REPORT

Report: The Feasibility of Zero-Emissions Drayage Trucks and Feasibility of Related Goals and Metrics. **(Engineering)**

MEETING DATE:	12/12/2019
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INTRODUCTION

On June 13, 2019, the Board of Port Commissioners (Board) approved the Seaport Air Quality 2020 and Beyond Plan – The Pathway to Zero Emissions (2020 and Beyond Plan) with Resolution 19-41. At that time, and as documented in Resolution 19-41, the Board directed staff to submit agenda reports to the Board within six months of the date of the Resolution on:

1. The feasibility of replacing all cargo handling equipment (CHE) at the Port with zero-emissions equipment including the feasibility of related goals and metrics ("CHE Study");
2. The feasibility of replacing all drayage trucks at the Port with zero-emissions trucks including the feasibility of related goals and metrics (Zero-Emissions Drayage Truck Feasibility Study, or "Drayage Truck Study"); and
3. The capacity of the Seaport's electrical system, tenant needs for electric vehicle charging equipment, and the ability of the Port to provide electric vehicle charging equipment ("Electrical Capacity Study").

Each of these studies supports strategies and goals of the 2020 and Beyond Plan. The CHE Study and the Drayage Truck Study directly support Strategy #2: *Promote the Pathway to Zero Emissions Equipment and Operations*. The Electrical Capacity Study supports Strategy #3: *Develop Infrastructure to Support the Pathway to Zero Emissions.* It is important to understand the relationship of each study individually and collectively to achieving the Board's vision of a zero-emissions Seaport.

This Agenda Report summarizes the results of the Drayage Truck Study, which examines the feasibility of the two existing types of zero-emissions trucks: battery-electric and hydrogen fuel cell. The Drayage Truck Study is available on the Port's website; a link is provided at end of this report.

CONTEXT

At the time that the Board approved the 2020 and Beyond Plan, some community and regulatory agency stakeholders noted that the San Pedro Bay Ports Clean Air Action Plan Update (CAAP 3.0, November 2017) has a stated goal of 100% zero-emissions trucks by 2035. These stakeholders questioned why the Port of Oakland did not include a similar goal in the 2020 and Beyond Plan. The CAAP goal was set by the Mayors of Long Beach and Los Angeles as an aspirational goal in a joint declaration on June 12, 2017. The CAAP does not, however demonstrate how this goal will be reached, nor provide for interim goals to transition to zero-emissions.

The Port of Oakland 2020 and Beyond Plan focuses on advancing feasible and attainable measures to continue to reduce emissions from Port sources with the long-term goal of a zero-emissions Seaport.

THE TRANSITION TO ZERO-EMISSIONS TRUCKS

There are currently two types of zero-emissions truck technologies, battery-electric and hydrogen fuel cell. From an air quality perspective, the emissions from generating electricity and hydrogen must be taken into account.

Transitioning to zero-emissions trucks will not provide significant reductions in diesel particulate matter (DPM) because trucks serving the Port already emit very low levels of DPM. The substantial decrease in DPM since 2005 is due to regulations promulgated by the California Air Resources Board (CARB) and initiatives by the Port. However, zero-emissions drayage trucks will reduce and ultimately eliminate greenhouse gases (GHG) once the source of electricity or hydrogen fuel becomes carbon free.[1]

Diesel Particulate Matter

The pollutant of highest concern for West Oakland is DPM because it is an airborne toxic known to increase cancer risk for individuals exposed to it regularly. According to the Port of Oakland's emissions inventories, DPM emissions from trucks serving the Port decreased 98% from 2005 to 2017 even as cargo volume grew by 6.5% total. This substantial reduction resulted from turning over the entire truck fleet to newer engines and installing diesel particulate filters.

The State legislature and CARB have multiple existing and proposed regulations for diesel trucks, the three most relevant are summarized below.

[1] Reducing oxides of nitrogen (NOx) is an additional related goal for the San Pedro Bay Ports because the Los Angeles air basin has a significant regional ozone problem. However, NOx reduction is not a driving factor in the San Francisco Bay Area.

1. Drayage Truck Regulation: Currently, every truck calling at marine terminals and rail yards in California must have an engine model year 2007 or newer. By the end of 2022, every truck must have a model year 2010 or newer engine.
2. Heavy-Duty Inspection and Maintenance Regulation: This rule, currently being developed, will use on-board diagnostics to ensure that all trucks in the State are maintained so their engines continue meeting model year emission standards.
3. Senate Bill 210: This law, recently signed by the Governor, will require smog checks for trucks (like passenger cars). Identifying and fixing the high emitters is important because 7% of trucks emitted 67% of black carbon in a recent local study.[2]

These three efforts will reduce the remaining 2% of DPM emissions another 20% by 2024, down to about 0.1 tons/year, according to recent health risk modeling results done by the Bay Area Air Quality Management District.[3]

CARB is also developing a new regulation which will promote the transition to zero-emissions trucks. The Advanced Clean Truck Rule will mandate that truck manufacturers sell a certain percentage of zero-emissions trucks each year. The proposed starting point is 3% of Class 8 truck sales in 2024. Subsequent updates to the regulation will require large fleet owners to convert certain percentages of their fleet to zero-emissions over time.

Greenhouse Gases

California has set a goal to reduce GHG to 40% below 1990 levels by 2030, including a target to deploy five million zero-emissions vehicles by 2030, including at least 100,000 zero-emissions capable freight vehicles and equipment. Heavy-duty trucks were responsible for about 8.4% of California's GHG emissions in 2017, or about 35.6M metric tons of CO_2 equivalent (CO_2e).[4]

Drayage trucks serving the Port were responsible for about 20,000 tons of CO_2e in 2017, which is about 10% of approximately 200,000 tons of CO_2e from the combined activity of ships, tugs, locomotives, cargo handling equipment and trucks operating at the Port of Oakland.[5]

From a GHG perspective, battery-electric trucks are only as clean as the electrical grid charging them. The Port's energy portfolio currently consists of 38% renewable and 17%

[2] Preble, Chelsea; Troy Cados, Troy; Harley, Rob; Kirchstetter, Tom (Preble et al.). 2018. Plume Capture Method to Characterize On-Road Emissions by Heavy-Duty Diesel Trucks. Presented at ASIC Oakland September 14.
[3] Final EIR for West Oakland Community Action Plan
[4] CARB's 2019 Edition, California Greenhouse Gas Emissions for 2000 to 2017, pages 3-6
[5] Port of Oakland 2017 Emissions Inventory

carbon-free sources. California's electric grid must be at least 44% renewable by 2024, due to the State's Renewable Portfolio Standard (RPS).

Hydrogen fuel cells provide benefits of being lighter than battery powered trucks, having a greater range of travel than current battery technology and faster refueling time. However, the most common method of creating hydrogen for fuel (steam reforming of methane gas) is currently about 50% more carbon intensive than diesel.[6]

ZERO-EMISSION TRUCK FEASIBLITY ANALYSIS

The 2020 and Beyond Plan established a set of seven criteria (see 2020 and Beyond Plan, Table D-2) to determine whether a clean air action is feasible. The criteria are: exposure reduction, affordability, cost-effectiveness, commercial availability, operational feasibility, acceptability, and need.

Port staff applied these criteria to the two known types of zero-emissions trucks (battery-electric and hydrogen fuel cell) and determined that the main challenges are affordability, cost-effectiveness, commercial availability, and operational feasibility.

For battery-electric trucks, the issues include:

- Commercial availability
- High truck cost
- Battery weight
- Range
- Lack of charging standards
- Lack of charging stations
- Charging duration

For hydrogen fuel cell trucks, the issues include:

- Commercial availability
- High truck cost
- Lack of fueling stations
- Cost of fuel
- Onboard fuel storage
- Carbon intensity of fuel

The results of the feasibility analysis, summarized below, indicate that zero-emissions trucks are not currently feasible. Demonstration projects currently underway at the Ports of Oakland, Los Angeles, and Long Beach will help address feasibility issues over the coming years.

Exposure Reduction: Fully transitioning the fleet would reduce exposure to a small amount of DPM (currently about 0.5 tons/year, reducing to less than 0.1 tons/year in 2024 due to State-wide diesel truck regulations[7]). GHG emissions are not an exposure concern

[6] CARB Certified Fuel Pathways List, downloadable version of Current Lookup Table, Tier 1, Tier 2, and Legacy Fuel Pathway List, accessed 10/31/19 and available here: https://ww3.arb.ca.gov/fuels/lcfs/fuelpathways/pathwaytable.htm

[7] Final EIR for West Oakland Community Action Plan

for human health, although they lead to global problems associated with climate change. Generating hydrogen fuel is not currently carbon-free, so transitioning to hydrogen fuel-cell trucks will not eliminate GHG. Electricity in California will be carbon-free once the 2045 RPS goal of 100% renewables is met.

Affordability: Zero-emissions trucks are not affordable. Drayage truck companies and owner-operators usually purchase used trucks, so the relevant up-front cost comparison is between a new electric truck and a used diesel truck.[8] The cost differential between a battery-electric zero-emissions truck and a used diesel truck is around $400K. Grants are available, but they are difficult to obtain and do not fully cover purchase costs. Zero-emissions trucks will be considered affordable for truck drivers when they are comparable to used diesel truck prices. Hydrogen fuel cell trucks are not yet commercially available.

Hydrogen Fuel Cell Truck	Battery-Electric Truck	Used Diesel Truck
Commercial trucks do not yet exist	$470,000 with charging infrastructure	$30,000 – 80,000

Cost Effectiveness: Transitioning to 100% zero-emissions trucks is currently not cost-effective. About 9,000 trucks are currently registered at the Port. If each truck had to be replaced today, it would cost $2.4 billion[9] and would reduce less than 0.5 tons per year of DPM, which is about 2.9% of the DPM from sources operating at the Port or about 1.7% of all local sources in West Oakland.[10] It would reduce about 20,000 tons of GHG per year.

Commercial Availability: Zero-emissions trucks are not yet commercially available as they are still in the pilot and demonstration phase. They have not been proven reliable under daily operating conditions at a marine container terminal for a range of duty cycles, and parts, repair, and maintenance are not readily available.

According to both the San Pedro Bay Ports' April 2019 report titled, "*2018 Feasibility Assessment for Drayage Trucks,"* and CARB's August 2019 report titled, "*Proposed Fiscal Year 2019-20 Funding Plan for Clean Transportation Incentives For Low Carbon Transportation Investments and the Air Quality Improvement Program,"* battery-electric trucks are at about Technical Readiness Level (TRL) 6 to 7, meaning they are in demonstration and might be at TRL 8 by 2021. TRL 9 is when technology is considered fully mature. Hydrogen fuel cell trucks are at an earlier stage of development. They are currently at about TRL 5 or 6, and might move into the demonstration phase by 2021.

[8] 2020 and Beyond Plan, Appendix F, page F-25
[9] Starcrest Consulting Group, LLC. 2018. Technical Memorandum: MAQIP Update - Emissions Forecast and Potential Additional Reduction Strategies. July.
[10] Final EIR for West Oakland Community Action Plan

Operational Feasibility: Zero-emissions trucks have not been tested in most operating modes. Current demonstration projects, including two at the Port of Oakland, will provide more information by 2021.

Some of the known challenges include: 1) the weight of batteries may prevent trucks from hauling standard loads because of roadway weight restrictions; 2) the range of batteries is currently limited to about 100-150 miles per charge; and 3) charging durations may prevent work in consecutive shifts.

Early adoption of battery-electric trucks will likely be for short-haul routes carrying lighter loads or repositioning empties. Companies with large fleets will likely be the first to transition to battery-electric, as other conventional diesel trucks within their fleets could be used in the event of mechanical malfunctions. Owner-operators and long-haul truckers will probably be among the last to transition to zero-emissions, given current range issues and owner-operators reliant on their single truck to move cargo.

Hydrogen fuel cells, once available, may be the better option for long-haul service. There may be operational advantages to truck owners such as reduced fueling and maintenance costs.

Acceptability: Anecdotal information from drivers and companies involved in demonstration projects indicates that battery-electric trucks are quieter, smoother, and more responsive than diesel. Drivers will likely shift to zero-emissions trucks once the technology has matured and the barriers such as cost, battery weight, range, and charging/fueling issues have been resolved. Many truck owners have recently purchased model year 2010 and newer low-emissions diesel truck to comply with California's Drayage Truck Rule. These trucks still have a long useful life, so there is little incentive to replace them soon.

Need: Although zero-emissions trucks are not needed to keep the Port operational, there is a need to continue doing demonstration projects to advance experience with the technology so that zero-emissions trucks will eventually become feasible. Zero-emissions trucks are needed to reduce GHG emissions and fulfil the Board's vision of becoming a zero-emissions Seaport.

ACTIONS TO ADDRESS CURRENT FEASIBLITY CHALLENGES

As seen above, two key limitations to deploying zero-emissions trucks are 1) commercial availability, and 2) operational feasibility.

Table 1 presents Port actions to address these limitations and accelerate the transition to zero-emissions trucks.

Table 1: Port Actions to Accelerate Transition to Zero-Emissions Drayage Trucks

Feasibility Criterion	Challenge	Action	Port Action and Comments
Commercial Availability	Technological Readiness	Demonstration Projects	Port staff are actively participating in two battery-electric truck demonstration projects, described below. Port staff will continue to seek out more opportunities to pilot zero-emissions trucks, especially with short-haul truckers and large fleets serving the Port.
Operational Feasibility	Heavy Batteries	Overweight Corridors	The weight of the batteries in battery-electric trucks is so high that the trucks may need special overweight permits to be able to haul a standard load. Without the permit, they can only haul lighter loads or empty containers. Port staff are contracting with a firm to evaluate the existing joint Port and City heavy container permit program. The evaluation will ensure this program meets Port stakeholder needs with consideration given to the new technology they are deploying, including battery-electric trucks.

Source: Port of Oakland

Two demonstration projects currently underway at the Port of Oakland are testing zero-emissions truck technology in real-world operating conditions.

Zero and Near-Zero Freight Facilities Grant (ZANZEFF): The Port is building ten electric truck charging stations at Port tenant Shippers Transport Express (STE) in partnership with the Port of Long Beach and CARB. With grant funding, STE will be buying ten battery-electric Peterbilt/Transpower trucks for testing at the Port.

BYD Demonstration Trucks: Port tenant GSC Logistics operates three battery-electric BYD trucks. Another tenant, SeaLogix has four battery-electric BYD trucks on site, and is currently in the process of making the trucks ready for operational use. All seven trucks will be used in short-haul service.

Port staff reviewed the progress of these two demonstration projects and revisited the Intermediate Goal stated in the 2020 and Beyond Plan to "deploy 21 zero-emissions drayage trucks by 2027." Port staff anticipate that over half of the Port's 21 demonstration trucks will arrive earlier than 2027. During the next 2020 and Beyond Plan update, Port staff will recommend revising the Intermediate Goal to "deploy 17 battery-electric trucks by 2021 and at least four more battery-electric trucks by 2027."

INTERIM SOLUTION TO ADDRESS GREENHOUSE GAS EMISSIONS

Until zero-emissions trucks become feasible and the method of charging and fueling them becomes carbon-free, an effective way to reduce GHG emissions is to use renewable diesel instead of conventional petroleum-based diesel. Renewable diesel is chemically identical to petroleum-based diesel, but it is made from renewable feedstocks such as vegetable oils and waste fats. It is completely interchangeable with conventional diesel, and does not have any of the drawbacks of biodiesel which must be blended with diesel, gels at cold temperatures, clogs filters, and can foul storage tanks.

Renewable diesel reduces GHG by about 58%-80% depending on the feedstock. Renewable diesel also reduces DPM in equipment that does not already have diesel particulate filters installed. However, drayage trucks serving the Port all have diesel particulate filters, so the main benefit from trucks would be GHG. Drayage trucks are currently responsible for about 10% of the GHG from all sources operating at the Port. If all trucks serving the Port switched to renewable diesel, then the truck contribution would decrease from 20,000 tons of CO_2e to about 11,600 to 16,000 tons of CO_2e.

Pending Board approval, beginning in January 2020, the Port's fleet of work trucks and equipment will be fueled with renewable diesel.

CONCLUSION

In conclusion, based upon the feasibility analysis summarized above, zero-emissions trucks are not currently affordable, cost-effective, commercially available, or operationally feasible. The demonstration projects underway at various California ports, including Oakland, will provide more information which will help address these feasibility issues. At this point in time, Port staff do not recommend setting a 100% zero-emission truck goal tied to a specific time frame. Instead, Port staff will continue monitoring demonstration projects and seeking new opportunities for more demonstration projects. Port staff will also evaluate the overweight corridor program and look for ways to improve it, which will help with the issue of battery weight.

To accelerate reductions in GHG emissions, Port staff recommend promoting the use of renewable diesel. Port staff have added a Suggested Action to the Pool of Suggested Actions in the 2020 and Beyond Plan to explore ways to encourage the use of renewable diesel in the Seaport area. The Pool of Suggested Actions is currently being screened

and evaluated by Port staff according to procedures outlined in Appendix D of the 2020 and Beyond Plan. As stated in the 2020 and Beyond Plan, the Near-Term Action Plan will be updated annually to include any additions, including the possible use of renewable diesel.

The Port's Zero-Emissions Drayage Truck Feasibility Study is available on the Port's website: https://www.portofoakland.com/community/environmental-stewardship/maritime-air-quality-improvement-plan/