Maritime Activity sectors. DPM emissions data from **Port Maritime Administration** sources is limited. The Puget Sound Maritime Air Emissions Inventory (discussed in the next section) estimates DPM for heavy-duty fleet equipment owned by the Port every five years. The Port-owned fleet vehicles emitted less than 0.1 metric tons (MT) per year of DPM as of the 2016 Inventory. No estimates are available for employee commute trips, solid waste, or natural gas. DPM emissions from all **Maritime Activity** sectors totaled about 9 MT per year in the 2016 Inventory from local sources, and 24 MT per year if including oceangoing vessels in transit. Local sources exclude oceangoing vessels in transit to focus on sources of DPM that are closer to local communities, as DPM emissions from oceangoing vessels in transit are measured for vessel journeys across the airshed. See **Appendix B** for more details on air emissions from these sources.

Figure 5. 2019 profile of Port Maritime GHG emissions



Port Maritime Administration sources make up less than 6 percent of total emissions and Maritime Activity comprises 94 percent of total emissions. Totals are net emissions and do not include emissions for business air travel, as the Port purchases offsets for all business air travel.

Figure 6. 2016 profile of Maritime Activity local DPM emissions (not including OGVs in transit)



In 2016, local DPM emissions from ocean-going vessels (maneuvering and hoteling) accounts for 19 percent of the total Port Maritime DPM. Ocean-going vessel DPM emissions for transiting account for 67 percent of the total but are excluded from this graphic to highlight sources that impact local communities.

How Does the Port Measure Emissions?

The Port measures emissions from Port Maritime Administration and Maritime Activity sectors through two separate emission inventory processes: annual GHG emissions inventories of **Port Maritime Administration** sources, and a broader inventory of air pollutant and GHG emissions from **Maritime Activity** sources that occurs on a five-year cycle. Each inventory provides critical data needed to understand the largest sources of emissions and where to focus emission reduction strategies.

Port Maritime Administration sources are inventoried annually for GHG emissions

The Port conducts inventories each year to estimate GHG emissions from **Port Maritime Administration** sources. GHG inventories were developed for milestone years for the Port's Century Agenda: 2005 and 2007 (baseline years per the Port's GHG reduction targets), 2011 (the year the Century Agenda was adopted), and annually starting in 2015. Emissions are reported in MT of CO_2 per year. [17] The results are used to track progress toward meeting GHG reduction targets and help set priorities for GHG emission reduction initiatives. The Port's GHG inventory methodology does not estimate air pollutant emissions from Port Maritime Administration sources; however, in some cases the Plan's climate strategies will reduce air pollutant emissions as well as GHG emissions related to these sources.

[17] Some emissions modeling gives results in CO_2 equivalents (CO_2e) which include other GHGs such as methane and nitrous oxide emissions weighted by their global warming potential. Because the Port uses CO_2 as the indicator for GHG emissions, and CO_2 accounts for over 99% of CO_2e from maritime sources, the Port uses CO_2e values as surrogates for CO_2 values.

Maritime Activity sources are inventoried every five years for GHG and air pollutant emissions

The Port collaborates with other ports, agencies, and organizations to conduct a voluntary, regional inventory of maritime-related emissions called the Puget Sound Maritime Air Emissions Inventory (Inventory). The Inventory is completed every five years, starting with the baseline in 2005, with follow-up inventories covering 2011 and 2016.[18] The next Puget Sound-wide inventory is anticipated to cover the year 2021.

The Inventory focuses on pollutants from **Maritime Activity** throughout the Puget Sound airshed – an area encompassing the waters of the Straits of Juan de Fuca and Puget Sound and the land between the Olympic and Cascade mountain ranges. Results are broken down by port and by source. The Inventory estimates the emission of GHG, DPM and other particulates, sulfur dioxide, and other air pollutants in U.S. (short) tons per year. The results provide critical data that informs the Port's and the region's environmental programs and policy decisions. More detail on the Port's emission inventories, including methodology and data gaps, can be found in **Appendix B**.

How Have the Port's Maritime Emissions Changed over Time?

GHG emissions decreased in 2020 due to the COVID-19 pandemic

The Port's 2020 GHG Inventory of Port Maritime Administration sources showed that GHG emissions declined sharply in 2020 from 2019 levels, reflecting the immediate impacts of the COVID-19 pandemic on the Port's businesses and internal operations. Employee commuting emissions dropped significantly, because non-essential employees worked from home from March 2020 through the end of the year. Fewer employees working onsite decreased building energy use, fleet vehicle use, and waste generation. Energy use at the cruise terminals and conference center declined due to the cancellation of the 2020 cruise season and on-site events.

It is likely that the pandemic also reduced emissions from Port Activity sources; however, those impacts have not been quantified, as they are only inventoried every 5 years.

While the Port can harness some lessons learned from its pandemic response, such as expanded use of telework and virtual meetings, the lower emission levels observed in 2020 are an anomaly. Emission

[18] Starcrest Consulting Group, LLC, 2018. *Puget Sound Maritime Air Emissions Inventory, Revised October 2018.*

levels in 2019, prior to the COVID-19 pandemic, are more representative of typical operations and activity levels. For this reason, the 2020 results were not included in the analysis of historical trends or forecasts of future GHG emissions.

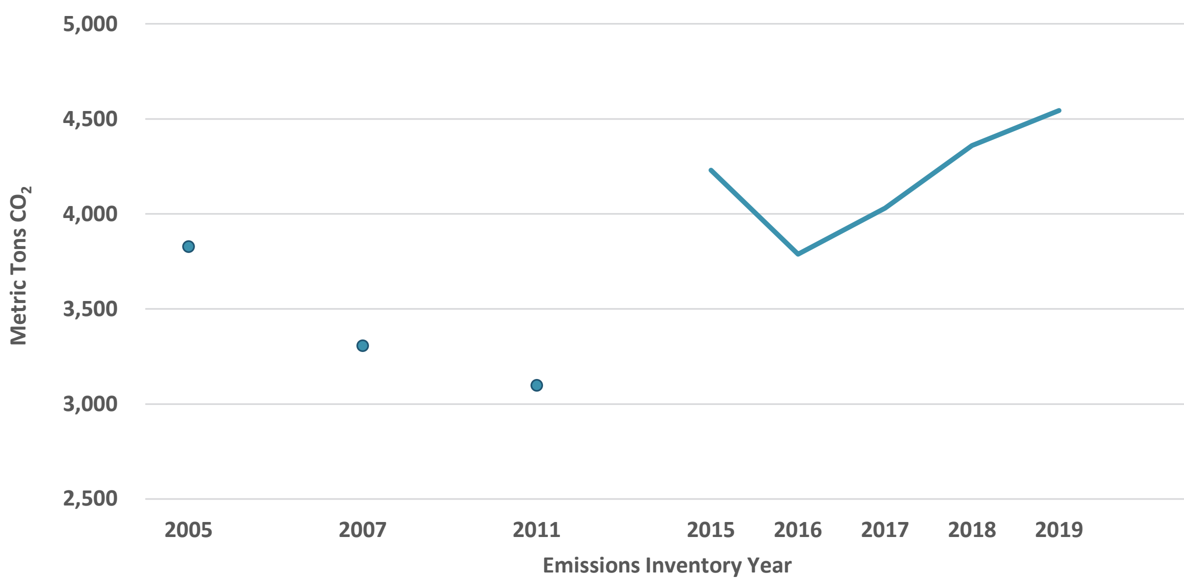
Port Maritime Administration GHG emissions are trending upward

GHG emissions from all **Port Maritime Administration** sources combined were 9 percent higher in 2019 than in 2005. With that trend, emissions are not on a trajectory to meet the Port's 2030 emission target, despite the many steps the Port has taken to conserve energy, decarbonize fuels, and maximize use of renewable energy. Energy conservation efforts include improvements in lighting, building insulation, and heating, ventilation, and air conditioning (HVAC) systems. Fuel decarbonization projects include early adoption of biodiesel-blended fuel for port vehicles and equipment; and, more recently, using renewable diesel in fleet vehicles starting in late 2019. The Port is also using renewable electricity via solar panels installed on several buildings and has purchased carbon offsets for GHG emissions from business air travel since 2016.

Four factors are driving recent increases in GHG emissions from Port Maritime Administration sectors:

- **Increased emissions from employee commuting:** Employee commuting emissions have increased as the Port's workforce has grown over the years. Most employees get to work by driving alone.
- **Increased use of natural gas in buildings:** Natural gas consumption has increased significantly over the past five years. Some variability in annual emissions is expected as conditions change, such as weather-related heating and cooling needs and tenant occupancy rates. Tenant-occupied spaces use the most natural gas, and often multiple tenants are served by the same gas meter. The lack of individual meters makes it difficult to pinpoint consumption patterns and introduce solutions, so key strategies include improving metering and conducting energy audits.
- **Increased gasoline consumption in fleet vehicles:** Gasoline consumption was 25 percent higher in 2019 compared to 2005. The increase was due to staffing growth in the trades, continued use of older, less efficient vehicles in the fleet, and past purchasing practices that favored gasoline vehicles over diesel vehicles. The Port has reduced emissions from diesel over the same period through use of blended biodiesel and renewable diesel but does not currently buy a renewable-blended option for gasoline.
- **Fluctuations in electricity emission factors from year-to-year variation in Seattle City Light's energy mix:** GHG emission factors for electricity provided by Seattle City Light have fluctuated over time, reflecting annual changes in the utility's energy portfolio. While Seattle City Light typically gets more than 90 percent of its electricity from hydropower, variations in power demand, weather, and events like droughts or major wildfires can impact the amount of fossil energy sources needed to supplement the cleaner hydropower. This influences the GHG calculation from electricity. In 2011, for example, electricity usage was on par with other years, but the corresponding emission factor was about 60 percent lower, substantially reducing 2011 GHG emissions.

Figure 7. Annual GHG emissions from Port Maritime Administration sources 2005 – 2019



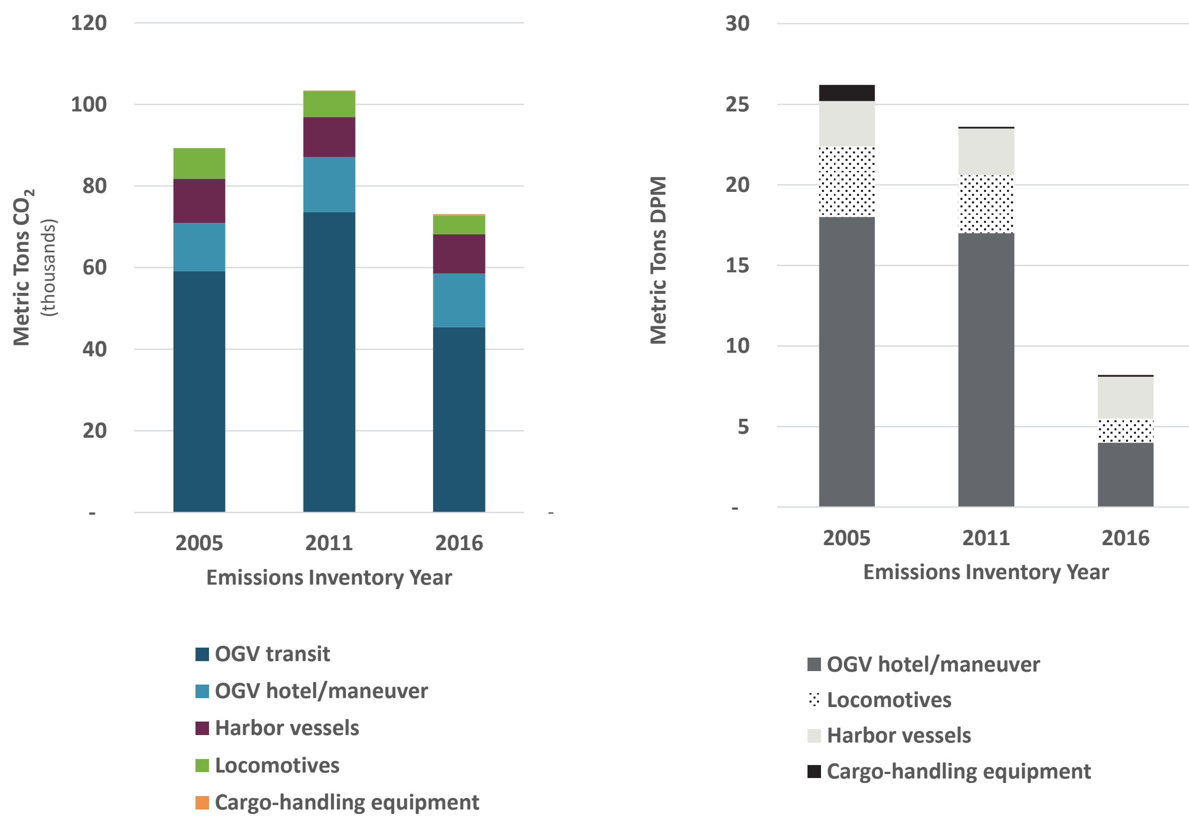
Emissions were inventoried for the Port's Century Agenda milestone years: 2005, 2007, and 2011, and annually since 2015. Note: the scale along the vertical axis has been narrowed to highlight small changes in recent years.

Maritime Activity emissions were lower for all air pollutants and GHG in 2016 compared to 2005. DPM emissions from Maritime Activity sectors dropped by 82 percent over this period. Emissions of other air pollutants fell by 25 – 96 percent, depending on pollutant, and GHG emissions were 20 percent lower in 2016 compared to 2005. In 2011, emissions were higher than in 2005 or 2016 because total vessel movements and cargo volume—two indicators of overall activity—were higher that year, and lower sulfur fuel was not yet required for vessels.

The steep reductions in DPM and other air pollutants were due to regulatory changes requiring the use of low sulfur fuel and more advanced pollution controls on newer vessels, vehicles, and equipment that went into effect over this period. Voluntary investments by the Port, maritime industry, and government agencies in cleaner equipment and fuels, as well as improved operational efficiency, also played a role in reducing emissions. The Port provided financial incentives to promote early adoption of cleaner fuels by ocean-going vessels calling at the Port from 2008 – 2015, for example.

Regulatory changes requiring low sulfur fuel and advanced pollution controls on diesel-powered engines target conventional air pollutants but have minimal effect on GHG emissions. GHG emissions declined due to lower cargo throughput, improved vessel efficiency, and broad adoption of cleaner and electric cargo-handling equipment on the cruise terminals.

Figure 8. Annual GHG and DPM emissions from Maritime Activity sources 2005 – 2016



Emissions were inventoried in the Puget Sound Maritime Air Emissions Inventories for years 2005, 2011, and 2016.

How Will the Port's Maritime Emissions Change in the Future?

Seaport-related trade is projected to grow in the coming decades. To account for growth, the Plan's emissions forecast incorporates estimated annual growth as well as the emission reduction potential of air and climate action strategies in 2030.

COVID-19 Impacts Are Not Included in These Forecasts

These forecasts do not incorporate the results of the Port's 2020 Maritime GHG Inventory, which are considered atypical due to pandemic impacts, or include future impacts of the COVID-19 pandemic or recovery.

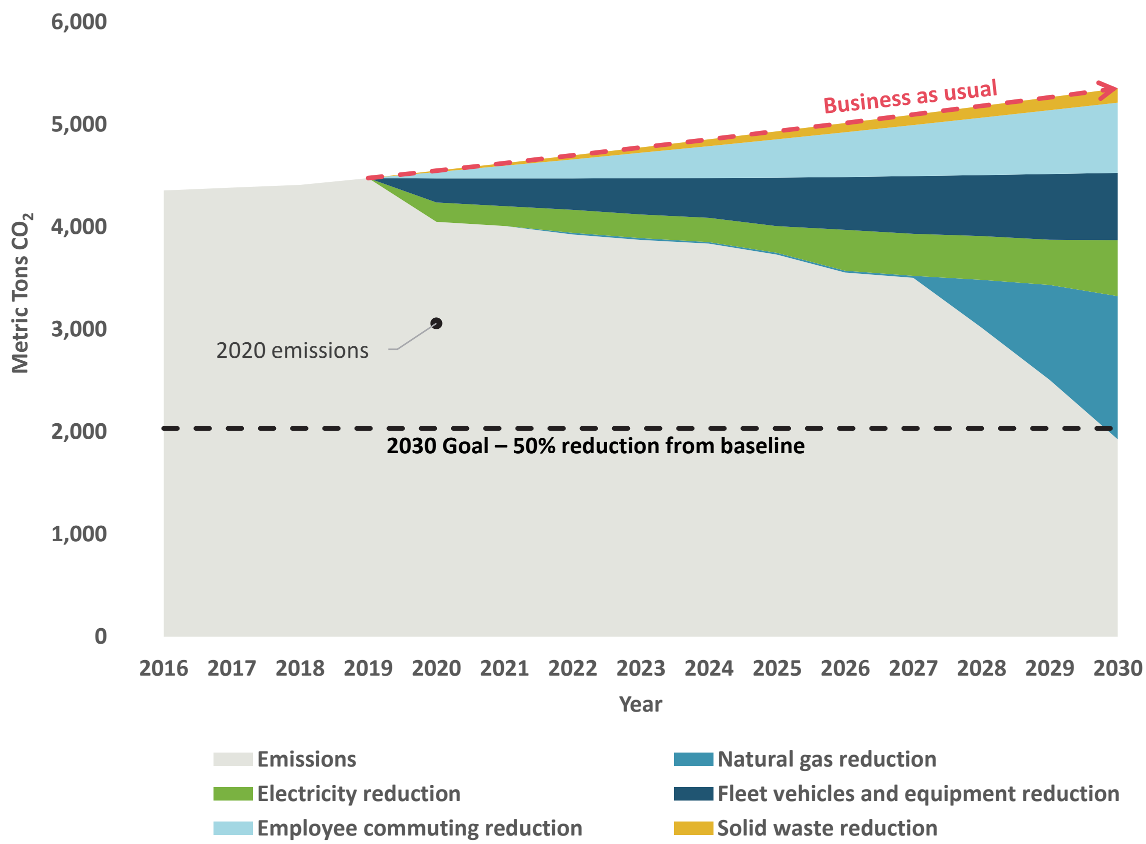
Projections will be reassessed and adjusted as the long-term impacts of the pandemic are better understood.

Business-as-usual forecast

To estimate future emissions, a business-as-usual or "no action" scenario was used to forecast emissions to 2030. This scenario includes projected business growth and assumes that the Port will continue operations without implementing any additional emission reduction strategies.

For **Port Maritime Administration** sources, an annual growth rate was developed for each sector using historic emission trends from 2005 – 2019 GHG inventory data, yielding annual growth rates ranging from 1 – 2 percent. For **Maritime Activity** sources, a composite annual growth rate of 1.9 percent was developed based on industry forecasts for the cruise, grain, commercial fishing, and recreational boating sectors. The analysis makes a conservative assumption that GHG emissions will increase proportionate to the rate of business growth. Based on these projections, business-as-usual emissions will grow by 23 percent between 2019 and 2030. As additional years' data is collected and market projections change, the forecasts can be adjusted.

Figure 9. Annual GHG emissions from Port Maritime Administration projected to 2030



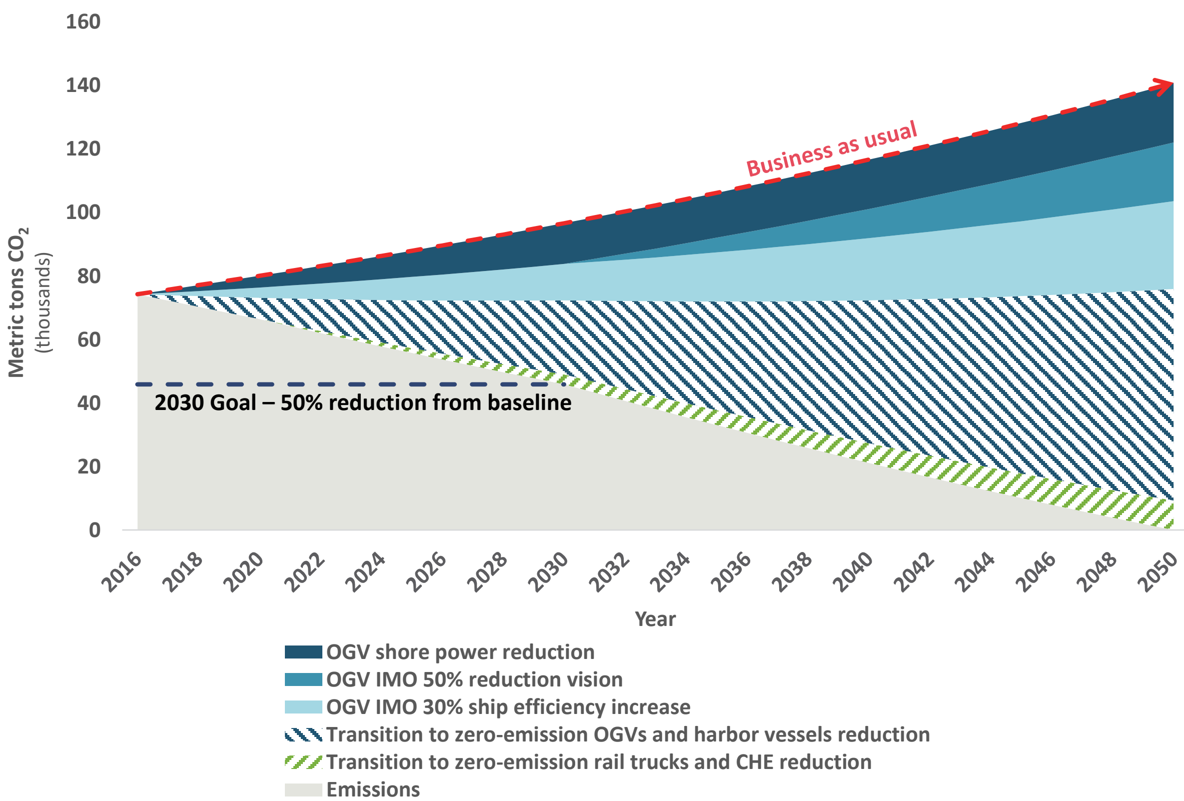
Annual emissions from Port Maritime Administration will continue increasing through 2030 under a business-as-usual scenario that includes projected growth and assumes that no further emission reduction actions are taken. The strategies identified in this Plan can reduce Port Maritime Administration emissions by 50 percent to meet the Port's 2030 GHG reduction target. Emission data from the 2020 inventory was not used in the analysis.

Action scenario forecast

In contrast, an "action" scenario was developed to forecast emissions if the strategies identified in the Plan are implemented. Expected emission reductions were subtracted from the business-as-usual totals to show the effectiveness of strategy adoption in 2030.

For **Port Maritime Administration** sectors, the Plan includes estimated potential emission reductions on a strategy-by-strategy basis. The potential reduction in emissions was calculated using Port-specific knowledge and data, as well as publicly available literature. The analysis included factors such as activity levels, energy usage, and timing of strategy implementation. When a strategy required substituting one energy source for another, the estimate reflects the net decrease in emissions.

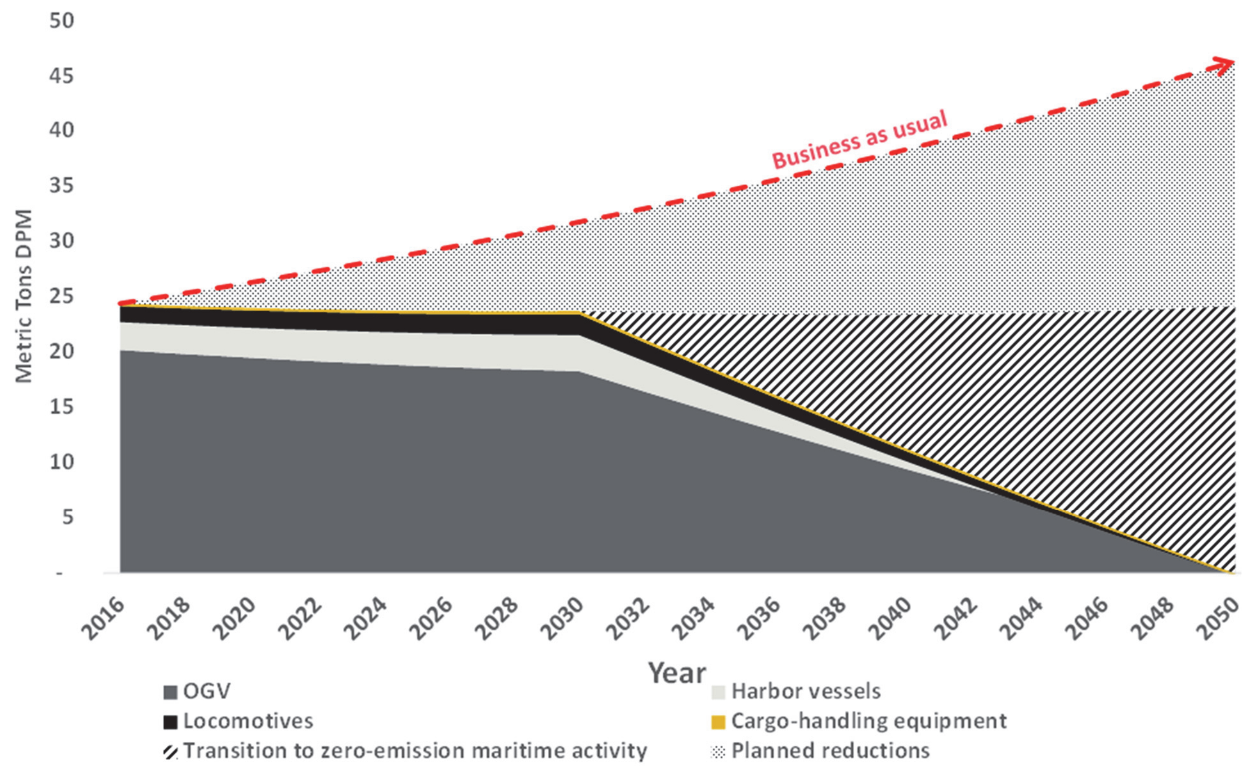
Figure 10. Annual GHG emissions from Maritime Activity projected to 2050



Annual emissions from Maritime Activity will continue increasing through 2050 under a business-as-usual scenario that includes projected growth and assumes that no further emission reduction actions are taken. The strategies identified in this Plan can reduce Maritime Activity emissions by approximately half. Transition to zero-emission maritime activity represents reductions from strategies in this plan that are not quantified, and new/innovative technologies that will be required to meet the 2050 Northwest Ports Clean Air Strategy vision.

For **Maritime Activity** sectors, the Plan includes potential emission reductions in the ocean-going vessel sector from planned shore power capability at the Port's cruise terminals, based on Port-specific knowledge and data, as well as publicly available literature. In addition, the action scenario includes the 30 percent vessel efficiency improvements regulatory mandate and a 50 percent overall reduction goal in shipping emissions (inclussive of the efficency improvements) by the International Maritime Organization (IMO). However, for other Maritime Activity strategies, the analysis assumed a theoretical straight-line reduction to zero emissions by 2050 that is needed to meet the goal set in the 2020 Strategy. Pathways and timeframes to phase out fossil fuels from other vessels, vehicles, and equipment that are not under Port control have not yet been determined.

Figure 11. Annual DPM emissions from Maritime Activity projected to 2050



Annual DPM emissions from Maritime Activity will continue increasing through 2050 under a business-as-usual scenario that includes projected growth and assumes that no further emission reduction actions are taken. The strategies identified in this Plan can reduce Maritime Activity DPM emissions by approximately half. Transition to zero-emission maritime activity represents reductions from strategies in this plan that are not quantified, and new/innovative technologies that will be required to meet the 2050 Northwest Ports Clean Air Strategy vision.

How Will the Port Reduce Emissions?

The Plan identifies a set of ambitious, timely strategies and actions to be taken by 2030 for both Port Maritime Administration and Maritime Activity sectors to decrease GHG and air pollutant emssions. These represent one path to achieve the 2030 goal of 50 percent GHG reduction and will be refined as more information becomes available, and to keep on track for the 2020 Strategy vision.

Strategies and actions to reduce emissions are detailed in Section 3 of the Plan for Port Maritime Administration sources, and in Section 4 for Maritime Activity sectors.