Response to Comments on the 2024 Zero-Emission Cargo Handling Equipment Feasibility Assessment

Introduction

This document presents the Port of Long Beach and the Port of Los Angeles (the Ports) joint Response to Comments received on the *2024 Zero-Emission Cargo Handling Equipment (ZE CHE) Feasibility Assessment* (Feasibility Assessment). Comments were received via comment letters and meetings with Port staff.

The purpose of this Response to Comments is to summarize key issues raised during the public review period, clarify the scope and intent of the Feasibility Assessment, and describe how comments were considered in finalizing the document. The Feasibility Assessment is intended to evaluate the current state of zero-emission cargo handling equipment technologies, including commercial availability, operational feasibility, technical viability, infrastructure readiness, and economic workability. It does not establish new policy commitments, regulatory requirements, or funding allocations.

Changes Made to Feasibility Assessment

The following corrections, clarifications, and additions were made to the text of the feasibility assessment:

- Figure ES-7 was updated to include seven Original Equipment Manufacturers (OEM) that were listed on page 5-24.
- In Table 2-1, the top handler vendor name was changed to “Taylor.”
- On page 2-6, the text was revised to clarify that the 10-year total cost of ownership analysis period reflects the expected service life of batteries for battery-electric cargo handling equipment, and that costs associated with electric utility upgrades, terminal electrical infrastructure, and hydrogen fuel supply investments were not included in the TCO analysis because they represent up-front infrastructure costs evaluated separately in the infrastructure readiness assessment.
- On page 2-6, the text was revised to clarify that operating costs do not include additional staff or labor that may be required to plug in or fuel zero-emission cargo handling equipment.
- On page 4-5, the assessment was updated to include a discussion of Los Angeles Department of Water and Power (LADWP) power quality and reliability considerations that may affect grid-electric cargo handling equipment, such as ship-to-shore cranes and potentially RTG cranes. The report also notes that voltage fluctuations are less likely to impact battery-electric cargo handling equipment.
- On page 5-9, location of the battery-electric top handler demonstration in Long Beach was updated to Pier J (not Pier C).
- Electricity costs were reevaluated and updated to $0.27 per kilowatt-hour, and diesel fuel costs were revised to $3.43 per gallon based on invoices provided by terminals, inclusive of fuel, environmental compliance fees, and applicable taxes. These updates resulted in revisions to all

total cost of ownership tables and figures (Table 5-5, Table 5-10 and Table 5-15). The revised cost assumptions did not meaningfully change the overall conclusions regarding the economic workability of zero-emission cargo handling equipment.

- On page 5-16, a deployment of Direct Current Fast Chargers (DCFC) at SSA Pier F was added. The DCFC for high-capacity Wiggins forklifts (36-55k) were commissioned in Spring 2024, and are in operation.
- On page 5-24, the grid-electric Rubber Tire Gantry (RTG) OEM was changed from "Sandy" to "Sany."
- The Ports reanalyzed hydrogen fuel cell commercial readiness and agree with one commenter that hydrogen fuel cell forklifts should be characterized as pre-commercial. The technology readiness level of 7 was retained, as the technology has not yet been demonstrated at a port.
- Throughout the assessment, the text was revised to clarify that the assessment period covers January 2021 through June 2025, reflecting the inclusion of information received by manufacturers of cargo handling equipment that was provided during that timeframe.
- Throughout the assessment, the estimated timeframe for electric infrastructure upgrades was revised from 4–5 years to a broader range of 4–10 years, reflecting input from numerous commenters.

Public Comments and Port Responses

Progress Toward the 2030 Zero-Emission Cargo Handling Equipment (CHE) Goal

Summary of Comments

Commenters expressed concern that the current rate of zero-emission CHE deployment is insufficient to meet the Clean Air Action Plan (CAAP) commitment to transition to 100 percent zero-emission CHE by 2030. Comments cited deployment percentages, increases in certain non-zero-emission equipment categories, and emissions trends associated with increased cargo throughput.

Port Response

The Ports acknowledge concerns regarding the pace of zero-emission CHE deployment. The Feasibility Assessment evaluates technology readiness and economic workability and is not intended to establish implementation schedules or enforceable policy requirements. Instead, the findings of the Feasibility Assessments inform CAAP implementation planning and decision making. Since the 2021 CHE Feasibility Assessment, the Ports have expanded zero-emission CHE deployment through incentive programs and grant-funded initiatives. However, as evidenced by the findings of the 2024 CHE Feasibility Assessment, progress towards a complete transition to zero-emission CHE has been slower than originally anticipated due to a variety of factors including prolonged technology development timelines, less favorable federal and state funding and policy support, and the need for substantial utility upgrades to some locations.

Infrastructure Readiness, Grid Capacity, and Planning Timelines

Summary of Comments

Commenters identified electrical infrastructure availability, grid capacity constraints, long permitting

and construction timelines, and utility procurement delays as major barriers to achieving zero-emission cargo handling equipment deployment. Comments also raised concerns regarding grid reliability, electricity cost assumptions, infrastructure redundancy and resiliency, and differences between Port estimates of future electrical demand and projections presented in California Air Resources Board (CARB) assessments.

Port Response

The Feasibility Assessment identifies infrastructure development and grid capacity as critical challenges to widespread electrification. Utility upgrade needs, including substations, switching stations, and other supporting infrastructure, are identified at a high level in the Feasibility Assessment, and the estimated timeframe for completing electric infrastructure upgrades was revised to 4–10 years based on input from terminal operators. Grid readiness was rated at 3.5 in the Feasibility Assessment, and the shorter 4–5 year timeframe referenced reflects aggressive implementation scenarios. Electricity cost assumptions were updated to $0.27 per kilowatt-hour. Considerations related to infrastructure redundancy and resiliency are outside the scope of this Feasibility Assessment but may be addressed by the Ports in other planning documents. Differences between Port and CARB projections reflect differing assumptions, data sources, and analytical approaches, and the Ports cannot evaluate CARB's underlying methodology.

The Evaluation of Battery-Electric and Hydrogen Technologies

Summary of Comments

Commenters urged the Ports to focus exclusively on battery-electric and grid-electric cargo handling equipment and to discontinue consideration of hydrogen fuel cell technologies, citing concerns related to safety, cost, infrastructure readiness, and commercial availability.

Port Response

The Feasibility Assessment evaluates multiple zero-emission technology pathways to provide a comprehensive assessment of zero-emission technology options that are in development or are commercially available for the specific equipment types evaluated. Battery-electric and grid-electric technologies are currently the most commercially mature and represent the primary focus of current deployments. However, hydrogen technologies have been proposed by several manufacturers and deployed in prior demonstrations and grant programs in support of the Ports' zero-emission goals. Their inclusion ensures the Feasibility Assessment reflects technology neutrality with respect to zero-emission equipment, even when feasibility remains limited. The Feasibility Assessment notes the limited commercial availability of hydrogen fuel cell equipment, infrastructure challenges, and higher costs. The Ports will continue to prioritize proven technologies while monitoring emerging options. Before any technology is implemented, we agree that proper safety protocols must be in place.

Summary of Comments

Commenters requested that hydrogen fuel cell forklift commercial availability be increased to early-commercial and the technology readiness level be increased to 8.

Port Response

The Ports reanalyzed both the commercial availability classification and the technology readiness level and determined that hydrogen fuel cell forklifts are appropriately characterized as pre-commercial, with a technology readiness level of 7, as the technology has not yet been demonstrated at a port.

Summary of Comments

Commenters emphasized that equipment reliability and downtime are critical factors in assessing the feasibility of zero-emission cargo handling equipment and noted that diesel equipment currently demonstrates high reliability with minimal downtime. Commenters stated that comparable reliability metrics for battery-electric and fuel cell equipment were not evaluated in the assessment.

Port Response

The Ports acknowledge the importance of equipment reliability and downtime in evaluating zero-emission cargo handling equipment. While the Feasibility Assessment includes qualitative observations from terminal operators regarding reliability considerations, quantitative reliability metrics were not available and were therefore not included in this Feasibility Assessment; such analysis may be considered in future evaluations as data become available and provided to the Ports from equipment owners/operators.

Summary of Comments

Commenters stated that battery-electric cargo handling equipment, particularly straddle carriers, remains technically immature relative to diesel equipment, citing limitations related to battery capacity, charging rates, performance under heavy loads, maintenance savings, and charging technologies. Commenters also asserted that comparisons to on-road electric vehicle maturity are misleading.

Port Response

The Ports reviewed these comments and clarified that the assessment period spans January 2021 through June 2025. While straddle carriers were not evaluated as part of this assessment, the analysis indicates that battery-electric cargo handling equipment is largely technically viable for certain applications, even though performance may not yet be equivalent to diesel equipment in all use cases. Analysis of straddle carriers may be considered in future assessments. The total cost of ownership analysis reflects average maintenance savings of approximately 29 percent for battery-electric yard tractors, top handlers and large-capacity forklifts, which is within the range noted by commenters, and the comment on hands-free charging is consistent with the current state of technology described in the report.

Summary of Comments

Commenters raised concerns regarding the limited commercial availability of battery-electric cargo handling equipment, citing a small number of port-ready OEM offerings, exclusions of straddle carriers, production timelines for higher-capacity batteries and chargers, and the lack of fully proven, scalable hands-free charging solutions.

Port Response

The Ports reviewed these comments and note that all of the OEMs referenced offer battery-electric yard tractors that were commercially available and marketed to ports during the evaluation period. Straddle carriers were excluded from this Feasibility Assessment as they are outside of this study scope but may

be considered for analysis in future documents. The report acknowledges that hands-free charging solutions are not yet fully viable at scale, and notes that larger-capacity battery options were commercially available and could be ordered during the assessment period.

Role of the Feasibility Assessment and Requests for a Zero-Emission Cargo Handling Equipment Roadmap

Summary of Comments

Commenters requested that the Feasibility Assessment should include a detailed roadmap, interim targets, and milestones demonstrating how the 2030 zero-emission cargo handling equipment goal will be achieved.

Port Response

The purpose of the Feasibility Assessment is to provide a current snapshot of the status of zero-emission cargo handling equipment development. The Feasibility Assessment is intended to inform, rather than replace, future CAAP implementation planning efforts. The findings of the Feasibility Assessment will support evaluation of infrastructure planning, funding strategies, and deployment priorities to support ongoing implementation. Ongoing and awarded grant and incentive programs represent near-term actions that contribute toward the 2030 goal and will be considered as part of the CAAP's broader planning efforts.

Summary of Comments

Commenters requested that ship-to-shore (STS) cranes, rail-mounted gantry (RMG) cranes, and automated stacking cranes (ASC) be included in the assessment.

Port Response

The Ports reviewed this request and determined that these equipment types are outside the scope of the current Feasibility Assessment. STS and RMG cranes were not evaluated because they are not substantially different from grid-electric RTG cranes, which are addressed in the assessment. In addition, the specific equipment covered by Feasibility Assessment was selected for evaluation because it encompasses close to 80% of the terminal equipment and their associated emissions at the two Ports.

Summary of Comments

Commenters expressed concern that straddle carriers were not included in the Feasibility Assessment, noting that they make up 9% of cargo handling equipment at the Port of Los Angeles and asserting that their exclusion represents a gap in evaluating zero-emission transition pathways.

Port Response

While straddle carriers comprise 9% of the Port of Los Angeles fleet, this equipment is not widely used and represents less than 5% of the San Pedro Bay's total cargo handling equipment count. Since the first Feasibility Assessment in 2018, the Ports have committed to assessing equipment that is responsible for most of the emissions and found broadly across marine terminals. The four types of cargo handling equipment selected for inclusion in the Feasibility Assessment meet these criteria. If at some point

straddle carriers begin to represent a larger share of the total cargo handling equipment fleet with wider use across the port complex, the Ports can re-evaluate their inclusion in future studies.

Port Funding, Incentives, and Budget Commitments

Summary of Comments

Commenters encouraged the Ports to increase allocations from their annual budget to support zero-emission cargo handling equipment and associated infrastructure, including through incentive programs and demonstration projects.

Port Response

The purpose of the Feasibility Assessment is to provide a current snapshot of the status of zero-emission cargo handling equipment development and is not directly a policy setting document. That said, Feasibility Assessment findings will inform future incentive design and funding considerations. The Ports have expanded incentive programs through both Port-led initiatives and external funding partnerships and continue to fund demonstration projects through the Technology Advancement Program. The Ports and the terminal operators will continue to explore all possible grant opportunities to implement or expand existing funding programs.

Future Cargo Handling Equipment Purchases and Replacement Policies

Summary of Comments

Commenters urged the Ports to require that all new purchases or replacements of cargo handling equipment be zero-emission.

Port Response

The Feasibility Assessment is intended to evaluate the current state of zero-emission cargo handling equipment technologies, including commercial availability, operational feasibility, technical viability, infrastructure readiness, and economic workability. It does not establish new policy commitments, regulatory requirements, or funding allocations. As zero-emission technologies and supporting infrastructure continue to mature, the Ports will continue to assess opportunities to support adoption through existing programs and initiatives while maintaining terminal operational continuity.

Workforce Considerations and Human-Operated Equipment

Summary of Comments

Commenters emphasized that the Ports have a duty to balance the socioeconomic well-being of the port communities with environmental mandates and the transition to zero-emission cargo handling equipment should prioritize human-operated equipment, support high-quality jobs, and should not be associated with automation. Additionally, it was requested that the Ports adopt a policy that no public funds or grants be used to purchase, incentivize, or otherwise promote automated equipment or its associated infrastructure.

Port Response

The continued transition to port wide zero-emission cargo handling equipment will require substantial financial investment. The Ports, local air agencies, and terminal operators will continue to collaborate to identify, seek, and support applications for state, federal, and private grant funding opportunities to accelerate the deployment of ZE infrastructure and equipment. The Ports acknowledge that there are legal restrictions on the use of public funds for ZE equipment, vehicles, and/or infrastructure. For example, certain state and federal laws either restrict the use of specific sources of public funding to projects using human-operated equipment (e.g., 42 USC 7433) or prohibit the use of specific sources of public funding for the purchase of automated equipment (e.g., California Streets and Highway Code Section 2192(c)(3)). Accordingly, current grants being implemented by the Ports limit funding to human-operated, fully ZE equipment, vehicles, and/or infrastructure. The deployment of zero-emission equipment does not, by itself, imply a change in operational practices from those currently in use.

Summary of Comments

Commenters stated that advanced workforce training in electrical safety, battery maintenance, and zero-emission equipment should be prioritized to ensure that troubleshooting, repair, and maintenance continue to be performed by members of the International Longshore and Warehouse Union.

Port Response

The Ports agree that a trained and skilled workforce is critical to ensuring that zero-emission equipment remains operational and is maintained at the terminals. Language was added to the Feasibility Assessment clarifying that while no adverse effects to the workforce were expected, additional training would be required to upskill the current workforce for the zero-emission equipment transition. The Ports will continue to pursue education and workforce development programs that advance and promote training opportunities to meet future workforce needs, including those that emphasize upskill/reskill and emerging technology.

Energy Systems, Microgrids, and Grid Resilience

Summary of Comments

Commenters recommended expanding discussion of microgrids and renewable-based energy systems as tools to support port electrification and manage grid impacts.

Port Response

The Ports appreciate the recommendations regarding microgrids and energy resilience. Microgrids and energy resilience projects remain in the early stages at the Ports. The Port of Long Beach microgrid demonstration at the Joint Command and Control Center has illustrated the challenges of deploying a microgrid on existing, older infrastructure. At the Port of Los Angeles, several microgrid projects are in development as part of the Port's EPA Clean Ports Program grant award, and will help further demonstrate the utility of this technology in port operations. While outside the scope of this Feasibility Assessment, future infrastructure planning efforts may include microgrids and distributed energy resources as strategies to support zero-emission operations and grid reliability.

Analytical Assumptions and Methodology

Summary of Comments

Commenters noted that the Feasibility Assessment appeared to cover the period from 2021 to 2024 and stated that yard tractors equipped with 300-kilowatt-hour batteries were not available during that timeframe.

Port Response

The report was revised to clarify that the Feasibility Assessment period spans January 2021 through June 2025. In addition, the third generation of BYD yard tractors deployed at Everport between 2021 and 2024 were demonstrated to complete two shifts without opportunity charging. The increasing commercial availability of yard tractors equipped with larger battery capacities supports the assessment of the technology's operational readiness in 2025.

Summary of Comments

Commenters stated that the analysis of cargo handling equipment manufacturing capacity does not adequately account for competing demand from other customers and asserted that OEM capacity cannot be assumed to be dedicated solely to the San Pedro Bay Ports. Commenters requested that manufacturing capacity be reassessed to reflect broader market demand.

Port Response

The Ports reviewed this comment and note that the manufacturing capacity discussion is informed by surveys and discussions with original equipment manufacturers regarding their planned ability to scale production to meet demand from the San Pedro Bay Ports and other customers. Based on this information, if orders for battery-electric cargo handling equipment are placed within the next few years, there is a high likelihood that manufacturers will be able to meet anticipated demand; delays in placing orders may affect manufacturers' ability to scale production accordingly.

Summary of Comments

Commenters raised concerns regarding the operational feasibility of battery-electric yard tractors and top handlers, stating that the ability to complete two full shifts without charging is generally limited to lower-duty yard operations and that higher-demand rail and vessel operations require opportunity charging. Commenters also disagreed with the assessment's distinction between yard and rail operations, asserting that zero-emission equipment must be capable of performing all tasks currently handled by diesel equipment.

Port Response

The Ports reviewed these comments and note that the Feasibility Assessment differentiates between yard and rail operating conditions to reflect differences in duty cycles and operational demands. Based on this application-specific approach, the Ports continue to find that yard tractors and top handlers are operationally feasible for certain uses, subject to the operational limitations and constraints described in the report. Language was added through the feasibility assessment to clarify where equipment is feasible only for certain uses.

Infrastructure Cost Analysis

Summary of Comments

Commenters requested an evaluation of the total cost to plan and construct supporting zero-emission infrastructure for the cargo handling equipment.

Port Response

While the Ports understand the importance of evaluating the zero-emission infrastructure costs, this type of analysis is outside the scope of the Feasibility Assessment. As the Ports and terminal operators develop zero-emission infrastructure plans, construction costs will be determined and refined.

Comments Considered without Resulting Revisions

Summary of Comments

Commenters requested clarification regarding references to eRTG crane performance at the Port of Long Beach, including whether cited performance was based on retrofit or new equipment deployments, and requested additional information on air emissions from various sources. Commenters also expressed general support for the transition to zero-emission technologies, noting that multiple technology pathways may be viable over the next decade, and shared personal experiences related to air quality and public health impacts.

Port Response

The Ports reviewed these comments and appreciate the perspectives and information provided. After consideration, no changes were made to the Feasibility Assessment, as the existing text accurately reflects the scope and purpose of the study and the comments did not identify factual errors or lead to changes in the analysis. The Ports also conduct annual, port-wide emissions inventories for port-related equipment, which are publicly available on each Port's website.