APPENDIX A | PERFORMANCE METRICS

Northwest Ports Clean Air Strategy Reporting Metrics

The Port will report on the following metrics identified in the 2020 Strategy as part of annual reporting requirements. These metrics apply to Maritime Activity sectors and a subset of Port Maritime Administration sectors: Building and Campus Energy and Fleet Vehicles and Equipment.

Sector	Metrics	Targets / Objectives
Overall emissions^	Absolute emissions (GHG, black carbon, DPM, PM2.5, SOx, NOx, VOC, CO)	Vision: phase out to zero emissions for all GHG and air pollutants by 2050
	Percent change in GHG emissions relative to 2005/2007/2010	Port, federal and state/provincial GHG targets 2030, 2050
Efficiency ^	GHG emissions per MT of cargo moved	Continuous improvement
	Impact of supply-chain efficiency programs on emissions, as available	Information only
Infrastructure	Percent of terminals with sufficient infrastructure in place to support uptake of zero-emission CHE, trucks, rail, harbor vessels	100 percent by 2030
	Total investments in zero-emission infrastructure	Information only
Ocean-going Vessels	Percent vessel calls with Tier 3 marine engines, cleaner fuel, or other emissions-reduction technologies while underway (e.g., wind or battery assistance)	Continuous improvement
	Percent major cruise and container berths with shore power installed	100 percent by 2030
	Percent of shore-power-capable ships that plug in and percent of total ships that plug in to shore power	Continuous improvement
Cargo-handling Equipment	Percent of CHE that meets Tier 4 emission standards (in progress)	80 percent of CHE meets Tier 4i equivalent by 2020 **
	Percent zero-emissions CHE adopted	100 percent by 2050
	Total cost of ownership of zero-emissions CHE relative to diesel CHE	Information only

Sector	Metrics	Targets / Objectives
Trucks N/A * **	Percent of container trucks that meet or surpass U.S. EPA standards for model year 2007 for particulate matter (in progress)	100 percent of container trucks meet or surpass U.S. EPA standards for model year 2007 by 2017 *
	Percent zero-emissions container trucks adopted	100 percent by 2050
	Total cost of ownership of zero-emissions container truck relative to diesel truck	Information only
	Percent renewable fuels adopted	Information only
Harbor Vessels	Percent tugs by tier level	Information only
	Percent commercial vessels with hybrid engines or using renewable fuels	Information only
	Percent zero-emissions commercial vessels	100 percent by 2050
	Total cost of ownership of zero-emissions tug relative to diesel tug	Information only
Rail	Percent of unregulated engines known to be upgraded (in progress)	20 percent upgraded by 2020, relative to 2013 *
	Percent switcher engines that use renewable fuels	Information only
	Percent zero-emissions switcher engines adopted	100 percent by 2050
Port Administration & Tenant Facilities	Absolute GHG emissions from buildings and lighting	Zero by 2050
	Percent of light-duty passenger fleet vehicles that are zero-emissions or use renewable fuels	100 percent by 2030
	Percent of entire port authority fleet (including all vehicles, equipment, vessels) that are zero-emissions	100 percent by 2050

^ Overall emission and efficiency metrics will be reported to coincide with port emission inventories. Currently emission inventories are completed every five years, with the next inventory years planned for 2020 (Vancouver), and 2021 (US Ports).

* Existing metrics that have not yet been met from the 2013 Northwest Ports Clean Air Strategy and remain relevant. Ports will continue to track progress until they are met.

** The Port has met this target.

*** The 2020 Strategy metrics are limited to container trucks that move cargo to and from marine terminals. Container trucks operating in Seattle-area terminals are associated with the Northwest Seaport Alliance rather than the Port of Seattle, so the metrics listed are not applicable. This Plan expands the definition of trucks to include shuttle vans on cruise terminals, buses providing ground transportation for cruise passengers, and heavy-duty trucks that serve cruise ships and commercial fishing fleet. The Port may establish truck-related metrics after evaluating these sources.

Port Maritime Administration Reporting Metrics

In addition to the metrics above, the Port will share findings from its annual Maritime GHG Emissions Inventory, which measures emissions annually for Port Maritime Administration sources. Because the Plan includes sources outside of the scope of the 2020 Strategy, the Port has identified additional reporting metrics specific to the Port Maritime Administration sectors.

Sector	Metrics	Targets / Objectives
Annual Maritime GHG Emissions Inventory	Percent change in absolute GHG emissions by sector and GHG Scope, relative to 2005/2007 levels	**Port of Seattle Century Agenda:** Scope 1,2 3: 50 percent below 2005 levels by 2030 Scope 1 & 2: (currently) carbon-neutral or carbon-negative by 2050, or (under consideration) net-zero or better by 2040 Scope 3: (currently) 80 percent below 2007 levels by 2050, or (under consideration) carbon-neutral by 2050
Building & Campus Energy	Percent change in fossil natural gas use (therms) relative to 2005/2007 levels	**Port of Seattle Century Agenda:** Meet all increased energy needs through conservation and renewable sources
	Percent change in electricity use (kWh) relative to 2005/2007 levels	
	Percent of total energy use (MMBtu) that is renewable energy	
	kWh of renewable energy generated	
	Annual change in Energy Use Intensity by building type for buildings over 20,000 sqft	
Fleet Vehicles & Equipment	Percent of light-duty passenger fleet vehicles that are zero-emissions or use renewable fuels	**2020 Strategy:** 100 percent of light-duty passenger fleet vehicles are zero-emissions or use renewable fuels by 2030; 100 percent of entire fleet is zero-emission by 2050
	Percent of liquid and gaseous fuel purchased that is renewable	
	Percent of entire fleet (including all vehicles, equipment, and vessels) that is zero-emission	

Sector	Metrics	Targets / Objectives
Employee Commuting	Drive alone rate at CTR-affected worksite (Pier 69)[25]	Continuous improvement
	Percent of employees utilizing telework or flexible work arrangements at CTR-affected worksite (Pier 69)	Continuous improvement
Solid Waste	Percent change in absolute waste tonnage relative to 2007 level	Continuous improvement
	Percent of solid waste tonnage recycled or composted	
Habitat Restoration & Carbon Sequestration	Number of acres of habitat restored (Port-wide)	**Port of Seattle Century Agenda:** Restore, create, and enhance 40 additional acres of habitat in the Green/Duwamish habitat

[25] 2020 Northwest Ports Clean Air Strategy: 100 percent of light-duty passenger fleet vehicles are zero-emission or use renewable fuels by 2030

APPENDIX B | EMISSIONS INVENTORIES

Port of Seattle GHG Emissions Inventories

An emissions inventory estimates the amount of air pollutant or GHG emissions from a source or operation, using globally recognized protocols.[26] These protocols define three types (scopes) of emissions.

- **Scope 1 GHG emissions** are direct emissions from sources that are owned or controlled by the organization
- **Scope 2 GHG emissions** are indirect emissions from sources that are controlled by the organization
- **Scope 3 GHG emissions** are from sources not owned or directly controlled by the organization

Activity levels (such as hours of operation, power load, miles traveled) are multiplied by emission factors to calculate the amount of pollutant emitted.

Results are typically expressed in MT per year of the relevant air pollutant. GHG inventories usually report results for individual GHGs, or in carbon dioxide equivalents (CO_2e) per year. CO_2e is a composite measure of various GHG based on their global warming potential, which converts all GHG to the equivalent amount of CO_2.

Two Categories of Emissions and Two Types of Inventories

The Port's maritime-related emissions fall into two distinct categories and each category is inventoried in a separate manner. Results from both inventories have been consolidated to form a complete picture of maritime-related emissions.

Table B-1. Port air and GHG emission categories, sectors, and inventory methods

Category: Maritime Activity (Scope 3)	Category: Port Maritime Administration (Scope 1, 2, or 3 as noted)
Sectors: • Ocean-going vessels • Harbor craft (includes tugs, commercial fishing vessels and recreational vessels) • Locomotives • Cargo-handling equipment • Cruise buses on terminals	Sectors: • Port-owned building & campus energy (includes tenant-occupied space) • Port-owned fleet vehicles & equipment • Port employee commuting (Scope 3) • Solid waste (Scope 3) Employee business air travel (Scope 3)

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

Category: Maritime Activity (Scope 3)	Category: Port Maritime Administration (Scope 1, 2, or 3 as noted)
Inventory Method: • Port of Seattle emissions extracted from Puget Sound Maritime Air Emissions Inventory • Conducted every 5 years, including 2005 baseline, 2011, and 2016 • Includes air pollutants and GHG • Covers air pollutants and GHG	Inventory Method: • Maritime internal GHG inventory per Greenhouse Gas Protocol Corporate Reporting Standard • Conducted annually, including 2005/2007 baselines, 2011, 2015 and beyond • GHG only

The **Maritime Activity** category includes externally controlled ships, harbor craft, recreational vessels, locomotives, vehicles, and cargo-handling equipment that are associated with the Port cruise terminals, grain terminal, and marinas. The Port is the hub for these sources but has limited influence over them.

Figure B-1. *U.S. portion of the Georgia Basin-Puget Sound International Airshed used for emission inventory and emission reduction planning for Maritime Activity emissions (not applicable to Port Maritime Administration emissions).*

The Port has collaborated with other ports, agencies, and organizations to conduct a regional inventory of these sectors — the Puget Sound Maritime Air Emissions Inventory (Inventory) — on a 5-year cycle.[27] The Inventory was conducted for calendar years 2005, 2011, and 2016. The next Inventory will be conducted for the year 2021. The Inventory quantifies emissions for criteria air pollutants as well as CO_2e and black carbon (soot).[28] Results are

[27] Puget Sound Maritime Air Forum, *2016 Puget Sound Maritime Air Emissions Inventory*.

[28] The CO_2e emissions reported in the Inventory include CO_2, methane, and nitrous oxide; these are the GHG pollutants associated with maritime industry fuels. Because Port of Seattle uses CO_2 as the indicator pollutant to track progress, the CO_2e values reported in the Inventory are treated as surrogates for CO_2 value in Port reporting.

compiled by port and by sector. Maritime Activity GHG emissions for years 2005, 2011, and 2016 have been extracted from the Puget Sound Maritime Air Emissions Inventory inventories and combined with emission totals for Port Maritime Administration sources.

The **Port Maritime Administration category** includes facilities, equipment, and associated activities that the Port can control directly or guide in its role as property owner, landlord, and employer. The sectors that fall under this category are Port-owned buildings including office buildings, maintenance shops, marinas, terminals, commercial and industrial rental properties, and conference centers; Port-owned fleet vehicles, equipment, and vessels; solid waste from Port-owned facilities; Port employee commuting; and Port employee business air travel. Collectively these sectors contribute 6 percent of emissions. Port Maritime has conducted internal GHG inventories of annual Port Maritime Administration emissions for 2005 and 2007 (baseline years), 2011, and annually from 2015 on. The maritime inventories report GHG emissions in Metric tons CO_2.[29] These inventories follow the Greenhouse Gas Protocol Corporate Reporting Standard but have not been third-party verified.[30]

Data Quality

Both the Inventory and internal Maritime GHG inventories use a mix of source-specific data and surrogate data (estimated activity and/or emissions). Because the Inventory is only conducted every 5 years, emissions from Maritime Activity in non-inventory years are assumed to be static until the next inventory cycle.

For the internal Maritime GHG inventories, surrogate data from the closest year was used to fill in missing years' information. There was less data available for the baseline years of 2005 and 2007, thus requiring use of surrogate data for some sectors. In subsequent years, data quality has improved, and the Port has identified additional tenant-managed properties to include as Scope 3 sources.

The Port has a wide variety of utility meters and submeters throughout its building and facilities and in some cases, multiple users share a single meter. When direct energy use by tenants is unknown, that usage is considered "Port-managed" energy use and is attributed to the Port as a Scope 1 or Scope 2 source. Energy metered directly to individual tenants is considered "tenant-managed" use, which is classified as a Scope 3 source. This data limitation results in an overestimation of GHG emissions from campus energy that is attributed to the Port vs. tenants.

[29] The Port Maritime internal GHG inventories use is CO_2 as the indicator pollutant. For the solid waste and employee commute sectors, modeling methodologies report results in CO_2e, which the Port applies as a surrogate value for CO_2.
[30] Greenhouse Gas Protocol, *Corporate Accounting and Reporting Standard.*

Table B-2. Port of Seattle Maritime GHG emissions 2005 – 2019 in metric tons CO_2. *Inventories were completed for the Port's Century Agenda milestone years only, and then annually from 2015 (i.e., 2005, 2007, 2011, and annually from 2015).*

	GHG Scope	Baseline^ (2005*/ 2007)	2011*	2015	2016*	2017	2018	2019	2020^^
Maritime Activity**									
Ocean-going vessel transit	3	59,159	73,573	73,753	45,383	45,383	45,383	45,383	45,383
Ocean-going vessel hotel/maneuver	3	11,732	13,517	13,517	13,156	13,156	13,156	13,156	13,156
Harbor craft	3	2,967	3,726	3,726	4,083	4,083	4,083	4,083	4,083
Recreational vessels	3	7,867	6,854	6,854	6,701	6,701	6,701	6,701	6,701
Locomotives	3	7,545	6,239	6,239	4,540	4,540	4,540	4,540	4,540
Cargo-handling equipment	3	3,926	407	407	354	354	354	354	354
Cruise buses on terminals	3	13	13	13	15	15	15	15	15
subtotal		**93,208**	**104,329**	**104,329**	**74,231**	**74,231**	**74,231**	**74,231**	**74,231**
Port Maritime Administration									
Building electricity, Port-managed	2	449	146	452	281	289	299	295	296
Building electricity, tenant-managed	3	797	207	767	439	536	520	547	382
Building natural gas, Port-managed	1	593	530	606	689	843	1,061	1,261	1,009
Building steam, Port-managed	2	348	365	0	0	0	0	0	0
Remediation propane	1	0	0	0	0	0	0	101	180
Vehicle fleet	1	867	694	820	802	871	986	888	538
Solid waste**	3	139	139	139	185	188	190	198	93
Employee commuting**	3	1,021	1,282	1,345	1,392	1,305	1,335	1,254	560
Employee air travel**	3	100	100	100	86	86	125	125	15
subtotal		**4,312**	**3,463**	**4,229**	**3,875**	**4,118**	**4,517**	**4,669**	**3,075**
Air travel offsets***		0	0	0	(86)	(86)	(125)	(125)	(15)
net Port Admin.		**4,312**	**3,463**	**4,229**	**3,789**	**4,032**	**4,392**	**4,544**	**3,060**
NET EMISSIONS		**97,520**	**107,792**	**108,558**	**78,020**	**78,263**	**78,623**	**78,775**	**77,291**

^ Baseline value noted (2005 is baseline year for Scope 1 and 2 sources, 2007 is baseline year for Scope 3 sources)

^^ 2020 values do not represent typical emissions due to impacts of the COVID-19 pandemic on Port operations, and have not been included in GHG emission projections included in this Plan

* Inventory years for the Puget Sound Maritime Air Emissions Inventory

** Emissions from this category were calculated in CO_2e; this is proxy for the CO_2 totals reported here

*** The Port of Seattle began buying carbon offsets for business air travel emissions in 2016

Table B-3. Maritime Activity air pollutant emissions for 2005, 2011, and 2016 in tons/year.[31] *Maritime Activity air pollutant emissions for years 2005, 2011, and 2016.*

*	NOx	VOC	CO	SO_2	PM_{10}	$PM_{2.5}$	DPM	BC
2016								
Ocean-going vessels	1,174	41	102	41	23	21	22	1
Harbor craft	75.7	2.40	12.51	0.04	2.49	2.29	2.49	1.76
Recreational vessels	52.4	94.0	657.9	0.1	2.0	1.8	0.3	0.5
Locomotives	61.6	2.7	13.1	0.1	1.6	1.5	1.6	1.2
Cargo-handling equipment	6.0	1.1	18.0	0.0	0.3	0.3	0.3	0.2
Heavy-duty vehicles	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Fleet vehicles	0.9	0.2	3.6	0.0	0.0	0.0	0.0	0.0
2016 total	**1,370.6**	**141.6**	**807.6**	**41.4**	**29.0**	**27.2**	**26.9**	**4.9**
2011								
Ocean-going vessels	1,729.2	57.8	137.4	1,335.2	166.2	132.8	164.1	4.0
Harbor craft	68.4	2.34	10.47	0.04	2.72	2.50	2.73	1.93
Recreational vessels	57.5	135.4	826.6	0.1	2.8	2.6	0.4	0.6
Locomotives	107.8	6.1	18.0	1.0	4.0	3.6	4.0	2.8
Cargo-handling equipment	5.3	0.9	20.7	0.0	0.2	0.2	0.2	0.1
Heavy-duty vehicles	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Fleet vehicles	1.3	0.3	5.0	0.0	0.0	0.0	0.0	0.0
2011 total	**1,970.0**	**202.8**	**1,018.2**	**1,336.3**	**175.9**	**141.7**	**171.4**	**9.6**
2005								
Ocean-going vessels	1,506.6	51.6	120.8	981.4	141.6	113.0	139.7	3.4
Harbor craft	57.8	1.83	7.57	6.08	2.52	2.32	2.52	1.79
Recreational vessels	56.1	198.2	1,221.4	1.8	4.2	3.9	0.5	0.9
Locomotives	172.0	8.3	22.8	13.9	4.8	4.4	4.8	3.4
Cargo-handling equipment	33.3	34.8	1,133.9	0.8	1.9	1.8	1.6	1.2
Heavy-duty vehicles	0.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Fleet vehicles	2.6	0.7	11.3	0.0	0.0	0.0	0.0	0.0
2005 total	**1,829.0**	**295.4**	**2,518.0**	**1,004.1**	**155.0**	**125.4**	**149.2**	**10.7**

***Key to abbreviations in column headers:**

NOx: nitrogen oxides

VOC: volatile organic compounds

CO: carbon monoxide

SO_2: sulfur dioxide

PM_{10}: particulate matter 10 micrometers or less in diameter

PM_{25}: particulate matter 2.5 micrometers or less in diameter

DPM: diesel particulate matter

BC: black carbon

[31] Puget Sound Maritime Air Forum, *2016 Puget Sound Maritime Air Emissions Inventory*. Excerpt from Tables 9.59 and 9.60.

APPENDIX C | EMISSIONS PLANNING ASSUMPTIONS

The Plan includes GHG and DPM emissions forecasts for both a no-action (business-as-usual) scenario and an action (emission reduction) scenario, as discussed below.

It is important to note that neither the business-as-usual (BAU) or action scenarios include the short or long-term impacts of COVID-19 on port operations or the maritime industry. The emissions forecasts should be revisited periodically to ensure that they reflect new information about the impacts of COVID-19, as well as changes in port business trajectories and the development of new technologies, policies, and regulations.

Business-as-Usual Forecasts

Each emissions forecast includes an emissions projection under a BAU scenario against which the impact of proposed actions is measured. The Port's consultant team reviewed standard GHG emission inventory protocols and did not find an explicit forecasting methodology for projecting BAU emissions. Analysis of fifteen climate action plans or emissions analyses for port or government entities found variation in data and assumptions used to estimate future changes in activity. For example, city or county community-based emissions forecasts tended to be based on population and/or gross domestic product projections, and port maritime emissions forecasts tended to be based on cargo volume projections or data from business plans. Emission forecasts of government operations (analogous to Port Maritime Administration operations described in this Plan) tended to be based on historical trends and/or planned updates to services. Some, but not all, climate action plans included regulatory changes in the BAU forecast, such as mandated low carbon fuels, engine improvements, or increased use of renewables in the energy portfolio that would occur independent of implementation of the Plan.

Based on this research, the Plan takes a hybrid approach: Maritime Activity sector BAU emissions (ocean-going vessels, cargo-handling equipment, trucks, harbor vessels, and rail) are forecasted based on industry trends; and Port Maritime Administration sector emissions (building and campus energy, fleet vehicles and equipment, employee commuting, and solid waste) are forecasted based on historical trends. The approach assumes that no additional regulatory changes or emission reduction efforts will be made under the BAU scenario. However, the emission reduction projections do account for the impacts of known or expected policy changes, as discussed below under action scenario forecasts.

Port Maritime Administration BAU forecast

For Port Administration sources, the BAU scenario assumes Port operations will grow linearly according to observed historical GHG emissions trends for each of the sectors between the years 2005-2019. The analysis resulted in the following annual growth forecast for Port Administration BAU emissions from 2020-2030:

- Building and Campus Energy: 1.8 percent
- Fleet Vehicles and Equipment: 2.2 percent
- Employee Commuting: 1.0 percent
- Solid Waste: 2.2 percent

The BAU projection does not account for specific future policy changes; it assumes that the Port would continue its historical trajectory without any additional emission reduction efforts. BAU assumptions do, however, incorporate the emission reductions achieved across sectors since the baseline year, such as improvements to buildings, vehicle modernization, policy changes and others. This decision, to project BAU emissions based on historical GHG emission trends, takes a conservative approach to the emissions forecasting and is a methodology consistent with other governments' operational emissions forecasts.

It is also important to note that emissions from Port Administration sources in the Plan are forecasted over a ten-year time horizon from 2020-2030. Over this period, known regulatory changes in state policy, such as the Clean Energy Transformation Act[32], will not yet require reduction in emissions.

Maritime Activity BAU forecast

Most port climate action plans forecast emissions from Port Activity sectors based on cargo throughput projections. Since a cargo throughput metric is not applicable for Port of Seattle's unique emissions portfolio, which includes cruise, grain, commercial fishing and recreational boating, the Plan uses a composite annual growth rate based on research of industry trends in each applicable sector. A composite annual growth rate of 1.9 percent was used for both the GHG and DPM emissions wedge analyses and developed with guidance from the Port's business units. The composite rate was calculated based on industry growth trends for each sector and weighted by the relative contribution of each sector to GHG and DPM emissions.

The following sources were used to forecast industry growth trends:

- BST Associates, *2017 Marine Cargo Forecast and Rail Capacity Analysis Report* (2017) prepared for the Washington Public Ports Association and the Washington State Freight Mobility Strategic Investment Board provides estimated growth for grain exports through Puget Sound ports.
- BST Associates, PCC 45th Semi-Annual Conference: *What lies ahead? Is your marina preparing for the future or just satisfying today's needs?* (2019) provided the outlook for recreational boating.
- McDowell Group, *Modernization of the North Pacific Fishing Fleet – Economic Opportunity Analysis* (2016), prepared for Port of Seattle and the Washington Maritime Federation, provided the outlook for commercial fishing.
- Port Maritime staff provided a cruise forecast that is subject to change.

The Port Activity BAU forecasts assumes GHG emissions will increase proportionate to the rate of business growth. It does not include an explicit assumption about the impact of new technology or emission standards in the future, such as the emission reduction potential from the natural attrition of older equipment and replacement with newer, cleaner models. In this way, it also represents a conservative, 'worst-case' assumption where the main driver for change in emissions under the BAU scenario is projected growth in port-related industries based on research and consultation with Port business units. For example, the cruise forecast included an increase in the number of cruise calls between 2020-2050.

[32] Under the *Clean Energy Transformation Act*, all utilities must supply Washington customers with 100 percent renewable or non-emitting electricity by 2045.

Action Scenario Forecasts

Each emissions forecast also incorporates an action scenario that estimates the emission reduction potential from implementing select strategies identified in the Plan, as discussed below.

Port Maritime Administration action forecast

For Port Maritime Administration sectors, the Plan includes estimated potential emission reductions on a strategy-by-strategy basis. Reductions were calculated using Port-specific knowledge and data, as well as publicly available literature. The analyses include 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 in emissions. The following assumptions were used in estimating emission reductions from 2019-2030 for each sector:

Building and Campus Energy sector

- Number and timing of energy projects are based on capital plan or typical equipment lifespan
- Eliminating natural gas includes 12 percent energy equivalent replacement with electricity
- 2019 emissions factor for electricity is assumed to remain constant to 2030

Fleet Vehicles and Equipment

- Number and timing of vehicles and equipment upgrades to lower-emission models is based on the Port's fleet replacement schedule
- Biogenic-based portion of renewable fuels is treated as zero-emission per GHG inventory protocols

Employee Commuting

- Progressive increase in telework days and drive-alone trips resulting from strategies identified in the Port's Commute Trip Reduction Plan

Solid Waste

- Progressive reduction in solid waste being landfilled resulting from strategies identified in the Port's Maritime Solid Waste Management Plan

Maritime Activity action forecast

For Maritime Activity sectors, the Plan includes potential emission reductions based on Port-specific knowledge and data, as well as publicly available literature. In addition, the action scenario includes the impact of vessel efficiency improvements resulting from regulatory mandates that are in force or being developed by the IMO. For other Maritime sectors, the analysis assumed a theoretical straight-line reduction to zero emission by 2050 that is needed to meet the goal set in the 2020 Strategy. The following assumptions were used in estimating emission reductions from 2019 – 2050 for each sector:

Ocean-going vessel sector

- GHG and DPM emission reductions for shore power are based on operational data provided by cruise lines, and emissions data from the Puget Sound Maritime Air Emissions Inventory

- Assumes 100 percent of homeport vessels are shore power-equipped with a 100 percent shore power connection rate by 2030
- The current IMO mandate for new ships to be 30 percent more energy efficient will not be fully realized until 2050, due to long operational life of ocean-going vessels
- An additional IMO strategy to reduce GHG emissions from shipping by 50 percent (this includes the 30 percent efficiency mandate above) by 2050 is expected to begin taking effect by 2030, ramping up by 2050

All other Maritime Activity sectors

- Analysis assumes a theoretical straight-line reduction to zero emissions by 2050 needed to phase out emissions (pathways still be determined)

Strategy Ease and Effectiveness Comparison

Figure 26 in the Plan displays the relative ease and effectiveness of implementing select strategies. (Only strategies with quantified GHG emission reduction potential were included.) The strategies were assigned scores based on their annual emission reduction potential in 2030. They were also assigned scores according to the relative implementation difficulty, which incorporates cost, technology readiness, and the Port's level of control over the emissions. The following strategy evaluation rubric was used to assign ease and effectiveness scores to each strategy.

Annual Emission Reduction Impact by 2030 (-6 is low impact, +6 is high impact)	Value
>10,000 MT GHG reduction and DPM reduction	+6
>10,000 MT GHG reduction with no DPM reduction	+5
5,000 – 9,999 MT GHG reduction and DPM reduction	+4
5,000 – 9,999 MT GHG reduction with no DPM reduction	+3
1,000 – 4,999 MT GHG reduction and DPM reduction	+2
1,000 – 4,999 MT GHG reduction with no DPM reduction	+1
500 – 999 MT GHG reduction and DPM reduction	0
500 – 999 MT GHG reduction with no DPM reduction	-1
300 – 499 MT GHG reduction and DPM reduction	-1.5
300 – 499 MT GHG reduction with no DPM reduction	-2
200 – 299 MT GHG reduction and DPM reduction	-2.5
200 – 299 MT GHG reduction with no DPM reduction	-3
100 – 199 MT GHG reduction and DPM reduction	-3.5
100 – 199 MT GHG reduction with no DPM reduction	-4
50 – 99 MT GHG reduction and DPM reduction	-4.5
50 – 99 MT GHG reduction with no DPM reduction	-5
0 – 49 MT GHG reduction and DPM reduction	-5.5
0 – 49 MT GHG reduction with no DPM reduction	-6

Implementation Difficulty (-4 is low difficulty, +4 is high difficulty)	
Technology readiness	**Value**
No technology impact	-3
Technology commercially available & can be used in existing equipment or infrastructure	-2
Technology commercially available with modification to existing equipment/infrastructure	-1
Preferred technology pathway identified and will be market-ready within 2 years	0
Technology pathways in demonstration	+1
Technology pathways in early demonstration	+2
Technology pathways still being researched	+3
Level of investment needed	**Value**
Strategy will save over $100,000/year	-4
Strategy offers cost savings of up to $100K/year	-3
Strategy is cost-neutral	-2
Strategy cost-competitive w/conventional alternatives	-1
Strategy requires 5-year cost < $1M	0
Strategy requires 5-year cost of $1M – $4.9M	+1
Strategy requires 5-year cost of $ 5M – $9.9M	+2
Strategy requires 5-year cost of $ 10M – $14.9M	+3
Strategy requires 5-year cost of $15M or more	+4
Level of control over emissions	**Value**
Port Maritime Administration, Scope 1 source	-3
Port Maritime Administration, Scope 2 source	-2
Port Maritime Administration, mix of Scope 1, 2, 3 sources	-1
Port Maritime Administration, Scope 3 source	0
Maritime Activity Scope 3, Port owns infrastructure/equipment	+1
Maritime Activity Scope 3, tenants or industry own infrastructure/equipment	+2
Maritime Activity Scope 3, no business relationship with emission source	+3

APPENDIX D | GLOSSARY AND ACRONYMS/ABBREVIATIONS

Actions: Specific and measurable steps needed to implement emission reduction strategies described in this Plan. Actions are grouped in 5-year increments

Air pollutants: Natural and human-made substances in the air we breathe that negatively impact human or environmental health. Air pollutants of most concern to ports include particulate matter, ozone-forming pollutants (nitrogen oxides and volatile organic compounds) and sulfur oxides.

Biodiesel: Diesel fuel made from waste oils and fats, rather than petroleum

B20: Diesel fuel with 20 percent biodiesel content and 80 percent petroleum diesels

Blue carbon: Carbon dioxide captured and stored in ocean and nearshore habitats

Carbon-neutral: Making no net release of carbon dioxide to the atmosphere; allows emissions to be offset with a reduction, including purchase of carbon offsets

Carbon sequestration: The process of trapping or capturing carbon dioxide in plants, sediments, water or underground, thus removing it from the atmosphere

Century Agenda: The Port of Seattle's 25-year strategic plan to stimulate economic development while remaining committed to social and environmental responsibility

CHE: Cargo-handling equipment

CO_2: Carbon dioxide, the primary greenhouse gas that traps heat in the atmosphere. Carbon dioxide enters the atmosphere through burning of fossil fuels used in for energy and transportation, from burning of solid waste and other organic materials, and from certain chemical reactions. In this Plan, the term CO_2 is generally synonymous with greenhouse (GHG) emissions.

CO_2e: Carbon dioxide emissions

DHW: Domestic hot water used in buildings. The water is heated by electricity, natural gas, or other forms of energy.

Emissions Inventory: A detailed estimate of air emissions (either air pollutants or greenhouse gases) that one or more sources produces over a certain period. Port emission inventories usually estimate pollutants in tons or metric tons of pollutant per year.

EV: Electric vehicle

Fossil fuel: Carbon-based fuels from fossil hydrocarbon deposits, including oil, diesel, gasoline, bunker fuel used by ships, coal, propane, and natural gas

Greenhouse gas (GHG) emissions: Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds.[33] GHGs included

[33] IPCC, *Data Distribution Center Glossary*.

in port inventories are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). In this Plan, the term GHG is generally referring to CO_2.

HV: Harbor vessels, including tugboats, bunker fuels used by ships, and diesel and gasoline commercial fishing vessels, and recreational vessels

HVAC: Heating, ventilation, and air conditioning for buildings

kWh: Kilowatt-hour; unit of energy used to describe electricity consumption or production

LED: Light emitting diode, a type of high efficiency light bulb

Lifecycle emissions: Emissions that result from the extraction, processing, and transport of the fuel or technology prior to its final use, in addition to those that are emitted at the tailpipe

The Plan: Port of Seattle's Maritime Climate and Air Action Plan (this Plan) which includes actions relating to the Maritime, Economic Development and Corporate divisions and excludes the Northwest Seaport Alliance and the Port of Seattle's Airport Division and its operations and emission sources

Maritime Activity: A category of the Port's maritime emission sectors; includes ships, harbor craft, recreational vessels, locomotives, trucks, and cargo-handling equipment that are not owned by the Port but are used on and around the Port's cruise terminals, grain terminal, marinas, and industrial properties. These are GHG Scope 3 sources.

MT: Metric ton, the unit of measure used to account for climate and air pollution magnitudes

Net-zero: Refers to a state in which the carbon dioxide released into the atmosphere from a company's activities is balanced by an equivalent amount being removed (excluding carbon offsets)

NWSA: The Northwest Seaport Alliance, a separate port authority formed in 2015 by a marine cargo operating partnership between the Port of Seattle and the Port of Tacoma

Northwest Ports Clean Air Strategy: Northwest Ports Clean Air Strategy (2020 Strategy), a regional, multi-port and multi-agency plan to reduce air pollutant and greenhouse gas emissions from seaport-related sources first established in 2008

OGV: Ocean-going vessels such as cruise ships and grain ships that exit Puget Sound as part of their domestic or international itineraries

Plug load: Energy used by equipment that is plugged into electrical outlets

Port-managed properties: Properties occupied by port staff or leased to tenants, but that remain primarily managed by the port

Port Maritime Administration: A category of the Port's maritime emission/carbon capture sources that are under direct control or strong guidance of the Port; includes Port-managed and tenant-managed buildings and campuses, fleet vehicles and equipment, remediation projects, habitat restoration, solid waste management, employee commuting, and business air travel. Includes GHG Scopes 1 – 3 sources.

Priority Actions: Key short-term ready-to-implement actions to be completed in 1 – 3 years that are first steps to enable or accelerate future actions

Renewable diesel: Renewable fuel made from plant or animal-based fat. Renewable diesel is chemically the same as fossil diesel and is a "drop-in" fuel capable of replacing fossil diesel without engine modifications. Renewable diesel and biodiesel are made from similar sources but by different chemical processes.

Renewable energy: Any form of energy from solar, geophysical, or biological sources that is replenished by natural processes at a rate that equals or exceeds its rate of use.[34] Examples include sunlight, wind, rain, tides, waves, geothermal heat, and some hydroelectricity.

Scope 1 emissions: GHG emissions from sources that are owned or controlled by the organization, also referred to as direct emissions

Scope 2 emissions: GHG emissions from the consumption of purchased electricity, steam, or other sources of energy (e.g., chilled water) generated upstream from the organization

Scope 3 emissions: GHG emissions that are a consequence of the operations of an organization but are not directly owned or controlled by the organization. These are also referred to as indirect emissions.

Strategies: Recommended approaches to reduce air pollutant or GHG emissions

SWCES: Seattle Waterfront Clean Energy Strategy

Tenant-managed properties: Properties leased by tenants from the Port or owned by tenants through ground leases where the lease terms limit the port's control over building management, which is primarily in the tenant's control

Ton: 2000 pounds, also called a Short Ton

Ton, Metric: 1000 kilograms or 2,204.6 pounds

Zero emissions: For this Plan and the 2020 Northwest Ports Clean Air Strategy, use of technologies and fuels that result in no tailpipe emissions, recognizing that emissions may still occur when looking at the full lifecycle. Tailpipe emissions refers to chemicals released as a result of burning a fuel to operate an engine (e.g., gasoline, diesel, biofuels). Electric- and hydrogen-fueled engines have zero tailpipe emissions.

[34] IPCC, *Data Distribution Center Glossary*.