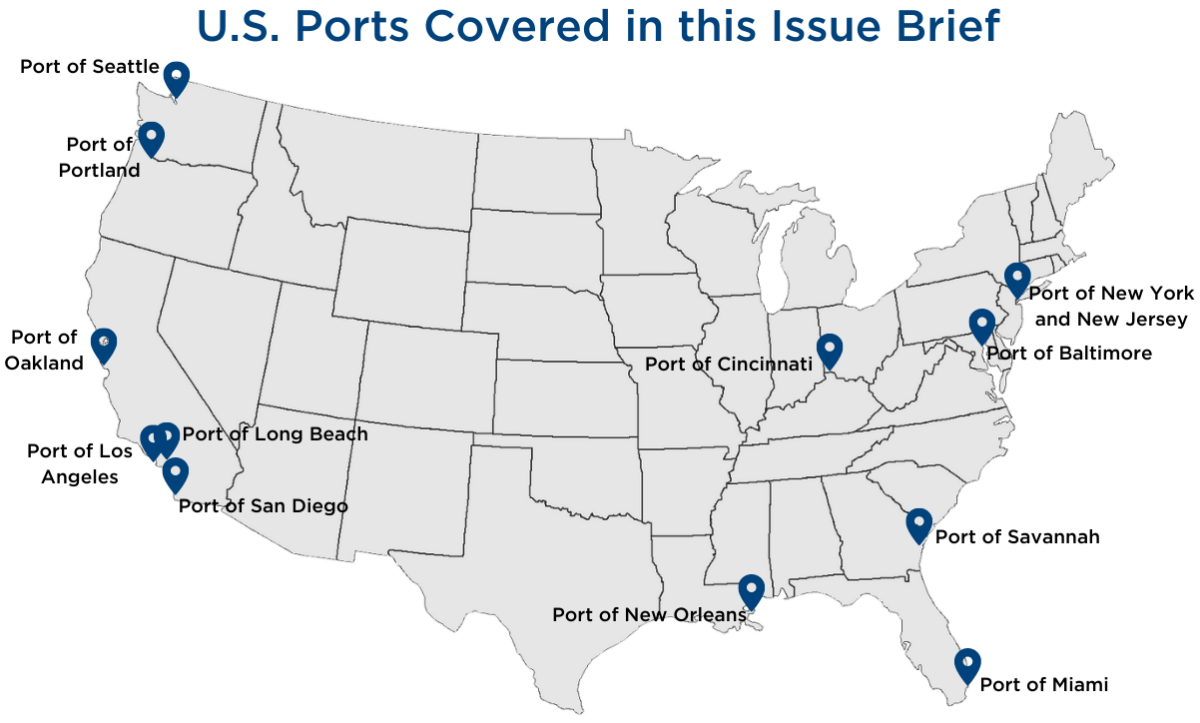
Environmental and Energy Study Institute

Issue Brief

Climate Change Mitigation and Adaptation at U.S. Ports

February 2022

With 90 percent of the world's goods transported by ship, disruptions to ports can ripple across the global economy and supply chains.[1] As a result, ports need to increase their resilience to climate change—one of the most significant threats facing operations. In its *Climate Adaptation and Coastal Resiliency Plan*, the **Port of Long Beach** notes that "climate change and extreme storms are already impacting the Southern California coast. Sea levels will continue to rise, and the frequency and magnitude of extreme storm events are likely to increase. The Port and its tenants will experience storm events with a greater potential to impact Port operations."[2] The **Port of Long Beach** is not alone—all ports will increasingly be impacted by bigger storms and other climate impacts, such as sea level rise and extreme heat.



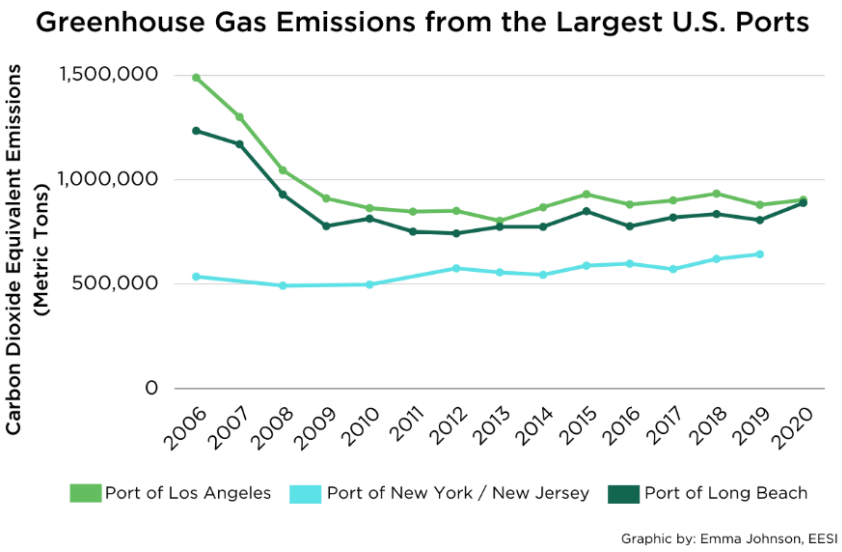
Graphic by: Emma Johnson, EESI

At the same time, ports themselves are a major source of greenhouse gas emissions and local air pollution. The **Ports of Los Angeles** and **Long Beach**—which together handle 40 percent of containers entering the United States—produce 100 tons of smog every day, more than the daily emissions of the six million cars in the Southern California region.[3] These emissions and pollutants do not only impact the climate, but they also harm the health and environment of near-port communities, many of which are already overburdened with multiple sources of pollution. To help advance environmental justice, efforts must be made to reduce the emissions and pollutants from ports.

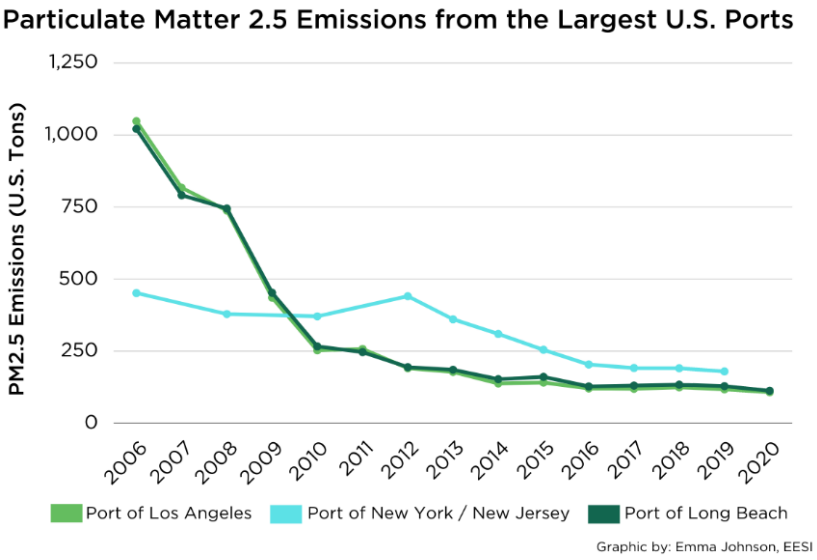
This issue brief outlines ways in which ports can mitigate and adapt to climate change through examples from U.S. ports already facing these challenges and capitalizing on the opportunity to become cleaner and more sustainable.

Current State of Emissions at Ports

In 2019, the three largest ports in the United States—the **Ports of Los Angeles, Long Beach,** and **New York and New Jersey**—emitted over 2.5 million tons of carbon dioxide equivalent (CO_2e).[4,5,6] This estimate includes emissions from ocean-going vessels at port, harbor craft, cargo handling equipment, locomotives, and heavy-duty vehicles. Other pollutants released from port operations include particulate matter (PM), nitrogen oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO), and hydrocarbons (HC), all of which are harmful to human health.



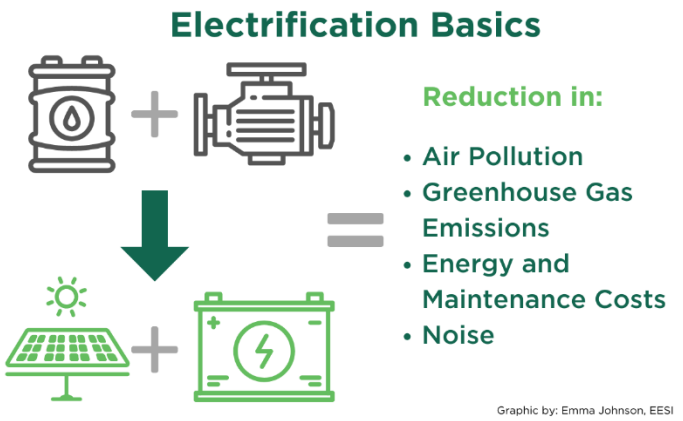
In recent years, progress has been made on reducing emissions at some ports. For example, sustainability efforts such as switching to fuels that produce fewer sulfur emissions, supplying land-generated electricity to ships docked at port (known as shore powering), reducing vessel speeds, and investing in energy efficiency contributed to emission reductions at the **Port of Los Angeles**.[4] Similarly, at the **Port of Baltimore**, cargo increased 10 percent between 2012 and 2016, but overall emissions dropped 19 percent, largely due to the modernization of cargo handling equipment, the replacement of older drayage trucks (heavy-duty trucks that transport cargo containers), and operational changes.[7]



However, much progress still needs to be made to reduce greenhouse gas emissions at ports and protect near-port communities. Near-port communities are often communities of color or low-income communities, and they face higher levels of air pollution from ports.[8] These communities are often overburdened with multiple sources of pollution, from ports to freeways and factories, which negatively impacts their health and can cause respiratory issues, cancer, and premature death.[9] Children, the elderly, outdoor workers, and other sensitive populations are especially vulnerable to this pollution. Many strategies discussed in this issue brief for mitigating and adapting to climate change at ports would also benefit communities by reducing pollution, noise, and traffic.

Climate Change Mitigation

Electrification

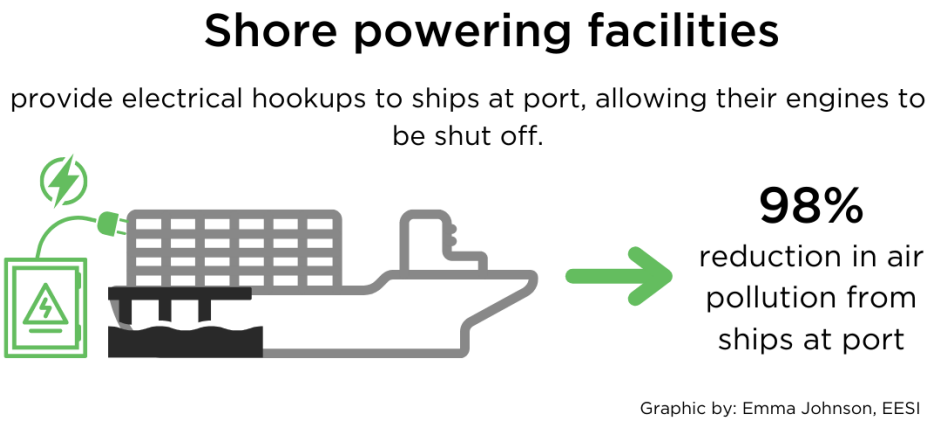


Electrification involves replacing engines that use fossil fuels like gasoline or diesel with ones that run on electricity. Ideally, renewable energy can be used as the source of electricity, resulting in even fewer greenhouse gas emissions. Electrifying port machinery—like trucks, cranes, forklifts, and tractors—reduces air and noise pollution, which can help mitigate the climate crisis and advance environmental justice for near-port communities. Electric engines are also easier and cheaper to maintain and refuel. Electric cranes, for example, reduce carbon dioxide emissions by 60 to 80 percent and have 30 percent lower repair costs when compared to diesel cranes.[10]

The **Port of Savannah** has taken steps to electrify. The port electrified 104 refrigerated container racks, which will save over 5.5 million gallons of diesel annually and reduce emissions by the equivalent of removing 12,000 cars from the road.[11,12] In 2018, the terminal received approval to build an additional 15 electric refrigerated container racks, which will save an additional 795,000 gallons of diesel every year.[11,14] Additionally, many of the port's ship-to-shore cranes—cranes used to unload cargo from ships—have also been electrified, which, coupled with the electrification of refrigerated container racks, avoids the use of 7.5 million gallons of diesel annually.[13,14]

The Georgia Port Authority, which includes the Port of Savannah, also electrified its rubber-tired gantry (RTG) cranes—cranes that move shipping containers around the port. The electric gantry cranes use 95 percent less diesel fuel than standard models, only using diesel to move around the port.[13,15] Every year, electric RTGs at the port eliminate the need for 700,000 gallons of diesel fuel, which is equivalent to taking 1,550 passenger vehicles off the road, and saves the Georgia Port Authority $2.2 million in fuel costs.[11,13]

Shore Powering

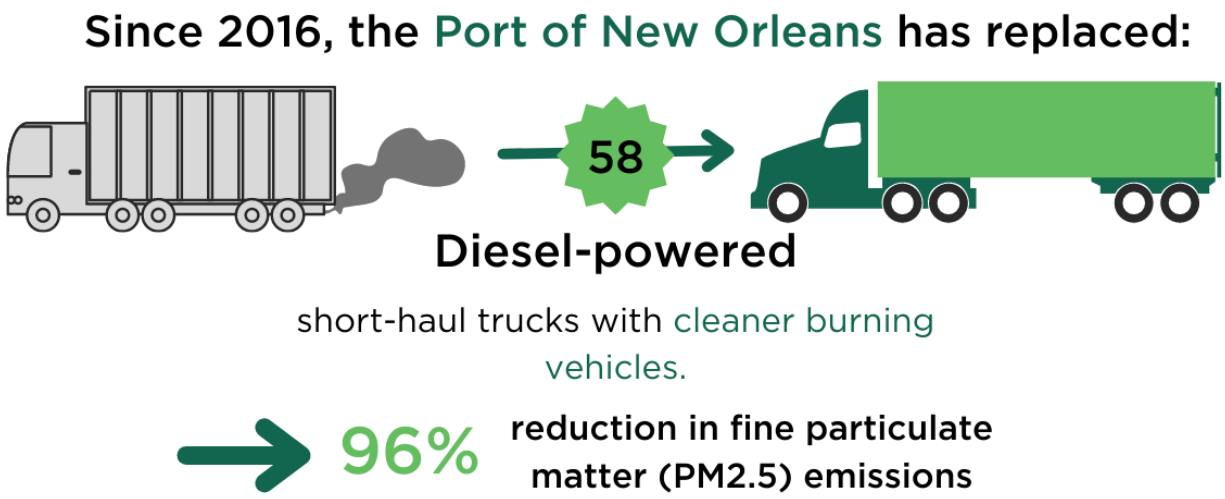


Ships at port, known as berthed ships, are often the largest source of greenhouse gas emissions at ports.[16] Shore powering facilities—electrical hookups available to berthed ships that allow their engines to be shut off while at port—can reduce air pollution from berthed ships by up to 98 percent.[17] Shore powering one container ship for one day reduces pollution by as much as taking 33,000 cars off the road for a day.[18] Through its shore powering initiative, the Alternative Marine Power program, the **Port of Los Angeles** has installed 79 shore powering hookups, more than any other port in the world.[19]

In 2007, California adopted the *Ocean-Going Vessels At-Berth* regulation to reduce emissions at ports.[20] Since 2014, the regulation has helped California ports achieve an 80 percent reduction in emissions from berthed ships by requiring certain ships to use shore-powering or shut down engines at port.[21] In 2020, the California Air Resources Board (CARB) approved the *Control Measure for Ocean-Going Vessels At Berth* regulation, which expands the 2007 rule and requires all vessels entering California ports to use shore power or other CARB-approved emission control technologies.[21] CARB estimates the new rule will prevent 237 premature deaths, 75 hospital visits, and 122 emergency room visits, saving over $2.3 billion dollars in healthcare costs.[22] Once the new rule is fully implemented, CARB estimates that the cancer risk for communities near the Ports of Los Angeles, Long Beach, and Richmond will be reduced by 55 percent.[21]

Truck Replacement Programs

At the three largest ports in the United States—the **Ports of Los Angeles, Long Beach, and New York and New Jersey**—heavy-duty vehicles produced emissions equivalent to over one million tons of carbon dioxide in 2019.[4,5,6] Across the country, heavy-duty vehicles at ports are a significant source of greenhouse gas emissions and other pollutants, such as particulate matter and nitrogen oxides, that contribute to the climate crisis and impact the health of near-port communities. To reduce these emissions, some ports have implemented truck replacement programs, replacing older drayage trucks with models featuring cleaner burning and more efficient engines.



Graphic by: Emma Johnson, EESI

The **Port of New Orleans** Clean Truck Replacement Incentive Program (Clean TRIP) began in 2016 and has replaced 58 diesel-powered short-haul drayage trucks with cleaner burning vehicles, leading to a 96 percent reduction of fine particulate matter (PM2.5) emissions.[23] The new trucks were bought using funding from the Louisiana Department of Environmental Quality and the Environmental Protection Agency (EPA).[24] Similarly, the **Port of Savannah**'s clean truck initiative, funded by a *Diesel Emissions Reduction Act* (DERA) grant, replaced 30 older, less efficient trucks.[14] The replacement trucks will prevent the release of 1,200 tons of nitrogen oxides, 56 tons of particulate matter 2.5, 62 tons of hydrocarbons, and 409 tons of carbon monoxide into the atmosphere.[14]

While these programs are a step towards more sustainable transportation at ports, electric trucks can help further reduce emissions and air pollution. In July 2021, the **Port of Oakland** began an electric truck demonstration project and unveiled 10 electric trucks, adding to the port's existing fleet of 17 electric trucks.[25] Funding for the project was secured through California's Zero and Near-Zero-Emission Freight Facilities program.[25] The port also invested $1.7 million to construct 10 electric charging stations.[25]

Renewable Energy

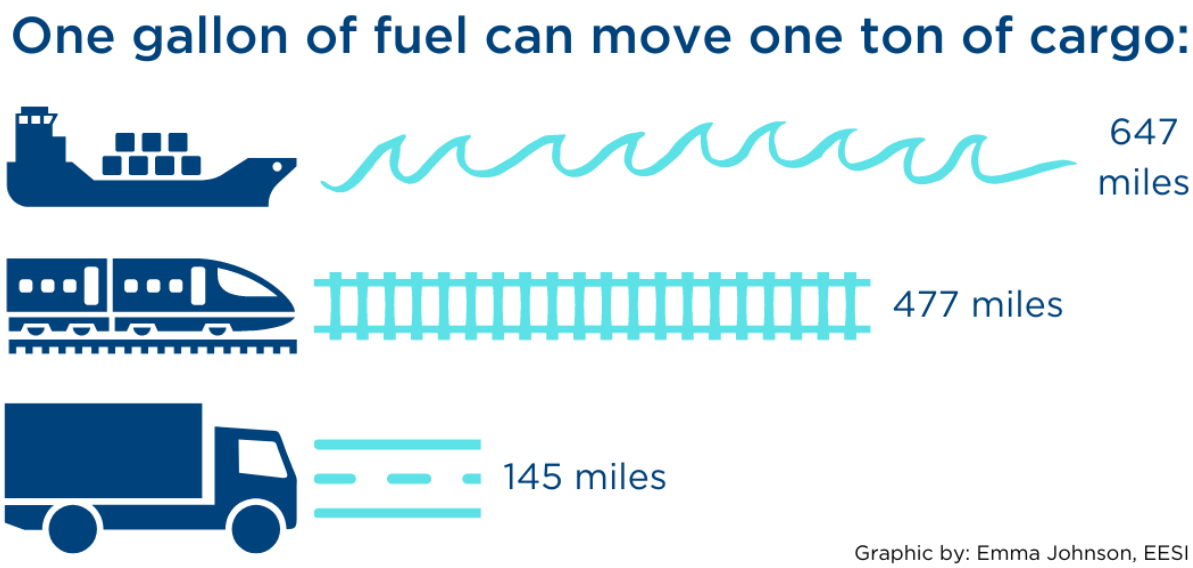
Large buildings and open spaces make ports viable candidates for renewable energy, most often solar. Generating renewable energy at ports can decrease the need for fossil fuels, thereby reducing emissions and air pollution. The **Port of Seattle** has installed solar panels that reduce carbon dioxide emissions by over 2.2 tons, produce 120,000 kilowatt hours of energy, and save over $10,000 in energy-related costs every year.[26] The **Port of Los Angeles**—which already has three megawatts of solar installed—is currently installing additional solar panels that are expected to provide one-sixth of the port's total power demand.[27] The **Port of Long Beach** has also installed solar panels, with those installed in 2016 reducing carbon dioxide emissions by over 1,000 tons annually.[28]

Energy Efficiency

Energy efficiency also plays a key role in mitigating the climate impacts of ports. New structures at the **Port of Miami** are certified to at least the silver level of Leadership in Energy and Environmental Design (LEED), which requires buildings to meet certain sustainability standards.[29] In 2012, the Port of Miami also installed white reflective roofing material, which serves as passive cooling technology for the buildings.[29] Similarly, the **Port of Savannah** installed lighting controls and fixtures that reduced light pollution and energy consumption by 60 percent.[40]

Operations

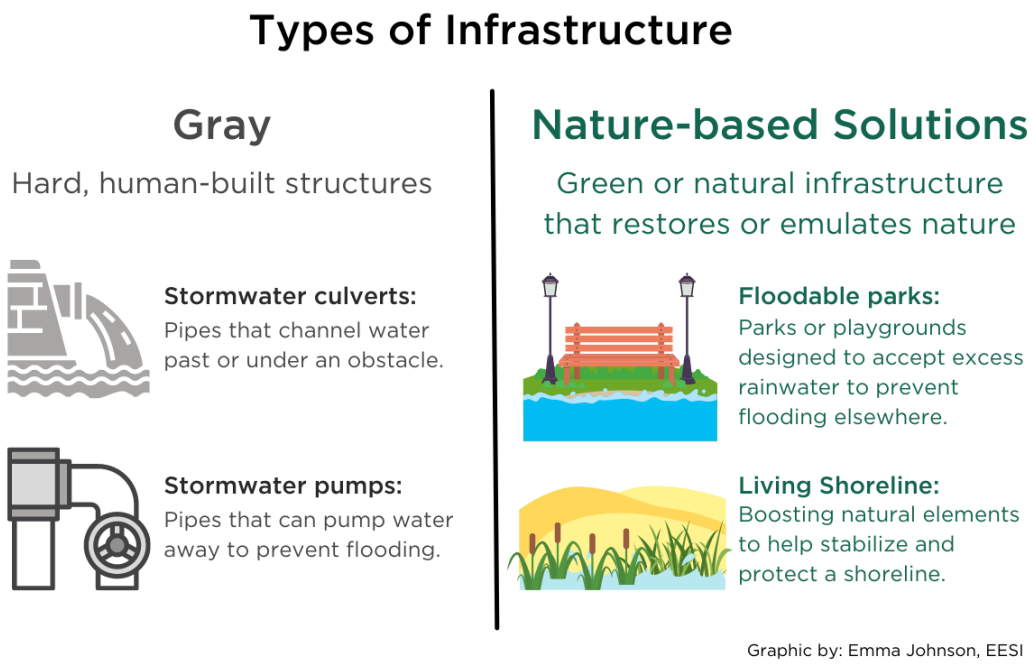
Ports can also modify their operations to reduce energy waste. For instance, using barges or rail to transport cargo is more efficient than using trucks: one gallon of fuel can move one ton of cargo 647 miles by barge, 477 miles by rail, and 145 miles by truck.[30] The process of off-loading cargo to overland modes of transportation can also be made more efficient. For example, the **Port of Cincinnati** relocated its truck and rail loading yards to minimize the frequency that cargo is handled while at the port, while also prioritizing rail over trucks.[31]



While trucking cannot be completely removed from port operations, it can be made more efficient. The **Port of Miami** and the **Port of Oakland** have both installed electronic security gates that open more quickly than manual gates to minimize truck idling and reduce fuel waste, cutting down unnecessary emissions.[29,32] In 2019, the **Port of Oakland** released a plan to further reduce truck idling by reengineering railroad locations around the port to reduce congestion.[32] [32] This will also have the co-benefit of reducing air and noise pollution for those living and working near the port.[32]

Climate Change Adaptation

Climate impacts are increasingly affecting port operations. As a result, ports must consider their near-term and long-term climate change vulnerabilities when planning for the future. In many cases, infrastructure will be needed to protect ports from flooding and sea level rise.



Graphic by: Emma Johnson, EESI

Gray Infrastructure for Shoreline and Flood Protection

Shoreline and flood protection come in two forms, gray infrastructure and nature-based solutions. Gray infrastructure is hard, human-constructed infrastructure whereas nature-based solutions include green and natural infrastructure (as discussed in the section below).[33] Many ports employ gray infrastructure—including wave attenuators such as bulkheads and seawalls—to combat sea level rise, flooding, and increased wave action from extreme weather. In its *Climate Adaptation and Coastal Resiliency Plan,* the **Port of Long Beach** identifies several gray infrastructure-focused climate adaptation strategies, including the installation of concrete barrier walls to protect against flooding.[2]

Some hard structures can be built using specialized building materials that improve habitat. In 2021, the **Port of San Diego** launched a three-year pilot project with ECOncrete, an eco-engineering company, to develop shoreline and erosion infrastructure that will provide habitat value.[34] The port hopes ECOncrete's environmentally sensitive concrete solutions will lead to shoreline stabilization, coastal flooding prevention, and improve habitats.[34]

Nature-based Infrastructure for Shoreline and Flood Protection

Research has shown that nature-based infrastructure—such as wetlands, reefs, living shorelines (an approach for addressing shoreline erosion that uses natural materials like plants, rocks, and sand), coastal dunes, and mangroves—can be just as effective, and often more effective, than gray infrastructure at protecting ports from climate impacts.[35] Nature-based solutions also provide the additional benefits of mitigating climate change, supporting plant and animal biodiversity, and improving water quality while also avoiding the use of carbon-intensive materials such as concrete, cement, and steel.

The **Port of Miami** restored 40 acres of mangroves at Oleta River State Park, planted trees at the port, and relocated coral to a designated Coral Habitat Area on port property, all of which increase the port's climate resilience and support wildlife habitat.[36] The **Port of San Diego**'s *2019 Sea Level Rise Vulnerability Assessment and Coastal Resiliency Report* looked at living shorelines and living breakwaters as approaches to protect shorelines from erosion and reduce wave action.[37] Beyond breakwaters, green and natural infrastructure like floodable parks, bioswales, and rain gardens can prevent flood damage to buildings during extreme weather while also providing habitat for plants and animals. The **Port of Portland**, for example, has installed rain gardens and vegetated swales as green infrastructure for managing stormwater.[38]

Stormwater

Effective stormwater management is crucial for protecting ports from more frequent and severe storms and extreme weather caused by climate change. Stormwater runoff can pick up pollutants on paved surfaces at ports and impact water quality by depositing them in the ocean or other bodies of water without treatment. Using a *Transportation Investment Generating Economic Recovery* (TIGER) grant, the **Port of Baltimore** installed a concrete stormwater management system to hold large amounts of water during extreme rain events.[7] The TIGER grant also enabled the elevation of some of the port's important assets, improving its resilience to sea level rise.[7]

Other ports have used nature-based solutions for treating stormwater. The **Port of Seattle** uses oyster shells in stormwater catchment basins to increase the amount of dissolved calcium and magnesium in water and remove copper.[39] The **Georgia Port Authority** created nine acres of wetlands, which treat 100 million gallons of stormwater every year and provide habitat for plants and animals.[40] Reducing port-related water pollutants can also improve surrounding aquatic ecosystems. The **Port of San Diego** found that hull paint released copper into waterways, which affected the port's marine ecosystem. Through repainting and cleaning programs, the port reduced copper in the water by 45 percent.[41]

Dredging

In some cases, dredged material can be used to increase resilience to climate impacts. According to the U.S. Army Corps of Engineers, which maintains waterways in the United States, demand for dredging and dredged material is increasing for coastal restoration and channel maintenance.[42]

Major channels in the Chesapeake Bay and the **Port of Baltimore** are maintained at 50-foot depths, which requires the Maryland Port Administration and the Army Corps of Engineers to remove about 5 million cubic yards of dredged material every year.[7] Ports are increasingly using this dredged material for beneficial use (e.g., in-water applications such as beach nourishment) and innovative reuse (e.g., land applications such as brownfield clean-up). For example, the Maryland Port Administration is using dredged material to restore the previously eroded Poplar Island in the Chesapeake Bay, which has helped restore wildlife habitat and provide shoreline protection.[7] However, dredging and the use of dredged materials can have negative ecosystem impacts, which must be managed. Dredging can cause sedimentation to cover sea grasses and coral, increased turbidity, and disturbances to fish and other aquatic organisms. For example, dredging at the **Port of Miami** resulted in widespread coral death when nearby reefs were covered in sediment.[43]

Port Planning and Policy Resources

Ports that are taking steps to reduce their greenhouse gas emissions, adapt to climate impacts, and address environmental quality challenges have developed practices and resources to carry out this work. Outside entities have also established programs to bolster sustainability work at ports.

Adaptation Plans and Emission Inventories

Some U.S. ports are developing climate mitigation and resilience and adaptation plans or updating existing ones. For example, the **Port of San Diego** released a *Sea Level Rise Vulnerability Assessment and Coastal Resiliency Report* in 2019 to assess climate impacts.[37] The **Port of Seattle** is part of an alliance called Washington Maritime Blue which aims to accelerate the blue economy and drive sustainability in Washington State's maritime industry.[44]

Some ports in the United States create and then subsequently update emission inventories. According to the EPA, 13 U.S. ports produce greenhouse gas emission inventories, and seven of those have set emission reduction targets.[45] The **Ports of Los Angeles, Long Beach,** and **New York and New Jersey** have produced the most recent and consistent emission inventories.[4,5,6]

Federal Resources for Port Sustainability

The EPA Ports Initiative works with U.S. ports and local communities to improve environmental performance.[46] The program provides technical resources, such as guides on creating port emission inventories, and toolkits and resources to promote community-port collaboration. The Ports Initiative is currently running pilot projects at four ports to provide technical assistance for community collaboration.[46]

Additionally, the EPA Ports Initiative provides a list of several federal, state, local, and private funding opportunities for ports and near-port communities to reduce emissions and improve the environment.[47] Federal funding opportunities for port sustainability include EPA's *Diesel Emissions Reduction Act* (DERA) funding program and the Department of Transportation's Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant program (formerly known as TIGER or BUILD). According to EPA, 26 ports have received federal DERA grants to reduce emissions.[47]

International Port Sustainability Programs

Multiple international programs exist to help ports reach their sustainability goals and hold them accountable. The Green Marine Program is a voluntary environmental certification for the North American marine industry and is based on 14 performance indicators that assess air, water, and land pollution.[48] Another program, the World Port Sustainability Program, is guided by the United Nations' 17 sustainable development goals and aims to advance port sustainability worldwide.[49]

For more information on ports, watch EESI's briefing *Ports Leading the Way on Mitigation and Resilience*.

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This fact sheet is available electronically (with hyperlinks and endnotes) at *www.eesi.org/papers*.

The Environmental and Energy Study Institute (EESI) is a non-profit organization founded in 1984 on a bipartisan basis by members of Congress to help educate and inform policymakers, their staff, stakeholders, and the American public about the benefits of a low-emissions economy that prioritizes energy efficiency, renewable energy, and new clean energy technologies. In 1988, EESI declared that addressing climate change is a moral imperative, which has since guided our work toward our vision: a sustainable, resilient, and equitable world.

ENDNOTES

[1] "Our economy relies on shipping containers. This is what happens when they're 'stuck in the mud'" (October 1, 2021). World Economic Forum, www.weforum.org/agenda/2021/10/global-shortagof-shipping-containers/.
[2] "Port of Long Beach Climate Adaptation and Coastal Resiliency Plan" (2016). Port of Long Beach, www.slc.ca.gov/wp-content/uploads/2018/10/POLB.pdf.
[3] "Clean Port." South Coast Air Quality Management District, www.aqmd.gov/nav/about/initiatives/clean-port (accessed October 15, 2021).
[4] "Port of Los Angeles Inventory of Air Emissions – 2019" (September 2020). Port of Los Angeles, www.portoflosangeles.org/environment/air-quality/air-emissions-inventory.
[5] "Air Emissions Inventory – 2019" (September 2020). Port of Long Beach, https://polb.com/environment/air/#emissions-inventory.
[6] "The Port Authority of New York and New Jersey Port Department 2019 Multi-Facility Emissions Inventory" (December 2020). The Port of New York & New Jersey, www.panynj.gov/port/en/our-port/sustainability/air-emissions-inventories-and-related-studies.html.
[7] "Ports leading the way on mitigation and adaptation" (November 17, 2020). Environmental and Energy Study Insitute, www.eesi.org/briefings/view/111720transportation.
[8] "Environmental Justice Primer for Ports: Impacts of Port Operations and Goods Movement." U.S. Environmental Protection Agency, www.epa.gov/community-port-collaboration/environmental-justice-primer-ports-impacts-port-operations-and-goods (accessed October 7, 2021).
[9] "Ports Primer: 7.1 Environmental Impacts." U.S. Environmental Protection Agency, www.epa.gov/community-port-collaboration/ports-primer-71-environmental-impacts (accessed January 24, 2022).
[10] "Analysis of electric-rubber tyred gantries for a more green Durban Container Terminal" (June 2015). IOSR Journal of Engineering, www.iosrjen.org/Papers/vol5_issue6%20(part-2)/E05622428.pdf.
[11] "Greenhouse Gas Equivalencies Calculator." Environmental Protection Agency, www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (accessed January 24, 2022).
[12] "Reefer Express Goes Green" (August 6, 2019). Georgia Ports, https://gaports.com/blog/reefer-express-goes-green/.
[13] "GPA completes latest fuel-saving eRTG phase" (January 17, 2020). Georgia Ports, https://gaports.com/press-releases/gpa-completes-latest-fuel-saving-ertg-phase/.
[14] "Georgia Ports Authority Reduces Diesel Emissions, Improves Efficiency, and Saves Costs." U.S. Environmental Protection Agency, www.epa.gov/ports-initiative/georgia-ports-authority-reduces-diesel-emissions-improves-efficiency-and-saves#projects (accessed October 8, 2021).
[15] "Seaports Need A Lot Of Energy, But Electrification Can Reduce Pollution and Costs." Alliance to Save Energy, www.ase.org/blog/seaports-need-lot-energy-electrification-can-reduce-pollution-and-costs (accessed January 27, 2022).
[16] "Green Omni Terminal" (2018). Burns & McDonnell, www.burnsmcd.com/projects/green-omni-terminal.
[17] "Shore Power Technology Assessment at U.S. Ports." U.S. Environmental Protection Agency, www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports (accessed October 8, 2021).
[18] "Clean Cargo: Can America's biggest ports go green?" (June 2019). Governing States and Localities, https://archives.erepublic.com/GOV/GOV_Mag_Jun2019.pdf.
[19] "Alternative Marine Power." Port of Los Angeles, www.portoflosangeles.org/environment/air-quality/alternative-maritime-power-(amp) (accessed October 8 , 2021).
[20] "At-Berth Ocean-Going Vessels Regulation" (December 18, 2008). California Environmental Protection Agency, https://sustainableworldports.org/wp-content/uploads/CARB-FACTS-ABOUT-At-Berth-Ocean-Going-Vessels-Regulation.pdf.
[21] "California approves updated "At-Berth" regulation, expanding efforts to cut pollution from ships in California ports" (August 27, 2020). California Air Resources Board, https://ww2.arb.ca.gov/news/california-approves-updated-berth-regulation-expanding-efforts-cut-pollution-ships-california.

[22] "Attachment D: Analyses Supporting the Second Notice of Public Availability of Modified Text and Availability of Additional Documents and Information" (July 10, 2020). California Air Resources Board, https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/ogvatberth2019/2nd15dayattd.pdf.
[23] "CLEAN TRIP" (2019). The Port of New Orleans, www.portnola.com/community/sustainable-development/clean-trip.
[24] "EPA awards more than $1.2M to Port of New Orleans to help reduce diesel emissions" (December 8, 2020). U.S. Environmental Protection Agency, www.epa.gov/newsreleases/epa-awards-more-12m-port-new-orleans-help-reduce-diesel-emissions.
[25] "Port builds electric charging stations for battery electric trucks" (July 19, 2021). Port of Oakland, www.portofoakland.com/press-releases/zero-emissions-truck-project-launches-at-port-of-oakland/.
[26] "Solar Power at the Port" (August 1, 2020). Port of Seattle, www.portseattle.org/projects/solar-power-port.
[27] "Solar Power." Port of Los Angeles, www.portoflosangeles.org/environment/sustainability/solar-power (accessed October 8, 2021).
[28] "Solar Panels Installed at Port of Long Beach" (November 29, 2016). Mitsubishi Electric Solar Innovation, www.mitsubishielectricsolar.com/images/uploads/documents/press/LBCT_press_release_-_final.pdf.
[29] "Protecting the Environment." Port of Miami, www.miamidade.gov/portmiami/sustainability.asp (accessed October 13, 2021).
[30] "A Modal Comparison of Domestic Freight Transportation Effects on the General Public: 2001-2014" (January 2017). Texas A&M Transportation Institute, www.nationalwaterwaysfoundation.org/documents/Final%20TTI%20Report%202001-2014%20Approved.pdf.
[31] "Audit Template for Inland Port Sustainability" (2014). Kentucky Transportation Center, https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=2462&context=ktc_researchreports.
[32] "Seaport Air Quality 2020 and Beyond Plan" (May 2019). Port of Oakland, www.portofoakland.com/files/PDF/Volume%20I.pdf.
[33] "Fact Sheet: Nature as Resilient Infrastructure-An Overview of Nature Based Solutions" (October 16, 2019). Environmental and Energy Study Institute, www.eesi.org/papers/view/fact-sheet-nature-as-resilient-infrastructure-an-overview-of-nature-based-solutions.
[34] "Port of San Diego and ECOncrete Begin Pilot Project to Boost Coastal Infrastructure and Ecosystems on Harbor Island" (February 3, 2021). Port of San Diego, www.portofsandiego.org/press-releases/general-press-releases/port-san-diego-and-econcrete-begin-pilot-project-boost.
[35] "The Coastal Squeeze: Changing Tactics for Dealing with Climate Change" (June 14, 2019). www.fisheries.noaa.gov/feature-story/coastal-squeeze-changing-tactics-dealing-climate-change.
[36] "A Sustainable Port" (2020). PortMiami, www.miamidade.gov/portmiami/sustainability.asp (accessed July 2020).
[37] "Sea Level Rise Vulnerability Assessment & Coastal Resiliency Report" (June 2019). Port of San Diego, https://pantheonstorage.blob.core.windows.net/environment/FINAL-San-Diego-Unified-Port-District-Sea-Level-Rise-Vulnerability-and-Coastal-Resiliency-Report-AB691.pdf.
[38] "Stormwater Maintenance Facilities: Operation and Maintenance and Inspections." Port of Portland, https://popcdn.azureedge.net/pdfs/StrmWtr-FactSheet-Management_Facilities.pdf (accessed December 16, 2021).
[39] "Maritime Stormwater Program." Port of Seattle, www.portseattle.org/programs/maritime-stormwater-program (accessed October 13, 2021).
[40] "Community and Sustainability." Georgia Ports, https://gaports.com/our-port/community-sustainability/ (accessed January 24, 2022).
[41] "Copper Reduction Program." Port of San Diego, www.portofsandiego.org/environment/environmental-protection/copper-reduction-program (accessed July 2020).
[42] "USACE Climate Action Plan." U.S. Army Corps of Engineers, www.sustainability.gov/pdfs/usace-2021-cap.pdf (accessed December 16, 2021).
[43] "New study finds over half a million corals killed during Port of Miami dredging" (May 29, 2019). USF College of Marine Science, www.usf.edu/marine-science/news/2019/new-study-finds-over-half-a-million-corals-killed-during-port-of-miami-dredging.aspx.
[44] "Maritime Blue Accelerator 2020." Port of Seattle, www.portseattle.org/programs/maritime-blue-accelerator-2020 (accessed January 27, 2022).
[45] "Interactive map highlighting clean air practices at ports." U.S. Environmental Protection Agency, www.epa.gov/ports-initiative/best-port-wide-planning-practices-improve-air-quality (accessed October 26, 2021).
[46] "Ports Initiative." U.S. Environmental Protection Agency, www.epa.gov/ports-initiative (accessed October 26, 2021).
[47] "Funding Opportunities for Ports and Near-Port Communities." U.S. Environmental Protection Agency, www.epa.gov/ports-initiative/funding-opportunities-ports-and-near-port-communities (accessed October 26, 2021).
[48] "Green Marine" (2020). Green Marine, https://green-marine.org/.
[49] "Sustainable World Ports." Sustainable World Ports, https://sustainableworldports.org/ (accessed August 2020).