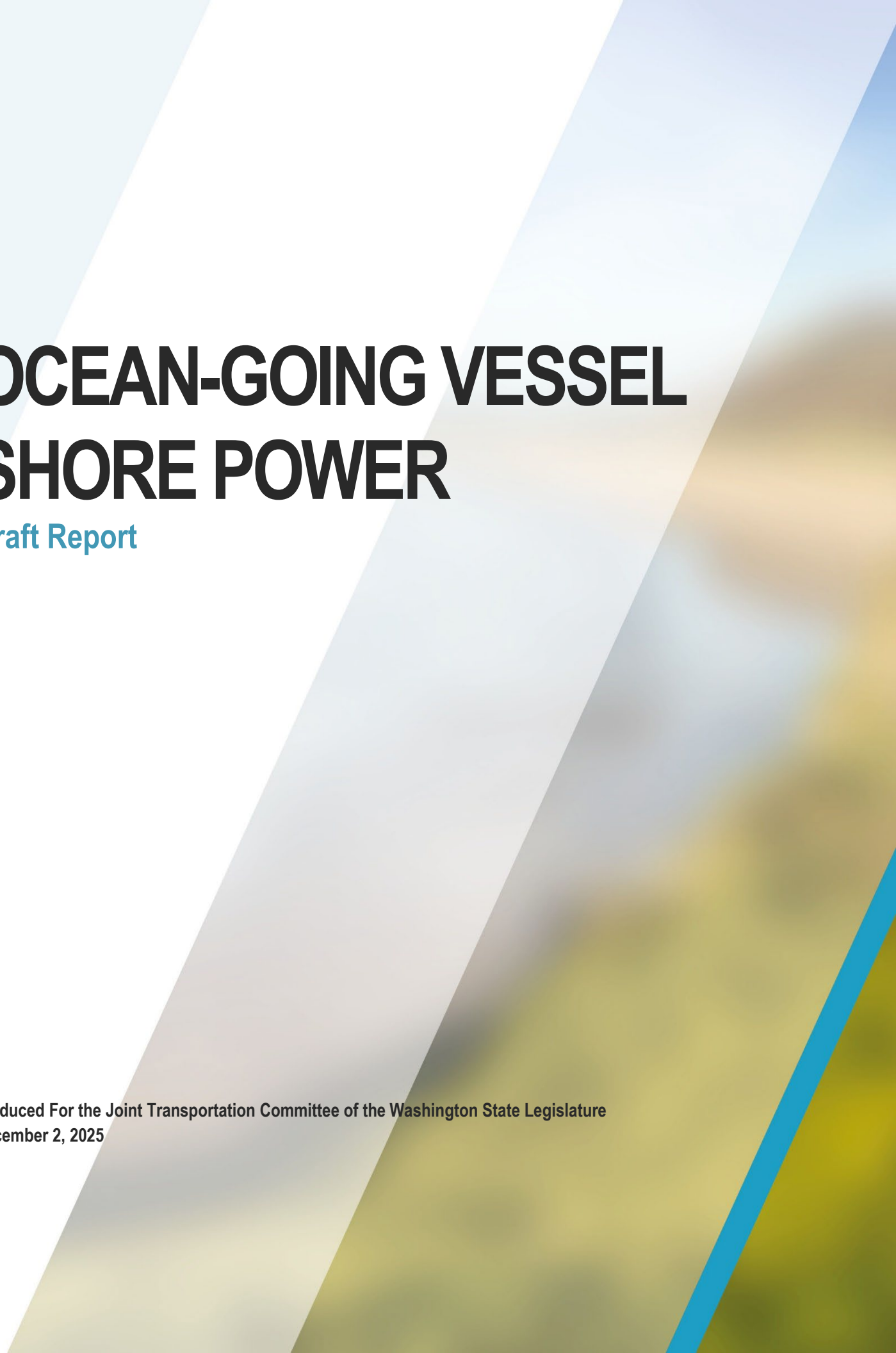
OCEAN-GOING VESSEL SHORE POWER

Draft Report



Produced For the Joint Transportation Committee of the Washington State Legislature
December 2, 2025

Produced by:

Moffatt & Nichol
600 University Street, Suite 610
Seattle, WA 98101
P: (206) 622-0222
www.moffattnichol.com

DNV USA, Inc. (DNV)
520 Pike Street, Suite 1350
Seattle, WA 98101
P: (832) 847-0802
www.dnv.com

Environmental Science Associates (ESA)
2801 Alaskan Way, Suite 200
Seattle, WA 98121
P: (206) 465-0729
www.esassoc.com

BST Associates (BST)
PO Box 2244
Anacortes, WA 98221
P: (425) 486-7722

Pacific Northwest National Laboratory (PNNL)
902 Battelle Blvd
Richland, WA 99354
P: (206) 909-1902
www.pnnl.gov

Table of Contents

List of Figures

List of Tables

Acronym List

AMP	Alternative Marine Power
CAA	Clean Air Act
CAECS	CARB-Approved Emission Control Strategies
CARB	California Air Resources Board
CCA	Climate Commitment Act
CETA	Clean Energy Transformation Act
CHC	Commercial Harbor Craft
CMS	Cable Management System
CRA	Congressional Review Act
DPM	Diesel Particulate Matter
ECA	North American Emission Control Area
FTD	Foreign Trade Division
GHG	Greenhouse Gas
H_z	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IMO	International Maritime Organization
JLARC	Joint Legislative Audit and Review Committee
JTC	Joint Transportation Committee
MR	Medium Range Tankers
MVA	Required Power Rating
NOx	Nitrogen Oxides
NWSA	Northwest Seaport Alliance
OGV	Ocean-Going Vessel
PM	Particulate Matter
ROG	Reactive Organic Gases
SOx	Sulfur Oxides
SPO	Ship Power Outlets
TIE	Terminal Incident Event
TEU	Twenty-Foot Equivalent Units
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
VIE	Vessel Incident Event
VLCC	Very Large Crude Carrier Tankers

Executive Summary

A. Study Background

When docked at port, ocean-going vessels (OGVs) such as container vessels and cruise ships generally run auxiliary diesel engines which emit nitrous oxides, particulate matter, diesel particulate matter, reactive organic gases, and greenhouse gas (collectively, "at-berth emissions"). To mitigate these at-berth emissions, in 2007 the California Air Resources Board (CARB) enacted regulations that require OGVs docked at California ports to restrict emissions while at berth by either connecting to locally provided grid electricity (known as shore power) or making use of other approved emission control strategies (collectively the At Berth Regulation).

The Washington State Legislature directed the Joint Transportation Committee (JTC) to study the impact of adopting regulations to control at-berth emissions in Washington modeled after the California At Berth Regulation. Phase I of the study identified potential impacts if the At Berth Regulation was adopted in Washington. Phase II analyzed costs and required infrastructure to support implementation.

B. Findings

- **Regulatory:** If Washington opts to regulate OGV at-berth vessel emissions, federal law will require that Washington closely follow the At Berth Regulation developed by California.
- **Infrastructure readiness:** Some ports in Washington have already begun voluntarily installing shore power for equipped OGVs, such as the Northwest Seaport Alliance (NWSA[1]) and Port of Seattle. A growing number of vessels calling at Washington ports and terminals are already equipped to connect to shore power. Port-sponsored shore power efforts have contributed to a decline in maritime-related pollutants. However, pollutant hotspots remain near terminals and ports, driven by where and how long vessels hotel at berth (and at anchor).
- **State support:** In addition to adopting regulations similar to the At Berth Regulation, Washington state can consider providing support and resources, such as funding, incentives, permit streamlining, and other regulatory reform to aid in a potential transition to shore power.
- **Washington terminals affected:** California's At Berth Regulation requires terminals that receive 20 or more visits from a regulated OGV type (e.g., container vessels, cruise ships, etc.) to control at-berth emissions. If Washington adopted similar regulations, 25 public port or private terminals located across the regional areas[2] of Grays Harbor, Everett, Ferndale, Anacortes, Seattle, Tacoma, and Vancouver could meet this threshold and thus be required to control at-berth emissions.
- **Emissions reduction:** Washington would see substantially reduced emissions of nitrogen oxides (NOx), fine particulate matter (PM2.5), sulfur dioxide (SO2), and greenhouse gases (GHGs) at its major maritime public ports and/or private terminals under a phased, 10-year implementation of an at-berth regulation akin to California's. Accounting for current port-sponsored shore power usage, full implementation of the at-berth regulations would reduce statewide commercial ship emissions by 13% and 9% for PM2.5 and NOx respectively, relative to the Washington State Department of Ecology's 2020 statewide comprehensive emission inventory. Overall vessel emissions (commercial and recreational) for GHGs would be reduced by 2% relative to Ecology's 2021 statewide GHG inventory.
- **Implementation costs:** The cost of implementing shore power includes capital costs for infrastructure (landside and on vessel), operating costs (including labor and contracting for services), and electricity costs to power ships at-berth.

[1] The Northwest Seaport Alliance is a cooperative venture between the Port of Seattle and Port of Tacoma. The NWSA handles container, breakbulk, auto, and some bulk cargo for both Ports.

[2] These regional areas may include public port terminals and/or private terminals, such as petroleum terminals.

  - The capital cost, net of grants, for installing required infrastructure both portside and on vessel is estimated to range between $7.5 million to $38.4 million per berth, depending on the vessel typed served by the berth.
  - Per call, the total cost of implementing shore power is estimated to range between roughly $4,500 to $58,440, depending on the vessel type served.
- **Competitiveness:** The combined impact of compliance costs, infrastructure readiness, and vessel routing decisions will affect port market share to varying extents, based on vessel type. This study found that the diversion of tanker, cruise ship, and ro-ro vessel traffic is unlikely given that implementing shore power will result in minimal added costs for each of these vessel types. The container trade is extremely competitive, and even slightly increasing costs will likely result in the diversion of some containers to other ports..
- **Stakeholder feedback:** Outreach was initiated with representatives of Washington public ports and shippers, private terminal operators and refineries, utilities, the trucking industry, labor union representatives, and environmental organizations. All expressed support for the goals of reducing air emissions and improving the health of workers and surrounding communities. Concerns were focused on:
  - Maintaining worker safety at shore power facilities,
  - Keeping up with the additional demand of adopting shore power technology,
  - Accommodating increased demands on the electrical grid, which will require a collaborative and well-planned and well-funded state-wide effort, and,
  - Possible loss of business lines.

C. State Options Constrained by Federal Law

If Washington opts to regulate OGV at-berth vessel emissions, federal law will require that Washington closely follow the At Berth Regulation developed by California. This is because the CAA generally prohibits states from adopting their own vehicle emission regulations. The exception to this rule is California. Under CAA §209, California may obtain waivers from the USEPA to enforce its own vehicle emission standards, provided that the standards are more stringent than what is required under the CAA. This is exactly what California did when it enacted the At Berth Regulation.

§209(e)(2)(B) of the CAA allows states to adopt California's standards for *nonroad* vehicles, which includes OGVs like the ones contemplated in the At Berth Regulation, as long as the standards, implementation, and enforcement, are "identical" to California's and notice is provided to the USEPA.[3] To date, no state has adopted California at-berth vessel emission standards for nonroad vehicles under §209(e)(2)(B), so there is no direct experience to determine how strictly this identicality requirement is interpreted by the USEPA and, potentially, courts.

In contrast, 17 states have adopted California's on-road motor vehicle emission standards through a similar pathway provided under §177 of the CAA. §177 requires emission standards to be identical but, unlike §209, allows implementation and enforcement to vary from California as long as doing so does not result in manufacturers needing to alter the existing design of a car that already complies with USEPA or California standards. Courts have nevertheless allowed states to adopt regulations under §177 that would result in minor changes to a car's design. This may suggest there is some limited ability to adapt the At Berth Regulation to fit local context, but the applicability of experiences under §177 is very limited since the provisions of §177 and §209(e)(2)(B) differ in critical ways as discussed.

[3] 42 U.S.C. §7543(e)(2)(B). Of note, not all parts of the At Berth Regulation fall under this identicality requirement. The At Berth Regulation's reporting requirements do not impact controlling emissions and are thus not preempted by the Clean Air Act, and the USEPA has explicitly carved out the At Berth Regulation's opacity requirements for visible emissions.

D. California's At Berth Regulation

In 2007, CARB adopted the *Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth In A California Port* (At Berth Regulation) to reduce oxides of nitrogen and diesel particulate matter emissions from vessels while docked at California ports.[4]

2007 At Berth Regulation

The 2007 At Berth Regulation required that, instead of burning diesel fuel when docked, OGVs could either connect to locally provided grid electricity ("shore power") or make use of other CARB-approved technologies to reduce or eliminate emissions while at berth. The 2007 At Berth Regulation, which obtained the required USEPA waiver in 2011 and began implementation in 2014, did not apply to all OGVs, nor did it apply to all ports. Instead, the regulation covered only three vessel types, container ships, cruise ships, and "reefer" (refrigerated cargo) vessels, and only if they berthed at one of six major California ports (Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme). Moreover, the regulation applied only if the vessel operator's fleet cumulatively made at least 25 visits per year to one of the covered ports (five times per year for cruise ships). To ease the burden of implementation on vessel operators, the 2007 At Berth Regulation provided for a phased-in approach, requiring vessels to comply in only 50% of calls in 2014 and ramping up to 80% of calls by 2020.

2020 At Berth Regulation

In 2020, CARB rewrote the At Berth Regulation to strengthen and broaden its reach in order to provide "more air quality and health benefits to the people living and working in and around California's busiest ports."[5] The 2020 At Berth Regulation expanded the categories of covered vessels to include tanker and "ro-ro" vessels (carriers that allow automobiles to be rolled on and rolled off), in addition to the container, cruise, and reefer vessels already covered by the 2007 At Berth Regulation. Moreover, instead of applying only at six ports where covered vessels dock more than 25 times per year, and only for a certain percentage of visits, the 2020 At Berth Regulation applies *every* time a covered vessel docks at any terminal or berth that receives more than 20 calls per year by a covered vessel, regardless of where the terminal or berth is located. Like the 2007 regulation, the 2020 amendments to the At Berth Regulation provided for a phased-in approach, expanding to all ro-ro vessels and to tanker vessels visiting the Ports of Los Angeles and Long Beach in 2025, and then to all remaining tanker vessels in 2027. Table ES-1 shows the coverage of the At Berth Regulation at each phase of implementation.

TABLE ES-1: CARB PHASED APPROACH

Year	2014	2020	2025	2027
Regulation	2007 At Berth Regulation		2020 At Berth Regulation	
Entities Covered	Vessels in a fleet that visited the 6 main California ports 25+ or 5+ times a year*		All berths receiving 20+ calls by a covered vessel type	
Vessel Types Covered	Containers, cruise, and reefers	Container, cruise, reefer	Container, cruise, reefer, ro-ro, tankers in LA and LB	Container, cruise, reefer, ro-ro, tankers at all terminals
Required Compliance Level	50%	80%	100%	100%

*The 25+ threshold applied to containers and reefers, where the 5+ threshold was applied to cruise ships.

Vessels and Visits that Fall Outside of the At Berth Regulation's Emission Control Requirements

[4] 2007 At Berth Regulation, Section 93118.3.

[5] CARB, At Berth Frequently Asked Questions (Sept. 26, 2024), https://ww2.arb.ca.gov/sites/default/files/2024-12/ADA_Updated%20At%20Berth%20FAQ%20Sept%202024.pdf.

Even in its expanded form, the At Berth Regulation does not require all OGVs to reduce emissions while at berth. Notably, the At Berth Regulation does not require bulk and general cargo vessels and government and military vessels to reduce emissions when docked.

Several types of vessel visits are also exempted so that even covered vessels may, in certain circumstances, dock without making use of shore power or other CARB-approved emission reduction methods. These include visits required by the United States Coast Guard (USCG), to render assistance, or due to force majeure or distress.

Anticipating that circumstances such as equipment repairs, construction-related activities, or other unavoidable constraints may prevent emission reduction during a particular vessel visit, the At Berth Regulation allows for a limited number of vessel visits in which emissions are not controlled, known as Vessel Incident Events and Terminal Incident Events (VIEs and TIEs). Operators who anticipate exceeding their TIE and VIE allotment also have the option of establishing and paying into a remediation fund to remain in compliance if effort towards compliance is shown.

Finally, operators can propose "innovative concepts" for complying with the At Berth Regulation. This option allows operators to put forth for CARB approval alternative methods to reduce emissions in and around the port at a level comparable to what would be achieved with reducing at-berth emissions.

E. Washington and California Shipping Environment

Both Washington and California boast major international shipping industries and are home to large container ports and terminals across a wide geographic area that are visited by a variety of cargo vessels serving both public and private entities.

At the same time, the two states differ in several respects. California is dominated by several large, urbanized, coastal ports such as the Ports of Los Angeles, Long Beach, and Oakland, that handle high volumes of container shipping. Ports such as San Diego and Hueneme also contribute further to the state's containerized trade. In contrast, the only comparably sized container shipping port in Washington is the NWSA, a cooperative venture between the Ports of Seattle and Tacoma. To illustrate, in 2024 the Port of Long Beach handled 9,648,724 twenty-foot equivalent units (TEUs) and the Port of Los Angeles handled 10,297,352 TEUs. By comparison, the NWSA handled about a third of that volume (3,340,733 TEUs). Washington's mix of waterborne export tonnage is much more heavily weighted towards bulk and breakbulk, mainly agricultural products. For example, in 2019 approximately 81 percent of Washington's exports (by tonnage)[6] were shipped via those vessel types, while only about 9 percent of exports were containerized. Figure ES-1 visualizes this contrast with 2022 container data.

Washington also differs from California in the geographic diversity of its ports. While California's ports are largely coastal and often located in deeper water, Washington's public ports and private terminals extend across three regions: the Puget Sound, the Pacific Coast, and the Columbia River, and each with their distinct characteristics. The Puget Sound region concentrates container and cruise vessel activity at major ports like the Port of Seattle and Port of Tacoma, while the Columbia River supports bulk cargo and ro-ro vessels through ports such as the Port of Vancouver, Port of Kalama, and Port of Longview. Meanwhile, the Pacific Coast is home to ports like the Port of Grays Harbor which focus on autos, forest products, and clean energy exports. This distribution leads to varied vessel profiles, call frequencies, and infrastructure across the state.

[6] Based on the report Analysis of the Impact on Washington State Exports from a Potential Public Utility Tax Applied by the State of Washington published at leg.wa.gov.

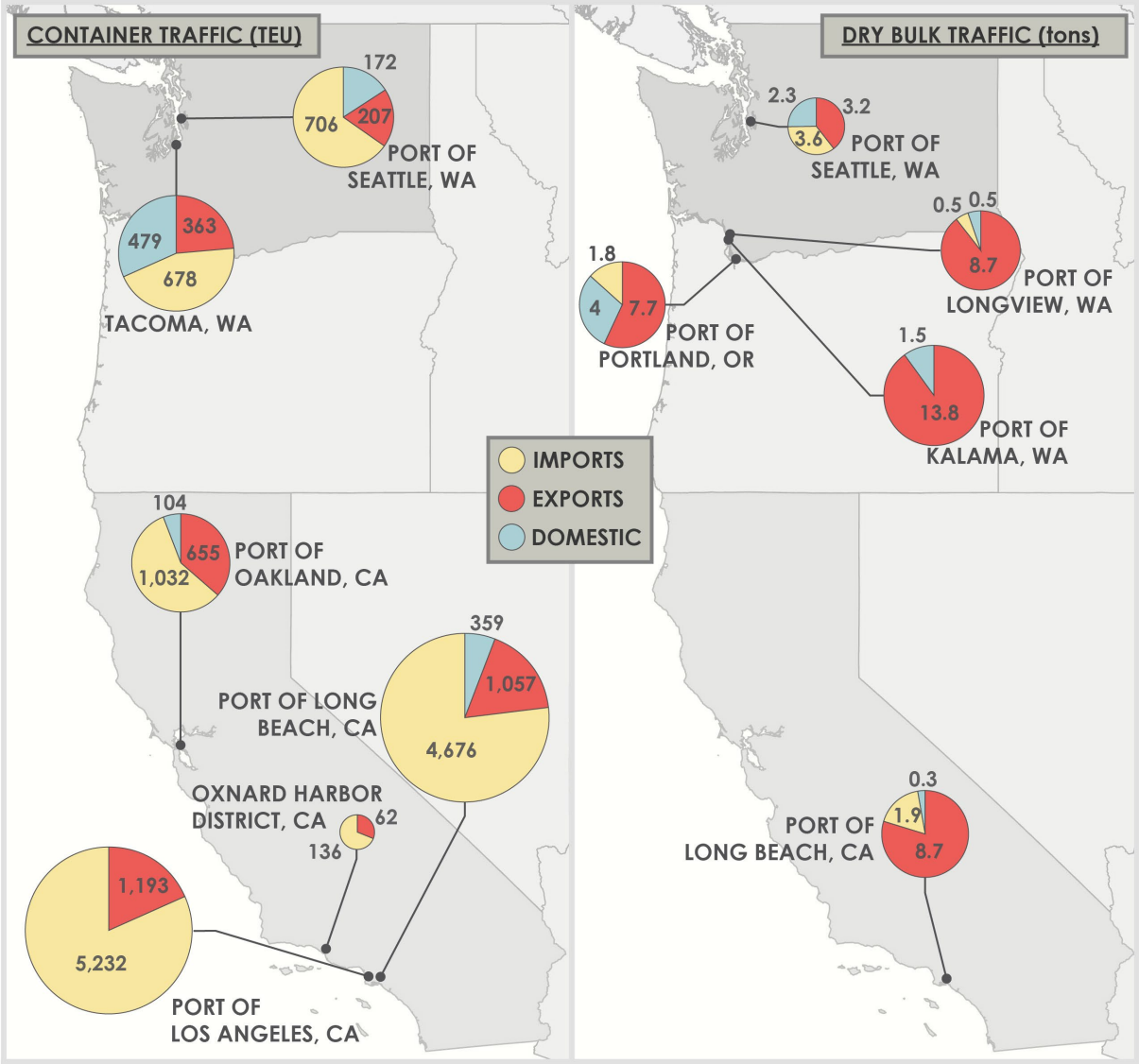


FIGURE ES-1: CALIFORNIA AND WASHINGTON PORTS COMPARISON; USDOT 2022 DATA[7]

Existing Shore Power Infrastructure in Washington

Washington does not currently require the use of shore power or other emission control system but public port authorities are able to independently implement shore power use through voluntary initiatives and local contractual agreements with tenants. Several Washington ports have already begun doing so. These early adopters have successfully installed the necessary infrastructure and coordinated with docking vessels to successfully implement shore power at several Washington berths. Specifically, at the Port of Seattle, all three cruise berths are shore power-ready. The Port of Tacoma and the NWSA have installed shore power infrastructure at several of their container berths. The Port of Vancouver is in the process of installing shore power infrastructure, and the Port of Anacortes has installed shore power for harbor craft (which fall outside of the reach of the At Berth Regulation).

Private terminals in Washington also operate berths that may have vessel traffic meeting the CARB regulation thresholds. Unlike public port authorities, these facilities are owned and managed by private companies, often dedicated to specific industries such as petroleum refining, bulk commodities, or

[7] USDOT, Bureau of Transportation Statistics, based on 2022 data (latest available) provided by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center. Tabulation as of July 2024.

manufacturing. Their governance structures, funding mechanisms, and operations differ from public ports, which can affect their ability and incentive to invest in shore power infrastructure. A number of private terminals in Washington have also voluntarily adopted shore power.

F. Potential Impact of Adopting the At Berth Regulation in Washington

Ports and Berths Likely to be Affected

This study analyzed all commercial vessel traffic to Washington port authorities and private terminals to obtain an overall picture of Washington's vessel traffic and determine which terminals would likely be affected if Washington adopted the At Berth Regulation.

In the first part of this analysis, regions associated with Washington ports and terminals were first "geofenced" to track vessel movements, allowing for the identification of high-traffic OGV areas. Through this analysis, Tacoma, Seattle, Vancouver, Kalama, Longview, Ferndale[8], Anacortes[9], Gray's Harbor, and Everett were identified as the state's highest traffic areas. Within these areas, the type of vessel traffic varied significantly. To the north, traffic in Ferndale and Anacortes was driven almost exclusively by tanker vessels. To the south, traffic through Longview, Kalama, and Vancouver was mostly in bulk cargo, which would not be subject to the emission standards of the At Berth Regulation. Traffic to Seattle and Tacoma was more diverse. Both ports saw the state's largest volumes of container vessels by far. Seattle received the state's cruise ship traffic, and Tacoma received significant ro-ro traffic. Bulk, general cargo, and tanker traffic also passed through both regions in smaller amounts.

In part two of this vessel traffic analysis, Marine Exchange data for 2024 was analyzed to identify which terminals would most likely be required to comply with at-berth emission standards if a CARB-style regulation was adopted. In Washington, 25 terminals exceeded the 20+ calls per year threshold set by the At Berth Regulation and thus would be required to control at-berth emissions by requiring shore power or the use of an alternative capture and control system. These public port or private terminals were located north to south across the general regions of Ferndale, Anacortes, Everett, Seattle, Tacoma, Gray's Harbor, and Vancouver (Table ES-2).

TABLE ES-21: TERMINALS THAT EXCEEDED 20+ OGV CALLS/YEAR IN 2024

Regions	Terminals (T-) with 20+ Qualifying OGV Visits/Yr/Vessel Type	Vessel Type(s)
Ferndale	BP, Intalco, Phillips	Tanker
Anacortes	Holly Frontier, Marathon	Tanker
Everett	Pacific Terminal and South Terminal	Container
Seattle	T-5, T-18 (SSA Marine), T-30, T-66, T-91	Container, cruise
Tacoma	T-3 and T-4 (Husky Terminals), T-7, Blair, East Blair (EB1), Pierce County Terminal (PCT), SSA Marine, TOTE, Washington Uniter Terminals (WUT)	Container, ro-ro
Grays Harbor	T-1, T-4	Ro-ro, tanker
Vancouver	T-4, T-2	Ro-ro, tanker

Emissions Calculations

Calculations were used to estimate OGV emissions when docked at berth in Washington and the potential reductions to these emissions from applying a CARB-like Regulation in 2030-2040 scenarios. While OGV at-berth activity is a small share of statewide GHG emissions, near-berth exposures to criteria pollutants from vessels at berth are concentrated locally, impacting the people who live and work near these terminals and the surrounding environment. Controlling at-berth emissions through shore power or

[8] The terminals identified within the general region of Ferndale include three refineries in and around the shoreline near Ferndale, Custer, and Cherry Point.

[9] The terminals identified within the general region of Anacortes are two petroleum refineries at March's Point, a peninsula in Skagit County east of downtown Anacortes.

other emission control systems shifts those emissions to the regional grid. The regional grid's emission intensity is much lower than vessel auxiliary engines, has remained stable over time, and is expected to decline based on state decarbonization goals and programs (e.g., Climate Commitment Act).

In Washington, maritime-related pollutants declined substantially from 2005 to 2021 across most categories. Pollutant hotspots remain near terminals and ports, driven by where and how long vessels hotel at berth (and at anchor).

Assuming phased implementation that closely follows the implementation schedule set forth in California's At Berth Regulation (Table ES-3), Washington would see substantially reduced emissions of NOx, PM2.5, SO2, GHGs at its major maritime public ports and/or private terminals. Across the general regions that are likely to contain regulated public port or private terminals (Seattle, Tacoma, Ferndale, Anacortes, Grays Harbor, Everett, and Vancouver as summarized in Table ES-3):

- NOx emissions from candidate terminals could drop between 76%-86% from current rates depending on terminal,
- PM2.5 emissions could drop by 72-84% from current rates,
- SO2 emissions could drop by 50-66% from current rates,
- and GHG emissions, measured by CO2 and CO2e, could drop by 47-64%.

These reductions are not port-wide, but specific to the terminals that would be regulated. Any reductions would not occur immediately but would step up over the assumed 10-year phased implementation period.

It is helpful to understand the emission changes in the context of our statewide emission inventories. Accounting for current shore power usage, full implementation of the at-berth regulations could reduce statewide commercial ship emissions by 13% and 9% for PM2.5 and NOx respectively, relative to Ecology's 2020 statewide comprehensive emission inventory. For GHGs, overall statewide vessel emissions (commercial and recreational) could be reduced by 2% relative to Ecology's 2021 GHG inventory.

TABLE ES-3: POSSIBLE IMPLEMENTATION SCHEDULE

	Phase 1 (Year 0) [10]	Phase 2 (Year 5)	Phase 3 (Year 10)
Vessel Type	Container and cruise	Add ro-ro	Add tankers
Threshold	20 visits per terminal or berth	20 visits per terminal or berth	
Required Plug in Rate	50% of visits	80% of visits	100% of visits
Regions	Seattle and Tacoma	Add Vancouver USA	All regions

G. Shore Power Cost and Labor Cost Analysis

The cost of implementing shore power includes capital costs for installing infrastructure, operating costs to run shore power programs and maintain shore power systems, and electricity costs for powering vessels at berth. This study estimated these costs, looking to the most recent information on shipping traffic patterns, capital costs of shore power projects in Washington, operating data drawn from a variety of industry sources, and regional costs for inputs such as fuel and labor.

Capital Costs: The capital costs for installing infrastructure vary widely, based on the vessel type served and existing site conditions. This report uses publicly reported costs for recent shore power projects in Washington, along with engineering estimates for facilities in development to support capital cost assumptions used in the estimations of total costs for shore power. The capital costs per berth for recently completed and planned shore power installation projects in Washington are as follows:

[10] Year 0 refers to the implementation date, which typically occurs several years after a regulation is first adopted. In California, the original At-Berth Regulation was approved in 2007, with its first compliance requirements taking effect in 2014, seven years later.

- Container – Port of Tacoma, Husky Terminal, T-3 and T-4 berths: $15.5 million, completed 2022
- Container – Port of Seattle, T-18, $22.5 million, in development
- Cruise – Port of Seattle, Pier 66, $40 million, 2024

Recent engineering studies for shore power installations in California prepared by Moffit and Nichol estimate capital costs for container facilities at $30 to $32 million per berth.

Cost information for berths serving other vessel types covered by the California regulations is scarce. Worldwide, there is only one operating shore power berth serving auto carriers and two serving tankers. Recent engineering studies by Moffat and Nichol estimated the cost of shore power facilities for tankers at $14 million per berth. For this study, the capital cost of shore power facilities for auto carriers were assumed to be similar to those for container vessels.

This wide variation is driven by factors such as vessel type served, electric utility service upgrade requirements, distance to and logistics of connecting to the grid, site conditions, and neighboring land uses.

Operating Costs: In addition to capital costs, vessel and landside operators will incur operating costs, largely labor costs to retain staff to connect and disconnect vessels from shore power; maintain shore power systems; manage programmatic elements such as scheduling, commissioning, and billing; and to contract for other services. These operating costs are expected to incur about $10,720 to $12,159 per call.

Fuel Costs: Shore power will incur fuel costs in the form of paying for electricity usage during a vessel's time at berth. These costs would be offset by the amount saved by not using diesel fuel to power the vessel's auxiliary engines. The net cost is likely to range between a savings of $20,882 to an additional cost of $1,113 per call. This variation is largely accounted for by variations in energy use profiles of different vessel types and applicable electric utility tariffs.

Combined Costs: Combined costs are summarized in Table ES-4.

TABLE ES-42: COMBINED SHORE POWER COSTS

Vessel Type	Cost Per Call	Cost per Shipping Unit
Container	$21,020	Per container: $10.61
Cruise	$53,696	Per passenger: $16.85
Ro-ro	$17,114	Per auto: $8.56
Tanker	$10,438	Per barrel: $0.02

H. Impact on Port Competitiveness

Adoption of a CARB-style regulation to reduce at-berth emissions could influence the competitiveness of Washington's ports vis-à-vis ports in California, Oregon, British Columbia, and other regions. However, with the exception of container vessel traffic, this study found that impacts to vessel traffic are unlikely.

Tankers: The diversion of tanker traffic due to the cost of shore power is unlikely. Most of the tankers that would be covered by the proposed regulations transport crude oil to refineries at Ferndale, Anacortes, and Tacoma. These refineries primarily supply the market for petroleum products in western Washington and western Oregon via pipeline, but also send refined products by vessel to California and British Columbia. Refineries in California may be able to fill some of this demand, but at a higher cost. The increase in the cost of crude oil delivered to Washington refineries due to shore power requirements is minimal when compared to historical changes in the price of crude oil, and is not expected to result in diversion of cargo.

Cruise: Cruise traffic in Washington is based in Seattle and focused on the Southeast Alaska market. Seattle competes with Vancouver, BC, for this traffic, and the market is essentially evenly divided between the two ports. The cruise industry has been an early adopter of shore power, and shore power

capability is in place at all three of Seattle's cruise berths, and at the Canada Place Cruise Terminal in Vancouver, Canada. Shore power is now used by the majority of vessels based at those two ports, and within several years 100% of the fleet will use shore power. New regulation is not required and may impose reporting and compliance costs.

Because the estimated shore power-related costs for cruise ships represents less than one percent of the price of a cruise, would be unlikely to cause a loss of traffic. Moreover, since the Port of Seattle has already completed installation of shore power infrastructure at all three of its cruise berths, the adoption of new shore power regulations will not impose additional capital costs. Also, because shore power capability is in place at Vancouver cruise berths, there is no competitive disadvantage.

Ro-ro: Ro-ro vessel traffic consists mainly of vehicle carriers transporting imported vehicles to Washington ports. The allocated cost per vehicle related to shore power represents a minimal increase in delivery cost, and is unlikely to result in diverted cargo. In addition, because vehicle carriers commonly call at multiple West Coast ports on the same voyage, any ship that called at a California port and Washington port on the same voyage would not face additional shipboard equipment costs due to the Washington regulations.

Containers: In contrast to the other three vessel types, higher costs resulting from shore power implementation will likely result in some containers diverting to other ports due to the competitiveness of the container trade. The primary competitors for NWSA container cargo are in British Columbia (Vancouver and Prince Rupert and southern California (Los Angeles Long Beach). In addition, ports on the East Coast and Gulf Coast have seen growing market share for container cargo originating in Asia, while Portland is a relatively minor player. Any increase in the relative cost of using Washington ports versus competitors (including those who now require shore power) may cause some container traffic to shift.

I. Outreach

Outreach was initiated with representatives of Washington public ports and shippers, private terminal operators and refineries, utilities, the trucking industry, labor union representatives, and environmental organizations. All expressed support for reducing air emissions and improving the health of worker and surrounding communities. Stakeholder input is summarized in Table ES-5 and categorized by stakeholder type.

TABLE ES-53: STAKEHOLDER OUTREACH INPUT ON A CARB-LIKE OGV AT BERTH REGULATION FOR WASHINGTON

Stakeholder Category	Summary of Shared Input
Public ports and private shipping terminals (cruise, container, ro-ro, liquid bulk tankers)	• Already started voluntarily shore power installation for equipped OGVs (and other vessel types and equipment) with their own clean air strategies in place. • Preference for voluntary adoption of shore power, which allows for greater flexibility in planning and budgeting for high capital costs, working and negotiating with power utilities, determining terminal-specific shore power requirements for visiting vessels, and responding to changing technologies. • Concerns over the potential loss of unique business lines, such as ro-ro. • Success of a CARB At Berth Regulation in WA will require full state backing and a coordinated approach (substantial state funding required, staff and funding for regulatory compliance, and would benefit from streamlined permitting to support infrastructure rehabilitation and power grid expansion.
Petroleum facilities (tankers)	• Facilities expressed support for decarbonization, with concern over how this can work safely and a need for alignment with international regulations. • Shore power remains unavailable or unproven (few CARB-approved capture systems exist for tankers or address boiler emissions). Safe, reliable, scalable

Stakeholder Category	Summary of Shared Input
	technologies are not yet available. Chartered/third party vessel operators reduce control over vessel modifications. • Operation of shore power occurs in high-risk environments, risk compounded by the absence of engineering standards and international regulatory guidelines (USCG, IMO, OCIMF). • Recommend detailed study including pilot studies specific to unique challenges for oil tankers before implementing any broad regulations.
Electric utilities	• Shore power requires reliable access to power grids. Meanwhile, utilities are facing growing electricity demands that can take years to plan for and upgrade. • Local utilities operate within their own budgets and schedule; some require financial support to engage in projects and/or provide data. • State regulations require WA utilities to achieve GHG neutrality by 2030 and 95% emissions reduction by 2050. Utilities will need to generate more renewable electricity to meet shore power demands.
Trucking	• Many trucking companies are working towards 2040 carbon neutrality goals. • Questions related to how Washington State will support a new OGV At Berth Regulation (how would power grid and infrastructure rehabilitation, and compliance, be funded and incorporated along with other state initiatives).
Labor	• Focus on worker safety and health and that of surrounding communities. View emissions reduction as an improved working condition. • Safety regulations need to be developed for new technologies.
Environmental/ regulatory	• Importance of reductions in at-berth emissions for community and state-wide health.

J. Conclusion

Washington can adopt at berth emission standards identical to California's to substantially reduce air emissions at regulated terminals and provide improved air quality and health for workers and surrounding communities. Some vessels arriving at Washington's largest public ports are already equipped for shore power. A number of Washington's ports have installed or are installing shore power infrastructure in the absence of regulations. While still in early phases of implementation, these installations are and will continue to reduce at berth emissions, though not as much as mandatory regulation. Voluntary implementation does, however, allow more flexibility for public port and private terminals to better prioritize emission-reducing capital projects in better alignment with local utility efforts and critical federal and state funding.

As this report describes, the cost and impact of regulating at-berth emissions in Washington would vary substantially across terminals and between types of vessel traffic. Only 7 areas in Washington are expected to contain terminals where compliance with an OGV At Berth Regulation may be required if implemented.

Installing shore power infrastructure and meeting operational costs will place significant demands on ports, terminal operators, and vessel operators. Some relief may be implied if implementation of such a regulation would occur similar to California with phased implementation in stages, allowing impacts to be distributed over a decade with at least two years' lead time between the adoption of a regulation and the beginning of enforcement. When broken down to the unit level, cost increases are marginal and, based

only on cost, unlikely to affect vessel traffic and port competitiveness (with the exception of container traffic, where an impact is more likely).

While large public ports in Washington have already commenced shore power implementation, mid-sized and smaller ports have only recently begun to do so, mainly due to the substantial funding support from recent federal grant opportunities. A collaborated and unified state-wide plan to outline long-term funding mechanisms, regulatory compliance and technology guidance, labor and safety needs for shore power operations and maintenance, and resolution to power grid demands to support a CARB-like OGV At Berth Regulation in Washington may be helpful.

1. Study Overview

California's At Berth Regulation for OGVs, implemented by CARB, has shown measurable success in reducing NOx, PM, and GHG emissions through the use of shore power and alternative emission control strategies. The Washington State Legislature directed the Joint Transportation Committee to conduct an analysis of implementing a similar regulation in Washington State. This study serves as a foundational step in understanding how such regulations could be applied locally, taking into account Washington's unique port and terminal system and landscape as well as the limitations imposed by the federal Clean Air Act's preemption of vehicle emissions regulation.

This study was completed in two parts:

- Phase I (Section 2 through Section 7) evaluates the technical, regulatory, operational, and environmental considerations associated with adopting the CARB At Berth Regulation (the At Berth Regulation) in the unique conditions and governance structures of Washington's public port authorities and private terminals. The study analyzes which ports and terminals in Washington would likely be affected if the state adopts regulations modeled after the California At Berth Regulation and explores pathways to encourage voluntary adoption of shore power and other emission control strategies.
- Phase II (Section 8 through 12) builds on this foundation to determine the infrastructure needs and costs likely to be associated with requiring shore power or other emission reduction strategies and the impact on labor costs, shipping industries, and port competitiveness. Stakeholder outreach for the study included engagement with state legislators, public port authorities, private terminal and/or vessel operators, labor organizations, environmental agencies, and public utility providers.

The study focuses on Washington State's diverse and decentralized public port authority system, which includes 75 public port districts, both marine or riverine, which are distributed across the Puget Sound region, the Columbia River system, and the Pacific Coast. Private terminals not affiliated with public ports, often dedicated to specific industries such as petroleum refining and bulk commodities, or manufacturing, also operate OGV berths. Major regions analyzed include the Puget Sound, the Pacific Coast, and the Columbia River. Public ports and private terminals in these areas vary widely in terms of cargo specialization, vessel type and traffic, infrastructure readiness, and environmental exposure.

1.1. Shore Power Defined

Shore power, also referred to as cold ironing or shore-to-ship power, involves providing electrical energy from a local utility to a vessel while it is docked at a berth (Figure 1-1). This allows the vessel to shut down its auxiliary diesel engines, which would otherwise operate continuously to supply onboard power. By replacing onboard power generation with grid electricity, shore power reduces emissions of nitrogen oxides (NOx), particulate matter (PM), sulfur oxides (SOx), and GHGs.

Implementation requires infrastructure on both the dock and the vessel, typically including medium- or high-voltage connections and compatible interface systems to enable a safe and reliable power transfer.

FIGURE 1-1: EXAMPLE OF SHORE POWER CONNECTION.[11]

The primary objective of shore power is to reduce air pollution in urbanized port areas by reducing emissions produced during vessel berthing. Since ships may remain at berth for extended periods, the elimination of auxiliary engine use can result in local air quality improvements. This is particularly beneficial in communities located near busy urbanized terminals. In addition to health and environmental benefits, shore power can contribute to long-term climate goals by supporting the transition to alternative energy sources, reducing GHG emissions. Shore power is the primary method for vessel, port, and terminal operators to comply with at berth emission standards contained in California's At Berth Regulation. Reduced at-berth air emissions is also supported by voluntary measures from port authorities and shipping companies committed to reducing their emissions footprint.

[11] Image obtained from https://indiaseatradenews.com

2. State Options Constrained by Federal Law

If Washington opts to regulate air emissions from OGVs while at berth, it will need to closely follow California's At Berth Regulation. This is because the federal CAA provides the USEPA with the authority to set nationwide standards for vehicle emissions and expressly prohibits other states from setting out their own standards. However, the CAA carves out an exception for California, allowing it to obtain a waiver from the USEPA to create standards higher than the ones set nationally. Other states are not able to obtain their own waivers, but can adopt California's emission standards, provided they meet certain requirements. In the case of nonroad vehicles such as OGVs, a state wishing to follow California's lead must adopt identical standards, implementation, and enforcement, give notice to the USEPA that it is doing so, and provide a two-year lead team between adoption and implementation.

2.1. Regulatory History

2.1.1. Federal Regulation: The Clean Air Act and the U.S. Environmental Protection Agency

The CAA, passed in 1970, is a federal statute granting the USEPA the authority to establish national ambient air quality standards and to regulate emissions from both stationary sources (e.g., industrial facilities) and mobile sources (e.g., motor vehicles) to safeguard public health and the environment.

Under the CAA, individual states are generally preempted from setting their own vehicle emission standards. However, §209 of the CAA grants California a unique exception due to its history of enacting air quality regulations prior to the passage of the CAA, as well as its persistent and severe air quality challenges. Under this provision, California may seek a waiver from the USEPA to implement its own, more stringent emission standards. If the waiver is granted, other states are permitted to adopt California's standards in lieu of the federal requirements, though they still must notify the administrator prior to doing so.

The USEPA granted CARB authorization to adopt the Ocean-Going Vessels At Berth Regulation in 2011, and compliance requirements began in 2014. On September 27, 2022, CARB submitted a request for authorization of amendments adopted on August 27, 2020, known as the 2020 At Berth Amendments. In October 2023, the USEPA formally granted CARB's request, thereby authorizing the implementation of the amended regulation governing emissions from OGVs while docked at California ports.

Under CAA §209, Washington may adopt and enforce California's emission reduction standards for nonroad vehicles, which include OGVs, only if the standards as well as their implementation and enforcement are "identical" to the California rule that has already received a federal waiver. There is little guidance on how strictly the USEPA and courts would interpret this requirement of identicality. To date, no other state has adopted California nonroad vehicle emission standards under §209 and the USEPA's implementing regulation mirrors the language of §209.[12] If Washington chose to adopt CARB's At Berth Regulation, it would need to provide notice to the USEPA Administrator and allow for a two-year wait time after adopting the rule to begin implementing and enforcing it, as long as California's waiver remains in effect.[13]

Some provisions of the At Berth Regulation do not fall within the purview of the USEPA waiver. The USEPA has specifically carved out the At Berth Regulation's opacity standards for visible emissions from CAA preemption. Further, the Regulation's reporting requirements do not require a waiver from the

[12] In contrast, 17 states and Washington, D.C. have adopted motor vehicle emission standards (for on-road vehicles), a process separately provided for at CAA §177. Unlike §209, §177 requires only that emission standards be identical, but does not require identicality for implementation and enforcement of such standards.

[13] States seeking to adopt California non-road vehicle emission standards must also have an EPA-approved attainment plan under Part D of 42 USC Ch. 85. 42 U.S.C. §7543(e)(2)(B) ("Any State other than California *which has plan provisions approved under part D of subchapter I* may adopt and enforce. . . standards relating to control of emissions from nonroad vehicles or engines. . .") (emphasis added). Attainment plans are required of states that contain nonattainment areas, i.e. areas that have not met the EPA's National Ambient Air Quality Standards.[13] These plans detail how the state will implement control measures to bring the area into attainment of air quality standards. 42 U.S.C. § 7502(c)(1). Washington contains multiple nonattainment areas that have presumably adopted plan provisions that satisfy this requirement.

USEPA as they do not directly impact the control of emissions. In these two areas, any future Washington regulation would not need to comply with the CAA's identicality requirement.

2.1.2. Challenges at the Federal Level

In June 2025, under the Congressional Review Act (CRA), Congress passed, and the President signed, three resolutions that nullified three previously issued USEPA waivers granted to California under the CAA. These revocations apply only to on-road vehicle programs and do not affect the At Berth Regulation. California and ten other states (Colorado, Delaware, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont, and Washington) immediately challenged these actions in federal court, arguing the waivers are not subject to the CRA and that revocation is unlawful.

In addition, on July 29, 2025, the USEPA Director announced that the USEPA is working to write a new rule that would rescind the 2009 "endangerment finding," which established that greenhouse gases pose a threat to public health and welfare and provided the legal basis for federal GHG regulation under the CAA. While separate from the waiver process and focused on climate-related pollutants rather than criteria pollutants.[14], this proposal signals broader scrutiny of federal emissions regulation that could influence future state waiver approvals, including the USEPA's authorization of California's waiver to enact the 2020 At Berth Regulation.

[14] Climate-related air pollutants, such as GHGs like carbon dioxide (CO2) and methane (CH4), have a broader global impact than more localized criteria pollutants, such as NOx and PM.

3. Additional Regulatory Context

3.1. International Requirements

Ocean-going vessels also fall under international maritime law, particularly the rules of the International Maritime Organization (IMO) as well as the rules of the North American Emission Control Area (ECA).

The standards of the IMO, established through MARPOL Annex VI, are implemented in the U.S. by the CAA and enforced by the USEPA and the USCG. They govern fuel quality, emissions, and vessel engine performance globally. While IMO regulations focus primarily on design and fuel content, any state-imposed operational requirements, such as mandating the use of shore power, must not conflict with these global standards. This is especially important when applied to foreign-flagged vessels, which must comply with both international and federal laws while operating in U.S. waters. Presently, no international standards have been enacted specifically with regards to shore power. However, such standards are in development and may impact shore power regulation at the state level in the future.

In addition to these legal frameworks, Washington must also operate within the parameters of the North American Emission Control Area (ECA), which includes the entire U.S. and Canadian West Coast and surrounding waters. The ECA enforces a sulfur content limit of 0.1% for marine fuels, in effect since 2015, which is far more stringent than the global IMO 2020 cap of 0.5%. It also imposes phased NOx controls, requiring Tier II engine standards[15] for ships built after 2011 and Tier III for those built after 2016.

These layers of international regulation have driven improvements in vessel emissions nationally, including changes to fuel content and engine tiers. However, vessels still create near-port air pollution even when in compliance with these standards due to their use of auxiliary and boiler engines—the issue that CARB's At Berth Regulation addresses head-on. Both California and any state seeking to adopt California's At Berth Regulation must also make sure that their provisions continue to comply with IMO and ECA standards into the future.

3.2. Washington Climate Commitment Act and Clean Energy Transformation Act

In addition to federal requirements, several Washington State laws may help facilitate the implementation of regulation modeled after the At Berth Regulation. Chief among them is the Climate Commitment Act (CCA), adopted in 2021 and launched in 2023, which created an economy-wide cap-and-invest program targeting a 95% reduction in GHG emissions below 1990 levels by 2050. This program requires major emitters to purchase emissions allowances, generating significant revenue for climate mitigation and adaptation projects. The CCA directs a portion of these funds toward infrastructure investments that reduce pollution and improve air quality, making it a potential funding source for shore power systems, emissions capture technologies, and grid upgrades at Washington ports.

The CCA is especially relevant to maritime emissions policy because of its emphasis on environmental justice and investments in overburdened communities, many of which are located near port and industrial areas. Shore power projects that reduce NOx, PM, and GHG emissions from at-berth vessels could be well-positioned for support under the program's funding priorities.

In parallel, the Clean Energy Transformation Act (CETA) requires Washington's electricity supply to be 100% clean by 2045, aligning closely with the electrification goals of at-berth emission reduction strategies. Together, these laws provide both regulatory support and financial mechanisms that could play a key role in enabling a Washington-specific approach to maritime emissions control.

[15] Tier standards are USEPA emission standards for engines, with each tier requiring more stringent limits and later tiers often phased in as new technology is made available.

4. California's At Berth Regulation

Federal preemption requires that Washington follow the emission standards, implementation, and enforcement set forth in California's At Berth Requirement if it plans to regulate emissions for ocean-going vehicles docked at berth. The below provides information on the At-Berth Regulation, including:

- Regulatory history and phased approach to implementation;
- Requirements imposed on vessel operators, ports, and terminal operators;
- Methods for compliance, including both shore-power as well as other CARB-Approved Emission Control Strategies;
- Compliance exceptions; and,
- Emission requirements and exceptions.

The purpose of the At Berth Regulation is to reduce air emissions from OGVs while they are docked at California ports. It accomplishes this goal by requiring vessels covered by the regulation to connect to shore power (locally-provided grid electricity) for power, rather than burning auxiliary diesel engines. Alternatively, vessels can make use of other CARB-Approved Emission Control Strategies (CAECS), instead of using shore power.

The At Berth Regulation does not apply to all OGVs. Instead, it applies specifically to container, reefer, cruise, roll-on/roll-off (ro-ro), and tanker vessels, leaving out major categories of ocean-going vessels such as dry bulk and general cargo vessels and military and government vessels. Nor does the At-Berth Regulation apply to harbor craft such as tugboats and ferries (vessel types are described in Section 4.4). Moreover, not all visits by covered vessels must comply with the requirement to connect to shore power or other CAECS. The At Berth Regulation exempts stops required by the USCG, stops made due to force majeure or distress, and stops to render assistance. It also allows vessel and terminal operators to claim a limit number of visit exceptions each year and allows operators to pay into a remediation fund for any additional visits in which emissions are not adequately controlled.

The At Berth Regulation does not regulate vessel operators alone. Rather, responsibility for reducing emissions at port is shared among vessel operators, public port authorities and private terminal operators, and operators of CAECs—each of whom must meet their own sets of requirements under the At Berth Regulation.

Finally, to allow time for operators to install the required updates and infrastructure, CARB opted to implement the At Berth Regulation in phases, first targeting limited categories of vessels at higher traffic ports and requiring lower rates of compliance before expanding to a wider set of ports and vehicle types and 100% compliance (not including excepted visits). Each of these facets of the At Berth Regulation is discussed in detail below.

4.1. Purpose

The 2020 At Berth Regulation, under section 93130.1, explains that the main purpose of the regulation is to reduce emissions of NOx, reactive organic gases (ROG), PM, diesel particulate matter (DPM), and GHG (collectively, "at-berth emissions') from ocean-going vessels while docked at California ports. The At Berth Regulation also makes sure that vessels comply with visible emissions standards, i.e. emissions that can be seen by the human eye. Given that many of these operations occur near at-risk communities, the measure supports local air quality improvements in line with Assembly Bill 617 (2017), which provides for the development of statewide reporting of air pollutants and contaminants.

The At Berth Regulation helps California meet its State Implementation Plan (SIP) for achieving or maintaining air quality standards under the CAA and CARB's regulatory obligations. By promoting shore power use, the measure contributes to the state's GHG reduction goals under the California Global Warming Solutions Act.

4.2. Regulatory History

4.2.1. 2007 At Berth Regulation

The original Ocean-Going Vessel At-Berth Regulation was approved by CARB in December 2007 and obtained authorization for a waiver from the USEPA in 2011, with compliance requirements beginning in 2014. The 2007 At Berth Regulation required affected vessels to reduce emissions while at berth by either plugging into shore power or using another equally effective CAECS.

The 2007 At Berth Regulation covered NOx, PM, CO2, and ammonia emissions of auxiliary engines on three vessel categories: container ships, cruise ships, and refrigerated-cargo ("reefer") ships at six California ports: Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme.

The 2007 At Berth Regulation applied on a fleet-wide basis, rather than to individual vessels. If covered vessels in the same fleet[16] made 25 or more visits per year to one of the six identified ports, then they would be required to reduce emissions at that port.

As part of its phased approach, the 2007 At Berth Regulation initially required that only 50% of visits by regulated vessels in a covered fleet actually reduce emission through shore power or other CAECS. Over time, this requirement was phased up to 80% of fleet visits in 2020. This approach afforded vessel operators and ports time to adapt to the new regulatory requirements.

4.2.2. 2020 At Berth Regulation

In 2020, CARB developed a new At Berth Regulation that expanded coverage to a wider set of operators, vessel types, and locations, and a higher percentage of visits. It also set limits on visible air pollutants for any OGV while at berth or anchor. (Section 93130.6) The 2020 At Berth Regulation received a USEPA waiver and took effect in 2023.

In addition to container, cruise, and reefer vessels, the 2020 At Berth Regulation added ro-ro and tanker vessels. Instead of applying to just the six ports originally covered in 2007, the 2020 At Berth Regulation also requires compliance at any terminal or berth[17] that receives 20 or more calls a year from a regulated vessel, without limiting to a set number of ports.

The 2020 regulation sets forth operational requirements for not only vessel operators, but also ports, terminal and berth operators, and operators of CAECS, creating a system of shared responsibility for emission reduction. It requires compliance in 100% of visits by regulated vessels to qualifying terminals and berths, but also allows for a limited number of noncompliant visits under certain circumstances.

Like the 2007 regulation, the updated At Berth Regulation phases in implementation. The At Berth Regulation first applied to the original three vessel categories (containers, cruise, and reefer) in 2023. In 2025, it added ro-ro vessels and tankers, but limited tanker application to only those docking at the Ports of Los Angeles and Long Beach. In 2027, the regulation will apply to tankers at all locations that meet the 20 vessel calls per year threshold. The regulation also stepped-up compliance requirements over time. In the first two years of enforcement, terminal operators were allowed uncontrolled emissions in 15% of visits. This percentage decreased to 5% of visits in 2025. To further prepare for increased coverage of the At Berth Regulation, ports and terminals were required to submit plans in advance detailing how they would adapt infrastructure and otherwise comply with the At Berth Regulation.

These regulatory updates aim to enhance public health protections for port-adjacent communities, reduce exposure to toxic air emissions, and support California's 2023 and 2031 NOx emission reduction targets. Table 4-1 shows the CARB At-Berth Phased approach.

[16] For purposes of the 2007 At Berth Regulation, CARB defined a fleet as the same type of vessel belonging to the same vessel belonging to the same owner and visiting a single port. Thus, "if a person owns or operates vessels that visit both the Port of Los Angeles and Port of Oakland, that person is deemed to have two fleets, one a 'POLA-based fleet' and the other a 'Port of Oakland-based fleet.'"

[17] The 2020 At Berth Regulation defines a terminal to include situations where an operational port rents a berth to vessel operators, rather than terminal operators. In such cases, a berth is treated as a terminal.

TABLE 4-1: CARB PHASED APPROACH

Year	2014	2020	2025	2027
Regulation Scope	Vessels that visited the 6 main California ports 25+ or 5+ times a year*		All berths receiving 20+ regulated vessel calls	
Vessel Types Covered	Containers, cruise, and reefers		Containers, cruise, reefers + ro-ro + tankers at LA and LB only	Containers, cruise, reefers, ro-ro + tankers
Required Compliance Level	50%	80%	100%	100%

*The 25+ threshold applied to containers and reefers. The 5+ threshold was applied to cruises.

4.3. Who must comply with the 2020 At Berth Regulation?

4.3.1. Smaller Vessels Not Covered

Not all vessels that visit California ports are required to comply with the At Berth Regulation. Rather, the At Berth Regulation applies only to a subset of ocean-going vessels, as described below.

CARB's OGV definition excludes harbor craft, which are subject to separate CARB regulations in California such as the Commercial Harbor Craft (CHC) rule[18]. Washington State sees a high volume of short-trip and regional shipping activity that falls outside the scope of the At-Berth Regulation. Key vessel types that are considered harbor craft and are thus excluded from the At Berth Regulation include (but are not limited to) tugboats, ferries, workboats, crew and supply vessels, commercial fishing vessels, excursion vessels, pilot boats, dredges, and barges[19].

Why Doesn't California Regulate Dry Bulk or General Cargo Vessels?

California considered but did not include dry bulk and general cargo vessels in its At Berth Regulation. These vessel types generally have lower auxiliary power demands while at berth and therefore contribute a smaller share of emissions compared to containers, reefers, or cruise ships. They also face operational challenges such as "line-hauling," where the vessel shifts along the berth during loading or unloading, making a continuous shore power or capture-and-control connection impractical. In addition, the commodities they carry are often lower in value, which makes the cost of electrification requirements less economically feasible than for higher-emission, higher-value vessel types.

4.3.1.1. Ocean-going Vessels, Generally and as Defined by CARB

Ocean-going vessels move cargo and people, often across long distances between foreign or domestic ports, and can have a significant impact on air quality. In most cases, OGVs are powered by main engines for propulsion, auxiliary engines for onboard electrical power, and boilers for heating fuel, water, or other essential vessel systems. The main propulsion engines are larger, consume more fuel, and generate the majority of emissions. However, most of their activity occurs during transit rather than while the vessel is at berth. These engines are regulated under International Maritime Organization (IMO) Tier standards, based on the vessel's keel-laying year and are not subject to CARB's At-Berth Regulation. In contrast, auxiliary engines and boilers, although less powerful, typically operate continuously while vessels are docked and are responsible for the majority of emissions generated during berth operations.

The At Berth Regulation applies specifically to ocean-going vessels as defined by CARB. This includes vessels that meet any of the following criteria:

[18] The CARB CHC Regulation is an additional state rule to reduce air emissions that is applied to commercial harbor crafts defined as any private, commercial, government, or military vessel that operates exclusively or primarily in California regulated waters, including internal waters, estuaries, ports, and within 24 nautical miles of the California coast.

[19] See CARB's Commercial Harbor Craft Regulation.

- Greater than or equal to 400 feet in overall length;
- Greater than or equal to 10,000 gross tons; or
- Propelled by a marine compression ignition engine with a per-cylinder displacement of 30 liters or more.

CARB's definition aligns with USCG classifications for ocean-certified vessels intended for international or long-range coastal service. Figure 4-1 shows the Alette Maersk Container Ship, built in 2024, with an approximate LOA of 1,150 ft. This is a typical example of an OGV based on CARB's definition.

Source: Northwest Seaport Alliance

FIGURE 4-1: OCEAN-GOING TYPICAL VESSEL

4.3.1.2. Ocean-going Vessels Covered by the At Berth Regulation (Section 93130.3)

The current At Berth Regulation applies to specific categories of ocean-going vessels, while leaving out other categories. Under the 2020 At Berth Regulation, covered vessel types consist of container vessels, passenger vessels, refrigerated cargo vessels, tanker vessels and ro-ro vessels. Dry bulk vessels, government, and military vessels are not covered by the regulation. Table 4-2 shows the OGV categories provided in the OGV Inventory Documentation developed by CARB.

TABLE 4-2: OCEAN-GOING VESSEL CATEGORIES

Vessel Type	Primary Function or Description	CARB Regulated if Meets OGV Category
Auto*	Transports automobiles and trucks.	Yes
Container	Transports a wide variety of cargo in standard-sized containers.	Yes
Cruise	Used for passenger transport and pleasure voyages.	Yes
Reefers	Transports perishable commodities that require refrigerated transportation (fruits, meat, fish, vegetables, dairy products, and other foods). Cargo carried in bulk holds or in refrigerated containers.	Yes
Ro-ro*	Transports large-wheeled cargo such as large off-road equipment, trailers or railway carriages. Ro-ro is an acronym for 'roll on/roll off'.	Yes
Tankers	Transports liquids in bulk, including both non-edible liquids such as crude oil and chemicals, and edible liquids (molasses and fruit juices).	Yes
Bulk Cargo	Transports dry bulk items (mineral ore, fertilizer, wood chips, grains).	No
General Cargo	Transports non-containerized cargo (steel, palletized goods, and heavy machinery).	No

* Auto and ro-ro vessels are referred to as separate vessel categories for the purposes of the emissions inventory but are considered the same category under "ro-ro" for CARB regulatory purposes. Source: CARB

Figure 4-2 shows a cruise ship (left) berthed at the Port of Seattle as an example of a passenger vessel that would be covered by the At Berth Regulation if implemented in Washington and a dry bulk vessel (right) at the Port of Kalama as an example of a vessel that would not be covered by the current CARB At Berth Regulation if implemented in Washington.

Source: Seattlemet.com (left) and Port of Kalama (right)

FIGURE 4-2: OCEAN-GOING VESSELS

4.4. Covered Ports, Terminals, and Berth Operators

The 2020 At Berth Regulation applies to all California terminals that receive at least 20 visits from covered vessels per year and requires California ports to provide the necessary infrastructure for terminals to provide shore power or an alternative CAECS.

Specifically, the At Berth Regulation applies to all terminals except those that are considered “low activity terminals,” defined as those receiving fewer than 20 visits per year by one of the covered vessel types discussed above. (Section 93130.2(b)(45); Section 93130.10(a)) The At Berth Regulation defines a terminal to include berths that operating ports lease to vessel operators, in addition to terminals run by terminal operators. (Section 93130.2(b)(75)). Thus, individual berths that are leased to vessel operators are treated as terminals under the regulation and must meet emission reduction requirements if they receive 20 or more covered vessel calls per year.

Ports, in turn, must accommodate terminals and berths that are required to reduce emissions under the At Berth Regulation by providing equipment or necessary infrastructure that is outside of the terminal operators’ contractual ability to provide. (Section 93130.13)

4.5. Emission Reduction Strategies

The At Berth Regulation requires covered vessels docked at berth to reduce the emission of NOx, PM, ROGs and GHGs through the use of shore power or an alternative CAECS. (Section 93130.5(d)) Each of these strategies is discussed below.

4.5.1. Shore Power

Shore power is defined in the At Berth Regulation as electrical power being provided by either the local utility or by distributed generation to a vessel at berth. (Section 93130.2(b)(72)) For a detailed discussion of shore power, see previous Section 1.1. Shore power is a CAECS and, under the At Berth Regulation, is the only CAECS that does not require approval from CARB through an executive order. (Section

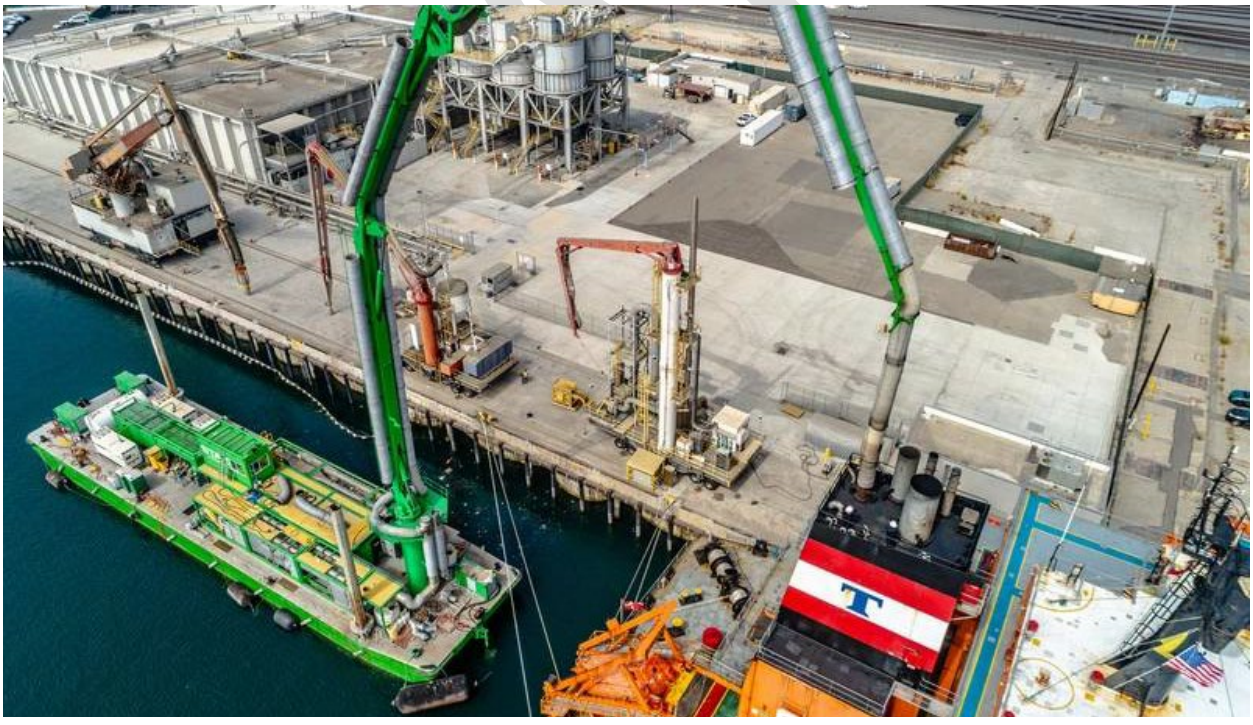
93130.5(a)) However, the electricity generated for shore power must also meet emission standards and be grid neutral.[20] (Section 93130.5(c))

Shore power is the preferred CAECS, and any OGV equipped with shore power that visits a berth equipped to provide compatible shore power must use shore power during every visit to that berth. If a shore power connection is not available, a vessel may use another CAECS. (Section 93130.7(a))

4.5.2. Other CARB-Approved Emission Control Strategies

To make use of an emission control strategy other than shore power, the strategy must first be approved by CARB through an executive order. The At Berth Regulation sets forth requirements for CARB approval of an emission control strategy, including how much the strategy must reduce specific emissions (for example, NOx emissions from auxiliary engines must be reduced from a default of 13.8 g/kW-hr to 2.8 g/kW-hr). Required reductions are substantial and are set based on whether the strategy is intended to reduce emissions from auxiliary engines or tanker vessels with steam driven pumps or makes use of selective catalytic reduction. Standards for approval are set forth at Section 93130.5(d).

To obtain an executive order approving an emission control strategy, an applicant must submit a test plan and then apply to CARB for approval. Approvals are valid for five years, and operators of CAECS can seek extensions of this term. CAECS operators must perform annual testing to demonstrate the strategy continues to meet CARB's standards. (Section 93130.5(e)-(j). Figure 4-3 shows an example of a capture and control barge, a recently CARB-approved CAECS (through executive order) that is presently the most widespread CAECS alternative to shore power.



Source: MarineLink.com

FIGURE 4-3: EXAMPLE OF A CAPTURE AND CONTROL BARGE

[20] The required emission standards are:

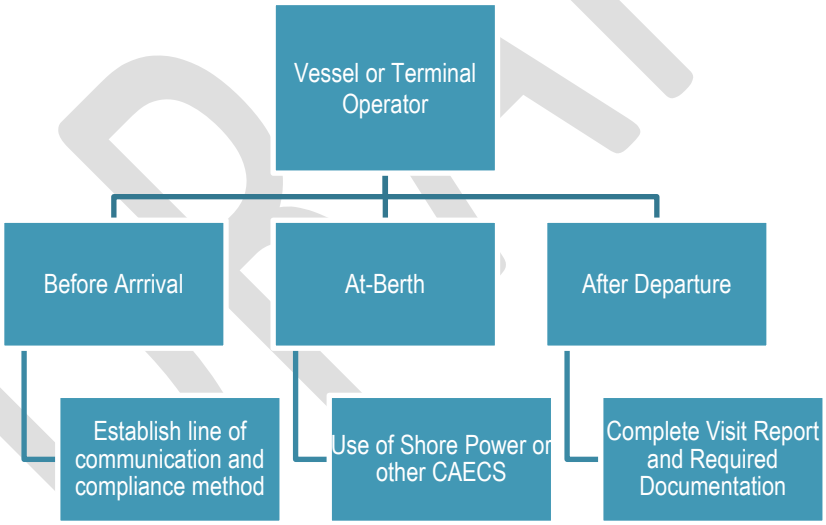
- NOx emissions no greater than 0.03 g/kW-hr.
- PM emissions equivalent to the combustion of natural gas with a fuel sulfur content of no more than 1 grain per 100 standard cubic foot.
- Distributed generation GHG emissions must be grid-neutral, meaning it does not emit more GHG emissions than if the strategy were powered by the California grid.
- Ammonia emissions are no greater than five ppmdv, if selective catalytic reduction (SCR) is used.

4.7. Operational Requirements (Section 93130.7, 93130.9, 93130.12, 93130.13)

The At Berth Regulation establishes operational requirements for all parties involved in compliance, including the vessel operator, the terminal operator, the port (as applicable), and the CAECS operator. All parties are responsible for ensuring that emissions are reduced to the required amount when a covered vessel is at berth. Generally, this shared responsibility involves:

- Seven days prior to arrival, the vessel operator, terminal operator, and CAECS operator coordinate to determine which CAECS will be used. Anytime a vessel is equipped to connect to a terminal's shore power, then shore power must be used. Otherwise, either the vessel operator or the terminal operator must arrange for an alternative CAECS. See Figure __ for a breakdown of which party must arrange for CAECS under different scenarios. If a vessel has an on-board capture and control system, it must confirm in writing that it will utilize this system during its visit.
- During the visit, the vessel either connects to shore power or utilizes an alternative CAECS if shore power connection is not possible.
- Within 30 days after departure, the vessel operator, terminal operator, and CAECS operator (if an alternative CAECS is utilized) send required information to CARB about the visit, including information on the vessel, location and time of visit, CAECS utilized, and, if an exception is utilized, information pertaining to the exception.
- All parties are required to retain records for a period of 5 years and must produce any records requested by CARB within 10 days.

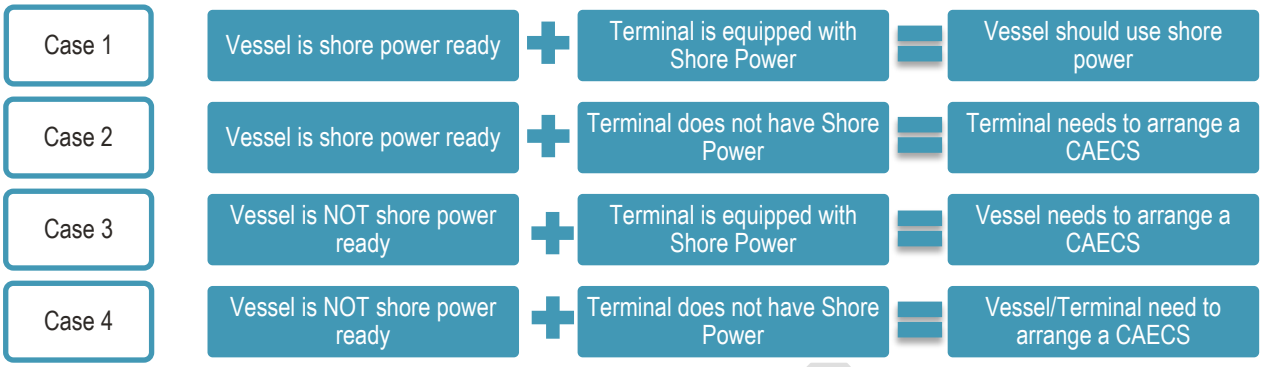
Figure 4-4 shows a summary of these responsibilities.



Source: CARB

FIGURE 4-4: COMPLIANCE REQUIREMENTS – VESSEL AND TERMINAL OPERATORS

Figure 4-5 shows under which circumstances either shore power or an alternate CAECS should be used, and which party is responsible for making such arrangement.



Source: CARB

FIGURE 4-5: SUMMARY OF RESPONSIBILITIES

4.7.1. Additional CAECS Operator Requirements

In addition to keeping records of vessel visit information, CAECS operators are subject to further reporting and recording requirements. These include reporting to CARB and keeping records of malfunctions and corrective actions and maintaining lists of subcontractors, agreements, and services performed. (Section 93130.12)

4.7.2. Additional Port and Terminal Requirements

As discussed, ports must provide necessary infrastructure to terminal operators to enable them to comply with the At Berth Regulation. This includes but is not limited to underground infrastructure, conduit, cabling, ducting, and shore power vaults. Ports must also provide Wharfinger data (information on vessels and visits to the port) to CARB annually (Section 93130.13).

During the initial rollout of the 2020 At Berth Regulation, terminal and port operators were required to submit plans by December 2021 outlining how they would comply with the updated regulation. These plans had to include necessary infrastructure modifications, necessary equipment, lists of berths and terminals, berthing restrictions, a schedule for equipment installation, and division of responsibilities between the terminal and the port. Operators for terminals receiving ro-ro and tanker vessels were required to revise and resubmit plans by 2024 and/or 2026, depending on the effective date for those vessel types.

4.8. Regulatory Exceptions

Although the 2020 At Berth Regulation requires the control of at-berth emissions at 100% of visits by regulated vessels to qualified terminals, it exempts certain categories of vessels and, for covered vessels, excludes certain types of visits. Even for visits that require emission reduction, the At Berth Regulation allows for a limited number of visits where emissions are not controlled and gives operators the option to establish and pay into a remediation fund for noncompliant visits beyond their allotted number of exceptions. These allow for operators to maintain some flexibility within the expanded reach of the new regulation.

4.8.1. Exception for Non-stop Voyages (Section 93130.4)

The At Berth Regulation does not apply to voyages that are considered non-stop, even if these voyages include brief stops by regulated vessels at a qualified berth. Such circumstances are:

- Stopping and anchoring is required by the USCG
- Stopping is necessary due to force majeure or distress; or
- Stopping solely to render assistance to persons, vessel, or aircraft in danger or distress.

This category allows for OGVs to stop and anchor in exigent circumstances without being in violation of the At Berth Regulation.

4.8.2. Exception for Vessels (Section 93130.4, 93130.8)

The At Berth Regulation also does not apply to government or military vessels, though they are encouraged to act consistently with the regulation as far as practicable.

In addition, bulk and general cargo vessels are not required to reduce emissions at berth, but must still report vessel activity.

4.8.3. Vessel Safety and Emergency Event (Section 93130.8(a))

The emission reduction requirements of the At Berth Regulation do not apply during safety and emergency events. These events are subject to review and audit by the CARB Executive Officer, and this exception applies only if approved and only for as long as the event occurs and to the extent necessary to secure the safety of the vessel, crew, cargo, or passengers. Vessel operators must take reasonable precautions to avoid repeated claims of this exception and must comply with reporting requirements. Safety and emergency events are subject to review and audit by the Executive Office.

4.8.4. Vessel Commissioning Exception (Section 93130.8(c))

The first visit by a vessel to a terminal, known as a vessel commissioning, may be exempt from emission reduction requirements if approved by CARB. Operators must still comply with reporting requirements.

4.8.5. Research Visits (Section 93130.8(d))

Vessel operators can qualify for an exception for visits conducted for research but must receive CARB approval of a research test plan prior to arrival and must still comply with reporting requirements.

4.8.6. Visits to Low Activity Terminals (Section 93130.8(e))

As discussed, vessels do not have to control emissions when visiting terminals that receive fewer than 20 visits from covered vessels per year. Operators are still required to comply with reporting requirements for visit activity.

4.8.7. Vessel Incident Event (VIE) and Terminal Incident Event (TIE) (Section 93130.11)

The At Berth Regulation allows for a limited number of visits where emissions are not controlled, even when the visit is by a covered vessel to a qualified terminal. These exceptions, known as vessel incident events (VIE) and terminal incident events (TIE) are granted based on the total visit activity from the prior year of either the fleet (in the case of VIEs) or the terminal (in the case of TIEs).

For 2023 through 2024, terminals were afforded TIEs for 15% of visits. Starting in 2025, this percentage was reduced to 5%. For vessel fleets, VIEs are granted for 5% of visits. These percentages are used to calculate the number of VIEs and TIEs a vessel operator or terminal is given, based on their vessel traffic in the preceding year.

While VIEs and TIEs are intended to anticipate situations in which a terminal or vessel requires repairs or upgrades or where a CAECS fails to perform, they can be invoked during any visit. Table 4-3 shows the VIE and TIE rates by vessel type per year.

TABLE 4-3: VIES AND TIES RATES BY VESSEL TYPE PER YEAR

		2023	2024	2025	2026	2027	2028+
TIEs	**All Terminals**	15%	15%	5%	5%	5%	5%
VIEs	**Container/Reefer**	5%	5%	5%	5%	5%	5%
	Passenger	5%	5%	5%	5%	5%	5%
	Ro-ro			5%	5%	5%	5%
	LA/LB Tankers			5%	5%	5%	5%
	Other Tankers					5%	5%

Source: CARB

4.8.8. Remediation Fund Use (Section 93130.15-16)

Vessel, terminal, and CAECS operators and ports that anticipate not being able to comply with emission reduction requirements due to needed repairs or construction also have the option of establishing and paying into a remediation fund for visits in which emissions are not adequately controlled. The operator or terminal seeking to use the remediation fund must show that it cannot comply with emission reduction requirements because of needed repairs to the terminal or vessel equipment, a terminal construction project, delays associated with operating a CAECS, or another physical or operational constraint.

To make use of a remediation fund, the operator or terminal must execute a Memorandum of Understanding and CARB must approve an entity to administer the remediation fund. Moneys from the fund must be used to mitigate the community impact of excess emissions, and typically fund administrators are local air quality management districts or air pollution districts with jurisdiction in the communities adjacent to ports or terminals that are regulated under the At Berth Regulation. Payments to remediation funds are calculated per hour of uncontrolled emissions, based on vessel type. Table 4-4 shows the hourly rate for remediation payments. Table 4-5 shows situations in which a VIE, TIE, or payment into a remediation fund can be used.

TABLE 4-4: REMEDIATION FUND HOURLY AMOUNT

Vessel Type	Hourly Remediation Payment Beginning in 2023*	
	Normal Rate	Tier III Rate
Container, Reefer, ro-ro	$1,900	$1,100
Tanker with electric pumps	$1,600	$1,000
Tanker with steam driven pumps	$3,400	$2,700
Passenger vessels with capacity under 1,500 combined passengers and crew	$5,300	$3,200
Passenger vessels with capacity of 1,500 or more combined passengers and crew	$12,000	$7,100
**Remediation payments used by vessel operators shall be reduced by 20% for IMP Tier III tanker vessels with steam driven pumps, and 40% for all other IMP Tier III vessels.*		

Source: CARB

TABLE 4-5: CIRCUMSTANCES THAT MAY QUALIFY FOR AN EXCEPTION, A VIE/TIE, OR REMEDIATION

Circumstances	Exception	VIE/TIE	Remediation Fund	Responsible Parties
Safety/emergency, research, vessel commissioning or innovative concept	X			
Visits without reductions		X	*	Terminal, Vessel
Vessel control equipment repair		X	X	Vessel
Terminal control equipment repair		X	X	Terminal, Port
Terminal upgrades/construction		X	X	Terminal, Port
Delays, but reductions occur		X	X	Terminal, Vessel, CAECS operator
CAECS equipment failure, or CAECS failure to perform		X	X	Terminal, Vessel, CAECS operator
**In general, all visits may use a VIE or TIE if available, but not all visits qualify for remediation. See section 93130.15(b) of this Control Measure.*				

Source: CARB

4.8.9. Innovative Concept Compliance Option (Section 93130.17)

Operators and ports are also given the opportunity to propose innovative methods for reducing emissions from sources in and around the regulated port or marine terminal. The innovative concept must reduce emissions at a level equivalent to or greater than what would be achieved through shore power or an alternate CAECS. This pathway allows operators to propose reducing emissions from sources other than the vessel itself, in lieu of reducing vessel at-berth emissions, as long as the reduction takes place within the same port or terminal or within adjacent communities or within three nautical miles of that port of terminal. The due date for applicants to seek approval was December 1, 2021.

To date, out of 12 applications, CARB has issued an executive order approving one innovative compliance option, involving the operation of a lower emission and fuel locomotive.[21] Other applications are still under review, and several have been denied.[22]

4.9. Implementation Challenges and Lessons Learned

California's implementation of the CARB At Berth Regulation has provided valuable insights into the complexities of mandating emissions reductions at ports and terminals. While the regulation has driven measurable air quality improvements, several challenges emerged during its rollout:

- **Infrastructure Delays:** Many terminals faced significant delays in installing shore power systems due to utility coordination issues, permitting complexities, and site-specific electrical limitations. High capital costs and long lead times for equipment, such as transformers, frequency converters, and cable handling systems, further extended implementation timelines.
- **Use of VIEs and TIEs:** The VIE and TIE mechanisms were introduced to provide limited flexibility for vessel and terminal operators during unforeseen or unavoidable circumstances. Their frequent use during the early phases of implementation highlights the importance of proactive planning, effective communication, and thorough documentation to ensure smooth compliance and minimize disruptions.
- **Technology Gaps:** For certain vessel types such as tankers and ro-ro vessels, commercially available shore power systems were not standardized or feasible at the time of regulation. This prompted increased development and testing of alternative solutions, such as barge-based emissions capture and control systems, which required CARB Executive Order approval and presented their own logistical and safety hurdles.
- **Coordination Across Stakeholders:** Achieving compliance required close coordination among vessel operators, terminal operators, ports, utilities, equipment vendors, and regulatory agencies. In several cases, inconsistent communication and unclear responsibilities delayed progress.

These lessons underscore the importance of early infrastructure planning, technology readiness, and clear enforcement frameworks. California's phased approach, coupled with alternative compliance pathways and remediation options, helped mitigate disruptions while maintaining progress toward environmental targets.

21 Executive Order approval: https://ww2.arb.ca.gov/sites/default/files/2024-06/FAB23-123%20-%20Chevron%20IC1%20Approval%20Letter%20ADA.pdf
22 https://ww2.arb.ca.gov/innovative-concept-application-clean-air-engineering-maritime

5. Potential Impact of Adopting California Emission Standards in Washington

The following section discusses the potential impact if Washington chose to adopt regulations identical to California's At Berth Regulation. It first describes Washington's unique shipping and port environment and ways in which it differs from California. This section also details ports where shore power has already been adopted, absent a state regulatory mandate. Finally, the report discusses the regions, terminals, and berths that are likely to be affected by adoption of an at berth regulation based on California's 20 visit threshold and the potential impact on at berth emissions.

As amended, the At Berth Regulation requires terminals that receive 20 or more visits from a regulated OGV type (e.g., container vessels, cruise ships, etc.) to control at-berth emissions. If Washington adopted similar regulations, 25 public port or private terminals located across the areas of Grays Harbor, Everett, Ferndale, Anacortes, Seattle, Tacoma, and Vancouver could meet this threshold once the regulations were fully implemented and thus be required to control at-berth emissions.

Washington would see reduced emissions of nitrogen oxides (NOx), fine particulate matter (PM2.5), sulfur dioxide (SO2), and greenhouse gases (GHGs) at its major maritime public ports and/or private terminals under a phased, 10-year implementation of an at-berth regulation akin to California's. Accounting for current shore power usage, full implementation of the at-berth regulations would reduce statewide commercial ship emissions by 13% and 9% for PM2.5 and NOx respectively, relative to Ecology's 2020 statewide comprehensive emission inventory. Overall vessel emissions (commercial and recreational) for GHGs would be reduced by 2% relative to Ecology's 2021 statewide GHG inventory.

5.1. Washington Ports and Shipping

Washington State is home to 75 public port authority districts, the highest number of any U.S. state, offering a uniquely decentralized and locally governed maritime system. These ports are both marine and riverine and are distributed across three key regions: the Puget Sound region, the Pacific Coast, and the Columbia River and Inland River System. Many are strategically located along protected waters, such as Puget Sound and the Columbia River, allowing for year-round operations and a wide range of cargo-handling capabilities. Washington is also home to a number of private terminals, not affiliated with a specific public port (i.e., some of Washington's petroleum facilities).

California is dominated by several large, urbanized, coastal ports such as the Ports of Los Angeles, Long Beach, and Oakland, that handle high volumes of container shipping. Ports such as San Diego and Hueneme also contribute further to the state's containerized trade. In contrast, the only comparably sized container shipping port in Washington is that of the NWSA[23]. To illustrate, in 2024 the Port of Long Beach handled 9,648,724 twenty-foot equivalent units (TEUs) and the Port of Los Angeles handled 10,297,352 TEUs. By comparison, the NWSA handled about 1/3 of that amount (3,340,733 TEUs). Washington's mix of waterborne export tonnage is heavily weighted towards bulk, breakbulk, mainly agricultural products. For example, in 2019 approximately 81 percent of Washington's exports (by tonnage)[24] were shipped via those vessel types, while only about 9 percent of exports were containerized. Figure 5-1 visualizes this contrast with 2022 container data.

[23] The Northwest Seaport Alliance is a cooperative venture between the Port of Seattle and Port of Tacoma. The NWSA handles container, breakbulk, auto, and some bulk cargo for both Ports.

[24] Based on the report Analysis of the Impact on Washington State Exports from a Potential Public Utility Tax Applied by the State of Washington published at leg.wa.gov.

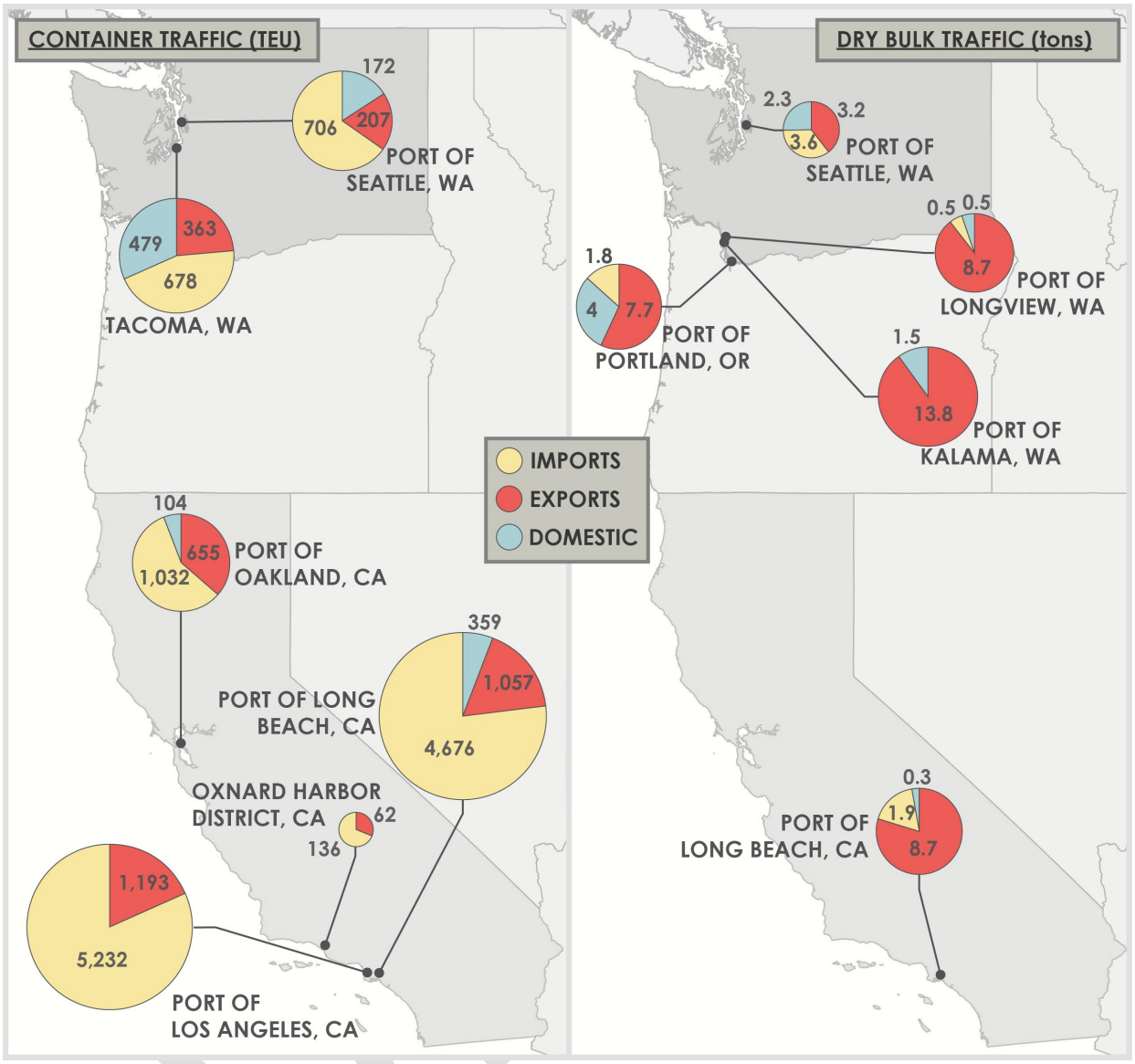


FIGURE 5-1: CALIFORNIA AND WASHINGTON SHIPPING TRAFFIC COMPARISON; USDOT 2022 DATA.[25]

25 USDOT, Bureau of Transportation Statistics, based on 2022 data (latest available) provided by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center. Tabulation as of July 2024.

Unlike California's more centralized and heavily urbanized port system (Figure 5-2), Washington's ports vary widely in size and function, supporting activities that include international trade, commercial fishing, shipbuilding, cruise services, and energy transport.

The Puget Sound region is home to the Ports of Seattle and Tacoma, the state's largest cargo-handling facilities. The Ports of Seattle and Tacoma also include the NWSA, a joint partnership formed between the two Ports that handles container, breakbulk, auto, and bulk cargo for both Ports (Figure 5-2). Together, the Ports of Seattle and Tacoma form the fourth-largest container gateway in the nation. The Port of Seattle also serves as a major cruise terminal and international air cargo hub through Seattle-Tacoma International Airport. The Port of Tacoma is known for its deep berths and strong intermodal connectivity, handling containers, automobiles, and breakbulk cargo.

The Northwest Seaport Alliance (NWSA) is a Federal Maritime Commission approved port development authority governed by both the Port of Seattle and Port of Tacoma as equal members. This joint partnership was formed in 2015 to better compete globally. The NWSA handles container, breakbulk, auto, and some bulk cargo for both Ports. Both the Port of Seattle and Port of Tacoma remain separate organizations that retain ownership of their respective assets. The presidents of the home port commissions serves as co-chairs of the NWSA.

FIGURE 5-2: RELATIONSHIP BETWEEN NWSA, PORT OF SEATTLE, AND PORT OF TACOMA

Other areas within the Puget Sound also carry unique characteristics. The region around the Port of Everett specializes in containers, bulk cargo, and aerospace-related cargo which supports Boeing's supply chain, while the Port of Bellingham region supports both commercial bulk cargo marine terminals and recreational maritime operations near the Canadian border and ferry services to Alaska (the southernmost terminus for the Alaska Marine Highway System). The Port of Anacortes handles petroleum and chemical products from nearby refinery operations. The Olympia region serves a range of industrial activities, including breakbulk cargo, log exports, and other marine terminal services.

On the Washington peninsula, the region near Port Townsend plays a unique role in supporting wooden boatbuilding and niche cargo operations and Port Angeles supports commercial ship repair and marine trades. Further southwest along the Pacific Coast, the region near the Port of Grays Harbor offers direct ocean access and is one of Washington's most versatile ports, handling automobiles, forest products, and bulk exports, with a growing focus on clean energy infrastructure.

On the Columbia River system, the Port of Vancouver USA handles bulk, breakbulk, and project cargo, including wind energy components and automobiles, while the Port of Longview is a key gateway for dry bulk commodities such as grain and minerals, supported by robust rail access.

In addition to public terminals, Washington's shipping industry also includes private terminals which, unlike public port authorities, are owned and managed by private companies. These facilities are often dedicated to specific industries such as petroleum refining, bulk commodities, or manufacturing. Their governance structures, funding mechanisms, and operational priorities differ significantly from public ports. As this overview indicates, the State of Washington hosts a diverse shipping industry that operates at multiple scales, across a range of geographies, industries, and specializations.

5.2. Shore Power in Washington

Some Washington ports have already taken independent action to implement emission reduction requirements for OGVs. For example, the Northwest Ports Clean Air Strategy is a voluntary initiative jointly developed by the Port of Seattle, Port of Tacoma, and NWSA, and the Vancouver Fraser Port Authority in British Columbia, Canada. The strategy provides a cooperative framework for implementing local emissions control measures, including the use of shore power for these ports.

Washington ports like NWSA and Port of Seattle have independently implemented shore power systems and are requiring vessel connection without state regulations. Other ports are in the process of updating berths and terminals for shore power. These ports can independently implement shore power use through voluntary initiatives and local contractual agreements with tenants. That is, they can require vessels to use shore power if: 1) the vessel is equipped with shore power capability; and 2) the Port has compatible shore power hookups available at a given terminal.

Port shore power requirements can be contractually enforceable and are not dependent on regulations . Washington ports leverage lease agreements or terminal use policies to require plugging in, meaning they can unilaterally require it where technically feasible, with no need for federally compliant regulations.

As of March 2025, the Port of Seattle reports 54 percent of homeported cruise vessel calls are shore-power capable, with 100 percent of Holland America and Princess Cruises ships at Pier 91 equipped.[26] Industry-wide trends show container and cruise vessel shore power capability is increasing. About 50 percent of container ships at NWSA terminals were compatible with shore-power as of 2019.[27] This voluntary adoption of shore power by some ports is also supported by the fact that a growing share of vessels calling at Washington ports already have the hardware to plug in.

These developments indicate that voluntary adoption can be an important avenue for increasing the use of shore power and promoting emissions reductions to enhance air quality for port adjacent communities. Washington may consider developing resources in the form of technical assistance, funding, or regulatory streamlining to promote voluntary shore power adoption, as it considers adopting regulatory mandates similar to the At Berth Regulation.

5.3. Washington Locations Potentially Impacted by At Berth Regulation Adoption

To determine which ports, terminals and berths would likely be affected by regulations identical to California At Berth Regulation, the study undertook a two-part analysis. First, a statewide traffic analysis was performed. Areas associated with ports and terminals were “geofenced” to allow for tracking of vessel movements within the geofenced areas (Figure 5-3). This allowed for determination of which ports and terminals were busiest and thus most likely to meet the At Berth Regulation’s 20 visit minimum threshold.

Through this analysis, Tacoma, Seattle, Vancouver, Kalama, Longview, Ferndale[28], Anacortes[29], Gray’s Harbor, and Everett were identified as the state’s highest traffic areas (Figure 5-4). Within these areas, the type of vessel traffic varied significantly. To the north, traffic in Ferndale and Anacortes was driven almost exclusively by tanker vessels. To the south, traffic through Longview, Kalama, and Vancouver was mostly in bulk cargo, which would not be subject to the emission standards of the At Berth Regulation. Traffic to Seattle and Tacoma was more diverse. Both ports saw the state’s largest volumes of container vessels by far. Seattle received the state’s cruise ship traffic, and Tacoma received significant ro-ro traffic. Bulk, general cargo, and tanker traffic also passed through both regions in smaller amounts.

[26] Based on the article The Past, Present, and Future of Shore Power published in the portseattle.org website.
[27] Based on the Northwest Seaport Alliance website.
[28] The terminals identified within the general region of Ferndale include three refineries in and around the shoreline near Ferndale, Custer, and Cherry Point.
[29] The terminals identified within the general region of Anacortes are two petroleum refineries at March’s Point, a peninsula in Skagit County east of downtown Anacortes.

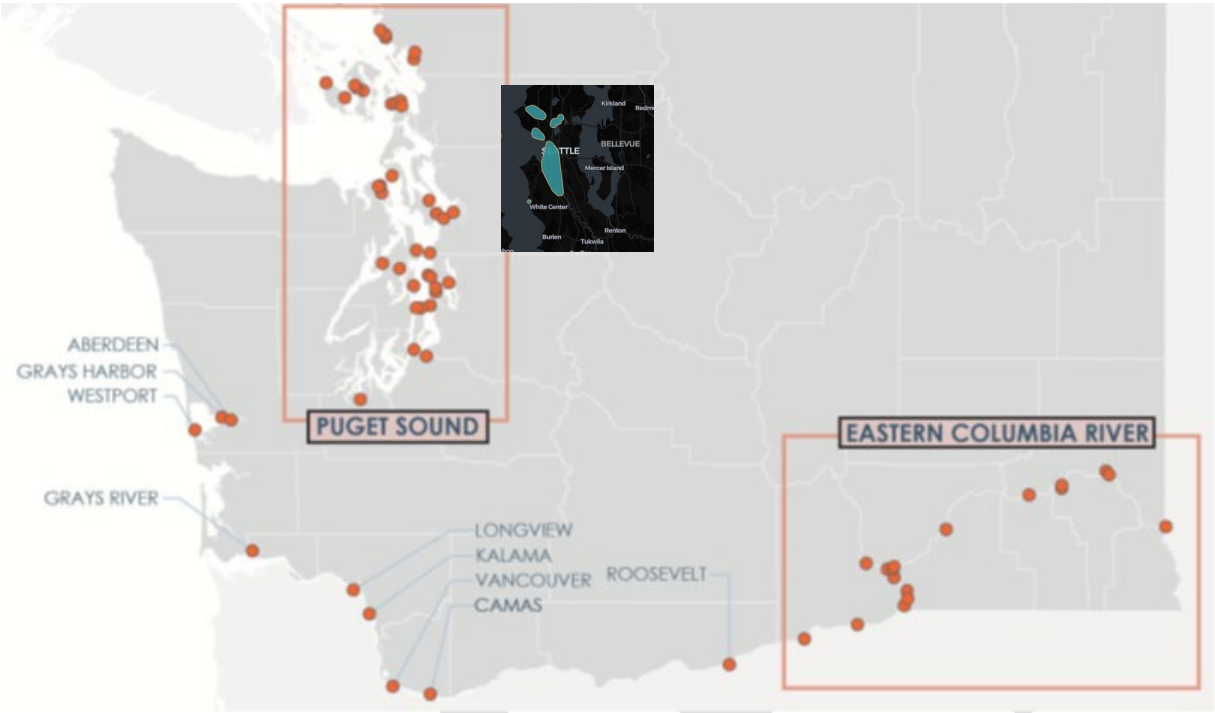


FIGURE 5-3: GEOFENCED AREAS WITH EXPANDED SEATTLE EXAMPLE

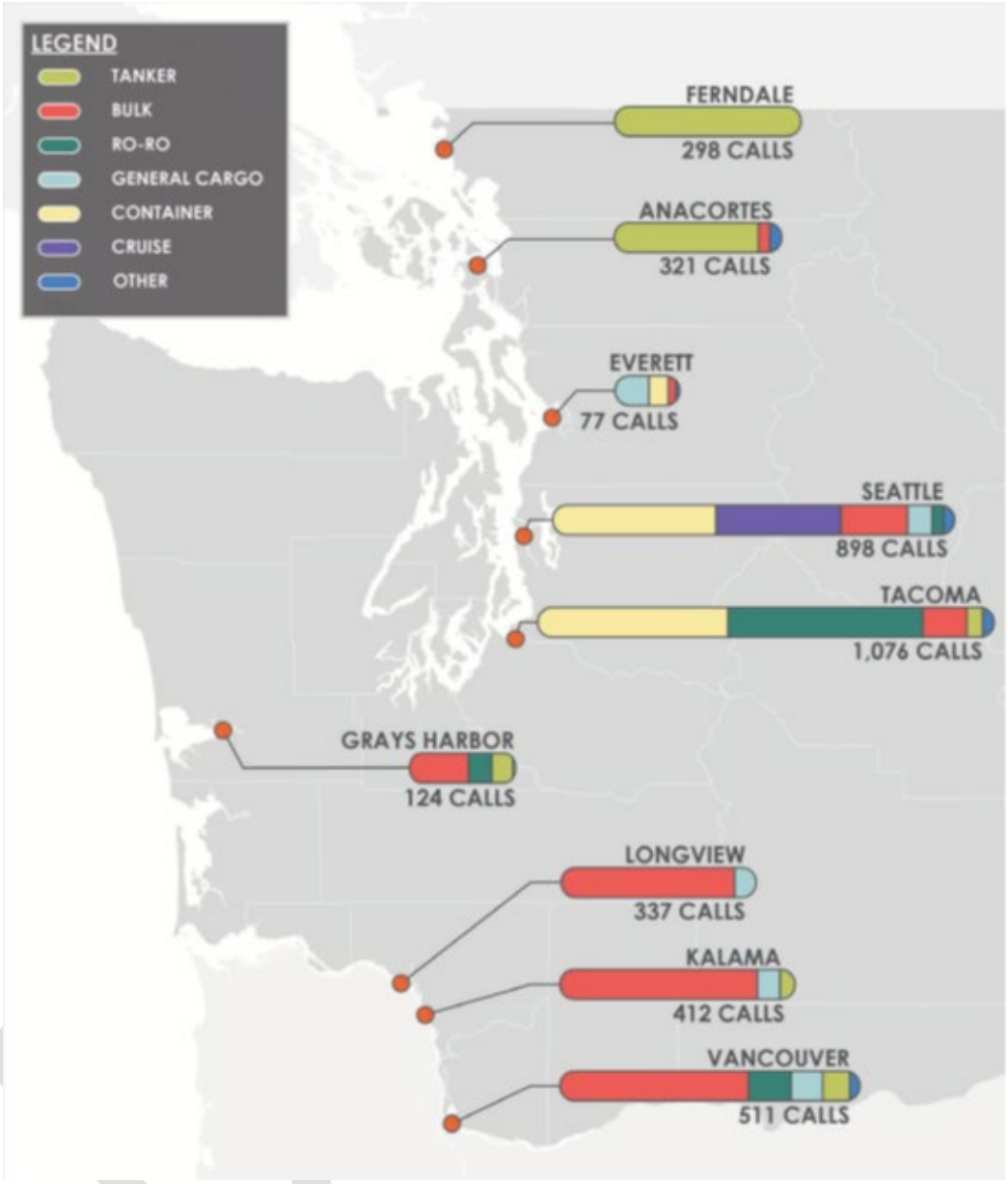


FIGURE 5-4: WASHINGTON PORTS THAT TYPICALLY RECEIVE OGVS

5.3.1. Regional Traffic Analysis

In part two of this vessel traffic analysis, Marine Exchange data for 2024 was analyzed to identify which terminals would most likely be required to comply with at-berth emission standards if a CARB-style regulation was adopted.

If Washington State chooses to implement the At Berth Regulation, and assuming it applies to container ships, cruise ships, passenger vessels, tankers, and ro-ro vessels with a threshold of at least 20 calls per year per terminal or berth, the following regions could include terminals or berths potentially subject to the At Berth Regulation based on 2024 vessel traffic data:

- Ferndale[30]
- Anacortes[31]
- Everett
- Seattle
- Tacoma
- Grays Harbor
- Vancouver

This list is based on regional vessel traffic, not limited to facilities owned or operated by a single port authority. For instance, the region near the Port of Vancouver recorded more than 20 vessel calls in 2024 for multiple vessel types, including bulk carriers, ro-ro cargo vessels, general cargo ships, and chemical tankers. Because ro-ro and tanker vessels fall under the proposed regulatory scope, Vancouver is included as an affected region.

Conversely, some regions are not included in the list. For example, while Longview and Kalama are high traffic ports, the vessel types they primarily service, bulk and general cargo, are outside the scope of the California regulations. In Kalama, only 14tanker calls were recorded in 2024, below the minimum required to trigger regulatory applicability.

If Washington adopts a regulation identical to CARB's At Berth Regulation, the regions most likely to be affected are those that regularly receive regulated OGVs, including container ships, cruise vessels, tankers, and ro-ro. These vessels generate emissions while at berth, making their operations a key focus for emission reduction strategies. The regulation would target deep-water, marine-accessible regions engaged in international or coastal maritime trade, rather than facilities serving only air, rail, or small craft. Figure 5-5 shows a map with the Washington Ports highlighting the ones that typically receive OGVs (including the OGVs not covered by the CARB At Berth Regulation).

Focusing only on the OGV definition under the At Berth Regulation, the primary candidates for inclusion, and based on 2024 vessel traffic data, are public port terminals/berths or private terminals/berths within the following regions:

- Grays Harbor: Marine activity at the Port of Grays Harbor contains ro-ro auto terminals handling import/export vehicles.
- Anacortes: Anacortes is centered on private petroleum refining and marine support industries, with the Tesoro/Marathon and Shell refineries at March's Point including tanker and barge calls.
- Everett: The Port of Everett contains project cargo, and specialized shipments, including oversized aerospace components for Boeing.
- Ferndale: Ferndale's main marine activity is at the Cherry Point industrial area, where oil refineries (BP and Phillips 66) historically operate[32]. Tankers and barges are the primary vessel types, focused on crude oil imports, refined product exports, and energy-related cargoes.
- Seattle: Marine activity in Seattle is mostly containerized cargo at the NWSA North Harbor, along with Port of Seattle cruise ship operations at multiple piers, and private petroleum and chemical terminals along the Duwamish Waterway.
- Tacoma: Tacoma's waterfront hosts large container terminals of the NWSA South Harbor, and auto import/export terminals.
- Vancouver: The Port of Vancouver USA, located on the Columbia River, handles a diverse mix of cargo including liquid bulk (petroleum, chemicals, vegetable oils), autos, wind energy components, and other project cargo.

[30] The terminals identified within the general region of Ferndale include three petroleum facilities in and around the shoreline near Ferndale, Custer, and Cherry Point.

[31] The terminals identified within the general region of Anacortes are two petroleum refineries at March's Point, a peninsula in Skagit County east of downtown Anacortes.

[32] Intalco, also in the region, was an aluminum smelter facility that closed; the site is undergoing redevelopment.

Table 5-1 summarizes the regions with facilities that are most likely to be affected if Washington moves forward with At Berth Regulation. Final applicability would depend on the scope of the regulation, including covered vessel types and sizes, frequency of visits, and infrastructure readiness.

Because the CAA requires that a state adopting California emission standards under Section 209 also adopt identical implementation and enforcement, a phased implementation schedule modeled after California's is assumed. The schedule is described in Section 5.4 and assumes that not all regions would be affected at the same time.

TABLE 5-1: REGIONS IN WASHINGTON WITH 20 OR MORE OGV VISITS IN 2024

OGV TYPE	Covered Vessels					Excluded Vessels	
	Phase I			Phase II		General Cargo	Bulk
	Container	Cruise	Reefer	Ro-Ro	Tankers		
Regions				Grays Harbor	Grays Harbor		Grays Harbor
					Anacortes		
	Everett					Everett	
					Ferndale		
						Kalama	Kalama
						Longview	Longview
	Seattle	Seattle				Seattle	Seattle
	Tacoma			Tacoma	Tacoma		Tacoma
				Vancouver	Vancouver	Vancouver	Vancouver

5.3.2. Terminals and Berths Likely to Be Impacted By At Berth Regulation

As discussed previously, shore power regulations in Washington, if adopted, will likely be identical to those in California. Under California's At Berth Regulation, the applicability of shore power requirements is assessed at the terminal level, as opposed to the port or ship level. Moreover, because berths leased by ports directly to vessel owners are considered terminals under the At Berth Regulation, the threshold of 20 visits can sometimes be assessed at the berth level.

Table 5-2 and Figure 5-5 shows the berth regulation threshold of 20 qualifying vessel calls in a calendar year. These terminals would likely be subject to emission-reduction requirements if a similar regulation were implemented in Washington. The table also provides vessel type, total dwell duration, and average dwell time per visit to support assessment of potential compliance strategies and operational impacts. Terminals shaded in grey have shore power already installed. These terminals would likely be subject to emission-reduction requirements if a similar regulation were implemented in Washington. Table 5-2 also provides vessel type, total dwell duration, and average dwell time per visit to support assessment of potential compliance strategies and operational impacts. Terminal shaded in grey have shore power already installed.

In Washington, 25 terminals exceeded the 20+ calls per year threshold set by the At Berth Regulation and thus would be required to control at-berth emissions by requiring shore power or the use of an alternative capture and control system. These public port or private terminals were located north to south across the general regions of Ferndale, Anacortes, Everett, Seattle, Tacoma, Gray's Harbor, and Vancouver.

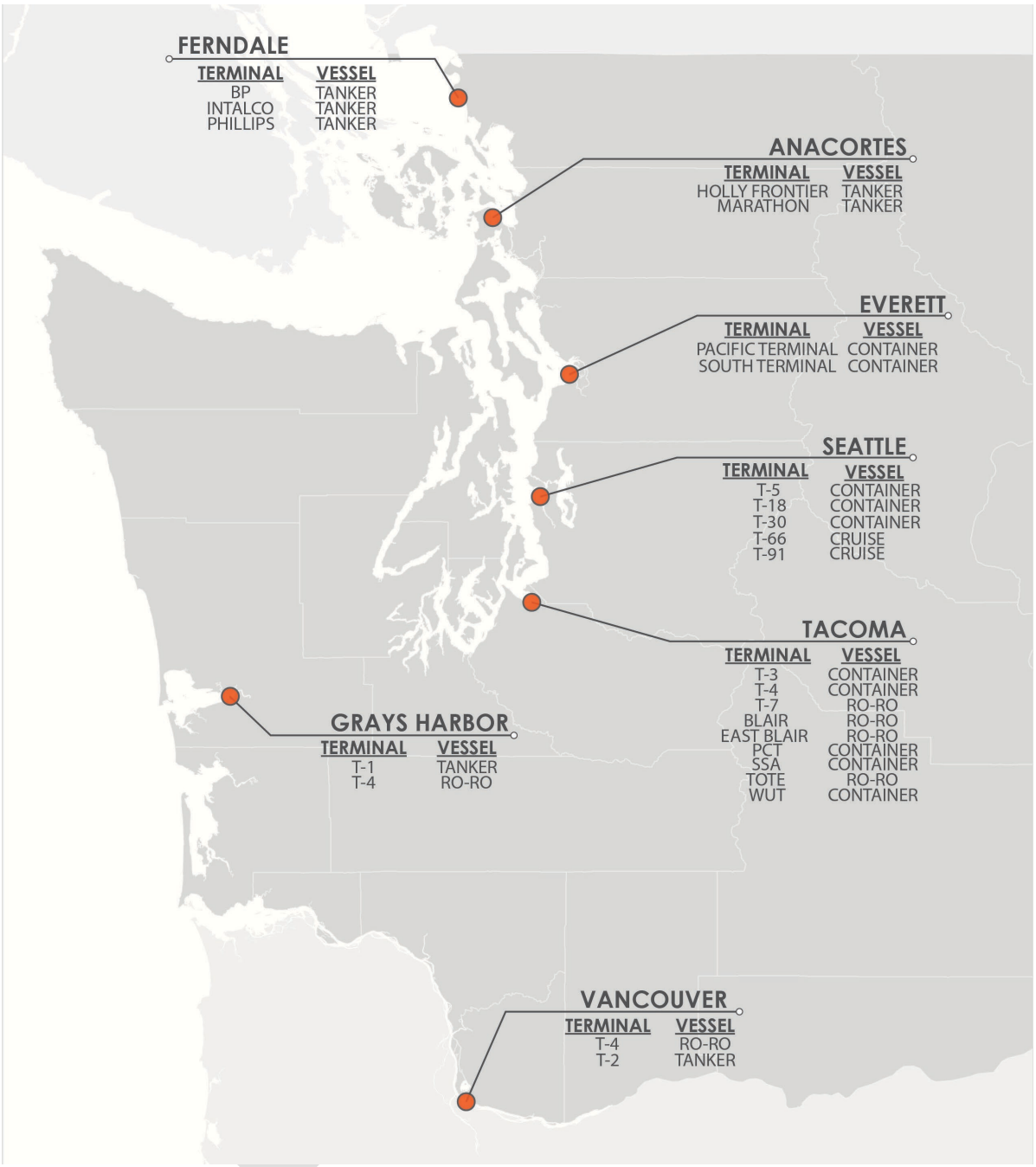


FIGURE 5-5: TERMINALS MEETING THE MINIMUM 20 OGV CALLS THRESHOLD

TABLE 5-2: TERMINALS MEETING THE MINIMUM 20 OGV CALLS THRESHOLD

Location	Terminal	Visits	Total Dwell Duration (days)	Average Dwell per Visit (hr)	Vessel Type
Grays Harbor	T-1	20	37.6	45.15	Tanker
Grays Harbor	T-4	24	36.5	36.47	Ro-Ro
Everett	Pacific Terminal	37	59.7	38.71	Container
Everett	South Terminal	51	78.9	37.27	Container
Ferndale	BP	204	263.3	30.97	Tanker
Ferndale	Intalco	49	100.8	49.37	Tanker
Ferndale	Phillips	51	84.7	39.85	Tanker
Anacortes	Holly Frontier	113	115.3	39.29	Tanker
Anacortes	Marathon	129	228.5	42.51	Tanker
Seattle	T-5	112	190.4	40.80	Container
Seattle	T-18	205	424.2	49.66	Container
Seattle	T-30	79	103.9	31.56	Container
Seattle	T-66	88	40.2	10.95	Cruise
Seattle	T-91	187	75.4	9.68	Cruise
Tacoma	T-3 (Husky)	46	151.4	78.97	Container
Tacoma	T-4 (Husky)	64	255.8	95.91	Container
Tacoma	T-7	62	145.7	56.41	Ro-Ro
Tacoma	Blair	103	96.1	22.39	Ro-Ro
Tacoma	East Blair	167	137.6	19.77	Ro-Ro
Tacoma	PCT	70	188.0	64.46	Container
Tacoma	SSA	164	267.1	39.09	Container
Tacoma	TOTE	102	64.1	15.25	Ro-Ro
Tacoma	WUT	87	399.6	110.22	Container
Vancouver	T-4	63	69.6	26.61	Ro-Ro
Vancouver	T-2	49	89.0	43.57	Tanker

Notes:

- Vessel types identified through cross-referencing with a 2020 Seaweb dataset. Where vessels were not identified, vessel type was inferred via cargo type in marine exchange reports.
- Puget Sound Marine Exchange (PSMX) and Columbia River Merchant Exchange (CRMX) data were filtered to remove durations and visits associated with anchorage activity and dry dock activities.
- For PSMX: bulk, other, offshore supply, and towing/pushing vessels were removed from the analysis.
- For CRMX: removed vessel types match those removed from the PSMX dataset, with research vessels also being removed.

5.4. Likely Impact of At Berth Regulation on Vessel Emissions in Washington

Ocean-going vessel emissions, when docked at berth[33] in Washington and the potential reductions to these emissions from applying regulations identical to California's At Berth Regulation in 2030–2040 scenarios were calculated. Drawing upon the findings of the vessel traffic analysis, which identified the Washington terminals likely to be regulated and the quantity of vessel traffic into these terminals, the USEPA Shore Power Emissions Calculator (SPEC) and Emissions and Generation Resource Integrated Database (eGRID) emission rates for the WECC-Northwest/NWPP grid were used to calculate changes in criteria pollutants and greenhouse gases (GHGs).[34, 35, 36, 37] Findings include:

- Transportation is the largest sectoral contributor to GHGs.[38] While OGV at-berth activity is a small share of statewide GHG emissions, near-port exposures to nitrogen oxides (NO_x), fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and sulfur dioxide SO_2 from vessels at berth are concentrated locally, impacting the people who live and work near these terminals and the surrounding environment.
- Controlling at-berth emissions through the use of shore power or other capture and control systems do not fully eliminate at-berth emissions. Vessels require time to hook up and unhook to and from shore power. During those times on-board diesel generators are used. While hooked up to shore power the power will come from the regional grid. While some emissions are generated by grid power, the intensity has declined over time and will continue to decline under state policy.[37, 39]
- In Washington, maritime-related pollutants declined substantially from 2005 to 2021 across most categories. Pollutant hotspots remain near terminals and ports, driven by where and how long vessels hotel at berth (and at anchor).[40] Thus targeting emissions from vessels at-berth is a leverage point for local air-quality improvements even as the overall maritime footprint trends down.[41, 42]
- Assuming a phased implementation that closely follows the implementation schedule set forth in California's At Berth Regulation, Washington would see reduced emissions of NO_x, $PM_{2.5}$, SO_2, GHGs at its major maritime public ports and/or private terminals. Across the regions that are likely to contain regulated terminals (Seattle, Tacoma, Ferndale, Anacortes, Grays Harbor, Everett, and Vancouver), NOx emissions from candidate OGVs would drop between 76%-86% from its current

[33] At-berth emissions refer to nitrogen oxides (NO_x), particulate matter ($PM_{2.5}$), diesel particulate matter (DPM), reactive organic gases (ROG), and greenhouse gases (CO_2e).

[34] U.S. Environmental Protection Agency (USEPA). Shore Power Emissions Calculator (v2022a), spreadsheet (May 4, 2022). Available at: https://www.epa.gov/system/files/documents/2022-05/shore-power-ems-calc-v2022a-2022-05-04.xlsx

35 USEPA. Shore Power Technology Assessment at U.S. Ports – 2022 Update. Program page (last updated 2025). Available at: https://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports

36 USEPA. eGRID2020 Summary Tables (subregion output emission rates and grid gross loss). January 27, 2022. Available at: https://www.epa.gov/system/files/documents/2022-01/egrid2020_summary_tables.pdf

37 USEPA. eGRID – Summary Data (program page; updated June 16, 2025). Available at: https://www.epa.gov/egrid/summary-data

[38] Washington State Department of Ecology. Washington State Greenhouse Gas Emissions Inventory 1990–2021. Publication 24-14-077. 2024. Available at: https://apps.ecology.wa.gov/publications/documents/2414077.pdf

39 Washington State Department of Ecology. Washington State Greenhouse Gas Emissions Inventory 1990–2021. Publication 24-14-077. 2024. Available at: https://apps.ecology.wa.gov/publications/documents/2414077.pdf

40 Puget Sound Maritime Air Emissions Forum. 2021 Puget Sound Maritime Air Emissions Inventory – Draft Results (Presentation). June 18, 2024. Available at: https://cms9files.revize.com/everett/Document%20Center/Your%20Port/Document%20Center/Commission/Commission%20Presentations/2024/June%2018%2C%202024%20PSEI%20Draft%20Results.pdf

41 Puget Sound Maritime Air Emissions Forum. 2021 Puget Sound Maritime Air Emissions Inventory – Draft Results (Presentation). June 18, 2024. Available at: https://cms9files.revize.com/everett/Document%20Center/Your%20Port/Document%20Center/Commission/Commission%20Presentations/2024/June%2018%2C%202024%20PSEI%20Draft%20Results.pdf

42 The Northwest Seaport Alliance. New report shows maritime-related air emissions continue to decrease in Puget Sound region. Newsroom article. 2024. Available at: https://www.nwseaportalliance.com/newsroom/new-report-shows-maritime-related-air-emissions-continue-decrease-puget-sound-region

rate, PM2.5 emissions would drop by 72-84%, SO_2 emissions would fall by 50-66%, and GHG emissions, measured by CO2 and CO2e, would drop by 47-64%. These reductions would not occur immediately, but would step up over the assumed 10-year phased implementation period.

For more detail on emission calculations, see ¶ 5.4.2, below.

5.4.1. Phased Implementation

In order to conduct an emissions analysis, it was necessary to select an implementation framework. For this study a phased three-step approach was assumed. This approach is modeled on California's framework because of CAA §209's requirement that states follow California's implementation and enforcement when adopting California emission standards. Moreover, a phased implementation schedule would give public port and private terminals time to install infrastructure and vessel operators time to adapt.

Just as the At Berth Regulation initially focused on California's six busiest ports, the first phase of a similar implementation schedule for Washington targets the busiest container berths at Seattle and Tacoma (within the NWSA) and the busiest cruise terminals at the Port of Seattle that receive at least 20 vessel calls per year. At these locations, 50 percent of calls would be required to shut down auxiliary engines and either connect to shore power or use a CARB-equivalent emissions-control system. This phase would also establish the reporting and enforcement framework that supports later program expansion.

Five years later, in phase 2, the program would broaden to include ro-ro vessels and likely extend coverage to terminals or berths at the Port of Vancouver, WA. The required At Berth Regulation compliance rate would increase to 80 percent, and a Remediation Fund Option could be introduced, allowing operators with an approved compliance plan to offset residual emissions from non-compliant calls while completing vessel or terminal retrofits.

Five years after that, full implementation for all container, cruise, ro-ro, and refrigerated cargo vessels calling at qualifying berths and terminals would seek to achieve a 100 percent plug-in rate (with a regulatory requirement that the VIEs and TIEs make up no more than 5% of visits). Tanker berths and terminals may also be added at this stage. Table 5-3 shows the potential implementation schedule.

TABLE 5-3: POSSIBLE IMPLEMENTATION SCHEDULE

	Phase 1 (Year 0) [43]	Phase 2 (Year 5)	Phase 3 (Year 10)
Vessel Type	Container and cruise	Add ro-ro	Add tankers
Threshold	20 visits per terminal or berth	20 visits per terminal or berth	
Required Plug in Rate	50% of visits	80% of visits	100% of visits
Regions	Seattle and Tacoma	Add Vancouver USA	All regions

5.4.2. Emissions Calculations

One of the primary goals of the at-berth regulations is to reduce emissions from at-berth OGVs. This section summarized the findings of emissions estimates from OGVs at berth in Washington and the potential reductions to these emissions from applying regulations identical to California's At Berth Regulation.

[43] Year 0 refers to the implementation date, which typically occurs several years after a regulation is first adopted. In California, the original At-Berth Regulation was approved in 2007, with its first compliance requirements taking effect in 2014, seven years later.

The development of the emissions considers a variety of variables, including temporal phasing similar to California's, tapered plug-in requirements, incremental inclusion of vessel types, and phased inclusion of geographic regions. Additionally, the modeling assesses emissions associated with three distinct scenarios: no use of shore power, current port-sponsored shore power adoption, and regulated shore power use akin to California's at-berth regulation. These scenarios allow for calculation of potential emission reductions associated with adoption of the at-berth regulations, as determined from the standpoint of current regulatory requirements and from the standpoint of approximate rates of existing shore power use.

The use of existing shore power is approximately 9% of container ship calls and 63% of cruise ship calls, per the 2024 Implementation Report of the Northwest Ports Clean Air Strategy. For container ships, it's recognized that this 9% value represents the plug-in rate of Ports of Seattle, Tacoma, and Vancouver Fraser in aggregate and that the actual plug-in rate may be slightly different without consideration of the Vancouver Fraser Port Authority activity.

Emissions are estimated using the EPA's Shore Power Emissions Calculator (SPEC), with minor tailoring for specifics of the at-berth regulation. The SPEC tool calculates emissions from auxiliary engine use and emissions from use of the electrical grid when shore power is in use. The SPEC tool uses inputs of the vessel traffic data, vessel engine characteristics (to estimate engine age and tier), and the information necessary to characterize the different variables and scenarios of adoption of California's at-berth regulation. The SPEC tool is tailored to also calculate the emissions associated with tanker auxiliary boiler activity tied to product unloading, per the requirements of the at-berth regulation.

The scenarios demonstrate that Washington could see reduced emissions of NOx, PM2.5, SO2, GHGs at its major maritime public ports and/or private terminals. Across the regions that are likely to contain regulated terminals (Seattle, Tacoma, Ferndale, Anacortes, Grays Harbor, Everett, and Vancouver), NOx emissions from candidate OGVs would drop between 76%-86% from its current rate, PM2.5 emissions would drop by 72-84%, SO2 emissions would fall by 50-66%, and GHG emissions, measured by CO2 and CO2e, would drop by 47-64%. These reductions would not occur immediately but would step up over the assumed 10-year phased implementation period. Depictions of the potential PM2.5 and CO2e emissions changes by scenario are shown in Figure 5-6 and Figure 5-7.

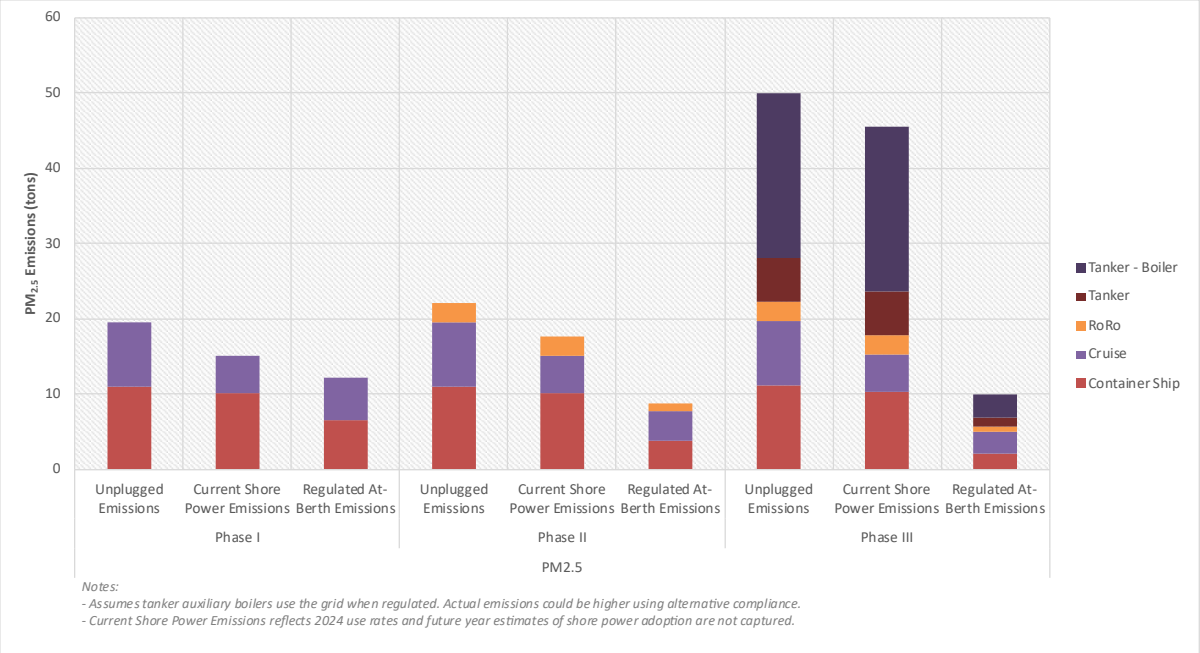


FIGURE 5-6: COMPARISON OF PM2.5 EMISSIONS DUE TO THE REGULATION, ORGANIZED BY IMPLEMENTATION PHASE AND VESSEL TYPE

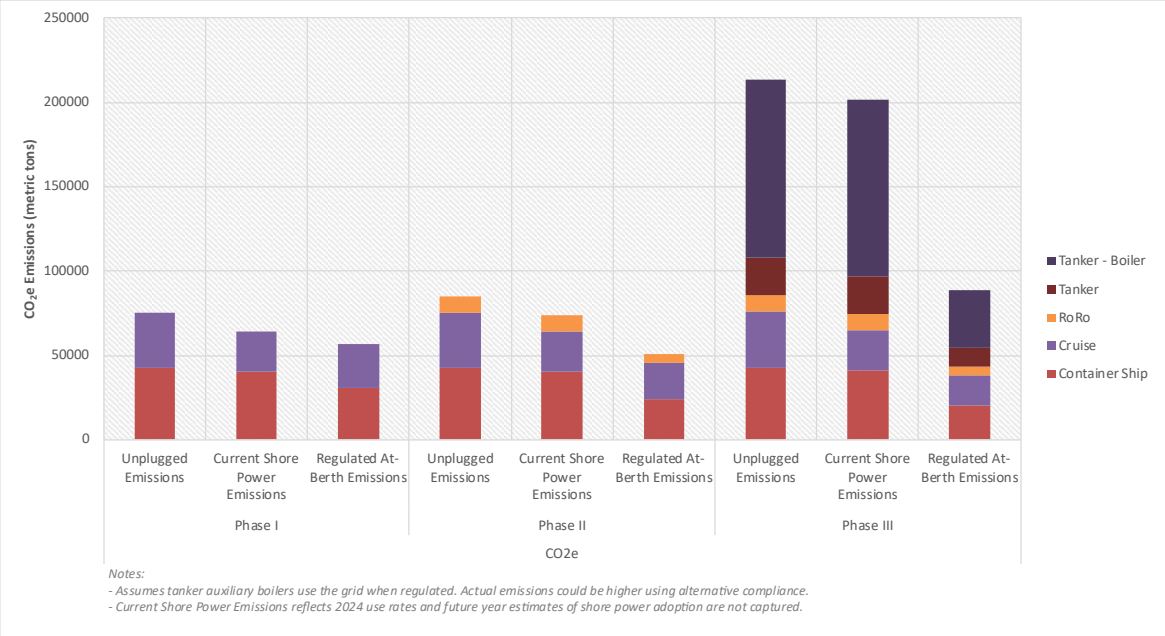


FIGURE 5-7: COMPARISON OF CO2E EMISSIONS DUE TO THE REGULATION, ORGANIZED BY IMPLEMENTATION PHASE AND VESSEL TYPE

The reductions of CO2e from the vessels are equivalent to the removal of nearly 25,000 vehicles from the roadways per year. Similarly, the PM2.5 reduction of emissions from the OGVs is equivalent to nearly 400,000 passenger vehicles being removed from the roadway per year. These estimates are based on the modeled emissions reduced, EPA estimates of emissions per mile for each pollutant, and EPA's estimated annual average passenger vehicle miles traveled.

An important caveat is that these projections assume that all complying vessel visits would plug into shore power. However, the At Berth Regulation also permits the use of alternative CARB-approved capture and control strategies (CAECS), the most prevalent of these being capture and control barges. Alternative CAECS must still meet emission reduction standards and must also be grid-neutral, but their use would likely result in lower percentage reductions than the ones projected here due to emissions from processes such as barge positioning by tug. Nevertheless, these projections show the potential for transformative reductions in pollutants and GHGs at all of these locations.

6. Regulatory Resources

If Washington State decides to adopt a CARB-style At Berth Regulation, a critical component of successful implementation will be establishing the regulatory capacity necessary to support regulatory development, enforcement, compliance tracking, and stakeholder engagement. California's experience through CARB offers a valuable reference for estimating the resources Washington may require. CARB's approach involved a coordinated effort across several specialized teams, reflecting the complex and multi-disciplinary nature of the regulation.

In California, a team within the Marine Strategies group of CARB developed the 2007 At Berth Regulation and the 2020 amendments. This included staff from the emissions inventory team focused on air quality modeling, staff economists conducting regulatory impact analyses, a legal team member dedicated to statutory and enforcement reviews, and personnel evaluating health risks and community impacts, particularly for overburdened port-adjacent communities. Today, a regulatory team fulfills core implementation responsibilities, including:

- Reviewing port and terminal compliance plans, issuing annual TIE/VIE events, assisting with the evaluation and approval of Innovative Concepts, and managing the approval of remediation fund requests.
- Providing technical support for the verification of vessel emission control technologies.
- Developing approval processes for new emissions control technologies and approving new technologies.
- Coordinating with stakeholders, technology providers, air districts, and other clean air agencies, ports, and marine terminals.
- Participating in ongoing assessment of potential future changes to the Regulation and assist with other regulatory development to achieve additional emissions reductions.
- Preparing public documents, host community outreach, engage with stakeholders.

Additionally, enforcement is accomplished with a team within CARB's Enforcement Division (situated within its Ports and Railroad Enforcement Section). They perform the following roles:

- Conduct visible emissions inspections in the field.
- Conduct enforcement audits of vessel visits and ensure information is reported and complete. 3,675 audits were performed in 2024, and 5,000 are expected in 2025.
- Take enforcement action for non-compliant visits.
- Develop and maintain auditing an auditing database.
- Perform desk audits and cross-reference with marine exchange data to validate records and ensure accurate reporting.
- Review annual reports submitted by vessel, CAECS, and terminal operators documenting approximately 5,000 vessel visits per year.

As part of its evolving enforcement structure, CARB emphasized the need for a robust, centralized database that links rule development, compliance reporting, and enforcement workflows.

The Washington State Department of Ecology serves as the State's centralized air regulatory agency, with numerous regional air agencies (e.g., Puget Sound Clean Air Agency) providing further support. However, additional resources may be necessary to effectively administer the adoption and oversight of a CARB At Berth Regulation. Additional staff would be required to manage rulemaking, legal compliance, public health assessments, and regulatory enforcement. Investment in a comprehensive reporting platform would also be essential to streamline compliance verification, facilitate audits, and reduce administrative burden. Washington may also need legal and economic experts to support waiver requests, stakeholder coordination, and the design of mechanisms like compliance plans or a Remediation Fund Option. These resource needs are foundational for establishing a credible and enforceable At Berth Regulation tailored to the state's port and water-terminal system.

7. Shore Power Cost Analysis

This section provides a comprehensive view of the capital and operating costs of shore power. It is based on the most recent information on shipping traffic patterns, capital costs of shore power projects in Washington, operating data drawn from a variety of industry sources, and regional costs for inputs such as fuel and labor. The key findings from this work are as follows.

- **Port Infrastructure Costs.** Infrastructure costs for shore power projects recently completed or in planning phases in Washington range from $5.3 million to $44.0 million per berth. The wide variation in costs is driven by several factors, including the type of vessel served, electric utility service upgrade requirements, distance and logistical complications connecting to the grid, existing site conditions, and neighboring land uses.
- **Amortization of Capital Costs.** After accounting for federal and state grants, amortization of capital costs for current shore power projects has a similarly wide range $4,000 to $45,600 per call assuming the use of bond financing practices and costs reported by the Ports of Seattle and Tacoma. The per call cost is likely higher at lower volume ports and terminals.
- **Net Fuel Costs.** The costs of purchasing electricity at berth are offset by avoided costs for diesel fuel to run auxiliary generators. In some cases, utility costs for shore power are less than the costs of diesel generation under current electricity tariffs and regional diesel prices. In other cases, the relationship is reversed, largely due to the structure of electricity tariffs. Net fuel costs to use shore power range from a savings of $2,861 per call to an additional cost of $1,113, depending on vessel type and structure of the applicable electric utility tariff.
- **Other Operating Costs.** Portside operating costs include salaries and benefits for port personnel who manage shore power programs, maintain shore power equipment, and connect and disconnect vessels to those systems, contracted system maintenance services. Shipboard costs include maintenance and depreciation of shipboard shore power systems. Estimates of other operating costs range from $10,720 to $12,159 per call depending on vessel type.
- **Average Total Shore Power Costs per Call.** Estimates of total shore power costs per call for the four major vessel types covered by the California regulations are as follows:
  - Container Ships: $21,020
  - Cruise Ships: $53,696
  - Auto Carriers: $17,114
  - Oil Tankers: $28,438

  Note, these estimates are currently under review by stakeholders and may change in the final version of this report.
- **Drivers of variability in cost per call.** The high level of variability among these costs is driven by the following factors:
  - Differences in port capital costs. Large differences in the capital costs of recently completed or planned shore power projects that serve specific types of vessels.
  - Differences in average and peak electricity demand. The average demand for a cruise ship while at berth is 11,480 kW versus 750 to 7,000 kW for an oil tanker.
  - Differences in average duration of connection. This key variable in energy use varies from 6 hours for cruise ships to 36 hours for container vessels.
  - Difference in number of calls. In calculating cost per call infrastructure, amortization and operating costs are spread over a larger number of calls, reducing costs per call. Smaller ports with lower vessel frequency have a smaller base over which to allocate those costs and thus a higher cost per call.
- **Shore power payments under current tariffs vs. shore power operator costs.** Current shore power tariffs at the Ports of Seattle and Tacoma do not fully recover the actual cost of providing

the service. The fees vessels pay are lower than the port's operating expenses, which include labor, contracted services for system operation and maintenance, and the cost of electricity. As a result, each shore power connection operates at a financial deficit of approximately $444 to $2,971 per call, depending on vessel type and tariff structure. When the amortized capital cost of the shore power infrastructure is also included, the deficit increases substantially, ranging from $4,436 to $47,815 per call. See Table 7-1 for details.

The remainder of this Section 7 is structured as follows:

- Section 7.1 Overview of Cost Analysis Approach and Results summarizes the methods and sources used in developing cost estimates, provides a worked example for cruise vessels, and summarizes top line results for all vessel types.
- Section 7.2 Shore Power Infrastructure Components and Their Costs provides descriptions of shoreside and shipboard infrastructure components, as well as information on costs individual components. This information is included to provide context for estimates of capital costs for shore power installations at the berth level.
- Section 7.1.1 Capital Costs of Shoreside Shore Power Projects presents information on costs of recent shore power system projects in Washington state, including grants received from federal and state agencies to reduce the level of capital costs to be financed.

Section 8 presents the port and other logistical labor requirements and costs including the description of portside shore power operations and staffing and labor costs for the shore power operation. Section 9 presents details on costs to shippers, including the costs of shipboard shore power equipment. Section 7.1 combines the results of the analysis in Sections 7, 8, and 9 into estimates of the total costs of shore power per call by vessel type, and the cost to ship owners and charter holders under port and electricity tariffs currently in force in Washington state.

7.1. Overview of Cost Analysis Approach and Results

This section provides an overview of the concepts, methods and input used to estimate and represent the costs of providing shore power services in Washington State. Estimates of the total capital and operating costs required to provide shore power services to container ships calling at a terminal in Seattle were worked through. The section also presents the high-level results of cost estimates for the three other vessel types that would be covered by the CARB At Berth Regulation if implemented in Washington.

Throughout there is a distinction made between total costs and shippers' costs.

- Total costs capture all costs of providing shore power, regardless of which market actors in Washington state ultimately pay them. Thus, Total Costs include amortization project capital costs being paid by port authorities or terminal operators, less grants received from Federal agencies and Washington State Agencies using revenues from broad-based taxes. Similarly, we do not include fees charged to shippers for port services such as scheduling and assistance with connections since those estimates of those costs are included in the port side of the ledger. Including the fee payments would amount to double counting some portion of the port's fixed and variable operating costs.
- Shippers' costs capture the costs that ship owners and charter holders pay to use shore power. They include port fees and other costs passed through to and paid by shippers and charter holders in the first instance. Under current tariff structures, they do not cover the full costs of providing shore power. In fact, as shown below, they basically cover operating costs. However, ports could change tariffs to recover a portion of capital costs, especially if other states and provinces adopt shore power regulations.

Throughout the cost estimation process, the most recent input information for the relevant goods, equipment, services, construction, and financing costs available for the Pacific Northwest region was sought. Information on annual number of calls and average hours at berth at Washington ports for the relevant vessel classes was used.

7.1.1. Example: Total Costs of Shore Power for Container Vessels

Table 7-1 displays the major categories of capital and operating costs for shore power operations, the annualized amount of those costs for a typical container berth in Washington, and the fraction of annualized costs they represent. Key points for interpreting the cost estimates are:

- **Representation of results per berth.** Costs were assessed at the berth level for several reasons. Shore power infrastructure projects vary greatly in configuration and cost, and operating costs vary greatly by vessel type. Framing the cost analysis at the berth level enables us to apply the most relevant information on recent shore power projects and operations to capture these variations.
- **Port Capital Costs.** The port capital costs shown in Table 7-1 reflect the latest estimate of costs for completing the retrofit of two berths at the Port of Seattle's T-18 container terminal, as summarized in meeting materials distributed to managing members of the Northwest Seaport Alliance, July 28, 2025. The distribution of capital costs among the categories shown is derived from cost estimates provided as part of the Alliance's 2024 USEPA Agency Clean Ports Program Grant Application. The port received a grant from the State of Washington Department of Transportation (WSDOT) for two-thirds the total capital costs of the project, which amount to $45 million for two berths. Thus, the amount amortization reflects a principal amount of $7.5 million per berth.[44]
- **Grant Funding.** Most shore power projects in the United States have received grant funding from state and/or federal government agencies. Port authorities and terminal operators can be hesitant to proceed with shore power projects without some government contribution to capital costs. Therefore, all projects are assumed to receive some level of government support which will reduce the capital costs to be amortized over time through project revenues or other sources. Assumptions on the share of government funding are based on documentation of recent, similar projects.
- **Borrowing Costs. I**nformation on the Port of Seattle's infrastructure financing activities and costs of capital from the Port of Seattle 2025 Budget were reviewed.[45] The Port finances infrastructure using a combination of General Obligation and Revenue bonds with maturities ranging from 10 – 30 years. The 2025 budget assumes a 5.25% interest rate for all bonds going forward, plus issuance fees that add 1.00% to the costs of borrowing. Bonds issued by Washington ports use a wide variety of repayment schedules and maturity structures. To simplify the calculations below a self-amortizing schedule was used.
- **Incremental Fuel Costs.** Under the current market prices and the structure of shore power electricity tariffs in force in Seattle and Tacoma, it is possible that it will cost less to use shore power than to provide electricity at berth using auxiliary diesel generators. The relative costs depend on the consumption level and load factors associated with different vessel types. In this example, it is less expensive to use shore power than to use auxiliary generators. The incremental fuel cost of using shore power is negative in this case. Those cost conditions may change over time, along with the structure and application of shore power tariffs.
- **Other Operating Costs.** Other operating costs include salaries and benefits for port personnel who manage shore power programs, maintain shore power equipment, and connect and disconnect vessels to those systems, contracted system maintenance services, and maintenance and depreciation of shipboard shore power systems. Estimates of these costs were taken primarily from testimony and comments submitted by stakeholders in the CARB 2020 revision, and updated using inflation factors for the relevant cost categories.
- **Calls per Year.** Operating costs are estimated using an assumption of 59 shore power calls per year. Current traffic at the container berth used to model costs is 74 calls per year. This figure is factored down by 25 percent to reflect experience in California. In the early years of regulation, all

[44] The Northwest Seaport Alliance. 2025. Item 9c Action Items. August 5, 2025.

[45] Port of Seattle. 2025 Budget. Budget and Finance Departments. 2024. Section10. https://www.portseattle.org/sites/default/files/2025-04/2025%20Final%20Budget_V2_.pdf

vessels calling at the berth will not be equipped for shore power. Also, a fraction of shore-power equipped vessels will be unable to use shore power due to technical or logistical issues.

TABLE 7-1: EXAMPLE - TOTAL COSTS OF SHORE POWER FOR A CONTAINER BERTH AT NWSA (IN $ 000S)

Cost Category	Total Per Berth	Port of Seattle Share
Port Capital Costs		
Port Labor & Fringe Engineering	$2,295	$765
Port Labor & Fringe Env. & Permitting	$729	$243
Port Labor & Fringe: Contract Admin	$328	$109
Contractual: EPC	$19,148	$6,383
Total Capital Costs per Berth	**$22,500**	**$7,500**
Annualized Costs		
Amortization: Port of Seattle Share - $7.5 Million, 20-Year Bond Maturity; Cost of Capital 7%	**$667**	**49.4%**
Operating Costs (Assuming 59 calls/Year)		
Incremental Fuel Cost	($162)	-12.0%
Onboard Shore Power Apparatus Depreciation	$492	36.4%
Onboard Shore Power Apparatus Maintenance	$18	1.3%
Port Program Administration & Operation	$195	22.5%
Portside Services (Connect/Disconnect/Maintenance)	$31	2.3%
Total Annual Operating Costs	**$573**	**50.6%**
Total Annualized Costs	**$1,240**	**100.0%**
Total Costs per Call at NWSA Terminal 18	**$21.02**	

Key results of the analysis summarized in Table 7-1 are:

- Total annualized costs per berth are estimated at $1.24 million.
- Total costs per call are estimated at $21,020.
- Amortization of capital costs and annual operating costs each account for roughly one-half of the total annualized cost.
- Depreciation of ship-board shore power equipment and costs of program are the largest operating cost items. Electricity costs average $7,098 per call. However, the cost of fuel to supply an equal amount of electricity using a diesel generator is $9,850 at current regional prices.

7.1.2. Example: Shippers' Costs of Shore Power for Container Vessels

Shippers' Costs. Shippers' costs were estimated for use in the analysis of the potential impact of shore power regulations on the Washington ports' ability to compete for maritime business. Table 7-2 summarizes the estimate of shippers' cost per container under current shore power tariffs (minimum) and including amortization of capital costs (maximum).

TABLE 7-2: SHIPPERS COST OF SHORE POWER FOR A CONTAINER VESSEL

Cost Category	Cost per Call
Physical Quantities/Rate Determinants	
Average Connected Hours per Call	36
Average Demand (kW)	1,100
Auxiliary Generator Load Factor	0.55
Peak Demand kW	2,000
Electricity Use per Call kWh	39,600
Port Charges	
Connect/Disconnect Charge $860/call	$860
Shore Power Fee/Call Calculation	
Average Energy Charges per Call	$3,623
Average Demand Charges per Call	$3,237
Average Service Charges/Call	$238
Total Electricity Charges/Call	$7,098
Cost of diesel fuel per call	$9,850
Unit Costs of Shore Power	
Incremental Cost of Shore Power/Call	-$2,752
Port fees (Current Tariff) /Port Operating Costs for Total Cost Scenario	$860
Vessel Operating and Tariff Costs/Call	**$6,741**
Cost per Container	**$3.37**

7.1.3. Overview of Cost Estimates for All Vessel Types

Table 7-3 summarizes high-level variable costs for the four vessel types covered by California's At Berth Regulation. The top line of the table displays the berth or berths used for modeling the costs. Records provided by the Merchant's Exchange of the Columbia River and the Pilot's Exchange of Puget Sound were used to determine the number and average duration of calls. That pattern of use was then applied to electricity and port tariffs for shore power at the relevant berth to estimate electricity costs and port fees. Information about recent shore power improvement projects was also used to provide capital cost estimates for all vessel types except tankers.

TABLE 7-3: VARIABLE SHORE POWER COSTS BY VESSEL TYPE

Cost Category	Container	Auto	Cruise	Tanker
Berth used for inputs and tariff structures	Seattle T-18-3	Tacoma East Blair 1	Seattle Pier 66	Tacoma & Refineries
Key Inputs/Intermediate Results				
Calls per Year	59	125	75	65
Average Connected Hours per Call	36	20	8	34
Average Demand (kW)	1,100	1200	11,480	5,447
Auxiliary Generator Load Factor	0.55	0.3	0.64	0.55
Peak Demand kW	2,000	4,000	17,938	9,904
Electricity Use per Call kWh	39,600	21,600	91,840	185,198
Electricity Costs per Call	$7,098	$2,942	$23,117	$25,185
Avoided diesel fuel costs per Call	($9,850)	($5,373)	($22,845)	($46,067)

7.2. Shore Power Infrastructure Components and Their Costs

The following section provides an overview of the main infrastructure enhancements required for vessels to plug into shore power when at berth, then follows with a detailed discussion of each enhancement.

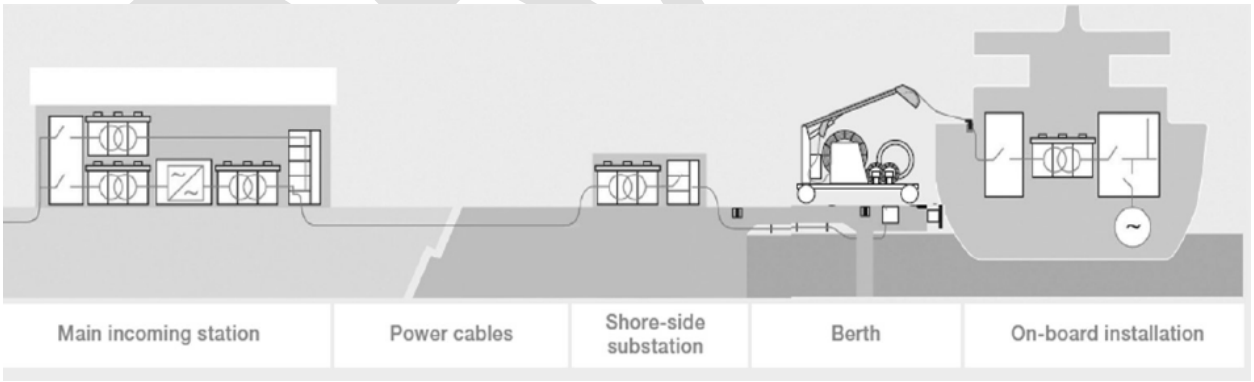


FIGURE 7-1: COMPONENTS OF OPS SYSTEMS FOR CONTAINER VESSELS (SOURCE: ABB. SHORE CONNECTION: SHORESIDE INSTALLATIONS)

As shown in Figure 7-1, a shore power system for OGVs consists of five sets of capital equipment. Briefly, they are:

7.2.1. Main Incoming Station

The main substation may serve one or more berths. In some cases, the local utility may already have sufficient capacity to support the additional load required for shore power connections; however, this is

uncommon. More often, the port authority or terminal operator must coordinate closely with the utility provider to assess available grid capacity and determine whether upgrades are necessary. Depending on site conditions and existing infrastructure, the utility may need to construct a new incoming station, which could involve installing additional power poles, overhead lines, or other significant electrical system improvements. Typically, the cost of these improvements do not fall under the utility company, but on the port, terminal, or operator.

The main incoming substation has to be sized to the peak demand required to service vessels while at berth. Peak load information for substations serving different vessels was gathered from industry literature and representatives of different port and/or terminal operators and equipment manufacturers. While there was some variation in response, the following was determined:

- Maximum electrical load during a single container vessel call has reached 8,000 kilowatts (kW) in Rotterdam. In Oakland, where data are drawn directly from interval meters on shoreside substation, the highest peak demand for a single call registered between 4,800 and 4,900 kW.[46]
- Most peak loads for individual container calls are in the range of between 1,000 kW and 3,000 kW.
- High peak loads are very short lived and appear to be linked to specific activities, such as start-up of refrigeration systems.
- The most recent Shore Power Update from the USEPA lists the average demand from cruise ships at 11,480 kW..[47]
- For tankers, the load typically ranges from 3,000 kW for medium range (MR) tankers to 10,000 kW for very large crude carrier (VLCC) tankers.

Detailed findings and sources on this topic are described further in the following sections.

Figure 7-2 shows the frequency distribution of peak loads on the shoreside substations for all onshore power supply (OPS) calls at the Port of Oakland from September 2019 through June 2021. The horizontal axis is in descending order. The graph shows that the peak loads for most calls cluster in the range from 1,000 kilovolt-ampere (kVA[48]) to 3,300 kVA, with a long tail out to maximum values of 4,900 kVA. This is consistent with reports received from other port operators and equipment vendors. Figure 7-2 provides the most comprehensive and best documented information currently available on the peak demand at individual OPS berths.

[46] To provide a frame of reference, a 1,000 kW power load is comparable to the continuous electricity consumption of roughly 750 homes. 8,000 kW is comparable to a typical NFL stadium on game day.

[47] U. S. Environmental Protection Agency. 2022. *Shore Power Technology Assessment: 2022 Update.* Washington D. C.: December 2022. https://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-port

[48] A kilo volt-ampere (kVA) or mega volt-ampere (MVA) are units of "apparent power" for an electrical circuit combining a circuit's voltage by its current. A kVA or MVA includes both real and reactive power, reactive power meaning that it doesn't perform useful work, and is used to rate generators and transformers. For example, a kW represents "real power" or "actual work". If a system was 100% efficient, a kW would equal a kVA, but this is rarely the case.

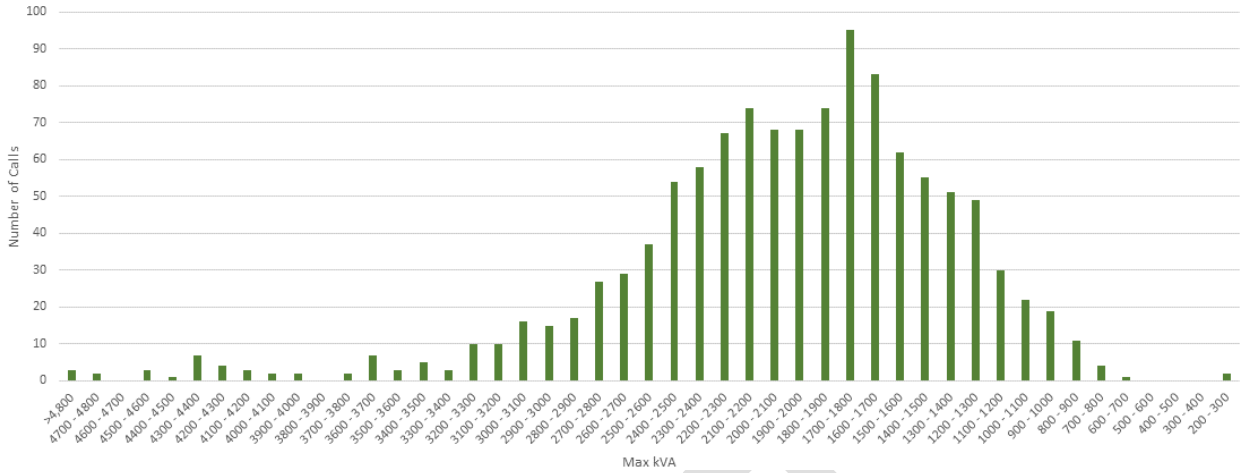


FIGURE 7-2: DISTRIBUTION OF PEAK DEMAND FOR PORT OF OAKLAND OPS CALLS: SEPTEMBER 29 – JUNE 2021

The cost of constructing a new incoming substation can vary significantly depending on several factors, including available utility capacity, required power rating (MVA), site conditions, proximity to existing infrastructure, required real estate acquisition, and coordination with the local utility provider. Because of these variables, a high-level ballpark estimate is used for the purposes of this study rather than a firm quote.

This estimate is informed by recent shore power projects designed by Moffatt & Nichol in the Los Angeles and Long Beach area, where coordination with a utility provider was required to supply additional power to two marine terminals. During that engineering effort, preliminary pricing for two new incoming switch stations was as follows:

- New 5 MVA incoming switch station: approximately $12 million
- New 7 MVA incoming switch station: approximately $17 million

It is important to note that these values represent planning-level cost estimates and not formal utility quotes. They were provided solely for engineering, budgeting, and feasibility assessment purposes, and include allowances for site acquisition, design, procurement, and installation of the new stations. Actual project costs depend on site-specific conditions and final utility design requirements.

7.2.2. Power Cables

Another critical component in the installation of shore power systems is the construction and installation of power cables. This portion of the work can generally be divided into three segments:

- Power cables feeding the main incoming station: Depending on the available grid capacity and the additional load required for shore power, the utility provider may need to install new feeder cables from an existing substation to the new incoming station. In some cases, the existing infrastructure already has sufficient capacity; however, where new feeders are required, this significantly increases the project's capital investment and coordination effort with the utility.
- Power cables connecting the main incoming station to the shore-side substation: These cables may be routed overhead on power poles, underground within duct banks, or, in limited cases, through surface-mounted conduit. The preferred routing depends on site conditions and the distance between substations. In compact sites, this connection may be relatively simple, whereas in larger or more spatially separated facilities, the installation can extend beyond terminal boundaries and involve substantial permitting and construction effort.
- Power cables running from the shore-side substation to the berth: This final section supplies power to berth-level electrical equipment such as the SPOs, cable management system (CMS), and associated switchgear. These cables are typically located within the terminal footprint and must comply with operational safety requirements. Surface conduit runs near the water are

generally avoided to prevent interference with cargo handling or create tripping hazards; therefore, the cables are typically buried to maintain operational clearances and safety.

In many documented cases, construction or modification of existing substations and installation of new power cabling represent more than half of the total capital cost of a shore power project. Utility grid connections, transformers, and power cables must be sized to accommodate the peak electrical demand of vessels, for example, large container ships drawing several megawatts of power while at berth.

7.2.3. Shore-Side Substation

The shore-side substation is a critical element of the overall shore power system, serving as the interface between the utility supply and the vessel connection equipment. Its primary function is to condition, convert, and distribute power from the port's electrical grid to match the voltage and frequency requirements of visiting vessels. The design and configuration of this substation vary depending on vessel type, berth layout, and local electrical infrastructure.

The shore-side substation typically includes the following components:

- Transformer: Steps down the incoming high-voltage power from the port or utility substation to match the vessel's operating voltage, typically 6.6 kV or 11 kV.
- Switchgear: Provides electrical isolation between the shore and vessel systems, protecting both from ground faults or abnormal voltage conditions, and allows safe interruption of power during maintenance or connection operations.
- (Optional) Frequency Converter: Adjusts the power frequency when the local grid frequency (usually 60 Hertz [Hz] in North America) differs from the vessel's requirement (often 50 Hz). While many shore power projects install frequency converters to ensure universal compatibility, others omit them to reduce capital cost, particularly when serving vessels already equipped with onboard converters or compatible electrical panels.

In most applications, one transformer feeds all electrical equipment for a single berth, including the SPOs or CMS. The number of SPOs varies depending on berth length and vessel configuration, typically ranging from two to six outlets per berth. In accordance with the Institute of Electrical and Electronics Engineers (IEEE) Standards, each transformer powers only one SPO or CMS at a time to maintain galvanic isolation between the shore-side and shipboard systems. This design ensures protection of the vessel's electrical system from irregularities in a port of operator's grid, particularly when the same grid also serves other terminal facilities.

Where additional loads exist, such as lighting, metering equipment, uninterruptible power supplies (UPS), or the CMS drive system, a separate 480 V feeder and auxiliary transformer may also be installed within the shore-side substation to supply these lower-voltage systems.

7.2.4. Berth Components

The berth components form the ship-to-shore electrical interface provide the physical and operational link between the terminal's electrical infrastructure and the vessel's shore power connection points. These systems must be designed to accommodate variations in vessel size, berth geometry, and terminal operations while maintaining compliance with applicable electrical and safety standards. The configuration of berth components depends heavily on available space, terminal layout, and operational preferences, and can include either fixed or mobile systems.

The berth terminal components typically include the following elements (Figure 7-3):

- Ship Power Outlets (SPOs). The SPOs house the electrical connectors used to establish the ship-to-shore power link. A recent project at the Ports of Long Beach and Los Angeles installed SPOs every 200 feet along container terminal quaysides to meet updated regulatory requirements, whereas earlier installations used spacings between 300 and 500 feet.

- Underground Vault. In many configurations, the SPOs are installed within prefabricated underground vaults located along the quay. These vaults typically measure 4 to 6 feet wide and 12 to 15 feet long, with spring-loaded, heavy-duty hatches designed to support vehicle loads when not in use. The underground configuration minimizes interference with cargo-handling operations and enhances safety by keeping cables and equipment below grade.
- Above-ground SPO Housings. Some terminals opt for above-ground SPO housings, which offer lower installation costs and easier access for maintenance but can present obstructions and safety hazards within active terminal areas.
- Cable Extension System. Using small motorized systems such as the one shown to the right patch cables can be extended safely by as much as 100 feet. Shipboard cables are generally 80 feet long. These dimensions motivated the selection of the 200-foot spacing by the Port of Long Beach. The connection of extension cables directly to the ship's cables does not comply with IEEE 80005-1.
- Cable Management System: In terminals with limited available space, an integrated cable management system may be installed. These systems combine reel storage and an articulating arm capable of adjusting to vessel height and position, ensuring safe and efficient deployment of the shore power cables to vessels of varying dimensions.

FIGURE 7-3: BERTH TERMINAL COMPONENTS

In locations with limited surface or underground infrastructure, the use of a CMS is effectively a requirement to provide a safe and compliant ship-to-shore power connection. Although these systems have not yet been implemented in the United States, Moffatt & Nichol is currently designing such an installation for an active project in California. For that project, the estimated cost of the CMS is approximately $3.5 million, reflecting the complexity and specialized nature of this equipment.

7.2.5. New Overwater Structures

At some terminals, available landside space is insufficient to accommodate necessary shore power infrastructure. In such cases, the construction of a new overwater platform may be required to support the necessary equipment while maintaining clearances and accessibility for operations. These platforms are typically pile-supported concrete or steel structures designed to withstand both operational loads and environmental conditions such as waves, tides, and vessel movement. They provide a stable mounting surface for heavy electrical components while ensuring compliance with local building codes and waterfront structural standards.

Overwater platforms also offer flexibility for equipment placement outside hazardous or congested terminal areas. For example, at petroleum tanker berths where shore power components must be located outside Class I, Division 1 zones, positioning the CMS or associated electrical gear on a dedicated overwater platform allows safe operation while maintaining proximity to the vessel's connection point. However, constructing overwater platforms introduces extensive in-water permitting, environmental, and cost considerations, as these structures typically require multiple state and federal permits, coordination with the resource agencies, and mitigation for impacts to state and federally protected species and their habitat. Despite the higher upfront investment, such installations are sometimes the only practical option for providing shore power capability at space-constrained or safety-sensitive terminals.

Based on in-house cost data from Moffatt & Nichol for similar shore power projects in California, the estimated cost for constructing an overwater platform to support a CMS is approximately $2 million, including both engineering and construction (excluding permitting costs). This estimate covers the installation of a single monopile and steel platform structure designed to provide CMS access and operational support.

If additional overwater structures are required, such as those needed to house a shore power substation or auxiliary electrical equipment, the overall footprint and design complexity increase substantially. In such cases, total costs can rise to approximately $7 to $10 million, reflecting the additional piles, platform area, and supporting infrastructure needed to accommodate heavier electrical components and ensure safe access for maintenance and operations.

7.2.6. Hazard Zones Considerations

Unlike container or cruise terminals, tanker berths present additional design challenges due to the presence of hazardous areas created by the potential release of flammable vapors during cargo loading or unloading operations. These areas are regulated under hazard classification standards such as Class I, Division 1 and Division 2, which define zones where explosive or flammable atmospheres may exist continuously or intermittently.

Because of these safety requirements, electrical equipment installed within or near tanker manifolds must be rated for hazardous environments or located outside the classified zone. This greatly influences the design and placement of shore power infrastructure. For example, underground vaults, commonly used for SPOs at container terminals, are generally not suitable for tanker applications, as the confined space can trap vapors and is typically considered a Class I, Division 1 area. Any electrical components located in such areas would therefore need to be hazard-rated, significantly increasing equipment cost and complexity.

As a result, shore power systems for tankers often require custom layouts that position transformers, outlets, or cable management systems in non-hazardous locations, with extended cabling or articulated arms used to safely reach the vessel connection points. These constraints represent one of the primary technical and regulatory challenges to implementing shore power at liquid bulk terminals.

Figure 7-4 and Figure 7-5 show aerial views of two Washington terminals that would face space constraints for providing shore power. The first is Cherry Point BP Terminal (Figure 7-4), a liquid bulk facility. In addition to facing limited space for shore power infrastructure, this location must comply with hazardous zone limitations. Installing an SPO plus cable extension solution is likely not feasible here. Instead, new overwater platforms may be required to house the needed CMS.

Similarly, Berth 10 at the Port of Vancouver USA, shown in Figure 7-5 could require new overwater platforms and CMS installation since limited space is available. Even though this berth does not have to comply with hazardous zone limitations, its configuration may not provide sufficiently flexible access to shipboard shore power systems.

FIGURE 7-4: AERIAL VIEW OF CHERRY POINT BP TERMINAL

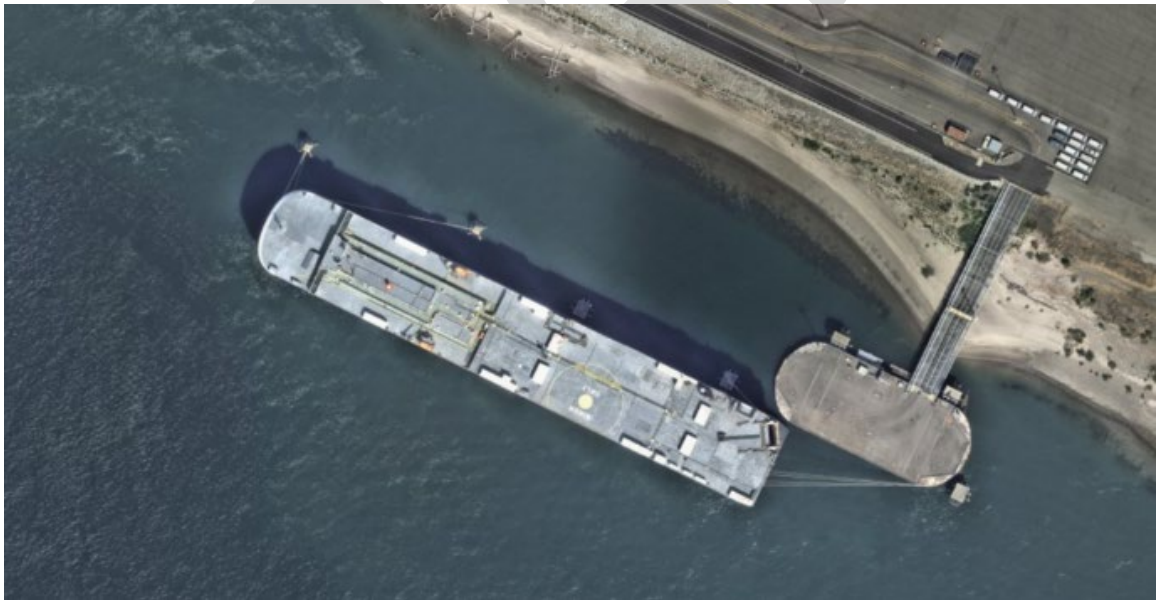


FIGURE 7-5: AERIAL VIEW OF PORT OF VANCOUVER BERTH 10

7.2.7. Onboard Components

The shipboard components form the onboard interface for receiving shore power and connecting it to the vessel's main electrical distribution system. These systems can include the cable management equipment on the vessel side, shore connection panels, and power feed assemblies that provide short-circuit protection, synchronization, and power conditioning between the vessel and the shore-side supply. In

many cases, vessels must undergo retrofits to integrate these systems, which can be technically complex and costly. The retrofit requirements vary significantly by vessel type and configuration, for example, container vessels, tankers, and cruise ships each have different voltage, frequency, and space considerations for integration with existing switchboards.

Some operators use containerized or modular solutions, such as AMPtainers, which house the shore power connection equipment in transportable enclosures that can be deployed on multiple vessels or stored at port facilities when not in use. While new vessels are increasingly being built with shore power compatibility, enforcing retrofits across existing fleets remains a challenge, particularly for international operators with mixed vessel classes.

7.2.8. Costs of Recent Shore Power System Infrastructure Projects in Washington

The costs of shore power installations vary greatly, driven by differences among sites in configuration, traffic, existing structures and utility services, and local costs for labor and equipment. Table 7-4 illustrates this variability with examples drawn from recent shore power projects in Washington. Costs per berth for the three current or recent container terminal projects vary from $5.3 million to $44.0 Million. Recent rapid inflation in infrastructure construction and heavy electrical equipment account for some of this difference. Some of the variation is likely due to differences in scope among the projects. Shore power installations often require extensive site preparation, demolition of existing structures, and expansion of existing utility infrastructure. However, this is not true in all cases, and there is no uniform approach to reporting on scope and budget.

The ratio of soft to hard costs also varies considerably based on the allocation of different roles to port authorities and terminal operators on one hand and Engineering, Procurement, and Construction Contractors on the other. Cost estimates from recent grant applications suggest that costs are distributed among these categories as follows:

- Owners' Internal Project Administration and Engineering: 15%
- Contracted Planning, Design and Engineering Services: 17%
- Equipment Procurement and Construction: 68%

TABLE 7-4: CAPITAL COSTS OF RECENT SHORE POWER PROJECTS

Shore Power Project: Year Completed Vessel Type/Number of Berths	Total Capital Cost	Capital Cost/ Berth	Fed/State Grants	Net Costs/ Berth
Port of Seattle, T-18: Planning Phase Container, 2 Berths[49]	$45.0 Million	$22.5 Million	$30.0 Million	$7.5 Million
Port of Seattle, Pier 66, 2024 Cruise, 1 Berth[50]	$44.0 Million	$44.0 Million	$5.6 Million	$38.4 Million
Port of Tacoma, Terminals 3 and 4: 2022, Container, 1 Berth[51]	$15.5 Million	$7.8 Million	$3.1 Million	$6.2 Million

[49] Northwest Seaport Alliance. 2024. *Accelerating Zero-Emission Technology Deployment at Puget Sound Ports: Project Narrative*.
[50] Port of Seattle. Pier 66 Shore Power Project. Accessed November 1, 2025. Accessed November 1, 2025. https://www.portseattle.org/projects/pier-66bell-street-pier-shore-power
[51] Northwest Seaport Alliance. 2022. Memorandum: Project authorization increase for work associated with the Terminal 3 & Terminal 4 Shore Power Project.

8. Port and Other Logistical Labor Requirements and Costs

In addition to the cost of installing infrastructure, implementing shore power will incur labor costs. This study finds that the total cost for labor and contracting will likely add up to $226,005 per berth. This estimate includes costs for retaining administrative and technical staff and contracting for services. Below, the report lays out the functions and services required to administer and operate shore power and describes cost estimate calculations in greater detail.

8.1. Description of Portside Shore Power Operations

Provision of shore power services entails the following technical and business processes:

- Scheduling. Ports or terminal operators maintain a scheduling system to ensure optimal utilization of shore power-equipped berths.
- Commissioning. Commissioning entails inspection of shipboard shore power components to ensure that they conform to international standards and are in good operating condition. The California ports each take quite different approaches to commissioning. The Port of Oakland uses its own engineers to conduct commissioning, which is required for each vessel entering the OPS registry for the first time, as well as for any registered vessel that has recently added or retrofitted related systems. The port charges the vessel operator $3,600 per commissioning. Port of Oakland staff report needing to commission registered ships once every four years on average.[52] In both public comments on regulation and correspondence with DNV, Port of Oakland staff maintain that this level of oversight over commissioning is needed to reduce the risk of damage to port side systems and ensure achievement of regulatory goals for the percentage of calls served by the OPS systems. The Ports of Los Angeles and Long Beach obligate terminal operators to oversee commissioning. In these cases, commissioning is generally carried out by independent agents under the supervision of the ship operators. The terminal operators require documentation of commissioning for use of the OPS systems.
- Connection. The connection between the shipboard and port systems is generally made by teams of the shipping line and port personnel. Port job categories assigned to this task include electricians and electrical technicians. Portside operations generally require a team of two working 6 hours each for a connect/disconnect.[53]
- Metering. As discussed above, one shoreside substation serves one ship at a time. Thus, most programs place meters on the shore-side substation. The ports and terminal operators in California have installed “smart” meters on dockside substations that record demand at 15-minute intervals. These can be used to estimate energy use, time at berth, and time charging, as well as peak demand. These are the principal billing determinants both for utility rates and fees charged by the port. In most cases, these meters are read remotely by the utility, and the information is returned to the port or terminal operator. The smart meter captures date stamps for hook-ups for time-based port fees.
- Billing. In most cases, the port or terminal operator prepares the bill for the customer, using the utility billing information and records of time at berth as inputs. This approach is necessary because multiple lines use any given berth. We are aware of only one instance of billing directly from the utility to shipping lines. That is at the Port of Seattle cruise terminals. In this instance, the shipping lines own and operate the terminals.
- Electricity Procurement. Most ports and terminal operators that offer shore power services purchase electricity under utility tariffs. In some cases, these are general commercial tariffs for customers in the categories defined by peak demand. In others, such as the Port of Los

[52] Port of Oakland. Comments on May 10, 2019, Draft Proposed Control Measure for Ocean-Going Vessels At Berth and Supporting Documents. June 10, 2019. p 4.

[53] Ports of Los Angeles and Long Beach. 2019. *Port of Los Angeles and Port of Long Beach Comments on February 22-23 Workshops for the “Control Measure for Ocean Going Vessels Operating At Berth and At Anchor”.*

Angeles, the port's electricity utility, the Los Angeles Department of Water and Power, has created a special tariff for shore power provision. Finally, we are aware of two ports, Oakland, CA, and Tacoma, WA, that have obtained utility franchises. This enables the utilities to procure power on the wholesale markets to optimize financial and environmental objectives. This approach does, however, subject the ports to regulatory oversight.

8.2. Staffing and Labor Costs for Portside Shore Power Operations

The most detailed and best documented reports of the staffing and operating costs for shore power services are found in technical testimony filed by California port and terminal operators. These materials were filed as part of comments on the proposed 2020 revisions of the CARB shore power regulations. As noted in the references below, those cost estimates were inflated to current wage, salary, product, and construction costs based information from job websites and government economic statistics. Cost estimates in the paragraphs below reflect the team's best estimate of current costs.

The key components labor and contracted labor operating costs for shore power services include the following:

- Program Administration. Ports and terminal operators generally assign responsibility for OPS services to a port operations manager. As program volume grows, the level of effort required to manage and coordinate scheduling, commissioning, metering, billing, and connection operations increases. Thus, program responsibility evolves into a part-time job. Port operators report needing a full-time administrator once annual volume exceeds 150 OPS calls at all berths.
- Contract Maintenance. Port and terminal operators in California reported that regular contracted maintenance of the shore power outlets, dockside substation, and related infrastructure costs from $24,000 to $44,000 per berth per year in 2020.
- Ship connection and other technical services. According to a study commissioned by the Pacific Merchant Shipping Association, the average time to connect and disconnect a ship to shore power at the Ports of Los Angeles and Long Beach was 5 hours in 2018. The median time was 3 hours. This work is typically done by pairs of port electricians or electrical technicians. Current hourly wages for workers in this classification are roughly $44 for west coast ports.

Table 8-1 displays estimates of personnel and service contracting costs for shore power operation per berth using traffic estimates for a typical container berth. Footnotes to the table provide sources for quantities and unit prices used in the estimates.

Maintenance costs will vary depending on the specific application and the type of shore power system selected (mobile CMS versus fixed CMS), which will be determined for each terminal. As discussed earlier, some terminals lack sufficient space to install a mobile CMS with outlets. In those cases, the alternative is a fixed CMS, a significantly larger system that requires more maintenance and uses more expensive components. The information available today is based primarily on installations at cruise and container terminals in California, which utilize mobile units with vaults. Maintenance costs will be higher at terminals that cannot accommodate this configuration and must instead install a fixed CMS.

TABLE 8-1: FIXED LABOR AND OPERATING COSTS FOR SHORE POWER OPERATIONS

Port Labor and Contract Costs/Call	2025 Costs	Notes
Fixed Labor Costs		
Shore Power Program Administrator	$68,750	Full time; $165,000/year, 25% benefits, covers 3 berths.[54]
Technical Staff	$62,500	1/3 time Electrical Engineer, $130,000/year, 25% benefits[55]
Contracted Services	$63,603	Per POLA/POLB comments on CARB regulations[56]
Annual Fixed Operating Costs	**$194,853**	
Port Costs per Call	$528	Port-side electrician, laborers for connections. 12 hours @ $44, per call[57]

[54] Salary.com. Senior Program Administrator Salaries at U. S. Ports range from $135,000 - $177,000 annually. Accessed November 7, 2025 https://www.salary.com/research/company/the-port-authority/senior-program-manager-salary?cjid=21163478

[55] Glassdoor.com. Engineering salary survey. Accessed October 31, 2025 https://www.glassdoor.com/Salaries/port-engineer-salary-SRCH_KO0,13.htm

[56] Ports of Los Angeles and Long Beach. 2019. *Port of Los Angeles and Port of Long Beach Comments on February 22-23 Workshops for the "Control Measure for Ocean Going Vessels Operating At Berth and At Anchor".*

[57] Indeed.com. U. S. Trades Service. Accessed October 14, 2025. https://www.indeed.com/jobs?l=Port+of+Long+Beach%2C+CA&q=electrician&from=mobRdr&utm_source=%2Fm%2F&utm_medium=redir&utm_campaign=dt&vjk=d8300628810d7770

9. Impact on Shipping Industries

This section analyzes how adoption of a CARB-style At Berth Regulation could affect Washington's shipping industries, with emphasis on both cost implications and downstream effects on goods movement. Specific categories of costs addressed include:

- **Shipboard shore power equipment costs.** Cost to shipowners of retrofitting existing vessels to for use of shore power or installing the required equipment in new vessels.
- Shipboard labor costs associated with shore power operations.
- **Shore power usage fees.** Cost to shipowners of using shore power facilities, including primarily port fees and electricity costs.

9.1. Shipboard Equipment

The major elements of the shipboard components consist of the following:

- Shore connection panel including cables management system and plugs to shore.
- Switch and control system for integrating and synchronizing the shore power supply with the ship's electrical system.
- Transformers to reduce supply voltages to the range of 440/690 V used on most container ships. Some container ships with significant reefer container capacity use medium voltage systems operated at 6.6 kV.

Figure 9-1 illustrates the basic elements of the shipboard components.

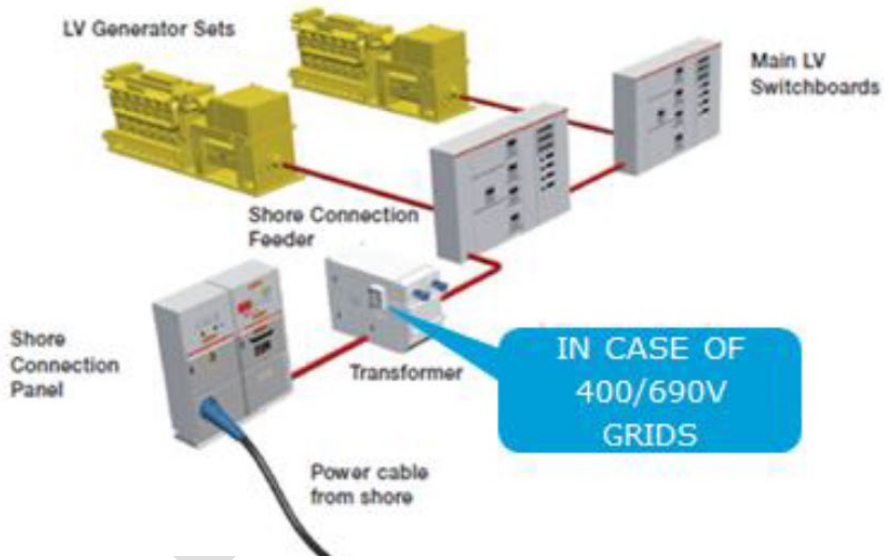


FIGURE 9-1: SHIPBOARD COMPONENTS (SOURCE: ABB)

In many cases, container ships use so-called AMP (Alternative Marine Power) containers to implement shore power supply. These prefabricated units fit into a standard 40' container and house the cable handling system and power feed to the ship's main switchboard. Alternatively, the AMP container can be placed on one ship that calls at multiple ports that offer OPS. The AMP container enables the location of bulky equipment outside the engine room, which facilitates and reduces the cost of future retrofits. Figure 9-2 shows an AMP container in use on a container vessel and Figure 9-3 shows a configuration with a cable management system permanently installed on the vessel.

Although vessel retrofit requirements will vary by vessel type, they are generally expected to resemble the approaches commonly used today for container and cruise ships. Tankers will likely be an exception due

to safety considerations and requirements for operating in hazard zones. There are currently only two tanker berths with shore power installations worldwide.

FIGURE 9-2: AMP CONTAINER IN USE (SOURCE: NAUTIC EXPO)

FIGURE 9-3: SHIPBOARD CABLE MANAGEMENT SYSTEM (SOURCE: CAVOTEC GROUP AB)

9.2. Costs of Shipboard Systems

The costs of installing the shipboard components can vary between $500,000 and $2 million depending on the following factors:

- Newbuild versus Retrofit: It is much less expensive to configure the ship's main switchboard and circuits to accept shore power during the build phase than as a retrofit.
- Configuration of the installed main switchboard: Main switchboards in older container vessels generally are not designed for integration to shore power. Expenses for updating or replacing components to accommodate shore power are expensive.
- One- or two-sided installations: In many ports, it is only possible to dock a container vessel facing in one direction. Thus, is critical to ensure the cable management system is mounted

on the correct side when scheduling a ship for an OPS berth. To avoid this issue, some shipowners have installed cable management systems on both sides.

As one data point, detailed cost estimates developed in 2022 to retrofit four tankers for shore power using AMP containers, including transformers to convert medium to low voltage, as would be the case for many container ships, were reviewed. The price was $658,000 per tanker.

9.3. Shore Power Fees and Other Shipping Industry Operating Costs

9.3.1. Overview

This section presents estimates of the net energy costs and port fees for using shore power under tariffs currently in place at the Ports of Seattle and Tacoma. Shore power electricity costs are driven by the amount of time a vessel is in port, its average and peak demand for electricity, and design of the electricity tariff under which the vessel is served.

- **Approach.** Time at berth and load shapes vary considerably by vessel type, and each port has its own schedule of port fees and tariffs under which electricity is provided from the grid. Thus, the most realistic and accurate way to represent fuel costs and port fees is to build estimates of those costs using the electric load information characteristic of each of the four vessel types in combination with the fee and tariff structures in force at the Washington terminals where they are most likely to call.

  For this report, the cost of typical container and cruise vessels calling at the Port of Seattle were modeled. The costs for a typical auto carrier calling at the Port of Tacoma, which handles most of that kind of cargo in the Puget Sound were also modeled. As was the cost of a tanker calling at the Port of Tacoma. Currently, no shore power services are available to oil tankers in Washington ports. Large tankers that would be covered by the CARB regulations only call at terminals associated with refineries in Ferndale and March Point. Traffic data for those terminals combined with Port of Tacoma fees and tariffs to estimate energy and port costs for tankers were used.

- **Key Findings.** Table 9-1 summarizes the findings from this analysis.

TABLE 9-1: SUMMARY OF PORT FEE AND ENERGY COST ESTIMATES

Tariff Structure	Port of Seattle		Port of Tacoma	
Vessel Type	Container	Cruise	Auto	Tanker
Cost Drivers				
Average Connected Hours/Call	36	8	18	34
Average Demand (kW)	1,100	11,480	1,200	5,447
Peak Demand (kW)	2,000	17,938	4,000	1,364
Electricity Use/Call (kWh)	39,600	91,840	21,600	185,198
Cost Indicators				
Electricity Costs/Call	$7,098	$23,117	$2,942	$25,185
Electricity Costs/Call net of avoided diesel use	($2,752)	$1,132	($2,431)	($20,882)
Port Fees	$860	$860	$1,643	$1,643
Incremental Shore Power Cost: Fuel + Port Fees v. diesel	-$1,892	$1,992	-$788	-$1,218
Total Cost Comparison				
Total Shipper Payments	$7,958	$23,977	$4,585	$28,126
Difference v. Port Operating Costs	($2,971)	($789)	($444)	($584)
Difference v. Total Port Costs	($14,279)	($47,815)	($4,436)	($19,745)

The high-level takeaways from the analysis are as follows:

- **Comparison to diesel auxiliary generator case.** Under current tariff structures, the variable costs per call for electricity and port fees are less than the avoided costs of diesel for use in auxiliary generators for container vessels, auto carriers, and tankers. Cruise is the exception to this pattern due to the interaction of high peak demand with significant demand charges included in the applicable Seattle City Light tariff.
- **Payments to ports v. port operating costs.** In none of the cases analyzed below do payments to the port or terminal operator for shore power related services and the pass through of electricity costs cover the full cost of those items. The shortfall ranges from $444 per call for auto carriers calling at the Port of Tacoma to $2,791 for container vessels calling at the Port of Seattle.

9.3.2. Port Fees and Electricity Costs

In this section the fees and electricity costs per call for the kinds of ocean-going vessels that call most often at Washington ports were estimated. Information on the number and duration of calls by different types of vessels at selected berths was combined with shore power tariffs currently in use at the Ports of Seattle and Tacoma to generate these estimates. Costs per barrel for tankers, per auto for car carriers, per passenger for cruise ships, and per TEU (standard container) for container ships were calculated.

Shore Power Costs at the Port of Seattle. Table 9-2 summarizes the inputs and results of estimating the shore power cost per call for container and cruise vessels at the Port of Seattle. The key takeaways from this table are as follows.

- **Cost to shipowners and charter holders.** The cost for an average-length call for container ships calling at Berth 18-4 is $7,958, of which roughly 90% represents pass-through's of electricity provided by Seattle City Light under its High Demand General Service Tariff. The remaining costs are accounted for by hourly port service charges. The cost for a large-scale passenger vessel is $23,997, of which 97% consists of energy charges. The large difference in cost is due to the difference between container and cruise ships in average demand between while at berth. Cruise ships need to maintain services to thousands of passengers and crew in port while container ships maintain minimal on-board services and receive most logistical service from port-side equipment. Thus, the average demand at berth for a container ship of the size that typically calls at Seattle is 1,100 kW versus 11,480 kW for a cruise ship. The applicable Seattle City tariff contains a peak period demand charge of $4.69/kW.[58]
- **Unit Costs.** For the cases analyzed for this report, the cost for shore power under the currently applicable tariffs are $0.20/kWh for container ships and $0.26/kWh for passenger ships. As a point of comparison, average utility rates for commercial customers of Seattle City Light were $0.12/kWh - $0.14/kWh in July 2025.[59]
- **Incremental costs.** Using shore power enables shipowners to avoid running diesel-powered auxiliary generators. A typical on-board auxiliary generator requires 0.22 litres of diesel fuel to generate 1 kWh of electricity. Current prices for marine diesel delivered in the Northwest are $4.28 per gallon or $1.13 per liter.[60] Fuel costs for on-board auxiliary engines are $0.248 per kWh in Washington ports, before accounting for depreciation and maintenance costs. These costs are slightly higher than the unit costs for shore power from the Port of Seattle and Seattle City Light. Thus, ship owners will reduce total costs by using shore power versus generators driven by auxiliary engines for electricity at berth. The average savings for

[58] Seattle City Lights. Business Rates. Accessed October 13, 2025. https://www.seattle.gov/city-light/business-solutions/business-billing-and-account-information/business-rates
[59] U. S. Department of Energy, Energy Information Administration. Electricity Monthly https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a
[60] Foss Maritime Fuel Prices, Pacific Northwest Ports. https://foss-maritime.com/fuel-prices/

container ships is estimated at $2,238 per call. Due to the high peak demand for cruise ships, it costs $1,132 more to use shore power than diesel generators per call under the applicable Seattle City Light Rate.

TABLE 9-2: SUMMARY OF SHORE POWER COSTS FOR CONTAINER AND CRUISE VESSELS CALLING AT PORT OF SEATTLE

Row	VESSEL TYPE	Container	Passenger
	BERTH	18-3	91-1
Physical Quantities/Rate Determinations			
1	Average Hours per Call	38	10
2	Average Connected Hours per Call	36	8
3	Average Demand (kW)	1,100	11,480
4	Auxiliary Generator Load Factor	0.55	0.64
5	Peak Demand kW	2,000	17,938
6	Electricity Use per Call kWh	39,600	91,840
Port Charges/Call			
7	Connect/Disconnect Charge $860/call	$860	$860
Shore Power Fee/Call Calculation			
8	Average Energy Charges per Call	$3,623	$8,403
9	Average Demand Charges per Call	$3,237	$14,595
10	Average Service Charges/Call	$238	$119
11	**Total Electricity Charges/Call**	$7,098	$23,117
12	**Total Costs/Call: Electricity + Port Fees**	$7,958	$23,977
Incremental Costs v. Diesel			
13	Cost of diesel fuel per call	$9,850	$22,845
14	Incremental Fuel Cost of Shore Power per Call	-$2,752	$1,132
15	Incremental Shore Power Cost: Fuel + Port Fees	-$1,892	$1,992
Unit Electricity Costs			
16	Shore Power Costs/kWh	$0.18	$0.25
17	Shore Power Costs/kWh with port fees	$0.20	$0.26
18	Average WA State Commercial Electricity Rates	$0.12 - $0.14	

Shore Power Costs at the Port of Tacoma. Table 9-3 summarizes the inputs and results of estimating the shore power cost per call for container, auto, and tanker vessels calling at the Port of Tacoma. The Port of Tacoma has obtained an operating franchise as a utility. Its shore power tariff is considerably less expensive and complicated than the Seattle City Light High Demand General rate used at the Port of Seattle. It consists only of a monthly service fee of $83 per vessel and a flat energy charge of $0.1359/kWh. In addition, the port charges a shore power connection fee of $1,642.50 per call..[61]

- **Cost to shipowners and charter holders.** The cost for an average-length call is $7,928 for auto carriers, and $28,126 for tankers. The differences in costs among vessel types is driven largely by differences in their average time at berth.
- **Unit Costs.** For the cases analyzed for this report, the cost for shore power under the currently applicable tariffs are $0.14/kWh for all relevant vessel types and $0.20/kWh

[61] Northwest Seaport Alliance. 2025. *Terminals Tariff No. 300*. July 5, 2025. https://www.nwseaportalliance.com/service-providers/shipper-resources/tariff-notices

including port fees. As a point of comparison, average utility rates for commercial customers of Tacoma Power were $0.12/kWh - $0.14/kWh in July 2025.

- **Incremental costs.** Given the relatively low level of Tacoma Power's shore power tariff, it is not surprising that incremental costs of using shore power are negative. The average savings per call are $781 for auto carriers, and $19,233 for tankers.

TABLE 9-3: SUMMARY OF SHORE POWER COSTS FOR CONTAINER, AUTO, AND TANKER VESSELS CALLING AT PORT OF TACOMA

Row	Vessel Type	Auto or Ro-Ro	Tanker
	Berth	**East Blair**	**Refineries**
1	Average Hours per Call	20	36
2	Average Connected Hours/Call	18	34
3	Average Demand (kW)	1200	5,774
4	Auxiliary Generator Load Factor	0.3	0.55
5	Peak Demand kW	4,000	9,904
6	Electricity Use per Call kWh	21,600	185,198
Electricity Rate Components			
7	Monthly Service Fee: $83.25	$83	$83
8	Electricity Charge, Flat $/kWh	$0.1359	$0.1359
	No demand charges		
Shore Power Fee/Call Calculation			
9	**Total Electricity Charges/Call**	$2,942	$21,185
10	**Shore Power Connection Fee**	$1,643	$1,643
Incremental Costs v. Diesel			
11	Cost of diesel fuel per call	$5,373	$46.067
12	Incremental Cost of Shore Power per Call	-$2,431	-$20,882
13	Incremental Costs with Port Fees	-$788	-$19.239
14	Shore Power Cost/kWh	$0.14	$0.14
15	Shore Power Costs/kWh including port fees	$0.21	$0.20
16	Average commercial rates: Tacoma Power	$0.12 - $0.14	

10. Impact on Port Competitiveness

This section analyzes how a CARB-style At Berth Regulation may influence the competitiveness of Washington ports, i.e., to what extent the costs associated with the regulations may cause cargo to shift to competing ports outside of Washington (Table 10-1). The evaluation considers how compliance costs, infrastructure readiness, and vessel routing decisions could affect port market share compared with ports in California, Oregon, British Columbia, and other regions.

The CARB-style Regulation govern four types of vessels: container, tanker, cruise, and ro-ro.

The analysis also assesses:

- Whether higher operating costs or capital requirements could shift cargo volumes to competing ports (i.e. diversion).
- How early adoption of shore power could enhance port reputation, attract environmentally conscious shippers, and support state climate goals.
- The role of funding support, regulatory flexibility, and phased implementation in mitigating potential disadvantages.

TABLE 10-1: SUMMARY OF POTENTIAL CARGO DIVERSIONS

Vessel Type	Competing Ports	Potential Level of Diversion
Container	Vancouver BC, Prince Rupert BC, Los Angeles/Long Beach, Oakland, CA; Portland, OR; East Coast, Gulf Coast	Initial estimates subject to stakeholder review
Tanker	San Francisco Bay, Los Angeles/Long Beach, CA	None
Cruise	Vancouver BC	None
Ro-Ro	Portland, CA	None

Source: BST Associates

Operating costs associated with shore power include allocated capital costs as well as labor, electricity and other costs related to vessel calls. With all four types of vessels covered by the potential regulations, marine terminals or berths with higher cargo (or passenger) throughput will have shore power costs per unit of cargo (or passengers) that are lower than average, while the opposite is also the case.

The potential impacts of higher operating costs associated with shore power requirements differ among the four types of affected vessels:

- The container trade is extremely competitive, and higher costs will likely result in some containers diverting to other ports. The primary competitors for NWSA container cargo are in British Columbia (Vancouver and Prince Rupert and southern California (Los Angeles Long Beach). In addition, ports on the East Coast and Gulf Coast seen growing market share for container cargo originating in Asia, while Portland is a relatively minor player. Based on average container terminal throughput the average cost per container is projected to be low, and the number of containers diverted is also projected to be low, but terminals with lower throughput may see a greater impact.
- Diversion of tanker traffic due to the cost of shore power is unlikely. Most of the tankers that would be covered by the proposed regulations transport crude oil to refineries at Ferndale, Anacortes, and Tacoma. These refineries primarily supply the market for petroleum products in western Washington and western Oregon via pipeline, but also send refined products by vessel to California and British Columbia. As an alternative, refineries in California may be able to fill some of this demand but at a higher cost. The increase in the cost of crude oil delivered to Washington

refineries due to shore power requirements is minimal when compared to historical changes in the price of crude oil, and is not expected to result in diversion of cargo.

- Cruise traffic in Washington is based in Seattle, and is focused on the Southeast Alaska market. Seattle competes with Vancouver, BC, for this traffic, and the market is essentially evenly divided between the two ports. Shore power capability is in place at all three of Seattle's cruise berths, and at the Canada Place Cruise Terminal in Vancouver. The estimated shore-power related costs for cruise ships represents less than one percent of the price of a cruise, and by itself is unlikely to cause a loss of traffic. Since the Port of Seattle has already completed installation of cruise power infrastructure at all three cruise berths, however, the adoption of new shore power regulations will not impose additional capital costs. Also, because shore power capability is in place at Vancouver cruise berths, there is no competitive disadvantage; however, they may impose some reporting and compliance costs.
- Ro-Ro vessel traffic is consists mainly of vehicle carriers transporting imported vehicles to Washington ports. The allocated cost per vehicle related to shore power represents a minimal increase in the delivered cost, for the Port of Tacoma but may have a more significant impact on smaller ports like Grays Harbor.

Past shore power projects have been funded through a combination of Port funds and grant funds. A key issue is how much of the Port funds will be recovered through use fees. Higher levels of grant funding reduce the level of fees needed to recover Port funds, and lower fees will reduce potential cargo diversions.

The final report will have more detailed analysis of estimated competitiveness impacts for different vessel types

11. Stakeholder Outreach

Outreach was initiated with representatives of Washington public ports and shippers, private terminal operators and refineries, utilities, the trucking industry, labor union representatives, and environmental organizations.

All expressed support for reducing air emissions and improving the health of worker and surrounding communities. Stakeholder concerns were focused on: maintaining worker safety at shore power facilities, keeping up with the additional demand of adopting shore power technology, accommodating increased demands on the electrical grid, which will require a collaborative and well-planned and well-funded state-wide effort. Their input is summarized below and categorized by stakeholder type (Table 11-1).

TABLE 11-1: STAKEHOLDER OUTREACH INPUT ON A CARB-LIKE OGV AT BERTH REGULATION FOR WASHINGTON

Stakeholder Category	Summary of Shared Input
Public ports and private shipping terminals (cruise, container, ro-ro, liquid bulk tankers)	• Already started voluntarily shore power installation for equipped OGVs (and other vessel types and equipment) with their own clean air strategies in place. • Overall preference for voluntary adoption of shore power, which allows for greater flexibility in planning and budgeting for high capital costs, working and negotiating with power utilities, determining terminal-specific shore power requirements for visiting vessels, and responding to changing technologies. • Concerns over the potential loss of unique business lines, such as ro-ro. • Success of a CARB At Berth Regulation in WA will require full state backing and a coordinated approach (substantial state funding required, staff and funding for regulatory compliance, and would benefit from streamlined permitting to support infrastructure rehabilitation and power grid expansion.
Petroleum facilities (tankers)	• Facilities expressed support for decarbonization, with concern over how this can work safely and a need for alignment with international regulations. • Shore power remains unavailable or unproven (few CARB-approved capture systems exist for tankers or address boiler emissions). Safe, reliable, scalable technologies are not yet available. Chartered/third party vessel operators reduce control over vessel modifications. • Operation of shore power occurs in high-risk environments, risk compounded by the absence of engineering standards and international regulatory guidelines (USCG, IMO, OCIMF). • Recommend detailed study including pilot studies specific to unique challenges for oil tankers before implementing regulations.
Electric utilities	• Shore power requires reliable access to power grids. Meanwhile, utilities are facing growing electricity demands that can take years to plan for and upgrade. • Local utilities operate within their own budgets and schedule; some require financial support to engage in projects and/or provide data. • State regulations require WA utilities to achieve GHG neutrality by 2030 and 95% emissions reduction by 2050. Utilities will need to generate more renewable electricity to meet shore power demands.
Trucking	• Many trucking companies are working towards 2040 carbon neutrality goals.

Stakeholder Category	Summary of Shared Input
	• Questions related to how Washington State will support a new OGV At Berth Regulation (how would power grid and infrastructure rehabilitation, and compliance, be funded and incorporated with other state initiatives.
Labor	• Focus on worker safety and health and that of surrounding communities. View emissions reduction as an improved working condition. • Safety regulations need to be developed for new technologies.
Environmental/ regulatory	• Emphasize reductions in at-berth emissions for community and state-wide health.

12. Report Findings

Washington can adopt at berth emission standards identical to California's to reduce air emissions at regulated terminals and provide improved air quality and health for workers and surrounding communities. Some vessels arriving at Washington's largest public ports are already equipped for shore power. A number of Washington's ports have installed or are installing shore power infrastructure in the absence of regulations. While still in early phases of implementation, these installations are reducing and will continue to reduce at-berth emissions, though not as much as mandatory regulation. Voluntary implementation does, however, allow more flexibility for public port and private terminals to prioritize emission-reducing capital projects in alignment with local utility efforts and critical federal and state funding.

As this report describes, the cost and impact of regulating at-berth emissions in Washington would vary substantially across terminals, between types of vessel traffic and between smaller and larger ports. Only 7 areas in Washington are expected to contain terminals where compliance with an OGV At Berth Regulation may be required if implemented. Installing shore power infrastructure and meeting operational costs will place significant demands on ports, terminal operators, and vessel operators. However, phased implementation over a fifteen-year phased implementation period as was done in California would allow impacts to be distributed, with an additional two years' lead time between the adoption of a regulation and the beginning of enforcement. Access to state and/or federal funding will be key to removing barriers to implementation.

While large public ports in Washington have already commenced shore power implementation, mid-sized and smaller ports have only recently begun to do so, mainly supported by substantial federal grants. Successful adoption of a CARB-like OGV At Berth Regulation in Washington will require a collaborative and unified state-wide plan to anticipate long-term funding mechanisms, regulatory compliance, technology guidance, labor and safety needs, and increased power grid demands.