SSA Pacific Agricultural Goods Movement Blueprint Final Draft

Prepared for: California Energy Commission

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Gavin Newsom, Governor

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1 Executive Summary

The agricultural industry in California is a key economic driver for the state, employing hundreds of thousands of people and generating billions of dollars in revenue. The structure of the agricultural industry presents challenges to full-scale decarbonization, including diverse equipment types and disaggregated operations. The deployment of zero-emission vehicles (ZEVs) infrastructure is a critical step in decarbonizing transportation at the Port of West Sacramento and the surrounding agricultural industries. The SSA Pacific Agricultural Goods Movement Blueprint seeks to address the education and information gap in deploying ZEV medium- and heavy-duty (MHD) charging infrastructure within the agricultural industry that relies on this port. Through partnership with the Port of Sacramento, SSA Pacific aims to showcase and demonstrate the capabilities and innovations around break bulk material handling and create a nexus where thousands of people and companies can benefit from ZEV equipment and infrastructure in action. The Scope of Work of the Blueprint included five key tasks: Community and Stakeholder Engagement, Flexible Infrastructure Pathways, Innovative ZEV Approaches, and Knowledge Transfer. The outcomes of each task are summarized in this document, in addition to action steps, recommendations, and conclusions for SSA Pacific's ZEV transition at the Port of West Sacramento.

The State of California's Advanced Clean Fleets (ACF) Regulation will effectively mandate a statewide transition to ZEVs for fleets under the regulation's scope beginning in 2024. In alignment with ACF and forthcoming regulations including a rule on cargo handling equipment, this Blueprint seeks to advance the adoption of ZEV technologies to meet state and federal mandates and reduce the environmental impact of port operations. The objectives of the Blueprint include engaging a broad stakeholder network to develop a comprehensive, economic, and equitable approach to rapidly deploying MHD ZEV infrastructure and distributed energy resource (DER) technologies, advancing California's ports to be cutting-edge technology demonstrators and innovators, and identifying innovative approaches for SSA Pacific to offer technical solutions to improve ZEV adoption across the agricultural goods movement industry.

The Blueprint team conducted significant engagement to understand community and stakeholders' views and needs regarding the transition to ZEVs at the Port of West Sacramento. The stakeholders expressed a general understanding of the current ZEV technology and indicated interest in the Port's decarbonization goals. However, they also identified concerns about operational performance and capital costs associated with the ZEV transition. The opportunities presented by the transition include reduced environmental impact and operational costs.

Reduced emissions in disadvantaged and low-income communities were identified as the greatest potential benefit for impacted communities. However, concerns were raised about incentivizing the ZEV transition for small operators and the reliability of the electrical grid. Collaboration opportunities that may be further explored include media outreach through radio resources and project partnership with the Yolo-Solano Air Quality Management District.

To better understand the Port's exposure to natural hazards, as well as potential solutions, the Blueprint Team conducted a resiliency assessment. This assessment highlights the potential hazards that electrified operations at the Port of West Sacramento are exposed to and the need to consider available mitigation options for existing and future on-site infrastructure. The primary concerns include direct damage from flood and seismic events and indirect impacts from wildfire, extreme heat, and drought related to disruptions in the electricity grid.

To mitigate against these risks, the report suggests the consideration of on-site flood mitigation efforts to defend against levee failure and sea level rise at the Port of West Sacramento. Additionally, SSA Pacific and the Port of West Sacramento could invest in private on-site electricity generation and storage measures and create contingency plans for higher marginal electricity rates. These measures will help the Port of West Sacramento to successfully transition to ZEVs while mitigating the risks associated with natural hazards and disruptions in the electricity grid.

To better understand pathways for climate adaptation planning at the Port, the Blueprint team used a process known as Flexible Infrastructure Pathways (FIP), which is used to identify potential infrastructure solutions for the transition to zero-emission vehicles. The Blueprint's FIP focuses on two types of zero-emission fuels: battery electric and hydrogen fuel cell electric. SSA Pacific is seeking to transition its fleet vehicles to zero-emission to comply with new regulations and reach its sustainability goals. However, converting to zero-emission vehicles is not a one-size-fits-all solution and requires consideration of vehicle type, refueling constraints, and electrical infrastructure constraints. As a part of this process and analysis, the FIP Tool was developed to help navigate a successful zero-emission vehicle infrastructure pathway at the Port of West Sacramento, allowing SSA Pacific and the Port to understand potential planning pathways and sensitivities. The FIP Tool is an excel-based tool that utilizes a dashboard to process user inputs about the existing fleet, the future-state fleet, operational constraints, and awareness of the electrical or hydrogen infrastructure that may accommodate a ZEV fleet.

While battery electric vehicles (BEVs) are a great solution for many instances due to lower costs and established technology, the conversion of medium-duty, heavy-duty, and off-road vehicles may be limited by the weight of batteries required. In these cases, hydrogen fuel cell electric vehicles (FCEVs) may be a useful alternative, particularly for fleets of 50 or more vehicles when land is available. Onsite storage or generation of hydrogen is more likely to prove cost-effective for these larger fleets. However, given the infancy of hydrogen technology and underdeveloped delivered hydrogen fueling networks, shared infrastructure or onsite generation may be required for smaller fleets. The FIP Tool considers these nuances and provides direction for SSA Pacific that is most appropriate and dynamic in helping navigate a successful zero-emission vehicle infrastructure pathway.

To understand how SSA Pacific's position as an industry convener could result in the adoption of MHD ZEV technology industry-wide, the Blueprint Team explored innovative ZEV deployment approaches. These include the use of shared ZEV infrastructure, the utilization of Marine 580

(M-580) inland waterway corridors through the deployment of diverse barge services, and approaches to leveraging LCFS credits to catalyze growth.

The Blueprint identifies six potential sites as optimal locations for shared MHD ZEV infrastructure at the Port of West Sacramento, and highlights the importance of dedicated stakeholder outreach to port authorities, electrical utilities, hydrogen providers, and other relevant industry groups. Standardization of equipment across the ZEV industry allows for consistency across communication protocols among many Original Equipment Manufacturers (OEMs), enabling opportunities for shared infrastructure and industry collaboration. The development and deployment of a ZEV rollout plan will require further criteria assessments and stakeholder consultations. The installation and implementation of ZEV infrastructure is largely dependent on organization objectives, technical needs, and industry standards.

The Blueprint team also explored whether operating a container-on-barge service along Marine (580) would be made more economically viable if powered by battery-electric technologies in order to avoid fuel price volatility. This effort could be supported by America's Marine Highway Program (AMHP), a USDOT-led initiative to fund projects that alleviate traffic congestion on the nation's highways by diverting cargoes to the nation's waterways, including along M-580.

The M-580 Study evaluated the economic viability and environmental benefits of deploying various diesel-powered container-on-barge services for the M-580 Corridor with varying frequency of port calls. Ultimately, the study found that there were very few options under which the barge service would be economically viable in the first 10-20 years of operation. However, an electric barge service would elevate the potential to completely eliminate harmful emissions from goods movement while generating as much as $750,000 in annual revenue from Low Carbon Fuel Standard (LCFS) credits. The overall economic viability of such a service remains uncertain due to the unknowns surrounding the ultimate Energy Economy Ratio (EER).

As the third element of its Innovative ZEV Deployments assessment, the Blueprint team explored how the (LCFS) program can help deploy ZEV and ZEV equipment in the rice industry. Electricity supplied to zero-emission vehicles and equipment, such as forklifts and cargo-handling equipment, are eligible as a low-carbon fuel and able to generate credits based on the quantity of electricity supplied. A deployment evaluation by e-Mission Control estimates that a zero-emission technology deployment for the rice industry can generate a total ten-year project credit value of approximately $2,584,932.

The rice industry is well-positioned to serve as a model for the rest of California's agricultural goods movement industry in transitioning to zero-emission on- and off-road ZEV equipment and infrastructure. By investing in low-carbon and renewable fuels, such as electric vehicles and biofuels, and developing infrastructure to support them, organizations like SSA Pacific can benefit from the financial incentives provided by the LCFS while reducing the carbon intensity of transportation fuels and mitigating the environmental impact of agricultural goods movement. This can lead to a more sustainable industry and benefit the region and economy.

The Blueprint includes a roadmap consisting of actionable items for SSA Pacific to pursue upon completion of the Blueprint process. This section is intended to serve as guideposts for the next steps in SSA Pacific's ZEV transition.

Overall, SSA Pacific, in partnership with the Port of Sacramento, is well-positioned to proceed with the implementation of recommendations provided in this Blueprint, and its success will depend on approval from the local port authority, transparent communication with the authority and related parties, consultations with the electrical utility and hydrogen provider, and the ability to identify and mitigate potential risks and challenges.

2 Introduction

California's agricultural industry is one of the state's most important economic drivers, employing hundreds of thousands of people across the state, laying a foundation for the Central Valley's economy, and bringing in billions of dollars in revenue. This industry consists of a highly diverse and disaggregated set of industries, making education about zero-emission vehicles (ZEVs) and ZEV infrastructure options challenging. Moreover, the diversity of equipment supporting the safe, reliable flow of agricultural imports and exports has been slow to decarbonize despite having significant utility in other industrial applications. This Blueprint seeks to address the education and information gap by utilizing the Recipient's unique position as a central convenor of agricultural and industrial goods to showcase and demonstrate the capabilities and innovations around break bulk material handling.

2.1 Project Background

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance, and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

The CEC issued Grant Funding Opportunity (GFO)-20-601 entitled "Blueprints for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure" under the CEC's Clean Transportation Program. To be eligible for funding under GFO-20-601, projects must also be consistent with the CEC's current Clean Transportation Program Investment Plan, updated annually.

The CEC awarded SSA Pacific, Inc. (SSA Pacific) a grant to complete a Blueprint seeking to address the education and information gap in the deployment of ZEV medium- and heavy-duty

(MHD) charging infrastructure within the agricultural industry by utilizing SSA Pacific's unique position as a central convener of agricultural and industrial goods to showcase and demonstrate the capabilities and innovations around break bulk material handling. SSA Pacific is a wholly-owned subsidiary of Carrix, Inc. which has marine terminal and rail yard operations in more than 250 locations worldwide, including nine locations in the Southwest Pacific Region. SSA Pacific is the sole operator of the Port of West Sacramento, a stevedore at the Port of Stockton and the Port of Benicia, and is affiliated with a terminal operator at the Port of Oakland. SSA Pacific is a central service provider to the rice industry and is one of the only organizations that works closely with each of the state's 30 highly competitive rice milling operations to support on-road transportation logistics, material handling at port and rail hubs, and export from the state via rail or vessel. The rice industry and SSA Pacific offer a unique opportunity to showcase how bulk and breakbulk port operations, agricultural operations, and agricultural goods movement can transition to zero-emissions and reduce both on- and off-road emissions. The SSA Pacific Agricultural Goods Movement Blueprint addresses concerns and risks associated with ZEV infrastructure through comprehensive design and planning for ZEV adoption.

The Blueprint effort focused on a unique and well- positioned market segment: agricultural goods movement. This focus captures important parts of California's rural economy and California's critical freight hubs, identifies a core market segment (the rice industry) that can be broadly replicated, and connects the entire goods movement system from food producer and processor to export. Utilizing the ports as demonstration sites of MHD ZEV equipment and infrastructure is an excellent way to create broad industry reach because tens of thousands of processors and partners in the agricultural goods movement supply chain utilize domestic ports. As an industry leader, SSA Pacific seeks to create a nexus where thousands of customers, companies, and employees can benefit from ZEV equipment and infrastructure in action, amplifying and multiplying the impact of California's inland ports to stakeholders across the Central Valley. Additionally, SSA Pacific seeks to evaluate new and innovative transportation models to remove MHD vehicles from highly congested corridors and leverage the network of inland waterways to facilitate the transportation of goods and freight throughout California.

2.2 Project Team

2.2.1 SSA Pacific, Inc.

SSA Pacific and its parent company, Carrix, Inc. operate over 250 locations across five continents and is the largest terminal operator in California with facilities at nine of California's 13 seaports. SSA Pacific brings with it the insights, experience, and engagement of the entire Carrix, Inc. network, including Rail Management Services, Tideworks Technology, and Shippers Transport Express. Rail Management Services is one of the world's largest rail yard operators with 42 facilities in 16 states, serving all Class 1 railroads. Tideworks Technology is a full-service provider of cost-effective, reliable terminal operating and graphical planning solutions for marine and intermodal operations. Shippers Transport Express is a bonded intermodal carrier operating throughout California and the surrounding western states with operations in Carson (serving the San Pedro Ports), Oakland, and French Camp (serving the French Camp railyards, the Port of Stockton, and the Port of West Sacramento). SSA Pacific has significant knowledge and history of goods movement trends throughout the state. As the sole operator at the Port of West Sacramento—the state's largest rice exporting port, SSA Pacific is uniquely positioned to understand the needs of this important agricultural sector. SSA Pacific routinely coordinates with Shippers Transport Express and Rail Management Services to manage multimodal goods movement from across the state.

2.2.2 Momentum

As a team of experts in science, engineering, policy, finance, and project management, Momentum executes planet-saving projects. Through the design and development of innovative campaigns, Momentum helps forward-thinking organizations deploy transformative technologies for transportation, energy, water, and manufacturing. Utilizing rigorous research, analytical rigor, and strategic engagement, Momentum empowers its clients to secure funding, expand their customer base, and commercialize advanced technologies. Since 2005, Momentum has helped raise over $1.5 billion in grants, loans, and other incentives for clients, developed more than $6.2 billion in funded projects and helped eliminate thousands of tons of harmful emissions.

2.2.3 Arup

Arup is the force at the heart of many of the world's most prominent projects in the built environment and across industry. Arup is a globally recognized leader in the conceptualization, planning, design, and implementation of sustainable transportation strategies, services, and facilities for a variety of public and private clients. Arup's team supports clients through the full range of electric vehicle transition including transportation planning, energy system design, electrical engineering, urban planning, financial and management advisory, and advanced digital and technology design services. Through this integrated offering, Arup accelerates the transition to low and zero emission vehicles, from strategy and policy through to design and implementation of charging and refueling infrastructure. Arup—an authority in transportation planning—builds upon SSA Pacific and Momentum's expertise by bringing extensive planning and engineering experience and processes to the ZEV transition.

2.2.4 e-Mission Control

e-Mission Control unlocks new revenue for operators of MHD ZEV equipment in California through the Low Carbon Fuel Standard (LCFS) program. e-Mission Control is a registered opt-in entity within the California Air Resources Board (CARB) LCFS Reporting Tool and Credit Bank and Transfer System (LRT-CBTS) system managing a portfolio of more than 2,000 pieces of MHD ZEV equipment. The LCFS program is expected to be an important financial tool for the acceleration of MHD ZEV equipment and e-Mission Control will evaluate the opportunities to generate, manage, optimize and deploy credits to engage the third-party investors to support public access deploy.

2.3 Scope of Work

The goal of SSA Pacific's Blueprint was to design and develop an implementable and replicable MHD ZEV Blueprint that will accelerate the adoption and deployment of MHD ZEV infrastructure across the diverse industrial operations at California's freight hubs and California's entire agricultural freight supply chain, from growers to food processors, to distribution networks locally and internationally. With a focus on quantitative and measurable data, the achievement of the goal was measured by three core objectives:

- **Objective 1: Engage a broad stakeholder network** to develop a comprehensive, economic, and equitable approach to rapidly deploying MHD ZEV infrastructure and distributed energy resource (DER) technologies.
- **Objective 2: Advance California's ports to be cutting-edge technology demonstrators and innovators**, harnessing the broad industry reach to accelerate wide-scale market adoption.
- **Objective 3: Identify innovative approaches for SSA Pacific to offer technical solutions to improve ZEV adoption across the agricultural goods movement industry** including the utilization of inland marine waterways to reduce on-road congestion and support shorter round-trip haul distances to better suit ZEVs, the deployment of shared infrastructure to reduce range anxiety, and the use of LCFS credits to catalyze adoption.

To complete this ambitious project, SSA Pacific identified four core tasks designed to achieve the quantitative and measurable objectives described above.

- **Task 1: Administration**: This task was designed to ensure clear, timely, and transparent communication between SSA Pacific and the Energy Commission. Recurring communication is expected to be conducted through monthly reports, presentations including at the kickoff meeting, critical project review (CPR) meetings, and the final meeting. Additional coordination by phone or videoconference was conducted as needed and in coordination with the CAM.
- **Task 2: Community Outreach and Engagement**: This task was designed to bring together a broad and diverse stakeholder audience—including industry participants, community stakeholders, finance partners, and technology providers—to foster productive and thoughtful dialogue around the deployment of shore power and alternative fueling infrastructure supporting the agricultural goods movement supply chain, including material handling, on-road, on-water, and on-rail MHD ZEVs, in furtherance of local, regional, and state objectives. The main deliverables in this task include: 1) a list of outreach targets; 2) a community and stakeholder engagement plan; and 3) a community and stakeholder engagement report.
- **Task 3: Flexible Infrastructure Pathways (FIP)**: This task was designed to leverage the experience of the Project Team to build upon stakeholder engagement and produce a series of navigable pathways for SSA Pacific to successfully implement ZEV infrastructure. The FIP approach will enable the project team to account for select uncertainties associated with the implementation of ZEV infrastructure, such as technology advancement, manufacturing scalability, incentive funding, and industry adoption. The Project Team identified the adaptation triggers, transfer points, and tipping points to inform decision making across the various pathways—improving confidence in the timely market adoption of MHD ZEV infrastructure. A key list of recommendations was produced that identify how to avoid stranded assets and technology lock-ins, and to promote "no regrets options"; those options which achieve positive outcomes under all or most plausible projected futures. The main deliverables

include: 1) Resilience Assessment, 2) Flexible Infrastructure Pathways Report, 3) Flexible Infrastructure Pathways Tool.

- **Task 4: Innovative ZEV Approaches**: SSA Pacific evaluated how its position as an industry convener can result in adoption of MHD ZEV technology adoption industry-wide, including the use of shared ZEV infrastructure, the Marine Highway 580 (M-580) inland waterway corridors, and approaches to leveraging LCFS credits to catalyze growth. This task included the evaluation of MHD ZEV infrastructure needed to support Class 8 ZEV drayage truck charging and associated business models to support widespread deployment. Additionally, SSA Pacific will leverage current efforts by Caltrans to evaluate the M-580 (SSA Pacific is an industry advisor on the project) to understand how the M-580 approach can utilize ZEV on-water technologies to move freight across Northern CA and reduce roundtrip travel for target agricultural commodities, better positioning those vehicles for ZEV adoption. The key deliverables include: 1) Summary of M-580 Benefits, 2) Infrastructure Needs Assessment, and 3) Agricultural LCFS Market Potential Analysis.

3 Community and Stakeholder Engagement

SSA Pacific and the Blueprint team collaborated with stakeholders throughout the process of Blueprint development. The purpose of community and stakeholder engagement was to meaningfully foster a two-way dialogue to share perspectives about challenges, risks, concerns, and opportunities associated with zero-emission vehicle planning. SSA Pacific's engagement activities were designed to solicit input from relevant stakeholders to understand stakeholder involvement in the transition to zero-emission equipment. Outreach and engagement activities included the establishment of a guiding committee and the identification of target stakeholders from a variety of industries and jurisdictions.

The objective of community and stakeholder engagement is to ensure that internal staff, local businesses, organizations, technology providers, institutions, and community groups are aware of SSA Pacific's goal to lay the groundwork for its transition into zero-emission (ZE) medium- and heavy-duty (MHD) agricultural goods movement. Early engagement ensured that stakeholders were provided with the opportunity to discuss challenges, risks, opportunities, and collaboration to support the transition.

The project team developed a questionnaire matrix of 141 questions related to ZEV technologies, challenges, assumptions, and concerns to guide surveys, interviews, and stakeholder meetings. The questions were further broken down by relevance to different stakeholder groups including internal staff, customers, electricity providers, hydrogen providers, energy storage providers, local jurisdictions, maritime industry organizations, warehousing and logistics industry, community-based organizations, Native American tribes, policymakers and regulatory agencies, financial partners, vehicle and equipment manufacturers, education and workforce partners, and other industry partners.

An Agricultural Stakeholders Survey and Community Stakeholders Survey were created using the questionnaire matrix, each with approximately twenty relevant questions for the respective stakeholder group. Stakeholders were invited to participate in the survey through a flyer sent via email. As a reward for completing the survey, the first fifty respondents were offered a digital $20 Visa Gift Card, limited to one per person and two per organization. Organizations were requested to limit responses to two individuals to encourage a greater diversity of responses. All survey responses were aggregated anonymously. Initial flyers were sent to stakeholders on January 17, 2023, and multiple follow-up reminders were sent throughout January and February. As of Thursday, February 23, the Community Stakeholders Survey received two responses, and the Agricultural Stakeholders Survey received two responses.

The full Community and Stakeholder Engagement Report can be found in Appendix A.

3.1 Target Stakeholders

Outreach targets were identified to ensure that a diverse stakeholder audience was engaged consistent with the Community and Stakeholder Engagement Plan. The list of outreach targets was designed to ensure a diverse stakeholder audience. SSA Pacific identified the following entities and organizations as important stakeholders in the evaluation of its transition into zero-emission (ZE) medium- and heavy-duty (MHD) vehicles, equipment, and infrastructure:

Internal Stakeholders: Staff, Consultants, Senior Management, C-Suite

SSA Pacific Customers: Two Rivers Cement, ADM, ADM Rice, Farmers Rice Cooperative (FRC), Sun Foods Rice, American Commodity Company (ACC), SunWest Foods

Electricity Providers: PG&E

Hydrogen Providers: Air Liquide, Linde, Praxair, Nel Hydrogen, Air Products, Shell

Energy Storage/Microgrids: Tesla Energy, BYD, ABB, Schneider Electric, General Electric, ITW, Pacific Power, XOS, EnelX

Local Jurisdictions: City of Stockton, City of West Sacramento, City of Sacramento, City of Benicia, San Joaquin Valley Air Pollution Control District, Sacramento Metropolitan Air Quality Management District, Bay Area Air Quality Management District, San Joaquin Council of Governments, Sacramento Area Council of Governments, Association of Bay Area Governments

Maritime Organizations: California Association of Port Authorities, Association of Pacific Ports, NAMO, Pacific Maritime Association, Pacific Merchant Shipping Association, Green Marine, Maritime Administration

Community-Based Organizations: Port Outreach Committee, AB617 Working Group, Rise Stockton – Third City Coalition, Environmental Justice Program, Catholic Charities of the Diocese of Stockton, Little Manila Rising, GRID Alternatives, Rising Sun Center for Opportunity, Restore the Delta

Warehousing/Logistics Industry Organizations: West Sacramento Chamber of Commerce, International Warehouse Logistics Association, California Trucking Association, Agriculture Transportation Coalition, Harbor Trucking Association

Policymakers and Regulatory Agencies: California Department of Food and Agriculture, U.S. Department of Transportation, California Department of Transportation (Caltrans), State

Assembly

Financial Partners: CEC, CARB, Caltrans, San Joaquin Valley APCD, Sacramento Metropolitan Air Quality Management District, Yolo-Solano Air Quality Management District, Bay Area Air Quality Management District, CA Governor's Office of Business and Economic Development, Ernst & Young, Wells Fargo, U.S. Department of Transportation, U.S. Maritime Administration, Federal Emergency Management Agency, Environmental Protection Agency

Vehicle and Equipment Manufacturers: Liebherr Cranes, Shuttlewagon, Hyster, XL Lifts/Wiggins, Taylor, Kalmar Ottawa, BYD, Orange EV, Dannar, Xos, Nikola, Volvo, Peterbilt, Kenworth

EVSE OEMs: Tritium, ABB, ChargePoint, WAVE, Intertie, FreeWire, Efacec, BTCPower

EVSPs: EVgo, Greenlots, Blink, Chargepoint, Electrify America

Charging as a Service: Amply, InCharge Energy, WattEV

Hydrogen Refueling Infrastructure: Nel, OneH2, FirstElement, Shell

Transportation Companies: Frank C. Alegre Trucking, Inc., Valley Farms Transports

Education and Workforce Development Partners: California Maritime Academy, San Joaquin County Office of Education, San Joaquin County Workforce Development Board, San Joaquin Delta College, California Mobility Center, San Joaquin Valley College, University of the Pacific, CSU Sacramento, CSU Stanislaus, UC Davis, West Sacramento, Sac City College, American River College

Industry Partners: E-Mission Control, Green Marine, Association of Pacific Ports, Benicia Port Terminal Company, California Rice Commission, Pacific Maritime Association, California Mobility Center, Port of San Francisco, Port of West Sacramento, Port of Stockton, Port of Benicia, Brusco Tugs, Port of Redwood City, Pacific Merchant Shipping Association.

3.2 Stakeholder Response and Findings

3.2.1 Community Stakeholders

The community stakeholder survey included twenty questions that assessed general understanding of the process of decarbonization, familiarity and experience with ZEV equipment, understanding of battery-electric and hydrogen equipment technologies, perceived challenges and opportunities associated with decarbonization, and existing community or workforce development partnerships. The survey was sent out via email on January 17, 2023, receiving a total of two responses from community stakeholders.

Community stakeholders expressed a general knowledge of current ZEV vehicles, equipment, and technology and indicated interest in the Port's decarbonization goals. Key concerns about the ZEV transition identified in the survey include operational performance and capital costs, while the greatest opportunities are environmental impact and operational costs. Stakeholders identified reduced emissions in disadvantaged and low-income communities as the greatest potential benefit for impacted communities, though concerns remain about incentivizing the ZEV transition for small operators and the reliability of the electrical grid. Potential collaboration opportunities that may be further explored include media outreach through radio resources and project partnership with the Yolo-Solano Air Quality Management District (YSAQMD).

3.2.2 Agricultural Stakeholders

The industry stakeholder survey included twenty-five questions that assessed general understanding of the process of decarbonization, familiarity and experience with ZEV equipment, understanding of battery-electric and hydrogen equipment technologies, perceived challenges and opportunities associated with decarbonization, and concerns and expectations about ZEV equipment. The survey was sent out via email on January 17, 2023, receiving a total of two responses from industry stakeholders.

The industry stakeholders who responded to the survey expressed a moderate level of familiarity with current ZEV technology and identified ZEV heavy-duty equipment manufacturers, onsite electricity generation developers, and agricultural companies as key partnerships that will be critical to broader decarbonization. Industry stakeholders raised concerns over operational flexibility, road weight limits, and burdens on California's electrical grid. The greatest concerns with ZEV equipment were reliability, maintenance, and capital and operational costs, while the greatest opportunity identified was environmental impact. Lastly, industry stakeholders identified vehicle mechanics and maintenance personnel as positions for which skills need to be developed for the MHD ZEV transition.

3.2.3 Policymakers and Regulatory Agencies

Policymakers and regulatory agencies guide legislation and funding that supports state and federal efforts to achieve clean air objectives. Support from policymakers and regulatory agencies to demonstrate and support the transition to ZEVs is critical to early adoption of zero emission technologies ahead of full market commercialization.

Outreach to policymaker and agency stakeholders was and will continue to be conducted to explore:

- Discussion of relevant policies, regulations, and technical reports,
- Discussion of relevant funding and technical assistance programs,
- Progress towards state and federal objectives, including opportunities to develop or use statewide collateral, tools, case studies, or frameworks,
- Synergies with related climate and public health issues and policy (forest management, wildfire, sea-level rise, landfills, housing, etc.) that have aligned goals and objectives,
- Participation in collaborative, multi-state, or regional initiatives,
- Approach to support for early adopters including mechanisms to incentivize:
    - Continued development of early-stage technology and R&D,
    - ZEV deployments at scale,
    - ZEV deployments in hard-to-decarbonize sectors,
    - ZEV deployments in underserved and low-income communities, economically challenged communities, and communities with underutilized resources,
- Barriers to an expedited ZEV transition including capacity building, natural resource

limitations, education, workforce development, interoperability, cost parity projections, and more,

- Qualitative and quantitative health and climate resilience impacts at varying scales

3.2.3.1 Industry Partners

West Sacramento Chamber of Commerce

In addition to survey dissemination among agricultural and community stakeholders, SSA Pacific also engaged the West Sacramento Chamber of Commerce on January 17, 2023, through a Blueprint presentation and discussion of progress, key lessons learned, and next steps.

3.2.3.2 Regulatory Agencies

CARB, CEC & Local Air Quality Management Districts

Description: CARB is the state's lead agency for climate change programs. CARB's primary objectives include identifying, monitoring, controlling, and reducing air pollutants, maintaining, and setting air quality and emissions standards, conducting research, and studying costs and benefits of pollution control solutions, and implementing programs to help entities meet regulatory requirements and advance state climate change goals. In the transportation sector, the CEC and CARB have complementary responsibilities, with CARB serving as the lead agency on zero emission and low carbon vehicle deployment and the CEC as the lead agency on vehicle fueling infrastructure and grid integration.

California Public Utilities Commission (CPUC)

Description: The CPUC regulates privately owned public utilities in California, including electric power, telecommunications, natural gas, and water companies.

Relating to the Clean Transportation Ecosystem: The CPUC regulates the energy companies that provide the energy for and supporting the implementation of MHD chargers and microgrids.

California Department of Transportation (Caltrans)

Description: Caltrans manages more than 50,000 miles of California's highway and freeway lanes, provides intercity rail services, permits more than four hundred public-use airports and special-use hospital heliports, and works with local agencies. Caltrans conducts its mission with six primary programs: Aeronautics, Highway Transportation, Mass Transportation, Transportation Planning, Administration, and the Equipment Service Center.

Relating to the Clean Transportation Ecosystem: Caltrans is working to develop zero emission and alternative fuel corridors across California to allow seamless and widespread travel by ZEVs.

3.2.4 Financial Partners/Investor Partners

The ZEV transition will require significant upfront capital investment. Items that may need to be purchased are quite diverse and include charging equipment and related infrastructure, vehicles, energy generation and storage equipment, related infrastructure upgrades, and more. Similarly, the financial/investor partners can vary from government agencies, traditional financial institutions, specialized financial businesses, individual investors, and more. Others, including economic development agencies, may be valuable secondary financial/investor partners as projects move forward.

Interviews were conducted with targeted financial partners/investor partners to explore:

- Existing financing programs that are available for the ZEV transition, including loan guarantee programs, loan loss reserve programs, collateral support programs, bond issuance and others,
- Potential adjustments to existing programs to increase the attractiveness for ZEV infrastructure and vehicles,
- Potential new programs which could help accelerate deployment of ZEV infrastructure and vehicles,
- Requirements to access existing and new financing programs,
- Mechanisms to reduce the perceived risk of ZEV financing.

Outreach was focused on a select cross-section of potential financial/investor partners in order to conduct a market sounding exercise including:

- Traditional financial institutions,
- Alternative financial institutions and non-traditional lenders,
- Local and state economic development experts and other financing experts.

3.2.4.1 Public Agency Funding

Multiple state and federal agencies are providing funding for clean transportation programs in California which SSA Pacific may be eligible for. The public policy to public funding cycle starts with a need for societal change, oversight, or regulation. This cycle typically ends with the development of programs intended to distribute funds and resources to projects and initiatives that progress the agency's overarching goals and mission to address these societal changes, ultimately impacting policy at the highest levels of government. In the business of deploying clean and sustainable technology, many entities seek funding from public agencies to help offset the prohibitive costs associated with adopting emerging technology, new industry, and new markets on the path towards large-scale adoption and commercialization. The diagram below shows how public agencies use legislative acts, laws, and bills to develop programs, priorities, and investment plans that ultimately turn into the notices of intent (NOIs), requests for information (RFIs), funding opportunity announcements (FOAs), solicitation releases, and notices of proposed awards (NOPAs).

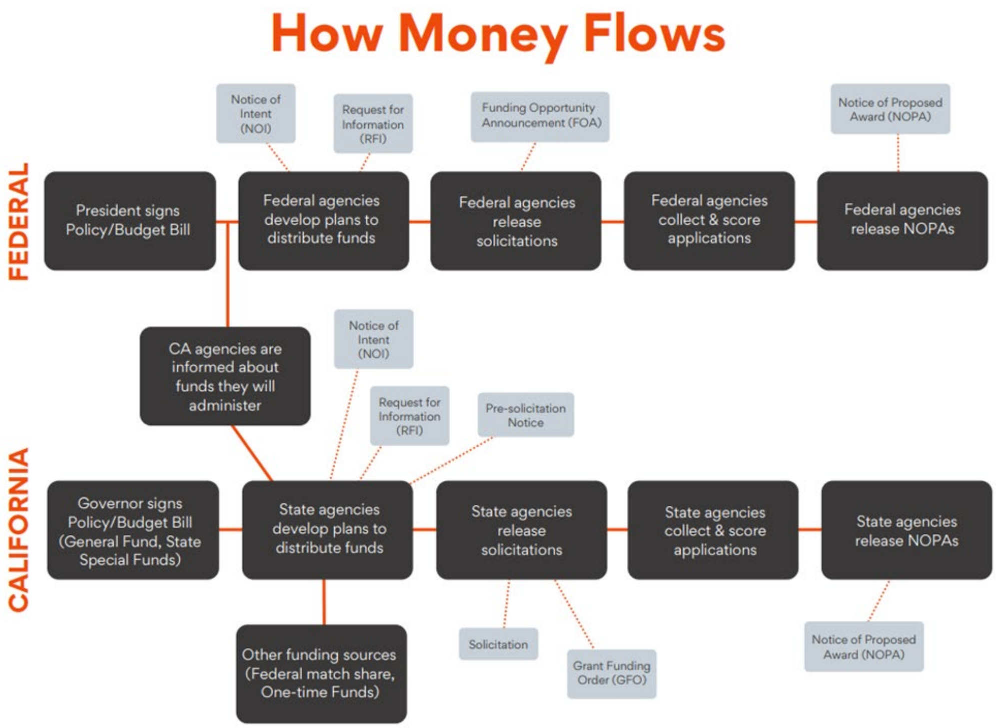

Figure 1: How federal and state money flows

Additionally, continuously engaging with public agencies involves more than applying for grants and incentives when available. To heighten chances of securing public funding and to build long term relationships with agencies who also act as partners invested in success, entities should not only develop competitive project scopes and grant applications but should also ensure their feedback and perspectives are regularly incorporated into agency investment planning, decision making, and program development. One approach is through participation in proactive and "pre-capture" activities (activities that take place leading up to a solicitation release or other decisions within the agency such as announcement of new or updated regulatory requirements and policy changes). There is a slate of proactive or "pre-capture" related activities that can help entities and organizations continuously engage with public agencies.

The diagram below outlines steps entities can take to continuously engage with key agencies that relate to their work, while constantly responding to an evolving clean transportation sector landscape:

Figure 2: Steps for entity engagement

Pre-capture activities lay the foundation for downstream activities including grant and incentive capture, grant application and proposal development, award, and implementation or grant management service (GMS), shown below. It is important to note that relating to public agencies does not stop once an award is made or a project has completed implementation and fulfilled grant requirements. Entities are encouraged to participate in all the steps outlined and additional activities (including attending workshops, meetings, conferences, site tours) throughout the year to maintain active engagement with agency partners.

3.2.4.2 State Agency Funding Programs

Momentum assessed funding programs and conducted outreach with the agencies addressed below.

CARB

Clean Transportation Incentives Program: Combined, the Low Carbon Transportation Investments (LCTI) and Air Quality Improvement Program (AQIP) make up CARB's Clean Transportation Incentives Program. The program provides mobile source incentives to reduce greenhouse gas, criteria pollutant, and toxic air contaminant emissions. Primarily, the programs of interest fund replacement of polluting engines, equipment, and vehicles to cleaner alternatives, while providing supporting infrastructure.

Low Carbon Transportation Investments (LCTI): Both programs below function as point-of-sale voucher incentive programs where the voucher is obtained by the dealership, distributor, or

OEM (sellers) supplying the vehicle or equipment and the purchasers receive the discount instantly upon purchase, thus offering a streamlined process and more straightforward interaction for fleet owners. Both operate on a first come, first served basis.

Carl Moyer Memorial Air Quality Standards Attainment Program: The Carl Moyer Program seeks to cost-effectively reduce smog-forming and toxic air contaminant emissions. To achieve these goals, the Carl Moyer Program focuses on vehicle or equipment replacement, repower, or retrofit, vehicle retirement, and alternative fuel infrastructure. The program is focused primarily on commercially available technologies. Carl Moyer funds are organized by CARB annually and distributed to each Air District for local awards, which are then divided through competitive solicitations. The funding is intended to support a wide range of mobile equipment, including heavy-duty trucks, drayage trucks, off-road equipment, locomotive equipment, and marine vessels. All project proposals submitted to the Carl Moyer Program are judged competitively on a cost per ton of emissions reduced or avoided.

Infrastructure: The 2017 update to the Carl Moyer Program Guidelines allow funding for infrastructure projects that enable the deployment of alternative, advanced, and cleaner technologies to support the State's air quality goals. Specifically, projects that install fueling or energy infrastructure to fuel or power a "covered source" are now eligible for funding consideration. A "covered source" includes heavy-duty on-road vehicles, off-road non-recreational equipment and vehicles, locomotives, marine vessels, agricultural sources of air pollution, and other categories as determined by CARB and local Air Districts that are necessary for the State and Air Districts to meet air quality goals.

CALSTART

Clean Off-Road Vehicle Equipment (CORE) Program: Administered by CARB and CALSTART, CORE opened its second round of funding in 2022 with $125 million available for off-road zero-emission equipment. CORE offers vouchers for point-of-sale discounts on equipment in the following categories: on- and off-road terminal tractors, truck- and trailer-mounted transport refrigeration units, large forklifts and cargo-handling equipment, airport ground-support equipment, railcar movers and switcher locomotives, mobile power units and mobile shore-power cable management systems, construction equipment, agricultural equipment, and commercial harbor craft.

HVIP: This program is designed to address market challenges of the ZEV transition by making clean vehicles more affordable for fleets through point-of purchase price reductions. HVIP offers up to $150,000 vouchers for MHD ZEVs on a first-come-first-serve basis. Electric refuse trucks are eligible for vouchers between $85,000 and $120,000. Approximately $196 million in vehicle vouchers will be available.

EnergIIZE: Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles (EnergIIZE) is the nation's first commercial vehicle fleet infrastructure incentive project. Funded by the CEC's

Clean Transportation Program and implemented by CALSTART, EnergIIZE provides incentives for ZEV infrastructure equipment for MHD battery electric and hydrogen fuel cell vehicles in California. The project provides a user-friendly and streamlined process for participation by breaking down infrastructure deployment barriers through targeted incentives and specialized assistance.

Supplemental Environmental Projects: The Supplemental Environmental Projects (SEP) policy permits community-based projects to be funded from penalties received during CARB's settlement of enforcement actions. CARB is required to include a public process to solicit, compile, and maintain a library of eligible projects from disadvantaged communities that violators may choose from during the settlement process. The SEP policy permits CARB to allocate up to 50% of penalties obtained from violators towards eligible SEPs that have some nexus to the violation, either by location or type of pollutant to be addressed. Funds may cover all phases of the selected SEP, including capital, operational, and administrative costs. Examples of potential projects include air monitoring studies, vehicle and equipment upgrades, workforce training and awareness campaigns, projects reducing exposure to air pollutants, and projects achieving direct and indirect emissions reductions beyond regulatory requirements. This funding mechanism is intended for projects that do not have an alternative avenue for funding. A pre-application process is used to evaluate CARB's level of interest in each proposed project and projects must (1) reduce direct/indirect air emissions or exposure to air pollution, (2) relate to the violation and not benefit the violator, (3) go above and beyond regulatory requirements, and (4) demonstrate that the proposal is technically, economically, and legally feasible. Priority is given to projects within or that benefit disadvantaged communities.

Low Carbon Fuel Standard (LCFS) Program: There are now four major credit pathways under the LCFS program:

1. Fuel Pathway-based Crediting (the primary pathway for all fuels produced and carbon capture and storage),
2. Project-based Crediting (refinery-oriented),
3. Zero Emission Vehicle Infrastructure (Capacity-based) Crediting,
4. Design-based Pathways.

The Zero Emission Vehicle Infrastructure (Capacity-based) Crediting provision covers DC fast charging and hydrogen refueling infrastructure. In addition to generating LCFS credit for dispensed fuel, the eligible hydrogen station, or DC fast charger can generate infrastructure credits based on the capacity of the station or charger minus the quantity of dispensed fuel. Currently this program is designed for light-duty vehicle refueling stations only.

3.2.4.3 Local and State Economic Development Experts

The Governor's Office of Business and Economic Development (GO-Biz)
Description: GO-Biz serves as the State of California's leader for job growth, economic development, and business assistance efforts. GO-Biz offers a variety of ZEV programs including

fleet transition services:

- https://cte.tv/services-area/fleet-transition/
- https://business.ca.gov/industries/zero-emission-vehicles/zev-funding-resources/

Relating to the Clean Transportation Ecosystem: Go-Biz offers multiple ZEV programs including fleet transition services.

3.2.4.4 Federal Agencies

Department of Transportation (DOT)

Description: Through the Infrastructure, Investment and Jobs Act (IIJA), DOT will be financing a wide variety of transportation related projects. Many of these programs are targeted at developing and implementing ZEVs and chargers.

Relevant Programs:

National Electric Vehicle Infrastructure (NEVI) Formula Program: The U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA) NEVI Formula Program will provide funding to states to strategically deploy electric vehicle (EV) charging stations and to establish an interconnected network to facilitate data collection, access, and reliability. In California, the funds will be distributed by Caltrans. Funding is available for up to 80% of eligible project costs, including the acquisition, installation, and network connection of EV charging stations to facilitate data collection, access, and reliability; proper operation and maintenance of EV charging stations; and long-term EV charging station data sharing.

To be eligible, EV charging stations must be non-proprietary, allow for open-access payment methods, be publicly available or available to authorized commercial motor vehicle operators from more than one company, and be located along designated FHWA Alternative Fuel Corridors (AFCs). The CEC and Caltrans hosted a joint seminar on June 14, 2022 to provide more information about the program.

Charging and Fueling Infrastructure Grants: Administered to deploy electric vehicle charging and hydrogen/propane/natural gas fueling infrastructure along designated alternative fuel corridors and in communities.

Eligible Uses: Acquisition and installation of publicly accessible electric vehicle charging or alternative fueling infrastructure, operating assistance (for the first five years after installation), acquisition, and installation of traffic control devices.

Congestion Mitigation and Air Quality Improvement Program: This is a flexible funding source to state and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards for ozone, carbon monoxide, or particulate matter (nonattainment areas) and for former nonattainment areas that are now in compliance (maintenance areas).

Eligible Uses: Transportation projects that reduce congestion and reduce the mobile source emissions for which an area has been designated nonattainment or maintenance for ozone, carbon monoxide, and particulate matter by the Environmental Protection Agency.

Local and Regional Project Assistance Grants (RAISE): The RAISE program provides supplemental funding for grants to the State and local entities listed above on a competitive basis for projects that will have a significant local/regional impact. Eligible recipients include those looking to advance airport surface transportation components of certain development projects.

Port Infrastructure Development Program (PIDP): The Port Infrastructure Development Program (PIDP) is a discretionary grant program administered by the Maritime Administration. Funds for the PIDP are awarded on a competitive basis to projects that improve the safety, efficiency, or reliability of the movement of goods into, out of, around, or within a port.

PIDP grants support efforts by ports and industry stakeholders to improve port and related freight infrastructure to meet the nation's freight transportation needs and ensure our port infrastructure can meet anticipated growth in freight volumes. The PIDP provides funding to ports in both urban and rural areas for planning and capital projects. It also includes a statutory set-aside for small ports to continue to improve and expand their capacity to move freight reliably and efficiently and support local and regional economies.

In FY2023, the Bipartisan Infrastructure Law (BIL) appropriated $450 million to the PIDP. An additional $212,203,512 was made available to the program under the FY2023 Consolidated Appropriations Act, resulting in a total of $662,203,512 in FY 2023 PIDP grant funding.

Reduction of Truck Emissions at Port Facilities Grant Program: The BIL established the Reduction of Truck Emissions at Port Facilities Grant Program, with funding allocated through 2026, to reduce emissions from truck idling at port facilities, including through the electrification of port operations.

Administered by the DOT's Federal Highway Administration (FHWA), the $400 million program is part of President Biden's Justice40 Initiative to ensure that 40 percent of the benefits of certain Federal investments flow to disadvantaged communities. The program focuses on projects that reduce truck emissions in communities adjacent to ports to improve the health of port workers, truck drivers, and nearby residents.

Eligible project activities include the development of port-related infrastructure that reduces emissions from truck idling, on-vehicle technologies that reduce emissions from truck idling, the deployment of zero or low emission powertrains or fuels, reducing truck traffic congestion near ports, and reducing port-related emissions from idling trucks, including through electrification or improved efficiency.

3.2.4.5 Traditional Financial Institutions

A list of financial institutions that provide fleet financing is provided below. Subsequent internal engagement with SSA Pacific is necessary to determine preferred financing options and existing partnerships.

Financial Institutions
- Wells Fargo
- Bank of America
- US Bancorp
- Morgan Stanley
- Citi

Equity Firms
- Sparkfund
- Hannon Armstrong
- Meridian
- Plenary
- Spring Lane Capital

Energy As a Service (EAAS) Providers
- EnelX
- Schneider Electric
- InCharge
- Amply

Bonds
- KNN
- PRAG
- Frasca

3.2.5 Vehicle and Equipment Manufacturers

There are many vehicles and equipment (e.g., charging and refueling) manufacturers and distributors with products that support ZEV transition. Each product under development has different abilities and capabilities. These products and capabilities are expected to develop rapidly over the next decade as battery and fuel cell technologies advance. Understanding how to evaluate technologies will be critical to the successful ZEV transition. Momentum conducted outreach to a wide variety of OEMs and service providers by initiating meetings and calls, attending webinars, and organizing face-to-face engagement at the Advanced Clean Transportation (ACT) 2022 Expo. A summary of engagement findings that addresses the following considerations is included below:

- Technical specifications, today and in future technology iterations,
- Product development efforts,
- Demonstration partners and references,
- What level of integration, coordination, or collaboration the OEM has with advanced technology developers,
- Supply chain constraints,
- Warranty offerings,
- Repair and maintenance capabilities.

3.2.5.1 MHD ZEVs

At least twelve companies have medium and/or heavy-duty on-road electric trucks that are ready for deployment in the coming year. Advertised tractor ranges are within 100 to 500 miles per vehicle full charge with charge times ranging between 60 and 270 minutes. ZEV battery capacities range from 280 to 800 kWh with an average of 450. Most OEM sales representatives expressed that supply chain challenges have delayed the availability of tractors/trucks. Nearly all trucks use CCS1 charging ports, and some have dual ports that offer CCS1 and CHAdeMO. HD ZEVs are significantly more expensive than existing diesel models but can be partially or fully offset by incentives and vouchers, including those listed above.

There are two types of hydrogen vehicle technologies: the hydrogen fuel cell electric vehicle (FCEV) and the hydrogen internal combustion engine. Currently, the FCEV is the preferred technology of OEMs. Operationally, fueling hydrogen vehicles is similar to fueling conventional diesel-powered vehicles, and fueling times range between ten and thirty minutes. The current use of hydrogen vehicles is limited by the availability of hydrogen refueling infrastructure and vehicles, but hydrogen industry representatives are generally optimistic about the availability and feasibility of hydrogen infrastructure in California's major population hubs.

There are numerous FCEV Class 8 tractor-trailers with varying technological approaches. The majority of these prototypes leverage a small battery of approximately 50 kWh to provide peak power for acceleration and climbing hills and to improve efficiency by providing regenerative braking. This battery is charged while the vehicle is operating by a hydrogen fuel cell. FCEVs are expected to provide between 300 and 900 miles of range once fully developed. The current limiting factor for FCEV technologies is cost, but the Hydrogen Council projects this to decrease by up to 50% by 2030 (or even lower, per the US DOE Earthshot program) as economies of scale are reached. Hydrogen refueling infrastructure is becoming widely available through Trillium, Chevron, and True Zero, currently in California's major population hubs. Generally, dedicated fleet fueling infrastructure for hydrogen vehicle appears to be a more reliable short-term solution for hydrogen ZEV fleet deployment.

Notably, CARB certified Hyzon Motors' repowered Class 8, 7, and 6 FCEV trucks as exempt from emission requirements, enabling the sale of their FCEV trucks in California. Hyzon's Class 8 truck was the first fuel-cell electric heavy-duty tractor available on California's Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) for a base incentive of $240,000 per truck. The Nikola Tre FCEV received CARB certification in 2022 and is pending HVIP eligibility. Further, Hyundai Motors is demonstrating Class 8 6x4 XCIENT FCEV tractors at the Port of Oakland for the Zero-Emission Regional Truck Operations with Fuel Cell Electric Truck Project (NorCAL ZERO). Expanded HVIP eligibility and the successful demonstration of heavy-duty FCEV trucks intend to advance commercialization and reduce the total cost of ownership of advanced commercial vehicles in California.

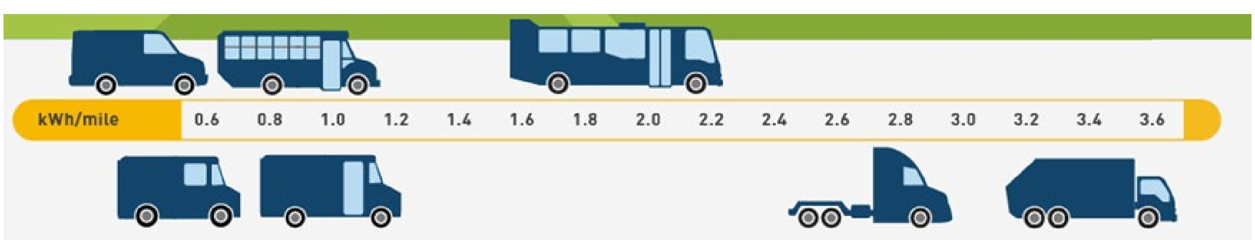

Figure 3: Typical EV energy consumption rates for medium and heavy-duty vehicles (PG&E)

3.2.5.2 MHD Charger Manufacturers and Distributors

Charger OEMs and service providers are working to develop faster and higher-powered chargers but are limited by current vehicles' ability to accept high charge rates. Most manufacturers create chargers that can supply more power than existing EV batteries can tolerate. Existing high-power chargers on the market range from 120 kW to 500 kW, while the average of those interviewed is 280 kW. CharIN, a global non-profit dedicated to standardizing EV charger plugs, released the Megawatt Charging System (MCS) in June 2022. While charging companies stated that they will be incorporating this standard into their systems as soon as possible, most vehicle OEMs contacted have not provided a deadline for when their vehicles will be able to accept this rate of charge.

Charger providers employ a range of business models ranging from selling chargers, selling and installation, and charger installation and operations/metering. Nearly all charger providers offer or require a maintenance contract and warranties. More information on repair and maintenance capabilities can be found in the Workforce Development section below. Most charger OEMs have expressed that their on-market products are available for installation on-demand. VGI capabilities are not yet widely available on the market. However, multiple charging companies indicated that they are either developing or undergoing pilot programs utilizing this technology with fleets.

Commercially available hydrogen refueling infrastructure is currently limited to California and parts of the East Coast. The California Fuel Cell Partnership is aiming to create 200 Hydrogen Stations capable of supporting 70,000 heavy duty FCEVs by 2035. In 2013, the United States Department of Energy launched H2USA, a public-private collaboration of federal agencies, automakers, hydrogen providers, fuel cell developers, and other stakeholders to advance the adoption of fuel cell electric vehicles. Among over thirty participating members, Air Liquide, General Motors, Toyota, and Nel Hydrogen represent key stakeholders in the development and deployment of hydrogen vehicles and refueling infrastructure. Nel Hydrogen, for example, has developed a hydrogen fueling station for fuel cell cars, buses, and trucks with a daily capacity of 1,800kg/day and a maximum capacity of 160kg/h. Though hydrogen refueling stations are increasingly in development, hydrogen infrastructure technology is not yet advanced enough for widespread adoption, making it less likely to be utilized in many places.

3.2.6 Education and Workforce Development Partners

New technologies will require new capabilities to service and operate the vehicles and charging equipment. Internal staff and external vendors will need to be trained to safely deploy, operate, and maintain the equipment. At the same time, communities throughout California and the United States are experiencing a chronic shortage of workers in the trades, including electricians, welders, and pipefitters. With ZEV adoption expected to grow rapidly, the need to develop pathways for a workforce trained with necessary technical skills will become more acute.

Momentum conducted outreach with potential Education and Workforce Development partners to explore:

- What training programs exist to support the needed workforce?
- What opportunities exist to partner with apprentice programs?

- What kind of opportunities exist to partner with high school Career and Technical Education (CTE) programs, as well as relevant workforce development programs at California community colleges?
- What are the top skills for trades sought by ZEV technology installers, maintainers, and operators?

Key Stakeholders engaged:

1. Regional Community Colleges
2. Internal Stakeholders
3. Vehicle and Equipment OEMs and Suppliers
4. Labor Unions
5. Workforce Development Organizations

3.2.6.1 Workforce Gaps

Workforce knowledge and capabilities essential to a ZEV transition were identified in a separate report by Long Beach City College in collaboration with OEMs, labor representatives and subject matter experts. Broadly, knowledge gaps exist in the following eight categories:

Figure 4: ZEV Transition Workforce Knowledge Gaps, Long Beach City College

The Advanced Transportation and Logistics (ATL) Final Report 2020 found that California is a leader in transportation-related jobs, though a gap remains in the data identification and market analysis of technical training for skills necessary to perform maintenance on alternative fuel vehicles. Supply chain management, automotive technician training, and hydrogen training are expected to expand as the workforce evolves. Addressing workforce gaps requires adequate education, training opportunities, and comprehensive skill development. ATL partners with industry leaders to offer programs related to light- and heavy-duty vehicles, electric, hybrid, and hydrogen fuel cell technologies, railroad operations, and emissions.

While a portion of EV maintenance will involve familiar conventional components, technicians must be prepared to handle high-voltage e-Powertrains and ancillary systems that are no longer mechanically driven. Safety precautions and emergency procedures need to address new safety hazards posed by high-voltage cables and batteries, and Industry professionals have expressed concern that there will be a shortage of licensed electricians to install electrical infrastructure.

3.2.6.2 Workforce Opportunities

Workforce development potential associated with the electrification of SSA Pacific's agricultural goods movement exists in three job categories: equipment vending, operations and maintenance, and infrastructure installation. Vendor and infrastructure workforce development will primarily be handled externally. Operations and maintenance of MHD ZEV equipment will likely be accomplished through a combination of training, warranties, and operation & maintenance (O&M) contracts. MHD ZEVs and charging equipment are expected to need 50% less maintenance than traditional equipment. Most OEMs include warranties and O&M contracts to encourage new technology adoption.

Statewide agency partnerships, along with regional and local programs, will enhance training and certification opportunities for the expanding ZEV workforce. The CEC invested $3 million in 2020 to fund ZEV training and related curriculum at community colleges. Additionally, the CEC allocated $2 million in funding for high schools across California for the development of auto courses with EV curriculum. Further potential workforce development opportunities include assisting unemployed workers with logistics training, connecting high school students to relevant college and career pathways, organizing, or participating in automotive industry summits, and offering internships in the transportation sector.

3.3 Conclusions and Lessons Learned

The Blueprint Questionnaire, webinars, and stakeholder engagement meetings provided valuable responses that helped the project team better understand SSA Pacific's understanding of the zero-emission transition ecosystem.

Primary themes identified through the analysis of stakeholder engagement results:

- **Hopes and concerns regarding the ZEV transition are fairly consistent across different stakeholder groups:** Reliability and capital costs are top concerns about ZEV equipment, while environmental impact and lifetime performance are the greatest perceived opportunities. Perceived benefits of the adoption of ZEV equipment include cleaner air, fewer environmental hazards, collaboration with community organizations, and health benefits. Most stakeholders agree that the impacts of the ZEV transition can be mitigated.
- **Financial subsidies and public agency funding are an important factor in encouraging the EV transition:** Stakeholders expressed curiosity and concern for the financial implications of the ZEV transition, particularly in the context of upfront costs. A multitude of federal and state regulatory agencies provide funding and financial incentives for MHD ZEV fleet adoption.
- **Education and awareness are necessary components of the ZEV transition:** A successful Blueprint will include basic information on relevant technology, capabilities, insurance, costs, and financing; SSA Pacific should develop and disseminate public information on decarbonization, ZEV technologies, and the Port's progress towards its zero emission goals.
- **The ZEV transition can foster greater collaboration:** SSA Pacific and the Port of West Sacramento can use the Blueprint to strengthen its relationships with key tenants, business partners, and community organizations.
- **CBOs need to be engaged in the ZEV transition:** CBOs are often constrained by bandwidth and unavailable for consultation. This barrier must be addressed and overcome in order to ensure that community engagement is meaningful, equitable, and accessible.
- **Education programs for MHD ZEV technologies are lacking in California and need additional development:** There are just two community colleges in the state that offer a ZEV MHD workforce development program, but several community colleges throughout the state that provide either MHD or ZEV programs, and these would be good targets for state funding to develop MHD ZEV training programs there to meet the needs of the coming transition.
- **Collaboration with customers and business partners in the ZEV transition space requires extensive coordination and clear delineation of partner responsibilities and benefits:** SSA Pacific's industry and community partners are interested in collaborating and sharing knowledge to support their efforts to transition to zero-emission operations.

The thoughtful insights and recommendations collected through community and stakeholder engagement will help SSA Pacific achieve its sustainability goals while benefitting the communities it serves.

4 Flexible Adaptation Pathways

4.1 Resilience Assessment

SSA Pacific's operations on the West Coast of the United States expose facilities to a variety of natural hazards. Climate change has already begun to impact the frequency and intensity of natural disasters globally. In the United States, and in the Pacific Southwest region in particular, these impacts have been recorded for wildfire, drought, and extreme heat hazard.[1] This section will focus on hazards at the Port of West Sacramento.

The following credible hazards were investigated via "desktop study": 1. Flood, 2. Seismic, 3. Wildfire, 4. Extreme Heat, and 5. Drought. Other hazards considered and deemed non-credible are wind, tornado, hail, lightning, extreme cold, ice, and snow.

The full Resilience Assessment can be found in Appendix B.

4.1.1 Flood

Flood hazard at the Port of West Sacramento is heavily impacted by a system of aging levees surrounding the City of West Sacramento, with some stretches over a half-century old.[2] While FEMA considers the levee to be effective in providing protection from the 100-year water surface elevation from the Yolo Bypass and Sacramento River, a 2015 U.S. Army Corps of Engineers report claims that, "[t]here is a high probability that flows in either the Sacramento River or the Yolo Bypass will stress the network of levees protecting the study area to the point that levees could fail."[2] An effort is ongoing to upgrade the levee system to provide protection from the 200-year event,[3] but until this effort is completed, the levee system may provide significantly less protection than that suggested by FEMA. Floods in West Sacramento have occurred most recently in 1986, 1997, and 2006. In the event of a levee breach, the Port of West Sacramento could be inundated with 0.5 feet of water from a 10-yr flood event and 0.5 to 3 feet of water from a 100-yr flood event. The Sacramento Deep Water Shipping Channel connects the Port to San Francisco Bay. As such, the Port is vulnerable to sea level rise (SLR). Medium and high local SLR projections at Port Chicago in Suisun Bay suggest 8-13 inches and 11-21 inches of mean increase by 2050, respectively.[4] According to Climate Central's Surging Seas SLR inundation viewer,[5] roughly 2 feet of SLR is needed before areas of the Port of West Sacramento become permanently inundated. Higher mean sea-levels will push more salty water to the Port. A 2011 CEC report also found that up to 25 coastal power plants and 86 substations are at risk of flooding, or partial flooding, due to sea level rise.[6]

A flood of 1-2 ft in the Port of West Sacramento could disrupt operations for weeks to months, including worker commutes and trucking which could be disrupted due to road closures. Floods can also impact utility or on-site power supply. For example, moisture in electrical equipment can disrupt its intended function and require repairs. Low-lying components, like pad-mounted

[1] California's Fourth Climate Change Assessment. (2019). www.energy.ca.gov.
[2] "West Sacramento Project General Reevaluation Report", USACE, December 2015.
[3] https://www.cityofwestsacramento.org/government/departments/city-manager-s-office/flood-protection/levee-projects-overview
[4] U.S. Government Interagency Local Probabilistic Sea-Level Rise Projections, 2022 (retrieved from: https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-data.html)
[5] https://sealevel.climatecentral.org/
[6] Sathaye et al. (2011), "Estimating Risk to California Energy Infrastructure from Projected Climate Change."

transformers and non-elevated switchgears, are typically the most at risk of damage from inundation. Additionally, the salt in brackish water can be particularly damaging due to the corrosive and conductive nature of salt residues. Contaminated flood waters with chemicals, sewage, oil, and other debris can also impact the integrity and performance of electrical equipment and stored inventory on site. Lastly, floods can also pose as electrical shock hazards in the presence of a downed power line or inundated electrical equipment.

General flood mitigation options include elevating, wet floodproofing, dry floodproofing, temporarily diverting operations to other regional ports such as Stockton, Oakland, and Benicia, and responding to levee warning systems. In the near-term, port infrastructure such as offices, maintenance facilities, grain silos, non-elevated electrical infrastructure, and equipment yards are vulnerable to floods and, in the longer-term, sea level rise. Electrical infrastructure in this context could include charging equipment and controls that support ZEVs. Permanently elevating these components where possible and/or incorporating flood barriers keeps water out and reduces the likelihood of damage and interruption in operation. Additionally, flood mitigation options that accommodate floods without causing damage are also good strategies for acute events, such as using higher ingress protection for electrical equipment. These measures may come with trade-offs that add complexity to day-to-day operations—such as needing stairs to access equipment and make repairs—which should be considered in the design of upgrades or new installations.

Dry and wet proofing approaches could be strategically phased in as flood hazard worsens over time. For example, building foundations can be designed such that they are compatible with future elevation upgrades in mind to raise the port bulkhead and the operations behind it. Effective flood mitigation measures do not all require immense upfront investment. Simply moving vulnerable equipment to higher ground during a levee breach warning could reduce damages from rare flood events.

4.1.2 Seismic

Several fault lines have been identified in Yolo County, including the Huntington Creek Fault and the Dunnigan Hills Fault.[7] Though neither of these faults cross through the Port of West Sacramento directly, West Sacramento may be impacted by their rupture or the rupture of faults nearby, in the coastal ranges or the Sierra Nevada foothills. Hazards that may impact the port include ground shaking, liquefaction, lateral spreading, and differential settlement. The USGS and ASCE 7-22 hazard maps show that the peak ground acceleration (PGA) corresponding to a probability of 2% in 50 years (2475-year return period) is expected to be about 0.25g.[8] Though this level of shaking hazard is not as high as other regions in California, and therefore less likely to pose a threat to ZEV infrastructure due to shaking, the potential for induced flooding consequences make it a serious risk to port operations.

[7] Health and Safety Element. (2020). County of Yolo 2030 Countywide General Plan. Retrieved from: yolocounty.org.
[8] ASCE 7 Hazard Tool. (2022). asce7hazardtool.online.

When considering seismic hazard, levee failure presents the greatest risk to the Port of West Sacramento. Breach to levees at the port or in the region will cause widespread disruption, not only to the community directly impacted by the breach, but to the regional agriculture and fisheries when the breach draws saltwater into the delta from the San Francisco Bay.[9] Recovery may take years to decades, as described in the previous section on Flood.

Additionally, operations at the Port may be impacted by damage to the lifelines on which they depend. Liquefaction in the region can lead to pipe ruptures along water and gas lines, even increasing the likelihood of fires due to gas main breaks and lack of water for fire suppression.

Because many of the consequences associated with regional seismic hazard are coupled with breaches in the levee infrastructure, mitigation strategies include elevating equipment or the site, wet and dry floodproofing equipment, and diverting operations to other ports within the region. In the event of damage to lifelines, maintaining back-up water and power supply on site can prevent disruption to operations dependent on their input. It is also important to properly anchor all critical equipment to prevent overturning or sliding during earthquakes. Operations at the Port of West Sacramento will likely be severely impacted in a regional seismic event, but site hardening and redundant systems can minimize losses and downtime to make the port more resilient to the existing seismic hazards.

4.1.3 Wildfire

In California, wildfires are an annual occurrence. The Port of West Sacramento is in a heavily urbanized area with limited vegetation to serve as wildfire fuels. As such, it is not vulnerable to embers or direct flames from major wildfires. However, smoke from distant fires in the Sierra Nevada have recently caused two "Hazardous" air quality conditions in the past four years in the Sacramento metro area. These are the only known occurrences of such events since records began in the mid-1980s. Power utility companies, like PG&E, use Public Safety Power Shutoffs (PSPS) as a common practice to mitigate wildfire risk during days with favorable conditions for wildfires. The Port of West Sacramento and its surrounding area are not currently identified as a Potential PSPS Area subject to these outages.[10]

Distant wildfires have led to disruptions within the Sacramento Metro area via electricity grid blackouts and wildfire smoke.[11] The interaction of overhead powerlines with high winds and vegetation can initiate wildfires. To mitigate this threat, utilities can invest in grid resilience. However, these upgrades are coming at a cost to rate payers.[12] One study suggests an increase in California electricity rates of 52-83% by 2030 due to grid resilience upgrades.[13]

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[9] Office of Planning and Environmental Review. (2017). General plan: Safety element. *Sacramento County*. planning.saccounty.net.

[10] SPS Planning Map. (2022). https://www.pge.com/en_US/residential/outages/public-safety-power-shuttoff/psps-planning-resources.page

[11] K. Blunt, *Wall Street Journal*, 2021: "PG&E Warns of More Blackouts During California's Wildfire Season," (retrieved from: https://www.wsj.com/articles/pg-e-warns-of-more-blackouts-during-californias-wildfire-season-11623414658).

[12] PG&E electricity and gas bills are slated to jump 9% in early 2022" Mercury News, December 31, 2021. Retrieved from: https://www.mercurynews.com/2021/12/31/pge-electric-gas-bill-jump-early-2022-utility-wildfire-safety/

[13] Hoy and Chhabra, *The Electricity Journal*, 2020: "The impact of wildfires and beneficial electrification on electricity rates in PG&E's service territory."

Wildfires can also damage above-ground power lines. A CEC report found that the probability of wildfire exposure for some transmission lines is expected to increase by as much as 40 percent[14]. Wildfire threats put upward pressure on electricity rates due to supply reductions during times of high demand. Severe wildfire smoke events are also health emergencies for even healthy individuals and could require outdoor workers to stay indoors until air quality improves. Further, wildfire smoke could contaminate agricultural products being stored in silos on site.

Because wildfire hazard in California will likely reduce the availability and quality of the grid's electrical power, mitigation efforts should focus on increasing redundancy in electrical power supply and increasing the amount of back-up power available to the site. Solar power supply may also be diminished in extreme events, which should also be considered in developing a plan to mitigate the risks from regional wildfires.

4.1.4 Extreme Heat

The Sacramento metro area is in a dry summer subtropical climate and experiences roughly four days per year with high temperatures above 103.9°F. According to the 4th California Climate Assessment Report, Midtown Sacramento will likely see a 10-fold increase in this number of days by the end of the century. Prolonged stretches of extreme high temperatures are likely to increase the likelihood of drought and conditions for wildfires,[15] and they may impact the reliability of electrical equipment, especially if not specified appropriately. Indeed, the Sacramento Valley experienced its hottest ever recorded temperatures in September 2022, marking temperatures as high as 115 °F at the Port of West Sacramento on September 5, 2022.

Extreme heat poses threats to both worker safety and port electrification. Extremely hot days can cause heat-related illnesses and may prevent outdoor work during certain times of day, thus interrupting port operations. Workforce safety and compliance with Occupational Safety and Health Administration (OSHA) requirements are a priority for SSA Pacific. During extreme heat experienced in September 2022, alternative schedules for workers were employed. This shift in workforce hours can have implications on costs for SSA Pacific.

Regionally, electricity supply may not be able to keep up with cooling demands during heat wave events. Additionally, intentional blackouts to mitigate wildfire ignition events may reduce electricity supply further. Electric transmission and distribution systems also operate less efficiently at higher temperatures. A 2011 report found that a +9 °F temperature increase will diminish the capacity of a fully loaded transmission line by an average of 7.5 percent. Extreme heat has the potential to impact other electrical equipment, including EV chargers or batteries.

Key tactics to avoiding impacts from extreme heat events include utilities investing in grid resilience, distributed electricity generation, grid-scale battery storage for intermittent sources of electricity, and increased air conditioning capabilities in vehicles and in buildings. Proper

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[14] https://www.energy.ca.gov/sites/default/files/2019-12/Forests_CCCA4-CEC-2018-002_ada.pdf
[15] State of California (2018), California's Fourth Climate Change Assessment Report, "Sacramento Valley Region Report."

specification of electrical and mechanical equipment to provide sustained performance during elevated temperature periods can also support operational resilience.

4.1.5 Drought

Nearly all regions of Northern California are currently in either a Severe or Extreme Drought. Northern California is a chronically water stressed region due in part to large variability of year-to-year precipitation and high demand for water consumption.

Drought conditions have acutely reduced California's hydroelectric power generation capacity, the third largest source of electricity generation. In 2021, electricity generation from hydropower was down 48% from the 10-year average.[16] Drought conditions are already impacting California's power supply. For example, last year the hydroelectric plant at Lake Oroville was shut down for the first time since its opening in 1967, resulting in hydropower becoming less reliable as a sole energy source to power operations. Yolo County has been in Severe to Exceptional Drought (D2 to D4 of US Drought Monitor) since 2020, entering its third year of drought and contributing to lower water levels. This lost baseload generation ability cannot be easily replaced by intermittent sources like wind and solar. This could cause electricity demand to be unmet, leading to blackouts. The marginal cost of Hydroelectric power is also lower than fossil fuel alternatives (like natural gas) and imports from out-of-state. As such, substituting with these sources could raise electricity rates.

Key tactics to avoiding impacts from drought focus on ways to lessen the burden of losing hydroelectric power generation. This includes more distributed electricity, grid-scale battery storage for intermittent sources of electricity, and increased budgets for paying higher electricity costs due to electricity supply constraints.

4.1.6 Conclusion

Electrified operations at the Port of West Sacramento are exposed and vulnerable to natural hazards present in the region, and the Port should consider available mitigation options for existing and future on-site infrastructure. Primary concerns include direct damage from flood and seismic events, which have more than a 1% chance of occurring in a given year, and indirect impacts from wildfire, extreme heat, and drought, related to disruptions in the electricity grid. While public efforts are ongoing to improve the levees protecting the Port of West Sacramento, on-site flood mitigation efforts to defend against levee failure and sea level rise should be considered. To mitigate against electricity grid disruptions, SSA Pacific and the Port of West Sacramento could invest in private on-site electricity generation and storage measures as well as create contingency for higher marginal electricity rates.

4.2 Flexible Infrastructure Pathways

[16] Utility Dive/ K. Balaraman (2022), "California drought could halve summer hydropower generation, leading to more natural gas, EIA finds", retrieved from: https://www.utilitydive.com/news/california-drought-could-halve-summer-hydropower-share-leading-to-more-nat/624489/#:~:text=Around%2041%25%20of%20California%20was,the%20state's%2010%2Dyear%20average.

Flexible Infrastructure Pathways (FIP) is a concept inspired and developed from a method known as Flexible Adaptation Pathways, common in climate adaptation and resilience planning, wherein strategies are explored to mitigate climate change impacts based on potential environmental hazards or natural disasters. Following a similar structure, the FIP process identifies potential ZEV transition routes that SSA Pacific and the Port of West Sacramento could follow over time, considering different infrastructure options and triggers. These navigable pathways account for uncertainties in the zero-emission vehicle transition and recommend the optimal infrastructure solution and/or additional areas of inquiry based on a set of user input parameters.

The full Flexible Infrastructure Pathways Report can be found in Appendix C.

4.2.1 Zero-Emission Vehicle Technology

The SSA Pacific FIP focused on two zero-emission fueling types: battery electric and hydrogen fuel cell electric. These are the two most likely zero-emission fuel types for light-, medium-, and heavy-duty vehicles, though much of the technology for medium- and heavy-duty is under rapid development.

Battery Electric

Battery electric vehicles (BEVs) are the most widely available zero-emission vehicles on the market. Current BEV technology is well suited for light-duty operations where range, either in terms of time or distance, and weight capacity are less of an issue. The BEV market is constantly evolving to provide alternatives for medium- and heavy-duty operations. This applies to on-road vehicles—such as delivery and drayage trucks, vans, shuttles, and buses—as well as off-road specialized vehicles, such as ride-on sweepers and forklifts.

BEVs require specific recharging infrastructure that varies depending on power needs, fleet size, and specific operational profile. Generally, there are three levels of charging stations available on the market today that are classified based on the charging power and, consequently, the approximate charging time. A fourth level of station that supplies one megawatt (MW) of power or more is in development but is not yet commercially available. Fleet operations and charger-type can impact the required quantity of chargers on-site. The FIP tool can accommodate a 1:1 assumed charger to vehicle ratio or be modified based on the operator's preference and infrastructure planning.

Depending on the scale of the fleet, recharging infrastructure for light-duty vehicles can generally be easily installed without major upgrades to the existing power utility network. More substantial infrastructure deployments to support a large fleet could require upgrades to the grid or onsite infrastructure, to be confirmed with the electric utility. Range (and service hours) limitations are one of the most common concerns when transitioning to BEVs, particularly for medium- and heavy-duty (MHD) vehicles. Costs are also an important consideration when transitioning fleet vehicles. Though the capital cost for BEVs is typically higher than gasoline and diesel vehicles, the total cost of ownership (TCO) can be significantly less over the lifetime of the vehicle, as fuel, maintenance and other savings are realized.

Under the current market conditions and given SSA Pacific's fleet make up at the Port of West Sacramento, BEVs have a strong value proposition for transitioning light-duty vehicles. This is applicable to both SSA Pacific's on- road and off-road vehicles. Medium- and heavy-duty BEV technology is still developing, but BEVs are likely to still prove valuable for these segments of the fleet, depending on operational profile. DC fast charging and opportunity charging may not be essential to maintain current operations but could be considered as part of a broader fleet transition plan.

Hydrogen

Though battery electric powertrains are very well suited to many applications, particularly for light-duty vehicles and those without significant auxiliary equipment demands, there is growing interest in hydrogen fuel cell technology, particularly for medium-duty, heavy-duty, and off-road applications. If fueled by green hydrogen (generated with renewable energy), hydrogen fuel cell vehicles (FCEVs) are zero-emission and present many of the same benefits as BEVs, such as quiet operations.

FCEV powertrains offer a solution for many medium-duty, heavy-duty, and off-road fleet operators due to their reduced weight and ability to power auxiliary equipment with fewer impacts to a vehicle's driving range. Refueling times present a significant advantage for FCEVs relative to their battery electric counterparts. Whereas charging times for large capacity batteries can be upwards of multiple hours, hydrogen refueling times are much like fossil fuel refueling and can be done in a matter of minutes.

The FCEV market is significantly more nascent than the BEV market. As of 2022, the number of available and upcoming battery-electric trucks outnumbered hydrogen fuel cell trucks by 23 to 1.[17] There is very limited public hydrogen refueling infrastructure in most markets. In California, which is considered the leader in the US ZEV market and has the highest rate of ZEV adoption, there are still very few public hydrogen stations.

In general, despite the nascency of the hydrogen market, its fast growth and cost-competitiveness with battery electric vehicles for larger fleets suggest that there could be applications for FCEVs for SSA Pacific. Medium- duty, heavy-duty, and off-road vehicles could be particularly well-suited to FCEV powertrains, assuming appropriate models become available. These could include the fleet of 16 forklifts, loaders, and sweeper vehicles currently in operation at the Port of West Sacramento. Hydrogen should continue to be evaluated through the lens of the FIP as a potential solution as part of comprehensive fleet conversion planning due to:

[17] Bloomberg NEF, 2022. Electric Vehicle Outlook 2022.

- The high Gross Vehicle Weight Rating (GVWR) of the forklifts, loaders, and sweeper vehicles, which could limit the suitability of large battery packs.
- The challenging duty cycles of these vehicles, averaging 5 daily operating hours and a peak of 7 daily operating hours, which currently exceeds the capability of most battery-electric vehicles on the market unless sufficient recharge time is built in.
- The Port's proximity to other industrial land uses and large fleet operators, and the potential to leverage co- investment in hydrogen refueling infrastructure.

4.2.2 Flexible Adaptation Tool

Flexibility is critical when planning in the context of uncertainty. While the flexible pathways concept has precedent in climate adaptation planning (i.e., flexible *adaptation* pathways), it is a novel approach to infrastructure implementation. FIP identifies infrastructure triggers over various time horizons to allow SSA Pacific to successfully transition the fleet to ZEV.

Arup developed an excel-based Flexible Infrastructure Pathway Tool, which utilizes a dashboard to take in user inputs about the existing fleet, the future-state fleet, operational constraints, and awareness of the electrical or hydrogen infrastructure that may accommodate a ZEV fleet. These inputs are used across the dashboard to discern early feasibility and effectiveness of vehicle types and charging infrastructure strategies. In conjunction with implications detailed in section 2. Zero-Emission Vehicle Technology, the tool outputs a score for each of the following four vehicle types:

1. **DER Electric:** Electric vehicle charged through Distributed Energy Resources (DER) infrastructure.
2. **Grid Electric:** Electric vehicle charged through the grid.
3. **Hydrogen:** Hydrogen vehicle including fuel cell (FCEV)
4. **Diesel:** Diesel vehicle with an ICE

In addition to scores, the pathways provide relative costs for each fuel type ranging from one to four-dollar signs ($-$$$$). Costs are based on high-level rough order of magnitude (ROM) price of vehicles, fuel, maintenance, and related infrastructure.

A comprehensive understanding of the fleet is critical to assessing infrastructure, triggers, and future pathways. Fuel types can significantly impact vehicle operations and therefore create varying pathways for infrastructure implementation. The FIP tool incorporates inputs including fleet makeup, operational constraints, and electrical infrastructure. Operational constraints focus on impacts to SSA Pacific's business operations. The primary parameters include time horizons for transitioning the fleet, refueling layover time, and vehicle duty cycles. If vehicles are limited in the length of layovers, for example, then refueling may need to occur quickly. This reduces the feasibility of charging electric vehicles, and thus the tool scores Diesel or Hydrogen more favorably. If long layovers are an option for refueling, then grid resiliency is considered. Electrical infrastructure is critical to supporting a fleet transition to ZEV. If grid infrastructure upgrades are required, it could have significant impacts on costs and transition timelines.

Engagement with the local utility is the best way to develop a holistic understanding of the local grid context.

Each category is lastly given a weight by the user out of 100%, based on prioritization of Operational Reliability, Implementation Timeline, or Infrastructure Consistency.

- **Operational Reliability** focuses on minimizing the impact to SSA Pacific's current operations. This will prioritize inputs such as short layovers and more established fueling types.
- **Implementation Timeline** refers to the evolving zero-emission vehicle market and feasibility of transitioning the fleet within a target timeline. Though the market is progressing rapidly, hydrogen infrastructure is less established and there is generally lower availability of specialty hydrogen vehicles. For that reason, if the user is urgently wanting to transition the fleet, then hydrogen would not be the preferred option. For each timeline option, a score has been assigned in the Data Dictionary tab of the tool. These scores can be addressed in future iterations of the tool, as the market context evolves. Though hydrogen is less ubiquitous in 2022, the market may transform by 2025, and the tool may be updated to reflect those changes.
- **Infrastructure Consistency** aims to optimize refueling requirements by first verifying that existing ZEV infrastructure cannot be leveraged. Feasibility of utilizing existing infrastructure is dependent on how many vehicles will be charging concurrently, how many vehicles have transitioned to ZEV, and how many vehicles are left to transition. If the number of vehicles planned for charging more than doubled, then additional infrastructure is required. For additional infrastructure, the tool considers existing grid capacity, if known. Estimated energy demand charging is based on a charging speed of 7 kW, consistent with a Level 2 charger. If the estimated energy demand exceeds the grid capacity or if the grid capacity is unknown but the estimated energy demand exceeds 0.5 MW, then further action is required. This may constitute grid upgrades or distributed energy resources. Users are asked to specify which of these options are feasible and corresponding recommendations are provided. Alternatively, if sufficient existing infrastructure does exist (the fleet size is not being doubled), the fuel type of the existing infrastructure is prioritized to maintain infrastructure consistency.

Outputs of the tool serve to identify feasibility, optimality, and cost-effectiveness. Scoring is defined in the Data Dictionary tab of the tool and can be adjusted per the user's context. Notes are also available in the Data Dictionary tab on how to change values and formulas accordingly. It's advised to review the assumptions that go into the estimations, including charging speed and grid capacity thresholds. This tool functions as a starting framework to demonstrate paths forward that benefit the fleet manager, the operators, and the planet.

The final consideration included in the tool is costs. The FIP tool provides comparative costs ranging from one- dollar sign ($) indicating the least expensive relative option, to four-dollar signs ($$$$) indicating the most expensive relative option. Costs included in the “Costing” tab are a rough order of magnitude (ROM) and can be updated by the user as prices fluctuate in the future or additional cost detail becomes available.

Included in the is vehicle price, estimated fuel costs, and refueling infrastructure costs for each fuel type. Additionally, the costs of battery energy storage systems are included in DER Electric results and the costs of grid infrastructure upgrades are included in Grid Electric results, if triggered.

The FIP Tool can be found in Appendix D.

4.2.3 Port of West Sacramento

The conversion of some current medium-duty, heavy-duty, and off-road vehicles to battery electric powertrains, including forklifts and loaders, is likely to be limited by the weight of batteries required for these vehicles. Thus, hydrogen fuel cell alternatives may be a useful option for SSA Pacific’s fleet. Based on current research, onsite storage or generation of hydrogen is more likely to prove cost-effective (relative to diesel and battery-electric alternatives) for fleets of 50 or more vehicles, when land is available. SSA Pacific currently operates a fleet of 33 on- and off-road vehicles at the Port of West Sacramento. Roughly half these vehicles are light-duty and would be better suited to battery electric powertrains, based on current ZEV model availability. For hydrogen to be cost- competitive for the remaining half of medium-duty, heavy-duty, and off-road fleet vehicles, shared infrastructure or delivered hydrogen would likely be required, as the costs of dedicated hydrogen production and/or storage infrastructure for fewer than 50 vehicles is anticipated to be cost prohibitive. The table below shows the various hydrogen solutions and relative cost depending on the size of the fleet needing to be fueled.

Table 1: Preferred Hydrogen Solution by Heavy-Duty Fleet Size

Heavy-duty fleet size	Preferred hydrogen solution	Relative cost ($/kg)
1-2 trucks	Mobile fueling	High
2-50 trucks	On-site storage and dispersing	Medium
50+ trucks	On-site production	Low

4.2.3.1 Local Hydrogen Refueling Infrastructure

Local hydrogen refueling infrastructure is limited in Sacramento. Though there is a public hydrogen station near the Port of West Sacramento, the station is designed for passenger vehicles, and travelling to refuel would be time-consuming for equipment operators, particularly given that daily fueling would likely be required. Further, off-road equipment may not be licensed for on-road operation, meaning that all fueling would need to be conducted on-site.

Given these limitations, on-site storage and dispensing or on-site production of hydrogen would likely be preferred for the Port of West Sacramento. These solutions would achieve greater refueling reliability and help maintain lower costs (assuming sufficient fleet size). Coordination with other local medium- and heavy-duty vehicle operators would be beneficial to achieve economies of scale and further reduce refueling costs on a per- kilogram of fuel basis.

4.2.3.2 Overview of Onsite Production

Zero-emission hydrogen fuel may also be produced onsite for convenient storage and refueling. This refueling option has a high capital investment but lower annual and fuel costs, as well as the advantage of a conveniently located refueling station and therefore lower fuel wasted on refueling trips.

Hydrogen is produced by electrolyzers, which carry out electrolysis, or the splitting of water. Electrolyzers must be supplied with electricity and purified water to generate hydrogen. The only byproducts of this process are oxygen gas, which is typically and harmlessly vented into the atmosphere, and effluent water, which may be produced if the feedstock water undergoes purification onsite because it is not clean enough for electrolysis. An onsite hydrogen generation and refueling system would consist of the following components:

- Zero-emission power supply
- Electrolyzer array
- Source of purified freshwater
- Gaseous or liquid hydrogen storage modules
- Hydrogen dispensing and refueling infrastructure.
- Balance of plant components

Electrolyzer arrays may be purchased from various manufacturers using one of three market-ready electrolyzer technologies: PEM (polymer electrolyte membrane), ALK (alkaline water), and SOEC (solid oxide electrolyzer cell). Hydrogen gas produced via electrolysis would be stored onsite either in gaseous hydrogen cylinders anywhere from 200 to 700 bar, or cryogenically chilled and stored in liquid form.

The main components of a hydrogen refueling station include hydrogen storage (usually gaseous), compressor, high-pressure buffer storage, refrigeration unit, and a dispenser. Output pressure of the gaseous hydrogen fuel will vary depending on the type of hydrogen fuel cell vehicle.

Renewable energy used to power the conversion of water into hydrogen may either be purchased from the grid or generated onsite. Onsite generation will require a larger capital investment but reduce annual utility bills and fuel costs. Alternatively, purchasing energy from the grid could have a lower capital cost but higher utility bills and fuel costs, provided there's sufficient capacity on the surrounding grid infrastructure to support the added energy demand.

Spatial requirements for a hydrogen facility suitable to refuel a sample fleet of 50 vehicles is shown in the table below. The space need may be assessed as either on-site storage only, which assumes trucked or piped delivery of hydrogen produced off-site or on-site storage + on-site production. The smaller size of the SSA Pacific's fleet at the Port of West Sacramento would reduce this size, but likely not on a pro-rata basis given component size to capacity ratios and component separation.

An alternative consideration to be monitored in future planning stages is the potential for shared infrastructure. If sufficient land space and refueling demands from non-SSA Pacific FCEV visitors to the Port of West Sacramento exist, then the increased investment utilization and economy of scale would further improve the financial basis for the hydrogen fueling options under consideration.

Table 2: Hydrogen Infrastructure Spatial Requirements For 50-FCEV Fleet

	On-site Storage		On-site production	
	Liquid Cryogenic	**Gaseous (350 bar)**	**Steam Methane Reforming**	**Electrolysis**
Space Need	4,800 sq ft	4,000 sq ft	13,300 sq ft	13,600 sq ft

As FCEVs are relatively new in the public eye, there is concern among the public about the safety of these vehicles, particularly with concern to explosions and leakage. Hydrogen has a lower heat of combustion and a wider flammability range than gasoline, which means that it will burn at a lower temperature, and at a greater variety of fuel-air mixtures, than gasoline does. However, FCEV manufacturers have developed safety measures to counteract the risk of combustion in fuel cell vehicles, making them just as safe as conventional gasoline- powered vehicles. Additionally, studies have demonstrated that collisions involving FCEVs typically do not result in leaks. A comprehensive safety plan should be developed for onsite refueling operations, if pursued.

Hydrogen stored onsite at a hydrogen refueling station poses certain hazards. For example, liquid hydrogen is stored at cryogenic temperatures. If the temperature in a liquid hydrogen tank rises above the boiling point of hydrogen, this may cause an explosion. Common safety measures include maintaining safe distances between hydrogen storage and other facilities, additional reliability of backup power to maintain temperatures, and following recommended practices regarding the location, demarcation, and design of hydrogen storage and handling equipment.

4.2.4 Conclusions

To reach its sustainability goals and comply with new regulation, SSA Pacific is striving to transition their fleet vehicles to zero-emission. Converting to ZEV is not a one-size-fits all scenario, however, and requires many considerations. The FIP Tool considers the nuances within a ZEV fleet transition, including vehicle type, refueling constraints, and electrical infrastructure constraints, to provide a relative score for each fuel type that may be quickly and dynamically interrogated to understand planning pathways and sensitivity. It also supports SSA Pacific with uncertainty around transitioning a fleet to zero-emission, such as grid capacity and vehicle maturity. Given these uncertainties and user inputs, the tool provides current and appropriate direction for SSA Pacific and the Port of West Sacramento, prompts questions and risks that need monitoring (e.g., tech maturity), and is dynamic in helping navigate a successful ZEV infrastructure pathway.

In many instances, BEVs are a great solution because this technology is more established and has lower associated costs. BEVs can be charged directly from the grid or from DERs, such as solar paired with battery energy storage. If considering grid-charged BEV, however, SSA Pacific will need to consult with its electric utility and understand if the grid can accommodate a ZEV fleet without upgrades. Should major grid upgrades be required, costs and timeline to transition the fleet could significantly increase.

Hydrogen FCEV is another zero-emission alternative, but the technology is more novice and has higher fuel costs. Given its infancy, the delivered hydrogen fueling network is underdeveloped, so SSA Pacific could consider onsite generation to support its fleet. Hydrogen technology is rapidly evolving, particularly due to government funding driving advancements. As the market develops, the implications of these fueling types could change and the FIP tool, which would be easily updated to reflect these shifts – resulting in a new preferred pathway.

SSA Pacific and the Port of West Sacramento can utilize the FIP tool in the initial decision-making process to consider the optimal fuel type or infrastructure options under various scenarios. The tool further allows SSA Pacific to make quick updates as new knowledge and details become available on technology, fleet operations, and electrical infrastructure. At any given time, the tool gradually charts the best possible path toward achieving ZEV goals, even when the path may need to shift over time. In conclusion, the FIP Tool will serve as a mechanism to score and compare options and financial implications for ZEV technologies and fuel types to ease the decision-making process throughout the ZEV transition.

5 Innovative ZEV Approaches

This section evaluates how SSA Pacific's position as an industry convener could result in the adoption of MHD ZEV technology industry-wide, including the use of shared ZEV infrastructure, the Marine 580 (M-580) inland waterway corridors, and approaches to leveraging LCFS credits to catalyze growth.

5.1 Agricultural Goods Movement Shared ZEV Infrastructure Evaluation

SSA Pacific's fleet vehicles are used in a variety of applications; as a result, the operational requirements vary, but the fundamentals of charging and fueling infrastructure are the same across all equipment and vehicle types with differences seen only in charging modes, rates, and connectors. Vehicles and equipment can charge at a "fast" or "slow" rate, with charging time primarily dependent on the size of the vehicle/equipment battery pack and the charger power level, further limited by the battery chemistry, which may accept only certain power levels depending on its design.

5.1.1 Baseline Charging Assessment

For medium-duty fleet vehicles, Level 2 charging at 32A to 80A (slow charging) is adequate for charging most vehicles in 4 to 6 hours. 50 kW-350 kW chargers are commercially available today, but these charging rates are considered "slow" for the power needs of the terminal equipment and heavy-duty vehicles. At this power level, it would take several hours to fully charge a drayage truck. At 500 kW or more – "fast" charging – the same truck could charge in as little as 30 minutes. If, as expected, the battery capacity of future drayage trucks increases to 400-500 kWh to support longer ranges, the charger power level would need to increase proportionally to 1 MW or more to maintain the equivalent fast charge session time. For overnight charging, when trucks and terminal equipment park for hours, the 50-150 kW "slow" chargers are sufficient.

Terminal equipment can run up to 16 hours a day with few breaks. As a result, charging will need to be maximized during the overnight five-hour shift and provide opportunity charging throughout the day. Overnight charging could take place at a rate of 50 kW, particularly for smaller pieces of equipment, but a rate of 175 kW ensures a healthy state-of-charge in one to two hours, even as battery pack sizes increase. For opportunity charging, 350 kW is the fastest available today, but rates of up to 1 MW, once available, should be deployed.

In order to maximize the efficiency of shared charging infrastructure for these vehicles, a combination of operational practices and software solutions should be implemented. Setting time limits is an operational action that can help free up charging units for additional vehicles. Time limits could also be used at opportunity charging stations for trucks to encourage frequent turnover. Most charging units today also come with robust data-tracking programs and algorithms that enable energy to flow where it is needed most. For example, charging systems can sense when one piece of equipment is reaching a healthy state of charge. It automatically reduces the energy dispensed to that equipment to redirect the energy to a piece of equipment at a lower state of charge. Fleet operators should have access to charging infrastructure dashboards, which will allow monitoring of infrastructure utilization, daily EV electricity usage, kWh/charge session, and other key parameters. For security reasons, EV charging and hydrogen fueling operations are typically monitored, controlled, and data logged by third-party back offices completely independent of Port operations.

5.1.2 Charging Site Assessment

Initially, it is important to develop an operational model that identifies operating issues, costs, fees, and department chargebacks (for a shared facility) that may make a potential charging location ideal, mediocre, or unacceptable.

For overnight charging of terminal equipment, each piece of equipment will require its own charging port in a 1-to-1 ratio. For opportunity charging, it is recommended that roughly 10% of the chargers at a given location be fast-charge capable, at least 350 kW today, increasing to 1 MW in the future, particularly at sites servicing equipment that must get through two full shifts.

For overnight charging of heavy-duty trucks, 50 kW to 125 kW DC chargers are suitable in a 1-to-1 vehicle-to-charger ratio depending on overnight dwell time. For example, shorter dwell times of four hours may require 125 kW DC chargers. For opportunity charging, location is important. Charging stations must be easily accessible to truck drivers, and the site must accommodate the large turning radii of port trucks. Generally, sites that meet the following criteria have the most potential:

- Vacant or already providing truck-serving or other heavy-duty vehicle auxiliary uses, such as a heavy-duty truck fueling station, truck wash, truck stop, or truck repair shop.
- Accommodates trucks without negatively impacting traffic on nearby roads, as it is critical to keep traffic flowing in a busy Port district.
- In close proximity to freeways and truck routes, where trucks regularly pass.
- Far from homes, schools, or other neighborhood uses, where a new source of trucks might constitute a nuisance to neighbors (i.e., install new charging facilities at least 500 feet from residents); exemption for sites that already serve heavy-duty trucks, where a shift to zero-emission trucks could reduce impacts on the community.

For opportunity charging of heavy-duty trucks, the goal is to move the vehicles in and out as quickly as possible, which requires fast charging speeds. Today's electric trucks charge at a maximum rate of 175 kW, but in the near future, trucks may be able to handle up to 350 kW, which will cut charge times in half. In the longer term, charging rates of 1 MW will be needed to serve trucks with larger battery packs in a duration comparable to diesel fueling. Those technologies are under development. Opportunity charging facilities must facilitate easy pull-through access for large trucks and their trailers. An island design, typical of conventional fueling stations, is preferred.

5.1.3 Infrastructure Implementation Incentives

The need for public charging and refueling infrastructure will be proportional to the adoption of ZEVs. Yet, ZEV charging and refueling infrastructure must be deployed at scale in advance of ZEV technologies being deployed to ensure adequate charging and fueling capacity to meet varying duty cycles. While the current demand for ZEV infrastructure is low compared to ICE infrastructure, the many drivers supporting ZEV adoption is changing this. Furthermore, public grants and policies are being made available that subsidize the deployment of ZEV infrastructure, leading to an opportunity to leverage these funds. Despite these funds, infrastructure developments must see adequate utilization to be worthwhile investments. Therefore, the rate of adoption of ZEVs is an important factor when planning the installation of infrastructure to support either EV charging or HFCV refueling.

5.1.3.1 State of California Legislative Action

The state of California has put forward statewide zero-emission targets and implemented legislation to begin advancing the steps required to meet these goals. Most notable for port decarbonization is Executive Order N-79-20 and subsequent CARB Advanced Clean Fleets Regulation, which applies to drayage trucks in addition to on-road class 2b-8 vehicles for "high priority fleets."

These actions aim to bolster EV adoption by mandating public fleets and private industries to begin transitioning to ZEVs on January 1, 2024. The year mandated is specific to the type of vehicle being transitioned and some exemptions are granted where ZEVs are unable to meet the requirements of the vehicle.

This regulation effectively mandates a transition into ZEVs beginning in late 2023. The process of transitioning may be slow at first as owner/operators may choose to extend the remaining useful lives of existing trucks or purchase used equipment in serviceable condition. However, these practices are unlikely to be economically sustainable compared to purchasing new ZEVs.

5.1.3.2 ZEV Adoption Incentives

Beyond the mandated adoption requirements, owners/operators of drayage trucks may be persuaded to purchase ZEVs to take advantage of existing grant and rebate programs. One example is the EV fleet program offered by PG&E. This program offers many rebates, including one applicable to drayage trucks for $9,000 per class 8 electric vehicle. It is important to note that projects are often not eligible once mandated ZEV regulations go into effect, and owners/operators must balance transition priorities and incentives with internal timelines for deployment.

Grants and rebates will likely act as accelerants to overall ZEV adoption. If the impact of these grants exceeds the barriers to transitioning perceived by drayage truck owners, we may see steep adoption beginning as early as 2024. This likelihood is greatly increased by the impressive levels of forthcoming investment and tax credits under the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA), as well as incentives from programs offered by CARB, CEC, utilities, and local air districts. Additional information on funding and incentives available to support ZEV adoption is discussed in Section 2.2.4.

5.1.4 SSA Pacific Initiatives Supporting ZEV Infrastructure Implementation

Beyond the public adoption of ZEVs, other factors may impact SSA Pacific's ability to implement supporting infrastructure. These factors include operational requirements, availability of equipment, success of technologies, and available grant funding to support these investments. SSA Pacific's environmental activities are directed by its parent company, Carrix, Inc. and can be viewed in the annual Carrix Sustainability Report.

5.1.5 Infrastructure Grants

Another factor to consider in planning ZEV infrastructure implementation is grant funding that could be leveraged to lower upfront investment. Some programs available today are set to expire beginning in 2025, in some instances being replaced by larger investment programs. Grant funding programs may be renewed in the future, however, there is always a risk that a project eligible for funds today may not be eligible in a future round of funding. To limit the risk of missing out on grant funding, it may be best to align phase(s) of an infrastructure rollout plan with the funding window of eligible grants, even if planning must be expedited.

The EV fleet program offered by PG&E serves as an example of how impactful this funding may be. For eligible customers, the program offers up to $25,000 for 50.1-149.9 kW chargers and up to $42,000 for 150+ kW chargers. This would result in more than a million dollars of external funding for each set of 24 chargers (150 kW or greater). Similarly, California programs including EnergIIZE, as well as investments from the IIJA and IRA will be able to support all aspects of ZEV charging and fueling infrastructure development, from in-depth planning through to grid modernization and infrastructure deployment. Where possible, infrastructure investments should be aligned with local and regional transportation policies and needs of communities, which can be coordinated with Intelligent Transportation System (ITS) technologies.

5.1.6 ZEV Installation and Implementation Factors

To determine a preferred schedule for the installation and implementation of ZEV infrastructure, there needs to be an alignment between desired infrastructure and the technical requirements of implementing said infrastructure. In this case, the desired infrastructure will be defined by SSA Pacific and regional stakeholders such as the City of West Sacramento and Caltrans, which will align public adoption of ZEVs, environmental targets, and infrastructure grant programs. The technical requirements may include a study to quantify the amount of infrastructure to be phased in overtime, referred to as a ZEV Infrastructure Rollout Plan. However, the technical requirements must include allowances for consultations with stakeholders, permitting, design, procurement, and installation. Common factors contributing to delayed implementation of ZEV charging and fueling infrastructure projects include utility upgrades, permitting, and manufacturing lead times. Close coordination with utility stakeholders and jurisdictions adopting streamlined ZEV permitting processes[18]—such as the City of West Sacramento—can alleviate two of these leading factors.

5.1.6.1 ZEV Infrastructure Rollout Plan (6 to 12 months)

The most effective way to plan the deployment of ZEV infrastructure is to create a ZEV Infrastructure Rollout Plan. For SSA Pacific, this plan needs to include a forecast of drayage ZEV adoption, a breakdown between EVs and HFCVs, a quantification of energy (both fuel and electricity) required to serve the ZEVs, a quantification of on-site infrastructure to support the service, and a high-level cost estimate. The forecast would be performed, at minimum, for each year up to 2035 so that infrastructure deployment phases could be developed. Ultimately, the Rollout Plan would serve as a roadmap to plan infrastructure that is aligned with forecasted adoption of drayage ZEVs and provide an approximation of the investments necessary to implement such a plan. This Rollout Plan will be facilitated through the utilization of the Flexible Infrastructure Pathways Tool developed under the Blueprint.

It is important to note that a holistic plan enables for economies of scale to be leveraged. Some infrastructure required to support EV charging is relatively cheap to deploy to sufficiently support the 100% buildout. Notably, underground conduits, transformer enclosures, fuel

[18] GO-Biz, Plug-in Electric Vehicle Charging Station Readiness. https://business.ca.gov/industries/zero-emission-vehicles/plug-in-readiness/

storage enclosures, and parking areas can be built with the full deployment in mind, such that charging and refueling equipment can be cost effectively installed later. The dates presented below are estimates based on current industry trends. These dates reflect specific times for ZEV rollout activities and do not factor in the implications of funding availability, application, and implementation, which may add lead time that includes review and contracting processes.

5.1.6.2 Permitting, Design, Procurement, and Installation (12 to 24 months)

As discussed above, permitting timelines can greatly influence the ability to rapidly develop ZEV charging and refueling infrastructure. Thus, SSA Pacific and similar stakeholders seeking to deploy ZEV charging and refueling infrastructure should conduct early outreach to their local planning agency to understand whether the jurisdiction has adopted streamlined permitting policies. The cities of Stockton, West Sacramento, and Benicia have all adopted streamlined permitting processes for deploying EVSE. For hydrogen infrastructure deployment, this can include the requirement to develop a Hydrogen Safety Plan, lengthening the process of obtaining authority to construct from the local Fire Marshal and permitting agency.

Procurement lead times are variable and can be influenced by domestic procurement and content requirements such Build America, Buy America (BABA). At the time of publication, many leading EVSE manufacturers are quoting lead times of more than 30 weeks, switchgear manufacturers more than 45 weeks, and electrolyzer manufacturers up to 14 months. Procurement lead times will fluctuate over the coming years as new manufacturing capacity comes online, both domestically and internationally, and demand increases for these technologies. Outreach to manufacturers or their authorized vendors, at least on an annual basis, can help infrastructure developers and fleet operators better align procurement, permitting, construction, and ZEV deployments.

To support these pre-construction activities, it is recommended that stakeholders investigate market lead times through the issuance of requests for information (RFI) or direct engagement with preferred vendors, engineering firms, and local agency stakeholders. Generally, these RFIs should be separated by technology type to ensure a diversity of responses from qualified respondents. If pursuing a single RFI encompassing multiple technologies, respondents should be invited to respond to any relevant sections for with they are qualified, with explicit statements affirming that respondents need not respond to all sections. For example, an RFI dedicated to EVSE could include questions around expertise and production timelines for numerous charging station types, such as Level 2 AC charging, DC Fast Charging, Overhead Charging, Inductive charging, etc. Similarly, an RFI dedicated to hydrogen infrastructure could cover liquid and gaseous hydrogen infrastructure, fast fill stations at various pressures, overnight slow-fill stations, on-site electrolysis, delivered hydrogen (and associated storage tanks), compressors to serve the selected equipment, etc. Developed RFIs should, to the maximum extent possible, also seek detail around solutions and deployment scenarios that can help avoid adverse grid impacts, such as load management and demand response technologies.

The variance in installation timeline expectations can be seen by comparing EV charger installation timelines with the hydrogen refueling installation timelines provided below. The EV charger installation timeline provided by PG&E, shows that they expect the process to last 9 to 13 months from the rebate application submission to rebates being issued. The Hydrogen Station Permitting guidebook, published by the California Governor's Office, shows its expectations for installation timelines to vary between 4 and 24 months, as seen in Figure 2. Notably, the guidebook includes average durations of each stage, which totals at 22 months. This means that the vast majority of hydrogen station deployments require close to two years to be finalized. A key takeaway from both electric and hydrogen station timelines is that they do not include the proceeding work required to define the high-level deployment strategy: site location, size and number of chargers/dispensers, stakeholder consultation and agreements, utility partnerships, and industry partnerships.

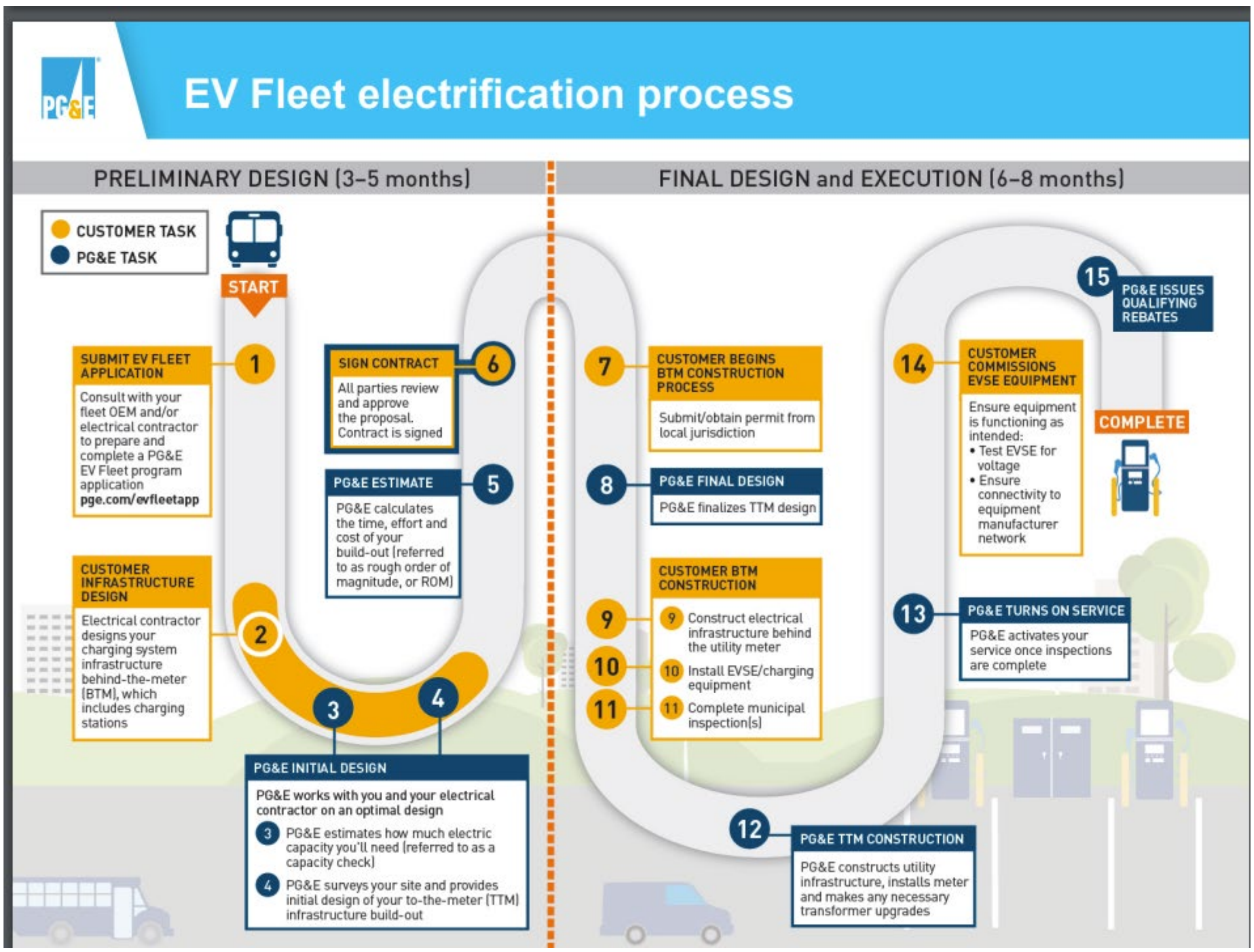

Figure 5: EV Fleet electrification process – PG&E EV Fleet Guide

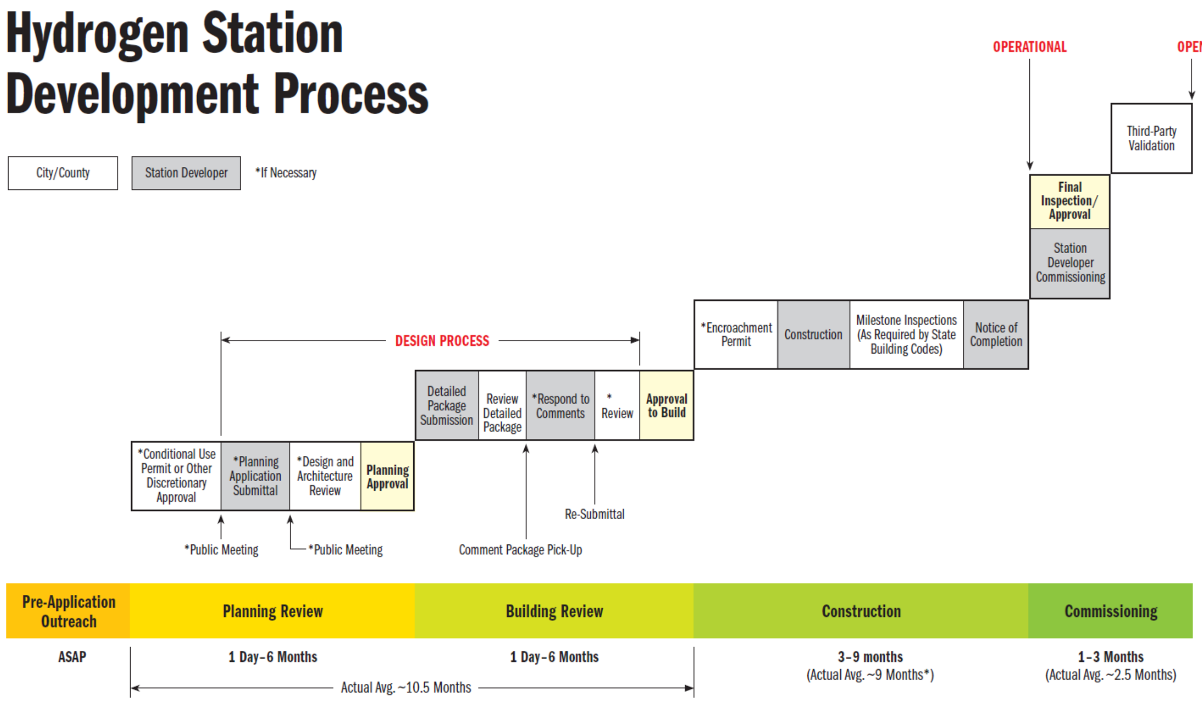

Figure 6 Hydrogen Station Development Process – Hydrogen Station Permitting Guidebook[19]

Given the range of timeline expectations for both EV and hydrogen stations, a general expectation to complete these tasks could be 12 to 24 months. EV stations tend to be quicker to implement, while hydrogen stations take longer. However, there must be recognition that complexity of the infrastructure to be installed will significantly impact the estimated timeline. For instance, if the infrastructure is limited to EV chargers such that no major facility or utility upgrades are required, the installation timeline may be shorter than the expectation listed as little as 3-6 months. For a significantly more complex development, such as the installation of multiple charging and refueling systems which are incorporated into microgrid configuration that leverages battery energy storage systems and on-site generation, the timeline may be longer.

5.1.6.3 Stakeholder Consultations

For any infrastructure project, it is important to engage stakeholders early in the process to identify any conceptual red flags and ultimately lower any risk of delays. In the case of SSA Pacific, the primary stakeholders are the City of West Sacramento and other local port authorities, electrical utility (PG&E), and prospective hydrogen providers.

The City of West Sacramento will be critical for approving the use of the land for SSA Pacific's desired developments, the electrical utility will need to provide sufficient power to the site, and

[19] https://static.business.ca.gov/wp-content/uploads/2019/12/GO-Biz_Hydrogen-Station-Permitting-Guidebook_Sept-2020.pdf

the hydrogen providers will be required to source the fuel if SSA Pacific chooses not to produce hydrogen on-site.

5.1.6.4 Port Authority Consultations

SSA Pacific is a Port tenant, meaning that all infrastructure investments must be made in coordination with the local Port authority—the City of West Sacramento for the Port of West Sacramento. The Port of West Sacramento is an important partner and financial supporter in collaborative infrastructure investments. Transparent communication and partnership on infrastructure developments planning will be key to project success.

5.1.6.5 Electrical Utility Consultation

SSA Pacific will need to collaborate with the electrical utility to determine if sufficient power can be provided on-site and if any grid improvements will be required to support the phased infrastructure installations. This consultation has the highest potential of introducing red flags and bottlenecks for EV chargers, as most if not all energy will be sourced from the utility.

It is recommended that SSA Pacific consult with PG&E to ensure that expectations for the project are aligned. It is also recommended that SSA Pacific provides a high-level estimate of the power and energy required as soon as possible, so that the utility has a quantifiable information to compare with its network. Ultimately, PG&E will need a list of infrastructure to be installed or ZEV Infrastructure Rollout Plan to completed to finalize approvals and agreements regarding the developments.

These consultations sessions are also an opportunity to address the following factors:

- Determine if the utility plans to implement EV friendly policies and pricing in the near future. This may impact the business case and anticipated usage of the infrastructure.
- Determine the utility's plan for decarbonization. This may impact SSA Pacific's environmental targets for decarbonization as electricity use is a Scope 2 emission counted in SSA Pacific's carbon inventory.
- Quantify any necessary investment and time necessary to implement grid improvements that will support SSA Pacific's ZEV infrastructure rollout.

5.1.6.6 Hydrogen Provider Consultations (if Applicable)

SSA Pacific will need to conduct consultations with hydrogen providers if hydrogen is pursued in the ZEV rollout plan. These consultations will address the following factors:

- Identification and introduction to hydrogen suppliers.
- Investigation of hydrogen availability in the context of the ZEV rollout plan.
    - Determine what color hydrogen it is: black, brown, blue, green, etc.
- Negotiations of $ per unit hydrogen agreements.

5.1.7 Potential ZEV Infrastructure Sites

The Port of West Sacramento is located near one of the most congested traffic areas in the Greater Sacramento Region: the junction of I-80, Business 80, and US-50. The Port, located along Industrial Blvd, is accessed via two exits, Harbor Boulevard (Westbound Exit 1B, Eastbound Exit 1) and Enterprise Ave (Exit 81). There is regular traffic congestion along Harbor Blvd due to the substantial amount of logistics facilities in the area, creating substantial challenges and delays for nearby residents, local employees, and logistics operators.

When considering the placement of infrastructure at the port to support a ZEV transition, it is important to categorize the vehicle types by their needs. In the context of this Blueprint, these categories include port and tenant owned vehicles and equipment that operate on-site, and vehicles owned by IOOs and trucking carriers that visit the port. Each of these vehicle categories will require support based on the rate that ZEVs are adopted and what mix of ZEV technology is selected between BEV and HFCV. The infrastructure implemented to support each vehicle category, however, will need to be coordinated across the port, both in terms of location and in terms of category being served. This is because, regardless of its purpose, each piece of ZEV supporting equipment and infrastructure will share electrical capacity allocated by the utility. Any allocated capacity used to support one category of infrastructure cannot, with limited exception, be used to support other categories.

The possible locations for this infrastructure have been listed in Figure 3 below.

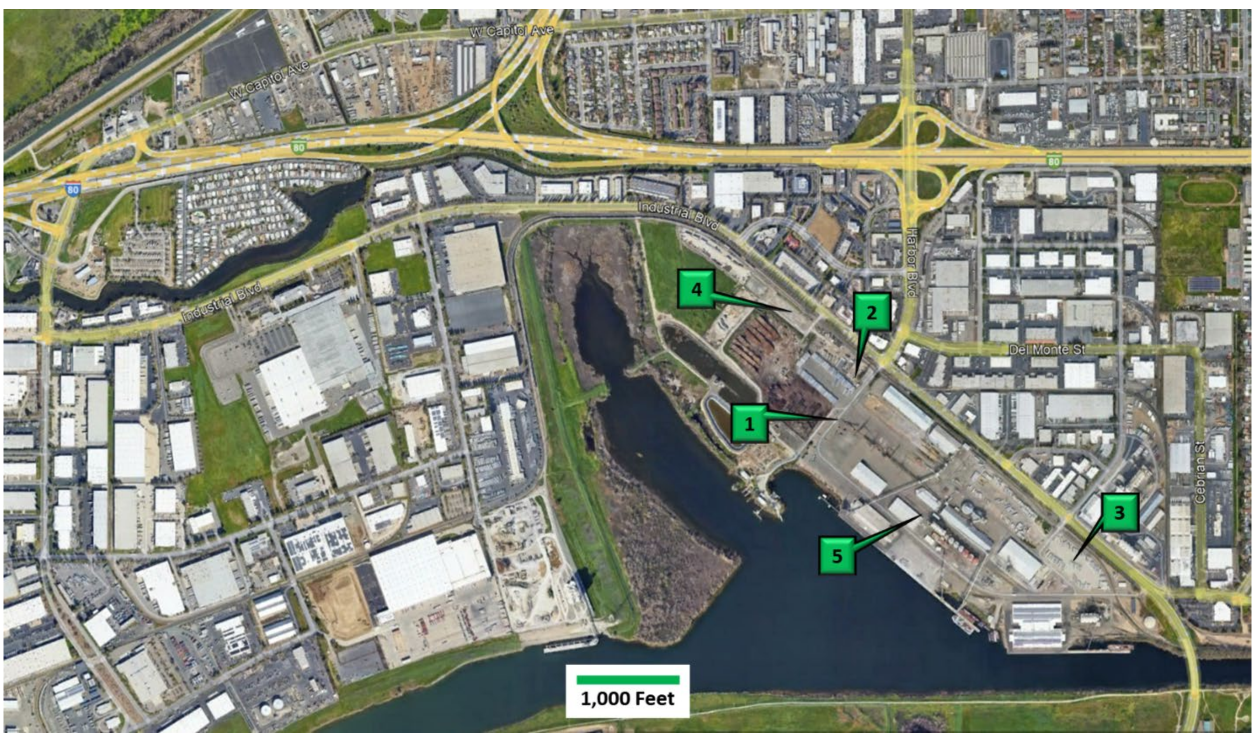

Figure 7 Potential locations to install ZEV infrastructure at the Port of West Sacramento

The location and opportunity of each location is listed below:

1. This location is the primary processing location for vehicles accessing the port through the primary access located at the end of Harbor Blvd. This location experiences long dwell times for port visiting vehicles, which could be optimal for charging. There is ample space to locate the charging equipment and infrastructure necessary to provide port visiting vehicles with many chargers. The challenge in that almost all local trucking is conducted via Harbor Blvd., making the access to this location of the port congested due to traffic competing for use of the Blvd.
2. This location is the primary port access located at the end of Harbor Blvd. This location leads to the primary processing location (location 1), meaning that most port visiting vehicles move through this space to access the port. Due to the nature of the location, vehicles experience a short period of dwell time at this location. Consequently, there is potential to install opportunity charging at this location to provide most MHD vehicles visiting the port with charging services. If done with an inductive charger, there would be no physical connection required to enable charging. The challenge is that the function of the location necessitates high vehicle throughput, meaning that any charging performed would have a very limited duration as prolonged stoppages would block traffic.
3. This location is an alternative access point that is located directly across from Terminal St. It currently does not see as much throughput as vehicles visiting the port are routed through the Capitol City Freeway which deposits traffic onto Harbor Blvd. Accessing this location is only most convenient for vehicles using the Jefferson Blvd from the South. There is an opportunity to incentivize vehicles visiting the port to take the less direct route to access the port from this location by installing ZEV supporting infrastructure. The challenge is that this location is not easily accessible, meaning that rerouting vehicles may lead to more congestion and difficulty of vehicles attempting to visit the port. Furthermore, vehicles visiting the port may prefer accessing the previous location, leading to dissatisfaction among that stakeholder group.
4. This location is a third access location which utilizes Boathouse Road. This location has limited access to the broader port as it predominantly focuses on delivering lumber products – which are stored in a segregated portion of the port. There is land available for development in this area which could support a larger footprint of ZEV supporting infrastructure – whether it be a bank of chargers or a hydrogen refueling station. The limited access to the location may be a challenge for port visiting vehicles to access. However, a redesign of the port access area may be able to better facilitate the more complex movements of vehicles moving between the processing area, refueling area, and port access checkpoints.
5. This location, in the center of the port, is used to unload product into the grain husk elevators. There is potential to use this location as a rapid charge location that could be utilized each time port staff take a break. This location is best suited to support Port and Tenant vehicles. The challenge is providing operators with meaningful charging opportunities to prevent disruptions in operations.

6. The last consideration is a distributed charging approach. This approach would not be limited to one location; rather, any locations that have repeated dwell times could be equipped with an opportunity charger. The charging strategy for this approach would be to charge vehicles as they perform their regular operations without adding any delay. The charging durations in this strategy could be very short, which are best enabled using wireless (inductive) charging. The challenge with this approach is identifying appropriate locations and providing electrical infrastructure to supply each piece of charging equipment.

Each of these locations have strengths and weaknesses in terms of providing ZEV supporting infrastructure. The process of determining which location, or mix of locations, is the most optimal will need to consider multiple factors. This type of assessment is best suited to a scoring matrix where the port will be able to work with stakeholders to identify scoring criteria, the relative weights of the criteria, and what score should be assigned to each possible solution.

5.1.7.1 Port Visiting Vehicles ZEV Infrastructure Requirements

The first step in determining the ideal allocation of ZEV infrastructure to be installed is to quantify the amount of energy that needs to be recovered. For vehicles visiting the Port, this value can be found by multiplying the number of ZEVs expected to be visiting the port each day by the average energy deficit to be recovered at the Port.

When considering the number of ZEVs expected to visit, it is important to know that value is going to evolve over time. Due to legislative requirements, all of the vehicles visiting the Port will need to be converted to ZEVs by 2035, however, a forecast is required to plan the transition in each year. A further complication is that IOOs and carriers have the choice of adopting BEVs or HFCVs, each of which require different supporting infrastructure.

When considering the amount of energy to be recovered by each ZEV the approach can be more straightforward. Ultimately, the energy required to travel to and from the Port is directly proportional with the distance traveled. If the Port is able to quantify this distance using surveys or a study of shipping origins, an energy consumption assumption can be applied. This should enable the port to understand volume of daily kWh and H2 kg consumption by each ZEV type.

The scale of this energy need will inform which infrastructure deployment strategy will be best suited to the needs of vehicles that visit the Port. For instance, the use of location 2 for an opportunity charge may result in high utilization of the equipment, however, the amount of energy recovered by each BEV may be insufficient to return to its origin. This would be indicative that a strategy relying on location 2 would need to be supplemented by additional charging locations to support BEVs.

The analysis of where to place HFCVs infrastructure is more flexible than BEVs due to the shorter refueling times. The needs for HFCV tend to support larger, more centralized, refueling infrastructure. In this case, a refueling station would still need to be sized for the volume of demand expected, however, since the single location would be a high frequency visit for HFCVs, it is more important to consider the impacts on vehicle circulation within the Port. Furthermore, if a single refueling station for HFCVs is planned, special consideration should be given to how any potential Port or Tenant owned vehicles and equipment will access refueling.

5.1.7.2 Port and Tenant Owned Vehicles ZEV Infrastructure Requirements

The Port and tenant owned vehicles at the Port have unique charging and refueling requirements. The duty-cycle of this equipment involves continuous operations for eight (8) hour shifts at a time. The challenge continues in that there is little idle time when transitioning from one shift to the next. In the case of BEV equipment, it will have limited time to charge without impacting operations.

These factors stress the importance of optimizing locations for charging infrastructure to maximize their utility and to minimize their downtime. To maximize the utilization, the fleet must assess where vehicles are most likely traveling, at what point in their route they need charging, and how much time they can allocate to recharge. Most of these questions can be answered with data analytics that include origin-destination, dwelling time, and trip length information. Terminals work in shifts that limit the available charging windows. The narrow charging windows emphasize the need to develop charging and fueling solutions that maximize minimal idling or parking time and maximize driving time.

Using the operation characteristics that makeup the duty-cycle of these vehicles, potential solutions can be devised. Based on the potential locations identified by the Port, there are likely two approaches to consider in more detail. The first would be to use a static set of high-power chargers at location 5, which could allow vehicles to quickly recharge during staff breaks and shift changes. Alternatively, the dispersed approach described for location 6 could be used to provide vehicles with opportunity for charging during operations. A mix of these two approaches will likely best serve any battery electric vehicles and equipment used by the Port and its tenants.

To evaluate the potential effectiveness of the location 6 approach, some specific locations and dwell times will need to be identified. This will form the basis of how much energy can be restored as Port and tenant battery electric vehicles and equipment perform operations. A separate assessment will need to be performed to understand if all the vehicles and equipment owned by the Port and its tenants will be able to access these locations. A potential approach for this would be to equip vehicles with GPS locators, if not already equipped, then performing a heat-map analysis to understand which locations have the most dwell time – time that could be used for mid-operation opportunity charging. It is possible that some vehicles have duty cycles that do not reliably return to potential locations for charging equipment. In this case, the Port may consider a new approach to charging, adjusting the duty-cycle of the vehicles and equipment with little charging access, or opting to use hydrogen fuel-cell vehicles and equipment.

Additional considerations when assessing potential locations for charging equipment include the availability of grid interconnections and electrical capacity to serve each location. These potential barriers may limit the Port's ability to install the appropriate equipment without incurring significant costs to implement the required changes. Therefore, once potential sites are identified the next step should be an assessment of the on-site connection and grid capacity. Integration Capacity Analyses and supporting distribution system maps are often one of the most useful tools to assess the appropriateness of a location with respect to grid capacity and interconnection availability.

The approach necessary for hydrogen refueling is comparatively less complex. If vehicles have overnight idle periods in assigned parking locations, there would be an opportunity for slow-filling hydrogen overnight. The mileage range of hydrogen vehicles means that they likely wouldn't need midday refueling. Furthermore, a hydrogen refueling station will be required to serve port visiting vehicles, meaning that any vehicles owned by the Port or its tenants would have easy access to fast refueling. Relatively inexpensive adjustments to the refueling station may allow for dedicated locations for Port and tenant vehicles and equipment to refuel, which may be a more flexible and convenient option that also has lower cost.

Once each feasible solution has been identified, the key performance metrics of each should be determined. These may include metrics such as cost to implement, cost to operate, lead time to install, system resiliency, system risk, impact to operations, flexibility to use different technologies/vehicles in the future, emission reductions, and other desired metrics. Each of these metrics should be given a relative weight that is reflective of the Port's strategic values. Using a scoring algorithm, each potential solution can be ranked at a high level to guide the Port in deciding which solution is most optimal for its operations.

5.1.8 Equipment Standards in the ZEV Industry

In the context of ZEV infrastructure, the creation of standards in this industry has been critical in defining a baseline level of service for consumers while enabling innovative interactions between equipment and technology. The standardization of communication protocols has allowed diverse products from a variety of OEMs to work together in providing a higher level of service. For instance, not only are connector ports on BEVs are compatible with charger connectors, but the two systems are able to negotiate an appropriate charging level that works between them. Furthermore, a management software may be able to manage hundreds of these charging interactions to manage peak demand by adjusting the rate of charge for select vehicles. These types of emergent functionality empower consumers and fleet managers to maximize the benefits of these technologies. Figure 8 shows how standards in the ZEV charging infrastructure industry connect the various components involved in supporting ZEV operations.

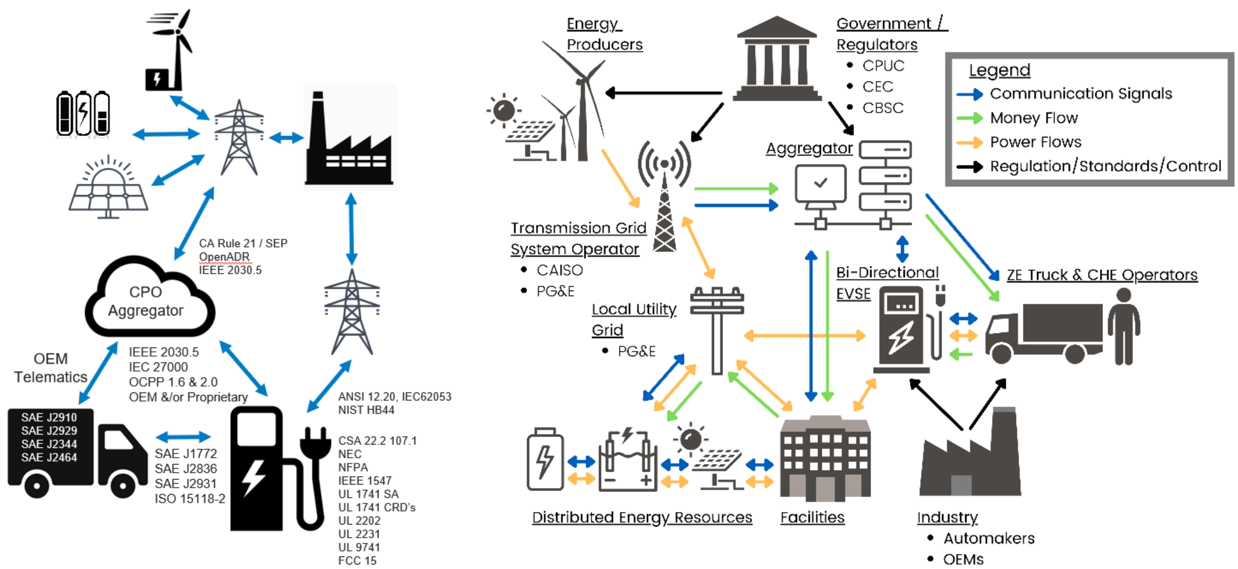

Figure 8 Common standards and communication interconnection in the ZEV Infrastructure Industry

When viewed in aggregate, the number of standards may seem overwhelming, but each aims to specify the requirement of specific components. To demonstrate this, a sample of standards are summarized below in simple terms:

- SAE standards refer to the connectors between ZEVs and Chargers. This ensures that vehicles are equipped with the correct receivers to be charged by chargers using the same standards. The various numbers indicate the type of connector specified in the standard. Put simply, there is a separate SAE standard for plug-in, pantograph, and wireless chargers.
- UL standards specify which materials to be used in equipment are appropriate and list testing procedures to ensure safety.
- OCPP1.6 and OCPP2.0 are communication protocols that allow management software to monitor ongoing charging functions and adjust operations to meet the needs of the user/network.
- OpenADR aims to standardize, automate, and simplify the interaction of Demand Response (DR) and Distributed Energy Resources (DER) with the grid.

5.1.8.1 Common MHD BEV charging connectors

All chargers need an interface to connect with vehicles to transfer energy. Between plug-in, pantograph, and wireless/inductive connection types, plug-in connectors are the most common due to their low cost and high energy transfer efficiency.

Figure 9: Plug-in, pantograph, and wireless/inductive connection types

These connectors can be categorized by the type of power that they use to transfer energy. The first type is Alternating Current (AC), which is divided into level 1 and level 2 charging. All battery technologies store energy using Direct Current (DC), which necessitates power transformation. This is accomplished in EVs using an onboard converter to transform the AC power provided by a charger into DC power required by the battery. This means that vehicle charging speeds are limited to the lower speed between the charger and the converter. In the context of BEVs, AC chargers are referred to as 'slow chargers' even for personal vehicles with relatively small batteries. For the purposes of supporting MHD BEVs, AC chargers are likely to be insufficient even when used for overnight charging.

DC fast charging, sometimes referred to as level 3 charging, is different in that the power provided by the charger is provided in the transformation required by the battery. This is done by through a connection within the vehicle that bypasses the onboard AC converter. This allows DC fast chargers to surpass the onboard converter's limited capacity to charge the battery at much higher speeds. The CCS Type 1 connector is becoming the most common industry standard in North America. This standard utilized single phase charging and supports charging up to speeds of 350kW. An additional benefit to using this connector is that it is simply Type 1 J1772 connector with additional pins to enable DC charging. Therefore, BEVs using CCS Type 1 have the flexibility of using AC charging if required. The problem for MHD BEVs used for long distance travel or used for extended operating hours is that they have limited charging time. Class 8 BEVs used to ship goods to and from the port may require more than two (2) hours of charging to recover 80% of their battery when using a charger sized as high as 250kW. For this reason, the industry is looking to develop charging standards to cater to the class 8 trucking segment with charging speeds above 1,000kW or one megawatt (1MW).

5.1.8.2 Vehicle-Grid Integration (VGI) Standards

Vehicle-grid integration (VGI) is an innovation that is whose potential impact is growing alongside the accelerated adoption BEVs. The innovation is defined by the CEC as "technologies, policies, and strategies for electric vehicle (EV) charging which alter the time, power level, or location of the charging (or discharging) in a manner that benefits the grid while still meeting drivers' mobility needs". The first element of this definition refers to managing the time and intensity of charging, which is a common strategy implemented for BEV fleet operators who aim to reduce their peak demand and take advantage of lower tariff periods. This charge management is sometimes referred to as 'smart charging' and technically is included in the CEC's definition of VGI. However, the reason that VGI has been developed as a concept separate from charge management is because of the potential for bidirectional charging. This includes vehicle-to-home (V2H) and vehicle-to-grid (V2G) technologies that can fundamentally change the interaction between energy consumers and utilities. In the past, consumers only had control over the time and intensity of their consumption, but with VGI any consumers that own a BEV are able to participate in providing the grid with energy. Furthermore, unlike renewable energy sources, the batteries used in vehicles can control when and at what intensity energy should be provided to the grid. This provides an alternative to utilities who are looking to manage peak demand periods, as rather than installing utility sized battery energy storage systems (BESS), individual consumers with enabled VGI capabilities can provided these functions.

The applicable standard for VGI interactions is ISO15118. This standard allows bidirectional chargers to take energy from a connected vehicle for use in the home/facility or on the grid. The rate of energy withdrawn will be limited to the charger being used and the battery equipped by the vehicle. These technologies rely on communications with other systems to understand which times are appropriate for energy to be used in this way. Furthermore, to ensure that vehicles are still able to provide serve their primary function of transportation, the systems need to understand when the vehicles will be used and what level of charge will be required.

5.1.9 Innovative Energy Applications

California has made incredible strides in decoupling emissions from economic growth, yet much of this success has come at the price of rapidly growing reliance on the electric grid for all aspects of life and industry. This expanding reliance on the electric grid carries increased risks in the face of rolling brownouts, blackouts, and Public Safety Power Shutoffs (PSPS). The costs of outages take various forms including lost output and wages, spoiled inventory, impaired access to emergency services, delayed production, inconvenience, damage to the electric grid, and loss of life. Today, wildfires pose the greatest threat to California's electric grid, and therefore to broad electrification. Wildfire damage over the last 40 years has cost California a total of $63.8 billion, compared to $21.9 billion across the rest of the nation. In 2020 alone, wildfires destroyed over 10,000 structures and cost over $12.1 billion in damages. To address electric power system ignition of wildfires, PSPS events have been used by the electric utilities in California during Red Flag fire weather events, which have resulted in multi-day outages for millions of customers, particularly those in high-risk zones. Cumulatively, wildfires and power shutoffs expose the vulnerability of all Californians, requiring resilient electric solutions for critical societal and business functions. Currently, mobile or stationary diesel gensets are commonly used for backup power, but these have two major limitations. First, the designs are limited to specific distribution system scenarios that constrain where they can be deployed, such as a particular system voltage, range of load (real and reactive power), phase balance, and dynamic characteristics. Second, the designs are polluting and noisy. Recently, some ratepayers have begun adopting battery and solar PV solutions for clean, quiet backup, but these solutions remain too expensive and bulky to reliably support multi-day outages for many customers. Most customers lack backup power altogether and have economic hurdles to adoption, particularly in remote or disadvantaged communities and low-income communities. A future solution to this growing series of problems with grid reliability is the use of VGI technologies to leverage the on-board energy storage of California's growing EV population. In the near future, VGI technologies will support critical facilities and infrastructure and vulnerable communities for multi-day outages and will also be able to utilize existing (fixed) renewable resources which have been already invested to extend this capacity.

5.1.10 Hydrogen Station Safety Plan

Beyond the fuel itself, hydrogen refueling stations are also home to electrical infrastructure and are planned to accommodate FCEVs onsite. This presents additional hazards relating the fuel cells, high voltage circuits, and vehicle high pressure tanks.

Examples of safety systems that can mitigate these hazards include pressure relief valves, hydrogen detectors, and fire suppression systems which aim to prevent leaks, fires, and explosions. However, these systems fail to address broader concerns with lack of public education, first responder training, and mechanisms for continuous improvements. Therefore, hydrogen station safety plans are required to ensure that risk mitigation is comprehensive.

Ultimately, the role of permitting agencies is to ensure that hydrogen refueling stations are safe. The HSP Guidebook explains the public expectation for hydrogen stations to be held to a standard that is safer than conventional fuel stations. To achieve this the HSP outlines high level activities necessary and refers project teams to the Hydrogen Safety Panel (HSP) for details. Notably, a third-party review performed by the HSP is required by the CEC to qualify for grant funding opportunities.

A foundational element to address is the lack of exposure to hydrogen vehicle and refueling technologies. This means that outreach is necessary to educate the public, occupants of neighboring properties, and local emergency services. A strong communication strategy is key in ensuring that anyone who could be impacted by the project is aware of the risks. The outreach is also an opportunity to introduce the benefits of the technology to the community.

The first step in creating a safety plan is the identification of project specific stakeholders. For an installation project, these stakeholders typically include hydrogen equipment suppliers, facility operators, maintenance/repair providers, local safety authorities. In terms of SAA's hydrogen station deployment, this group should also include the port authority and the local electrical utility.

Equipment manufacturers tend to work closely on hydrogen implementation with project leads and regulatory agencies. Manufacturers and experts in the field of hydrogen safety should be engaged early in the transition process to ensure that the safety plan properly addresses all potential risks and impacts to personnel, equipment, and the environment. The scope of work, as outlined by the HSP, should include:

- Reviewing designs with the intent of approving or assisting with the approval of the project
- Assisting with the identification of safety vulnerabilities and development of mitigation plans
- Inspecting the installation
- Investigating and lessons learned reporting for incidents and near-misses.
- Safety-related change management issues

HSP provides a Safety Plan Template that is representative of the elements that must be addressed in the plan. However, the template is not exhaustive. Individual projects may have unique considerations which require addressing and incorporation into their safety plans.

5.1.11 Conclusions

SSA Pacific's transition towards zero emission vehicles, equipment, and infrastructure opens up opportunities for shared infrastructure for both on- and off-road applications. This report identified actions necessary for the implementation of MHD ZEV infrastructure, including an assessment of needs, relevant policies, and industry standards. SSA Pacific's fleet vehicles are utilized in numerous applications, resulting in a variety of operational requirements. However, the fundamental needs for charging and fueling infrastructure will remain relatively consistent across equipment and vehicle types.

Many federal, state, local, and internal incentives exist that will support and facilitate SSA Pacific's transition to zero emission operations. Notably, the State of California's Advanced Clean Fleets Regulation will effectively mandate a statewide transition to ZEVs for fleets under the regulation's scope beginning in late 2023. There are many new and expanding funding programs, including those allocated in the IIJA and IRA, that will support a more seamless industry transition. Further, SSA Pacific has identified internal environmental targets aiming to reduce emissions and improve air quality at port operations.

The installation and implementation of ZEV infrastructure is largely dependent on organization objectives, technical needs, and industry standards. The development and deployment of a ZEV rollout plan will require dedicated stakeholder outreach to port authorities, electrical utilities, hydrogen providers, and other relevant industry groups. This Blueprint identified six potential sites as optimal locations for shared MHD ZEV infrastructure at the Port of West Sacramento, though ultimate decision making will depend on further criteria assessments and stakeholder consultations.

Regarding the potential for shared infrastructure, the standardization of equipment across the ZEV industry allows for consistency across communication protocols among many OEMs.

Overall, the deployment of ZEV vehicles, equipment, and infrastructure at the Port of West Sacramento will create opportunities for shared infrastructure and industry collaboration, align with existing industry trends and standards, and ultimately benefit SSA Pacific's operations.

5.2 ZEV M-580 Benefits Assessment

The America's Marine Highway Program (AMHP) is an initiative led by the United States Department of Transportation (USDOT), Maritime Administration (MARAD) to fund projects that alleviate traffic congestion on the nation's interstate highway system by diverting cargoes to the nation's 25,000-plus miles of navigable waterways. Established under the Energy Independence and Security Act of 2007 (Pub.L. 110-140) as the Short Sea Transportation Program, the program now provides up to $15 million on an annual basis—subject to annual appropriations—to projects that "offer a waterborne alternative to available land-side transportation services using documented Vessels."[20] As a result of the program, MARAD has designated 29 sections of the nation's navigable waterways and coastal waters as Marine Highways, corresponding to the major highway arteries they parallel (e.g., I-5 and M-5). California is a potential beneficiary of two Marine Highway designations: the M-5—spanning the entire coast of California and extending to the Aleutian Islands in Alaska—and the M-580—spanning from the entrance of the San Francisco Bay to the Ports of Stockton and West Sacramento. Notably, the Marine Highways Program has the potential to be a major contributor in the battle against climate change and reducing transportation emissions as the movement of goods by barge and vessel has been founded to be eight times more fuel efficient than over-the-road trucking and up to twice as fuel efficient as moving goods by rail, both on a ton-mile basis.[21] Notably, waterborne transportation is also the safest mode of transportation, resulting in only .01 deaths per billion ton-miles as compared to 0.84 deaths for trucking and 1.15 deaths for rail. As one of California's three major container ports, the Port of Oakland induces an average of 3,182 daily truck trips, the vast majority of which utilize highway routes that parallel the M-580.[22] In addition to these public health and safety benefits, a recent study out of Lawrence Berkeley National Lab found that all vessel routes under 550 nautical miles will become economically viable to operate on battery-electric vessels as soon as battery costs come down to $100/kWh.[23] That study also found that further cost efficiencies and improved cargo capacities could be achieved by installing maritime charging networks or battery swapping facilities at key points along the feeder route, enabling reduced battery sizing.

While an M-580 container-on-barge service briefly operated in 2014, this network has encountered numerous challenges that limit the ability to deliver an economically viable alternative to rail- and truck-based goods movement.[24] Foremost among these challenges are

[20] Pub.L. 110-140 (2007), at 1760.
[21] Comparison of Shipping Modes, Tennessee-Tombigbee Waterway (2013). Available at https://web.archive.org/web/20130503023308/http://business.tenntom.org/why-use-the-waterway/shipping-comparisons/.
[22] Dike Ahanotu, M-580 Corridor Multimodal Freight Network Optimization Study (Aug. 2021), Figure 2-16 at Pages 22-3. CPCS Ref: 18416.
[23] Kersey, J., Popovich, N.D. & Phadke, A.A. Rapid battery cost declines accelerate the prospects of all-electric interregional container shipping. Nat Energy 7, 664–674 (2022). https://doi.org/10.1038/s41560-022-01065-y.
[24] These challenges are further discussed in the M-580 Corridor Multimodal Freight Network Optimization Study (Aug. 2021) (See, Note 4).

the variable costs of fuel, availability of shoreside cargo handling infrastructure and equipment, and the ability to identify and secure revenue-generating cargoes for each direction of transit. With the maturity of the LCFS Markets, this paper seeks to understand whether operating an M-580 container-on-barge service would be made more economically viable if powered by battery-electric technologies in order to avoid fuel price volatility. As a common operator at the Ports of Oakland, Stockton, and West Sacramento, SSA Pacific could coordinate with shippers, freight forwarders, and longshoremen to identify and assign cargoes that could be diverted to the envisioned barge system to avoid truck trips and related emissions. This ability to coordinate across labor and shippers will help address two of the leading challenges that lead to the failure of the prior M-580 barge service.

The M-580 Study evaluated the economic viability of deploying various diesel-powered container-on-barge services for the M-580 Corridor with varying frequency of port calls (weekly, twice per week, or three times per week) across three categories of barge service: 1) Small Barge; 2) Similar Barge to Previous M-580 Service; and, 3) Roll-on/Roll-off (RO/RO) Barge Service. Ultimately, the Study found that there were very few options under which the barge service would be economically viable in the first 10-20 years of operation. Indeed, only two "optimistic" models demonstrated the ability to achieve profitability within that time frame, neither of which included the RO/RO barge service.

5.2.1 LCFS Revenue Potential from an Electric M-580 Barge Service

In addition to the benefits identified in the M-580 Corridor Multimodal Freight Network Optimization Study, an electric barge service would elevate the potential to completely eliminate harmful emissions from goods movement while generating as much as $750,000 in annual revenue from LCFS credits. For this assessment, LCFS credit calculations have been run for six scenarios in which each route.

The assessment assumes a flat 30-hour round-trip transit time between the Ports of Oakland, Stockton, and West Sacramento, yet Scenario 1 (e.g., A1, B1, C1) envisions this service occurring twice per week while Scenario 2 (e.g., A2, B2, C2) envisions the service on a weekly basis. The assessment provides estimations of credit values based upon selling Credits at $50 and $200 to generate low and high dollar value revenue forecasts. Due to the unknowns surrounding the ultimate Energy Economy Ratio (EER)[25] to be awarded to any barge deployed in this service, the assessment evaluates three EER scenarios:

- Vessel A assumes an EER of 2.6 as currently defined for eOGV, representing electricity dispensed for shore power or cold ironing of oceangoing vessels.
- Vessel B assumes an EER of 3.8, representing a mid-range efficiency currently assigned to electric forklifts.

[25] EER is the dimensionless Energy Economy Ratio (EER) relative to the baseline fuel (e.g., gasoline, diesel, or jet fuel.

- Vessel C assumes an EER of 5.0, the highest EER currently in the LCFS regulation which currently represents heavy-duty on-road vehicles.

As shown in Table 3, below, a vessel service calling once per week at the three ports (Scenarios A2, B2, and C2) could generate between $75,791 and $382,060, annually. Conversely, a vessel calling at all three ports twice per week (Scenarios A1, B1, and C1) could generate between $151,581 and $764,120, annually.

	Credit or Deficit Generated Per Unit (MT)/Unit	Total Credit or Deficit Generated (MT)	High $ Value Per Unit	Low $ Value Per Unit	High $ Value for the Fleet	Low $ Value for the Fleet
Vessel A1	3,031.6	3,032	$ 606,325	$ 151,581	$ 606,325	$ 151,581
Vessel A2	1,515.8	1,516	$ 303,163	$ 75,791	$ 303,163	$ 75,791
Vessel B1	3,550.7	3,551	$ 710,137	$ 177,534	$ 710,137	$ 177,534
Vessel B2	1,775.3	1,775	$ 355,069	$ 88,767	$ 355,069	$ 88,767
Vessel C1	3,820.6	3,821	$ 764,120	$ 191,030	$ 764,120	$ 191,030
Vessel C2	1,910.3	1,910	$ 382,060	$ 95,515	$ 382,060	$ 95,515

Table 3: Potential Credit Generation for Vessel Scenarios

Blue Cells: User Entered Information Orange Cells: Calculated Information Green Cells: Calculated Results		Baseline Vehicle/Equipment Information					
		Average Annual Hours of Operation	Baseline Fuel Type (Drop-Down Menu)	Estimated Fuel Consumption (gal/hr)	Estimated Baseline Unit Fuel Consumption (gal/yr/unit)	Estimated Baseline Fleet Fuel Consumption (gal/yr)	Estimated Baseline Fleet Fuel Energy Usage (MJ/yr)
Vessel A1	1	3,120	Diesel	125	390,000	390,000	52,443,300
Vessel A2	1	1,560	Diesel	125	195,000	195,000	26,221,650
Vessel B1	1	3,120	Diesel	125	390,000	390,000	52,443,300
Vessel B2	1	1,560	Diesel	125	195,000	195,000	26,221,650
Vessel C1	1	3,120	Diesel	125	390,000	390,000	52,443,300
Vessel C2	1	1,560	Diesel	125	195,000	195,000	26,221,650

Table 4: Baseline Assumptions for Credit Calculations (1/3)

	Alternative Vehicle/Equipment Information						
	Proposed Fuel Type (Drop-Down Menu)	Proposed LCFS Equipment Type	Estimated Alternative Fleet Fuel Equiv. Quantity Usage		Estimated Alternative Fleet Fuel Equiv. Quantity Usage		Estimated Alternative Fleet Fuel Energy Usage (MJ/yr)
Vessel A1	Electric	eOGV	5,602,917	(kWh/yr/unit)	5,602,917	(kWh/yr)	20,170,500
Vessel A2	Electric	eOGV	2,801,458	(kWh/yr/unit)	2,801,458	(kWh/yr)	10,085,250
Vessel B1	Electric	Electric Forklift	3,833,575	(kWh/yr/unit)	3,833,575	(kWh/yr)	13,800,868
Vessel B2	Electric	Electric Forklift	1,916,787	(kWh/yr/unit)	1,916,787	(kWh/yr)	6,900,434
Vessel C1	Electric	EV Truck or Bus	2,913,517	(kWh/yr/unit)	2,913,517	(kWh/yr)	10,488,660
Vessel C2	Electric	EV Truck or Bus	1,456,758	(kWh/yr/unit)	1,456,758	(kWh/yr)	5,244,330

Table 5: Baseline Assumptions for Credit Calculations (2/3)

	$CI^{XD\ Standard}$	$CI^{XD\ Reported}$	$CI^{Alt\ Fuel}$	EER^{XD}	$E^{XD\ Displaced}$	E_i	
	(g/$MJ_{Baseline}$)	(g/$MJ_{Baseline}$)	(g/$MJ_{Alt\ Fuel}$)	($MJ_{Baseline}$/M)	($MJ_{Baseline}$/yr/Unit)		
Vessel A1	89.15	31.34	81.49	2.6	9	3.6	(MJ/kWh)
Vessel A2	89.15	31.34	81.49	2.6	9	3.6	(MJ/kWh)
Vessel B1	89.15	21.44	81.49	3.8	14	3.6	(MJ/kWh)
Vessel B2	89.15	21.44	81.49	3.8	14	3.6	(MJ/kWh)
Vessel C1	89.15	16.30	81.49	5	18	3.6	(MJ/kWh)
Vessel C2	89.15	16.30	81.49	5	18	3.6	(MJ/kWh)

Table 6: Baseline Assumptions for Credit Calculations (3/3)

5.2.2 M-580 Corridor Multimodal Freight Network Optimization Study

While there have been multiple successful demonstrations of battery-electric ferries, the development of zero-emission container-on-vessel systems remain nascent around the world, with only a handful of demonstrations currently underway in the Netherlands, Norway, and China. These systems are demonstrating the viability of at-berth charging and battery-swapping while also proving the safety, operability, and durability of emerging zero-emission vessel technologies. Still, these demonstrations remain largely limited in their service, with the longest forecasted service range being limited to 120 miles—sufficient to meet the demands of the M-580 service. Moreover, as drag is a coefficient of speed and vessel shape and depth, the efficiency of zero-emission vessels, like all vessels, is greatly impacted by the vessel's size, hull form, cargo capacity, and desired operating speeds. Thus, drawing direct comparisons against forthcoming zero-emission barge and inland waterway liner services is an inexact science. Yet, for purposes of this study, generalizations will be made to assume approximate energy/fuel consumption as relates to capacity and distance as compared against the following publicly available data on the four emerging zero-emission barge systems.

Project	**Country**	**Cargo Capacity**	**Vessel Length (ft)**	**Max. Distance Travelled Between Charge (Miles)**	**Battery Capacity (kWh)**	**Charging Rate (kW)**	**Charging Method**	**Delivery**
Guangzhou Shipyard Intl.[26]	China	2,000 MT	231	50	2400	1200	Plug at Berth	Oct-17
COSCO Yangtze[27]	China	700 TEU	393	650	57600	TBD	Battery Swap	Oct-23
Yara Birkeland[28]	Norway	120 TEU	263	10	6800	TBD	Plug at Berth	Apr-22
Alphenaar[29]	Netherlands	104 TEU	295	75	4000	1600	Battery Swap	Sep-21

Table 7: Comparison of Announced Zero-Emission Inland Waterways Vessel Services

While the weights of cargoes to be moved by the three battery-electric container vessels has not been disclosed, this assessment assumes a standard unit for purposes of estimating energy

[26] *Fully electric cargo ship launched in Guangzhou*, China Daily (Nov. 2017). Available at https://www.chinadaily.com.cn/business/2017-11/14/content_34511312.htm.
[27] *COSCO Building Battery-Powered Electric Containership for Yangtze*, Star Concord (Mar. 2022). Available at https://www.starconcord.com.sg/cosco-building-battery-powered-electric-containership-for-yangtze/.
[28] *MV Yara Birkeland*, Yara (2023). Available at https://www.yara.com/news-and-media/media-library/press-kits/yara-birkeland-press-kit/.
[29] *First emission-free inland shipping vessel on energy containers in service*, Port of Rotterdam (Sep. 2021). Available at https://www.portofrotterdam.com/en/news-and-press-releases/first-emission-free-inland-shipping-vessel-on-energy-containers-in-service.

consumption. With the maximum weight limit per TEU container being 28 tons or 56,000 lbs., this assessment assumed the average TEU to be 70% laden in order to standardize calculations. Additionally, these calculations assume that the proposed battery systems only ever experience an 80% depth of discharge. For the Guangzhou Shipyard vessel, a bulk commodities barge dedicated to moving coal, the proposed system demonstrates a potential 45.65 kWh/ton-mile of cargo moved.[30]

5.2.3 Technology and System Combinations

Battery-electric technologies are the primary zero-emission system currently being proposed to enter commercial vessel service around the world, yet there are multiple technology arrangements for these systems offering differing tradeoffs. The two leading energy storage solutions for these battery-electric barge systems are at-berth charging and swappable battery systems. The choices behind these two systems are diverse, including considerations for grid infrastructure, utility rate structures, availability of real estate near the berth, vessel turn times, and cargoes. Beyond charging considerations, additional technical factors—including battery chemistry, motor efficiencies, hull form, and propulsion systems— will greatly influence economic, environmental, and technical performance. These latter technical factors are best addressed during the vessel design and construction process.

5.2.4 Charging Infrastructure: Opportunities for Optimization

Two major advantages of swappable battery systems are the ability to charge at lower rates over longer periods of time and maintain a shoreside battery energy storage system (BESS) upon the vessel's departure, both of which enable greater optimization with the grid and innovative utility rate structures. The ability to charge at lower power over longer periods of time mitigates potential need for substantial infrastructure upgrades, enabling greater flexibility in siting cost-effective deployments of charging infrastructure. Similarly, the flexibility provided by charging over longer periods of time enables charging to be interrupted to support grid stability without negatively impacting vessel operations. As the vessel departs, shoreside BESS can be utilized as a grid resource, providing voltage regulation, load following, demand response, load balancing, and other beneficial grid interactions, enabling additional opportunities to increase revenue and resilience. These swappable battery systems can also be integrated with local microgrid controllers to achieve maximal benefit to local energy systems by acting as a dispatchable resource.

Opportunities for grid optimization are reduced but not eliminated when batteries are permanently installed aboard the vessel and reliant upon cross-dock charging infrastructure. Vessels have varying turn times depending upon multiple factors, including cargo types, means of loading and discharging cargoes, and cargo capacity. With larger vessel deployments, targeting capacity in the hundreds to thousands of TEU, turn times would likely be multiple days and allow for the at-berth vessel to engage in the same grid services as battery swapping systems. Smaller vessels, such as roll-on/roll-off vessels, used in chassis-based operations may

[30] Fuel efficiency on a ton-mile basis is calculated by multiplying the mass of cargo in tons by the fuel economy and then dividing by the total fuel consumption. For the TEU comparison, calculations assume the theoretical maximum weight capacity of 56,000 lbs. per TEU.

be able to achieve turn times under 24 hours, limiting the ability to interrupt charging or utilize the vessel's batteries for grid services, such as participating in demand response events. With permanent battery systems, the grid benefits offered by swappable battery systems are eliminated while the vessels are under way, transiting among regional port terminals. Yet, permanent charging systems at multiple ports could be established with standardized charging connectors to allow for multiple vessel services to utilize the charging infrastructure and increasing competition among waterborne operators.

5.2.5 Innovative MHD Charging and Hydrogen Refueling Options

In addition to the two leading charging systems for battery-electric barge services, there is ongoing discussion across the heavy-duty goods movement sector around using liquid hydrogen as a transportation fuel. While liquid hydrogen does appear to have promising potential as an energy carrier for longer duty cycles, there have been no deployments to date of liquid hydrogen-powered vessels in the maritime sector. Thus, current literature around existing and near-term zero-emission barge deployments is limited to the design considerations around charging infrastructure.

5.2.5.1 Battery Swapping

As discussed above, battery swapping has higher capital costs due to the additional investment in duplicate battery systems—enabling one or more sets of batteries to be charging on shore while the vessel is underway—as well as the requirement for a crane capable of loading and unloading the batteries from the vessel at each port of call. Yet, this upfront capital cost could be partly offset by the shoreside batteries being used for grid balancing and load serving purposes (e.g., demand response, peak shaving, frequency regulation, grid islanding, load following, etc.), enabling greater charge-discharge cycles on the system for economically beneficial uses. Moreover, the shoreside battery systems can be charged at lower rates, reducing the demand on the grid as well as the capital costs associated with the need for larger and more costly grid infrastructure upgrades such as transformers, switchgears, and substations. The proposed charging system for the shoreside batteries could be integrated with a local or community microgrid, enabling the battery assets to provide resilience to port and industrial operations as well as for the communities nearest to the ports of call.

While there are numerous benefits to the grid and local electricity consumers, the battery swapping system requires more real estate to be dedicated to the charging system than would be required of a cross-dock charging solution. As port real estate is highly valuable, often constrained, and primarily dedicated to revenue generation through tariffs levied on cargoes moved through the port facility, this dedication of land to the charging infrastructure could slightly impact some cargo operations and port revenues. Where available real estate and laydown areas near the dock, berth, or quay are limited, a cross-dock charging solution may be more beneficial and avoid larger distances over which swappable batteries must be transported between the vessel and the charging system.

5.2.5.2 Cross-Dock Charging

Cross-dock charging mimics many aspects of existing electric vehicle charging. Indeed, some prospective project developers are evaluating whether standardized charging connectors, such as CCS and MCS (Megawatt Charging Standard), could be deployed to support charging standardization for the industry. Yet, the few battery-electric vessel deployments made to date have primarily utilized proprietary charging connectors, oftentimes provided or designed by the developer of the vessel's battery energy storage system (BESS). To date, ABB and Cavotec represent two of the leaders in cross-dock charging solutions, each having demonstrated their systems across multiple battery-electric ferries currently operating in commercial service. ABB's solution, *Shore Connection*, offers both manual and automated connection systems, with the automatic connection offering charging rates up to 7.2 MW and the manual connection offering charging rates up to 10.3 MW—both far higher than commercially-available battery systems are currently rated.[31] Cavotec offers its Automatic Plug-in System (APS) which is integrated with Cavotec's MoorMaster system, a vacuum-based mooring solution that eliminates mooring lines and ensures the vessel remains stationary within a set tolerance level to avoid damaging the charging infrastructure. The Cavotec APS is rated at 4400A @ 1100V DC, achieving a theoretical maximum charge rate of 4.84 MW, sufficient to meet the charging needs of every battery-electric vessel deployed to date.

As discussed above, the primary benefits to cross-dock charging are the minimization of real estate dedicated to charging infrastructure and the reduced capital costs of purchasing additional swappable batteries. Moreover, cross-dock charging infrastructure enables a future standardized solution to be deployed that would enable multiple vessel types to utilize the shared infrastructure, supporting broader decarbonization in the maritime sector. The greatest downside of dedicated cross-dock charging is the risk of demand charges and adverse grid impacts associated with bringing online multiple Megawatts of intermittent load. Yet, this challenge can be addressed through the deployment of a microgrid-coupled charging system that is supported by a stationary BESS or even relies upon power sharing from existing battery-electric cargo handling equipment (CHE) and vehicles operating at the port through Vehicle-to-Grid (V2G) solutions. Thus, as comprehensive analysis should be undertaken to compare real estate, grid capacity, power quality, component costs, and opportunities for future shared infrastructure utilization when determining the optimal charging solution to deploy.

5.2.6 Project Partner and Stakeholder Responsibilities

The successful deployment of a waterborne trade network between the Ports of Oakland, Stockton, and West Sacramento will necessitate substantial collaboration and coordination among diverse stakeholders. The prior M-580 barge service received significant subsidy supporting startup costs yet was unable to secure sufficient cargoes to cost-effectively operate the service beyond the second year of operations. To overcome this, stakeholders must coordinate across all phases of designing and implementing the service, to enable a timely,

[31] *Short Sea Solution*, ABB (2023). Available at https://new.abb.com/marine/generations/technical-insight/short-sea-solution.

cost-effective M-580 service. Critical aspects of project design and implementation across which responsibility (R), accountability (A), consultation (C), and information (I) have been identified include: planning and permitting; funding and finance; construction; cargo commitments; promotion of the service; operations; and workforce readiness. Table 6, below, provides RACI chart showing the roles key stakeholder groups will need to undertake to enable the successful deployment and long-term operations of the M-580 vessel service.

	Planning & Permitting	Funding & Finance	Construction	Cargo Commitments	Promotion	Operations	Workforce Readiness
Government Agencies	A	A	C	C	A	I	R
Port Authorities	A	A	A	C	A	A	C
Vessel Service Operator(s)	R	R	R	R	R	R	A
Technology Developers	C	C	A	I	A	C	A
Infrastructure Developer(s)	R	R	R	I	C	C	C
Terminal Operator(s)	C	C	C	A	A	A	A
Utilities	A	C	A	I	I	C	C
Cargo Interests	I	I	I	R	R	A	I
Financial Institutions	I	A	C	I	C	I	I
Consultants	A	A	A	I	C	I	C
Community-Based Organizations	C	I	I	C	C	I	C

Table 8: RACI Chart for M-580 Cargo Service

5.2.6.1 Government Agencies

Government agencies will have diverse interests and roles to play in supporting and enabling the successful establishment of a waterborne freight network serving Northern California via the M-580 marine highway. Government transportation planning entities (U.S. Department of Transportation, Maritime Administration, Caltrans, and metropolitan planning organizations) are critical to ensuring adequate infrastructure, investment, and standards are established to enable the regular, safe, and efficient operation of the M-580 service. These transportation agencies are well-positioned to provide technical and financial support as well as encourage regional transportation industry stakeholders to utilize the M-580 service. Lead environmental and energy policy agencies including CARB, CEC,, U.S. Environmental Protection Agency, U.S. Department of Energy, and local air districts) will be relied upon to establish policies and provide financial support to establish a zero-emission service, considering—and hopefully quantifying—the environmental, public health, utility, and societal benefits achieved by the M-580 service. Moreover, these agencies can be supportive of the service being permitted by coordinating with local planning agencies in an advocacy manner to ensure the many benefits of the service can be realized. Lastly, agricultural, workforce development, and economic development agencies (U.S. Department of Agriculture, U.S. Economic Development

Administration, California Department of Food and Agriculture, and the Governor's Office of Business and Economic Development) can support the service by advocating for local and regional stakeholders to avail themselves of the M-580 goods movement corridor.

5.2.6.2 Port Authorities

Port authorities likewise will play a critical role in the successful development of the M-580 service as they maintain the ability to provide incentives or specialized cargo tariffs to enhance the service's financial viability. Moreover, as regional cargo convenors, ports can play an integral role in identifying cargoes that are well-suited to be diverted from trucks to the M-580 service. Port authorities will also be key to coordinating with other government agencies to develop a comprehensive funding strategy to offset the capital costs of re-establishing the M-580 service. In addition to these roles, the port authorities would also play a direct role in the issuance of permits of authority to construct and operate the M-580 service. Notably, port authorities are also well-positioned to support workforce development initiatives and also engage with local community stakeholders to identify challenges and opportunities that will make the M-580 service deliver maximal benefits to a broader swath of Californians.

5.2.7 Vessel Service Operator(s)

The vessel service operator will be the de facto responsible party in most situations and a knowledge and skilled organization will be required to successfully develop and operate the system cost-effectively. The vessel service operator may likely be a joint venture consisting of many of the stakeholders mentioned in this section due to the complexity, costs, and risks associated with operating various aspects of the system (e.g., vessel, workforce, infrastructure, and cargo contracts). The prospective vessel service operator will be responsible for coordinating all parties throughout the process of developing the M-580 service and will need to work particularly closely with terminal operators and cargo interests to ensure the reliable cargo throughput necessary to generate sufficient revenues to maintain the service. Vessel service operators will be responsible for purchasing or fabricating an electric vessel and making final determinations associated with technology types to be integrated, ports of call, scheduling of the vessel, crewing the vessel, and ensuring all partner and contractors are advancing their respective efforts in a timely manner.

5.2.7.1 Technology Developers

A diverse array of viable technology developers will need to be engaged to develop the proposed zero-emission M-580 vessel service, from onboard systems to shoreside charging infrastructure and freight scheduling. A major challenge with emerging technologies is often encountered as the project developer seeks to integrate the series of systems, components, and services to achieve operational success. Where early-stage technologies are to be integrated, the project developer should coordinate closely with its consultants to evaluate the viability of technology integration while also coordinating with standards bodies (U.S. Coast Guard, local Fire Marshals, and the American Bureau of Shipping (ABS)) to ensure the proposed technologies will not adversely impact the vessel's seaworthiness, insurability, or ability to operate safely and reliably under all conditions. Due to the many technology configurations that could be deployed, it is critical that both trusted and prospective technology developers and vendors be rigorously vetted to ensure the various systems will be interoperable and support the cost-effectiveness of the M-580 vessel service.

5.2.7.2 Infrastructure Developers

As has been well-established in the on-road electrification space, there can be no battery-electric vessel service absent the availability of robust charging infrastructure. Thus, prospective infrastructure developers will be a critical lynchpin to the success of the service and must be held to the highest standards to ensure the systems and infrastructure deployed are reliable, well-integrated, and cost-effective. The infrastructure developer should be engaged during the selection of final technology deployments to ensure familiarity with the various systems and their requirements. Additionally, infrastructure developers will be expected to coordinate closely with all permitting bodies (local permitting agencies, Fire Marshals, utilities, etc.) to ensure the timely delivery of project infrastructure.

5.2.7.3 Terminal Operators

Terminal operators could provide a unique angle of support to the envisioned M-580 service due to their regular engagement with cargo interests and their direct relation to managing cargo throughput at various ports. Terminal operators will have to coordinate with the prospective vessel service operator, infrastructure developer, and port authority to ensure any infrastructure deployed would not adversely affect their ongoing cargo handling operations or critical cargo laydown areas. Moreover, the terminal operators should be closely engaged in the design of the infrastructure to maximize efficiency of cargo handling operations during the loading and unloading operations for the M-580 service. Terminal operators can also provide substantial support in workforce development initiatives to ensure there is a reliable and qualified labor pool to support stevedoring operations in a low-carbon future.

5.2.7.4 Utilities

Utilities will be tantamount to the success of the M-580 service by supporting the timely delivery of electrical capacity for any future charging infrastructure as well as coordination with technology developers to ensure any systems interacting with the grid are properly certified and safely interconnected.

5.2.7.5 Cargo Interests

Cargo interests—including Cargo Owners, Cargo Brokers, and Freight Forwarders—must be closely involved in the design and continued operation of the future marine highway vessel service to ensure adequate cargoes are booked for all voyages. As a key missing component in the prior deployment of the M-580 barge service, cargo interests coordinating with producers, shippers, and terminal operators will maximize waterborne cargo throughput and be capable of balancing tariffs to make the service closer to price parity with over-the-road trucking.

5.2.7.6 Financial Institutions

Financial institutions will provide the primary line of capital to implement the project, reducing their outlays only where grants and incentives are made available to offset upfront costs. With a variety of innovative financing mechanisms being developed, prospective financial institutions should be capable of navigating the world of loans, liens, bonds, carbon credits, ship financing, systems-as-a-service financing, and other financing arrangements. Financial institutions should likewise act as a backstop to ensure proper alignment and eligibility among various funding sources.

5.2.7.7 Consultants

Consultants can support on a wide array of project deliverables and planning activities, from funding and finance to design, engineering, and construction. A diverse range of consultants should be engaged to ensure the full spectrum of services and project development tasks are well-rounded, adequately evaluated, and professionally implemented. Consultants should be engaged to vet funding and financing opportunities and engage in advocacy efforts to secure capital to support the timely and cost-effective deployment and operation of the M-580 service. Other consultants should be engaged to support technology assessment and validation, ensuring all proposed systems would provide for an advanced, reliable solution. Consultants will also be able to support identifying potential project partners and cargo interests that could commit to utilizing the M-580 service in the future. Lastly, consultants can also support the development of strategies and programs to maximize the impact of community engagement, community benefits, and workforce readiness and development activities.

5.2.7.8 Community-Based Organizations

Community-based organizations are key to developing strong local and regional support for the project while also engaging in activities advancing workforce readiness and development. Community-based organizations should be engaged early to gather local buy-in, ideally identifying local community champions that will support the project and gather additional buy-in from local and regional stakeholders. Community stakeholders should be kept informed of progress on developing the M-580 service, enabling them to understand areas for improvement and collaboration that enhance the multitude of benefits that will be achieved once the M-580 service is realized.

5.3 Low Carbon Fuel Standard (LCFS) Opportunity Report

CARB implements and administers the LCFS program, which was launched in 2009. It is designed to reduce GHG emissions in the on- and off-road transportation sector, which is responsible for about 50 percent of GHG emissions and 80 percent of ozone- forming gas emissions in the state. This program also transforms and diversifies the fuel pool in California to increase renewable energy usage and achieve air quality benefits.

Nearly identical programs, such as Oregon’s Clean Fuels Program (CFP), Washington’s Clean Fuel Standard (WA-CFS), and British Columbia’s Low Carbon Fuel Standard (BC-LCFS) are additional geographies implementing similar approaches to address their jurisdictional GHG reduction goals.

Collectively referred here as LCFS, these programs were designed to encourage the use of cleaner, low- carbon transportation fuels. These programs encourage the production of fuels which reduce greenhouse gas (GHG) emissions and decrease petroleum dependence in the transportation sector. Standards are expressed in terms of the “carbon intensity” (CI) of gasoline and diesel fuel and their respective substitutes. Low carbon fuels below the benchmark (such as electricity) generate credits, while fuels above the CI benchmark generate deficits. Credits and deficits are denominated in metric tons of GHG emissions and are transacted on a private market.

Electricity supplied to zero-emission forklifts, cargo-handling equipment, refer units, and on-road vehicles, among other technologies, are eligible as a low-carbon fuel consumers and able to generate credits. Credit generation is relative to the quantity of electricity supplied to the equipment. For electric forklifts, electricity consumption can be estimated based on a variety of fleet and business operation variables. Every quarter, data is gathered, reports are developed and submitted, credits are generated, transacted, and transferred, and payments are issued to credit- generators.

5.3.1 Deployment Evaluation

The following deployment evaluation is based on provided OEM equipment selections, duty-cycle estimates, and EVSE quantity and capacity. It also includes values of projected clean fuel program market pricing, as estimated by e-Mission Control, industry standard estimates, and other relevant company or program data. All values are subject to change and can vary widely between equipment, deployment timelines, and a host of other external factors. Closer to formal project TCO analysis determination, a subsequent in-depth analysis should be conducted when more granular data is available. This deployment evaluation is based on recent averages of LCFS Credit & Renewable Energy Certificate (REC) prices, with sensitivity analysis shown below.

Evaluation Summary: e-Mission Control estimates this zero-emission technology deployment to generate a total ten-year project credit value of approximately $2,584,932.

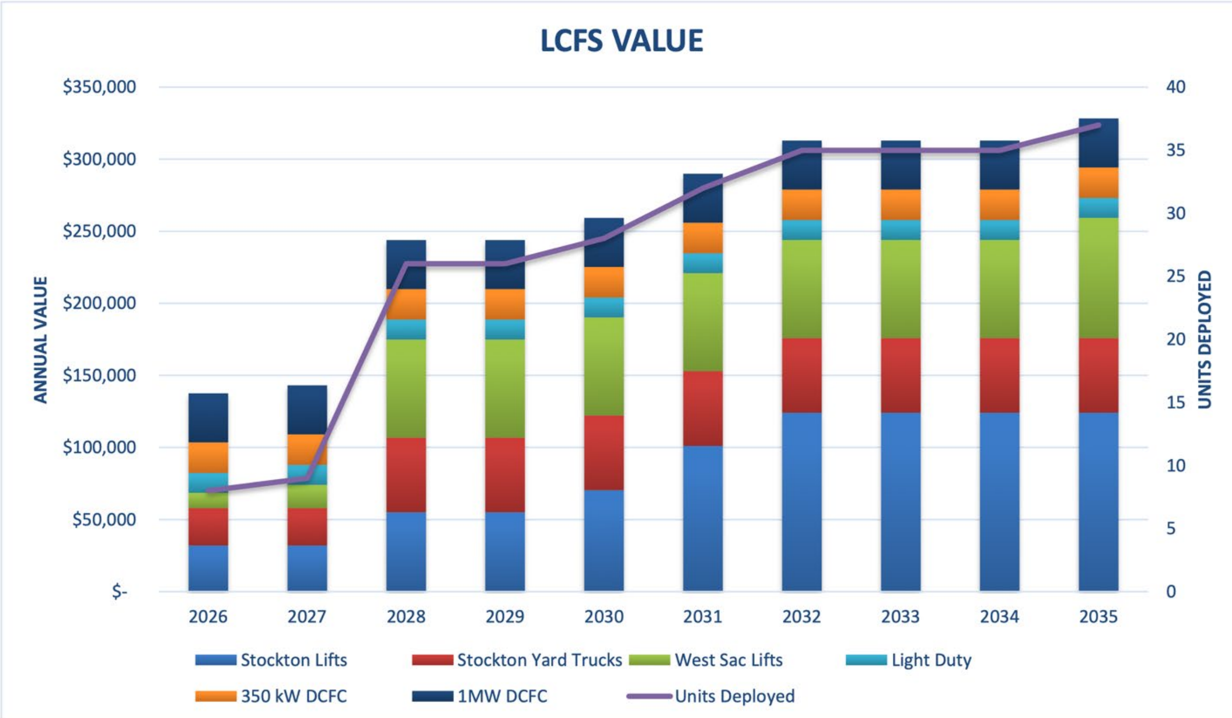

Figure 10: LCFS Value Evaluation Summary

Assumed Variables and/or Sensitivity Factors:

1. 2 350kW and 2 1MW DCFC systems installed co-located at one site.
2. No major co-location of solar or other ability to generate Renewable Energy Certificates (REC's)
3. LCFS FCI Capacity Crediting Cap has not yet been reached (about 15% of the cap has been awarded as of late-2022).
4. No other grant funding utilized for DCFC deployment on EVSE or infrastructure (CARB will only credit for out-of-pocket- expenses).
5. Energy consumption of eBulls at SSA Pacific yards based on past consumption of currently-deployed units.
6. LDV Vehicle use of 5,370 kWh across an estimated 15,000 miles annually.
7. LCFS credit prices gradually increasing from current levels of $65 to $125, the projected target of CARB, in context of their pending regulatory amendment. CI's scores used beyond 2030 do not reflect an expected decrease in standard beyond 2030.

The full LCFS Opportunity Report can be found in Appendix E.

5.3.2 Value to Agricultural Goods Movement in California

The rice industry, while not the largest agricultural industry in California in terms of export value (9th) it is still a significant one, it is the largest medium-grained rice producer in the United States and is a major domestic supplier and global exporter, sending more than 1 million short tons of rice to Japan, Korea, Jordan, and Europe, bringing in approximately $700 million annually to the state. It is well-positioned to be a model to the rest of California's agricultural goods movement industry and show how zero-emission on- and off-road ZEV equipment and infrastructure can benefit the region and economy. With continued zero- emission vehicle and equipment deployment, SSA Pacific is able to evaluate the entire transportation logistics chain, including off-road material handling equipment and truck transportation, from rice mill to port or rail yard.

The LCFS plays a critical role in encouraging the transition to zero-emission vehicles and infrastructure in the agricultural goods movement industry. It provides a financial incentive for organizations like SSA Pacific to invest in low-carbon and renewable fuels, such as electric vehicles and biofuels, and to develop infrastructure to support them. By reducing the carbon intensity of transportation fuels, the LCFS helps to mitigate the environmental impact of agricultural goods movement and supports the development of a more sustainable industry. The rice industry's LCFS transition will not only benefit the industry but will serve as a model for the rest of California's agricultural goods movement industry. This can be a great opportunity for the rice industry to showcase how zero emission on- and off-road ZEV equipment and infrastructure can benefit the region and economy.

5.4 Conclusions

Through the analysis of innovative ZEV approaches, the Blueprint team identified six sites as potential locations for shared infrastructure at the Port of West Sacramento. Opportunities for shared infrastructure are enhanced through the standardization of equipment and protocols across OEMs. There is significant potential for the use of shared infrastructure through the ZEV transition, though this will require further substantial research and engagement with port authorities, electrical utilities, hydrogen providers, and other industry stakeholders. Shared infrastructure is a possibility in the future and will be dependent on SSA Pacific's internal objectives, needs, and evolution of industry standards.

The Marine Highways Program and the proximity of the Port of West Sacramento to the M-580 present an opportunity to explore innovative electric container-on-barge services. The results of the M-580 study indicate that a container-on-barge service would not be economically beneficial for the first ten to twenty years of operation, but it would generate significant revenue from LCFS credits. Ultimately, the economic viability and potential for electric barge services will depend on the energy economy ratio, technology readiness, and regional cargo movement and availability. These opportunities can be researched and analyzed further as the economic potential may change or as technologies become more widely accessible. In the near term, it is recommended that SSA Pacific take advantage of LCFS credit generation through shoreside ZEV deployments at the Port.

6 Knowledge Transfer

SSA Pacific conducted significant knowledge transfer activities through outreach to stakeholders and community members, which is documented in Section 2 of the report. In addition to knowledge transfer activities that have already been completed, SSA Pacific will continue exploring opportunities to disseminate Blueprint findings and progress. This section outlines knowledge transfer activities that will continue after completion of the Blueprint.

6.1 Knowledge Transfer Targets

Throughout the Blueprint development process, SSA Pacific conducted outreach with internal and external stakeholders to provide information on the MHD ZEV transition while collecting feedback on opportunities for improvement and collaboration. Due to the large size and scope of the Blueprint, SSA Pacific will provide condensed informational materials, based on the executive summary, in the form of PowerPoints, articles and infographics through the above-mentioned channels to the following target audiences: internal stakeholders, Port of West Sacramento and other ports, other terminal operators, business partners, local, state and federal jurisdictions, utilities, education and workforce development partners, financial partners and investors, local communities and Stockton residents.

6.2 Blueprint Findings Presentation

Beyond distributing the Blueprint, the project has yielded several key sources of information related to the electrification of the Port of West Sacramento. These include the following reports and presentations:

- Community and Stakeholder Engagement Report
- Resilience Report
- Flexible Adaptation Pathways Report
- FIP Tool
- Agricultural Goods Movement Shared ZEV Infrastructure Evaluation
- ZEV Rollout Plan
- ZEV M-580 Benefits Assessment
- Charging and Refueling Infrastructure Report
- LCFS Opportunity Report

These reports, referenced throughout the Blueprint, are included in the appendices. These reports may also be converted into presentations, infographics, newsletters or planning documents on an as needed basis for knowledge transfer and transition planning.

6.3 Flexible Infrastructure Pathways (FIP) Tool

The FIP Tool, discussed in Section 3.2, will be made publicly available upon completion of the Blueprint project, allowing other entities and organizations to conduct ZEV transition research and planning. The FIP Tool is a valuable resource that will transform ZEV planning capabilities beyond SSA Pacific's operations. A comprehensive understanding of a fleet is critical to assessing infrastructure, triggers, and future pathways. The FIP tool incorporates inputs including fleet makeup, operational constraints, and electrical infrastructure. This tool functions as a starting framework to demonstrate paths forward that benefit the fleet manager, the operators, and the planet. The dissemination of the FIP Tool is an important component of SSA Pacific's knowledge transfer activities, as it extends beyond information sharing into actionable resource sharing.

6.4 Future Knowledge Transfer Activities

SSA Pacific will leverage existing industry and community relationships to continue knowledge transfer and outreach efforts related to Blueprint development, implementation, and progress. In addition to external Blueprint sharing opportunities, SSA Pacific will ensure that the Blueprint is accessible internally to keep all departments appraised of organization-wide objectives and decarbonization activities.

SSA Pacific sends representatives to many of the major conferences in the transportation, logistics, maritime, and energy industries. These conferences are great opportunities to learn and distribute knowledge about industry trends, new technologies, best practices, and regulations. Employees from SSA Pacific have attended many of the following conferences and will explore opportunities to attend and present the Blueprint at the following events as appropriate, including workshops, lectures, and booths:

- ACT Expo: The largest clean fleet event in North America.
- American Association of Port Authorities (AAPA) Conferences: These conferences provide a forum for discussing current port issues and strategies for addressing them.
- Break Bulk Americas: This annual conference focuses on the transportation of project cargo and breakbulk cargoes.
- EPRI Electrification: A biennial conference that explores the latest advancements in electrification technologies.
- Electric & Hybrid Marine Expo: A conference that showcases the latest in electric and hybrid marine propulsion systems.
- CALSTART Symposium: A conference that brings together industry leaders and policymakers to discuss the latest in clean transportation technology.
- GreenTech: A conference hosted by Green Marine—a sustainability certification body for the ports and maritime sector—that focuses on environmental issues facing the marine industry.
- Green Transportation Summit & Expo: An annual conference that explores the latest in sustainable transportation technology.
- Smart Energy Decisions: Hosts a Renewable Energy Forum and Net Zero Forum.
- International Association of Ports and Harbors Conference: Hosts annual World Ports Conferences.

Blueprint outreach throughout the development progress was successful in reaching a variety of community and industry stakeholders. The proactive preparation and collaboration among project team members facilitated thorough distribution of survey flyers and reminders. Participants expressed interest in how the Blueprint will be implemented, indicating a desire to access the Final Blueprint when completed.

The Blueprint will be a public document that is accessible to community and industry stakeholders who would like to learn more about the MHD ZEV transition process. By sharing the Blueprint and FIP Tool, SSA Pacific will work to increase general knowledge and support for this project while providing resources for other organizations to engage in ZEV planning. This dedication towards knowledge sharing will facilitate broader ZEV transition efforts in the agricultural industry, California, and across the United States.

6.5 Knowledge Sharing Best Practices

The following lessons learned describe the best practices identified by SSA Pacific throughout the process of community and stakeholder engagement and knowledge sharing:

1. Port and Nearby Community Engagement – Early and consistent engagement with the Port of West Sacramento, SSA Pacific customers, and the West Sacramento Chamber of Commerce was particularly important for this project. Incorporating important stakeholders into the SOW to ensure consistent involvement will increase the likelihood of meaningful replicability of the Blueprint.
2. Engage Proactively - Beginning engagement ahead of time can increase a project's network of invitees. Essentially, there is a direct pipeline of individuals engaged during community and stakeholder outreach and individuals who are interested in—and can benefit from—knowledge transfer activities. The sooner community and stakeholder outreach begin, the more successful they will be. The success of community outreach effects the success of knowledge transfer activities.
3. Pathways for Follow-Up – Create accessible pathways for stakeholders and community members to follow-up on information provided during community outreach and knowledge transfer.
4. Engagement Format – It can be difficult to determine optimum engagement tools when deciding to pursue in-person versus online meetings, surveys, and feedback collection. Context and accessibility are important considerations when establishing engagement activities.
5. Advertise – There were limited opportunities to advertise the community and industry surveys. A CEC webpage advertising outreach/events associated with its funding could help boost participation of interested parties.

7 Project Fact Sheet

The Project Fact Sheet is included in Appendix F.

7.1 High Quality Digital Photographs

High quality digital photographs are included in Appendix G.

8 Actions and Recommendations

SSA Pacific is well-positioned to proceed with the implementation of recommendations provided in this Blueprint, and its success will depend on communication, collaboration and support from the Port of West Sacramento, city government, and other related parties, consultations with the electrical utility and hydrogen fuel providers, and the ability to identify and mitigate potential risks and challenges.

Below is a step by step, actionable roadmap to begin this transition, which can also serve as an implementation guide to facilitate electrification of other fleets or ports.

1. Review zero-emission vehicle and infrastructure deployment considerations detailed in Sections 3 and 4 for both on- and off-road assets.
2. Determine zero-emission infrastructure deployment phasing and timeline by forecasting short and longer-term ZEV transitions, in consideration of technology choice (BEV or HFCV), financial resources, electrical utility allocations, and land-use permissions.
3. Identify which on- and off-road assets are most critical to the Port's operations and prioritize zero-emission vehicles and equipment to transition. Compare BEV and HFCV technologies to understand which mix of technologies is optimal for Port operations. Each mix of technologies assessed can be considered a transition scenario, with extremes being solely BEVs or solely HFCVs.
4. Perform an internal review of ZEV infrastructure prioritization in line with internal strategic goals, immediate needs, and existing capacity. Consider the existing capacity of the Port's infrastructure and prioritize planning for any areas where upgrades or additions may be necessary.
5. Develop a ZEV transition schedule to map equipment and vehicle replacement and investment over time.
6. Use data-driven analysis to develop a fleet transition schedule.
7. Evaluate opportunities to implement the next phase of the ZEV transition, starting with readily available vehicles, equipment, and infrastructure, to evaluate and test performance and interoperability with other Port activities, while minimizing risks.
8. Work with port partners to develop a phased infrastructure rollout plan with a preliminary engineering design and estimate.
9. Install infrastructure to take advantage of economies of scale while limiting excess capacity.
10. Consider the potential growth of the Port's operations when determining the necessary capacity of the infrastructure.
11. Select placement for new charging infrastructure, as well as number and capacity of chargers needed, in consideration of recommendations made in Sections 3 and 4.
12. Following an RFP and vendor selection process, apply to PG&E's EV Fleet Program (if applicable) to begin the EVSE planning and installation process.
13. Based on ZEV adoption forecasts, evaluate options for deploying needed opportunity charging and/or hydrogen refueling infrastructure.
14. Calculate daily fuel and energy requirements for zero-emission vehicles and equipment. These estimates should be based on existing duty cycles and cross referenced with the advertised efficiency and fuel (electricity or hydrogen) capacity of the replacement ZEVs.
15. Consider how innovative technologies can be used to manage increasing electric load and demand on capacity.
16. Evaluate possible partnerships to deploy a short-sea shipping service to eliminate harmful emissions from goods movement and generate LCFS credits.
17. With possible short sea shipping operators, evaluate installation of maritime charging networks or battery swapping facilities at key points along the feeder route.

18. Consider deployment of Distributed Energy Resources (DERs), such as solar and/or Battery Energy Storage Systems (BESS), on Port property to offset increasing electricity consumption, manage demand, and maximize the value of LCFS credits generated.
19. Determine capital budget internally and with Port partners required for the next phases of infrastructure, vehicle, equipment, and renewable energy/BESS deployment.
20. Evaluate expected savings from conversion to zero-emission vehicles and equipment.
21. Apply for all applicable funding, voucher, and tax credit sources to support the transition, as detailed in Section 2.
22. Develop a managed charging plan to minimize the need for utility upgrades.
23. Determine operations and maintenance plans for the deployed vehicles, equipment, and infrastructure.
24. Seek opportunities to share Blueprint lessons learned and implementation strategies through technology transfer opportunities, including conferences, industry organizations, industry publications, and working groups.

As a first of its kind project, steps may need to be modified based on actual results and real-time equipment readiness as project planning progresses. SSA Pacific should continue to incorporate lessons learned during implementation, and remain flexible should steps not always follow sequential order, or other challenges arise.

9 Conclusions and Lessons Learned

This Blueprint is an essential step in addressing education and information gaps in the deployment of ZEV MHD vehicles and charging infrastructure within California's agricultural transportation industry. The report highlights the importance of this industry to the state's economy, identifies the risks and challenges facing the adoption of ZEVs, and provides valuable insights from stakeholder engagement. The Blueprint's focus on the agricultural industry and the Port of West Sacramento as a demonstration site for ZEV equipment and infrastructure is intended to reach a broad audience in the agricultural goods movement supply chain.

9.1 Lessons Learned

9.1.1 Stakeholder Outreach and Coordination

Stakeholder engagement revealed that reliability and capital costs are top concerns about zero-emission equipment, while environmental impact and lifetime performance are the greatest perceived opportunities. Education and awareness are necessary components of the zero-emission vehicle transition, and a successful transition push will include providing basic information on relevant technology, capabilities, insurance, costs, and financing. The diversity of equipment used in the agriculture and port industry complicates the transition to zero-emission vehicles and infrastructure by requiring deep knowledge of technologies by a variety of users. This challenge is compounded by a lack of educational programs for MHD ZEV technologies. Developing such programs in community colleges throughout the state will be an essential step in ensuring a smooth transition to zero-emissions in the agricultural industry.

Close coordination with utility stakeholders and streamlined ZEV permitting processes can help alleviate delays in implementation. Ultimately, a holistic plan enables the leveraging of economies of scale to cost-effectively install charging and refueling equipment later. The success of the infrastructure investments planned by SSA Pacific at the Port of West Sacramento will rely on approval from the local port authority. To reduce the risk of delays in securing the required approvals, transparent communication with the authority and related parties will be crucial. Consultations with the electrical utility and hydrogen provider, if applicable, will help identify any red flags and bottlenecks for EV chargers and determine necessary investments to support the ZEV infrastructure rollout.

9.1.2 Resilience

The Port of West Sacramento faces exposure to multiple natural hazards, including flood and seismic events, extreme heat, drought, and wildfire, which could significantly impact electrified operations. Mitigation efforts such as private flood mitigation measures and on-site electricity generation and storage could help to defend against these hazards. Furthermore, the transition to a zero-emission fleet is a critical sustainability goal for SSA Pacific, but it requires careful consideration of various factors such as vehicle type, refueling constraints, and electrical infrastructure constraints and their relationship to these hazards. The FIP tool provides a flexible adaptation pathway that considers uncertainties, prompts questions and risks that need monitoring, and is dynamic in helping to navigate a successful zero-emission infrastructure pathway. It will allow SSA Pacific to consider the optimal fuel type under various scenarios and make quick updates as new knowledge and details become available.

9.1.3 Technology and Deployment

SSA Pacific's position as a marine terminal operator puts it in a unique position to facilitate the widespread adoption of MHD ZEV technology. This could include encouraging the development of shared ZEV infrastructure and Marine 580 (M-580) inland waterway corridors. By evaluating the charging needs of fleet vehicles, terminal equipment, and heavy-duty trucks, the Blueprint Team highlighted the importance of implementing a combination of operational practices and software solutions to maximize the efficiency of shared charging infrastructure.

Incentives like the deployment of ZEV-supporting infrastructure and grant funding programs can play a significant role in expediting the adoption of ZEVs for drayage trucks. However, there are technical requirements to consider when creating a deployment timeline, including consultations with stakeholders, permitting, design, procurement, and installation. A ZEV Infrastructure Rollout Plan can help facilitate the alignment of desired infrastructure with the technical requirements of implementing the infrastructure.

Optimizing locations for charging and refueling infrastructure for terminal vehicles is crucial to maximize their utility and minimize their downtime. Data analytics and operation characteristics of these vehicles can help identify potential solutions such as a static set of high-power chargers or a dispersed approach. It is essential to assess the feasibility of each solution, including grid interconnections, electrical capacity, and safety concerns for hydrogen refueling. Key performance metrics such as cost, system resiliency, emission reductions, and impact on operations should be evaluated to guide the Port in selecting the most optimal solution for its operations. It is also crucial to consider energy storage safety when it comes to ZEV infrastructure, as lithium-ion batteries and hydrogen fuel cells both have their own unique safety concerns that must be addressed.

9.1.4 M-580 Benefits Assessment

The Marine Highways Program has the potential to reduce transportation emissions and traffic congestion on the nation's interstate highway system. The Blueprint found that the diesel-powered container-on-barge service would not be economically viable in the first 10-20 years of operation, and only two optimistic models showed the ability to achieve profitability within that time frame. An electric barge service, on the other hand, would eliminate harmful emissions from goods movement and generate as much as $750,000 in annual revenue from LCFS credits. Further cost efficiencies and improved cargo capacities could be achieved by installing maritime charging networks or battery swapping facilities at key points along the feeder route, enabling reduced battery sizing. There is also an ongoing discussion around using liquid hydrogen as a transportation fuel in the maritime sector, but there have been no deployments to date.

The deployment of a waterborne trade network between the Ports of Oakland, Stockton, and West Sacramento requires significant collaboration and coordination among diverse stakeholders. The prior M-580 barge service encountered challenges in securing sufficient cargoes to sustain operations beyond its second year. By working together and fulfilling their respective responsibilities, stakeholders can achieve a sustainable waterborne trade network that benefits the economy and the environment.

9.1.5 Low Carbon Fuel Standard Opportunities

The deployment of zero-emission technology at the port has the potential to generate significant LCFS credit values, as demonstrated by the evaluation summary provided in the report. The rice industry in California, which is a significant agricultural industry and a major domestic supplier and global exporter, is well-positioned to benefit from the LCFS transition and serve as a model for the rest of the agricultural goods movement industry.

9.2 Conclusion

In conclusion, the Blueprint provides step-by-step recommendations for SSA Pacific to transition its fleet vehicles and cargo handling equipment to zero-emission options supported by new charging infrastructure. The report outlines 24 specific action items in Section 8 which can also serve as an implementation guide to facilitate electrification of other fleets or ports. The Blueprint is an essential step in addressing education and information gaps in the deployment of ZEV MHD vehicles and charging infrastructure within California's agricultural transportation industry and can serve as a model for other ports and fleets to follow in their own transition to zero-emission vehicles and infrastructure.

The lessons learned through Blueprint development highlight the importance of reliability, detailed budget analysis and capital expenditure plans, environmental impact, and lifetime performance to SSA Pacific and other Port stakeholders. Education and awareness will be necessary components for a successful transition push to zero-emissions in the agricultural industry. In the short term, SSA Pacific should pursue a streamlined ZEV permitting and deployment process, and coordinate closely with utility stakeholders to ensure energy is available for these projects within established time frames.

The resilience of the Port of West Sacramento faces exposure to multiple natural hazards which could significantly impact electrified operations. SSA Pacific will continue to support Port master planning for climate resiliency as a Port tenant. Mitigation efforts such as private flood mitigation measures and on-site electricity generation and storage should be pursued to help to defend against these hazards.

By implementing this Blueprint, SSA Pacific can strengthen its relationships with key tenants, business partners, and community organizations, foster collaboration, and help California meet its ambitious climate goals. Importantly, support from the Port of West Sacramento, primarily through collaborative and cooperative infrastructure investments, will accelerate the adoption of ZEVs and facilitate a successful and cohesive transition. By utilizing the Port of West Sacramento as a demonstration site of MHD ZEV equipment and infrastructure, a broad industry of food producers, processors and shippers will become a part of the clean transportation transition. Ultimately, this Blueprint demonstrates the transformative potential of electrified operations at the Port of West Sacramento that will reshape the agricultural goods movement in California and the United States.