

# Clean Air Guide for Ports & Terminals

Technologies and Strategies to Reduce Emissions and Save Energy



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# INTRODUCTION

Many ports operate in regions that fail to meet federal health-based air quality standards. Many also operate near communities that face significant air quality challenges. Consequently, port authorities and marine terminal operators have engaged in efforts to **reduce emissions** from freight transportation activities. In striving for the goal of addressing all sectors of operations, **best practices** have proven effective at a variety of ports and terminals. Implementing more of these practices across the country will reduce harmful air emissions. Together, the strategies and technologies in this guide can drive innovation, build partnerships, and ultimately improve the **economic and environmental performance** of port authorities and marine terminal operators.

Many of these best practices are applicable at both landlord and operating ports. While each port or terminal will adapt the tools to fit their own operating requirements, this guide showcases how the initiatives implemented at one port have valuable learnings for others in the industry.

Similarly, terminal operators are varied in their business profiles as compared to ports. Their commonalities, however, make terminal operators well positioned to be engaged partners in the drive toward energy savings and emissions reductions. Ultimately, terminal operators will help the industry achieve the next generation of air quality improvements.

Port authorities and marine terminal operators are only one part of the puzzle of reducing localized emissions from freight transportation. Although no stakeholder can solve the challenge single-handedly, the strategies and technologies presented here emphasize the collaborative nature of improving environmental performance.

# HOW TO USE THE GUIDE

This guide describes frameworks, such as leveraging tenant relationships, as a first step in establishing the groundwork for individual sector strategies. These frameworks are divided into **measurement practices, planning initiatives, and engagement strategies**. Ensuring that these three elements are in place will facilitate and enhance any future emissions reduction project.

The guide is then organized by sector and includes a brief description, a successful example, and a characterization of derived benefits and needed resources or considerations, such as time or money. Certain elements are highlighted as model strategies or technologies. The digital version of this guide links the capitalized blue text to a more in-depth profile. Individual sectors include **heavy-duty trucks, ocean-going vessels, cargo-handling equipment, rail, and harbor vessels**.

Sector strategies are divided into three categories of **frameworks, technologies, and operational actions**. Frameworks are overarching actions that lay the foundation for implementing projects. Technologies are about introducing cleaner equipment, and operational actions incentivize behavioral change that reduce emissions. These categories help differentiate which strategies are more appropriate for landlord versus operating ports. Readers should approach the tables from left to right, beginning with the category and then an individual strategy.

The guide emphasizes strategies and actions which are able to be implemented or supported directly by ports and terminals. Therefore, the derived benefits and needed resources are from the perspective of ports and terminals. The benefits from implementing these strategies range from reductions in particulate matter (PM) and ozone precursors, like nitrogen oxides (NOx), to traffic congestion and community concerns. Many of the operational improvements are also a financial benefit as they reduce operational costs through efficiency gains. Depending on particular needs, a port or terminal may elect to implement different suites of strategies.

Prioritization and tailoring can occur even within one particular strategy to emphasize benefits of a certain nature. For example, a clean truck program may focus on replacing/introducing specific model years to maximize NOx reductions. Or an air strategy plan may focus on engagement opportunities with the community. An individual analysis will help frame targets for ports and the accompanying key strategies. A roadmap for implementation is provided to help frame decision-making on selecting strategies.

The sector analysis is accompanied by a section on funding strategies, which is cross-cutting and applies to all areas. Many air quality projects have been implemented through a combination of private and public investment, and the guide highlights efforts that leverage multiple resource opportunities for maximum air quality benefits.

*Inclusion of a product, technology, company or entity in this guide does not constitute an endorsement by EDF.*

# ADDITIONAL CONSIDERATIONS

In order to make the guide accessible and user friendly, we have condensed discussion of each tool. Certain elements are noted here to provide additional context.

- **Alternative fuels** – From LNG to electricity, there are a variety of alternative fuel options to displace diesel as the traditional energy source for freight transportation equipment. Instead of selecting a particular fuel option, the guide elects to provide a summary of opportunities to use alternative fuels and allow each port or terminal to decide which fuel is most appropriate for each application. As industry moves toward zero-emission technologies, the alternative fuel space will undergo significant and rapid changes.
- **Automation** – As congestion concerns and demand for transport services increase, advanced automation is being implemented as one tool to improve port operations. Automating a terminal or parts of a terminal can be a lengthy process and requires close collaboration with maritime stakeholders, particularly labor. A mutually beneficial emissions reduction strategy can reduce emissions and improve overall efficiency.
- **Communications** – Sharing information and reporting results help advance clean air efforts by building trust and accountability as well as gaining knowledge from similar efforts. Strategic communications happens two ways, and a successful organization is prepared to receive feedback, suggestions, and information from stakeholders. Developing a platform for communications may be helpful in developing a communications strategy.
- **Community partnerships** – Port activity affects neighboring communities through emissions generation, land use, water quality, noise, traffic, and economic development. As ports attempt to strengthen each of these areas, a collaborative relationship with community organizations from the early stages of a project can add a vital perspective and contribute to the project’s design and implementation. These relationships, as with any stakeholder, benefit from open dialogue, shared objectives, and common understandings. Improving air quality is a multi-party effort that benefits from community engagement.
- **Compliance** – This guide was developed outside the scope of compliance issues and serves as a resource for air emissions reductions efforts. Regulatory requirements may differ from region to region, and each entity is responsible for ensuring compliance under their jurisdiction.
- **Construction** – Many ports and terminals are undergoing major construction projects. These projects may have significant impacts on neighboring communities that extend beyond air quality concerns. Given the high visibility, significant capital costs, and opportunity for new technology implementation, major construction projects have positive potential for emission reduction initiatives. Most directly, this entails establishing clean construction preferences for contractors and subcontractors.

- **Hotspots** – Certain areas at ports or terminals may be hotspots in terms of emissions challenges and require additional attention. A gate with a particularly long queue or a wharf with particularly old cranes are examples of hotspot areas within ports that may account for disproportionate emissions. Understanding these areas and their characteristics will help ports prioritize projects.
- **Leadership groups** – Participating in leadership groups demonstrates commitment, providing a way to shape future direction and learn from stakeholders. EPA’s Ports Workgroup, part of the Mobile Source Technical Review Subcommittee (MSTRS), is an example of a leadership group with a number of port and terminal representatives. Lending time and expertise to leadership groups may open doors to additional opportunities.
- **Mode shift** – Given that traditional trucks generate more emissions on a per container basis as compared to other modes of transport, shifting cargo to rail and barge is seen as a general emissions reduction strategy. However, infrastructure and scheduling constraints may dampen the opportunity for mode shift. Similarly, local geographies may not be able to sustain significant mode shifts depending on existing air quality challenges near alternative mode hubs, and further mitigation may be required.
- **Software** – Initiatives such as a Virtual Container Yard (VCY) or the Freight Advanced Traveler Information Program (FRATIS) leverage advances in information communication technologies to solve some of the most persistent efficiency challenges at ports. These programs help reduce emissions by reducing unnecessary vehicle miles traveled (VMTs) and idling, while also helping to reduce operational costs by providing critical information to facilitate drayage moves.
- **Transport Refrigeration Units (TRU)** – Additional scrutiny is being placed on refrigerated units at freight hubs and the potential of TRUs to reduced emissions associated with refrigerated transport. Alternative fueled TRUs, including fuel cell technology, are entering the market and may provide air quality benefits. The potential for TRUs includes truck, rail, and vessel applications.



# FRAMEWORKS

	Strategy	Description	Example	Benefits	Considerations
Measure	Emissions inventory	An inventory establishes a baseline for measuring emissions over time	<a href="#">Port Authority of New York and New Jersey emissions inventories by facility and sector</a>	Facilitates measurement of progress toward goal; provides for public facing data	Cost of consultant; staff time for review
	Profiling equipment	A profile facilitates an emissions inventory and can help target equipment investments	<a href="#">Truck registry through Intermodal Assoc. of North America (IANA)</a>	Sets up future successes and establishes coordination efforts by including tenants	Time to develop profile and coordinate with equipment owners and tenants
Plan	Clean air strategy	A public, data-driven strategic plan to reduce multi-sector emissions at the port; includes performance targets	<a href="#">Northwest Ports Clean Air Strategy at Port of Seattle, Port of Tacoma, and Port Metro Vancouver</a>	Enables progress tracking; builds public and stakeholder confidence; demonstrates commitment	Resources to develop and implement strategy
	Community engagement	A formalized path for community dialogue and engagement	<a href="#">Port of Oakland Maritime Air Quality Improvement Plan with community stakeholders</a>	Identifies common objectives early; improves dialogue; establishes common framework	Staff time; risk of segregating all community engagement into one effort
	Funding opportunities	Identify funding sources and draft project ideas with stakeholders during planning process	<a href="#">Port of Houston federal grants with support of partner fleet</a>	Leverages public funds to match internal investment	Time required to apply; meeting grant requirements
	Collaborative goals	In emission reduction projects, setting a goal that involves diverse partners can leverage further resources	<a href="#">Port of New Orleans sustainability indicators with University of New Orleans</a>	Helps advance clean tech; positions port as a leader and innovator; builds relationships with tech providers	Time required for coordination; financial element of projects; capital planning for cost-share

# FRAMEWORKS (Continued)

	Strategy	Description	Example	Benefits	Considerations
Engage	Technology demonstration	Innovative tech. can dramatically reduce emissions but need to be proven in the real world	<a href="#">Technology Advancement Program at Port of Los Angeles and Port of Long Beach</a>	Leverages financial and political support for projects	Technology risks, time to build partnerships
	Tenant/Operator partnerships	Compliance workshops, lease agreements, and grants can help tenants/operators reduce emissions	<a href="#">Green Practices Task Force at PANYNJ</a>	Leverages additional resources; can be foundation for future projects	Time to build mutually beneficial partnerships
	Incentive programs	Initiatives such as Green Marine and Environmental Ship Index can frame sustainability plans	<a href="#">Port of Long Beach Green Flag Program</a>	Provides credibility; introduces accepted benchmarks	Time to participate in reporting requirements and program targets
	Standards and policies	Establishing port or terminal-wide environmental standards can quickly and uniformly reduce emissions	<a href="#">Clean truck standards at Port of LA and LB</a>	Places emissions reductions on an accelerated path	Difficulty in securing acceptance from stakeholders
	Operational improvements	Efficiencies reduce turn times and reduce emissions	<a href="#">James River Barge Service in Virginia</a>	Enables productivity co-benefits	Difficulty in attributing emissions benefits to operational changes

# HEAVY-DUTY TRUCKS

	Strategy	Description	Example	Benefits	Considerations
Frameworks	Drayage outreach	A forum for the driver and drayage community helps in disseminating information and recruiting fleets	<a href="#">Port of Tacoma Truck Outreach</a>	Early and ongoing outreach builds a platform for future projects	Staff time in developing relationships and conducting outreach
	EPA SmartWay Program	Established program for improving fuel efficiency and environmental performance of goods movement	<a href="#">Mid-Atlantic Dray Truck Program</a>	Builds on proven, well-known model	Administrative costs
	Collaborative programs	Coordinated efforts can validate port efforts and help verify data	<a href="#">Regional cooperation as part of truck programs at Northwest ports</a>	Data sharing can help streamline practices	Requires external agency involvement
	Truck registry	Truck registries are a valuable data source for truck emission initiatives	<a href="#">Drayage Truck Registry at Ports of LA and LB</a>	Helps track progress toward goals	Initial set-up costs but long term costs are minimal
Technology	<a href="#">CLEAN TRUCK PROGRAM</a>	Incentivizing drayage truck replacement to cleaner models	<a href="#">Drayage Loan Program at Port of Houston</a>	Highly cost effective programs that target major source of emissions	Ports have invested tens of thousands to millions in these programs
	Alt. fueling infrastructure	Port can play a big role in facilitating fueling infrastructure for hydrogen, nat. gas, electrification	<a href="#">Port of Los Angeles Zero Emission Initiatives</a>	Demonstrates leadership, helps industry advance	Cost to port may include offering land/space below market rates
	RFID tags	Wireless technology streamlines gates and truck registry data collection	<a href="#">Radio-frequency identification (RFID) at Port of Seattle</a>	Helps improve data accuracy, gate processing times	Initial system installation
	GPS	Some truck programs require the use of GPS units to track mileage and destination information	<a href="#">Houston trucks with Global Positioning System (GPS)</a>	Generates rich data set for further efficiency refinements	Minimal if working with third party data manager
	Automation	Automated Gate Systems (AGS) can reduce queue times and emissions	<a href="#">AGS at Port of Virginia</a>	AGS can reduce turn times and improve terminal efficiency	Cost for installation

# HEAVY-DUTY TRUCKS (Continued)

	Strategy	Description	Example	Benefits	Considerations
Operational	Green driving	Efficiency campaign focused on truck driving habits and operations	<a href="#"><u>Freight Advanced Traveler Information Program (FRATIS)</u></a>	Green driving can benefit drivers and the environment	Outreach can be time consuming but should build on drayage outreach
	Gate/chassis operations	More efficient gate and chassis operations can reduce VMTs and idle times	<a href="#"><u>Hampton Roads Chassis Pool at Port of Virginia</u></a>	As trade increases, improved efficiency is a business necessity	Requires cooperation from diverse stakeholders
	Reduce congestion	Many elements affect congestion, but reducing turn/wait times can reduce emissions	<a href="#"><u>Infrastructure investment by Georgia Ports Authority to reduce turn times</u></a>	Reducing congestion may also help address community concerns	Multi-party coordination can be politically difficult and time intensive
	Idling reduction	Measures taken by port to facilitate less idling	<a href="#"><u>Port of Vancouver USA anti-idling campaign</u></a>	Overall efficiency gains may reduce idling	Improving terminal efficiency is an ongoing and time intensive process

# OCEAN-GOING VESSELS

	Strategy	Description	Example	Benefits	Considerations
Frame-works	Incentive programs	External programs can frame further emissions reductions	<a href="#">Port Metro Vancouver partnership with RightShip</a>	External credibility and measurement frameworks	May need tailoring for unique port characteristics
Technology	Alternative fuels	Cleaner burning fuels that meet or exceed Emissions Control Area requirements	<a href="#">Alternative fuels position paper by DNV GL</a>	Vary upon type of fuel	Vary upon type of fuel
	Shore power	Enables vessels to turn off engines while docked and connect to landside electricity	<a href="#">Shore power at Prince Rupert Port Authority</a>	Directly reduce emissions closest to communities	Consider frequency of vessel calls; emissions of power source; vessel equipment
	<a href="#">MOBILE SCRUBBERS</a>	Flexibility of air scrubbing system that can be moved from vessel to vessel	<a href="#">Alternative Maritime Emission Control System (AMECS) at Port of Long Beach</a>	Ability to reduce emissions from more vessels	Equipment costs for ports
Operat-ional	Slow steaming/VSR	Vessel speed reduction (VSR) close to ports is proven to reduce emissions	<a href="#">VSR at Port of San Diego</a>	Flexibility with no new technology; take advantage of Automatic Identification System (AIS)	Must adapt to channel and traffic considerations

# CARGO-HANDLING EQUIPMENT

	Strategy	Description	Example	Benefits	Considerations
Frameworks	Equipment profile	Develop an inventory of CHE age and operational information	<a href="#">CHE section of Port of Long Beach emissions inventory</a>	Early data gathering helps frame future efforts and partnerships	Staff time and coordination required for updated profile
	Grant funding	Equipment replacement/ retrofits can be paid for in part by grant funding	<a href="#">Port of Houston grants from Texas Emissions Reduction Plan</a>	Leverage public funding for clean air initiatives	Time and coordination for application materials
	Tenant cooperation	Recruit fleets for equipment profile, grant funding, and partnerships	<a href="#">PANYNJ CHE Fleet Modernization Program for tenants</a>	Maximizes cost sharing and scope of project	Staff time and coordination for partnership
Technology	<a href="#">ELECTRIFICATION</a>	Electric cranes can fit different operational profiles and will replace older diesel equipment	<a href="#">Electric gantry cranes at Georgia Ports Authority</a>	Direct fuel savings and diesel emissions reductions	Lead time and capital cost for equipment investment
	Alternative fuels	Fueling constraints make some alternative fuels an ideal option for use in cargo equipment application	<a href="#">Clean Air Action Plan at San Pedro Bay Ports</a>	Infrastructure can help facilitate other alt. fuel projects	Equipment investment

# RAIL

	Strategy	Description	Example	Benefits	Considerations
Frameworks	EPA SmartWay Program	Established program for reducing emissions through shipper, logistics, and carrier participation and incentives	<a href="#">Port of Tacoma rail initiatives</a>	Builds on proven, widely-adopted model	Administrative costs
	Infrastructure improvements	New rail capacity is an opportunity to ensure latest clean technologies and operations are utilized	<a href="#">New container terminal at Port of Charleston (not rail specific)</a>	Demonstrate commitment to minimizing impacts from growth	Depends on project
Technology	<a href="#">SWITCHER ENGINE IMPROVEMENTS</a>	Transitioning engines to latest technology, such as hybrid gensets, with support of ports/MTOs	<a href="#">Alabama State Port Authority repower of Terminal Railway switcher locomotives</a>	Often provides greatest amount of emissions reductions	Capital investment from partners may be significant
Operational	Idling reduction	Similar to shore power system for vessels, locomotive idling can be reduced by connecting to the grid or using auto start stop	<a href="#">Port Authority of New York and New Jersey pilot of Kim Hotstart System to reduce idle of engines in cold weather</a>	Reduce fuel cost and emissions	Adding technology/developing a policy

# HARBOR VESSELS

	Strategy	Description	Example	Benefits	Considerations
Technology	Engine repower/retrofit	Repowering engines with support of ports/MTOs can have significant localized benefits	<a href="#">Puget Sound Clean Air Agency tugboat repower project</a>	Highly effective way to reduce emissions	Capital costs to equipment owners
	Shore power	Harbor vessels can plug in while docked to avoid emissions	<a href="#">Private tugboats at Port of San Diego using shore power</a>	Additional benefits of noise reduction	Land-side and water-side infrastructure costs
	<a href="#">ALTERNATIVE FUELS</a>	Fuels such as LNG can help reduce harmful diesel emissions	<a href="#">Wartsila LNG harbor tug</a>	Direct and significant emissions reductions	Fueling infrastructure, partnership development



# FUNDING

Financing emission reduction strategies and technologies for equipment owned by ports or by tenants will involve many stakeholders. Once sustainability considerations are built into overall strategic planning then long-term capital purchases, lease agreements, contracts, and other operational considerations can better incorporate clean air principles. The growth or changes in cargo patterns that many ports are experiencing is also an opportunity to secure long-term emission reductions from the very beginning of construction or modification projects.

Many successful clean air projects have leveraged private capital with public grant and loan opportunities that accelerate the emissions reductions trajectory. Some of the more well-known funding sources include the Diesel Emissions Reductions Act ([DERA](#)), the Transportation Investment Generating Economic Recovery ([TIGER](#)) grant program, and the Congestion Mitigation and Air Quality Improvement ([CMAQ](#)) program. The U.S. EPA provides a list of other relevant [transportation and air quality grant programs](#), including those from the Department of Energy. Similarly, the Maritime Administration and the American Association of Port Authorities have developed a “Port Planning and Investment Guide” that includes a [funding strategy module](#). While the module is not specifically about air quality, long-term capital investment projects can be tailored to maximize emissions reduction potential.

Emission reduction objectives are most successful when embedded into long-term capital planning that integrates established financing mechanisms with unique partnership opportunities. In some cases, the port authority or marine terminal operator is not the owner or operator of the equipment in question. Given their convening and landlord role, however, ports and terminals have the ability to engage with tenants and operators and facilitate emission reductions projects through tools like land easements, financial support, public support, and partner coordination.

Operational cost savings from many of these strategies will also help pay for a broader package of initiatives. Tactics that reduce congestion and improve efficiency yield an important benefit of reducing operational pressures at terminals and nearby infrastructure. By monetizing these direct benefits, ports can make a financial case for investing in emissions reductions.

As many ports and terminals look toward the next generation of emission reduction opportunities at a time of general growth for the industry, continuous improvement will require innovative partnerships and new financing mechanisms. Ensuring financial sustainability helps ensure the success of current projects and establishes the necessary groundwork for future efforts.

# ROADMAP FOR IMPLEMENTATION

The menu of options in this guidebook presents a broad array of diverse strategies to reduce emissions. As ports and terminals select strategies that are most relevant and beneficial to them, this roadmap for implementation helps demonstrate a sample package of initiatives. Strategies and packages will work best when tailored for each individual port. And common guiding principles help spread best practices across the industry.

As noted in the example below, ports approach strategies from the short and long-term and recognize that some initiatives are better suited for tenant/stakeholder cooperation or community engagement. In this example, the port prioritizes PM reductions and takes advantages of grant opportunities.

## EXAMPLE ROADMAP

**SITUATION:** Port serving as operator of one container terminal with near-dock rail and landlord of private terminals handling container and breakbulk. The port has not formally engaged tenants and community groups on air issues although they have a constructive relationship.

**FIRST STEP:** Their first step is implementing some of the framework strategies, including the development of an equipment profile for all operations and setting a timeframe for an emissions inventory. They also look for quick wins on cargo-handling equipment through funding opportunities and begin to develop a community engagement plan.

**SECOND STEP:** After analyzing their emissions profile and considering community priorities, they focus on developing a robust clean truck program that focuses on PM reductions and include GPS units and RFID tags as part of the program. They set a longer term goal for adding alternative fuel infrastructure.

**OTHER STEPS:** On the rail side, they work with their rail partners to apply for retrofit and replacement grants on switcher engines. Shore power is seen as having potential and they commission a study to explore the viability of employing the system at their port.

# ADDITIONAL RESOURCES

This resource guide builds on past clean air strategy efforts that have helped the goods movement industry move toward greater efficiency and reduced emissions. While some of the resources listed in this section are geared toward a specific sector or a specific issue, they all include practical tools that marine ports and terminals can utilize to improve their environmental performance.

Source	Title	Target Audience
U.S. EPA Region 1	<a href="#">Port Technology and Management Strategy</a>	Ports, terminals, vessel operators
Natural Resources Defense Council	<a href="#">Clean Cargo Guide</a>	Communities, freight industry
U.S. EPA	<a href="#">Port Sector Strategies</a>	Port authorities
Environmental Defense Fund	<a href="#">Green Freight Handbook</a>	Logistics managers, shippers
Port of Portland and International Institute for Sustainable Seaports	<a href="#">Environmental Initiatives at Seaports Worldwide</a>	Port authorities
Port of Long Beach	<a href="#">Sustainable Design and Construction Guidelines</a>	Port engineers and planners
Transportation Research Board	<a href="#">Truck Drayage Productivity Guide</a>	Transportation planners, drayage carriers
American Association of Port Authorities	<a href="#">Sustainable Design and Construction Guidelines</a>	Port project managers
Business for Social Responsibility	<a href="#">Assessing Terminal Operator Environmental Performance</a>	Terminal operators
Carbon War Room	<a href="#">Shipping Efficiency at Ports</a>	Port authorities
MIT Sloan School of Management	<a href="#">Greening of Rubber-Tired Gantry Cranes</a>	Ports authorities, terminal operators

# HIGHLIGHTED STRATEGIES

## HEAVY-DUTY TRUCKS **CLEAN TRUCK PROGRAM**

Truck programs have been vital elements of clean air efforts at ports and have resulted in significant emissions reductions. Ports have taken both voluntary and mandatory approaches, and many have provided or helped provide incentives to owner-operators and fleets to help facilitate the fleet turnover. The most successful programs share characteristics including:

- Administrative partner such as local council of governments
- Comprehensive driver and fleet outreach plan
- Support and visibility from port leadership
- Clear methodology to calculate emissions benefits
- Coupling with other strategies such as GPS and green driving to maximize emission benefits
- Targeted replacement of oldest trucks and introduction of trucks meeting most stringent emissions standard

[\*Return to Chart\*](#)

## OCEAN-GOING VESSELS **MOBILE SCRUBBERS**

Mobile scrubbers for ocean-going vessels, also known as bonnets in early versions of the technology, are being demonstrated for their effectiveness in reducing emissions at low cost. Considered an alternative to shore power, mobile scrubbers have the flexibility to operate on ships without major capital investments by the vessel operator. This is helpful for ships that do not make frequent calls at a particular port or where adding shore power capability is not feasible. The Advanced Emissions Control System at the Port of Long Beach is currently going through final testing after many rounds of initial trials.

[\*Return to Chart\*](#)

# HIGHLIGHTED STRATEGIES

(Continued)

## CARGO-HANDLING EQUIPMENT ELECTRIFICATION

Port and terminals have been increasingly pursuing the electrification of cargo-handling equipment as a method to reduce fuel use and emissions. As the industry moves toward [zero-emission frameworks](#), equipment electrification is one of the most direct paths to emissions reductions.

Due to their energy intensity, cranes represent a highly cost-effective opportunity. A recent [MIT study](#) highlights leading technologies and expected paybacks for greening cranes.

Expansion projects and long-term capital investment planning are well-suited for the electrification of cargo-handling equipment, particularly given co-benefits such as noise reduction, efficiency improvements, maintenance savings, and fuel savings.

[Return to Chart](#)

## RAIL SWITCHER ENGINE IMPROVEMENTS

While mode shifts and increased intermodal rail capacity are underway at many ports, the switcher engines that operate at rail yards also represent significant opportunities for emissions reductions. Ports and terminals can play an important role in facilitating the introduction of cleaner switcher locomotives by incentivizing and supporting such a transition. Specifically, ports can provide financial support, provide political support in grant applications, convene other stakeholders to leverage additional support, build collaborative clean air strategies, and develop complementary long term capital plans that advance clean air goals.

This is particularly impactful for ports due to the location of some rail facilities near overburdened communities seeking local emissions reductions. Rail connectivity is an important factor for port authorities, and clean air collaboration between ports and rail carriers on switcher engines can result in major emissions reductions.

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# HIGHLIGHTED STRATEGIES

(Continued)

## HARBOR VESSELS **ALTERNATIVE FUELS**

While alternative fuel options for harbor vessels are perhaps less advanced than other applications, there are promising technologies entering the market. Harbor vessel owners and operators can be supported by ports as they seek to make equipment upgrades and modernize their fleets. The Foss Maritime [hybrid tug](#) and the Wartsila [LNG tug](#) are two examples of alternative fuel technologies in this space. Both were heavily supported by local ports and terminals as their development and testing were demand and customer driven. The leadership role that ports take in overall emissions reductions had a significant positive impact in advancing alternative fuel options for harbor vessels.

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