Port Operational Strategies: Port Management Information Systems

This fact sheet is one of a series of documents produced by the EPA Ports Initiative to inform port stakeholders about potential emission reduction strategies.[1] Each fact sheet contains basic information about the strategy, emission impacts, cost components, and example programs. While each strategy can achieve benefits on its own, implementing them together could create synergies.[2]

Strategy Summary

Description: Port management information systems (PMIS)—also referred to as agile port or port community systems—electronically track ship movements, cargo manifests, drayage truck arrivals/departures, cargo handling equipment use, and other port activities. Software systems use the collected data to coordinate key port operations in the most efficient manner, maximizing productivity and minimizing delays and unnecessary fuel consumption.

Ports around the world have implemented variations of PMIS. The European Union has prioritized implementation of PMIS at its major ports, and funds research to further develop these systems. The Port of Rotterdam is well-known for its large-scale use of PMIS, and the Ports of Valencia and Hamburg also have developed advanced PMIS. In Asia, the Ports of Singapore, Hong Kong, and Busan are prominent users of PMIS.

Many major U.S. ports have implemented PMIS to varying extents including the Port of Virginia, Port Authority of New York and New Jersey[3], Port of Oakland[4], and the Port of Los Angeles. Many locations, such as the Northwest Seaport Alliance[5], have adopted standardized software-as-a-service systems with add-on modules for managing scheduling, truck registration, fee collection, and/or Radio Frequency Identification (RFID) tag management, among other functions.[6] Others, such as the Port of Los Angeles, have worked with service providers to design and implement tailored systems from the bottom up.[7]

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1 The emissions evaluated in these fact sheets include nitrogen oxides (NO_x), particulate matter (PM), hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2), and sulfur dioxide (SO_2).

2 See the Ports Initiative's fact sheets on gate management (https://www.epa.gov/ports-initiative/port-gate-management-strategies-improve-air-quality-and-efficiency-ports), virtual vessel arrival (https://www.epa.gov/ports-initiative/virtual-vessel-arrival-systems-ports-improves-air-quality-and-saves-fuel), and vessel speed reduction (https://www.epa.gov/ports-initiative/marine-vessel-speed-reduction-reduces-air-emissions-and-fuel-usage.

3 PortTruckPass (PTP) Port Authority of New York and New Jersey. https://www.porttruckpass.com/. Accessed 3-5-2021.

4 Port of Oakland Emodal Portal. http://portofoakland.emodal.com/. Accessed 3-5-2021.

5 Northwest Seaport Alliance Clean Truck Program. https://www.nwseaportalliance.com/environment/clean-air/clean-truck-program. Accessed 3-5-2021.

6 Advent Intermodal Solutions. 2020. Customer Case Studies. https://www.adventemodal.com/casestudy.html. Accessed 3-5-2021.

7 Port of Los Angeles and GE Transportation. 2019. Port Optimizer. https://www.portoflosangeles.org/business/supply-chain/port-optimizer%e2%84%a2. Accessed 3-5-2021.

A PMIS may focus on a subset of port operations or encompass all freight movement activities and integrate several efficiency improvement strategies. The port functions and technologies commonly addressed by PMIS are discussed below.

- ***Vessel scheduling:*** Advanced vessel scheduling functions, also known as virtual vessel arrival systems, can be integrated within PMIS to inform vessel operators to anticipate delays at destination ports. This can reduce or eliminate vessel wait times and associated hoteling emissions. While promising, virtual vessel arrival is a relatively new operational strategy and has been demonstrated only on a limited basis to date. [8]

- ***Drayage operations:*** PMIS can improve drayage efficiency through various gate management strategies, reducing truck wait times and associated idle emissions at terminal gates and inside freight yards. Ports have adopted three types of gate management strategies: truck appointment systems, extended hours of operation, and automated gate systems.

  Gate management strategies can redistribute drayage activity at ports, shifting truck arrivals away from peak periods and reducing average wait times at the terminal gates. A well-designed program can also improve the coordination of freight transfer and staging activities within a port, decreasing truck turn times and reducing the number of empty backhauls and tractors without trailers (bobtail) trips. Various strategies have been tested and fine-tuned over several years at many ports, including Los Angeles and Long Beach, New York and New Jersey, Baltimore, Savannah, New Orleans, and Oakland.[9]

- ***Cargo handling equipment (CHE):*** PMIS can streamline cargo handling operations across a port. Primarily designed for container operations, integrated CHE management can improve efficiency of manual CHE operations and enable increased automation (Figure 1), allowing for more rapid loading and unloading of trucks.

Figure 1. Automatic Guided Vehicle Transporting Two 20-Foot Containers[10]

  A PMIS uses various algorithms to streamline manual and automated CHE operations. The PMIS requires access to detailed, up-to-date information on ship, truck, and container location, as well as yard space. By combining these data streams, PMIS can provide better container

8 U.S. Environmental Protection Agency. 2020. Port Operational Strategies: Virtual Vessel Arrival. https://www.epa.gov/ports-initiative/virtual-vessel-arrival-systems-ports-improves-air-quality-and-saves-fuel.

9 U.S. Environmental Protection Agency. 2020. Port Operational Strategies: Gate Management. https://www.epa.gov/ports-initiative/port-gate-management-strategies-improve-air-quality-and-efficiency-ports.

10 Alf van Beem, Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Automated_guided_vehicle_container_mover_at_Port_of_Rotterdam.JPG. Accessed 3-5-2021.

routing and storage decisions, resulting in more efficient allocation of CHE. For instance, PMIS can inform yard operators in advance which containers need to be staged for loading at what times.

Container storage and stacking presents a unique logistical challenge, one that is particularly suited to PMIS. Since only the top container in a stack can be moved at a time, reducing temporary stacking and shuffling can create significant efficiencies. Through rapid container identification and schedule coordination, a well-designed PMIS can plan ahead, allowing sorting and stacking of containers to give drayage trucks faster access to their designated freight and thereby shorten turn times. Effective identification and scheduling also facilitate better stowage techniques (e.g., grouping containers bound for specific destinations together during vessel loading, or double-cycling, which involves simultaneous unloading and loading of the same vessel). Better information management also allows container terminals to reduce empty backhauls.

- ***Automated gate systems:*** These systems use a range of technologies to improve communication between the terminal gate and the freight yard. Typically integrated within a port's terminal operating system or PMIS, they automatically identify trucks and containers and facilitate access, loading, and unloading for drayage trucks entering the terminal gate.[11]

  Automated gate system technologies include:

  - *Bar code readers and mounted data collection computers,* which use bar code labels and laser scanners to identify and track containers at gates and within the terminal.
  - *Optical character recognition (OCR) systems,* which use cameras and scanners to identify containers, chassis information, and truck license plates upon entry and exit. OCR systems may be easier to install and maintain than other technologies that require tag application or receiver installation, since their scanners can read existing markings and identification placards.[13]
  - *Radio frequency identification (RFID) systems,* which use tags attached to containers (Figure 2) and trucks that transmit information to RFID readers via radio signal.

Figure 2. Container-Mounted RFID Tag and Hand Scanner[12]

  - *Real-time location systems (RTLS*), which use wireless tags on trucks and containers to track their position relative to fixed receiving points.

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[11] Heilig, L., and Voss, S. 2017. Information Systems in Seaports: A Categorization and Overview. Information Technology and Management 18: 179–201. doi: 10.1007/s10799-016-0269-1. https://www.researchgate.net/publication/309666501_Information_systems_in_seaports_a_categorization_and_overview. Accessed 3-5-2021.

[12] Usage granted by ISL Institute of Shipping Economics and Logistics, Bremen, Germany, https://www.isl.org/. Accessed 3-5-2021.

[13] Port Strategy. 2013. OCR Grabs the World. http://www.portstrategy.com/news101/port-operations/planning-and-design/ocr-grabs-the-world. Accessed 3-5-2021.

- *Closed circuit television,* which uses strategically positioned gate and terminal cameras to assess real-time gate and yard conditions.
- *Differential Global Positioning System (DGPS),* which use satellite-based navigation systems to transmit truck and container location coordinates. This requires DGPS receivers on target units.

Some automated gate systems integrate multiple strategies. For example, the U.S. Department of Transportation's Freight Advanced Traveler Information System (FRATIS) combines automated gate technologies with a dynamic appointment system to streamline drayage activities.[14] FRATIS provides up-to-date information to drayage drivers so they can make more efficient decisions about routing, pickup and drop-off, shift scheduling, and mandatory rest periods. These systems electronically inform the driver using cellular applications about highway traffic, port queue times, and congestion. They also allow for more efficient matching of pickups and drop-offs because port operators can see the location of approaching trucks and match them to containers waiting for pickup.[15,16]

- ***Terminal operating systems:*** These provide centralized, integrated control of all terminal functions, including scheduling and management of vessels, drayage trucks, CHE, and RFID systems.
- ***Port community/single window systems:*** These track drayage trucks, containers, and ships, allowing port operators to see all this information in a "single window." The term is also used to describe systems that give key stakeholders access to selected operational data. Access is commonly granted to customs agents, shippers, and trucking and logistics companies that use location and scheduling information to coordinate their activities with the port, and to help the port meet regulatory requirements.

There are various ways to implement the operational efficiency strategies described above.[17] Figure 3 presents a generalized description of common PMIS components. Because of the tremendous variation in port size, configuration, throughput, labor requirements, and other operational details, a PMIS must be tailored to address each port's constraints and opportunities. In general, a successful PMIS optimizes control across each category of freight movement (e.g., container, bulk) for maximum benefit.

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14 U.S. Department of Transportation. n.d. Freight Advanced Traveler Information System (FRATIS). https://www.its.dot.gov/research_archives/dma/bundle/fratis_plan.htm. Accessed 3-5-2021.

15 U.S. Department of Transportation. n.d. Using Freight Advanced Traveler Information Systems to Promote Urban Freight Mobility. Presentation by Randy Butler. https://ftp.dot.state.tx.us/pub/txdot-info/freight/meetings/fratis.pdf. Accessed 3-5-2021.

16 U.S. Department of Transportation. n.d. Freight Advanced Traveler Information System (FRATIS). https://www.its.dot.gov/research_archives/dma/bundle/fratis_plan.htm. Accessed 3-5-2021.

17 Steenken, D., Voss, S., and Stahlbock, R. 2004. Container Terminal Operation and Operations Research—A Classification and Literature Review. OR Spectrum 26: 3–49. doi: 10.1007/s00291-003-0157-z. https://pdfs.semanticscholar.org/6aad/0d153b2f5d2170eab3c5678e907bdcb5ae53.pdf. Accessed 3-5-2021.

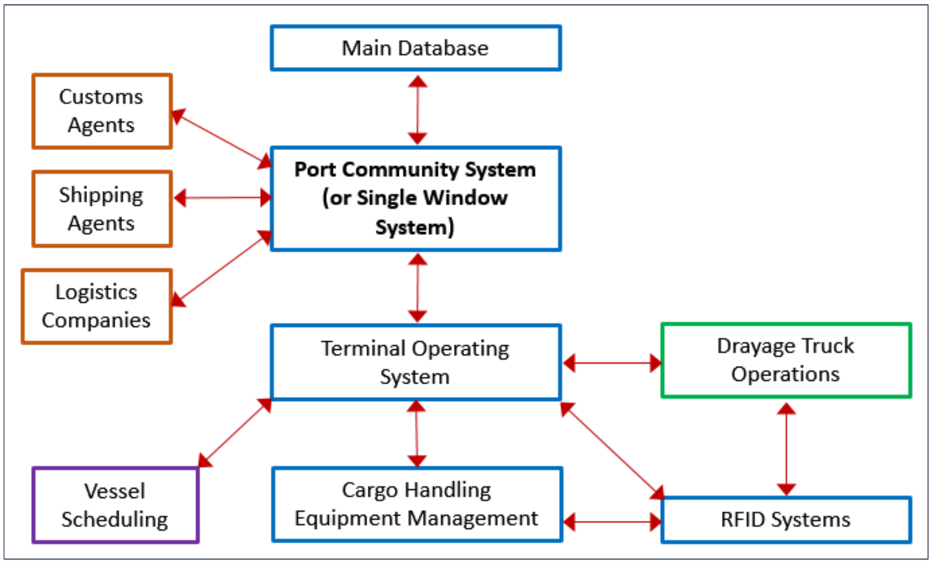

Figure 3. PMIS Information Flow and Control

Advantages: A well-designed, integrated PMIS can improve the overall efficiency of port operations in a variety of ways, reducing the time and fuel needed for ships to approach and dock, decreasing the number of container movements within the terminal yard, and improving drayage truck turn times. For example, Global Container Terminals (GCT) estimates that an integrated appointment system at the GCT Bayonne facility at the Port of New York and New Jersey improved truck turn times by over 40 percent.[18]

PMIS can significantly reduce demurrage, detention, and other costs associated with delays for both shippers and drayage carriers, thereby increasing port throughput capacity. By alleviating traffic congestion and engine idling, PMIS can reduce fuel use and engine emissions, which can improve the health of port workers and nearby communities.[19] For example, GCT estimates that decreased idle times from its truck reservation system at the Bayonne terminal has saved $5.3 million per year in fuel costs.[20]

PMIS can also reduce port administrative requirements and decrease the incidence of misplaced cargo by automatically tracking cargo manifests, facilitating customer invoicing, and automating reports covering all aspects of port operations. To the extent that yard congestion is decreased, and container moves are automated and/or reduced in number, these systems may also improve safety.

PMIS implementation can reduce truck traffic, shorten gate queues, and decrease diesel truck noise in and around a port. Reducing peak period traffic volumes reduces local road congestion, although community benefits may be offset to some degree by increased traffic and noise during off-peak hours. Improvements

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[18] U.S. Environmental Protection Agency. 2018. GCT Bayonne's Drayage Truck Appointment System. https://www.epa.gov/ports-initiative/gct-bayonnes-drayage-truck-appointment-system#reduced. Accessed 3-5-2021.

[19] Exposure to air pollution associated with emissions from diesel engines can contribute to significant health problems—including premature mortality, increased hospital admissions for heart and lung disease, increased cancer risk, and increased respiratory symptoms—especially for children, the elderly, outdoor workers, and other sensitive populations. (See U.S. Environmental Protection Agency. 2014. Near Roadway Air Pollution and Health: Frequently Asked Questions. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100NFFD.PDF?Dockey=P100NFFD.PDF. Accessed 3-5-2021.)

[20] U.S. Environmental Protection Agency. 2018. GCT Bayonne's Drayage Truck Appointment System. https://www.epa.gov/ports-initiative/gct-bayonnes-drayage-truck-appointment-system#reduced. Accessed 3-5-2021.

in facility throughput may also reduce locomotive dwell times and associated engine idling. Access to consistent, up-to-date activity information through single window systems may also facilitate cooperation and proactive problem-solving between the port and its stakeholders.

Considerations: PMIS typically focus on container operations and may offer fewer benefits for bulk and other types of terminals and cargo. In addition, ports that are already relatively efficient (or less congested) will realize fewer benefits from PMIS adoption.

The data streams managed by PMIS often include confidential business information, for example from private terminal operators and trucking companies. Data security must be ensured directly by the port authority or other organization responsible for PMIS operation, or through contractual requirements of the PMIS service provider. Depending on terminal and equipment ownership/lease arrangements, the PMIS operator may also need to mandate or otherwise coordinate the purchase and installation of the hardware and software necessary to collect, integrate, and distribute the information streams across the port.

PMIS offers the greatest potential efficiency improvements if the full range of components are implemented together, so that the system can coordinate all aspects of container movements. However, complete adoption will entail greater development costs, installation and testing requirements, and personnel training up front. In some cases, ports can still see benefits with a phased adoption—for example, a limited application of RFID tagging to a subset of containers might improve efficiency incrementally, allowing implementation costs to be spread out over time.

Appropriate port size and type: A port of any size can benefit from a well-designed PMIS. In general, large and complex container operations can benefit the most due to the large incremental efficiency improvements and cost savings that ports, terminal operators, freight carriers, and Beneficial Cargo Owners (BCOs) can realize.

Emission Reductions[21]

Primary Pollutants affected: NO_x, PM, HC, CO, CO_2, and SO_2

Anticipated reductions: PMIS supports a wide range of possible emission reduction opportunities. One example is the potential impact on drayage truck and CHE activity, which can contribute significantly to total port emissions (along with vessel scheduling/virtual arrivals, discussed in another EPA fact sheet).[22] For example, Table 1 presents the emissions by source type for the Barbours Cut Container Terminal at the Port of Houston. Combined, drayage trucks and CHE were responsible for 36.9 percent of NO_x emissions, 49.6 percent of $PM_{2.5}$ emissions, and 53.3 percent of CO_2 emissions at the terminal in 2013.[23]

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[21] The information in this section is for illustration: although the types of inputs and methods used in this section are generally consistent with EPA established methodologies, it does not constitute official EPA technical guidance for regulatory purposes. Please note that EPA has comprehensive guidance on developing inventories of emissions from ports and port-related goods movement. EPA's *Port Emissions Inventory Guidance*, September 2020, EPA-420-B-20-046, is available at EPA's web site at: www.epa.gov/state-and-local-transportation/port-emissions-inventory-guidance. Accessed 3-5-2021.

[22] U.S. Environmental Protection Agency. 2020. Port Operational Strategies: Virtual Vessel Arrival. https://www.epa.gov/ports-initiative/virtual-vessel-arrival-systems-ports-improves-air-quality-and-saves-fuel.

[23] In-terminal emission estimates from Eastern Research Group, Inc. 2017. 2013 Goods Movement Air Emissions Inventory at the Port of Houston. Available from the Port of Houston Authority upon request.

Table 1. Emissions by Source Type: Barbours Cut Container Terminal (2013)[24]

Source Type	NO_x	$PM_{2.5}$	CO_2
Oceangoing vessels	57.5%	47.2%	42.9%
Harbor craft	5.6%	3.2%	3.8%
Drayage trucks	6.8%	12.9%	11.5%
CHE	30.1%	36.7%	41.8%

For horizontal operations (i.e., temporary movements around the yard), CHE emission reductions associated with PMIS use will be proportional to the decrease in container movements. For drayage trucks, emissions benefits will mainly depend on decreased idle time, although streamlining truck routes through the terminal may reduce emissions as well. Decreased road congestion outside the port may further reduce emissions.

At the time of publication of this document, emission reductions associated with comprehensive PMIS adoption have not been estimated in the literature. This may be because many port efficiency improvements are often made slowly and incrementally, during which time port throughput may change, making it difficult to establish a clear baseline for comparison. To estimate potential emission reductions in advance, ports would need to characterize specific operational inefficiencies before PMIS implementation. The potential emission reductions from PMIS do not take into account other measures implemented during the measurement period (baseline to target year) that may improve efficiency, such as equipment changes and road improvements.

Calculation methodology: The inputs needed to calculate emission reductions from truck and CHE operation associated with PMIS adoption are listed below. This approach is limited to truck idle and CHE emission reductions at gate queues and on port property. (In some cases, though, these strategies also may reduce idle emissions in surrounding neighborhoods where trucks are waiting to enter port property.) It does not cover potential locomotive and marine vessel emission reductions associated with PMIS use.

Drayage truck inputs:

- Annual truck volume (trucks/year) for the analysis year
- Average turn time (hours/truck) before PMIS implementation, from baseline port data for a typical year
- Anticipated average turn time (hours/truck) after PMIS implementation[25]
- Drayage truck counts by model year, from gate surveys or other port records
- Heavy-duty truck idle exhaust emission factors (grams/hour) from EPA or California Air Resources Board emission models or EPA defaults—see Table 2 for diesel and natural gas emission factors.

[24] Ibid.

[25] The approach assumes decreased turn times are solely due to reduced truck idling. Adjustments to the emission reduction calculation may be needed for ports with truck waiting areas inside or outside the terminal gates, where idling is limited or restricted.

Table 2. Default Class 8 Heavy-Duty Vehicle Idle Emission Rates (Grams/Hour)[26]

Model Year Group	NO_x	$PM_{2.5}$	CO_2
Diesel[27]			
Pre-1990	191.99	3.87	8,273
1990–1993	148.27	3.87	8,322
1994–1997	139.40	5.92	8,382
1998	117.06	5.66	8,420
1999–2002	154.42	5.66	8,420
2003–2006	56.80	5.11	8,426
2007–2009	53.19	0.19	8,439
2010–2012	10.05	0.18	8,441
2013–2014	8.96	0.16	8,318
2015+	6.49	0.11	8,028
2019 national average age distribution	*64.12*	*2.44*	*8,320*
Natural Gas[28]			
Pre-1992	13.87	2.107	8,342
1992–1994	13.87	2.107	8,384
1995–2000	13.87	2.107	8,447
2001	13.87	1.596	8,447
2002–2005	22.15	0.080	7,103
2006	22.15	0.061	7,103
2007–2010	5.32	0.025	7,103
2011–2012	5.32	0.021	7,103
2013	5.32	0.019	7,103
2014	5.32	0.019	6,900
2015–2016	2.88	0.017	6,900
2017+	2.88	0.011	6,692
2019 national average age distribution	*8.30*	*0.322*	*7,168*

Use the following equation to calculate idle emission reductions for drayage trucks:

$$ER_i = \sum_1^k (TRKPYk \times (TURN1 - TURN2) \times IDLEFik) \times C$$

Where:

ER_i	=	Emission reduction for pollutant *i* (tons/year)
$TRKPY_k$	=	Annual truck volume for model year group *k* for analysis year (trucks/year)
$TURN1$	=	Average turn time before strategy adoption (hours/truck)
$TURN2$	=	Average turn time after strategy adoption (hours/truck)
$IDLEF_{i\,k}$	=	Idle emission factor for pollutant *i* and model year group *k* (grams/hour)
C	=	Unit conversion factor, grams to tons (1.10231×10^{-6} tons/gram)

This equation assumes that savings in turn time is associated with reduced idling. If model year information is not available, the emission factors associated with the 2019 national average truck model

[26] Values for short-duration idle (< 60 minutes of consecutive idling) for calendar year 2019 using MOVES2014b. U.S. Environmental Protection Agency. n.d. Motor Vehicle Emission Simulator (MOVES). Version 2014b. https://www.epa.gov/moves. Accessed 3-5-2021.

[27] For Class 8b trucks.

[28] For urban transit buses, assumed similar to Class 8b natural gas truck idle emission rates. MOVES does not model emissions for heavy natural gas trucks.

year distribution can be used without summing across model year groups. However, given the large variation in emission rates, using truck model year distributions specific to the port of interest will result in more accurate emission reduction estimates reflecting local port data.

Example drayage truck calculation: A port with an annual average drayage truck volume of 300,000 and an average turn time of 1.5 hours implements a gate management strategy lowering turnarounds to 0.8 hours. The model year of the drayage truck fleet is unknown.

ER_{NOx} = (300,000 trucks/year × (1.5 hours/truck – 0.8 hours/truck) × 64.12 g NOx/hour) × 1.10231×10-6 tons/gram

ER_{NOx} = 14.8 tons per year of NO_x reduction

CHE inputs:

- Hours of reduced operation by equipment type for analysis year (e.g., yard trucks, top loaders, forklifts), based on port-specific operations data
- Average engine power by equipment type (horsepower)
- Emission factors (grams/horsepower-hour) by equipment type and engine tier level, from EPA's MOVES2014b emission model—see Table 3

Table 3. Emission Factors for Selected CHE, by Type and Engine Tier (Grams/Horsepower-Hour)[29]

Equipment Type	HP Range[30]	Tier	NO_x	$PM_{2.5}$	CO_2
Terminal tractor	$175 < hp \leq 300$	0	8.73	0.785	534
Terminal tractor	$175 < hp \leq 300$	1	5.38	0.338	536
Terminal tractor	$175 < hp \leq 300$	2	3.82	0.171	536
Terminal tractor	$175 < hp \leq 300$	3	2.62	0.203	536
Terminal tractor	$175 < hp \leq 300$	4	0.51	0.007	537
Top handler	$175 < hp \leq 300$	0	8.58	0.488	529
Top handler	$175 < hp \leq 300$	1	5.71	0.273	530
Top handler	$175 < hp \leq 300$	2	4.04	0.135	530
Top handler	$175 < hp \leq 300$	3	2.51	0.137	530
Top handler	$175 < hp \leq 300$	4	0.51	0.006	531
Forklift	$75 < hp \leq 100$	0	6.69	1.217	593
Forklift	$75 < hp \leq 100$	1	5.40	0.695	594
Forklift	$75 < hp \leq 100$	2	4.48	0.332	595
Forklift	$75 < hp \leq 100$	3	3.14	0.468	596
Forklift	$75 < hp \leq 100$	4	1.57	0.056	596

29 The MOVES2014b model was used to generate annual, nationwide estimates of emissions and activity for multiple calendar years. Mass emissions were extracted from the emission output results and average HP, hours of operation, and engine load factor (LF) were extracted from the activity output results. The emissions (in grams) were divided by the product of LF, HP, and hours to obtain the final emission rates in grams per hp-hr.

30 HP ranges selected to be representative of common port applications.

Use the following equation to calculate CHE emission reductions:

$$ER_i = \sum_{j,k} (HR_k \times HP_k \times EF_{ik}) \times C$$

Where:

ER_i = Emissions reduction for pollutant *i* (tons/year)
HR_k = Hours of reduced operation per year for CHE equipment type *k*
HP_k = Average horsepower for CHE equipment type *k*
EF_{ik} = CHE emission factor for pollutant *i,* equipment type *k* (grams/horsepower-hour)
C = Unit conversion factor, grams to tons (1.10231×10^{-6} tons/gram)

Example CHE calculation: The terminal's fleet of 175-horsepower Tier 1-yard trucks (terminal tractors) has its activity reduced by 5,000 hours per year, and its use of 300-horsepower Tier 2 top loaders (top handler) is decreased by 4,000 hours per year.

ER_{NOx} = [(5,000 hours/year × 175 horsepower × 5.38 grams/horsepower-hour) + (4,000 hours/year × 300 horsepower × 4.04 grams/horsepower-hour)] × 1.10231×10^{-6} tons/gram
ER_{NOx} = 5.2 tons (avoided yard truck emissions) + 5.3 tons (avoided top loader emissions)
ER_{NOx} = 10.5 tons per year of NO_x reduced

Cost Components[31]

Capital costs: Upfront investments can include labor associated with installation and system integration. Equipment and software needs may include:[32]

- Scanners, tags, cameras, and/or receivers for each gate and terminal
- Commercial scheduling software for truck appointment or virtual vessel arrival systems
- Communication system upgrades such as mobile apps for communicating pickup and drop-off times to truckers and terminal dispatchers
- Retooling or replacing CHE equipment when integrating and automating CHE along with PMIS implementation

Capital costs should be annualized over the expected lifetime of the equipment and software to estimate annual costs of PMIS.

Operational costs: Operational costs for PMIS may include:

- Labor for staff training, system administration, data compilation, and analysis
- Maintenance of equipment
- Updates to software
- Electricity to operate system

[31] The information in this section is for illustration: it does not constitute official EPA technical guidance for regulatory assessments.

[32] Where gate management and terminal operating systems are already in place, PMIS may be implemented with little to no additional hardware. RFID system costs will be lower if existing IT systems allow for modular addition of the new data streams.

Cost savings: Cost savings from implementing a PMIS are potentially sizeable, and may include:

- Reduced fuel consumption for all modes of transportation at a port (CHE, drayage truck, locomotive, and marine vessel) from idle reduction and fewer unnecessary cargo movements
- Labor cost savings from quicker turn times for all modes of transportation
- Reduced demurrage fees due to quicker turn times
- Reduced truck idling fines (in relevant jurisdictions)[33]

Port operators may also incur costs associated with providing incentives to other operators (e.g., individual terminals, drayage truck drivers, or vessel operators) to encourage participation. These costs would amount to savings for the operators receiving the incentives.

Example System

The Port of Virginia is the fastest growing port on the East Coast[34], and its largest terminal, the Norfolk International Terminal, encompasses 567 acres and has over 2,147,200 TEU capacity[35]. However, trucks servicing the port often experienced lengthy wait times, which created bottlenecks and led to vehicle idling. To relieve congestion, the port implemented an electronic appointment system in 2014, ultimately integrating it with its overall terminal operating system.

In 2017, the port launched the Port of Virginia Pro-Pass[36], which integrates a new electronic appointment system–the Truck Reservation System (TRS)–with Navis N4, the port's existing terminal operating system. The newly integrated system works across various port operations and includes:

- A reservation system for gate appointments and support.
- A community portal for import and export cargo and vessel schedules.
- A mobile app for import container availability.
- A drayage truck registry with RFID tag support, distribution, and management services.

Furthermore, the Pro-Pass system allows for two-way data flows with other supply chain stakeholders (e.g., truckers, railroads, shippers, etc.)[37]. This real-time data subscription delivery gives the end users more confidence in knowing where their goods are and the estimated time of arrival. This single window collaboration platform has helped decrease truck turn times by nearly 50 percent, leading to improved traffic conditions and a 20 percent reduction in truck-related emissions[38].

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33 For example, California Assembly Bill 2650 (implemented in 2003) imposed fees on terminal operators at the Ports of Los Angeles, Long Beach, and Oakland for trucks idling more 30 minutes while waiting to enter terminal gates. However, the fee of $250 per incident could be waived for ports extending their gate hours (to 70 hours/week for Los Angeles and Long Beach and 65 hours/week for Oakland) or implementing truck appointment systems. See Maguire, A. 2010. Relieving Congestion at Intermodal Marine Container Terminals: Review of Tactical/Operational Strategies. Center for Intermodal Freight Transportation Studies, University of Memphis. https://ageconsearch.umn.edu/bitstream/207280/2/2010_161_Relieving_Congestion_Marine_Terminals_Strategies.pdf. Accessed 3-5-2021.

34 Federal Highway Administration Virginia Port Authority - Truck Reservation System Expansion and Automated Work Flow Data Model: Advanced Transportation and Congestion Management Technologies Deployment Initiative. https://ops.fhwa.dot.gov/fastact/atcmtd/2017/applications/portofva/project.htm. Accessed 3-5-2021.

35 Port of Virginia Norfolk International Terminals (NIT). https://www.portofvirginia.com/facilities/norfolk-international-terminals-nit/. Accessed 3-5-2021.

36 Port of Virginia Pro-Pass. https://www.propassva.com/. Accessed 3-5-2021.

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