United States
Environmental Protection
Agency




NATIONAL PORT STRATEGY ASSESSMENT: Reducing Air Pollution and Greenhouse Gases at U.S. Ports

Executive Summary


Office of Transportation Air Quality
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Note: This document contains the Executive Summary of the *National Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at U.S. Ports*. The full report can be accessed at: https://www.epa.gov/ports-initiative.

Introduction

Ports are a vital part of the United States economy, with seaports, Great Lakes ports, and inland river ports serving as gateways for moving freight and passengers across the country and around the world. Seaports alone account for more than 23 million jobs and seaport cargo activity accounts for 26% of the United States economy.[1] The U.S. Army Corps of Engineers estimates that bigger Post-Panamax size ships that currently call at U.S. ports will dominate world trade and represent 62% of total container ship capacity by 2030.[2] As our nation adapts to meet these emerging economic and infrastructure demands, it is critical to understand the potential impacts on air pollution, greenhouse gases (GHGs), and the people living, working, and recreating near ports.

The U.S. Environmental Protection Agency (EPA) developed this national scale assessment to examine current and future emissions from a variety of diesel sources operating in port areas, and to explore the potential of a range of available strategies to reduce emissions from port-related trucks, locomotives, cargo handling equipment, harbor craft, and ocean-going vessels.[3] Diesel engines are the modern-day workhorse of the American economy, and although they can be reliable and efficient, older diesel engines can emit significant amounts of air pollution, including fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx), air toxics, and carbon dioxide (CO_2), which impact human health and the planet.

The entire nation benefits from economic activity from the trade that passes through commercial ports located around the country. And while those emissions can reach significantly inland,[4] it is the people who live, work, and recreate near ports that experience the most direct impacts on their health and welfare. EPA estimates that about 39 million people in the United States currently live in close proximity to ports[5]; these people can be exposed to air pollution from diesel engines at ports and be at risk of developing asthma, heart disease, and other health problems.[6] Port-related diesel-powered vehicles, equipment, and ships also produce significant GHG emissions that contribute to climate change. Even though EPA has adopted stringent emission standards for diesel engines, many ports and related freight corridors and facilities are located in nonattainment or maintenance areas for EPA's ozone and $PM_{2.5}$ national ambient air quality standards (NAAQS), per Figure ES-1.[7]

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[1] American Association of Port Authorities (AAPA), http://www.aapa-ports.org/advocating/content.aspx?ItemNumber=21150.

[2] U.S. Army Corps of Engineers, *U.S. Port and Inland Waterways Modernization: Preparing for Post-Panamax Vessels: Report Summary*, June 20, 2012.

[3] This assessment was conducted to evaluate the emission reduction potential of a range of available strategies based upon a national scale approach, rather than the cost and other details necessary to apply strategies in a specific area.

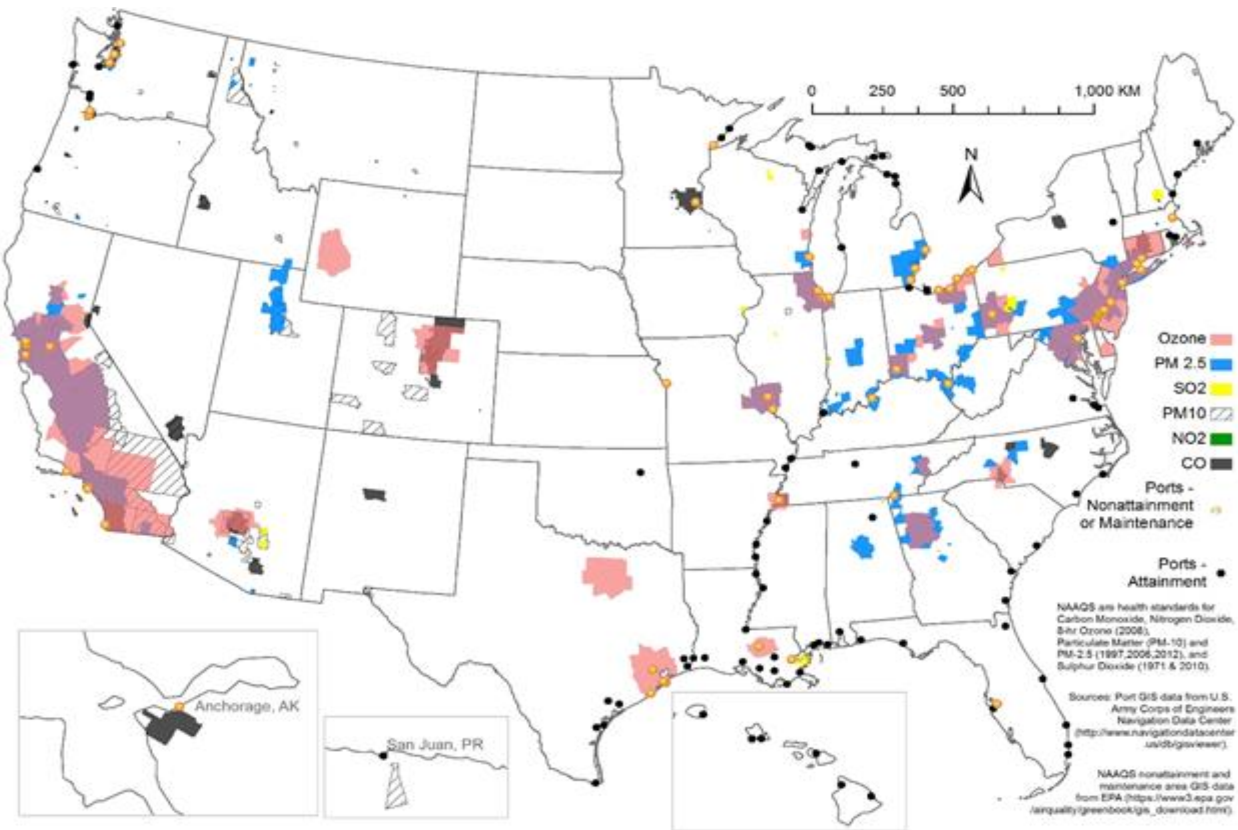
[4] U.S. Environmental Protection Agency, *Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder,* 75 FR 24802, April 30, 2010.

[5] EPA's analysis is based on overlaying and merging U.S. Census tract level geospatial data (Census Bureau 2010) with EPA's National Emission Inventory (NEI 2011) ports data indicating that approximately 39 million people lived within 5 kilometers of ports in the United States.

[6] U.S. Environmental Protection Agency, *Near Roadway Air Pollution and Health: Frequently Asked Questions*, EPA-420-F-14-044, 2014, https://www3.epa.gov/otaq/nearroadway.htm.

[7] Based on a review of available data, EPA approximates that 40% of "Principal Ports" are located in or near areas that have violated a NAAQS (nonattainment areas) or have previously violated but are now meeting a NAAQS (maintenance areas).

Figure ES-1. Ports in Areas Designated Nonattainment or Maintenance for the Clean Air Act's NAAQS



This assessment supports the vision of EPA's Ports Initiative to reduce air pollution and GHGs through a collaboration of industry, government, and communities.[8] EPA already supports voluntary efforts to reduce diesel emissions through EPA's Clean Diesel Campaign and its SmartWay program. State and local governments, ports and port operators, Tribes, communities, and other stakeholders can use this assessment as a tool to inform their priorities and decisions for port areas and achieve more emission reductions across the United States. Economic growth can go hand-in-hand with continued improvements in the health and welfare of near-port communities and the safeguarding of our planet.

EPA developed this assessment in consultation with the Mobile Sources Technical Review Subcommittee (MSTRS) of the Clean Air Act Advisory Committee (CAAAC) over a two-year period. In 2014, the MSTRS formed a Ports Workgroup to develop recommendations for developing an EPA-led voluntary ports initiative, and effectively measuring environmental performance at ports. The MSTRS Ports Workgroup included technical and policy experts from a range of stakeholders, including industry, port-related agencies, communities, Tribes, state and local governments, and public interest groups.[9]

[8] The goals of EPA's Ports Initiative are to reduce air pollution and GHGs, to achieve environmental sustainability for ports, and improve air quality for near-port communities. For more information, see https://www.epa.gov/ports-initiative.

[9] For further information on MSTRS Ports Working Group participants, see https://www.epa.gov/sites/production/files/2016-06/documents/portsinitiativewkgrp_2016.pdf.

Port-related diesel emissions impact public health and the climate.

Emissions from diesel engines, especially $PM_{2.5}$, NOx, and air toxics such as benzene and formaldehyde, can contribute to significant health problems—including premature mortality, increased hospital admissions for heart and lung disease, and increased respiratory symptoms—for children, the elderly, outdoor workers, and other sensitive populations.[10] EPA has determined that diesel engine exhaust emissions are a likely human carcinogen,[11] and the World Health Organization has classified diesel emissions as carcinogenic to humans.[12] Many ports and port-related corridors are also located in areas with a high percentage of low income and minority populations who are often disproportionately impacted by higher levels of diesel emissions.[13]

Port-related diesel emissions, such as CO_2 and black carbon, also contribute to climate change. Research literature increasingly documents the effects that climate change is having and will increasingly have on air and water quality, weather patterns, sea levels, human health, ecosystems, agricultural crop yield, and critical infrastructure.[14] Other health impacts that are projected from climate change include heat stroke and dehydration from more frequent and longer heat waves and illnesses from an increase in water and food-borne pathogens. [15] This assessment provides options to inform voluntary, place-based actions that may be taken by federal, state, and local governments, Tribes, ports, communities, and other stakeholders to reduce these impacts and enhance public health and environmental protection.

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[10] *Third Report to Congress: Highlights from the Diesel Emission Reduction Program*, EPA, EPA-420-R-16-004, February 2016, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100OHMK.pdf; and *EPA's Health Assessment Document for Diesel Engine Exhaust*, 2002.

[11] *Health Assessment Document for Diesel Engine Exhaust*, prepared by the National Center for Environmental Assessment for EPA, 2002.

[12] *Diesel Engine Exhaust Carcinogenic*, International Agency for Research on Cancer (IARC), World Health Organization, June 12, 2012, http://monographs.iarc.fr/ENG/Monographs/vol105/.

[13] U.S. Environmental Protection Agency, *Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder,* 75 FR 24802 (April 30, 2010).

[14] U.S. Environmental Protection Agency, *Climate Change Indicators in the United States*, 4th edition, 2016, https://www.epa.gov/climate-indicators.

[15] United States Global Change Research Program, *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*, April 2016, http://www.globalchange.gov/health-assessment.

Progress is already happening, but more emission reductions are possible.

EPA's technology standards and fuel sulfur limits are expected to significantly reduce emissions as new diesel trucks, locomotives, cargo handling equipment (CHE), and ships enter the in-use fleet. For example, the North American and U.S. Caribbean Sea Emissions Control Areas require lower sulfur fuel to be used for large ocean-going vessels (OGVs). This has reduced fuel-based PM emissions by about 90%. Some stakeholders have also adopted voluntary strategies like those examined in this assessment. EPA supports these efforts, encourages them to continue in the future, and hopes that this assessment will encourage more areas to adopt and incentivize such voluntary programs.

EPA developed this national scale assessment based on estimated emissions from a representative sample of seaports. EPA estimated Business as Usual (BAU) emissions by projecting future trends under the status quo. As shown in Figure ES-2, total $PM_{2.5}$ emissions are projected to decrease in the future for most mobile source sectors and years. The assessment considered the impact from all mobile source sectors, and the levels of emissions shown in Figure ES-2 are based on the assessment's geographic scope.

Figure ES-2. Total BAU $PM_{2.5}$ Emissions by Mobile Source Sector

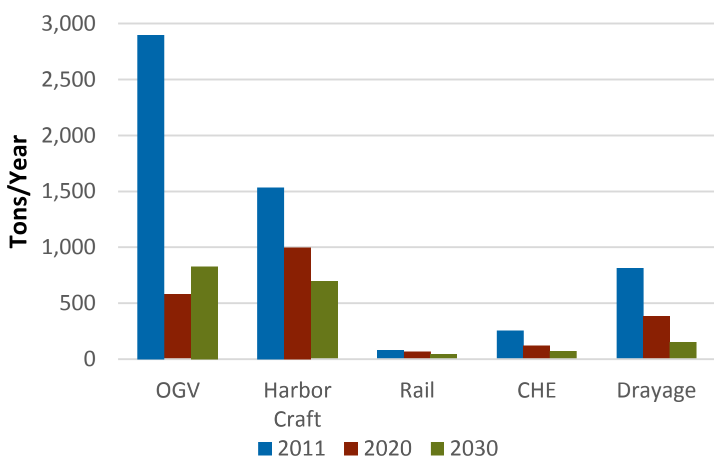
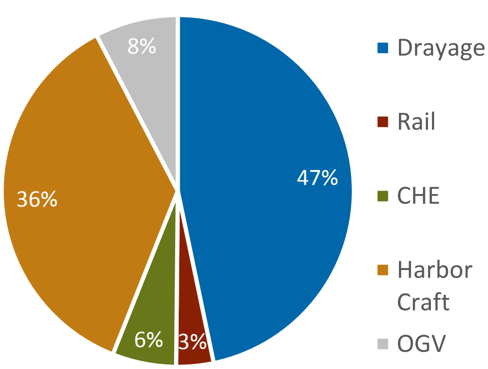


Figure ES-3. Relative Reductions for $PM_{2.5}$ in 2020 (Scenario A)



EPA then estimated the potential reductions from a suite of available strategies for all mobile source sectors for the years 2020, 2030, and 2050. For example, Figure ES-3 shows the break-out of $PM_{2.5}$ reductions for all mobile source sectors for Scenario A in the year 2020, with the highest emission reductions being achieved in the drayage truck sector. In this scenario, total $PM_{2.5}$ emissions are projected to be reduced by 47% in the year 2020 by replacing older trucks with newer, cleaner trucks. This example illustrates that voluntary, place-based actions can reduce emissions from port activity and benefit public health in the communities living near truck corridors.

We can reduce emissions with effective strategies that are currently available.

This assessment examined a suite of currently available strategies, including zero emissions (e.g., electric) technologies that can be used to develop voluntary programs to achieve additional emission reductions. Some ports are already using the strategies in this assessment, including emerging technologies, and their wider use could achieve even greater public health benefits.

Table 1-1 provides examples of some of the strategies in this assessment. The categories include replacing older diesel fleets; operational improvements to reduce idling; and switching to cleaner fuels. The strategies examined are not exhaustive; there may be other strategies that could also be effective at a given port or for another application. For example, diesel retrofit technology has been a highly effective strategy to reduce diesel emissions from school buses, transit buses, and long-haul trucks. EPA did not include this technology option in its analysis since retrofitting port drayage trucks is less effective than simply replacing them. While this assessment included a few strategies to improve operational efficiency at ports, the focus was primarily on assessing technological strategies. EPA continues to believe that operational strategies (e.g., reducing truck or locomotive idling) can be effective at reducing diesel emissions.

Table ES-1. Examples of Strategy Scenarios Assessed

Sector	Scenario Description
Drayage Trucks	Replace older diesel trucks with trucks that meet cleaner EPA standards and plug-in hybrid electric vehicles.
Rail	Replace older line-haul locomotive engines with cleaner technologies, including electric locomotives.
	Improve fuel economy.
	Replace older switcher locomotive engines with cleaner technologies and Generator Set (GenSet) technology.
Cargo Handling Equipment	Replace older yard truck, crane, and container handling equipment with cleaner technologies, including electric technologies.
Harbor Craft	Replace or repower older tugs and ferries with cleaner technologies, including hybrid electric vessels.
Ocean-going Vessels	Switch to lower sulfur fuel levels that are below EPA's regulatory standards, and liquified natural gas for certain vessel types.
	Utilize shore power to reduce hoteling of container, passenger, and reefer vessels.
	Apply Advanced Marine Emission Control Systems for container and tanker vessels.

Replace older, dirtier diesel vehicles and equipment first.

As noted earlier, EPA's regulations for new diesel vehicles and equipment are projected to significantly reduce NOx and $PM_{2.5}$ emissions into the future. However, older trucks and equipment are longstanding fixtures of many port operations, and it will take many years before these fleets turn over to newer technology. Accelerating the retirement of older port vehicles and equipment and replacing them with the cleanest technology will reduce emissions and increase public health benefits beyond what would be achieved without further voluntary actions.

Table 1-2 provides examples of the emission reduction potential of port strategies evaluated in this assessment. For example, the potential for replacing older drayage trucks with cleaner diesel trucks is significant, with NOx being reduced in 2020 by 19–48% and $PM_{2.5}$ being reduced by 43–62% as compared to the BAU case. In 2030, adding plug-in hybrid electric vehicle fleets resulted in even more NOx and $PM_{2.5}$ relative reductions. In another example, shore power reductions of NOx and $PM_{2.5}$ were also significant, with higher reductions being expected if shore power was applied to a larger portion of OGVs.

Table ES-2. Examples of Effective Port Strategies to Reduce NOx and $PM_{2.5}$ Emissions

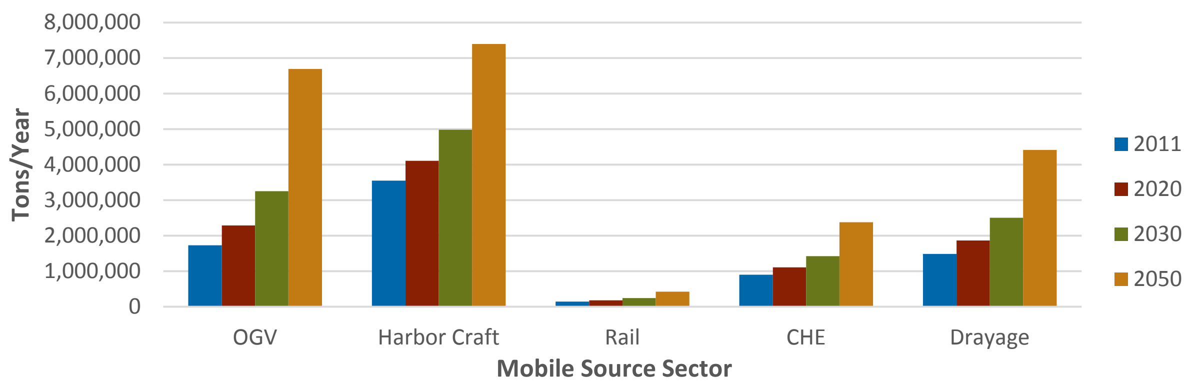
Strategy Scenario	Percent reduction from BAU			
	NOx		$PM_{2.5}$	
	2020	2030	2020	2030
Replace older drayage trucks	19–48%	48–60%	43–62%	34–52%
Replace older switcher locomotives	16–34%	17–43%	22–44%	24–47%
Replace older CHE	17–39%	13–25%	18–37%	12–25%
Replace or repower harbor craft	10–24%	25–38%	13–41%	28–37%
Reduce OGV hoteling emissions with shore power[16]	4–9%	7–16%	3–8%	7–16%

[16] The shore power results also account for the emissions from generating electricity.

CO_2 continues to increase, but effective strategies are available.

Port-related CO_2 emissions are projected to increase from current levels for all mobile sources in all future years, as shown in Figure ES-4, in large part due to significant increases in economic trade and activity. In addition, most of EPA's existing regulations and standards do not address CO_2 emissions for port mobile source sectors.[17]

Figure ES-4. Total BAU CO_2 Emissions by Mobile Source Sector



This assessment evaluated voluntary replacements of diesel vehicles and equipment with zero emissions and other advanced technologies that are currently in use or in development for most port sectors. Several strategies reduced the magnitude of increasing CO_2 levels. Examples of some of the assessment's strategy scenarios and estimated relative CO_2 reductions are included in Table 1-3.

Table 1-3. Examples of Effective Port Strategies to Reduce CO_2 Emissions

Strategy Scenario	Percent reduction from CO_2 BAU	
	2030	2050
Replace older drayage trucks with plug-in hybrid electric trucks	0–4%	6–12%
Replace older locomotives with electric locomotives, GenSets, and fuel efficiency	3–6%	11–23%
Replace older CHE with electric technologies	7–18%	27–45%
Reduce OGV hoteling emissions with shore power[18]	2–5%	4–10%

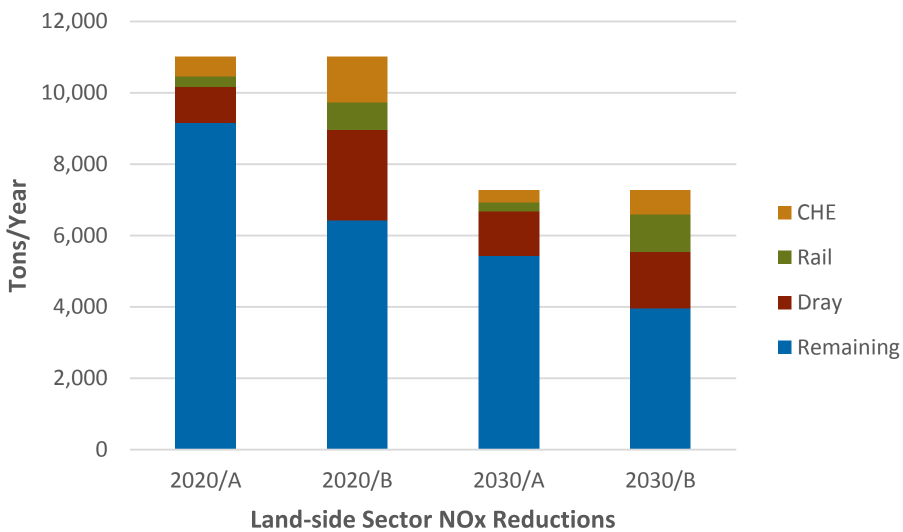
[17] The assessment's estimates for drayage trucks and OGVs do not include the impacts of recent CO_2 reduction programs. Specifically, the CO_2 reductions of EPA's heavy-duty engine and vehicle GHG regulations and the International Maritime Organization's Energy Efficiency Design Index and Ship Energy Efficiency Management Plan were not included due to the timing of the assessment. If such programs were included, EPA would expect smaller CO_2 increases in drayage truck and OGV emissions in 2030 and 2050.

[18] The shore power results also account for the emissions from generating electricity.

Reduction potential varies across mobile source sectors.

The voluntary strategies examined in this assessment do not achieve the same level of reductions across all mobile source sectors and pollutants. Specifically, strategy scenarios that target land-side operations (i.e., drayage trucks, locomotives, and CHE) are generally expected to result in greater emission reductions than those targeting water-side operations (i.e., harbor craft and OGVs). This is illustrated in Figure ES-5, which shows the total tons of NOx reduced from the 2020 and 2030 BAU cases assumed in this assessment for land-side mobile source sectors.

Figure ES-5. Total NOx Reductions for Land-side Mobile Source Sectors



The 2020 and 2030 BAU emission levels are the total bars for 2020 and 2030, with the amount of NOx emissions reduced from CHE, rail, and drayage truck strategies shown in different colors respectively. For each of these years, there were two strategy scenarios examined (i.e., Scenarios A and B),[19] with Scenario B being a more aggressive suite of strategies than Scenario A. The significant levels of reductions shown above are especially important for the drayage truck and rail sectors since these are the sectors that are typically closer to neighborhoods, schools, and other parts of communities located in close proximity to ports.

In contrast, the scenarios for harbor craft and OGV sectors produced lower, but still significant, reductions from these respective 2020 and 2030 BAU emission levels. In practice, the most effective emission reduction strategies for any mobile source sector would be those that are tailored to the specific circumstances of a given port area.

[19] For example, "2020/A" shows the emissions reduced from Scenario A in 2020.

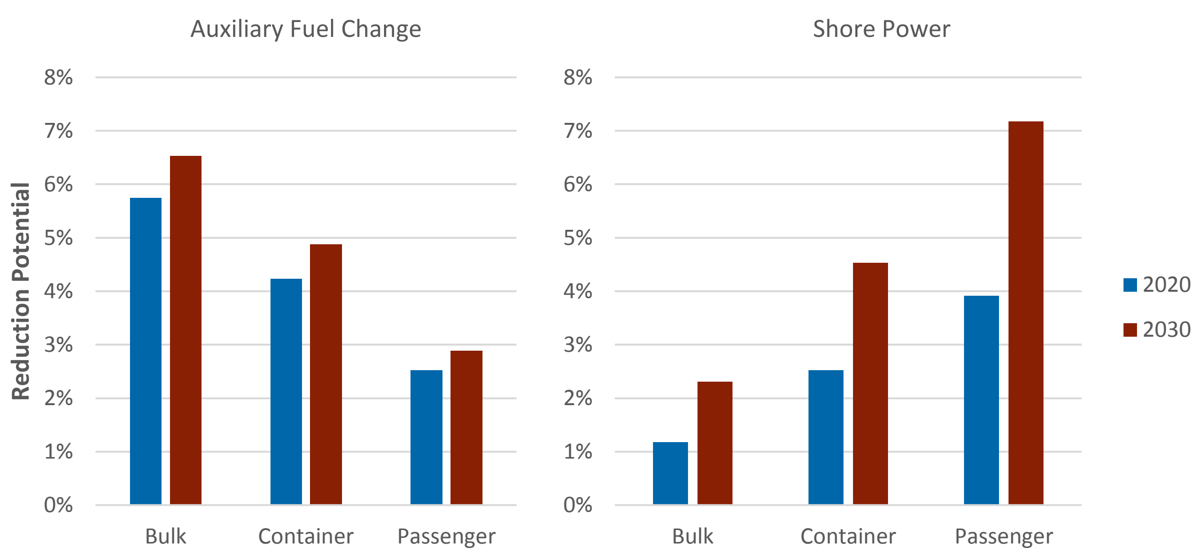
Effective strategies are available for every type and size of port.

EPA recognizes that many strategies reduce diesel emissions across different port emission profiles, as illustrated by the effective strategies examined at the assessment's representative sample of U.S. seaports. But the assessment could also be informative for voluntary decisions at other seaports, Great Lakes and inland river ports, or other freight and passenger facilities with similar mobile source profiles. EPA conducted a stratification analysis to further understand the assessment results, since U.S. ports vary in size, purpose, mix of vessels, and ground transportation. This analysis assessed the effectiveness of strategies for ports of different types: container, bulk, and passenger; and sizes: large and small.[20]

The stratification analysis shows that not all strategies can be expected to have the same results at all ports. For example, Figure ES-6 illustrates the effectiveness of reducing emissions while OGVs are operating their auxiliary engines. For the year 2020, switching to a cleaner fuel was projected to be more effective for reducing emissions from ships carrying bulk cargo while shore power technology was more effective at reducing NOx emissions for passenger ships. Shore power is expected to be more effective at reducing NOx emissions for a passenger port because passenger ships tend to call the same ports frequently, making it more feasible to adapt these vessels to use shore power.[21] In contrast, ships carrying bulk cargo typically do not call on the same port as often in a given year.

Stakeholders should consider what combination of strategies should be used to reduce emissions for a particular port area, depending upon the type of activity at a port.

Figure ES-6. NOx Reduction Effectiveness of Different Strategies at Different Kinds of Ports (Scenario B)



[20] These terms are not official classifications, but were defined and used in this analysis to differentiate among port sources considered in this assessment.
[21] The shore power results also account for the emissions from generating electricity.

More focus is needed to reduce port-related emissions.

State and local governments, ports and port operators, Tribes, communities, and other stakeholders can use this assessment as a tool to inform priorities and decisions about their port area. EPA's assessment illustrates how more investment in reducing port-related emissions through voluntary place-based programs can make a difference. This is important to consider in future planning, with U.S. port and private sector partners projected to spend $154.8 billion on port-related infrastructure, with an additional $24.8 billion of investment by the federal government in U.S. ports through 2020.[22]

Many of the strategies in this assessment are also eligible for existing federal funding sources, such as EPA's Diesel Emissions Reduction Act (DERA) grant program, which has been instrumental in furthering emission reductions through clean diesel projects located at ports and goods movement hubs. Since the first appropriation of the DERA program in Fiscal Year 2008, $148 million has gone toward 129 grants to fund projects at or near ports, with $80 million of this amount going to projects specifically at port facilities, including CHE upgrades, drayage truck replacements, locomotive engine repowers, and more. Other sources of federal funding that have been used for port-related emission reduction projects include the Department of Transportation's Transportation Investment Generating Economic Recovery (TIGER) and Congestion Mitigation and Air Quality Improvement (CMAQ) programs, and the Department of Energy's Clean Cities program.

When assessing strategies for a specific port area, here are some questions to consider:

- ✓ Is there a port-specific emission inventory or clean air plan available to inform decisions?
- ✓ What is the type and size of the port?
- ✓ What source sectors are the most significant diesel emitters at the port?
- ✓ How old are the diesel fleets of each port sector?
- ✓ Is there an existing forum for stakeholder participation?

[22] Results of AAPA's Port Planned Infrastructure Investment Survey: Infrastructure investment plans for U.S. ports and their private sector partners, 2016 through 2020, AAPA, April 6, 2016, http://aapa.files.cms-plus.com/SeminarPresentations/2016Seminars/2016PRCommitteeMarchMeeting/2016-2020%20Port%20Planned%20Infrastructure%20Investment%20Survey%203-3-2016.pdf.