Draft
Seaport Air Quality
2020 and Beyond Plan

June 29, 2018

PORT OF OAKLAND

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TABLES

FIGURES

APPENDICES

ACRONYMS

AB617	Assembly Bill 617
AGV	Automated Guided Vehicle
BAAQMD	Bay Area Air Quality Management District
BC	Black Carbon
CAAP	Clean Air Action Plan
CARB	California Air Resources Board
CARE	Community At Risk Evaluation
CEC	California Energy Commission
CES	California EnviroScreen
CHE	Cargo-Handling Equipment
CO2e	Carbon Dioxide Equivalents
CTMP	Comprehensive Truck Management Plan
CNG	Compressed Natural Gas
DPF	Diesel Particulate Filter
DPM	Diesel Particulate Matter
DERA	Diesel Emissions Reduction Act
EI	Emissions Inventory
ECA	Environmental Control Area
GGRP	Greenhouse Gas Reduction Plan
GHG	Greenhouse Gas
HC	Harbor Craft
HRA	Health Risk Assessment
HVIP	State of California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
IA	Implementing Action
IMO	International Maritime Organization
LNG	Liquefied Natural Gas
MAQIP	Maritime Air Quality Improvement Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MMRP	Mitigation Monitoring and Reporting Program
NAAQS	National Ambient Air Quality Standard
NZE	Near-Zero Emission
NZEV	Near-Zero Emission Vehicle
NO	Nitric Oxide
NO2	Nitrogen Dioxide
NOx	Nitrogen Oxides
OAB	Oakland Army Base
OEHHA	Office of Environmental and Health Hazard Assessment
OICT	Oakland International Container Terminal
OIG	Oakland International Gateway (railyard)

OEM	Original Equipment Manufacturers
OGRE	Oakland Global Rail Enterprise (railyard)
OGV	Ocean-Going Vessels
PETF	Port Efficiency Task Force
PG&E	Pacific Gas & Electric Company
PM	Particulate matter
PM2.5	Particulate matter less than 2.5 micrometers in diameter
PN	Particulate Number
RD	Renewable Diesel
RNG	Renewable Natural Gas
RPS	Renewables Portfolio Standard
RTG	Rubber Tired Gantry
SCA	Standard Conditions of Approval
SCR	Selective Catalytic Reduction
SIP	State Implementation Plan
SPBP	San Pedro Bay Ports
SSAT	Stevedoring Services of America
STEP	Secure Truck Enrollment Program
TAC	Toxic Air Contaminant
TEU	20 Foot Equivalent Units
TIGER	Transportation Investment Generating Economic Recovery
TMP	West Oakland Truck Management Plan
TOS	Terminal Operating Systems
TWG	Trucker Working Group
UTR	Utility Tractor Rig
VOC	Volatile Organic Compounds
VSR	Vessel Speed Reduction
USEPA	United States Environmental Protection Agency
USDOT	United States Department of Transportation
WOEIP	West Oakland Environmental Indicators Project
ZE	Zero Emission
ZEV	Zero Emission Vehicle

GLOSSARY

Ancillary Maritime Services	Services such as Customs and Border Protection, agricultural inspection, truck repair, truck parking, fueling, and other services that support Seaport operations.
AB617	In response to Assembly Bill (AB) 617 (C. Garcia, Chapter 136, Statutes of 2017), the California Air Resources Board (CARB) established the Community Air Protection Program (CAPP or Program) to develop a new community-focused action framework for community air protection. This first-of-its-kind statewide effort, established by AB 617, includes community air monitoring and community emissions reduction programs. In addition, the Legislature has appropriated funding to support early actions to address localized air pollution through targeted incentive funding to deploy cleaner technologies in these communities, as well as grants to support community participation in the AB 617 process. AB 617 also includes new requirements for accelerated retrofit of pollution controls on industrial sources, increased penalty fees, and greater transparency and availability of air quality and emissions data, which will help advance air pollution control efforts throughout the State. (Source: CARB)
Co-benefit	A benefit derived from an action addressing another concern. In the context of this Plan, reducing GHG emissions typically provides a co-benefit of DPM reduction.
Community	The residents and businesses in West Oakland and in other areas near the Seaport.
Container-Handling Equipment	All types of equipment used to move containers within the container terminal. CHE in use at the Port of Oakland includes Rubber-Tire Gantry cranes (RTGs), yard tractors, side-picks, and top-picks. Note that the large ship-to-shore cranes that move containers from the vessel to the container yard and vice-versa are not usually included in the definition of container-handling equipment.
Drayage Truck	A truck used to haul containers to and from the container terminals. It consists of the tractor unit and a semi-trailer consisting of the container on a chassis (wheeled base).

GLOSSARY (Continued)

Emissions Inventory	A study to quantify the amount of emissions generated within a certain area or by certain activities. An emissions inventory consists of defining the emissions-generating activities that may occur; quantifying the amount of these activities, the conditions under which they occur, and the equipment used to perform the activities; and using modeling and emissions factors approved by CARB to convert the equipment activity into estimated emissions.
Fiber Communications Systems	Fiber communications systems transmit information from one place to another by sending pulses of light through an optical fiber. Optical fiber is used by many telecommunications companies to transmit telephone signals, Internet communication, and cable television signals.
GHG-free	Energy that is produced without emitting GHGs into the atmosphere. This includes solar power, wind power, geothermal power, and hydroelectric power.
GoPort Program	The GoPort (Global Opportunities at the Port of Oakland) Program is designed to improve truck and rail access at the Port Oakland. It includes four components designed to reduce congestion and increase efficiency to improve sustainability and economic competitiveness. The four components are the 7th Street Grade Separation East, 7th Street Grade Separation West, the freight intelligent transportation system (FITS), and Port Utility Relocation.
Harbor Craft	Smaller vessels, including tugs, survey boats, and work boats that are used in water-based Seaport operations.
Heavy-Duty Diesel Truck	A heavy-heavy diesel truck is a Class 8 truck. It has a gross vehicle weight rating of over 33,000 lbs. The typical 5-axle tractor-trailer combination, also called a "semi" or "18-wheeler", is a Class 8 vehicle.
Hybrid	An engine that runs partially on electrical power recovered from braking or other sources (e.g., when an RTG lowers a container) that is normally wasted. Hybrid equipment runs on battery power until the battery is exhausted, and may then use an internal combustion engine to either power the engine directly, or to recharge the battery.

GLOSSARY (Continued)

Maritime Area	See Seaport Area
Near-Zero Emissions	Equipment that provides substantial reductions in criteria air pollutants compared to conventional equipment. For example, engines certified as having near-zero NOx emissions emit 90% less NOx than comparable approved engines.
Ocean-Going Vessel	Large vessels used in trans-oceanic commerce. The vast majority of the OGVs calling the Port of Oakland are container vessels.
On-Road Truck	A truck permitted to operate on public roadways. Yard tractors are not classified as on-road trucks, and are only permitted to operate within the container terminal.
Partner	A business, agency, NGO, community or other organization working collaboratively with the Port to accomplish this Plan.
Renewable Electricity	Renewable electricity is electricity that is produced from renewable sources that may include solar power, wind power, and hydroelectric power from small sources. Electricity from large hydroelectric projects and municipal waste incineration is specifically excluded.
Renewable Fuels	Renewable fuels include renewable diesel, renewable natural gas, hydrogen (if generated using GHG-free electricity), and biodiesel, among others. Renewable liquid fuels, primarily renewable diesel and biodiesel, can often be used directly in place of petroleum diesel in existing engines, or require only minor operating changes.
Seaport	Seaport describes the maritime businesses and operations at the Port of Oakland.
Seaport Area	Consists of the Seaport and immediately adjacent areas associated with the Seaport, including warehouses and truck support facilities on the Port-owned portions of the OAB, and ancillary maritime services. The Seaport Area includes tidelands under the Port's jurisdiction. The Seaport Area as used in this document excludes the UP Railyard and Schnitzer Steel facility.
Semi-Trailer	A semi-trailer is a trailer without a front axle. In the USA, the term is also used to refer to the combination of a truck and a semi-trailer, a tractor-trailer. A large proportion of a semi-trailer's weight is supported by a tractor unit.

GLOSSARY (Continued)

Shipper	An ocean carrier operating vessels that call the Port of Oakland.
Stakeholder	An organization or individual with an interest in or potentially affected by implementation of this Plan, including but not limited to residents, regulatory agencies, Port tenants, and Seaport-related businesses.
Tenant	A business renting land or facilities at the Seaport.
Terminal Operator	A company operating a container terminal. Sometimes also known as a Marine Terminal Operator (MTO.)
Terminal Velocity	That rate at which containers can be moved into and out of a container terminal. The higher the terminal velocity, the more efficient the container terminal.
Tractor-Trailer	A tractor-trailer is the combination of a tractor unit and one or more semi-trailers to carry freight. A semi-trailer attaches to the tractor with a fifth wheel hitch, with much of its weight borne by the tractor.
Tractor Unit	A tractor unit (prime mover or traction unit) is a heavy-duty towing engine that provides motive power for hauling a towed or trailered load. Drayage trucks serving the marine terminals are typically commercial rear-wheel drive “semi tractors” used for hauling semi-trailers.
Yard Tractor	A tractor unit designed specifically for use in a container yard.
Yard Truck	See Yard Tractor
Zero Emissions	Equipment that does not emit any criteria air pollutants or GHGs. However, the fuel source (e.g., electricity or hydrogen may still generate emissions at the point of production or in transport.

INTRODUCTION: BUILDING ON MAQIP; PLANNING FOR THE FUTURE

Air quality improvement is a strategic and organizational priority for the Port of Oakland (Port.) Since 2009, the framework for the Port's Seaport-related air quality efforts has been the Maritime Air Quality Improvement Plan (MAQIP.) The Board of Port Commissioners (Board) adopted the MAQIP in April 2009.

The MAQIP is a master plan. As such, it established a vision, goals, strategies, and targets to reduce emissions from Seaport-related activities. The MAQIP established a 12-year time frame from 2009 to 2020 for plan implementation. Central to the MAQIP is the Maritime Air Quality Policy Statement: "Reduce excess cancer health risk related to exposure to diesel particulate matter (DPM) emissions by 85% from 2005 to 2020." The MAQIP expressed this target as an 85% reduction in DPM emissions. (Henceforth, this document will consistently refer to the target in terms of the 85% reduction in DPM emissions.)

In pursuit of the MAQIP target and to comply with State of California (State) regulations, the Port and the maritime industry undertook large-scale emissions reductions programs and projects. As a result, based upon the Port's 2015 emissions inventory, DPM emissions at the Port decreased 76% since 2005. To achieve the 85% DPM emissions reduction target by 2020 will require continued focus on existing programs as well as additional reduction measures.

At the same time, the Port is looking ahead and planning for the future. New factors and issues are shaping air quality planning. For example, the State has declared ambitious greenhouse gas (GHG) emissions reductions targets for 2030 and 2050. Community organizations and the public are concerned about localized exposure to air pollutants. Technology changes, including advances in batteries and storage, are creating the prospect of zero-emissions equipment and operations. Business growth, revenue generation and financial capacity constitute critical inputs for long term air quality planning.

The Port is responding to these factors by developing a new Seaport Air Quality Plan. Known as the "2020 and Beyond Plan" (Plan), it builds on the foundation established by previous air quality programs and projects, primarily the MAQIP. It renews MAQIP's focus on emissions reduction measures by placing these within the context of the State's GHG targets and zero-emissions initiatives

Like the MAQIP, the 2020 and Beyond Plan provides a master plan-level framework to guide decision-making, policy and action. Whereas the MAQIP focused largely on reducing emissions from existing maritime equipment, the 2020 and Beyond Plan addresses not only equipment, but also fuels, operations and, significantly, infrastructure.

This "Draft 2020 and Beyond Plan" presents the proposed plan concept (Part I) and implementation approach (Part II). It largely reflects the results of technical studies and policy discussions conducted to date.[1] The Final Seaport Air Quality 2020 and Beyond Plan will reflect stakeholder engagement and Board and stakeholder review and comments.

PART I: CONCEPT

Overview of Part I

Part I describes the overall 2020 and Beyond Plan structure at a conceptual level. It describes the Plan's key elements that constitute the master plan framework for the Plan. Planning assumptions are provided in Appendix A, and further details regarding the Plan's background and context are provided in Appendix B.

Vision

The vision of the 2020 and Beyond Plan is the transition of Seaport operations to zero-emissions operations through changes in equipment, operations, fuels, and infrastructure. The vision of the Plan is to contribute to cleaner regional and local air quality; reduce toxic air contaminants and GHG emissions; sustain Seaport business growth, financial health, and development in a competitive market; and contribute to improvements in local public health and quality of life.

Purpose

The functional purpose of the 2020 and Beyond Plan is to provide a common structure and guidance for all stakeholders involved in moving towards a zero-emissions Seaport. While the Port intends that the overall framework remain stable, the Port expects to update the Plan in five years, with a focus on the Near-Term Action Plan, so that implementation can reflect changing conditions and perspectives, especially technology, financial resources, emissions reductions and stakeholder input.

Guiding Principles

Guiding principles are the values that apply to all aspects of the Plan, including plan development, stakeholder participation, and implementation. These are the guiding principles:

- Planning is a joint fact-finding and co-learning process.
- All stakeholders share the desire and intention to develop knowledge to promote informed decision-making.
- The pursuit of near-term "wins" delivers verifiable air quality benefits and adds value to long-term planning.
- Pragmatic and cost-effective solutions advance Plan progress.
- Strong partnerships among stakeholders are a critical element of Plan implementation.

Goals

The 2020 and Beyond Plan includes five goals. The goals are:

- Goal #1: Keep the Port competitive, financially sustainable, and a catalyst for jobs and economic development.
- Goal #2: Minimize emissions of criteria air pollutants and toxic air contaminant (TACs)—with a focus on reducing DPM emissions—and local community exposure.
- Goal #3: Reduce GHG emissions.
- Goal #4: Build and strengthen partnerships among the Port, tenants, equipment manufacturers, owners and operators, community organizations, regulatory agencies, and the public.
- Goal #5: Provide opportunities for meaningful stakeholder engagement.

Strategies

The "building blocks" of the Plan are its strategies and implementing actions. The 2020 and Beyond Plan relies on primary and supporting strategies to guide action and process. The three primary strategies focus on actions that the Port can take to reduce GHG and DPM emissions. These three strategies rely on supporting strategies, which address the process of achieving the transition to a zero-emissions Seaport.

Primary Strategies

I. **Strategy #1: Continue Emissions Reduction Programs and Projects (Focus: Continue to Reduce DPM)**
   Strategy #1 focuses on continued reductions in Seaport-related emissions from existing equipment to achieve existing MAQIP goals. Strategy #1 seeks to identify additional emissions reduction measures "above-and-beyond" regulatory compliance. Strategy #1 relies on the Seaport emissions inventory to identify which additional measures or programs may contribute to further emissions reductions.

II. **Strategy #2: Promote Pathway to Zero-Emissions Equipment and Operations (Focus: Reduce GHG Emissions and Localized Exposure to TACs)**
   Strategy #2 focuses on programs and projects that promote the pathway to zero emissions, such as fully-electric or hybrid trucks, drayage trucks (used during the transport of goods over a short distance) with natural gas (low-NOx [2]) engines that produce lower levels of oxides of nitrogen (NOx) emissions, and electric or hybrid-electric cargo handling equipment (CHE). To support the transition, the Port will work with its tenants, equipment manufacturers, grant-making agencies, and truckers to identify projects for grant and incentive funding support. The key method to reduce GHG emissions is to reduce fossil fuels emissions by switching to hybrid or electrified equipment and operations, cleaner fuels, alternative power sources such as hydrogen fuel cells, and GHG-free sources of electricity.

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[2] NOx are oxides of nitrogen

III. **Strategy #3: Construct Required Infrastructure to Support the Pathway to Zero Emissions (Focus: Systems and Technologies):**
Strategy #3 focuses on the transition to zero-emissions operations, with the presumption that the predominant source of power will be electricity. This will require investments in electrical systems to upgrade existing systems, increase resilience (i.e., backup system capacity), and build new infrastructure, including information technology systems to improve goods movement efficiency. The Port will need to plan and coordinate electrical system upgrades in areas served by the Port as a utility jointly with the terminal operators, off-dock tenants, and equipment owners in these areas. The Port will also coordinate with Pacific Gas & Electric Company (PG&E) in PG&E's service area, as will certain tenants who are PG&E customers. Strategy #3 also provides flexibility for other technological options (such as hydrogen-powered equipment) to provide power for zero-emissions operation.

Figure 1 depicts the primary strategies.

FIGURE 1: 2020 AND BEYOND PLAN PRIMARY STRATEGIES

#1 Continue Emissions Reductions

- Current MAQIP goals to 2020
- Emissions inventory-based
- Ongoing programs
- New measures

#2 Promote Pathway to Zero Emissions

- GHG emissions
- Local exposure
- Phased implementation
- Fuels

#3 Construct Infrastructure

- Electrical system upgrades
- Other power technologies
- Information technology
- Resiliency (i.e., back-up systems.)

Supporting Strategies

IV. **Strategy #4: Build and Strengthen Partnerships**
Strategy #4 focuses on building and strengthening partnerships among the Port, Port tenants, equipment owners, operators, other businesses, community organizations, original equipment manufacturers (OEMs), researchers, the community, and agencies as well as with other ports to achieve the 2020 and Beyond Plan goals. Strategy #4 also focuses on economic and workforce development, particularly Goal 1 (keeping the Port competitive, financially sustainable, and a catalyst for jobs and economic development.)

V. **Strategy #5: Engage Stakeholders**
The 2020 and Beyond Plan will involve stakeholder participation opportunities to inform plan development and implementation. Stakeholder participation for the 2020 and Beyond Plan engages stakeholders in the planning process and provides ongoing opportunities for input as decision-making and plan implementation progresses.

VI. **Strategy #6: Pursue Funding**

Strategy #6 addresses costs associated with 2020 and Beyond Plan development and implementation. It especially focuses on grants and other incentive funding from non-Port sources (such as other public agencies and equipment manufacturers) to support the implementation of technology, equipment, fuels and infrastructure. While grants and incentive funding from other sources will typically be sought for projects that have been identified as priorities, grants and other incentive funding from non-Port sources may also lead to projects being accelerated and/or new projects being implemented.

Implementing Actions (IAs)

To put the six Strategies into effect, the Port and its partners will identify and adopt specific implementing actions (IAs). An IA is a specific, time-bound and measurable action, activity, or initiative to promote a strategy on behalf of the Plan goals and vision.

The Plan identifies four broad categories of implementing actions:

1. Infrastructure
2. Fuels
3. Equipment
4. Operations

Throughout the life of the Final Plan, the Port and its stakeholders will continue to identify new Implementation Actions. Part II describes the process to identify, screen, implement and track implementing actions.

Appendix C provides a list and detailed description of a comprehensive range of potential IAs identified to date. The Draft Proposed Near-Term (Years 2018-2023) Action Plan (Draft Proposed Near-Term Action Plan), presents potential actions over the next five years. The Port expects to revise the Draft Near-Term Action Plan based upon 1) comments received from stakeholders on the Draft Plan, and 2) cost and resources analyses conducted as part of Final Plan preparation.

Feasibility Criteria

Each IA must satisfy six feasibility criteria: 1) affordability; 2) cost effectiveness; 3) priority; 4) commercial availability; 5) operational feasibility; and 6) acceptability. Depending on the IA under consideration, some feasibility criteria may not apply. Implementing actions that satisfy the applicable criteria will have high priority. Part II describes the feasibility criteria.

Funding, Grants and Incentives

Implementation of this Plan will require substantial investments in technology, equipment, fuels and infrastructure, as well as in Plan management and workforce development (such as training). The 2020 and Beyond Plan provides the framework to assist funding agencies, businesses, and the Port to ascertain how to best apply their respective resources in support of Final Plan strategies and goals. The Port will assess the resources required to implement this Plan in the cost and resources analyses (i.e., financial and staffing resources, organization structure, etc.). The Port and Plan stakeholders will rely on technical feasibility studies as well as on financial and workforce assessments (see Appendices E and F [note: to be provided in the Final Plan]) to guide Final Plan implementation. The Port and its business partners will consider a range of appropriate funding options to promote the Plan, including grants and other incentive funds, particularly from outside (i.e., non-Port) sources such as regulatory agencies.

Timeline

The transition to a zero-emissions Seaport will occur in phases over several decades. This Plan proposes three implementation phases, which roughly correspond to milestone years found in State policies and regulations: Near-Term (2018-2023); Intermediate-Term (2023-2030); and Longer Term (2030 -2050). The Near-Term phase overlaps with and incorporates MAQIP implementation through 2020.

Planning Area and Planning Assumptions

The planning area for the 2020 and Beyond Plan consists of the planning areas identified in the Seaport emission inventories (EIs) (that is, the Seaport and related operations) and West Oakland. The planning area does not include the City-owned portions of the former Oakland Army Base. The Plan includes an acknowledgment that Seaport-related activities may affect nearby areas, such as Downtown Oakland, East Oakland and neighboring cities. The Stakeholder Engagement process will include outreach to these areas.

A series of planning assumptions form the basis for the development of the Plan. These planning assumptions include, for example, the expected rate of Seaport cargo growth and the evolution of commercially available technology. Appendix A presents a detailed description of the planning assumptions.

Stakeholder Engagement

The 2020 and Beyond Plan will involve stakeholder participation to inform the plan development and implementation. Public Participation for the 2020 and Beyond Plan intends to involve stakeholders in the planning process and provide multiple ongoing opportunities for input as decision-making progresses.

The process will facilitate meaningful engagement with stakeholders so that they have fair access to participate in plan development and implementation phases. Meaningful engagement includes two-way information and input exchange. At times, stakeholders will be engaged in a manner to provide input, while other times they will be engaged to receive information.

Public participation will also facilitate access to the decision process and decision makers. Stakeholders will be provided the opportunity to give input throughout the process, including the Final Plan, and will receive direct feedback on how their input helped to influence the decision.

Additionally, the process will be supported by the Seaport Air Quality 2020 and Beyond Plan Task Force – led by a steering committee of Co-Chairs. In their role, the Co-Chairs will assist the Port in determining the different and appropriate levels of engagement as the Final Plan progresses. Co-Chairs will also support efforts to engage other stakeholders in the process, including organizations and residents who may not have previously participated in the Port's air quality planning efforts.

The Port will use a range of stakeholder engagement activities, such as a series of public information meetings, consultations, and social media to seek input and advice and respond to input. Stakeholder engagement activities will take place as the Final Plan develops and stakeholder input will be reflected in the Final Plan, which the Board will consider for approval.

Prior to presenting the Draft Plan at the July 12, 2018, Board Meeting, Port staff held three Task Force Meetings (February 23, 2018; May 9, 2018; and June 21, 2018.) The February 23, 2018, meeting focused on identifying additional emissions reduction measures under the existing MAQIP (i.e. MAQIP Update.) The May 9, 2018, meeting continued the MAQIP Update and also presented a briefing on the key elements of the proposed 2020 and Beyond Plan. At the Seaport Air Quality 2020 and Beyond Plan Task Force meeting on June 21, 2018, the agenda included a briefing on zero emissions by the California Air Resources Board (CARB). The Port presented key policy issues associated with the Draft Plan. A professional facilitator, aided by Port staff, facilitated group discussions with Task Force meeting attendees on the key policy issues. The Port also presented the process for stakeholder engagement for the Final Plan.

Monitoring and Reporting

Monitoring is central to ensuring that the Port meets its targets toward achieving Plan goals. "Monitoring" takes on multiple meanings in this Plan:

- Monitoring the execution of an Implementing Action
- Monitoring the results of an Implementing Action
- Monitoring the progress toward achievement of the Plan's goals

The Port will track and report on progress towards zero emissions through an on-going reporting program. Staff will report to the Board annually. For criteria air pollutants, DPM, and GHG, the Port will continue to track progress through periodic emission inventories. The

Port expects that regulatory agencies, such as the Bay Area Air Quality Management District (BAAQMD) and the California Air Resources Board (CARB), and the community will consult and engage with the Port while identifying and deploying monitoring and reporting tools to track progress on reducing localized "hot spot" emissions.

PART II: IMPLEMENTATION

Overview of Part II

Part II provides a detailed description of Plan implementation.

Part II focuses on:

- Strategies
- Implementing Actions (IAs)
- Feasibility Criteria
- Timeline and Phasing
- Action Plan
- Funding
- Monitoring and Reporting
- Plan Management

Strategies

The "building blocks" of the Plan are its strategies and implementing actions. The Draft 2020 and Beyond Plan relies on primary and supporting strategies to guide actions and progress. The three primary strategies focus on actions that the Port can take to reduce GHG and DPM emissions. The three primary strategies rely on the supporting strategies, which address the process of achieving the transition to a zero-emissions Seaport.

Strategy #1: Continue Emissions Reductions

Strategy #1 applies primarily in the near-term (2018-2023) and intermediate term of the Plan (2023-2030). Potential implementing actions associated with Strategy #1 have regulatory compliance and DPM emission reductions as their primary focus. For IAs associated with Strategy #1, the Port will prioritize those actions that can be implemented in the near-term, are operational in nature (not requiring large investments in infrastructure), contribute to attainment of federal and State ambient air quality standards, are cost effective, and for which grant or incentive funding opportunities exist.

Some examples of IAs that support Strategy #1 include:

- Use of renewable diesel in diesel-powered equipment
- Alternative "at berth" emissions capture systems (barge-based exhaust scrubber system)
- Voluntary or incentivized vessel speed reduction
- Harbor craft repowers
- Continuing to improve efficiency measures (such as truck appointments and intelligent transportation systems)

As discussed in more detail in Appendix B (see Emissions Estimates in Appendix B), 82% of the remaining Seaport-related DPM emissions are associated with ocean-going vessels (OGV), primarily OGV in transit. The Port has little control or influence over emissions reductions associated with OGV in transit, but will continue to track and support, where applicable, new standards for OGV, such as the recent GHG emissions reductions targets in the April 18, 2018 MARPOL guidance (IMO 2018.)

Strategy #2: Promote Pathway to Zero-Emissions

Strategy #2 focuses on the equipment and fuel aspects of the pathway towards zero emissions. The various actions taken to transition the Seaport to zero emissions over time will continue to reduce local exposure to criteria air pollutants and TACs. Strategy #2-related actions would occur throughout the duration of the Final Plan. Potential IAs associated with Strategy #2 have GHG emission reductions as their primary focus; however, the Port will give higher priority to IAs that also provide a higher level of associated DPM emissions reductions. Reductions in GHG emissions can be achieved through two means: by reducing fuel consumption and by replacing existing fuels with lower carbon or carbon-free fuels, such as renewable liquid fuels, GHG-free electricity, and hydrogen from renewable sources.

Reduced fuel consumption is largely driven by improved (i.e., more efficient) operations and by hybrid technologies involving energy recovery. Some lower-carbon renewable fuels are readily available now, and may require little effort to implement. Transitioning to zero-emissions equipment for Seaport operations will require substantial investments in infrastructure, equipment, and training, and will likely occur over decades (see discussion of Strategy #3.) However, transitional actions can be taken to reduce GHG emissions in the near-term, and continue to move Seaport operations along the pathway to zero emissions.

For Strategy #2, the Port and its partners will seek to:

- Identify actions that can reduce GHG and associated DPM emissions in the near-term through operational measures (such as use of renewable diesel and renewable natural gas) and through the implementation of hybrid container handling equipment;
- Develop a thorough understanding of the types of equipment (and associated infrastructure) required to transition to a zero-emissions Seaport;
- Promote transitional solutions, such as hybrid rubber-tired gantry cranes (RTGs), that are convertible in the future to zero-emissions operations to the maximum extent feasible; and
- Select IAs, that focus emissions reduction benefits within the planning area.

The Port will prioritize IAs that provide immediate reductions in emissions and are consistent with a longer-term transition to a zero-emissions operation, as well as actions that are needed to more fully understand the requirements for moving to a zero emissions Seaport. Transitional solutions may provide very substantial emissions reductions benefits. The decision to move from transitional solutions to zero-emissions equipment will depend on the multiple feasibility factors, including incremental emissions reductions achievable, the incremental cost, and operational considerations, such as the useful life of the equipment.

Some potential IAs for Strategy #2 include:

- Engineering and operational feasibility studies for zero-emissions drayage trucks;
- Fiber communications systems [3] infrastructure upgrades to support expanded and enhanced computer- and artificial-intelligence-based systems to promote more efficient operations, which lead to emissions reductions from equipment; and
- Convertible hybrid [4] and zero-emission CHE at tenants' facilities (such as zero-emission RTG cranes, yard hostlers, intra-port trucks, forklifts, top-picks, and side picks.)

Strategy #3: Construct Required Infrastructure

Strategy #3 is designed to address the infrastructure needs of a zero-emissions Seaport. Foundational to a zero-emissions Seaport is adequate infrastructure to support power and alternative fuel demands, as well as fiber communications systems for more efficient maritime operations. Strategy #3 focuses on the transition to zero-emissions operations, with the presumption that the predominant source of power will be electricity. This will require investments in electrical systems specifically to upgrade existing systems, increase resiliency (i.e., backup system capacity), and to build new infrastructure. The Port will need to plan and coordinate electrical system upgrades in areas served by the Port as a utility jointly with the terminal operators, off-dock tenants, and equipment owners in these areas. The Port will also coordinate with Pacific Gas & Electric Company ("PG&E") in PG&E's service area, as will certain tenants who are PG&E customers. Strategy #3 also provides flexibility for other technological options (i.e., hydrogen-powered equipment) to provide power for zero-emissions operation.

Pursuant to Strategy #3, the Port proposes to:

- Define specific infrastructure needs for various electrification and smart technology initiatives;
- Determine operating reliability needs for new zero-emissions equipment and computer/network systems;
- Identify critical vulnerabilities within the Port grid and the overall power supply as it may affect the Port grid (i.e., reliability of the larger grid);
- Continue to track the development of technology utilizing GHG-free fuels other than electricity;
- Continue to evaluate the infrastructure needed for these other GHG-free fuels; and
- Create and implement an overall plan for developing the necessary infrastructure to support a zero emissions Seaport.

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[3] Fiber communications systems is the term used for infrastructure related to computer- and wifi-based systems (Smart technology). The increased efficiency achieved using smart technology reduces air emissions resulting from idling, extra truck trips, etc.

[4] "Convertible hybrid" is the term used in this Plan to refer to hybrid technology systems that could be converted to zero emissions when battery and/or fuel cell technology improve.

Potential IAs to implement Strategy #3 include:

- Engineering feasibility studies for container terminal electrification;
- Assistance with development of consistent charging standards for zero-emissions equipment;
- Electrical system upgrades, including upgrades designed to increase the resiliency [5] of the Port's electrical grid;
- Infrastructure that includes charging stations for battery-electric, heavy-duty equipment and vehicles;
- Feasibility studies for other alternative fuels, such as hydrogen fuel cells;
- Plug-in charging infrastructure for Port-owned fleet and personal vehicles; and
- Financial feasibility analysis and assessment of proposed infrastructure modifications.

Strategy #4: Build and Strengthen Partnerships

Implementation of the 2020 and Beyond Plan requires extensive collaboration with a wide range of parties and entities outside the Port. The Plan refers to these parties and entities as partners, and the collaboration as partnerships.[6] The Port will rely on agency, community, and business partners to help identify and pursue implementing actions. The Port's many stakeholders have unique knowledge and perspectives to inform Plan development and aid in its implementation. Strategy #4 is designed to ensure that existing and potential partners: 1) contribute to Plan development, 2) engage in and contribute to Plan implementation, 3) provide subject matter expertise, and 4) make financial and other necessary organizational and operational commitments. As part of Strategy #4, the Port will expand existing partnership networks to increase Port-to-partners and direct partner-to-partner information exchange. Potential IAs that contribute to putting Strategy #4 into effect include:

- Continue to convene working groups such as the Trucker Working Group (TWG) and the Port Efficiency Task Force (PETF);
- Conducting regular meetings with tenants;
- Attending industry trade conferences;
- Collaborating with public agencies;
- Making tenants and other Port partners aware of potentially applicable grants and incentives;
- Providing support during development of grant applications;
- Partnering with other Ports on grant applications; and
- Advocating for cleaner OGVs and fuels.

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[5] The more Port operations are dependent on electricity, whether for cargo handling equipment or smart technology/communications systems, the more important it becomes to have back-up systems in place to ensure that the Port can continue to operate if something happens to the electrical grid. Having adequate back-up is also referred to as reliability.

[6] The terms "partner" and "partnership" as used in this document are not intended to convey a specific legal relationship among the parties and entities involved.

Strategy #5: Engage Stakeholders

Under Strategy #5, the Port will design and implement a robust stakeholder engagement program that:

- Seeks to increase stakeholder knowledge regarding status of new zero-emissions technologies ("joint fact-finding" and/or "joint knowledge-building");
- Allows for on-going engagement during Plan implementation;
- Identifies and specifically reaches out to organizations and residents who may not have previously participated in the Port's air quality planning efforts; and
- Reflects stakeholder contributions.

Strategy #6: Pursue Funding

Strategy #6 addresses costs associated with Final Plan development and implementation. It especially focuses on grants and other incentive funding from non-Port sources such as other public and regulatory agencies and equipment manufacturers to support the implementation of technology, equipment, fuels and infrastructure.

Pursuant to Strategy #6, the Port plans to:

- Determine overall costs associated with the 2020 and Beyond Plan;
- Estimate costs by sector or infrastructure element (such as cargo-handling equipment, trucks, or a substation upgrade);
- Identify the full range of financing mechanisms and sources;
- Identify grant and incentive funding opportunities that support Plan goals;
- Develop a thorough understanding of the specific requirements of each grant or incentive funding program and of the related zero-emissions technologies;
- In collaboration with partners, obtain sufficient grant and incentive funding to enable the Port to reach the Plan goals;
- Be ready to timely consider and, where consistent with Plan goals, apply for grant and incentive funding when it becomes available (be "first in line"); and
- Advocate for new or expanded grant and incentive funding programs where needed.

The Port and its partners rely on outside funding through grants and incentive programs. The following actions, among others, support Strategy #6:

- Monitor CARB, California Energy Commission (CEC), and BAAQMD websites monthly for information on upcoming grant and incentive funding programs and subscribe to email alerts;
- Form working relationships with regulatory agencies and equipment owners;
- Collaborate with OEMs and equipment vendors on grants- and incentives-related activities;
- Advocate for grant and incentive programs at the State and Federal levels; and
- Work with regulatory agencies to identify grant opportunities.

Implementing Actions

An IA is a specific, time-bound and measurable action, activity, or initiative to promote a strategy to achieve Final Plan goals, purpose, and vision. IAs constitute the core building blocks of the Plan. Appendix C provides a table listing the potential IA's and provides detailed descriptions. The table shows the IAs by equipment category, and cross-references the IAs by applicable strategy and category.

The Plan identifies IAs for Primary and Supporting Strategies. Some of these IAs overlap. For example, an any equipment converted to zero emissions will provide local DPM and criteria air pollutant reduction benefits in addition to GHG emissions reductions.

The plan implementation phase includes identifying, screening, and implementing new IAs (i.e., IAs not included in Appendix C of this Plan). Appendix D presents the screening criteria for new IAs.

Feasibility

To be identified as a potential IA under this Plan, a proposed activity must align with one of the six strategies. Implementing Actions must satisfy the following feasibility criteria: affordability, cost effectiveness, priority, commercial availability, operational feasibility and acceptability.

Table 1, below, describes the proposed feasibility criteria.

Table 1: SUMMARY OF FEASIBILITY CRITERIA FOR IMPLEMENTING ACTIONS	
Criterion	**Description**
Affordability	Is the proposed action affordable for the Port or other party implementing the action? Has the Port's Board approved the use of Port cash for the proposed action?
Cost Effectiveness	Does the action provide cost-effective emission reductions? Is the action a required infrastructure project or does it support required infrastructure? Does the proposed action jeopardize usage requirements for any grant-funded equipment already in place or would it result in stranded equipment or infrastructure?
Priority	Is the proposed action a priority action? The priority assessment will depend on many factors, including, for example, where the emission benefits accrue (i.e., locally, regionally, etc.)
Commercial Availability [7]	Has the proposed technology or system reached, at a minimum, the pre-production stage? Does sufficient experience with the technology/system exist to determine that its operational performance is acceptable? Preferably, the equipment should be feasible from a commercial and operational perspective.
Operational Feasibility	Can the technology or equipment be integrated into existing operations? Is there sufficient experience with the technology or equipment to determine that its operational performance is acceptable? For actions to be taken or equipment to be used by tenants or other Port partners, it is the Port partner who will make the operational feasibility determination.
Acceptability	Is there a party or entity willing to undertake the implementing action, given the range of other considerations, such as availability of land, ability to densify operations or financial capability? Does the IA allow for continued reliable and satisfactory service delivery to customer(s?)

[7] This is the Port's working definition used in this Plan.

Implementing actions that meet the applicable feasibility criteria will be prioritized and implemented as funding becomes available. In general, the priority for the various IAs will be set based on their cost effectiveness in reducing DPM and GHGs, or advancing the Plan by other means (i.e., providing needed infrastructure.) While no specific threshold has been set, each applicable IA will be evaluated to determine the level of emission reductions it provides and the projected duration of those reductions. In addition, the priority of a potential IA will be adjusted to reflect the potential for that IA to serve as a model to be replicated by other businesses and organizations within the Seaport area.

New Implementing Actions

Identification

It can certainly be anticipated that, through various channels, including stakeholder input, the Port will continue to identify new potential IAs. New technologies and innovative approaches to emission reductions are essential to achieve additional reductions in DPM and GHGs on the pathway to a zero emissions Seaport.

The Port will use the screening process described below to identify and assess potential new IAs. This approach intends to move forward a wide range of potential new IAs. The screening process may also serve to eliminate new IAs (for example, if an IA involves deployment of new equipment, and the Port is unable to identify an interested partner, the new IA would fail during the last stage of the screening process.) When an IA fails the screening process solely due to a lack of funding or other factors that may change in the future, the Port will retain the IA for later re-screening.

Screening

During the development of the 2009 MAQIP, a working group screened 355 suggestions regarding various means of achieving DPM emissions reductions. This screening process has been adapted slightly for the 2020 and Beyond Plan to reflect the proposed stakeholder participation process and the shift to an entirely new technological foundation. Appendix D contains the preliminary list of proposed screening criteria for new IAs that supplements the feasibility criteria described previously. Potential new IAs would have to pass the screening according to the criteria presented in Appendix D before being incorporated into the existing pool of potential IAs. It is anticipated that the screening process will be refined further through the stakeholder participation process. In addition, the screening process may be revised as part of the five-year update of the Plan, depending on its effectiveness.

Tracking

Many potentially applicable technologies are still in the development or pre-commercialization phase. For technologies and other actions that pass the screening process but are not yet ready to be implemented, the Plan provides a tracking process. The tracking approach will depend on the specific technology and how close the technology is to being commercially available. Steps included in the tracking process may include 1) checking in with the original equipment manufacturer; 2) contacting other ports to determine the outcomes of pilot trials; and 3) reviewing scientific research. For example, in their 2017 Clean Air Action Plan (CAAP), the San Pedro Bay Ports committed to conducting feasibility studies for zero-emissions CHE starting in 2018 and updating these studies every three years (SPBP, 2017 CAAP.)

Timeline

The current 2009 MAQIP has a planning horizon in Year 2020. This 2020 and Beyond Plan looks beyond the Year 2020 to Years 2030 and 2050 as its planning horizons. The Years 2030 and 2050 correspond to planning horizons established in the State's policies for GHG emissions (i.e., 40% reduction in GHGs below the 1990 baseline by 2030 and 80% reduction in GHGs below the 1990 baseline by 2050.)

The 2020 and Beyond Plan will be implemented in a phased manner, as determined by available funding and technology. This Plan proposes three implementation phases:

- Near-Term (2018-2023)
- Intermediate-Term (2023-2030)
- Longer Term (2030 -2050)

The 2020 and Beyond Plan proposes that an Action Plan be developed for each phase (see Action Plan section, below.)

The Plan anticipates that the pathway to a zero-emissions Seaport can begin almost immediately by deploying commercially available and operational equipment, and for which adequate infrastructure exists. Similarly, the Port can commence the studies (i.e., needs assessments and feasibility studies) related to the infrastructure required to support future deployment of zero-emissions equipment.

Figure 2 shows the implementation timelines for the Plan.

Action Plan

The Draft 2020 and Beyond Plan identifies potential implementing actions for each phase.

Table 2 presents the Draft Proposed Near-Term (Years 2018-2023) Action Plan.

Near-Term Actions (Years 2018-2023)

Near-term IAs include existing MAQIP programs as well as new IAs pursuant to the 2020 and Beyond Plan. The Near-Term phase overlaps with and incorporates existing MAQIP implementation through the Year 2020 as well as new IAs commenced in 2018, such as the hybrid RTG project at the Oakland International Container Terminal (OICT) supported by a Carl Moyer program grant through the BAAQMD.

Existing MAQIP Programs

Actions that are in progress are as follows:

- Continued tracking of shore power systems usage and compliance;
- Conversion to hybrid RTG cranes at OICT;
- Zero-emissions yard tractors;
- Tracking grants and incentives and seeking partnerships;
- Emissions inventories; and
- MAQIP Task Force meetings (currently transitioning to 2020 and Beyond Task Force meetings.)

FIGURE 2: TIMELINE AND ACTION PLAN PHASES

MAQIP Implementation	Near-Term	Intermediate-Term	Longer Term
2018 - 2020	2018 - 2023	2023 - 2030	2030 - 2050

Draft Proposed Near-Term (Years 2018-2023) Action Plan

As shown in Table 2, the Port has identified 20 potential IAs for consideration for the period 2018-2023. Some of these are on-going, such as participating in industry groups to share information about potential grants and incentives, while others are specific projects.

The following is a selection of potential Near-Term IAs:

- Investigate use of renewable diesel for land-based and marine equipment;
- Evaluate voluntary and incentivized Vessel Speed Reduction program;
- Initiate data needs assessments and engineering feasibility studies for drayage truck-charging infrastructure, container-yard specific electrical infrastructure, and fiber communications systems infrastructure;
- Collaborate with the Port Efficiency Task Force and agencies, such as the Alameda County Transportation Commission, to continue to implement terminal operations and roadway efficiency measures; and
- Evaluate replacement of Port-owned vehicles to zero-emission vehicles as these reach the end of their useful life and as zero-emissions vehicles become feasible from a commercial and operational perspective, and cost-effective.

Other IAs may be undertaken in addition to those shown in Table 2, depending on available resources and other factors. Priorities will be set based on funding, availability and use of technology by various Port partners, and the success of earlier IAs, including operational and equipment actions. The Near-Term Action Plan will be updated on annual basis to reflect any changes in the IAs contained in the Action Plan (for example, as IAs are completed, or new priority IAs are identified). The Port will continue to work with its tenants to identify opportunities to deploy zero-emissions and convertible hybrid equipment.

Intermediate Term Actions (Years 2023-2030)

Intermediate-Term actions will build on the Near-Term actions. Once the studies and plans included in the Action Plan are completed, design and physical implementation of significant infrastructure projects can begin, depending on available funding. The IAs that may occur in the intermediate term include:

- Upgrades and/or construction of Port-owned and PG&E-owned [9] substations;
- Expansion of electrical infrastructure on terminals;
- Upgrades and expansion of fiber communications systems infrastructure to reduce air emissions through increased Seaport operational efficiency;
- Implementation of an environmental performance incentive program for vessels similar the Environmental Ship Index (used by the Port of Los Angeles) and the Port Authority of New York and New Jersey's Clean Vessel Incentive Program;
- Increased use of hybrid and zero-emissions CHE;
- Conversion of Port-owned fleet to zero-emissions vehicles; and
- Continued use of grants and incentive funding to replace or convert existing CHE and drayage trucks to zero emission or hybrid equipment.

By 2030, the Seaport area will likely resemble an emerging mosaic of zero-emissions and hybrid technologies and associated infrastructure improvements on the pathway towards a zero-emissions Seaport. During this time period, it is expected that CARB will promulgate numerous additional emission regulations, including regulations pertaining to OGV (expected to take effect in 2023), harbor craft (expected to take effect in 2026), drayage trucks at seaports and railyards (expected to take effect between 2026 and 2028), CHE (expected to take effect after 2026), and rail yard idling emissions restrictions (expected to take effect after 2025.)

These new regulations will likely drive additional innovation in the regulated equipment sectors and operations. Also, zero emissions technologies will continue to mature, and it is very likely that incremental costs will continue to decrease. This may change the viability of various technologies and equipment over time. Port staff will continue to track and screen new potential IAs and regularly reevaluate the priorities set for the new IAs.

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[9] The Port does not have control over the PGE's infrastructure, so Port tenants served by PG&E will communicate their needs to PG&E. Furthermore, the Port will coordinate with PG&E regarding PG&E's FleetReady program for infrastructure improvements in support of electric vehicles and equipment.

Longer-Term Actions (Years 2030-2050)

During the Longer-Term phase, construction of required infrastructure will continue to support the pathway to zero emissions. Port partners are expected to continue to replace fossil fuel-based equipment with zero-emissions equipment as resources, regulations, and technological development allow. Port staff will continue to implement ongoing actions, track and screen new potential IAs, and regularly reevaluate the priorities set for the various potential IAs. The Port will also continue to advocate for cleaner ocean-going vessels (OGVs), as OGVs in transit are likely to remain the largest source of Seaport-related DPM emissions.

Table 2: Draft Proposed Near-Term (Years 2018-2023) Action Plan (subject to revision in Final Plan)

Infrastructure

- Develop comprehensive infrastructure improvement implementation plan
- Conduct Maritime Power Capacity Study for Terminal Electrification
- Install electrical charging infrastructure at tenant location (Shippers Transport Express [STE]), pending CARB Zero and Near Zero Freight Facilities (ZANZEFF) grant award receipt and execution of a Memorandum of Understanding ("MOU") with the Port of Long Beach
- Evaluate installation of two additional electrical vehicle chargers at Port public garage
- Conduct needs assessment and feasibility study for: drayage truck charging infrastructure; expanded fiber communications systems infrastructure; and providing infrastructure to support zero-emissions Port fleet
- Develop guide for Port tenants about electrical vehicle charging infrastructure

Fuels

- Assess feasibility of tenant access to Alameda County Transit Authority (ACTA) hydrogen fueling stations
- Investigate use of renewable diesel for land-based and marine equipment
- Investigate use of ultra-low sulfur fuel for ocean-going vessels
- Investigate use of renewable diesel in Port-owned diesel-powered vehicles

Equipment

- Monitor hybrid RTG installation at Oakland International Container Terminal ("OICT") pending BAAQMD Carl Moyer grant
- Support demonstration of 10 electrical Class 8 drayage trucks at Port tenant STE, and up to six pieces of electrical cargo handling equipment at the Matson Terminal, upon ZANZEFF grant award receipt and execution of MOU with Port of Long Beach

Table 2: Draft Proposed Near-Term (Years 2018-2023) Action Plan (subject to revision in Final Plan) (cont.)

Equipment

- Track development of uniform charging standards for electrically-powered CHE equipment at San Pedro Bay Ports ("SPBP"), and advocate for specific Port needs as applicable
- Evaluate replacement of Port-owned vehicles with zero-emissions vehicles as existing vehicles reach the end of their useful life, and zero-emissions vehicles become commercially available and cost-effective

Operations

- Track vessel shore power use
- Meet with Port tenants annually to discuss current air quality measures and room for improvement
- Track Port tenant incentive-funded zero-emissions equipment and associated infrastructure (e.g. Prop 1b and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project [HVIP] funding)
- Continue conducting emission inventories
- Continue to coordinate with Port Efficiency Task Force (PETF) and others to identify and implement efficiency measures
- Evaluate voluntary and incentivized vessel speed reduction program

Partnerships

- Track Clean Air Action Plan ("CAAP") and SPBP Harbor Commission meetings and Port of Long Beach zero/near-zero emissions feasibility studies
- Actively participate in Trucker Worker Group ("TWG"), Harbor Trucking Association ("HTA"), and Western States Trucking Association ("WSTA")
- Work with Port of Long Beach to deliver Port's component of the ZANZEFF grant project (electrical infrastructure installation and demonstration period), pending ZANZEFF grant award receipt and execution of MOU with Port of Long Beach
- Coordinate with PETF, Pacific Merchant Shipping Association, and other industry stakeholders to keep informed and provide updates on zero-emissions technologies.

Source: Port of Oakland Draft Seaport Air Quality 2020 and Beyond Plan, June 29, 2018

Monitoring and Reporting

Monitoring, evaluation and reporting are critical components of the implementation process for the 2020 and Beyond Plan. The monitoring program builds on, and is similar to, the monitoring program developed for the MAQIP. The monitoring program designed for the 2020 and Beyond Plan includes a greater focus on lessons learned, because the Plan intends to build capacity and share knowledge for future actions.

Three types of monitoring will be conducted: monitoring of individual IAs, monitoring of emissions reductions, and monitoring of progress toward Plan goals. Pollutants that will be monitored for emissions reductions include DPM, criteria air pollutants, and GHGs. The Port will report on the monitoring results using multiple channels and media.

Monitoring of Implementing Actions

As each IA is planned, the implementation team (see Plan Management section, below) will determine the appropriate level of monitoring associated with that action. Depending on the specific action, this may include emissions reductions, schedule compliance, or other items. The team will also seek expert input from knowledgeable stakeholders on the proposed monitoring approach. A benefit of discussing IAs with knowledgeable stakeholders during the planning and early implementation stages is that problems can be detected and addressed more promptly. Continually evaluating the progress and early results of an implementing action, then adjusting accordingly, will improve the overall effectiveness of the action.

Emissions reductions will occur as a direct result of IAs in the equipment, fuels and operations categories. Infrastructure actions would typically be conducted in support of the other actions and would not result in direct emissions reductions. Emissions reductions from equipment and fuels actions can normally be estimated with some accuracy, based on available information regarding operating hours, fuel usage, and emission factors.

Emissions reductions from operations actions will likely be harder to measure. Port staff will collect data periodically from business partners and other organizations implementing emissions reductions actions, and include the results in the annual reports to the Board.

Individual actions will also be evaluated following implementation. The evaluation process will assess challenges that were encountered during implementation (and operation, if applicable), compare the benefits being realized from the action to the intended or expected benefits, and compile lessons learned from implementing the action to share with stakeholders and other interested parties.

Monitoring of Emissions Reduction

While monitoring emissions reductions associated with a single IA will typically be straightforward, the Port will also conduct emissions inventories to estimate the emissions reductions accruing from the source-based IAs. Development of a full inventory for sources at the Port is a complex process involving collection of data on all emission-generating activities (ship calls, berthing times, truck trips, etc.), equipment (engine types and sizes, exhaust after-treatment devices, etc.), operating parameters (engine loads, travel speeds, idling times, etc.), and associated emissions factors. Emissions inventories will address criteria air pollutants, DPM, and GHGs.

The Port will conduct periodic emissions inventories. The Port will compare the results of the EIs to applicable baseline years to determine total emissions reductions relative to key targets. In addition, the Port will evaluate the trend in total DPM and GHG emissions relative to Port growth over time.

Monitoring of 2020 and Beyond Plan Goals

The Port will assess its progress toward substantially reducing Seaport-related GHG emissions using the emissions inventories and by tracking the completion of infrastructure and equipment projects. The Port will also report reductions in GHG emissions compared to regulatory and policy targets. The Port will provide the results of its emissions inventories to stakeholders and will consider the data generated by community-based monitoring and research efforts in its evaluation.

Reporting

The Port is committed to reporting on a regular basis to facilitate continued involvement of stakeholders and to update stakeholders on monitoring results. At least once per calendar year, the Port implementation team will assess the progress of implementing the Action Plan. The Port implementation team will consider changes in equipment, improvements to infrastructure and operating processes, regulatory and other developments, and the overall trajectory of DPM and GHG emissions reductions associated with Seaport operations. The team's report will be presented to the Board and will be made available on the Port's website.

The Port will include data and information from other parties. For example, tenants will be asked to report periodically on the status of air quality improvements, regardless of whether they are participating in Port or grant-funded incentive programs. These status updates will inform the Port's annual report to the Board. Input provided by stakeholders through Task Force meetings and other channels and media will also inform the annual report.

Informal reporting and discussions will continue through both existing and potentially new forums. The Port contemplates agency-focused discussions via an Interagency Group. The

Interagency Group was established as part of the MAQIP to provide public health and regulatory agency expertise and resources in support of the MAQIP. The interagency Group was comprised of representatives of the agencies and elected officials that participated in or advised on MAQIP development. These include CARB, USEPA, BAAQMD, the City of Oakland, Port of Oakland, Alameda County Public Health and Environmental Health Departments, staff from the Oakland Mayor's office, and Alameda County Supervisors. An Interagency Group would meet periodically to coordinate efforts in support of the 2020 and Beyond Plan.

Funding

Implementation of this 2020 and Beyond Plan will require significant financial resources from both the Port and its tenants and other businesses. The Port, its tenants, and other businesses are unlikely to be able to provide all the required funding. External funding, in the form of grants and incentives from the State and other sources, will be key to Plan implementation, especially for infrastructure. Incentives and grant funding from local, State, and federal sources for zero and near-zero emissions technology are also essential to provide cost parity with conventional diesel-fueled equipment. A commitment by a tenant to use a certain amount of power could accelerate the Port's schedule for implementing the required infrastructure associated with providing that power. [Note: An analysis of the cost and resources required to implement the Plan and programs contemplated under the Plan is anticipated as part of the development of the Final Plan, and will be presented in Appendix F.]

Grants and Incentives

The transition from current combustion equipment to near-zero and zero-emission equipment will take time. During the transition period, before new regulatory mandates make grant funding unavailable, the State is encouraging new technologies through an array of grant and incentive programs. Incentive programs may include grants and other incentives such as voucher programs, for example, the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP.) Grant and incentive programs typically exclude projects that are mandatory because of existing regulations and other legal requirements (e.g., tenant compliance with Port leases.) Grants and incentive funding are also available from the federal government.

In some cases, the Port may apply for grants or incentive funding directly for its own electrical system upgrades and charging infrastructure. The Port previously applied for and/or received CEC, CARB, BAAQMD, and Transportation Investment Generating Economic Recovery (TIGER) grants (from the US Department of Transportation) to accelerate installation of electrical infrastructure to support implementation of shore power. This would also be the case if the Port were to be the lead applicant on behalf of multiple tenants or if the grant required the applicant to be a public agency.

An important consideration regarding the viability of grant funding for potential grant recipients is the administrative burden and complexities that may be imposed as part of the grant process. Some grant program requirements may be so burdensome and carry such high uncertainty that they fail to make economic or business sense. Factors that can impede use of grants include application deadlines that are too short, difficult reporting requirements, vague or onerous non-performance provisions, unclear guidelines, and excessively demanding cost effectiveness criteria. In addition, grant applicants (Seaport businesses and/or the Port) will consider the emissions reduction benefits of the potential action funded by any grant. The amount of emissions reductions achievable will factor into the decision of whether to proceed with a grant application.

Joint Development of Grant and Incentive-Eligible Projects

For incentives involving new equipment provided by other agencies, the Port is generally not the equipment owner. Grant making has been an integral part of the MAQIP implementation process (e.g., Proposition 1B Goods Movement grants for shore power, EPA grants for trucks, etc.). Port staff have focused efforts on meeting with Port tenants, equipment owners, and manufacturers to develop grant-eligible projects. Port staff have identified and publicized at its Trucker Working Group and the Port Efficiency Task Force, and at ad-hoc meetings, numerous grant programs and other agencies' incentive programs, which are potentially applicable to Port tenants, equipment owners, and/or manufacturers. For these types of grants, the Port can play a role by identifying grant opportunities, conducting feasibility studies, preparing grant applications, and encouraging partnerships between tenants, equipment manufacturers, and grant-making agencies. Coordination and cooperation among the Port, tenants, and the agencies are essential for these grants to be successful and effective.

Grants to Tenants and Local Equipment Operators

Port tenants have also applied independently for State and BAAQMD grants. For example, Centerpoint Oakland Development, LLC, which entered into a 66-year lease with the Port covering approximately 27 acres of the Port-owned former Oakland Army Base (OAB), applied for a CEC grant to provide charging infrastructure for its future warehouse development. Similarly, several Port truckers have received Prop 1B grants from the BAAQMD for additional low NOx and zero-emissions trucks.

Other Funding Opportunities

Some funding may also be available from equipment vendors or other proponents of specific technologies. In general, these types of funding are linked to testing of specific technologies. This type of funding would generally be applicable to equipment or systems that would be purchased and implemented by Port partners, and vendors are likely to approach partners for opportunities to test their new technologies.

Plan Management

Given the strategic importance of long-term air quality planning, a key element of successful implementation of this Plan is a dedicated implementation team tasked with Plan management and implementation. The implementation team will identify potential implementing actions and screen them against the feasibility criteria and their ability to meet the goals of the Plan.

The implementation team will manage the Plan on an ongoing basis. The implementation team will be responsible for:

- Tracking grant opportunities
- Applying for and managing grants for Port projects, acting as lead applicant for a group of applicants, or both
- Identifying/tracking of new technologies
- Tracking performance of existing actions (e.g., shore power and hybrid RTGs)
- Tracking regulatory requirements
- Coordinating and collaborating with potential partners
- Administering contracts in support of studies and other actions
- Conducting periodic emissions inventories

The dedicated implementation team will work with potential funding agencies and organizations (such as CARB, PG&E, and equipment vendors) and potential grant recipients (Port partners) to secure grants for eligible equipment, infrastructure upgrades, other IAs, and monitoring efforts, as available. This may include applying for grant funding to the Port, providing information and assisting other grant applicants with the grant application. The decision to dedicate resources to pursuing grants will be made based on the likelihood that a grant application will be successful, the value of the grant opportunity, and other business or organization priorities and constraints.

Due to the rapid change in technology that is expected to occur in the coming years and decades, the implementation team will update the list of potential implementing actions frequently. New potential IAs that pass the initial screening process will be added to the list and evaluated as part of the overall pool of potential IAs. The team will then manage or track, as appropriate, the progress of the selected implementing actions. This Plan is deliberately designed to be opportunistic and flexible. For example, it is likely that grant funding will become available for certain types of equipment, operational improvements, or infrastructure. In this case, the team will reassess priorities to determine whether the benefit of the available funding changes the priorities among implementing actions. A conceptual diagram of the implementation process is shown in Figure 3.

Information gathered and lessons learned will continually be incorporated into the overall implementation process for this Plan. As specific implementing actions are conducted, the team will use the lessons learned to plan and evaluate potential future actions. Similarly, as new technologies mature, it may become apparent that some assumptions made in this Plan are incorrect, and the Port, in collaboration with its partners and stakeholders, will modify the approach outlined in this Plan to reflect the new information.

Data gathering, in the form of infrastructure needs assessment(s) and feasibility studies, led or coordinated by the implementation team, will be an important component of the initial implementation of this Plan. Currently, the Port has preliminary information to determine the full extent of infrastructure needs, and the required time and cost to construct the required infrastructure. This information is required to appropriately prioritize various components of the overall infrastructure improvements.

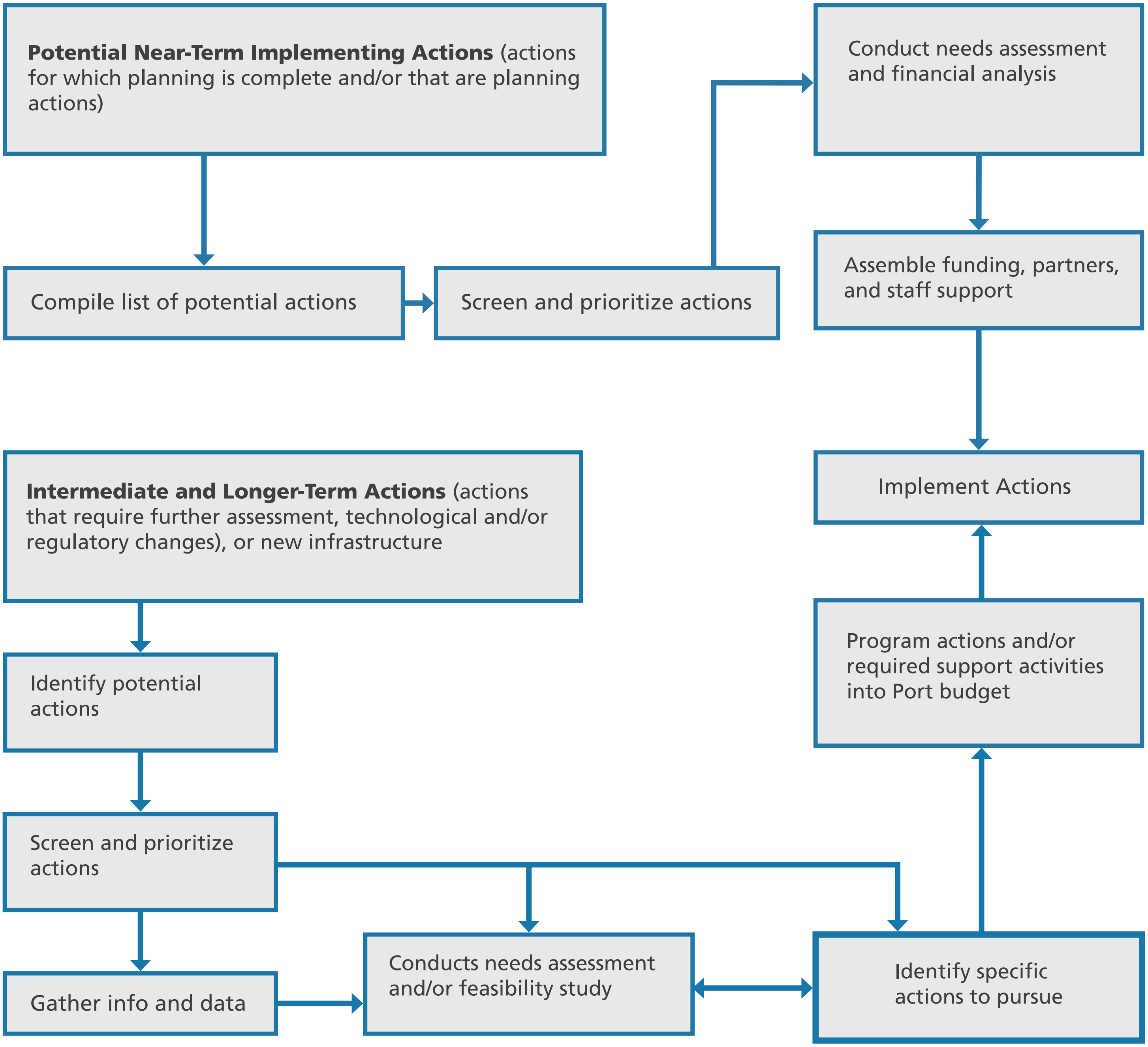
In addition to actualizing potential implementing actions, the implementation team would also be responsible for monitoring the effectiveness of implementing actions, documenting and reporting the progress made pursuant to this Plan, and disseminating lessons learned.

Plan Update

As discussed previously, technology is changing rapidly, and State regulations and policy are increasingly targeting zero-emissions requirements and substantial reductions in GHG emissions. Regulations are also increasingly focusing on exposure, in addition to emissions. These shifts in technology and regulations are expected to be more fully developed in five years. In addition, many of the Near-Term actions will have been implemented and data will be available to evaluate the benefits of these actions. Consequently, the 2020 and Beyond Plan will be updated in 2023 to reflect changes in technology and regulations, as well as lessons learned from implementing the initial set of actions.

As part of the Plan Update process in 2023, the Port will discuss material changes to the 2020 and Beyond Plan with stakeholders and present the proposed update (and amendments, if applicable) for the consideration and approval of the Board of Port Commissioners.

FIGURE 3: PROPOSED IMPLEMENTATION APPROACH



CONCLUSION

Based upon the 2015 Seaport Emissions Inventory, the 2009 MAQIP has been successful in serving as a framework to guide plans, programs, and projects that have substantially reduced Seaport-related emissions. The 2020 and Beyond Plan builds on this foundation of emissions reductions and expands beyond the MAQIP by providing a framework for the transition to a zero-emissions Seaport. A zero-emissions Seaport will require a new technological operating basis built on new equipment, using renewable fuels, including GHG-free electricity, and new infrastructure. Commercially available measures, such as the use of renewable diesel and hybrid-electric RTGs, can provide emissions reductions in the near-term. These near-term actions are an important component of this Plan. However, the full transition envisioned by this Plan will involve substantial financial and resource investment and resource commitments by both the Port and its partners, and will occur over decades. The full transition to a zero-emissions Seaport will also require the sustained engagement and commitment of all stakeholders over the long-term.

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Appendix B

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Appendix D

No references

Appendix E

To Be Provided (Appendix will be provided as part of the Final 2020 and Beyond Plan)

Appendix F

To Be Provided (Appendix will be provided as part of the Final 2020 and Beyond Plan)

APPENDIX A

PLANNING ASSUMPTIONS

PLANNING ASSUMPTIONS

This 2020 and Beyond Plan serves as the Port's master plan for reducing Seaport-related air emissions and transitioning to a zero-emission Port. The 2020 and Beyond Plan was developed in the context of specific planning assumptions shown in Table A-1. Specific considerations regarding the transition from the MAQIP to the 2020 and Beyond Plan, as well as the geographic scope of the Plan, are provided below.

Table A-1. PLANNING ASSUMPTIONS

Planning Assumption	Basis for Assumption
Throughput* Growth *The quantity or amount of material processed within a given time	Per the Port's business projections, cargo volume is expected to grow at a rate of approximately 2% per year, based on the most current forecasts.
Criteria Air Pollutant and Toxic Air Contaminant (TAC) Emissions	As a result of continued improvements in technology driven by existing regulations, emissions of criteria air pollutants and DPM will remain relatively flat compared to current emissions even though cargo volume is expected to increase.
Greenhouse Gas (GHG) Emissions	With no action by the Port, emissions of GHGs will increase with cargo growth, although at a lower rate than total growth due to improvements in engine and operational efficiency.
Port Air Quality Funding Capability - Improvements Consistent with Growth	Implementation of the 2020 and Beyond Plan will be dependent on available Port revenue and maximizing the use of the Port's resources to leverage grants, incentives, and partnerships. Following the retirement of the Port's current debt in 2033, increased funding for infrastructure and related improvements may become available.
Technological Paradigm Shift Requires Phased Transition	The path to a zero-emissions Seaport is based on a radical change in technology, rather than the incremental changes in existing technology that have occurred to date. A shift away from fossil fuels will be an important factor in continuing to reduce community health risks associated with Seaport operations, and to achieve GHG reductions in support of the State's GHG reduction efforts.

Table A-1. PLANNING ASSUMPTIONS (Cont.)	
Planning Assumption	**Basis for Assumption**
Increased Efficiency through Use of Smart Technology	Use of smart technology to drive efficiency improvements is increasing at ports all over the world. As both data transmission and data management capabilities increase, use of smart technology is expected to increasingly drive the container management process, reducing fuel use and truck trips. These efficiency measures will likely displace some existing jobs, and create some avenues for employment. Workforce training and retraining will be required to address the impacts of increased reliance on smart technology as well as the change in technology to zero-emissions equipment.
Flexibility and Adaptability	All aspects of technology required for the implementation of this Plan are evolving rapidly; there will be constant change throughout the life of this Plan. A flexible, adaptive approach is required to be able to meet the goals set out in this Plan.
Changing Regulatory Environment	The regulatory environment is expanding from a focus on criteria pollutants to an approach encompassing both GHG emissions and exposure to TACs. However, many of the regulations currently contemplated by CARB will not be put in place until 2023 and later, which will reduce their effectiveness as a driver of change in the short term.
Building Knowledge and Capability	As the Port and its partners progress toward achieving a zero-emissions Seaport, knowledge will be required and developed regarding the performance, operability, and maintenance requirements of various types of equipment, as well as infrastructure needs and monitoring processes. This Plan explicitly seeks to increase the knowledge base of the Port and its stakeholders so that each step in the transition to a zero-emissions Seaport can be informed by the previous step, and so that the effectiveness of each step can be evaluated objectively.
Practical Port of Oakland Approach	The Port has always had a practical, hands-on approach to getting things done. This Plan will be successful if it is built on technologies that are commercially available and demonstrated to perform in a maritime environment.
Compliance with Regulatory Requirements	The Port and its partners comply with regulations regarding air pollutant emissions.

Table A-1. PLANNING ASSUMPTIONS (Cont.)	
Planning Assumption	**Basis for Assumption**
Continuous Learning through Monitoring	The Port will monitor the success of various actions in reducing air pollutants and track effects of the actions on the Port's and its partners' business activities. The results of the monitoring and lessons learned from implementing various actions will help determine the most appropriate and successful future actions.
Plan Update	It is likely that technology will change and mature considerably over the next five years. In addition, community-based science will progress and new regulations may be enacted. The Plan will be updated in five years (in 2023), with an emphasis on the Action Plan.

Moving from the MAQIP to the 2020 and Beyond Plan

The 2009 MAQIP has been successful in substantially reducing DPM emissions originating from Seaport activities. As noted earlier, compared to the Year 2005 baseline, the Port's 2015 emissions inventory showed a decline in total DPM emissions of 76%. This 2020 and Beyond Plan builds on this foundation of emissions reductions from Seaport sources while looking to the future to provide a framework for the transition to zero-emissions operations.

The MAQIP focused on incremental improvements to existing technology (combustion engine-based equipment) that relied on an existing (roadway) infrastructure. The transition to a zero-emissions Port will include new technologies as well as infrastructure that supports the renewably-powered equipment and systems. Thus, while the MAQIP focused primarily on laying out a timeline for achieving emissions reductions, the 2020 and Beyond Plan addresses both the temporal and spatial components of the transition to a zero emissions Seaport. At its essence, this 2020 and Beyond Plan is designed to answer the questions of "What will the Port be doing, and how will it get there?" Table A-2 outlines the primary differences between the factors addressed by the MAQIP, and the factors that are being addressed by the 2020 and Beyond Plan.

Table A-2. COMPARISON OF MAQIP AND 2020 AND BEYOND PLANS		
Item	**MAQIP**	**2020 and Beyond Plan**
Technology	• Incremental improvements to long-established existing technology • Existing fuel source • Known and well-defined control technology	• New and rapidly-changing technology; most equipment types not commercially available yet • Battery- and grid-electric systems are the most likely future power sources, but need to maintain ability to include or change to a different fuel source if new technology dictates
Infrastructure	• Focused on existing infrastructure • Shore power project focused on at berth compliance	• Comprehensive improvements to electrical grid • Expansion of electrical grid throughout the terminals • Increased resilience of current grid • New/improved substations • Additional fiber line capacity • Likely need for advanced infrastructure solutions like distributed energy resources (DERs)[10] and microgrids • Need for other types of new infrastructure to support GHG free fuels use, such as hydrogen storage for hydrogen fuel cells
Target	• 85% reduction in Seaport-related DPM relative to the 2005 baseline	• Pathway to zero-emissions Seaport

[10] Distributed generation, also distributed energy, on-site generation (OSG) or district/decentralized energy is electrical generation and storage performed by a variety of small, grid-connected devices referred to as distributed energy resources (DER).

Table A-2. COMPARISON OF MAQIP AND 2020 AND BEYOND PLANS (Cont.)		
Item	**MAQIP**	**2020 and Beyond Plan**
Scope of Effort	Temporal: implement specific actions by 2020	Temporal: implement specific actions within the timeframe of this Plan. Spatial: 2020 and Beyond Plan applies to maritime area infrastructure (not just to mobile sources/equipment). Without improvements to or addition of new infrastructure, most new equipment cannot be deployed.
Regulatory Environment	Regulatory requirements were driving technological innovation	• Regulatory drivers for new technology are limited • New rules likely to be issued 2023 and later

Geographic Area

The MAQIP focused on a designated primary impact geographic area—West Oakland and the Port's emissions inventory area (Figure A-1). This 2020 and Beyond Plan extends the scope of the local focus, recognizing that the implementation of this Plan will have benefits to a larger area that may also be affected by Seaport-related air emissions (including downtown Oakland and Chinatown, as well as the City of Alameda.) Implementation of actions identified in this Plan will occur in the Seaport area, including Port-owned areas of the Oakland Army Base (OAB). The Port is not proposing any emission reduction initiatives on OAB property owned by the City of Oakland (City.)

Approximately 8,750 trucks are registered in the Port's Secure Truck Enrollment Program (STEP). The majority of the STEP-registered trucks visit one or more of the Port's marine terminals. The marine terminals require STEP registration as well as compliance with the CARB Drayage Truck Regulation. The CARB drayage truck regulations are more stringent than those for over-the-road trucks. Thus, the vast majority of trucks serving the Seaport are compliant with CARB regulations and these regulations are more stringent than those for over-the-road trucks. Thus, trucks serving the Seaport compare very favorably with California overall; CARB estimates that 30% of the 1 million trucks on the road in California are non-compliant (CalSTA 2018.)

Furthermore, on an average day, approximately 3,000 to 5,000 trucks call on businesses on Seaport property, indicating that between 43 to 65% of the trucks in the STEP work outside of Seaport property, again, the vast majority of these meeting CARB's requirements for drayage trucks.

The cleaner trucks not serving the Seaport on a given day, and the degree to which the Port installs infrastructure (e.g., charging stations) that support zero-emissions trucks, are partly responsible for a continued "halo" effect that has resulted and will continue to result in regional emission reductions not captured in the emission inventories prepared by the Port.

FIGURE A-1: GEOGRAPHIC AREA

APPENDIX B
BACKGROUND

Background

This Draft 2020 and Beyond Plan addresses emissions reductions for three categories of pollutants: criteria air pollutants, toxic air contaminants (TACs) - specifically diesel particulate matter (DPM), and greenhouse gases (GHGs).

The Clean Air Act requires the United States Environmental Protection Agency (U.S. EPA) to set National Ambient Air Quality Standards (NAAQS) for common air pollutants, known as criteria air pollutants. Regulation of criteria air pollutants, which include oxides of nitrogen (NOx) and ozone among other, may include precursors such as volatile organic compounds (VOCs). Many criteria air pollutants contribute to regional air quality concerns (such as smog.) The U.S. EPA, California Air Resources Board (CARB), and the Bay Area Air Quality Management District (BAAQMD) all regulate criteria air pollutants through different programs, depending on the source category.

TACs are associated with acute and chronic health effects, including increased risk of cancer. Central to Port planning efforts is the reduction of DPM emissions. DPM is listed as a known carcinogen by the State of California.

GHGs contribute to global climate change and its attendant consequences such as sea level rise and increases in severe weather. In the State of California, only CARB has regulatory authority over GHG emissions. State executive orders and legislation have also set goals for GHG reductions to be achieved through CARB programs.

Bay Area Air Quality

The Bay Area Air Basin currently is not in attainment of federal and State ambient air quality standards for ozone and particulate matter (PM). The Bay Area Air Basin is designated as being in Marginal Nonattainment of the 8 hour NAAQS, and Moderate Nonattainment of the 24 hour PM2.5 NAAQS. The 2017 BAAQMD Clean Air Plan Spare the Air: Cool the Climate states, regarding PM2.5:

"On January 9, 2013, U.S. EPA issued a final rule to determine that the Air District attains the 24 hour PM2.5 national standard. This U.S. EPA rule suspends key State Implementation Plan (SIP) requirements as long as monitoring data continues to show that the Air District attains the standard. Despite this U.S. EPA action, the Air District will continue to be designated as non-attainment for the national 24 hour PM2.5 standard until the Air District submits a redesignation request and a maintenance plan to U.S. EPA, and U.S. EPA approves the proposed redesignation."

To achieve attainment with NAAQS, the BAAQMD adopts rules for stationary sources of NOx, VOC, and PM (such as refineries.) CARB regulates mobile sources (such as trucks and ships) of ozone precursors and PM through fuel and engine standards as well as by requiring turnover to newer equipment through in-use fleet rules. Rulemaking is guided by the priorities and analysis of the SIP for each pollutant. Both CARB and BAAQMD may provide grant funding to incentivize action in advance of regulation or where they do not have regulatory authority.

Ocean-going vessels (OGV) calling at the Port are subject to CARB regulation within 24 nautical miles of the California baseline.[11] CARB currently limits the type of fuel used by these vessels to less than 0.1% sulfur distillate fuels. The International Maritime Organization (IMO) North American Sulfur Emission Control Area (ECA) limits OGV to no more than 0.1% sulfur within 200 miles of the US and Canadian coastlines.

The Port develops plans, programs and projects that support the goals of certain regulations. The City regulates land use through zoning, including the location of industrial activities that may be sources of emissions. The City also has authority over truck routes, rules regarding where trucks can park on City streets, enforcement of truck routes and parking rules.

As a landlord Port, the Port has limited means to reduce air emissions. The Port does not own or control most of the equipment working in the Seaport area. Therefore, it can only directly control a very small percentage of air emissions (those directly associated with its operations). Other reductions have to be achieved through the Port's efforts to influence other businesses in the Seaport area.

The Port is potentially able to influence its tenants, shippers, truckers, and other Port-related businesses through education, lease terms, contractual requirements, and involvement in the regulatory process. The Port is also eligible for grant funding sources, such as U.S. EPA Diesel Emissions Reduction Act (DERA) grants, which private entities may not be able to access directly. In other cases, such as for a recent CEC grant, private entities may be required to provide a cost match, while public agencies are exempt from providing matching funding.

West Oakland Community and Health Risk

In 2005, the Port prepared a Seaport air emissions inventory (EI) to identify and quantify air emissions from maritime activities. In 2008, CARB used the 2005 Seaport EI to conduct the West Oakland human health risk assessment (HRA.) CARB's HRA attributed 16% of the DPM-related cancer risk in West Oakland to Seaport sources, while other sources (primarily over-the-road trucks not associated with the Seaport) and the Union Pacific Railroad operations accounted for 80% and 4% of the health risk, respectively.[12] A summary of the results of the 2008 HRA is presented in Table B-1. The Port prepared additional annual EIs for calendar years 2012 and 2015. The most recent inventory is for 2017; it is currently in development.

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[11] "Baseline" in this context means the mean lower low water line along the California coast.

[12] California Air Resources Board (CARB). 2008. Diesel Particulate Matter Health Risk Assessment for the West Oakland Community. December

Table B-1. Population-weighted Potential Cancer Risks in West Oakland Community by Parts and Source Category (2005 Baseline)

Source Category	Part I (Port)	Part II (UP)	Part III (Port)	Combined
OGV Transiting, Maneuvering, & Anchoring	57	0	23	81
OGV Hotelling	57	0	10	67
Harbor Craft	15	0	78	93
Trucks	42	7	795	844
Cargo Handling Equipment	16	21	7	43
Locomotives	4	15	37	56
Others	0	0	2	2
Total	192(16%)	43(4%)	951(80%)	1186(100%)

Notes: Total area for the community = 1,800 acres; total population = 22,000. Part III anchorage activities are included with impacts from Part III hotelling.

Source: CARB 2018b

CARB has not updated the 2008 HRA to reflect current emission standards and the current Port EI. If the HRA is updated, ambient air concentrations of Port-related pollutants will be lower than the Port-related pollutant levels in the 2008 HRA, due to the significant reductions in Seaport-related emissions over the past 13 years.

However, an updated HRA would not be directly comparable to the 2008 HRA because the Cal/EPA Office of Environmental and Health Hazard Assessment (OEHHA) changed the risk assessment factors used in HRAs in 2015. Also, the California EnviroScreen (CES) model, which is used to identify highly impacted communities under Assembly Bill 617, uses a broader set of criteria to assess health impacts, and is not comparable to the 2008 CARB HRA. In addition to air quality, the CES includes a wide range of factors, such as access to sidewalks and healthy food.

While the Port will continue to take action to reduce DPM emissions associated with Seaport operations, the Port looks to CARB and the Alameda County Department of Public Health to assess health risk.

This Plan also addresses emissions of GHGs. Any zero-emissions technology that relies on GHG free fuels from renewable or other non-carbon sources (i.e., that eliminates the use of diesel and other petroleum-based fuels) also eliminates DPM. Technologies and fuels that provide a reduction in GHGs (but do not completely eliminate GHGs) typically also result in reductions in DPM. Therefore, in the long term, reducing GHGs provide the co-benefit of further reducing DPM emissions. These co-benefit local and regional reductions in DPM will further reduce air pollution in the West Oakland community.

Existing and Pending Regulatory Action and Policies

As stated above, this Plan addresses three forms of air pollutants: criteria air pollutants, TAC (including DPM), and GHGs. While all three categories of air pollutants are associated with diesel engine emissions, they are subject to separate regulatory regimes. In the context of diesel emissions, criteria air pollutants and TAC are closely linked because DPM, which comprises a portion of the criteria pollutant PM, is a TAC. Similarly, GHG emissions are directly linked to fuel consumption by diesel engines. Engines fueled by compressed natural gas (CNG) or liquefied natural gas (LNG) also emit PM. However, the difference in the fuel source means that natural-gas-fueled engines emit different constituents that do not pose the same types of health risks as DPM.

Regulatory Setting

Since the 2009 MAQIP was developed, the regulatory setting has changed. As the Bay Area Air Basin gets closer to attainment of federal and State ambient air quality standards, CARB and BAAQMD regulations are increasingly focused on GHG and TAC reductions. Some of the relevant new policies are captured in Table B-2.

Table B-2. RECENT POLICY, STATUTORY, AND REGULATORY MEASURES

Executive Orders	
Executive Order B-30-15	Sets a statewide goal for a 40% reduction in GHG emissions from 1990 levels by 2030. This interim goal was adopted by CARB in its 2017 California Climate Action Plan approved December 14, 2017. The State's 2030 and 2050 GHG emission reduction goals create a long-term "frame" for implementation of this Plan.

Table B-2. RECENT POLICY, STATUTORY, AND REGULATORY MEASURES (Cont.)	
Executive Order B-32-15 and the Sustainable Freight Action Plan	Interagency development of a guidance document to establish freight efficiency targets, transition to zero-emission technologies, and increase the competitiveness of California's freight system. The Sustainable Freight Action Plan has three targets: 1) increase freight system efficiency 25% by 2030; 2) transition to zero-emissions technology; and 3) increase State competitiveness and future economic growth within the freight and goods movement industry. The targets are not mandates but rather aspirational measures of progress toward sustainability for the State to meet and try to exceed.
Executive Order B-48-18	This EO is designed to boost the supply of zero-emissions vehicles and charging and refueling stations in California. It includes a new eight-year, $2.5 billion initiative to help bring 250,000 vehicle charging stations and 200 hydrogen fueling stations to California by 2025, and targets 5 million zero-emissions vehicles by 2030. It also continues the state's clean vehicle rebates.
Legislation	
Senate Bill 1 (Beall, 2017)	Provides for transportation funding and restricts in-use truck fleet regulations to allow in-use equipment to remain in use for either 800,000 miles or 18 years.
SB 350 (de León, 2015)	Extends the Renewable Portfolio Standard to require 50% of California electricity to be renewable by 2030, requires building energy efficiency to double by 2030, and requires publicly owned utilities to develop Integrated Resource Plans and invest in transportation electrification.

Table B-2. RECENT POLICY, STATUTORY, AND REGULATORY MEASURES (Cont.)	
Assembly Bill 617 (Garcia, 2017)	Requires community-focused air quality planning to reduce exposure to existing sources, through the Community Air Risk Evaluation program. AB 617 represents a fundamental shift in air quality regulation because it focuses on local health effects, with specific attention to communities affected by a high cumulative exposure to criteria air pollutants and TACs, including DPM. BAAQMD staff has identified West Oakland as a high-priority AB 617 community. The goal of the program is to eliminate air quality disparities and reduce health burdens. Port staff participated in BAAQMD's February 26, 2018, workshop and submitted comments requesting funding to promote the widespread proliferation of local electric drayage trucks. CARB requires local districts to work with communities to select all areas in the region that have a "high cumulative exposure burden" and prioritize areas for community monitoring and/or action plans over the next six years. Up to $50 million are available through a clean technology grant program in the Bay Area to address air pollution sources contributing to excess health risks in CARE[13] communities. The program requires an equipment owner cost share.
Regulation and CARB Policy	
State Strategy for the SIP, including the Mobile Source Strategy	While CARB's 2016 Mobile Source Strategy focuses on light-duty equipment, when adopting the State Strategy for the SIP for ozone and PM2.5 in 2017, CARB directed staff to revisit the At-Berth Regulation and the Cargo-Handling Equipment Regulation as well as to develop concepts for Indirect Source Rules. Staff returned in March 2018 with a proposed schedule for updating regulations regarding freight activity.
2030 Scoping Plan	Plans California's path to a 40% reduction in GHG emissions from 1990 levels by 2030.

[13] CARE communities are communities that were identified under the Community Air Risk Evaluation (CARE) Program as experiencing higher air pollution levels than others.

Mobile Sources at Ports-Specific Air Quailty Regulations

In 2006, CARB announced its intention to establish emissions regulations and health risk goals to protect public health from the impacts of ports and goods movement operations.[14] To achieve these goals, the State promoted new regulations affecting the five main mobile sources associated with ports and goods movement: ships, commercial harbor craft (HC), container-handling equipment (CHE) at ports and intermodal yards, heavy duty (Class 7 and 8) diesel trucks, and locomotives.

The Port responded to the new CARB air rules by partnering with neighborhood and business representatives and air quality regulators to develop the original MAQIP. The Board approved the MAQIP in April 2009. The MAQIP created a comprehensive 12-year policy and planning framework through the year 2020.

In Southern California, the Port of Los Angeles and the Port of Long Beach (collectively "San Pedro Bay Ports" or "SPBP") developed a similar air quality plan—the Clean Air Action Plan (CAAP). The San Pedro Bay Ports developed the original CAAP in 2006, updated it in 2010, and approved significant updates to the CAAP in November 2017 (also referred to as CAAP 3.0).

New Air Quality Rules Being Developed by CARB

On March 23, 2017, CARB adopted Resolution No. 17-8, which requires CARB staff to take the following actions, among others:

- Within 18 months, develop amendments to existing "At-Berth Regulation" that will achieve up to 100% compliance by 2030 for Los Angeles Ports and Ports in or adjacent to the top 10% most impacted areas based on the CES. [15]
- Within 24 months, develop amendments to the Cargo Handling Equipment regulations to achieve up to 100% compliance with zero-emission vehicle (ZEV) requirements by 2030 for the Ports identified above.
- Within one year, return to the CARB with concepts for an Indirect Source Rule (ISR) to control pollution from large freight facilities, including ports, railyards, warehouses and distribution centers, as well as any alternatives to ISR capable of achieving similar levels of emission reductions.

On March 23, 2018, rather than proposing an ISR, CARB staff recommended a schedule of freight rulemaking. Amendments to the At-Berth Regulation are underway with the goal of taking amendments to the CARB in 2019. Amendments to the CHE regulation are anticipated to go to the CARB in 2022, with the earliest implementation beginning no earlier than 2026. CARB staff did not recommend a state-wide ISR, but acknowledged that local air districts have authority to develop their own ISR.

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[14] State of California, Air Resources Board, Resolution 06-14, April 20, 2006.

[15] Although the Seaport is not in the top 10% pursuant to CES, Port staff assume that ships calling at Oakland would be subject to any new CARB At-Berth amendments

Air Quality Planning

Historically, air quality was regulated with a focus on individual constituents, such as criteria air pollutants and TACs. Regulations were designed to reduce excess levels of specific constituents identified as being of concern, with a goal of reducing ambient concentrations within a given region (air basin). While the goal was to protect human health and the environment, regulations focused on the constituents that together created the health and environmental concerns. Consistent with the regional approach to air quality, data collection typically occurred on a regional level as well. Monitoring stations were designed to detect a certain limited set of parameters, and the typical monitoring interval was hourly or daily, depending on the constituents. Health risk calculations (modeling) were then performed using the regional data. These health risk calculations provided regional estimates of excess cancer and non-cancer effects associated with the modeled constituents. There is one regional monitoring station located in West Oakland.

More recently, air quality regulations (such as AB 617) have begun to focus directly on localized health risks, and new dynamic data collection processes provide the ability to distinguish levels of pollutants on a scale as fine as one city block (Apte et al. 2017), and even to identify specific vehicles that may not be achieving expected emission standards (Harley 2014.)

Community-Based Science and Research Initiatives

New community-based research and data provide important insights into exposures at increasingly refined scales. In recent years, there have been multiple data collection efforts conducted in or initiated by the West Oakland community. These efforts have added to the understanding of air quality and diesel truck emissions in West Oakland (as well as some other Oakland neighborhoods). The Port has provided support for some of these studies by providing access to Port property for placement of monitors and coordination with the researchers as needed. The recent studies included:

- Distributed Monitoring of Community Black Carbon Exposure (100 x 100 Study)
- Real-Time Truck Emission Monitoring
- Street-Level Air Monitoring (Google/Aclima Study)

These studies are briefly summarized below. This new community-based science is in the developmental stage and protocol and processes for collecting quality, reliable data are not well established. Nevertheless, in the future, data gathered through community-based initiatives will continue to inform the air quality planning process.

Distributed Monitoring of Community Black Carbon Exposure (100 x 100 Study)

The University of California at Berkeley (UC Berkeley), in collaboration with the Environmental Defense Fund, West Oakland Environmental Indicators Project (WOEIP), and the University of Texas at Austin conducted a study of the distribution of black carbon (BC) in West Oakland and nearby Seaport areas. The study placed 100 BC sensors in various location and collected data for 100 days. The data compiled was compared to the BAAQMD regional air quality sensor to provide relative concentrations. Except for monitoring locations within the Seaport area, average sensor concentrations were typically within a factor of 2 of the BAAQMD sensor. Concentrations in the Seaport area tended to be higher. Some locations in the southwest portion of West Oakland exceeded the regional average approximately 20 to 30% of the time; however, PM concentrations showed daytime variation.

Real-Time Truck Emission Monitoring

In 2011 and 2013, pursuant to a CARB grant, UC Berkeley, led by principal investigator Robert Harley, conducted real-time air monitoring to assess the effects of diesel engine turnover and engine retrofits on total truck emissions (Harley 2014; Preble et al. 2015). The researchers were able to correlate the emission data collected for each truck with the applicable engine and retrofit information for that truck by noting the license plate of the truck.

Data were collected from a bridge overpass on Seventh Street at the entrance to the Seaport Area by sampling emissions from trucks passing under the bridge. Nitrogen oxides (NOx), black carbon (BC), particle number (PN), and particle size distributions were measured in the exhaust plumes of about 1,400 drayage trucks near the Seaport area. The researchers concluded that average NOx, BC, and PN emission factors for newer engines (2010–2013 model years) equipped with both diesel particulate filters (DPFs) and selective catalytic reduction (SCR) were 69 ± 15%, 92 ± 32%, and 66 ± 35% lower, respectively, than 2004–2006 engines without these technologies.

Increased deployment of advanced controls distorted emission factor distributions; a small number of trucks emit a disproportionately large fraction of total BC and NOx. Emission factor distributions for BC and PN were more distorted than those for NOx. In 2013, the highest emitting 10% of trucks were responsible for 65% of total BC and 80% of total PN, compared to 32% of total NOx emissions. The researchers noted that an imbalance of NOx emission factor distributions is increasing, and this trend is likely to continue as the number of engines equipped with SCR increases in future years.

The study also demonstrated the effectiveness of the Port's incentive programs for DPF retrofits and engine replacement. The fraction of DPF equipped drayage trucks increased from 2 to 99% and the median engine age decreased from 11 to six years between 2009 and 2013. Over this period, fleet-average BC and NOx emission factors decreased by 76 ± 22% and 53 ± 8%, respectively. Emission changes occurred rapidly compared to what would have been observed due to natural (i.e., unforced) turnover of the truck fleet serving the Seaport. The study authors concluded that these results provide a preview of more widespread emission changes expected statewide and nationally in the coming years.

Street-Level Air Monitoring

Affordable portable air monitors are enabling researchers to obtain near instantaneous information on local air quality. The new data collection processes are accompanied by a rapid increase in computing power, allowing the analysis of very large volumes of individual data points. For example, a joint effort by the Environmental Defense Fund, Google, the University of Texas at Austin, and Aclima equipped two Google Street View vehicles with a fast-response pollution measurement system and repeatedly sampled every street in a 11.6 square-mile area of Oakland, including all of West Oakland.

Each 30-meter (98.4-foot) road segment was sampled on average 31 times during the six-month study period., with data was collected during weekdays. A total of 3 million data points were collected. Resulting maps of annual daytime NO, NO2, and BC reveal stable, persistent daytime pollution patterns with sharp small-scale variability, up to 2-8 times within individual city blocks and neighborhoods. The researchers attempted to link a subset of hot spots in West Oakland to local sources, and were able to identify potential sources for all but one of the 12 hot spots reviewed. The report also indicated that the median daytime concentration measured by this study differed from the values reported by the West Oakland BAAQMD regional monitoring location by approximately 1/3 for BC and NO2, and 2/3 for NO (Apte et al. 2017).

Initiatives by Other West Coast Ports

Ports along the entire West Coast, from Mexico to Canada, are typically visited by the same vessels, as most vessels from Asia have multiple ports of call. Therefore, the Port of Oakland has the opportunity to learn from the experiences of larger ports with greater operating budgets when those ports conduct pilot and demonstration tests of new technologies.

In their 2017 CAAP, the San Pedro Bay Ports commit to achieving fully electric CHE in both ports by 2030. However, as noted in the CAAP, this commitment is subject to sufficient funding and available technology. The Ports of Seattle, Tacoma, and Vancouver, Washington, jointly developed the Northwest Ports Clean Air Strategy, which is currently being updated.

MAQIP (2009) Accomplishments and Current Actions

The Port has substantially reduced its DPM emissions from the 2005 baseline and continues to seek out actions that could contribute to further reductions. MAQIP programs and projects support this goal through regulatory compliance, early actions before regulations come into effect, and by targeting emission reductions that exceed legally mandated requirements. The Port calculates MAQIP progress through periodic EI updates. For 2015, the EI showed a 98% reduction in truck-related DPM emissions and 76% reduction in DPM for all Seaport sources from the 2005 baseline. Port staff are currently working on the year 2017 EI, and the results of the 2017 EI will be presented in the Final Plan.

The Port is continuing to implement the MAQIP and working to achieve an 85% reduction in risk from DPM by 2020.

Certain actions will be completed by 2020; other actions will continue as part of the 2020 and Beyond Plan's Near-Term Action Plan. Emissions inventories are discussed in more detail in the subsequent section of this appendix.

Shore Power Implementation

Shore power implementation (compliance with the CARB's "At-Berth Regulation" for OGV) is a priority because OGVs are the largest source category for DPM in the Port's emissions inventory. Shore power compliance has resulted in substantial emissions reductions. In 2005, OGV emissions were calculated to be 208.5 tons DPM; in 2015, OGV emissions were 51.8 tons. This represents a 75% reduction in OGV DPM emissions between 2005 and 2015, with approximately 11 tons of those reductions attributable to shore power.

Although significant DPM emission reductions have been achieved using shore power, shore power compliance continues to constitute a challenge due to many factors, which are primarily tied to vessel capabilities outside the control of the Port, such as equipment damage and failure, vessel size, inconsistent positioning of cables on the vessel, and foremost, the absence of shore power equipment on certain vessels. As a result, data show a wide range of compliance performance by the fleets at the Port. For example, in 2017, some fleets achieved 100% plug-ins while other fleets were only at 50%. (Note: the CARB "At Berth" regulation does not apply to fleets with fewer than 25 vessel calls per year or steamships.

Port staff track shore power usage monthly and work with shipping lines and terminal operators to identify factors that prevent plug-ins to overcome those factors and achieve increased shore power usage. For example, to overcome cable-positioning issues, the Port is currently developing the engineering design for extending the reach of a vault plug from a few feet to up to 100 feet from the nearest shore power outlet. This will enable improved plug-in rates. Tracking of shore power compliance and actions to improve plug-ins will continue as part of the Near-Term Action Plan of the 2020 and Beyond Plan.

Hybrid RTG Cranes

Stevedoring Services of America (SSAT), the terminal operator at the Oakland International Container Terminal (OICT), was awarded a Carl Moyer grant for the purchase of 13 hybrid RTGs. SSAT will use this grant to replace its entire fleet of RTGs. Phase-in is expected to require approximately two years.

The hybrid RTGs use a battery electric system; the battery stores recovered energy from lowering containers and receives supplemental charging from a small Tier 4 final diesel engine. Because of the significant energy recovery and the fact that the diesel engine is very clean and runs at a steady level, overall criteria air pollutant emissions from the RTGs are reduced 99.5% compared to the existing units. Because the cranes are battery operated, they could be converted to fully electric operation once appropriate battery and any charging systems are developed and installed. Conversion of the RTGs to hybrid-electric RTGs would require approximately 18 to 24 months.

Zero-Emission Yard Tractors

A terminal operator at the Port is currently considering using five battery-electric yard tractors at its facility. The project would assess the performance of the yard trucks, including operating time between charges, time required to recharge the vehicles, performance under load, and more.

Emissions Estimates

DPM Emissions

Baseline DPM Emissions

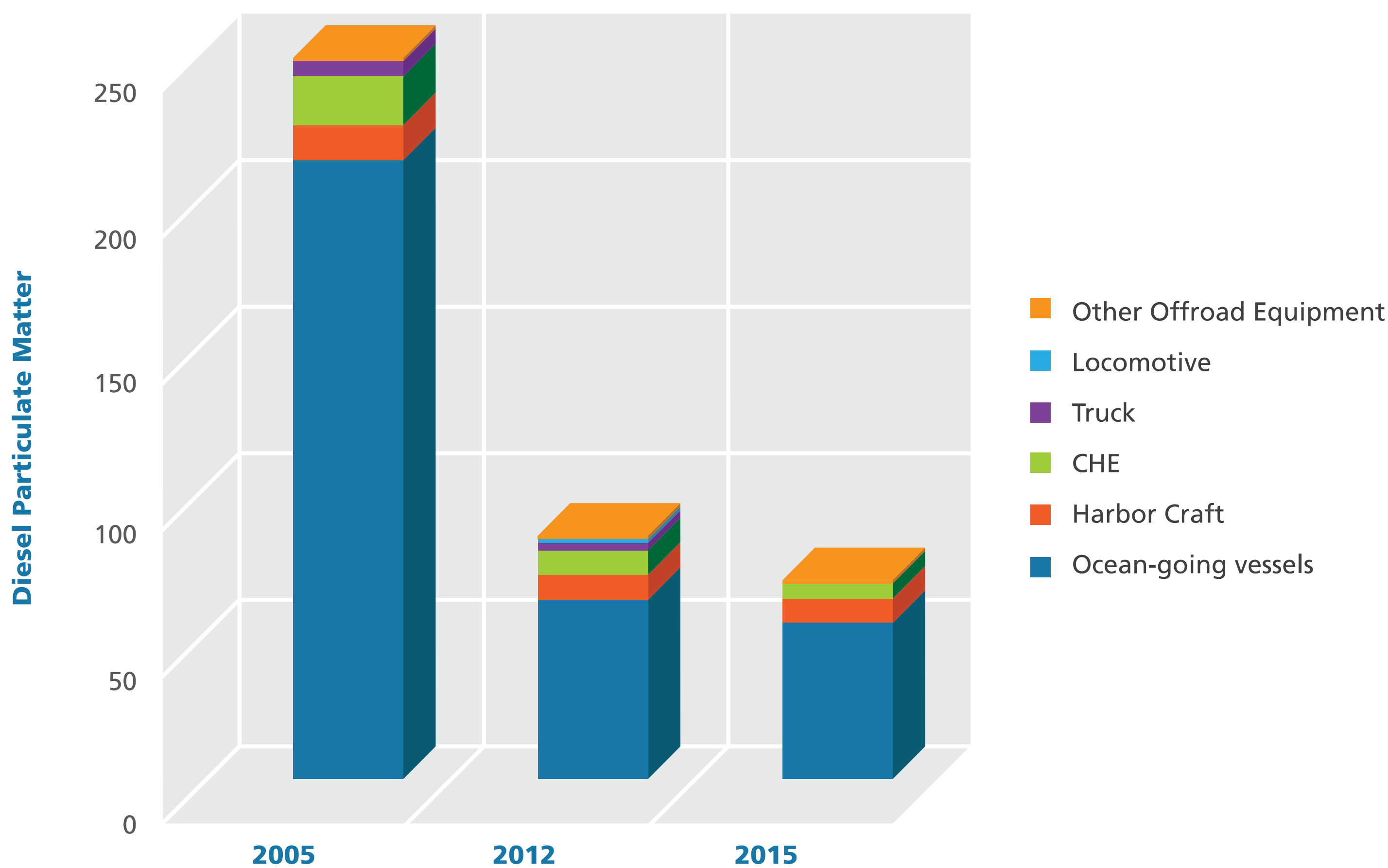
Since 2005, the Port has conducted three Emissions Inventories: in 2012, 2015, and 2017 (in progress), respectively. The Port has also committed to annual Seaport EIs through 2020. BAAQMD and CARB were involved with the protocol for the first EI in 2005. Each EI uses established methods of emissions estimation, such as those used by CARB in regulatory development. To ensure that the 2017 emissions inventory reflected regulatory agency input, the Port convened a meeting with BAAQMD and CARB on January 25, 2018, to determine the inventory modeling protocol, which included determining the extent of the EI.

The comparison between the 2005 and 2015 Seaport emissions shows a significant decline in total DPM emissions of 76%. As shown in Figure B-1 below, the two largest source categories are OGV (82% of residual emissions) and HC (9.8% of residual emissions). Port truck emissions declined by 98%, constituting 6% of DPM emissions in 2005 and just 0.3% of the residual emissions in 2015

Projected DPM Emissions

The Port has forecasted Year 2020 and 2030 emissions to determine the additional reduction needed to achieve and maintain the MAQIP DPM reduction goal. The estimates were based on activity forecasts developed from a range of potential growth trajectories. The key findings of the modeling are:

- Emissions from vessels (OGV and HC/tugs, neither of which the Port owns) are the largest current sources of DPM emissions
- The Port will need to go above and beyond State regulatory requirements to reach its 85% reduction goal for DPM and risk from DPM



Sources: Port of Oakland 2015 Emissions Inventory; Port of Oakland Draft 2015 Emissions Inventory (Note: graph will be updated to reflect data from the 2017 EI in the Final Plan.)

After 2020, if cargo volume increases, the projections show a slight increase in DPM. This increase can abated through additional regulation of OGVs and HC or changes in fuel (such as ultra-low sulfur fuel for OGV.)

The information used to develop emission estimates will continue to be refined as new information becomes available. Most recently (for the 2017 EI), the Port included emissions associated with fueling tugs for the first time.

PFigure B-1. EMISSIONS BY EQUIPMENT CATEGORY

GHG Emissions

Baseline GHG Emissions

The first GHG emissions estimate for the Seaport was completed in 2012. Subsequent EIs also include GHGs; GHG emissions will be included in future EIs.

Projected GHG Emissions

Unlike criteria air pollutants and DPM, diesel engine improvements only achieve limited reductions in GHG emissions. Improvements in engine technology have increased diesel engine energy efficiency and reduced GHG emissions since 2005. However, unless further steps are taken, GHG emissions are projected to increase again after 2020, assuming the cargo volume at the Port increases.

Related Initiatives

Today, about 3,000 to 5,000 trucks serve the Seaport daily. With the proposed new warehouses at the Port, more transfer of goods occur at the Port. Many of the warehouses will have nearby rail access to limit truck trips to and from the warehouses.

In addition to activities performed specifically in relation to the MAQIP and the additional activities proposed in this Plan, the Port and the City are engaged in several related initiatives to reduce air pollution from trucks, reduce GHG emissions from the redevelopment of the OAB, and minimize truck impacts to the West Oakland neighborhood. These initiatives include implementing the Port's Comprehensive Truck Management Plan (CTMP), developing and implementing the Joint Port and City of Oakland West Oakland Truck Management Plan (TMP), and developing and implementing GHG Reduction Plans, required as a condition of redevelopment of the former OAB. The Port completed the CTMP in 2009. The CTMP was successful in substantially reducing truck-related DPM emissions in West Oakland, both in advance of regulatory deadlines and overall. More detail regarding the CTMP is provided in Appendix C.

As part of implementing the CTMP, the Port has maintained the TWG Trucker Working Group (TWG) that was initiated in 2007 and also provided interim truck parking and container staging areas at various locations throughout the Seaport. Currently, the City is working on providing a convenient 15-acre truck parking area on the former OAB with a gas station, food court, truck repair services, and bathrooms.

The Port and the City are preparing the West Oakland TMP to meet the requirements of Mitigation Measure 4.3-7 of the Standard Conditions of Approval/Mitigation Monitoring and Reporting Program (SCA/MMRP) for the 2012 Oakland Army Base Redevelopment Project, adopted by the Board of Port Commissioners in 2012 and the Oakland City Council in July 2013. It states that "[t]he City and the Port shall continue to work together and shall create a truck management plan designed to reduce the effects of transport trucks on local streets."

The TMP is intended to:

- Reduce the effects from circulation and parking by trucks serving the Port and the OAB on local streets, residential neighborhoods and businesses in West Oakland
- Improve communication with the trucking community about where trucks are and are not allowed to drive and park

As of June 29, 2018, three of five planned community workshops have been held to gather input for and support the development of the TMP.

The SCA/MMRP for the OAB Redevelopment Project also required the development of GHG Reduction Plans (GGRP) for new development at the OAB. Each project-level development, whether on Port or City property, submits a GGRP for City review as a condition of development. Each GGRP shows how the project will meet the goals of the City of Oakland Energy and Climate Action Plan.

Status of Current Technology and Transition to Zero-Emissions Equipment

The Port has been tracking the development of near-zero and zero-emissions technology suitable for the maritime industry. While personal vehicle and solar collection technology is advancing rapidly, heavy power demands, variety of sources, and challenging operating conditions in the maritime environment create greater challenges to progress.

Furthermore, most zero-emission technology based on electrical power currently has a very limited operating range or duration and requires frequent charging. Charging takes considerably longer than refueling a comparable piece of equipment with petroleum-based fuel. Improved batteries (lighter weight, capable of holding a greater charge, with a longer lifespan, and able to be charged more rapidly) are required to make much of the electrically powered zero-emission equipment feasible from a commercial and operational perspective.

While battery technology is continuing to advance, it is impossible to predict at this point when the right types of batteries will become available. Equipment based on hydrogen fuel cells can be charged more rapidly, but would require more extensive infrastructure investments and can pose safety concerns. While two equipment manufacturers have developed trucks powered by hydrogen fuel cells, development of new cargo-handling equipment (CHE) powered by hydrogen fuel cell technology appears to be lagging the development of battery-electric equipment (M&N 2018).

A recent CARB study (conducted by the University of California at Riverside, CARB 2018) indicated that the expected efficiency gains from electrification of trucks and buses are better than previously estimated, especially for low-speed duty cycles. The resulting GHG emissions benefits and fuel saving would therefore also be higher than previously estimated.

The energy efficiency ratio (EER) is used to determine how many credits an electric vehicle owner can receive for using electricity as a motor vehicle fuel. Potential updates to the Low Carbon Fuel Standard program to reflect the higher EER would result in higher credits per kilowatt hour (kWh)[16] used and would lower the total cost of ownership of a given electric vehicle.

Based on the CARB study, when compared to conventional diesel vehicles, the battery electric vehicle EER is about 3.5 at highway speeds and five to seven times more when operated at lower speed duty cycles where idling and coasting losses from conventional engines are highest. The average daily speed for near dock drayage trucks, vans and yard tractors is commonly below 13 miles per hour (mph). The EER can be higher than 6 for yard tractors. CARB expects that in the next decade, battery electric trucks and buses are more likely to be placed in service in slower speed operations because of battery range limitations and battery costs.

Some electrical equipment can also be powered by grid electricity. However, this type of equipment is limited in its range as it either needs be connected to a fixed rail or a cable reel. Depending on the layout of the terminal, this type of equipment may also present operational challenges. Electric rails could limit yard tractor and truck movements within the terminal. Cables on cable reels are typically run in trenches; truck traffic on the terminal causes debris to enter the trenches, which can cause failure of the cable reel. As a result, some ports that operate their own terminals have gone to a fixed container yard layout to allow for a high level of automation in their terminals. The Port of Oakland is a land-owner port and does not operate its own terminals. In addition, any such changes are subject to Port labor agreements.

Currently, the technologies that are most feasible from a commercial and operational perspective are typically hybrid technologies; electric yard trucks may also be workable, provided that adequate charging infrastructure is available. Some hybrid technologies achieve near-zero criteria air pollutant emissions and provide substantial GHG reductions. When these hybrid technologies rely on a battery or batteries to drive the engine and support other functions (such as heating and cooling, lights, and controls in a crane operator's cab), they can be converted to zero-emissions equipment at a later date, when charging systems, battery

[16] A kWh is a measure of how much energy is used. It does not mean the number of kilowatts used per hour, but a measurement equal to the amount of energy that would be used to keep a 1,000-watt appliance running for an hour. For example, a lit 100-watt lightbulb would take 10 hours to use 1 kWh of energy.

capacity, and related issues have been resolved. Thus, some hybrid equipment can be deployed now to provide substantial emission reductions while serving as a very effective bridge to zero-emissions technology in the future.

There are currently no commercially available zero or near-zero emission options for OGVs in transit. Approximately 70% of OGVs calling on the Port of Oakland already use shore power, and the Port is continuing to work with the shipping lines to increase participation. Criteria air pollutant and DPM emissions could also be captured at the exhaust stack for vessels that are unable to use shore power (by use of a "bonnet" over the exhaust stack, coupled with filtration of the exhaust gases, see Appendix C). However, a bonnet does not provide any GHG reduction benefits, and operation of the barge equipped with the bonnet and the operation of the bonnet itself may increase GHG emissions relative to not using a bonnet (see discussion of Barge-Based Exhaust Scrubber System [Bonnet] in Appendix C).

Reduction in OGV emissions from transiting vessel must come from improvements to OGVs. On April 13, 2018, the United Nations International Maritime Organization (IMO) agreed to set targets to reduce the carbon intensity of global transport. The goal is to reduce CO2 emissions per unit freight, as an average across international shipping, by at least 40% by 2030, compared to 2008, and moving toward 70% by 2050. In addition, the IMO set a target to reduce the total annual GHG emissions by at least 50% by 2050, compared to 2008, while pursuing efforts towards phasing them out, consistent with the Paris Agreement temperature goals (IMO 2018).

Currently, there are also no commercially available near-zero and zero-emission technologies suitable for HC. While there is at least one hybrid retrofit system that has been approved, and others are in development, the maximum criteria air pollutant and GHG reductions are on the order of 30% over engine technology. CARB is considering issuing additional tug engine regulations in 2020. However, these regulations are not expected to take effect until 2023.

Zero and near-zero emission CHE is currently in use in portions of 18 ports around the world. The San Pedro Bay Ports currently have the greatest variety of operating zero and near-zero emission CHE equipment (M&N 2018). As noted earlier, BAAQMD's Mobile Source Committee recently recommended that SSAT receive a grant to help fund the installation of 13 hybrid, near-zero emission RTGs at the Port of Oakland.

The National Renewable Energy Laboratory (NREL), in collaboration with the South Coast Air Quality Management District (SCAQMD), is evaluating the in-service performance of electric drayage trucks compared to conventional diesel drayage trucks operated in and around the San Pedro Bay Ports. The Class 8 electric drayage trucks under study, produced by TransPower and U.S. Hybrid Corporation, transport cargo containers between the port complex and local rail yards and distribution centers. According to NREL, by utilizing advanced batteries and high-efficiency components, the electric drayage trucks can operate up to 100 miles on a single battery charge while handling gross vehicle weight loads of up to 80,000 pounds (NREL 2018).

Some manufacturers are currently taking orders for their electric heavy-duty trucks, while others have unveiled prototype electric drayage trucks. When battery-electric trucks become commercially available, it is expected that the technology will most easily be adopted for trucks typically used for shorter trips (such as hauls between the terminals and the rail yards). This would also permit charging infrastructure to first be developed locally.

Challenges

Continuing to achieve further emission reductions and transitioning to a zero-emissions Seaport will be challenging. Among the challenges that will need to be addressed are the following:

Sources of Residual DPM Emissions: The majority of the remaining DPM emissions associated with Port operations are due to OGVs in transit (82%) and HC (9.8%), none of which are owned, operated, or otherwise controlled by the Port. There are few measures and only limited regulations that address these sources. Recent action by the International Maritime Organization (IMO) suggests that OGV emissions are likely to be reduced in the future, but given the long life cycles of container vessels, the changeover is likely to be a decade or more in the future.

Tenant- and Trucker-Owned and Operated Equipment: The vast majority of the equipment operating at or in association with the Seaport is not owned by the Port. Therefore, the Port can only work with the equipment owners to try to convince them to switch to cleaner equipment. Even when grant funding is available to assist with the cost of implementing new technology, and environmental and economic considerations (such as reduced fuel use) are favorable, operational factors, such as equipment downtime, maintenance, and training requirements, as well as completing grant applications and complying with grant reporting and performance requirements, can be a burden to business.

Infrastructure: The transition to a zero-emissions Seaport will require extensive, costly improvements to energy and fiber communications systems infrastructure. Infrastructure will have to be constructed before zero-emissions equipment can be deployed; this means that design and construction of the required infrastructure may need to occur five or more years before the equipment is deployed.

Funding: Installing all the equipment that would have to be replaced to achieve a zero-emission Port is costly. For example, a hybrid RTG may cost more than $500,000, including installation. The Final Plan will include a cost analysis.

Technology Reliability/Failures: Once new technology is implemented, it must be monitored regularly to ensure that it is performing as intended. For example, recent studies show that approximately 6% of trucks in the 2015 fleet were high emitters of BC (Preble, pers. comm. 2018), suggesting that diesel particulate filters or on-board diagnostics may be failing.

Operational Impacts: New technologies may require changes in operations that may or may not be compatible with existing operations at a terminal or other business. In addition, maintenance, labor, and safety may be significant considerations.

Stranded assets: A stranded asset is equipment or infrastructure that has experienced unanticipated or premature write-downs, devaluations or conversion to liabilities. The Port, its tenants, and other businesses serving the Port have made substantial investments in new, cleaner equipment and infrastructure that still has useful life. Abandonment or accelerated replacement of this equipment will not allow businesses to capture the full useful life for the equipment or infrastructure in which they have recently invested, resulting in excess costs.

APPENDIX C

DETAILED DESCRIPTION OF POTENTIAL IMPLEMENTING ACTIONS

Detailed Description of Potential Implementing Actions

This appendix provides a description of potential implementing actions (IAs) identified to date. The amount of information currently available about each of these IAs varies. Typically, more information is available for IAs that are included in the Draft Proposed Near-Term (Years 2018-2023) Action Plan. At the end of this appendix, Table C-1 provides a list of IAs. Table C-1 also indicates the status of the IAs, the level of control, and the strategies associated with each IA.

Potential IAs fall into four primary categories:

- Infrastructure
- Fuels
- Equipment
- Operations

There is some overlap between these categories. For example, electrically powered equipment is a measure that involves fuel, typically infrastructure, and equipment.

Structure of an Implementing Action

Each potential IA will follow a similar structure and will include the following components:

- Description of the proposed IA including its specific purpose and anticipated emission reductions benefits, where applicable
- Schedule of implementation with times of completion of phases, if applicable and available
- Parties involved in implementation and their respective roles and responsibilities
- Cost estimate and proposed funding source(s), including on-going operating and maintenance costs and the ability to pay for these
- Monitoring and Reporting

As an example, the following shows the structure for Renewable Diesel in the Port's fleet (note that this is only an example, and the specific timeline, cost, and monitoring efforts have not been determined):

Implementing Action:
Convert Port diesel-powered fleet to renewable diesel (RD) to reduce GHG and DPM emissions. Emissions reduction benefit: 30-50% reduction in DPM and 60-70% reduction in GHG emissions, as well as a 15-20% reduction in NOx emissions.

Schedule:
Identify preferred RD supplier, issue contract, receive fuel, monitor fuel performance, report to Board.

Participants:
Port staff: facilities, environmental, contracting;
Board (to approve procurement)

Cost Estimate, Operating and Maintenance Cost, and Funding Source:
Unit cost per gallon, Port budget amount, estimate of reduced maintenance cost.

Monitoring and Reporting:
Monitoring: Fuel use, frequency of routine and non-routine maintenance.
Reporting: Compare performance to petroleum diesel; findings and recommendations; possible interim briefings to the Board and/or stakeholders.

Screening of Potential Implementing Actions

The Port will screen all potential IAs against the feasibility criteria described in Table 1: Summary of Feasibility Criteria for Implementing Actions. The Port's screening process will also include an initial assessment of supporting infrastructure needs for the potential IA.

The highest-ranking IAs will receive priority for implementation. The Port will first determine whether the IA can be funded solely by the Port, or whether outside funding is required to implement the IA. If outside funding is required, for example, for equipment owned by tenants, implementation of the IA would be delayed until outside funding can be obtained.

As technologies or other IAs approach commercial feasibility, the Port will reassess the supporting infrastructure needs to determine whether the proposed technology or action is operational feasibility. If a technology or action is deemed operationally feasible. The Port will also determine whether additional infrastructure is required to support implementation of that technology or action, and the time required to provide the infrastructure in advance of implementation of the new technology or action.

As technologies or other actions approach commercial feasibility, the Port will consult with its partners, such as terminal operators, shipping lines, and truck fleet owners, to explore implementation of the new technology or action. Simultaneously, the Port will work with its partner(s) to determine funding needs, and seek grants and/or other sources of funding, if available.

Infrastructure Improvements

New or improved infrastructure in all categories (i.e., electrical, fueling, fiber, and physical improvements to roads within the Port, etc.) is an underlying requirement to promote the pathway to zero-emissions Seaport. For electrical equipment, most types will either need to plug into grid power, recharge at charging stations, or be equipped with batteries that are changed out and recharged outside of the equipment. Until substantial electrical system improvements are made to the portion of the grid serving the Port and within individual terminals, use of electrical equipment as the predominant equipment type will not be feasible at most container terminals.

Similarly, until a local network of fast-charging stations is available locally and nationally, the feasibility of all-electric trucks will be very limited. For equipment utilizing hydrogen fuel cells, a hydrogen supply and hydrogen charging infrastructure must be provided. Even for small uses of hydrogen (e.g., hydrogen fuel cell-equipped forklifts), the end user of the equipment must at minimum install a tank and charging equipment, and arrange for regular deliveries of hydrogen to the tank. Larger systems would require a hydrogen pipeline or on-site generation of hydrogen.

Other infrastructure improvements related to operational improvements at the Port, such as the 7th Street grade separation/Go Port program[17], currently under way, will promote more efficient circulation within the Seaport Area, thereby contributing to lower emissions. Additional infrastructure upgrades also include the need for expanded fiber communications systems to support computers systems and related smart technology, microgrids to serve specific terminals or areas within the Seaport, and other features to enable more automated movement of containers from ships. These types of infrastructure improvements are required to meet the State's System Efficiency Target.[18]

The Port intends to play its part in the development of the infrastructure required to move to a zero-emissions Seaport. Required infrastructure upgrades will have to be constructed over time. However, according to a recent engineering feasibility study conducted by the Port, the required electrical upgrades to provide sufficient capacity and localized infrastructure for the Seaport terminals alone are estimated to cost from $120 to $155 million[19] (Burns and McDonnell 2016.) This estimate does not include any electrical infrastructure related to drayage truck charging or railyard conversion, nor does it include the other fiber communications systems and smart-technology-related infrastructure described above. (Shore power is discussed in the Equipment subsection, under ocean-going vessels.)

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[17] The Go Port (Global Opportunities at the Port of Oakland) Program is designed to improve truck and rail access at the Port Oakland. It includes four components designed to reduce congestion and increase efficiency to improve sustainability and economic competitiveness. The four components are the 7th Street grade separation east, 7th Street grade separation west, the freight intelligent transportation system (FITS), and Port utility relocation.

[18] The State's System Efficiency target, set in the Sustainable Freight Action Plan pursuant to EO B-32-15, is to "Improve freight system efficiency 25 percent by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030."

[19] The cost to complete the upgrades was estimated to be approximately $42 to $56 million for the primary electrical lines and substation upgrades/construction, while electrification of the terminals was estimated to cost an additional $80 to $90 million (Burns and McDonnell 2016).

Infrastructure upgrades will need to be reviewed both on an individual IA (project) basis, and then from a system-wide perspective. For example, the Port may install additional electrical infrastructure at a terminal, but must also evaluate the impact of the additional load on the broader Port electrical capacity, and on future terminal operation.

Resilience of the system (also known as reliability) is another critical element of upgrading electrical, fuels and fiber communications infrastructure. Resilience in infrastructure systems refers both to the ability of the system to resist hacking, and the ability of the system to continue operating if part of it is disabled. Technology is increasingly integrated into the day-to-day activities associated with cargo movement and into management and operations of fuels infrastructure (electrical grid, pipelines.)

The electrical grid in the Seaport area is composed of areas served by PG&E and areas served by the Port's utility. The Port's utility serves one large container terminal and the areas of the former Oakland Army Base now owned by the Port. The Port is able to upgrade the electrical infrastructure it controls. Table C-2 summarizes which features at the Seaport are supplied by PG&E and the Port's utility.

Table 3-1. Summary of Electrical Service Provider by Area

	Shore Power		Crane Power		Lights, Reefer, Admin	
Area	Primary	Backup	Primary	Backup	Primary	Backup
Berths 20-21	N/A	N/A	PG&E	PG&E	PG&E	PG&E
Berths 22-26	Port	Port	Port	PG&E	PG&E	Port
Berths 30-32	Port	Port	PG&E	Port	PG&E	Port
Berths 35-38	Port	Port	PG&E	Port	PG&E	PG&E
Berths 55-59	Port	Port	Port	Port	Port	Port
Berths 60-68	PG&E	PG&E	PG&E	PG&E	PG&E	PG&E
OAB	N/A	N/A	N/A	N/A	Port	Port
JIT	N/A	N/A	N/A	N/A	Port	Port

Source: Burns and McDonnell, 2016

Electrical infrastructure controlled by PG&E must be upgraded by PG&E. The Port is only able to facilitate the work and to provide development permits for work on Port lands (electrical permits are provided by the City of Oakland as well as building permits if charging structures weigh more than 400 pounds.) While the Port has initiated communications with PG&E as part of PG&E's FleetReady Program recently approved by the CA Public Utilities Commission, much work is also needed to upgrade PG&E's infrastructure.

Engineering Feasibility Studies

The Port is conducting feasibility studies related to infrastructure and technology. The studies described below are intended to show the range of engineering studies required to support implementation of the pathway to a zero emissions Seaport.

Previous Studies

In 2016, the Port conducted a study of projected electrical loads should all CHE be converted to run on electricity (Burns and McDonnell, 2016.) The study determined that several levels of electrical system improvements would be required to first support improved shore power access, and then the potential conversion of the container yards to a fully electric operation. The study determined that some upgrades to the electric transmission and electric utility distribution system would be required, including a new transmission line and new utility substation. In addition, upgrades to the existing substations would also be required. Finally, specific upgrades and new electrical infrastructure would be required on the terminals (Burns and McDonnell 2016.)

The Port also recently commissioned a cost analysis of electrically-powered equipment at container terminals (M&N 2018). The study concluded that some electrically powered equipment exists, for example, RTGs and automated stacking cranes (ASCs) that connect to the electrical grid through a cable or bus bar. Full battery-electric solutions for these types of equipment are in the development or at the prototype stage.

The study also indicated that for CHE operating on the Seaport marine terminals, solutions are limited and primarily include early commercial technologies for yard tractors (driverless battery-electric Automated Guided Vehicles are in use, but are primarily suitable for fully-automated terminals, which do not exist at the Seaport.) The battery power required to operate the types of CHE operating on the Seaport marine terminals, and the required rapid recharging of the batteries is stretching the limits of current battery technology. Emerging technologies are providing battery solutions for electrified yard tractors. Battery-electric solutions for RTGs and top picks are in the development or at the prototype stage. These types of electrified CHE still need to be developed.

Container Terminal Electrification and Capacity Study

Currently, the Port is beginning a study to assess the specific requirements to provide needed infrastructure to support a container terminal using 100% electrically powered equipment.

The study is scheduled to be completed by the end of 2018. One terminal will be selected for detailed evaluation. The information gained from this study could also be applied to other terminals (scaled to reflect the amount of equipment in use at each terminal) in the future. The study will assess the projected electrical demand, the electrical infrastructure needed to support that demand, location of and acreage required for the charging infrastructure within the terminal, proposed charging cycles, and the level of charging (slow-charging versus fast-charging) that might be used.

The specific terminal operations are a crucial component of any electrification and capacity study. For example, if a terminal owns 100 yard tractors, would all those tractors have to be charged at once, or could they be charged in two rounds of 50? The operational aspects of charging, including the location of the chargers, amount of space required to accomplish the charging and the power demand during charging will greatly affect the feasibility of operating a fully electrified terminal. In addition, the study will consider the operational impacts of installing the necessary infrastructure within the terminal as well as utility infrastructure outside of the terminal; the process may be very disruptive to terminal operations, and may require several years to complete. Consultation with terminal operators will be an integral component of any engineering feasibility study.

Engineering Feasibility Studies for Increased Efficiency through Smart Technology

To gain efficiencies in cargo movement, shippers, terminal operators, and truckers will increasingly need to rely on smart technology. As described below in "Efficiency Measures," data collection and processing, and integration of various data systems will be vital elements of continuing to improve the efficiency of cargo movement. While it is unlikely that any terminal at the Port will be fully electrified in the foreseeable future, certain elements, such as terminal gate truck processing functions, are likely to be operated by smart technology in the short-term. To function effectively, smart technology systems must be highly reliable. Any downtime can create significant delays and backups. Many organizations that are heavily reliant on smart technology systems have begun to install local electrical grids (known as microgrids) to ensure that their smart technology systems remain operational, whether or not the main electrical grid is functional.

A similar study, regarding electrical infrastructure, will have to be conducted to assess the adequacy of fiber communications lines and related facilities, establish a common data management protocol across the entire Seaport, and assess specific electrical supply needs, such as microgrids, to support smart systems.

Engineering Feasibility Studies for On-Road Electric Truck Charging Infrastructure

While commercially produced on-road electrically powered trucks are likely to be available in the foreseeable future, the existing charging infrastructure for these trucks is very limited.

Widespread use of electrically powered trucks serving the Seaport area will require available high-speed charging infrastructure to accommodate thousands of trucks. Trucks in short drayage services (within the Seaport and its vicinity) may be feasible from a commercial and operational perspective within several years. Fully electric trucks in long distance drayage service will require additional improvements in battery technology, charging speed, and the development of a State or national charging network. An assessment of the existing truck charging options and associated power demands needs to be conducted to evaluate the overall viability of converting to zero-emissions drayage trucks in both the near- and long-term. The costs for any such infrastructure are not included in the electrification infrastructure cost estimates described earlier.

Port Fleet Plug-in/Charging Infrastructure Feasibility Study

The Port can evaluate the conversion of its own vehicles to battery-electric or other zero-emissions technology as the equipment is replaced at the end of its useful life and zero-emissions equipment becomes feasible from a commercial and operational perspective. In addition, the Port can evaluate the feasibility of charging stations in Port parking areas to encourage the transition of personal vehicles to zero emissions or hybrid-electric vehicles. The Port's fleet conversion could serve as a demonstration study for other fleet conversions. By installing the required infrastructure and moving to zero-emissions vehicles for its own fleet, the Port would be able to assess operational and other impacts resulting from a fleet conversion.

Roadway and Other Hard Infrastructure Upgrade Studies

The Port regularly assesses the roadway system within and in the vicinity of the Seaport to identify bottlenecks. These studies would continue, as needed, to ensure that the road infrastructure in and near the Seaport area meets the long-term needs of the Seaport.

Uniform Charging Standards for Electrically-Powered Terminal Equipment

In their 2017 CAAP, the San Pedro Bay Ports noted that manufacturers of electric terminal equipment are using different methods and equipment design specifications to charge their vehicles, resulting in different infrastructure requirements, depending on the equipment selected. As more terminal equipment is transitioned to electric power, this transition may lead to significant challenges. The San Pedro Bay Ports determined the need for charging standards so uniform infrastructure can be built throughout the SPBP complex to deploy a range of equipment types built by different OEMs.

Since 2015, the San Pedro Bay Ports have been working with regulatory agencies, technology developers and equipment operators to establish charging standards for yard tractors and other pieces of terminal equipment. These standards, currently under development, reduce the complexity and cost of charging a large fleet of equipment, simultaneously. (SPBP 2017.)

The Port will continue to track the development of the charging standards, and assist with the review of the standards, in relation to their utility for local implementation.

In addition, direct current (DC) fast charging is currently available for light-duty vehicles but not the prototype electric drayage trucks. Alternating current (AC) charging is available for the first generation of electric drayage trucks. The Port will track the development of lower-cost inductive wireless charging and smart chargers.

Infrastructure Modifications

The extent of necessary infrastructure modifications will be determined based on the feasibility studies described above, as well as other feasibility studies that may be conducted in the future. This is likely to be a somewhat iterative process as zero-emissions technology continues to mature. Once infrastructure needs have been adequately defined, capital costs can be programmed into the Port's annual budget cycle based on available funding. Expenditures will likely occur in the following areas:

- Electrical grid and container terminal electrical infrastructure upgrades;
- Freight Information Technology system (FITS) and other fiber communications systems infrastructure;
- Zero-emissions on-road truck charging infrastructure; and
- Port vehicle fleet plug-in/charging infrastructure.

While the current direction of zero-emissions technology appears to be toward electrification, it is possible that shifts in technology could occur in the future. The Port will continue to monitor the trajectory of zero-emissions technology, and to assess proposed infrastructure modifications and the need for future infrastructure modifications in the light of technology evolution. Note that Strategy #3 provides flexibility for other technological options (such as hydrogen-powered equipment) to provide power for zero-emissions operation.

Fuels

This category includes alternative fuels and electricity. Shifting from petroleum diesel to alternative and enhanced fuels is the fundamental step in reducing or eliminating air emissions; DPM and GHGs. Alternative fuels include electricity, hydrogen (in hydrogen fuel cells), non-petroleum diesel, natural gas (CNG and LNG from fossil or renewable sources), and ultra-low sulfur petroleum diesel.

Hydrogen and electricity are considered zero-emissions fuels, provided the electricity generated is made from GHG-free sources. Switching to a reliance on hydrogen and any electricity as a primary fuel in Seaport operations will require significant investments in infrastructure, as well as new equipment. In the meantime, the Port can increase the GHG-free percentage of the electrical power it provides within the Port's utility service area. While the Port cannot control the GHG-free content of electrical power provided by PG&E, renewable diesel, natural gas (including renewable natural gas), and ultra-low sulfur diesel all provide potential benefits without requiring new infrastructure, and may form part of the transitional solution.

Seaport equipment that uses gasoline, diesel, and natural gas for fuel is covered under CARB's Cap and Trade program, meaning that through Year 2030, users of this equipment (such as tenants and truckers) are not required to take any further action to reduce GHGs. The Cap and Trade program accounts for GHG emissions reductions in this sector. Emissions reductions from switching away from these fuels will result in GHG emissions reductions beyond those achieved through the Cap and Trade program.

One important consideration with battery-electric equipment is the current state of battery technology. Traditional car batteries (lead-acid batteries) were the batteries initially used by mobile CHE, such as electric Automated Guided Vehicles (AGVs.) Lead-acid batteries are easy to manufacture at a low cost, reliable, and tolerate overcharging. However, they take relatively long to recharge, emit lead into the environment and present corrosion problems. In addition, lead-acid batteries produce acid fumes and suffer from reduced battery life due to sulfation (M&N 2018.) Furthermore, these batteries are hazardous waste once their useful life has been exhausted.

Recently, CHE manufacturers have displayed an increasing preference for Lithium-Iron-Phosphate (LFP) batteries. While they are more expensive than lead-acid batteries, they are a safe and secure technology. Lighter and more compact, they degrade gradually, have a long life, present less risk of thermal events (as found in less expensive Lithium-Ion batteries, which charge much faster), and have a low environmental toxicity. During Moffatt and Nichols' review of vendors' equipment (2018), most equipment makers reported they are now producing LFP batteries and are moving away from lead acid types. Alternately, Lithium-Polymer batteries (used in cell phones, tablets, and radio-controlled aircraft) have higher energy densities and weigh less than LFP batteries, at the cost of varied degradation rates and thermal activity.

Manufacturers and academia are constantly innovating as the cost, energy density, and lifespan of batteries are expected to rapidly improve. In addition to bringing new battery products to the market place, this innovation is expected to drive costs downward with improved reliability (M&N 2018.)

Technology Assessment for Hydrogen and Hydrogen Fuel Cells

Hydrogen fuel cells are one of the potential primary alternatives to electricity and battery electric technology. Fuel cell technology has significant potential for use in heavy duty trucks

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[20] Fuel cells can come in extremely compact sizes, allowing for their placement wherever electricity is needed. This includes residential, commercial, and industrial settings.

and other mobile applications, and for distribution generation.[20] A fuel cell works by passing streams of fuel (usually hydrogen) and oxidants (usually oxygen from air) over electrodes that are separated by an electrolyte. This produces a chemical reaction that generates electricity without requiring the combustion of fuel, or the addition of heat as is common in the traditional generation of electricity. When pure hydrogen is used as fuel, and pure oxygen is used as the oxidant, the reaction that takes place within a fuel cell produces only water, heat, and electricity.

Fuel cells have the potential to offer maintenance and operating benefits. They are completely enclosed units, with no moving parts. In addition, they are very quiet and safe sources of electricity. Fuel cells also do not have electricity surges, meaning they can be used where a constant, dependable source of electricity is needed.

Fuel cells have a much higher energy density than existing batteries, so that trucks equipped with fuel cells have a lower gross weight. In addition, refueling is rapid, comparable to refueling with liquid fuels (on the order of 6 - 8 minutes for a car). The benefit of fuel cells in this application is partially off-set by the need to carry hydrogen, a flammable gas, on the vehicle. However, experience with compressed natural gas engines has provided an effective technology base for on-board storage of hydrogen.

Fuel cell technology has progressed in certain applications, including forklifts, but it still in the development stage for heavy duty trucks and other heavy-duty vehicles. In addition, before hydrogen fuel cells can be considered commercially feasible in clean energy applications, the cost of generating hydrogen by electrolysis will have to drop significantly. As of 2017, there were 19 fuel cell buses in service in California, with 30 more planned to be put into service. This compares to hundreds of electric buses. The first demonstration-level fuel cell truck was put into service (also in California) in 2017.

The technology assessment for hydrogen fuel cells needs to address both the source of hydrogen and the fuel cell technology itself. Hydrogen generated using renewable sources can be used in fuel cells to generate clean electricity to power mobile and stationary equipment. However, the GHG content of hydrogen fuel depends on the way it is made. Currently hydrogen is typically generated by steam reforming of methane gas (SRM). This type of hydrogen, when used as a fuel, has a higher carbon intensity (ranging from 98 to 142) than petroleum diesel (95). Hydrogen can also be made by electrolysis using renewable sources of energy. Currently, hydrogen made by electrolysis is approximately 2.5 to 3 times as expensive as hydrogen made by SRM. While fuel cells can be powered by a variety of fuels, hydrogen is the preferred fuel for fuel cells in clean energy applications.

Electricity Supply

The Port serves as the electric utility to a large container terminal in the Seaport as well as to several small Seaport support facilities, primarily those located on the Port's portion of the former Oakland Army Base. Other areas of the Seaport are served by PG&E. At portions of the Seaport served by the Port, the Port purchases most of its electricity from the wholesale power market and resells the electricity to its end users. The State-mandated Renewable Portfolio Standard (RPS) program requires investor-owned utilities, publicly-owned utilities, electric service providers, and community choice aggregators to increase electricity procurement from eligible renewable energy resources to 50% of their retail sales by 2030. Both the Port and PG&E will continue to increase the renewable content of the electricity they sell, in compliance with the RPS. Increases in renewable electricity due to the RPS and Cap and Trade will reduce GHG emissions from electricity use at the seaport.

Electricity generation within and near the Seaport area is limited. Aside from the excess electricity generated by the East Bay Municipal Utility District Wastewater Treatment Plant and the Dynergy Oakland Power Plant (Dynergy) adjacent to Jack London Square, electricity is mainly transmitted from outside the Bay Area into the Seaport area through a network of transmission lines (Transmission System) owned by PG&E. The Dynergy plant is more than 30 years old and is nearing the end of its useful life. If the Dynergy plant is retired, transmission system upgrades or new transmission lines or locally generated renewable energy will be required to meet the electrification needs of the region and provide transmission reliability.

Local Solar Power Generation

The Port and its tenants are considering installing solar panels on rooftops of large warehouses and other canopy-type structures to generate electricity within the Seaport. While the overall amount of electricity that could be generated within the footprint of the Seaport is likely to be small relative to the total demand given that there are relatively few large buildings because Seaport uses are land-intensive, it would contribute toward moving the Port to a zero emissions future.

Renewable Diesel Fuel

Renewable diesel (RD) is made by a different process and has a different chemical composition than biodiesel. Made from a high percentage renewable content, RD is marketed at many locations by petroleum jobbers (persons or companies that purchase refined fuel from refining companies either for sale to retailers or to sell directly to the users of those products) throughout California and particularly throughout the Bay Area.

RD is a fuel made partially or entirely from waste materials, such as animal fats, slaughterhouse waste, fish oils, and used restaurant vegetable oil. These waste sources are supplemented by virgin raw materials (non-petroleum oils). RD can reduce DPM emissions by 30 to 40% and GHG emissions by 50 to 80% (depending on the feedstock) relative to petroleum diesel (Neste 2018; Mitchell, pers. comm. 2018). RD shipped to or produced in California (as part of the State's

Low Carbon Fuel Standard program) typically provides GHG reductions of 60% or greater, with the average being on the order of 67 to 68%. RD also provides NOx reduction benefits on the order of 10 to 20% (Mitchell, pers. comm. 2018.)

RD fuel is readily available and costs little or no more than regular diesel, and is completely transparent and interchangeable with traditional fossil diesel fuel in engines and in storage tanks. The price for RD in California has routinely matched or been slightly lower than standard petroleum diesel. RD is a very low-carbon intensity fuel, with better combustion performance characteristics than fossil diesel. Because RD burns very cleanly, experience has shown that it reduces the need to regenerate diesel particulate filters. CARB estimates that currently approximately 500 million gallons per year of RD are available to California. That is expected to increase to 1.5 billion gallons per year by 2030, or sooner (Mitchell, pers. comm. 2018).

Unlike biodiesel, RD does not have a "shelf life" issue because it is hydrogenated in the refining process (meaning it does not contain any oxygen). This greatly reduces the potential for microbial degradation (the disintegration of materials by bacteria, fungi, or other biological means) and keeps the fuel from gelling in cold temperatures.

Many cities, counties, and local and state agencies throughout California now require only RD for use in their diesel vehicles and equipment. This measure has been made an important part of compliance with GHG emissions reductions requirements across the State.

A question remains as to whether RD provides emissions reductions benefits when used in marine applications. Pure RD and RD mixed with petroleum diesel both appear to be suitable for use in marine environments. A study conducted by the Scripps Institute of Oceanography (Scripps 2016) on its own research vessel found that the vessel operated well on RD. No problems were noted during more than 40 research cruises conducted over the period of more than a year (the vessel was at sea for a total of 89 days). The US Navy tested RD in a laboratory setting in 2014 (US Navy 2014) and concluded that pure RD absorbed less water than petroleum diesel and was less susceptible to microbial activity than petroleum diesel. However, a mixture of 50% RD and 50% petroleum diesel had greater microbial activity than either pure RD or pure petroleum diesel. The relative microbial susceptibility of biodiesel was not evaluated. However, biodiesel had a very high water absorption rate; at saturation, the biodiesel tested contained approximately 1,400 ppm seawater, compared to 41 ppm for RD and 67 ppm for petroleum diesel. Parts per million or ppm means out of a million, so one ppm is equivalent to 1 milligram of something per liter of fluid (mg/L).

The 50/50 RD-petroleum diesel blend exposed to microbial activity had a higher salt carry-over than the corresponding pure RD or petroleum diesel. This suggests that while RD can be mixed with petroleum diesel in most applications, in a marine environment it would be preferable to minimize the amount of petroleum diesel mixed with RD.

While RD does not appear to pose any operability problems in marine applications, the Scripps study found that emissions of DPM actually increased with use of RD, especially at high engine speeds. During the study, the four engines aboard the research vessel logged a total of 6,985 hours of engine time using 100% RD. The study showed that the total number and total mass of particles increased with use of RD. The increase in particle emissions was larger at higher engine speeds. At lower engine speeds (700 rpm), particle emissions were similar for both petroleum diesel and RD. Further evaluation is required to determine if RD would provide emissions reductions benefits in marine applications.

Biodiesel

Biodiesel is a renewable fuel typically made by reacting vegetable or animal fat feedstocks (the same types of feedstocks as for renewable diesel) with alcohol. Biodiesel can be made using waste fats or virgin fats. Pure biodiesel provides approximately a 55% reduction in DPM, and typically (depending on feedstocks, processing efficiency, etc.) reduces GHG emissions by 80% to 85%, compared to petroleum diesel (Mitchell, pers. comm. 2018.) In California, biodiesel has reached cost parity relative to petroleum diesel (when accounting for credits under the low carbon fuel standard) (BiofuelsDigest 2017). Biodiesel is typically used in a blended form (20% biodiesel with petroleum diesel, referred to as B20). However, it is also possible to operate on 100% biodiesel (B100). Pure biodiesel has proven successful in fleets and some trains (Wikipedia 2018). B20 delivers 20% of the emission reduction benefits of B100.

Biodiesel, sometimes referred to as fatty acid methyl ester (FAME), is made through a process called transesterification. The transesterification process results in a fuel that contains more oxygen and is more polar than petroleum diesel. This results in mild surfactant (lowering surface tension of a liquid) properties and a substantially higher water uptake capacity than petroleum diesel. As a result, there are three specific operating considerations associated with biodiesel in on-road diesel engines:

- Fuel filter plugging: When biodiesel is first introduced into an engine, its mild surfactant properties often cause it to make existing fuel tank deposits soluble or more soluble. This can result in plugging of the fuel filter, and may require more frequent fuel filter replacements after initially switching to biodiesel
  - Operators who switch from petroleum diesel to biodiesel are more likely to experience this problem in older vehicles that have used petroleum diesel for many years as these are likely to have more deposits in the fuel tank
- Cold weather gelling: Biodiesel will gel more at higher temperatures than petroleum diesel, leading to the potential for cold-weather start-up challenges
  - The amount of saturated fats in the feedstock determines the gelling point, which can range from a low of 15°F to a high of 60°F
  - The use of flow-improving additives and "winter blends" has proved effective

  at extending the range of operating temperatures for biodiesel fuel (Penn State 2018)
- Water carry-over: Most diesel fuel storage tanks have some water in the bottom of the tank
  - Because biodiesel is hygroscopic, a tank to be used for biodiesel storage needs to be cleaned, or a water filter needs to be installed prior to placing biodiesel into the tank

Warranties may also be a consideration. Using a fuel that that is not approved by an original equipment manufacturer may void the warranty. Most manufacturers approve blends of up to 20% biodiesel (B20) when blended using biodiesel approved by the American Society for Testing and Materials.

All diesel fuel is subject to microbial breakdown in storage. However, because of its structure, biodiesel is more susceptible to biological breakdown than petroleum diesel or RD. If engines are expected to be out of service for a period of time, it may be necessary to drain the engine of all fuel before storage, change back to petroleum diesel before storage, or add a fuel stabilizer.

Natural Gas

Natural gas is a colorless, odorless gas that is easy to burn and typically consists mostly (90% or more) of methane. Natural gas generated from fossil sources has a lower carbon intensity than diesel fuel, and renewable natural gas (see discussion below) has extremely low to negative carbon intensity. In addition, engines using natural gas do not generate diesel particulate matter, and may burn cleaner overall than diesel engines. According to the United States Department of Energy Alternative Fuels Data Center, due to increasingly stringent emissions regulations, there is less difference between tailpipe emissions benefits from natural gas vehicles and conventional vehicles with modern emissions controls. One advantage to natural gas vehicles is their ability to meet stringent emissions standards with less complicated emissions controls.

Natural gas technology is well established in certain applications, including for forklifts and light to medium duty vehicles. While CARB-certified 12-liter natural gas engines are available, true heavy-duty (15-liter) natural gas engines are in the pre-commercialization stage. Natural gas is typically used in a compressed natural gas (CNG) or liquefied natural gas (LNG) form. Compressed natural gas has a lower carbon intensity than LNG, due to the energy required to liquefy the gas and keep it cooled. Natural gas can also be used to power fuel cells. Fuel cells convert the energy in fossil fuels into electricity much more efficiently than traditional generation of electricity using combustion.

Renewable Natural Gas

Renewable natural gas (RNG) is methane that is captured from landfills, wastewater treatment facilities, meat production, dairies, and other organic sources. It is fully interchangeable with fossil natural gas. The methane is collected, scrubbed to remove impurities, and injected into an available natural gas distribution pipeline. Similar to green electricity, the user contracts for and receives credit for using a certain volume of RNG, but receives the gas that is available at its location. RNG does not provide any particulate matter (PM) reduction benefits compared to conventional natural gas, but does provide substantial GHG reductions, ranging from 85% to 355% (where 100% GHG reduction is equivalent to eliminating the use of diesel fuel). In other words, depending on the source of the RNG, use of RNG in one engine may offset the GHG emissions from more than one engine using diesel fuel.

Ultra-Low Sulfur Diesel Fuel

Ships maneuvering within the North American Environmental Control Area (ECA), including California, are required to use fuel that contains no more than 0.1% sulfur (USEPA 2010). Sulfur is a significant contributor to PM emissions. Based on fuel emission factors from the Port Authority of New York and New Jersey's 2016 Emissions Inventory, reducing the sulfur content of fuel used in OGV could reduce PM emissions by approximately 10.6% for fuel containing 0.01% sulfur, and 9.5% for fuel containing 0.02% sulfur (PA NYNJ 2017).

This approach has been proven in practice. The Port Authority of New York and New Jersey Clean Vessel Incentive (CVI) Program allows vessels to earn incentive payments for reducing emissions by traveling slower and using cleaner fuel than required. During 2016, 420 individual vessels making 1,058 calls (69% of vessel calls) earned incentive payments. Participating vessels switched to lower sulfur fuel than the 0.1% sulfur ECA requirement while calling at the Port Authority; sulfur content in fuel used by participating vessels ranged from 0.01 to 0.05% sulfur. The SPBPs also have vessel incentive programs that reward shippers for using fuel containing less than 0.1% sulfur.

Equipment

Equipment actions are specific technologies applicable to a given category of equipment. Equipment actions have been identified for all six categories of equipment contained in the Port's emissions inventory. As new equipment is successfully implemented, other Seaport businesses are likely to consider implementing similar technology when it makes sense economically and operationally, based on their planning and capital funding cycles.

Ocean-Going Vessels

Options to reduce DPM and GHG emissions from ocean-going vessels are limited. Actions for OGVs focus both on emissions while at berth (hotelling) and in transit from outside the Outer

Buoys. Over time, the majority of emission reductions for this category of equipment will come from voluntary engine improvements and technological changes implemented by the shippers. Substantial reduction in hotelling emissions have already been achieved through the Port's implementation of shore power requirements (constructing the electrical grid for power needs while at berth).

For OGV, this Plan assumes that shippers have a financial incentive to implement more efficient engines, that the shipping lines calling on the Port are complying with the International Maritime Organization's (IMO's) fuel and engine standards,[21] and they are adhering to CARB's requirement for lower sulfur fuels.[22] In addition to equipment options, some emission reductions from OGV could potentially be achieved through the use of ultra-low sulfur fuel (see discussion in fuels subsection, above), and through any vessel speed reduction programs (voluntary, incentive based, etc., see Operations subsection, below.)

The San Pedro Bay Ports (SPBP) are also considering measures to incentivize energy efficiency improvements and the use of cleaner technologies and impose a differential rate system to incentivize newer, cleaner vessels. The Port of Oakland will track the SPBP's experience with these initiatives. Because the same vessels call up and down the entire West Coast, the Seaport and its workers and community are likely to experience the emissions reduction benefits from any successful incentives. If the incentive program proves effective, other West Coast ports, including the Port of Oakland, may consider a joint incentive program.

Shore Power Improvements

CARB's current regulations require at-berth emissions reductions from container, cruise and refrigerated cargo vessels ("reefers"), generally by plugging the ship into the electrical grid and turning off the auxiliary engines, which is known as "shore power." In March 2017, CARB directed its staff to amend the At-Berth Regulation to achieve up to 100% compliance by all vessels by 2030. This new regulation would apply, if adopted, at the SPBP and at ports that

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[21] MARPOL (The International Convention for the Prevention of Pollution from Ships) Annex VI, which governs pollution control regulations for vessel in international commerce, was amended in 2008, to set more stringent fuel sulfur limits and more stringent NOx emission standards, especially for vessel operation in designated Emission Control Areas (ECAs). The North American ECA for both fuel-sulfur and NOx emission includes most coastal waters up to 200 nautical miles from the coasts of the continental United States. Vessels operating in ECAs must meet the following requirements:

- Fuel-sulfur concentrations may not exceed 0.10 weight percent, or vessels may use an approved equivalent method (such as SOx scrubbers, also known as exhaust gas cleaning systems); and
- Engines above 130 kW installed on vessels built (or modified) since 2000 must be certified to meet appropriate emission standards corresponding to the vessel's build date (or modification date). As of January 1, 2016, engines installed on new and modified vessels are subject to the Annex VI Tier III NOx standards while those engines are operating in the ECA.

[22] CARB adopted the regulation, "Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline" on July 24, 2008. The regulation is designed to reduce PM, oxides of nitrogen, and sulfur oxide emissions from OGV.

are in, or adjacent to, areas defined as in the top 10% of the most impacted communities, as determined by the California EnviroScreen (CES) model. This action would require at-berth emission reductions from vessels not currently subject to the regulation, such as bulk and break bulk vessels, tankers, and auto carriers.

Use of shore power eliminates criteria air pollutant and GHG emission from vessels at berth within the Port. The Port and its tenants, and shippers have invested over $55 million to provide shore power at berths. The CARB regulation, which has been in place since 2014, ramps up the required shore power usage until 2020, when fleets must demonstrate an 80% reduction in at-berth power generation from auxiliary engines. Through grant commitments, the requirement for the use of shore power at most Port of Oakland berths is 80% through 2019 and 90% for 2020 and beyond.

Currently, approximately 73% to 78% of vessels are using shore power while berthed at the Port -- a substantial accomplishment. Additional modifications to infrastructure (e.g., providing extension systems to enable some additional vessels to connect to available shore power, as described in Appendix B) may lead to a higher percentage of shore power utilization. The biggest obstacle to shore power use is that some ships are not equipped to plug into shorepower (see below). The Port is continuing to examine the obstacles that prevent maximum shore power use, and will make additional improvements as they are identified. While the current CARB requirement for each fleet is to reduce onboard auxiliary diesel engine power generation by 70% in 2018; meeting the Port's grant requirements to exceed the regulatory requirements by 10% (80% overall) requires additional coordination with the terminal operators and shippers.

Barge-Based Exhaust Scrubber System (Bonnet)

For vessels that are not able to plug into shore power, it may be possible to control criteria air pollutants by capturing and filtering the emissions from vessels' stacks (using a "bonnet" over the stacks.) CARB has certified two alternative technologies (AMECS [Advanced Maritime Emission Control System][23] and METS-I[24]) for container vessels that can be used to comply with the At-Berth Regulation. Both technologies are barge-based systems. Currently, these technologies are approved only for container vessels meeting certain configurations. However, operators of both systems are working with CARB to expand approval to include other sizes and types of vessels.

Still, a bonnet would only reduce criteria air pollutants; it would not provide any GHG

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[23] https://www.arb.ca.gov/ports/shorepower/eo/ab-15-02.pdf; CARB Executive order for AMECS

[24] https://www.arb.ca.gov/ports/shorepower/eo/ab-15-01.pdf, CARB Executive order for METS-1

reduction. On an average per-OGV call basis, use of a bonnet system will reduce DPM by 75% while at berth. Assuming 75% emissions control efficiency of the barge-based system used during the entire at-berth stay for 12% of the total calls not currently required to use shore power, there is potential to reduce approximately 3.5 to 3.7 tons of DPM in 2020. Total emissions reductions will depend on type of system, system utilization, the system's emissions capture and control efficiencies, and emissions from diesel generators needed to start up and shut down the barge system when the OGV is at-berth. Because the bonnet would be barge-based, use of a bonnet would result in increased GHG emissions as well as some DPM (due to fuel use by the barge's engines while maneuvering and while operating the barge when the bonnet is in use as well as fuel used by auxiliary equipment on the barge itself).

The barge operator would need to work with terminal operators and shipping lines and potentially conduct studies to determine how such emission-control devices could be deployed and to evaluate possible barriers to implementation, such as berth space for the barges while not in use, piloting hazards, the ability to use a system at multiple terminals, and financing (the estimated cost of one barge is approximately $6 million). Because ships have different stack configurations and more than one vessel may be at berth at any time, several barge-based systems would be required to achieve 100% at-berth control. Grant funding, if available, could partially offset this cost. AEG, the manufacturer and operator of the AMECS barge, has received Prop 1B funding from the BAAQMD to build a new barge for use in Oakland. Information on the specific vessel types (stack configuration) that could be served, projected fees, and operating process is not yet available.

Use of one or more bonnet barges is likely to present operational difficulties, as there is little available space to store (tie up) the barge while not in use, and placing the bonnet barge adjacent to the container vessel while the bonnet is in use may preclude other container vessels from transiting past the vessel due to space constraints. The greater the number of bonnets required to address various stack configurations, the more substantial the operational challenges.

Increased Shore Power Capability on Vessels

According to Port data, approximately 18% of vessels calling on the Port are currently not shore power-capable. Retrofitting a vessel to make it shore-power-capable costs approximately $1 million. New vessels are typically put into service on the Asia-Europe routes and are later transferred to the Asia-North America routes. The vessels are retrofitted for shore power when they are transferred to North American routes.

Steamships are not required to be shore-power-capable under the At-Berth rule. They represent approximately 6% percent of the vessels calling on the Port of Oakland. Steamships will be phased out by 2020 and will most likely be replaced by shore power equipped vessels. Amendments to the CARB At-Berth Regulation will likely require that certain vessels that are infrequent callers must also be shore power equipped by 2023, capturing another approximately 6% of vessels calling at the Port. Due to the categories of steamships and infrequent callers not subject to the At-Berth regulation, the maximum level of shore power usage that can be achieved at the Seaport is 88%.

Enhanced Ship and Engine Design

Ship and engine design is driven by economics and international environmental agreements, such as the International Convention for the Prevention of Pollution from Ships, known as MARPOL 73/78. As long as operating characteristics of the vessel are not affected, reducing fuel use provides great economic benefits to shippers. Therefore, economic and environmental drivers are in alignment. With the recent goals for GHG reduction announced by IMO (IMO 2018), it is likely that on a unit-cargo basis, future vessels will have substantially lower emissions than current vessels. At this point, it is impossible to predict whether the ambitious targets set by IMO will be met, and when more energy-efficient vessels would be put into service in the Asia North America trade. Nonetheless, over time, it is clear that emissions from OGV while in transit will continue to decline. This is critical as vessels in transit represent by far the greatest residual source of DPM.

Harbor Craft

Harbor Craft (HC) are the second largest contributor of DPM in the Port's emissions inventory, behind OGV. HC are forecasted to contribute 10% of total DPM in 2020 and 8% to 10% of total DPM in 2030. An estimated 12 to 13 tugs serve the Seaport. Based on normal attrition and CARB's in-use fleet regulation, close to 50% of the HC engines at the Port will meet Tier 3 or Tier 4 standards in 2020, with most of the remaining fleet meeting the Tier 2 emissions standard. The tier standards for commercial HC are not the same as those for cargo handling equipment or ocean-going vessels. The USEPA maintains emission standards for marine engines, with higher tier numbers indicating increasingly stricter standards for NOx, Hydrocarbons, PM, and CO.

Provide Harbor Craft Engine Retrofit Incentives

CARB has proposed to update the Commercial Harbor Craft regulation by 2020, but new regulatory measures would not be implemented until after 2023. Under this proposed measure to reduce HC emissions, remaining vessels with Tier 2 engines will be repowered with Tier 4 engines resulting in an 85% reduction in DPM on a per-engine basis. In advance of an updated regulation, the engine replacement must rely on incentives and is limited by the amount of incentive funding that can be obtained. For example, Port tenant AMNAV has applied for Carl Moyer Program funding to retrofit two of its tugs with Tier 3 engines.

Repowering costs are estimated at $1.4 million per engine or $2.4 million per tug, as most tugs are equipped with two engines.[25] On average, DPM emissions per engine will be reduced by 85%, which is approximately between 2.7 and 3.2 tons in 2020 for the entire Bay Area HC fleet that calls at Oakland. On a per tug basis, the average DPM reduction will be between 0.23 to 0.24 tons. Due to cost and operational considerations, including the downtime required to retrofit engines, it is very unlikely that all 12 or 13 tugs serving the Seaport could be retrofitted. Therefore, the actual DPM emissions reductions achievable through tug retrofits cannot be predicted. The only reductions in GHGs by implementation of this measure will occur as a result of improvements in efficiency. GHG reductions will depend on tug efficiency improvements.

Hybrid Harbor Craft Retrofit

It is possible to reduce emissions from existing tug engines by retrofitting them to hybrid technology. In 2013, Foss Maritime Company (Foss) received verification from USEPA for their XeroPoint[26] Tugboat Hybrid Retrofit system. According to the USEPA verification letter, the hybrid technology will reduce DPM emissions by at least 25% and GHGs measured as carbon dioxide equivalents (CO_2e) by at least 30%, based on the duty cycle provided by Foss. The letter states that fuel savings and emission benefits are dependent on reduced operation of the main propulsion engines and operation with the XeroPoint system while in transit, idling, and stopped.

Actual emission reductions will vary depending on the engine selection, duty cycle, and battery selection. While the verification letter requires the highest available tier engine to be used as the replacement engine, it also states that greater emission reductions could be attained with Tier 3 and Tier 4 engines. The technology is certified for harbor tugboat vessels with auxiliary generator engines (rated horsepower range between 100 and 750 hp) and main propulsion engines (up to 5,000 hp each). In 2017, Wärtsilä launched new eco-friendly[27] tug designs based on hybrid technology that reduces criteria pollutants as well as GHG emissions. The company's website does not provide any specific emissions reductions performance.

There is little operating experience with hybrid tugs in the US. Only two hybrid tugs have been built in the US (at the Ports of Los Angeles and Long Beach), although Baydelta Maritime plans to build a hybrid tug, anticipated to begin operations in the San Francisco Bay in early 2019[28]. Unless retrofits or equivalent engine performance are required by future CARB regulations, hybrid tug technology would also have to be implemented through an incentive program.

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[25] https://www.dieselforum.org/files/dmfile/Cost-Effectiveness_Memo-Task-1-Final-February-2018.pdf

[26] https://www.epa.gov/sites/production/files/2016-03/documents/verif-letter-foss.pdf

[27] https://www.wartsila.com/media/news/18-09-2017-wartsila-launches-new-eco-friendly-tug-designs

[28] https://www.maritime-executive.com/article/new-hybrid-tug-at-port-of-san-francisco#gs.50icchw

On average, DPM emissions per vessel would be reduced by 25% (approximately 1 ton per year in 2030) if all 12 13 in-use tugs are hybridized by 2030. On average, GHG emissions per vessel will be reduced by 30%, (approximately 4,400 to 4,600 MT of CO2e per year in 2030) if all in-use tugs are hybridized by 2030. However, as for tug engine retrofits, it is highly unlikely that, given the costs and operational considerations associated with the retrofit, that all tugs serving the Seaport would be retrofitted.

LNG-Powered Tugs

Natural gas-powered tugs are available to order or in development from several manufacturers. At the current time, a very small number of LNG powered tugs are in service at various locations around the world. Developing reliable engines and gas storage systems for natural-gas-powered tugs requires meeting several challenges that are unique to tugs. Tugs are vessels specifically intended to be capable of high-power performance in assisting, towing or re-positioning a vessel. At the same time, while assisting a vessel, the majority of the time is spent waiting on stand-by with the engines idling or operating at extremely low power. Tugs must also be able to transition from idling to maximum output in an extremely short time. Finally space for fuel storage is limited on board tugs.

A natural-gas-powered tug can either rely solely on natural gas as fuel for starting, running without load, and operating continuously at any engine load, or it can be designed or retrofitted to be a dual-fuel vessel. A dual-fuel vessel may be able handle longer trips, and requiring less LNG storage can reduce capital expenditures for retrofits projects, and/or preserve the ability to sell the vessel to users who may not have access to LNG. Given the state of the technology for natural-powered tugs, a dual-fuel system can also increase reliability, should the natural gas system fail to perform.

Shore Power for Tugs

Like OGV, tugs could also plug into shore power while at berth. The Port currently provides berthing to one tug company, AMNAV, which already uses shore power for its tugs, and other tug operators are based outside of the Port of Oakland. Thus, there is little opportunity for reducing local DPM emissions from expanding shore power capability for tugs.

Cargo-Handling Equipment

Electrically-Powered Container-Handling Equipment Study

The Port has just completed a study of the current status of electrically powered equipment for container handling (M&N 2018.) While the study showed that a majority of the different types of CHE is available as electrically powered equipment, a lot of the equipment is still in the demonstration or early use stages. Some types of electrically powered CHE can only be used in fully automated terminals (M&N 2018).

Expand Use of Hybrid Equipment Convertible to Zero Emission

Terminal operator SSAT has secured Carl Moyer program grant funding to replace its existing RTGs in use at the OICT with hybrid cranes. Under the grant, SSAT will replace its 13 existing RTGs with the new hybrid-electric cranes. The hybrid cranes use a diesel-hybrid engine to power a battery that is used to operate the crane. Once appropriate technology is developed to allow for rapid charging and any change out of batteries, the cranes could be converted to a fully electric operation. Provided the hybrid cranes are determined to have satisfactory operating performance at the OICT, other container terminals at the Seaport could convert their RTGs to hybrid cranes as well. Similar opportunities may exist for other CHE, such as top picks and yard tractors. In addition, in the future, it may be possible to replace batteries with hydrogen fuel cells, although no such retrofit technology exists currently.

Retrofit Hybrid Equipment to Zero Emission

As battery technology improves, it is likely that hybrid yard equipment running on a battery powered through energy recovery and a diesel-engine-driven generator can be converted to full battery-electric operation. There are two options for charging the batteries, depending on the size of the battery and the complexity of removing and reinstalling the battery. If removal and replacement of the battery is a relatively quick and straightforward process, it may be most efficient to recharge the batteries outside of the equipment and replace the depleted batteries as needed. Large container terminals currently use mobile fueling for their equipment, delivering diesel fuel to the equipment rather than having to have the equipment return to a central location for fueling. Being able to rapidly change out batteries would integrate most easily with the current container yard operating protocol.

For equipment with batteries that are difficult to change out, a fixed charging station would be required. Due to the size of container yards and the slow speed at which some of the equipment moves, requiring equipment to return to a central charging location could measurably reduce terminal productivity. The battery would have to charge quickly enough and carry enough charge to last through the equipment's full duty cycle, which may be as much as two shifts. As discussed in the fuels section, equipment vendors are increasingly using LFP batteries in their equipment, which reduces the hazardous waste generation associated with spent lead-acid batteries.

Electrically-Powered Cargo Handling Equipment

Progress is being made with development of electrically powered CHE. At its March 23, 2017, meeting, CARB directed its staff to amend the CHE regulation to require 100% zero-emissions CHE by 2030.[29] CARB staff currently proposes to update the CHE Regulation by 2022, with new measures for zero-emissions CHE not being implemented until after 2026. The 2017 SPBP CAAP calls for those ports to replace all CHE with zero-emissions equipment by 2030.[30] This momentum will encourage the continued development of the technologies needed for this implementing action.

If yard operations permit, and if required electrical infrastructure is in place, replacement of existing CHE with electric equipment may become an option for most of the CHE in use today in the foreseeable future, although certain types of equipment, such as battery-electric top-picks, are still in the developmental stage. The terminal operators will continue to evaluate operational and infrastructure needs, and then develop a plan to replace CHE with commercially available electric alternatives over time, where feasible.

In parallel with the effort described above, the Port will continue to work with tenants to identify and apply for grants and other incentive funding.

Heavy-Duty Trucks

CTMP Implementation/Clean Truck Program

The Comprehensive Truck Management Plan (CTMP) is an element of the MAQIP. The CTMP consists of five primary elements:

- **Truck Ban Ordinance:** The Port adopted a truck ban Ordinance (October 2009) for non-compliant drayage trucks seeking access to Port terminals. This Ordinance goes above and beyond" the CARB regulation's reporting requirements and bans non-compliant drayage trucks at all Port of Oakland maritime terminals, including rail yards.
- **Drayage Truck Retrofit Project.** The Port, CARB, BAAQMD, and EPA provided $38 million in grant funds to help truckers purchase diesel particulate filters or a newer truck. The combined $38 million in funding provided grants for 1,319 diesel particulate filter retrofits and for 587 replacement trucks
- **Idling Restrictions:** The Port installed "No Idling" signage along Port roadways.
- **Truck Parking:** The Port provides Port land for drayage truck parking. This parking allows drayage truck drivers to leave their trucks in the Port area, lessening the likelihood that truckers will use local streets as parking areas, and allows drayage truck

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[29] www.arb.ca.gov/board/res/2017/addendum17-8.pdf

[30] www.cleanairactionplan.org/2017-clean-air-action-plan-update/

drivers a place to rest during the day while awaiting dispatch.
- **CTMP Web Page:** The Port developed a CTMP web page on the Port of Oakland's public website dedicated to informing the trucking community about CARB regulatory requirements, a CTMP overview, STEP Registry requirements, a restroom facility map, webcams, and other trucker resources.

In addition, the Port conducted studies on parking supply and demand, and conducted West Oakland truck parking surveys every year from 2015 through 2017. The Port is currently completing the joint City of Oakland-Port of Oakland West Oakland Truck Management Plan (TMP.)

Truck Emissions Control Equipment Repair Facilities

As discussed in Appendix B, according to the 2015 Seaport Emissions Inventory, DPM emissions from trucks have dropped by 98% since 2005. These emissions reductions are attributable in part to use of diesel particulate filters (DPFs) and, increasingly, selective catalytic reduction (SCR) as well. When emissions control equipment fails, especially on older model year trucks, emissions from that truck can increase by more than a factor of 10. Consequently, to protect emissions reductions that have already been achieved, it is critical for truckers to have ready access to qualified repair facilities that can service the emissions control equipment. Furthermore, modern trucks have on-board monitoring equipment that does not allow the engine to run if the emissions control equipment is out of specification range. Emissions control repair facilities are available in Oakland and near-by communities. In addition, at least one provider offers a mobile DPF repair service.

Incentives to Upgrade to Zero-Emissions Drayage Trucks

The truck-related emissions attributed to the Seaport have been reduced greatly, and currently only make up a very small fraction of the total emissions inventory (see Figure B-1 in Appendix B.) While upgrading the drayage truck fleet to zero-emissions trucks would effectively eliminate all emissions from this category in the Seaport, it is unlikely due to the high cost of converting thousands of trucks and the cost of installing the necessary infrastructure (see below.) Nonetheless the benefits of converting drayage trucks to zero emissions would extend beyond the Seaport when those trucks are engaged in business not related to the Seaport ("halo" effect.) The Port anticipates that grant funding that may be available under AB 617 in the future would be used to convert a number of trucks operating in and around the West Oakland area, including some trucks serving the Seaport area, to zero-emissions vehicles.

While BYD[31] through HVIP is currently taking orders for electric heavy-duty trucks, electric

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[31] www.byd.com/usa/truck/

drayage trucks have not been proven in commercial service, and the performance of these trucks in port drayage operations is currently being studied by the National Renewable Energy Laboratory (NREL 2018). Two considerations make development of battery-electric drayage trucks more challenging than development of yard tractors. First, drayage trucks are much less likely to have access to dedicated charging infrastructure, and it can also be more difficult operationally to schedule adequate time for charging. Secondly, it is more problematic if a drayage truck breaks down on a public road than if a yard tractor breaks down in its own terminal.

It is likely that the technology will initially be most easily implemented for trucks used for shorter truck trips (such as truck trips between the terminals and the rail yards). As charging infrastructure and battery technology are developed, longer truck trips will become more feasible. Electrical charging time for battery-electric trucks is currently longer than fueling time for diesel- or hydrogen-fueled equipment. Electrical charging also requires the truck to return to base or dock at a charging station along each route.

Unlike the other measures, which will require working with a small number of fleets or terminal operators, this implementing action requires coordinating with hundreds of truck owners and companies. This will require additional administrative time and effort that needs to be included in the cost analysis and decision process.

Near-zero emissions trucks (90% cleaner than current NOx standards) are currently available and CARB is working on a regulation to introduce near-zero emissions truck standards. However, those standards are targeted toward NOx and will not help in reducing DPM and GHG emissions. The Port is not proposing any measures to implement low-NOx trucks.

The total cost per truck for 10 zero emissions drayage truck is estimated to be approximately $470,000. This cost includes charging infrastructure costs estimated at $200,000 per truck (this cost can vary depending on the on location and available power.)[32]

The incremental cost of replacing the entire drayage fleet of 8,750 trucks would be approximately $2.4 billion. However, due to cost and technological limitations, it is clearly infeasible to convert the entire truck fleet serving the Seaport. The actual percentage of trucks that might ultimately be converted to battery-electric operation is unknown.

Replacing all 8,750 drayage trucks would eliminate all DPM associated with drayage trucks (approximately 0.07 to 0.11 tons in 2030, an insignificant amount) and would also result in 100% reduction at tailpipe of GHG emissions. After accounting for PG&E grid emissions, overall GHG emissions would be reduced by 88%, which is equivalent to approximately 15,000 to

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[32] www.portoflosangeles.org/pdf/CAAP_2017_Costing_Report-Final.pdf

24,000 MT of CO_2e per year in 2030. The actual emissions reductions that could be achieved through conversion of a portion of the trucks serving the Seaport to battery-electric operation is unknown.

Locomotives

Switch Locomotive Replacement (Upgrade to Tier 4)

The Oakland International Gateway (OIG) rail yard and the Oakland Global Rail Enterprise (OGRE) are on Port land and the emissions from locomotives operating in the yards are included in the Seaport emissions inventory. Several locomotive switchers are assigned to the yards, with the total hours of operation at both yards averaging approximately 9.6 hours per day, seven days a week. Replacing the existing Tier 0 switch locomotives with Tier 4 switch locomotives would provide DPM and GHG emissions reductions. OIG is a Class 1 railway and as such CARB can only regulate certain elements of its locomotive operation, such as idle time. OGRE is a Class 3 railway and is subject to CARB rulemaking. Because the activity of the switcher locomotives at OIG and OGRE is relatively low, their emissions are relatively low, although it is worth noting that the total emissions exceed the residual diesel truck emissions.

Both yards have several switch locomotives sharing the switching duties. Unless the operators of the yard can operate the new Tier 4 locomotive exclusively (with a few of the older locomotives as backups or used in cases where more than one locomotive is needed), then several of the switchers would need to be replaced. In addition, switchers are not necessarily tied to one yard, so upgraded switchers may not stay in the yard at all times.

Incentives or grants could be used to encourage replacement of the OIG and OGRE switcher locomotives. In February 2018, OGRE was granted Carl Moyer Program and USEPA Diesel Emissions Reduction Act (DERA) funding to replace one diesel switcher locomotive engine. The grant requires that the project be completed by June 14, 2019. Moyer grants have been used by other railroads (e.g., Pacific Harbor Lines) to replace locomotives. A new Tier 4 switcher costs approximately $2 to $2.5 million.[33] Replacing one switcher engine and using it for the majority (greater than 90%) of the switching would yield a more than 90% reduction of DPM (approximately 0.13 to 0.37 tons per year in 2030). GHG emission reductions are expected to be approximately 40%,[34] resulting in emission reductions of approximately 250 to 750 metric tons of CO_2e per year in 2030.

Miscellaneous Off-Road Equipment

Miscellaneous off-road equipment consists of construction equipment and equipment used at

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[33] www.arb.ca.gov/railyard/ted/122208ted.pdf

[34] www.nre.com/

warehouses. In addition to the specific measure outlined below, diesel-fueled equipment could easily be converted to use renewable diesel, which would result in immediate DPM reductions of 30% to 40% and GHG emissions reductions of 60% or more.

Highest Engine Tier Construction Equipment on Port Projects

Lower tier diesel engines emit considerably more DPM and other pollutants than the highest tier engines. By requiring that any construction conducted within the Seaport use only the highest tier equipment, DPM emissions would be reduced and some reductions in GHGs would also occur, as newer engines are typically more efficient.

Zero-Emission Loading and Unloading Equipment

Mobile equipment used at warehouses, maintenance facilities, and other support services within the Seaport area could be converted from their existing fuel sources (typically diesel, and propane or LNG/CNG) to battery electric service. Also, hydrogen fuel cell-powered forklifts are commercially available. The Cool Port facility will use battery-electric equipment in its operation, and also provide electrical plug-ins for refrigerated containers. As noted previously in the Fuels section, hydrogen fuel cell technology only provides reductions in GHG emissions if the electricity used to generate the hydrogen is from renewable sources.

Operations

Efficiency Measures

Broadly speaking, efficiency measures fall into two categories: direct energy efficiency measures, and measures designed to improve operational efficiency, thereby reducing fuel consumption and associated air emissions.

Fixed Asset Energy Efficiency Measures Studies and Implementation

Buildings and other infrastructure can be made more energy-efficient through energy-efficient lighting, insulation, low-carbon intensity building materials, painting to reduce heat absorption, and related improvements.

Overall Seaport Operating Efficiency (Studies and Implementation)

Efficiencies at a container terminal and within a Seaport are achieved through a more rapid and smoother cargo loading and unloading process, including the process of moving the containers onto or off the container yard. The more the various elements of a Seaport operation are working well together, the more efficient the overall cargo movement process becomes. Terminal velocity is the term used to describe the speed at which containers can be moved in and out of the terminal en route to their next destination.

Terminal velocity provides an overall measure of the relative efficiency of each terminal within a Seaport. While individual elements of the cargo movement process can be optimized, the greatest efficiencies are achieved when the various elements are integrated. For example, accelerating the rate at which containers can be loaded without ensuring that trucks can be processed quickly enough to provide sufficient containers for loading would limit the value of the improved loading process. Truck turn time data (the amount of time it takes a truck to enter the terminal and load or unload a computer) can identify bottlenecks in the system.

Based upon consultation with Port maritime staff reflecting their close working experience with Port tenants, optimal operations would include all the following:

- Arriving vessels receive a pilot, enter the harbor, dock and begin off-loading as soon as they arrive
- Containers are off-loaded at a steady rate and placed in areas where they are quickly loaded onto and hauled away by trucks
- Trucks enter the terminal without delays due to having to wait on paperwork to be processed or a container to become available, and
- Vessels are reloaded rapidly and cleared for departure as soon as they are fully loaded

Port of Oakland Seaport terminal tenants and operators terminal tenants and operators are constantly working on and investing in increasing efficiency. For example, the optimal operating scenario includes a steady flow of containers, where CHE is working consistently at a steady state, and sufficient trucks that can move through the terminal to pick up containers and deliver them to their next destination. Idling by trucks and CHE is avoided because the container loading and unloading operations are synchronized with the rate at which trucks can enter the terminal to unload or retrieve a container. In addition, a truck would both drop off and pick up a container during each trip to the terminal. This is a challenging goal because of the many factors that must be integrated to provide for smooth operation. For example, a vessel would have to provide the information on the containers that it will be off-loading prior to arriving at the Port, including their ultimate destination. This information, in turn, could then be used by the container terminal operator to set up truck appointments.

To facilitate coordinated operations requires terminal operating systems (TOS), which help avoid bottlenecks through proper planning, thereby increasing productivity. While each container terminal has its own TOS, they are currently unable to communicate with each other. A secure community network is required to optimize terminal and Seaport operations.

Voluntary Vessel Speed Reduction

Under a voluntary Vessel Speed Reduction (VSR) program, participating ocean-going vessels (OGVs) reduce speed while transiting. When OGVs slow down, the load on the main engines decreases considerably compared to the engine load when transiting at higher speeds, leading to a decrease in the total energy required to move the OGV through the water. This energy reduction in turn reduces emissions for this segment of the transit. Since the load on the main engines affects power demand and fuel consumption, this strategy can significantly reduce all pollutants including PM (including DPM), NOx, SOx, and GHG emissions. Experience shows that incentivizing these programs increases participation rates from around 70% to near 100%.

In San Francisco Bay, OGVs already transit at a relatively slow speed east of the Sea Buoy, where the Bar Pilot boards. The Port is consulting with the SF Bar Pilots to identify and discuss issues and concerns associated with a voluntary VSR program. The consultations focus on a voluntary VSR within the Precautionary Zone outside SF Bay. The Port would consider a voluntary VSR only with SFBP consultation and support. VSR could provide emissions reduction benefits inside the Precautionary Zone between the outer buoys and the Sea Buoy. In its 2018 VSR pilot program, BAAQMD in collaboration with other air districts is incentivizing lower transit voyages through the Precautionary Zone, which is included in the Port's emission inventory.

The potential benefits of VSR in the outer Precautionary Zone would be approximately 2 tons per year in 2020. The potential GHG benefits in the outer Precautionary Zone would be approximately 4,200 to 4,500 MT of CO2e per year in 2020.

Track Shore Power Compliance

Under CARB's At-Berth regulation, shipping lines calling on the Port are required to reduce onboard auxiliary diesel engine power generation by 70% (2018 requirement) on a fleet-wide basis while at berth. To date, all shipping lines that call on the Port have chosen to plug into shore power, although in the future some vessels may use a barge-based emission reduction system (bonnet; see discussion in Ocean-Going Vessel section). Port staff have been tracking the success of shore-power plug-ins to determine the issues preventing plug-ins, and to enhance usage. For issues that are identified, the Port works with the shipping lines and marine terminal operators to evaluate potential solutions.

Combined Environmental Performance Incentive Program for Shipping Lines

A combined environmental performance incentive program provides an opportunity for shippers to earn incentives for each vessel call depending on specific types of actions they take to meet performance requirements in two or more categories incentivized actions. Depending on the type of program developed, shippers may be incentivized at different levels for achieving certain levels of environmental performance. For example, a program that includes an incentive to use ultra-low sulfur diesel fuel (see discussion in Fuels section) may award different levels of incentive award points depending on the specific sulfur content of the fuel, with the lowest sulfur fuel resulting in the highest incentive points. Other environmental performance measures that could be added to a combined incentive program include vessel speed reduction, use of vessels with cleaner engines, shore-power plug-in performance, and potentially use of alternative fuels such as renewable diesel (if beneficial in marine use), or, longer-term, natural gas. A combined incentive program could be similar to the Environmental Ship Index current used by the Port of Los Angeles.

Other Incentive-Based Programs

The SPBP are considering measures to incentivize energy efficiency improvements and use of cleaner technologies and impose a differential rate system to incentivize newer, cleaner vessels. The Port will track SPBP's experience with these initiatives along with implementation of the 2017 CAAP in general. Oakland is likely to benefit from any successful incentives, as will other ports along the West Coast. It will be important to track the benefits of any such program against the improvements in ship emission reductions pursuant to the most recent MARPOL guidance (IMO 2018).

The SPBP are also planning to develop a Green Terminal program. The Port of Oakland will continue to track various efficiency and incentive measures tested at the SPBP. Successful programs will be evaluated for their applicability to the Port of Oakland, consistent with the screening process described in Part II.

Table C-1. Potential Implementing Actions [35]

Technology or Implementing Action	Implementing Action Category	Location	Status	Port's Level of Control (Note 1)	Associated Strategy or Strategies		
					1	2	3
Infrastructure							
Container Terminal Electrification and Capacity Study	Infrastructure	Terminals	In planning	Control	●	●	●
Engineering Feasibility Study for Increased Efficiency through "Smart" Transportation”	Infrastructure	Seaport lands (Note 2)		Control	●	●	●
Engineering Feasibility Study - Over-the-Road Truck Charging Infrastructure	Infrastructure	Seaport lands		Control	●	●	●
Port Fleet Plug-in/ Charging Infrastructure Feasibility Study	Infrastructure	Seaport lands		Control	●	●	●
Roadway and Other Hard Infrastructure Upgrades	Infrastructure	Seaport lands		Control/ Influence	●	●	●

[35] The actions listed in this table could be implemented at any time during the life of the Plan. The Near-Term Action Plan described in the main body of the report and summarized in Table 2 in the main report describes the actions are proposed to be taken in the next five years.

Table C-1. Potential Implementing Actions [35]

Technology or Implementing Action	Implementing Action Category	Location	Status	Port's Level of Control (Note 1)	Associated Strategy or Strategies 1	2	3
Uniform Charging Standards for Electrically-Powered Terminal Equipment	Infrastructure	Terminals		Influence	●	●	●
Infrastructure Modifications	Infrastructure	Seaport lands	Completed	Control	●	●	●
Engineering Feasibility Study - Roadway and Other Hard Infrastructure Needs	Infrastructure	Seaport lands		Control	●	●	●
Electricity Supply	Infrastructure, Fuels	Seaport lands		Control/ Influence	●	●	●
Ocean-Going Vessels							
Ultra-low Sulfur Fuel	Fuel	Waterways		Influence	●		
Shore Power Improvements	Infrastructure	Terminals	In planning	Control	●	●	●
Barge-Based Emission Reduction System (Bonnet)	Equipment	Waterways		Influence	●		
Increased Shore Power Capability on Vessels	Equipment	Waterways		Concern	●	●	
Enhanced Ship and Engine Design	Equipment	Waterways		Concern	●	●	
Voluntary Vessel Speed Reduction	Operations	Waterways		Influence	●		
Track Shore Power Compliance	Operations	Waterways/ Terminals		Control	●		
Combined Environmental Performance Incentive Program for Shipping Lines	Operations	Waterways		Influence/ Control	●	●	
Harbor Craft							
Provide Harbor Craft Engine Retrofit Incentives	Equipment	Waterways		Influence	●		
Hybrid Harbor Craft Retrofit	Equipment	Waterways		Influence	●		
LNG-Powered Tugs	Equipment	Waterways		Influence	●	●	
Shore Power for Tugs	Equipment	Seaport lands		Influence	●	●	
Renewable Diesel Fuel (if effective in marine applications)	Fuel	Waterways		Influence/ Control	●	●	
Container Handling Equipment							
Electrically-Powered Container Handling Equipment Study	Equipment	Terminals	Completed	Control	●	●	●
Hybrid RTGs	Equipment	Terminals	13 in progress	Influence	●	●	●

Table C-1. Potential Implementing Actions [35]							
Technology or Implementing Action	**Implementing Action Category**	**Location**	**Status**	**Port's Level of Control (Note 1)**	**Associated Strategy or Strategies**		
					1	**2**	**3**
Expand Use of Hybrid Container-Handling Equipment Convertible to Zero-Emissions	Equipment	Terminals		Influence	●	●	●
Retrofit Hybrid Equipment to Zero Emissions	Equipment	Terminals		Influence	●	●	●
Electrically-Powered Container Handling Equipment	Equipment	Terminals		Influence	●	●	●
Renewable Diesel Fuel	Fuel	Terminals		Influence	●	●	
Biodiesel	Fuel	Terminals		Influence	●	●	
Renewable Natural Gas	Fuel	Seaport lands		Influence	●	●	
Locomotives							
Switch Locomotive Replacement (Upgrade to Tier 4)	Equipment	Railyards	In progress at OGRE	Influence	●		
Renewable Diesel Fuel	Fuel	Railyards		Influence	●	●	
Biodiesel	Fuel	Terminals		Influence	●	●	
Trucks							
Technology Assessment for Hydrogen and Hydrogen Fuel Cells	Fuel	Seaport lands		Control	●	●	●
Natural Gas	Fuel	Seaport lands		Influence	●	●	
CTMP Implementation/ Clean Truck Program	Operations	Seaport lands	On-going	Influence/ Control	●		
Truck Emission Control Repair Facilities	Equipment	Seaport lands and West Oakland	Existing	Influence/ Concern	●		
Operational Efficiency Measures	Operations	Various	On-going	Influence/ Control	●		
Incentives to Upgrade to Zero-Emissions Drayage Trucks	Equipment	Seaport lands		Influence	●	●	
Renewable Diesel Fuel	Fuel	Seaport lands		Influence	●	●	
Biodiesel	Fuel	Seaport lands		Influence	●	●	
Renewable Natural Gas	Fuel	Seaport lands		Influence	●	●	
Miscellaneous							
Use Alternative Fuels (Renewable Diesel, Biodiesel, Renewable Natural Gas, etc.)	Fuel	Seaport lands		Influence	●	●	
Highest Engine Tier Constructon Equipment on Port Projects	Operations	Seaport lands		Control	●		

Table C-1. Potential Implementing Actions [35]							
Technology or Implementing Action	**Implementing Action Category**	**Location**	**Status**	**Port's Level of Control (Note 1)**	**Associated Strategy or Strategies**		
					1	**2**	**3**
Zero-Emissions Loading and Unloading Equipment	Equipment	Warehouses		Influence	●	●	
Local Solar Power Generation	Infrastructure	Warehouses		Influence/Control	●	●	●
Fixed Asset Energy Efficiency Measures Studies and Implementation	Infrastructure	Warehouses		Influence	●	●	●
Overall Seaport Operating Efficiency (Studies and Implementation)	Operations	Warehouses		Influence	●		
Other Incentive-Based Programs	Operations, Equipment	Waterways, Seaport lands		Influence/ Control	●	●	

Notes:

1. The Port may have direct control ("control"), be able to influence the likelihood that the initiative or action will occur ("influence") or may have no control over the action, although the action would affect air emissions within the emission inventory area of the Seaport ("concern".)

2. Seaport lands include the container terminals, warehouses, AMS, Port-owned rail yards, and certain roadways.

APPENDIX D

POTENTIAL SCREENING CRITERIA FOR NEW IMPLEMENTING ACTIONS

PRE-SCREENING CRITERIA FOR NEW POTENTIAL IMPLEMENTING ACTIONS

New IAs would first be screened according to the pre-screening criteria defined below, and then using the feasibility criteria presented in Part II of the main text. The pre-screening criteria below are designed to determine whether the potential implementing action would contribute to the overall goals of the 2020 and Beyond Plan.

Table D-1. Pre-Screening Criteria for New Potential Implementing Actions

Pre-Screening Criterion	Description
1. Regulatory Duplication	Does the proposed action achieve "surplus" emission reductions, defined as emission reductions in advance of, or "above and beyond," an existing regulation or Port commitment (for example, an existing MOU?)
2. Criteria Air Pollutants	Does the proposed action contribute to local DPM emission and/or to regional ambient air quality improvement?
3. GHG Reduction Benefit	Does the proposed initiative contribute to GHG emissions reductions?
4. Contribution to Zero-Emissions Pathway	Does the proposed technology contribute to the Port's pathway to a zero-emissions Seaport by: • Delivering infrastructure in support of zero-emissions equipment? • Deploying zero-emissions equipment? • Deploying hybrid equipment that could be converted to zero-emissions equipment in the future, or creating fiber communications systems infrastructure required to operate some zero-emissions equipment?
5. Measurement and Tracking	Can the emission reductions from implementation of an action be estimated quantitatively and tracked over time?
6. Side Effects	Does the proposed technology or other option avoid or at least minimize foreseeable negative environmental, economic, or social side effects?

APPENDIX E

WORKFORCE DEVELOPMENT -

[To be provided in Final Plan]

APPENDIX F
COST ANALYSIS AND RESOURCE ANALYSIS – [to be provided in Final Plan]