ARV-21-010: STC Traffic

STC Traffic Equity-Driven Public Access ZEV Charging Blueprint

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Prepared For

The California Energy Commission

Prepared by

Momentum

1 Executive Summary

To fulfill the requirements of its 2021 award under the California Energy Commission's (CEC) GFO-20-601, STC Traffic, Inc. (STC) has prepared this "STC Traffic Equity-Driven Public Access ZEV Charging Blueprint." The goal of the Blueprint is to support and encourage equity in the marketplace by promoting public access to Medium- and Heavy-Duty (MHD) Zero-Emission Vehicle (ZEV) infrastructure so that small businesses and individuals are not squeezed out of the market during the transition to zero-emission vehicles. The geographic focus of the project is National City, California, specifically candidate sites for charging and hydrogen refueling infrastructure owned by the Port of San Diego (POSD).

Diesel trucks operating near California seaports, including POSD, have been an economic driver for port communities and the state, but at great expense to the climate and to the health of people living near ports and along truck routes serving them.

According to the Environmental Health Coalition:

- San Diego residents living in proximity to the POSD are burdened with more pollution than 97% of Californians and breathe more diesel-polluted air than 90% of the state.
- The Barrio Logan community adjacent to POSD, which is predominately LatinX, has a cancer rate that is 85-95% higher than the rest of the United States, is in the top 5% most polluted areas in California, and has the highest diesel pollution in San Diego County
- Children's asthma hospitalization rates in National City are more than double the San Diego County average.[1] [2]

These factors place National City census tracts and neighboring communities such as Barrio Logan in the highest tiers of CalEnviroScreen 4.0 Disadvantaged Communities rankings, where scores are a function of pollution burden and socioeconomic factors.[3] The impact on climate from diesel emissions is related to health impacts; emissions from heavy-duty trucks generate 20% of the state's transportation-related greenhouse gas (GHG) emissions.[4]

California Advanced Clean Fleets Regulation

In response to the climate and health impacts of diesel trucking, California is leading the transition of the industry to ZEVs. The California Air Resources Board (CARB) has developed a draft Advanced Clean Fleets (ACF) regulation, with the primary goal to "accelerate the market for zero-emission trucks, vans, and buses by requiring fleets that are well suited for electrification to transition to ZEVs where feasible." As part of the draft ACF regulation, all new drayage truck registrants in CARB's online system must be ZEVs, beginning in 2024, whether battery-electric trucks or hydrogen fuel-cell electric trucks. While trucks currently in service may continue to serve ports if they meet certain conditions and register in CARB's online system before 2024, only zero-emission trucks will be permitted beginning in 2035. Under the proposed ACF regulation, all MHD vehicles must be zero-emission by 2042.

Port of San Diego Zero-Emission Goal

The Port of San Diego has an even more ambitious timeline, with a target of 2030 for trucks calling on the Port to be 100% ZEV, with an interim goal of 40% of the port's annual cargo truck trips being performed by zero emission trucks by June 30, 2026.[5] To help achieve these goals, the POSD Board voted at its meeting on November 8, 2022 to issue a Request for Proposals (RFP) for ZEV infrastructure development on two sites it owns near the Port in National City. The RFP built on the 18 responses the port received to a Request for Information (RFI) issued in May 2022 for design concepts and business plans for public ZEV

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[1] https://www.environmentalhealth.org/communities/logan/
[2] https://www.environmentalhealth.org/communities/national-city/
[3] https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40
[4] https://www.ucdavis.edu/climate/news/decarbonizing-california-transportation-by-2045
[5] portofsandiego.org/mcas#:~:text=A%20goal%20of%20100%20percent,in%20some%20cases%2C%20even%20more.

hydrogen fueling and/or electric charging infrastructure at numerous sites in proximity to the port, including two sites in National City subsequently selected for evaluation in the RFP.

Site Selection

The STC Traffic Equity-Driven Public Access ZEV Blueprint project team aligned its evaluation of public opportunity charging and hydrogen refueling sites identified by the POSD RFI in National City. Site evaluation criteria included:

- Number of charging stations and hydrogen dispensers the site can accommodate
- Proximity to truck routes, freeway, National City Marine Terminal, goods, services, and amenities
- Level of electrical infrastructure upgrades or new connections required and construction timeline
- Existing site conditions and level of effort required to prepare the site
- Capacity to include amenities on-site (such as restrooms, showers, locker rooms)

The two POSD sites on Tidelands Avenue in National City that were chosen by POSD for its RFP were also scored highest by the STC ZEV Blueprint team as best suited to support deployment of electric truck charging and hydrogen refueling infrastructure. This Blueprint details the proposed placement of charging infrastructure on each of the three National City sites evaluated, for both overnight and opportunity charging, in consideration of traffic patterns through the sites and access to amenities for truckers utilizing the sites. Hydrogen refueling infrastructure is designed on the two highest-scoring sites.

The Blueprint project team developed a two-phase site development plan, including site layouts, Electric Vehicle Supply Equipment (EVSE) and hydrogen infrastructure installations, and truck turning simulations for the Tideland Ave. sites evaluated. Each site was designed for one-way truck flow in and out of the charging areas. Overnight and opportunity charging and hydrogen refueling were separated, with overnight charging located furthest from Tidelands Ave for a quieter experience for truckers sleeping in their cabs. Each charging and refueling stall was designed to accommodate a Class 8 truck, utilizing distinct charging space recommendations for opportunity and overnight charging.

Independent Owner Operators

As the transition to zero-emission trucks accelerates in the years ahead, independent owner operators (IOOs), who as a group are lower income and more diverse than the trucking industry average, are at risk of being left behind or struggling to keep up with required changes. This equity-driven Blueprint has been designed with these truckers in mind to help usher in a truck transformation that works for all.

POSD gathered input from IOOs as it was developing its RFI for ZEV infrastructure to support trucks calling on the port. The upfront cost of purchasing zero-emission trucks emerged as the top concern. Other concerns expressed by IOOs included uncertainty and confusion regarding such issues as vehicle reliability, operations and maintenance, and how technological developments will affect the value of initial investments in charging infrastructure and vehicles.

IOOs said they can purchase used diesel trucks for about $100,000, while new electric and hydrogen trucks cost several times that amount, putting them out of reach. For this reason, the Blueprint Business Framework highlights “Trucking as a Service,” an emerging and credible business model and a promising solution for IOOs to overcome the upfront cost barrier.

In the Trucking as a Service model, a third-party developer develops, owns, and operates EV chargers and/or hydrogen dispensers, as well as electric trucks. The truck lease package may also be inclusive of low- cost/free charging or hydrogen refueling for a limited period. The lessor funds the package with federal and state funding programs (such as new CARB Clean Transportation Investment programs designed to support small fleets and IOOs), fuel and maintenance savings, and Low Carbon Fuel Standard (LCFS) credits. The significant operational savings gained by the lower cost of electricity compared to diesel are used by lessees to pay back the upfront capital. At the end of the lease period, IOOs would have the option to extend the lease at a reduced rate, buy the vehicle at fair market value with the option to lease the parking space and extend their charging plan, or terminate the lease.

Putting people in trucks creates demand for charging infrastructure, which in turn helps provide a reliable customer base and source of income for site developers. ZEV truck drivers need access to convenient charging stations and places to park trucks overnight, and ZEV infrastructure site developers need truckers to utilize the stations. Tying deployment of trucks to public charging and hydrogen refueling infrastructure—such as proposed in the Trucking as a Service model—reduces the risk of deploying under-utilized assets that deter potential investment. Developing a successful model connecting affordable access to both zero-emission trucks and infrastructure will set the stage for replication across the state. One such opportunity is to deploy charging stations and/or hydrogen refueling infrastructure at private lots where IOOs currently park overnight, as recommended for consideration by CALSTART. The proposed Business Framework for developing the sites to serve the intended IOOs is discussed in Section 0.

The Blueprint contemplates the increasing use of charging and refueling infrastructure in response to regulatory requirements, as well as financial benefits expected from abundant public funding opportunities and fuel and maintenance savings. To accommodate this growing demand at POSD, the Blueprint maps out deployment of considerable charging and hydrogen refueling infrastructure over the next five years along with an analysis of required electrical capacity.

The Blueprint details a build-out scenario at the two selected sites in National City that would encompass 66 charging stations, ranging from 200 kW in capacity for overnight charging to 1-megawatt (MW) opportunity charging stations, along with nine hydrogen dispensers. One site would include 26 overnight, 200-kilowatt (kW) charging stations, 10 350-kW opportunity charging stations, six 500-kW charging stations, and six hydrogen dispensers. Total peak demand for this site would be 11.7 MW. The second site would place 10 200-kW overnight charging stations, 11 350-kW opportunity charging stations, three 1-MW charging stations, and three hydrogen dispensers. Total peak demand for this site would be 8.85 MW. The two sites combined would have a 19.55 MW total peak demand, the equivalent demand for approximately 10,000 homes—the equivalent of a small California city.

A report released by National Grid, CALSTART, and others in November 2022 emphasizes the importance of planning for the expected built-out capacity of sites: "By implementing the right-sized interconnection upfront, rather than investing in a series of smaller distribution upgrades that will soon need to be replaced, we can avoid duplicative investments, reduce total costs, and futureproof high-traffic sites for accelerated charging deployment. Taking this long-term perspective will allow site operators and utilities to design for future demand, like growth in MHDV charging."[6]

Early coordination with the electric utility—San Diego Gas & Electric (SDG&E)—will be critical to planning for and meeting this level of electrical demand. For this reason, key issues identified in the Blueprint for proceeding to the development stage include completing an assessment of available electrical capacity on the circuits feeding the two sites and the timeline for SDG&E to make any necessary electrical upgrades to support the first and second phases of development.

The development of the opportunity charging and hydrogen refueling sites will provide significant green job opportunities for local businesses, including minority business enterprises (MBE), woman-owned business enterprises (WBE), small businesses (SB), and disabled veteran business enterprises (DVBE). Workforce development and education programs to support ZEV business and job opportunities are detailed in Section 0.

[6] https://www.nationalgrid.com/document/148616/download

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2 Glossary

Acronym	Definition
AQMD	Air Quality Management District
CaaS	Charging as a Service
CAEATFA	California Alternative Energy and Advanced Transportation Financing Authority
CARB	California Air Resources Board
CCTC	California Competes Tax Credit
CEC	California Energy Commission
CMP	Carl Moyer Program
CORE	Clean Off-Road Equipment Incentives
CPCFA	California Pollution Control Financing Authority
CPUC	California Public Utilities Commission
CTP	Clean Transportation Program
DOE	Department of Energy
DOT	Department of Transportation
EaaS	Energy-as-a-Service
EPA	Environmental Protection Agency
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HD	Heavy-Duty
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
IBank	California Infrastructure and Economic Development Bank
IIJA	Infrastructure, Investment and Jobs Act
IOO	Independent Owner/Operator
LCFS	Low Carbon Fuel Standard
MHD	Medium and Heavy-Duty
OEM	Original Equipment Manufacturer
PPA	Power Purchase Agreement
REC	Renewable Energy Credit
TBD	To-be-determined; Not yet available
TOU	Time of Use
ZEV	Zero-Emission Vehicle

3 Introduction

Communities near California ports have some of the worst air quality in the state due in large part to emissions from vehicles transporting port goods.[7] These communities are frequently low-income and priority populations.

CARB has developed an ACF regulation that would require all new port registrations for heavy-duty drayage trucks to be ZEVs beginning January 1, 2024. Vehicles that are already registered ("legacy drayage trucks") would have 13 to 18 years to continue to operate in any California port, prior to 2035. The draft ACF regulation further requires that, beginning January 1, 2035, all drayage trucks must be ZEVs. Under the proposed ACF regulation, all MHD vehicles must be zero-emission by 2042. These and other rules and regulations aim to reduce harmful emissions from heavy-duty vehicles, particularly in port communities.

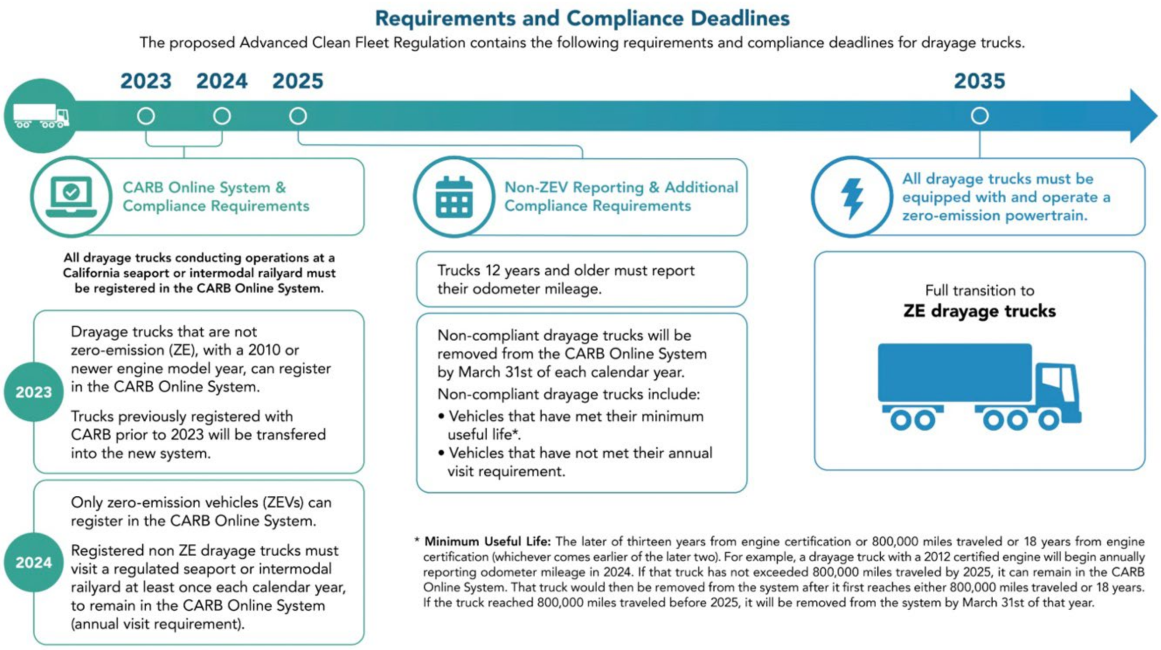

Figure 1: CARB draft ACF regulation for drayage trucks.

The transition to zero-emission heavy-duty vehicles will require alternative "refueling" infrastructure, namely high-capacity electric charging infrastructure and hydrogen refueling infrastructure and equipment. The fuel-agnostic term "ZEV supporting infrastructure" is used throughout the document to refer collectively to hydrogen and electric "refueling" infrastructure.

Large fleet owners typically have private refueling infrastructure on-site for their exclusive use, and many may choose to continue this practice and replace existing diesel refueling infrastructure with ZEV supporting infrastructure, as appropriate. Smaller fleets and individual owner-operators, however, have historically relied on gas stations and truck stops for refueling given the cost-prohibitive nature of refueling infrastructure procurement and installation. Further, MHD ZEV supporting infrastructure is substantially more cost-prohibitive than its fossil-fuel equivalents, and many small businesses could be forced out of the market without an alternative, affordable, convenient place to refuel.

Small fleets and IOOs comprise a significant portion of the industry participants and diversity of the sector. Without a pathway for including the IOOs in industry projections, future drayage truck operations will experience a larger gap between those who can afford to participate in the new zero-emission

[7] https://www.latimes.com/california/story/2020-01-03/port-ships-are-becoming-la-worst-polluters-regulators-plug-in

transportation regime and those who cannot. This creates a need for publicly accessible MHD ZEV supporting infrastructure facilities.

Some terms used to describe these facilities include “smart truck stop” and “MHD ZEV supporting infrastructure facility.” Generally, the distinction is that a smart truck stop likely has more services such as those found at a conventional truck stop serving diesel-fueled vehicles, while a MHD ZEV infrastructure facility may or may not have those services.

In demonstration of its commitment to healthier port communities and its Maritime Clean Air Strategy, POSD adopted a target of 2030 for trucks calling on the port to be 100% ZEV, with an interim goal of 40% of the port’s annual cargo truck trips being performed by zero-emission trucks by June 30, 2026. To help achieve these goals, the POSD Board voted at its meeting on November 8, 2022, to issue an RFP for ZEV infrastructure development on two sites it owns near the port in National City. The RFP built on the 18 responses the port received to an RFI issued in May 2022 for design concepts and business plans for public ZEV hydrogen fueling and/or electric charging infrastructure at numerous sites in proximity to the port, including two sites in National City subsequently selected for evaluation in the RFP.

In this CEC-funded Blueprint, the project team developed site designs for public-access heavy-duty ZEV infrastructure at the three POSD sites in National City. The two sites that emerged as the strongest candidates for ZEV infrastructure development are the same sites that the port will solicit development proposals for in its forthcoming RFP. In alignment with the port’s priorities, the STC Traffic Equity-Driven Public Access ZEV Blueprint has a specific goal of ensuring equitable access for the entire ecosystem of diverse and disparate trucking companies that serve the port, including independent-owner operators and small fleet owners—those with the least ability to pay for private MHD ZEV supporting infrastructure.

4 Project Background

4.1 Project Goals

The goal of the STC Traffic Equity-Driven Public Access ZEV Blueprint is to support and encourage equity in the marketplace by promoting public access to MHD ZEV infrastructure so that small business and individuals are not squeezed out of the market during the zero-emission technology transition.

The objectives of the Blueprint are to:

1. Engage a broad stakeholder network to develop a comprehensive, economic, and equitable approach to designing and financing MHD ZEV infrastructure that will be accessible to all industry participants.
2. Evaluate the ZEV charging technologies, infrastructure deployment considerations, and associated traffic flows for public-access MHD ZEV infrastructure.
3. Create a credible business case identifying, among other things, key roles and responsibilities for market players (public and private) and strategies to overcome cost and revenue barriers to achieve scalable and replicable networks of MHD ZEV infrastructure to be deployed throughout neighborhoods that surround freight facilities.
4. Support locally-based minority business enterprises (MBE), woman-owned business enterprises (WBE), small businesses (SB), and disabled veteran business enterprises (DVBE) through knowledge transfer and skills training programs to enable organically grown efforts to thrive.

4.2 Project Team

STC served as the prime contractor and organizer for the project. In addition to technical services, including site design in collaboration with Momentum, STC managed and oversaw the Blueprint process, facilitated engagement with Project Team members, and worked to collaboratively develop a successful and deployable Blueprint. STC is a full-service traffic engineering consulting firm founded in 2007. STC is a leader in the Intelligent Transportation System (ITS) field and is the largest discipline-specific traffic engineering and ITS consulting firm in San Diego County, with the most staff dedicated to ITS in the region. The company has extensive experience and knowledge in a broad range of traffic signal systems, communications, and operations services. The company's technical staff have dozens of years of unique expertise working on the manufacturer side of these systems and on the user-side operating the same systems for municipal agencies.

Momentum designs, develops, and deploys innovation campaigns for forward-thinking organizations—from entrepreneurs to public agencies and Fortune 500 companies—that research, demonstrate, commercialize, and operate transformative transportation, energy, water, and manufacturing technologies. Momentum has supported the design and development of some of California's most prominent programs, including the West Coast Electric Highway, and the California Sustainable Energy Entrepreneur Development Initiative (CalSEED). Momentum has advanced the infrastructure necessary to combat range anxiety and ease the transition to widespread EV adoption by working with technology manufacturers, regulators creating new markets, and deployment partners. For this Blueprint, Momentum led development of community and stakeholder engagement, technology assessment, and the final Blueprint. Momentum also collaborated with STC Traffic on site assessment/design and served as the project manager.

Arup is a global design engineering, planning, and advisory firm at the forefront of the clean, affordable, and resilient energy transition with 600 staff in California. The company's international, 14,000-person network provides capacity, global perspective, and innovative solutions. Arup's experience with transportation ZEV infrastructure includes feasibility, planning, site assessment, layout, cost/benefit analysis, design, cost estimation, risk management, commercial evaluation and benchmarking delivery models, investor due diligence, scheduling, utilities coordination, and construction administration. Arup developed the business model section of this Blueprint.

5 Community and Stakeholder Engagement

5.1 Purpose

The purpose of community and stakeholder engagement was to gather the perspectives, opinions, and input of community members and stakeholder groups for use in the development of the Blueprint. Outreach was designed to meaningfully foster a two-way dialogue to share perspectives about challenges, risks, concerns, and opportunities. Each stakeholder group has a different relationship to ZEV planning with overlapping goals and objectives. Understanding the roles, responsibilities, and approach of each stakeholder helped create a stronger, more dynamic ZEV planning effort. Key stakeholders in ZEV planning include:

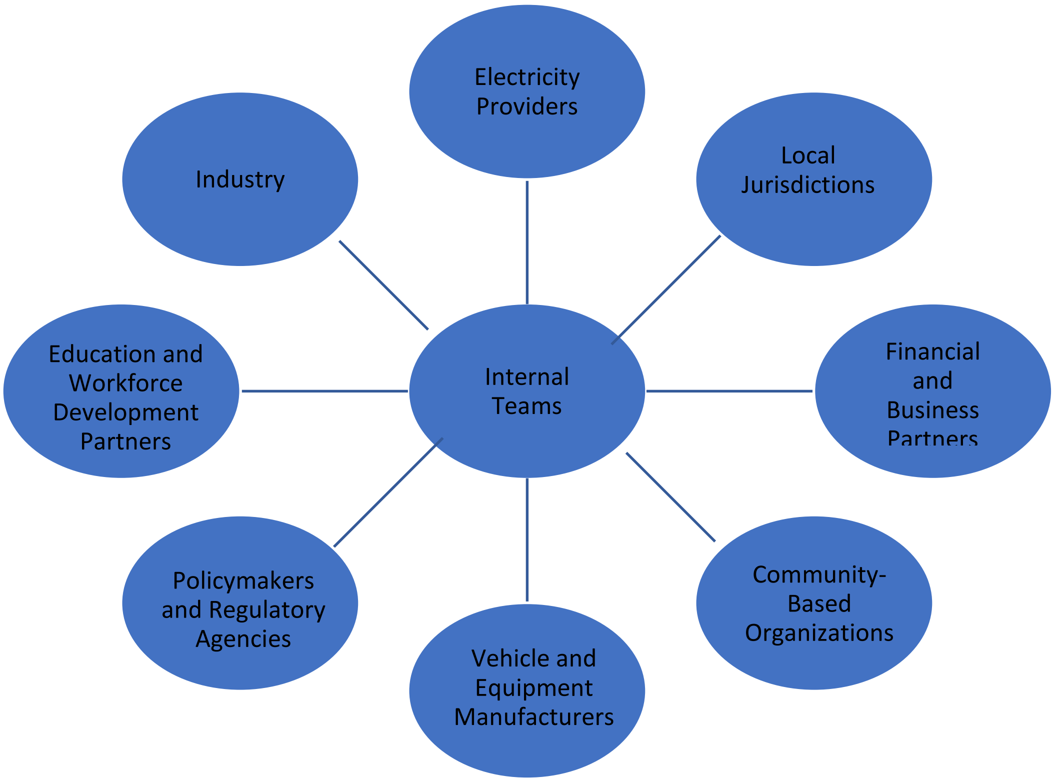

Figure 2: Network of relevant stakeholders that will participate in the ZEV transition.

5.1.1 Timeline

Outreach efforts began in January 2022 with the submission of the list of outreach targets and the Community and Stakeholder Engagement Plan. The Blueprint team initially struggled to get meetings with outreach targets due to a surge in COVID-19 cases at the time, as well as COVID-19-induced labor shortages. The first outreach meetings with targets were held in March 2022. The project team learned then that POSD was in the early stages of planning a study very similar in scope to the STC Traffic Blueprint, but on a longer timeline. Coordinating outreach efforts with those of the port to avoid duplicating efforts and unnecessarily burdening community members and stakeholders with redundant outreach queries slowed outreach considerably.

5.1.2 Methodology

Given the range of diversity among stakeholder groups, a tailored approach was used with each one. Unfortunately, many targets either did not respond to requests or responded that they were overwhelmed, understaffed, and lacked the capacity to engage meaningfully. The individual approaches to outreach are described in greater detail in the respective sections below.

The Blueprint team developed and distributed an outreach survey to all outreach targets, but received just four responses, which is not a statistically significant number of responses for a valid statistical analysis. Therefore, each survey response is referenced in its respective section and full survey responses can be found in Appendix A. The full Community and Stakeholder Engagement Report can be found in Appendix B.

5.2 Internal Stakeholders

Internal stakeholders are representatives from within distinct business units or operating groups within an organization that will be impacted by the ZEV transition. For the STC Traffic Blueprint, internal stakeholders are IOOs, small logistics businesses, and POSD.

Internal stakeholder outreach was designed to establish a baseline of understanding that reflects the state of the IOO sector of goods movement in its ZEV journey and to create communication that addresses:

- How a target's role/division relates to vehicles today
- What parameters (e.g., performance, cost) are required of vehicles for successful operation of the part of the business within a target's purview
- How much a target knows about ZEV options
- The risks or challenges a target foresees in switching from fossil-fueled technologies
- The opportunities a target foresees in switching to ZEVs

Port of San Diego

As the key driver of MHD vehicle traffic in the region and a key player in the transition to MHD ZEVs, POSD was one of the first organizations the Blueprint team contacted. The team discovered that the port was in the early stages of planning MHD ZEV supporting infrastructure facilities to support its Maritime Clean Air Strategy (MCAS) and Truck Transition Plan (TTP). The port agreed to meet with the team monthly and to share its plans as developed.

The deployment of new ZEVs is key to meeting POSD's Climate Action Plan goals. Light-duty EV charging stations are already installed in some parks and public areas of POSD, as well as at POSD facilities for fleet and employee use.

The port collected data to understand truck routes, truck operating profiles, and driver and fleet manager perspectives. Outreach and data collection were conducted with two primary groups: drivers and fleet managers/operators. A driver survey was conducted at port entrances at the Tenth Avenue Marine Terminal and the National City Marine Terminal, where port employees distributed surveys to drivers entering and exiting the port. Drivers were offered a flyer with a QR code on it which linked to a survey for the drivers to complete. Fleet managers received a survey distributed through port tenants that requested information on truck inventories and typical operations. Survey results were used by the Blueprint team in the development of Section 7 and can be found in Appendix C.

On May 4, 2022, the Blueprint team attended a webinar hosted by the port to share its *Truck Transition Plan.* The webinar and corresponding discussion with drivers and small fleet owners covered the Port's TTP, relevant state and local regulations and policies, and funding opportunities. There were approximately 40 attendees, composed primarily of IOOs and small fleet managers, with a few representatives from organizations that support the industry in the transition (i.e., CALSTART and SDG&E). After a 30-minute review of regulations and a 30-minute discussion on funding opportunities, IOOs and small fleet managers shared their concerns about the transition.

The single greatest concern expressed by attendees was the cost of ZEV MHD trucks. Several stated that to consider purchasing a zero-emission truck, the price would need to be close to what they pay currently for a used diesel truck, about $100,000. Further, there seemed to be an inflated price conception with several commenters stating that zero-emission trucks cost more than $500,000. This misconception seemed to close the door on any conversation about financial assistance, with one commenter saying to the group: "Even with the stackable price rebates mentioned today, we're being forced to foot the bill for a quarter-of-a-million-dollar truck." The primary upfront cost concern led the Blueprint team to explore and propose a "Trucking as a Service" model, in which upfront costs are financed and paid back with fuel savings and LCFS credits. This option is detailed in Section 8.1.3.

Other concerns mentioned, grouped by topic, include:

- **Cost**
    - Participants perceived that leasing isn't an affordable option: $10,000 per month for a brand-new electric truck instead of $7,000 for a new diesel truck (a 43% increase in monthly payments). The Blueprint team shows a much more favorable economic picture with a Trucking as a Service model.
    - Depreciation concerns: Participants wondered whether HD ZEV truck values will diminish at a greater rate than those for a diesel HD truck.
- **Range anxiety**
    - 500 miles per day is not possible with current electric truck technology, which has top ranges of 300-350 miles currently (note: as of January 2023, Tesla has begun delivering electric trucks with 500-mile ranges).
    - Charging time for opportunity charging might infringe on hours of service (the number of hours a driver is legally allowed to drive each day).
    - Lines at the pump are already long, and it takes longer to charge a truck than to fuel it up.
    - Battery electric trucks are too heavy.

Hearing these concerns, the port assured attendees that it was committed to supporting drivers in the transition and agreed to hold another meeting to continue discussions and learn how it can best support drivers.

IOOs

IOOs are by their very nature independent. Consequently, it proved difficult to reach IOOs. With no local IOO organization in the San Diego region, the Blueprint team reached out to the Owner-Operator Independent Drivers Association (OOIDA). OOIDA is the international trade association representing the interests of independent owner-operators and professional drivers on all issues that affect truckers. With more than 150,000 members, OOIDA represents drivers in all 50 states and Canada, who collectively own and/or operate more than 240,000 individual heavy-duty trucks and small truck fleets. The mission of OOIDA is to serve owner-operators, small fleets, and professional truckers; to work for a business climate where truckers are treated equally and fairly; to promote highway safety and responsibility among all highway users; and to promote a better business climate and efficiency for all truck operators.

The Blueprint team spoke with the Director of the OOIDA Foundation. The OOIDA Foundation, Inc. is an affiliate of OOIDA, which allows it access to owner-operators and drivers in all states and Canada. The Mission Statement of the Foundation is to fight for the rights of truckers through research and education.

Drawing on 25 years of experience and the results of several internal surveys the organization has conducted in recent years, the Director laid out several concerns the organization has identified for IOOs in the ZEV transition. He echoed many of the concerns expressed in the port's outreach meeting identified the procurement cost of ZEVs as the single greatest concern for IOOs. Similar to what the Blueprint team heard at the port's outreach meeting, the Director felt that IOOs could not afford to purchase a vehicle that cost more than $120,000. He shared that many drivers struggle to make their lease payments each month and that maintenance savings realized over the lifetime of the vehicle were simply not enough to offset the additional upfront costs of procurement in the initial months and years. He further stated that many IOOs drive used vehicles, about 15 years old on average, because the cost of new (diesel) trucks was generally out of reach for them. Other concerns expressed by the OOIDA Foundation Director include:

- **Infrastructure**
    - Nationwide infrastructure will lag California significantly, making it very risky for long-haul

drivers to drive a ZEV.
    - Hydrogen infrastructure technology is not yet advanced enough for widespread adoption, making it less likely to be utilized in many places.
    - Many IOOs deliver to rural areas, while the major logistics companies deliver to urban areas. High-capacity chargers can be a significant drain on the grid in rural areas, making them unattractive or even non-viable in those areas.
- **Maintenance**
    - Drivers don't trust that ZEVs are as reliable as the OEMs say they are.
    - ZEV mechanics will be more expensive and more difficult to find because there are fewer of them.
    - Many drivers currently maintain their own vehicles, except major repairs, but they know nothing about maintaining ZEVs, and therefore expect to have to pay for maintenance that they currently do themselves, adding to the cost of maintenance.
    - Long-term savings in maintenance is a moot point because IOOs can't afford the upfront costs of ZEVs (note: this doesn't factor fuel savings, LCFS credits, funding and tax credit offerings, or models such as Trucking as a Service underwritten by these sources).
    - The COVID-19-induced global supply shortages of vehicles and vehicle parts would make replacement parts more difficult to get for ZEVs, while diesel-fueled vehicles could employ used parts while waiting for new ones.
- **Vehicle Depreciation**
    - ZE Vehicle depreciation is unknown and possibly unpredictable.
    - Diesel vehicle depreciation will be adversely affected by California ZEV regulations.

- **Miscellaneous**
    - Hydrogen fuel is dangerous and would increase the risk to the driver while driving and refueling.
    - Drayage trucks get paid per trip/delivery; times spent charging would infringe on the number of trips/deliveries (note: opportunity charging deployed widely at POSD and at customer locations served by drayage trucks would help solve this problem).
    - Drivers don't trust the government. They've seen environmental regulations impact their operations before and it was worse than the government said it would be, with the supply of required technologies unable to meet demand and drivers being forced out of business (sometimes permanently) while supply and government exemptions caught up.

The Director also shared some suggestions and observations with the Blueprint team, including:

- California might consider making exemptions to various ZEV regulations for vehicles that don't operate more than a certain number of miles in California per year.
- AB5 may have significant impacts on driver classification, and this should be considered when planning funding and other support for driver-owners.
- A hybrid vehicle might alleviate many IOO concerns.
- Drivers might consider drop-and-hook solutions to comply with the ZEV Port registrations requirements (see below for a note on drop-and-hook solutions).
- Drivers are on the front lines and not opposed to cleaning up truck emissions, as they're the first to breathe them, but their priority will always be paying their bills and supporting their families.

"Drop-and-hook" is the trucking industry's term for when a driver drops a full container at a facility and hooks their tractor to a pre-loaded trailer at the same facility. In the case of using drop-and-hook as a solution to compliance with proposed ZEV port registration requirements, the Director explained that drivers of non-ZEVs would drop their trailer at or near a port entrance where a ZEV truck would pick it up to deliver it to its destination.

5.3 ZEV Fuel Providers

Electricity and hydrogen providers represent the producers and providers of fuel for ZEVs. Both electricity and hydrogen are produced and distributed in formats that significantly deviate from gasoline and diesel. Given the significantly greater levels of current and projected access to electric charging compared to hydrogen MHD fueling stations—particularly for IOOs—the primary fuel focus of this Blueprint is on electricity. Accordingly, outreach was conducted solely to electricity providers. See Section 6 for a discussion of the state of hydrogen trucks and construction of hydrogen refueling infrastructure.

Electricity providers include utilities, community choice aggregators (CCAs), and microgrid service providers. Generally, electricity service consists of two primary components: generation and transmission + distribution. The two agencies that provide service to the City of National City are SDG&E and the CCA San Diego Community Power (SDCP), with SDG&E providing generation and transmission services while SDCP provides generation only. SDG&E is also the primary service provider to POSD. SDG&E maintains ownership of the infrastructure and will manage installation and modification of infrastructure in the area and at the three National City sites evaluated in this Blueprint. Accordingly, the Blueprint team met with a Senior Customer Solutions Advisor in SDG&E's Clean Transportation program, Lianna Rios, to discuss:

- Tariff Requirements
    - Site plans
    - Improvement plans
    - Project-approval and permit conditions
        - Utility design
        - Construction activities
    - Load considerations
- Applicable rate schedules and fixed costs
- Grid conditions and service delivery
    - Current infrastructure
- Infrastructure cost and timelines
- Utility Specific ZEV and Customer Resources
    - Customer account manager(s)
    - ZEV programs and personnel

The Blueprint team learned that SDG&E has several clean transportation programs, including Power Your Drive for Fleets (PYDFF). PYDFF was designed to support charging infrastructure for MHD electric vehicles.

The PYDFF program includes a $107 million budget over five years, and a goal of serving 3,000 new MHD EVs at more than 300 customer sites throughout SDG&E’s service area. The PYDFF program offers two different ownership options as shown in Figure 3. For primary service or associated distributed generation projects, Option 2 is required. Under Option 1, the utility side (in front of the meter) and customer side (behind the meter) electric infrastructure are 100% funded, constructed, owned, and maintained by the utility. Under Option 2, the utility side is 100% funded, constructed, owned, and maintained by the utility. The customer side is funded, constructed, and maintained by the customer and the utility will pay up to 80% of the cost of the customer side infrastructure (as determined by SDG&E).

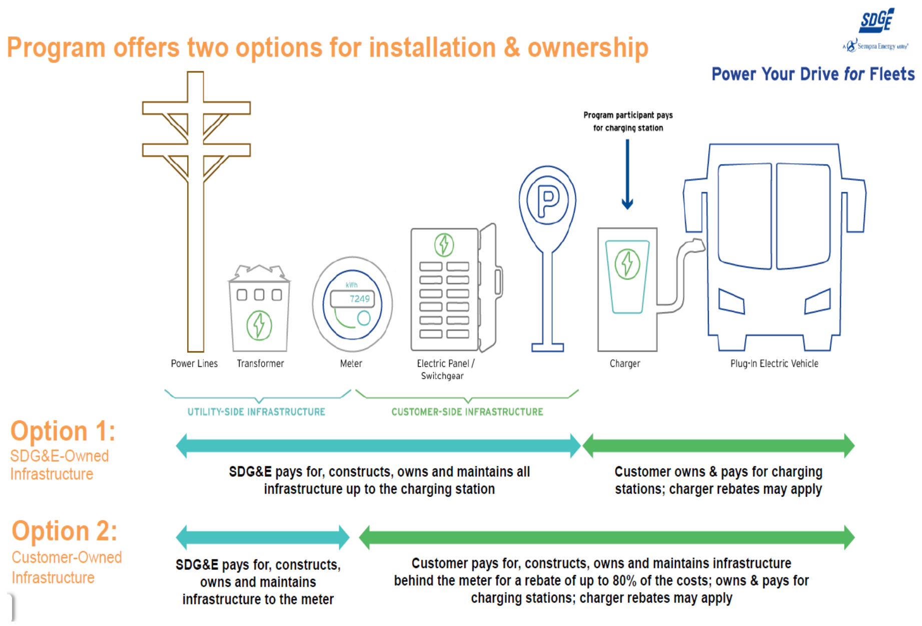

Figure 3: SDG&E PYDFF options for installation and ownership.

To be eligible for the PYDFF program, an applicant needs to: 1) demonstrate a commitment to procure a minimum of two electric fleet vehicles and demonstrate a long-term electrification growth plan; 2) operate and maintain electric vehicles for a minimum of 10 years; 3) own or lease the property where chargers are installed and provide an easement, if required, for utility facilities; and 4) provide data to SDG&E related to charger usage for a minimum of five years. To qualify for a charger rebate of up to 50% of the cost of the charger, the charger must be used for school buses or transit buses or be located at sites in disadvantaged communities, as are all three National City sites analyzed in this Blueprint. Chargers of the size required for heavy-duty vehicle charging (150.1+ kW) qualify for a rebate of $75,000.

Under the PYDFF program, customers are provided "white glove" service by a team of professionals solely dedicated to the promotion and installation of EV charging infrastructure. As demonstrated in **Figure *4***, each project usually takes 11-16 months to complete, depending on the adequacy of existing electrical infrastructure in relation to the planned electrical charging load.

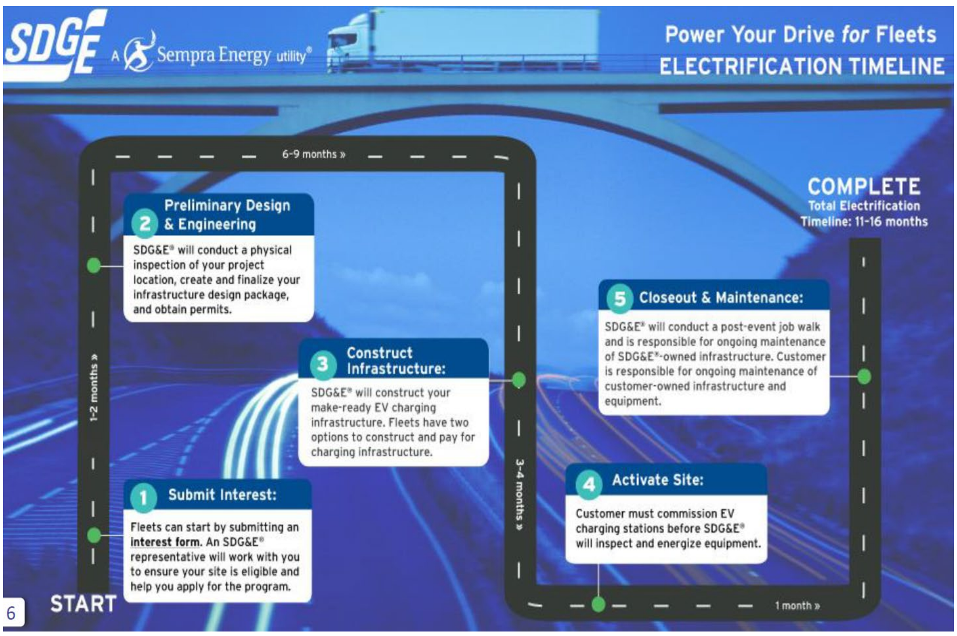

Figure 4: SDG&E's PYDFF electrification timeline.

To better manage EV charging costs, SDG&E provides an optional Electric Vehicle high Power (EV-HP) rate, which requires EV chargers to be placed on a dedicated meter. The EV-HP rate eliminates demand charges, simplifies billing, and allows EV fleet customers to choose the amount of power they need to charge their vehicles and pay for it with a simple, predictable monthly subscription fee. See Appendix E for more information on the EV-HP rate. SDG&E does not currently have a cap on the amount of funding provided to MHD charging project sites. SDG&E is, however, weighing such a cap, whether based on installed electrical capacity or total funding per site, to stretch program dollars further.

In addition to the PYDFF program, the recently approved California Public Utility Commission (CPUC) Rule 29 allows SDG&E and other California utilities to pay for EV Charging Infrastructure on the utility side of the electrical meter, with costs borne by all ratepayers rather than the EV charging developer alone. Rule 29 allows SDG&E to install, own, and maintain the "make-ready" equipment upstream of the customer meter. Examples include transformer and electrical conductors, construction work like trenching and repaving a parking lot, and service-related ducts and structures.

5.4 Local Jurisdictions

An array of permits, approvals, and contracts are typically required by local jurisdictions for applicants seeking to deploy ZEV charging infrastructure, including the California Environmental Quality Act (CEQA) and various zoning, land-use, building, fire marshal, and air permits. Local jurisdictions are grounded in the needs of their communities, and as such were an invaluable asset to this project. Outreach to local jurisdiction partners explored permitting processes, including the status of compliance with AB 1236 requirements, as well as zero-emission and climate policies adopted.

City of National City

National City is a city located in the South Bay region of the San Diego metropolitan area, in southwestern San Diego County, California. The population was 56,173 in the 2020 census, down from 58,582 in the 2010 census.[8] National City is the second-oldest city in San Diego County, incorporated in 1887. The City borders POSD and is a port member city. The drayage truck industry is a vital component of maritime operations for National City's working waterfront.

Poor air quality due to port operations has been of considerable concern to the city due to negative impacts on public health. Census tracts in the vicinity of POSD and throughout National City are ranked poorly in the CalEnviroScreen 4.0 Disadvantaged Communities (DAC) tool, where scores are a function of pollution burden and socioeconomic factors.

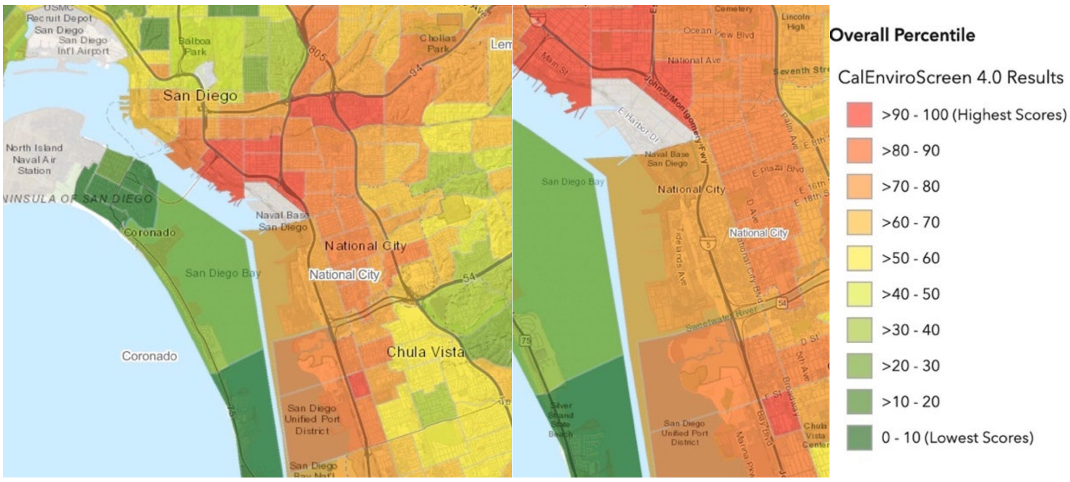

Figure 5: CalEnviroScreen 4.0 DAC map of National City census tracts.

[8] https://en.wikipedia.org/wiki/National_City,_California

According to Environmental Health Coalition, residents of Westside (Old Town) neighborhoods near the POSD are "burdened with more pollution than 97% of California, according to CalEnviroScreen 4.0. With the Marine Terminal operations creating pollution, in addition to the heavy-duty diesel trucks driving to and from the Terminal, residents breathe more diesel-polluted air than 90% of the state. Exposure to pollution has been shown to cause breathing problems, chronic diseases, and low birth weight. The percentage of low birth weight in the Westside is higher than 84% of California and children's asthma hospitalization rates in National City are more than double the county average." 90% of Westside residents are Latinx, 70% are renters, and almost a quarter live below the poverty level. [9]

The adjacent Barrio Logan neighborhood is described by EHC as "a vibrant hub of Chicano culture." EHC asserts Barrio Logan has a history of experiencing environmental racism which continues to affect the people who reside there. According to EHC, "due to the toxic, polluting industries in Barrio Logan and the freeway running through it, it is in the top 5% most polluted areas in California. It has the highest diesel pollution in San Diego County. According to the EPA, Barrio Logan residents have an 85%-95% higher risk of developing cancer than the rest of the United States. On top of these health concerns, long-time residents are now being displaced by rising rents and gentrification." [10]

The City of National City is in the process of updating its Climate Action Plan (CAP), including analysis of the effectiveness of the strategies in its 2011 CAP. The 2011 CAP addressed the major sources of greenhouse gas (GHG) emissions in National City and set forth a detailed and long-term strategy that the city implemented to achieve a GHG emissions reduction target of 15% below 2005 baseline emission levels by 2020 in support of the city's and state's goals. The CAP was also utilized for tiering and streamlining development within the city and aligned with the land use, transportation, infrastructure, and public investment goals of the San Diego Association of Governments (SANDAG) Regional Transportation Plan.[11]

The 2011 CAP identified transportation as the sector responsible for the greatest percentage of community-wide GHG emissions (62% of an estimated 9.9 MTCO2e). Citing state policies aimed to reduce GHG emissions in the transportation sector (AB 1493 and EO S-01-07), the City forecast transportation-sector-related GHG emissions to decrease from 359,029 MTCO2e in 2005 to 321,256 MTCO2e by 2020. [12]According to a 2019 report, titled "City of National City Greenhouse Gas Emissions Inventory and Projections," by the Energy Policy Initiatives Center (EPIC), the City saw transportation-related emissions drop 43% (to 208,900 MTCO2e), despite the sector still accounting for 62% of community-wide emissions. [13]The City continues to prioritize a reduction in transportation sector-related GHGs to improve public health.

While National City has complied with AB 1236 requirements to streamline permitting for residential and non-residential electric vehicle charging stations within the City, the three sites evaluated in this Blueprint are on POSD property within the City of National City in San Diego County. Site development therefore requires consultation with three permitting agencies. In a meeting with the city's Planning Department, the Blueprint team learned that 1) the city is responsible for issuing the building permit (which also includes compliance with National City Fire Department standards); 2) the port is the Lead Agency under CEQA and is responsible for issuing the land use permit; and 3) the San Diego Air Pollution Control District (SDAPCD) is responsible for issuing any air permits that might be needed. Meetings with the port and the SDAPCD confirmed this; all agencies agreed to work together in support of the development of heavy-duty ZEV supporting infrastructure in the area.

The Blueprint team concluded that the City of National City is an actively engaged community, intent to support the growth of the local clean energy economy, including deployment of ZEV drayage trucks and

[9] https://www.environmentalhealth.org/communities/national-city/
[10] https://www.environmentalhealth.org/communities/logan/
[11] https://www.nationalcityca.gov/services/documents/general-plan/climate-action-plan
[12] https://www.nationalcityca.gov/home/showdocument?id=6785
[13] https://www.nationalcityca.gov/home/showpublisheddocument/23174/637120864527600000

charging infrastructure in a way that works for all community residents.

Port of San Diego

POSD is a seaport in San Diego, California. It is located on San Diego Bay in southwestern San Diego County, California, and is a self-supporting Special District established in 1962 by an act of the California State Legislature. It is charged with implementing the Tidelands Trust Doctrine. In addition to port activities, the Port District controls San Diego Bay and owns and manages the Bay's immediate waterfront under the state's Tidelands Trust. The port brings in nearly 3 million metric tons (3,000,000 long tons; 3,300,000 short tons) of cargo per year through the Tenth Avenue Marine Terminal and the National City Marine Terminal.

In 2021, the POSD Board of Port Commissioners adopted its Maritime Clean Air Strategy (MCAS) to help identify future projects and initiatives to improve health through cleaner air for all who live, work, and play on and around San Diego Bay, while also supporting efficient and modern maritime operations. The MCAS and its vision, “Health Equity for All,” represent the Port’s commitment to environmental justice. The MCAS is more ambitious than any other clean air policy document of its kind in the state, with nearly all goals and/or objectives going beyond what is currently required by the State of California. The Port is actively implementing the MCAS and its Truck Transition Plan.

The three National City sites evaluated in this Blueprint are zoned for medium- or heavy-duty industrial uses and likely will not require re-zoning for the type of development proposed in this project. The port is the CEQA lead agency and monitors and enforces conditions of approval in project reviews and CEQA/Coastal documents. Further, the Port:

- Oversees preparation and processing of CEQA documents for Port and tenant projects
- Prepares environmental review language for Board of Port Commissioner agendas
- Prepares and processes CEQA and Coastal Determinations for Port and tenant projects
- Prepares and processes Coastal Development Permits for Board review
- Coordinates project reviews and information as needed with the California Coastal Commission
- Coordinates as needed with Planning & Green Port to ensure consistency with the Port Master Plan
- Prepares and processes Port Master Plan Amendments (except those which are processed by Planning & Green Port for comprehensive Port Master Plan updates and location-specific planning initiatives)
- Coordinates with other Port departments and other public agencies

San Diego Air Pollution Control District

SDAPCD is a government agency that regulates sources of air pollution within San Diego County. Its mission is to improve air quality and to protect public health and the environment. SDAPCD:

- Evaluates and issues air quality permits, maintains the ambient air monitoring network, and records air quality readings and forecasts
- Ensures that regulated sources operate in compliance with permit conditions and all applicable regulations
- Prepares long-term regional plans to reduce unhealthful pollution levels and develop air quality rules
- Administers a few state and local funding programs to reduce emissions, primarily from mobile sources.

The team met with the SDAPCD to discuss its role in the development of MHD ZEV Infrastructure and learned that a charging-only facility would likely not require an air permit. The representative the team met with was unsure about the rules regarding hydrogen refueling and promised to follow up.

In addition to informing our team of the permitting process, SDAPCD informed the team of several funding opportunities it administers and through which it has distributed over $127 million dollars to reduce total pollutants (Volatile Organic Compounds (VOC), Nitrogen Oxides (NOx), Carbon Monoxide (CO), Particulate

Matter (PM)) by more than 1,700 tons per year. More on this can be found below in the section on regulatory agencies (Section 5.7 and Appendix F).

5.5 Community-Based Organizations (CBO)

CBOs represent the communities situated in proximity to the proposed ZEV supporting infrastructure. Generally, CBOs are expected to be supportive of the transition away from fossil- fueled vehicles. Outreach to CBO partners was conducted to explore:

- Goals, objectives, concerns, and priorities of the community in the ZEV transition
- How to equitably support the ZEV transition in their communities
- Challenges to deployment of ZEVs today (community concerns, cost, lack of infrastructure, duty cycle restrictions)
- Ways for CBOs to collaborate to support ZEV adoption

The EHC is a community-based organization that works for environmental justice in the San Diego/Tijuana region and throughout California. Founded in 1980, EHC has worked to reduce pollution and improve health and well-being for thousands of people in underserved, low-income communities. EHC is actively engaged in another CEC Clean Transportation Program Blueprint project with SANDAG. Due to resource constraints, EHC did not have the capacity to engage significantly on this Blueprint project, but the Executive Director responded to a survey prepared by the Blueprint team and directed the team to its website for more information on their perspectives regarding development in the communities of National City and Barrio Logan.

5.6 Native American Tribes

There are 104 federally recognized Tribes in California[14] located throughout the state. As an integral part of the fabric of California, engagement with local Tribes is critical to understanding impacts and opportunities that a business has within its community. Members of local tribes are likely to be affected by the transition to ZEVs, and this stakeholder group has been under-recognized. There may be opportunity for concerted engagement to determine pathways to development given Tribes' active influence in the community.

To ensure appropriate engagement, the Blueprint team consulted relevant sections of the California Natural Resources Agency's Tribal Consultation Policy. Outreach to the local Tribe was conducted in an attempt to illuminate tribal concerns and, more specifically, to explore:

- Opportunities to engage the workforce within Tribes to support ZEVs
- Values of reducing the carbon intensity of goods movement

The Sycuan Band of the Kumeyaay Nation has a presence in the case study area but has not responded to phone calls and voicemails. The Sycuan Band website lists no email addresses for the Sycuan Tribal Development Corporation or any members of its Board of Directors or other departments.

5.7 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 will be critical to early adoption of zero-emission technologies ahead of full market commercialization.

Outreach to policymaker and agency stakeholders was conducted to explore:

- Discussion of relevant policies, regulations, and technical reports
- Discussion of relevant funding and technical assistance programs

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[14] https://www.ihs.gov/california/index.cfm/tribal-consultation/resources-for-tribal-leaders/links-and-resources/list-of-federally-recognized-tribes-in-ca/?mobileFormat=0

- Progress toward 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.

There are many ways for entities to relate to and build relationships with local, state, and federal agencies. Public agencies have dual purposes of serving constituents to provide public benefits and advancing goals across varying levels of government and interest sectors.

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 advance the agency's overarching goals. Many entities seek funding from public agencies to help offset the high costs associated with deploying clean and sustainable technology, new industry, and new markets on the path towards large-scale adoption and commercialization. **Figure *6*** 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), RFIs, funding opportunity announcements (FOAs), solicitation releases, and notices of proposed awards (NOPAs) throughout the year.

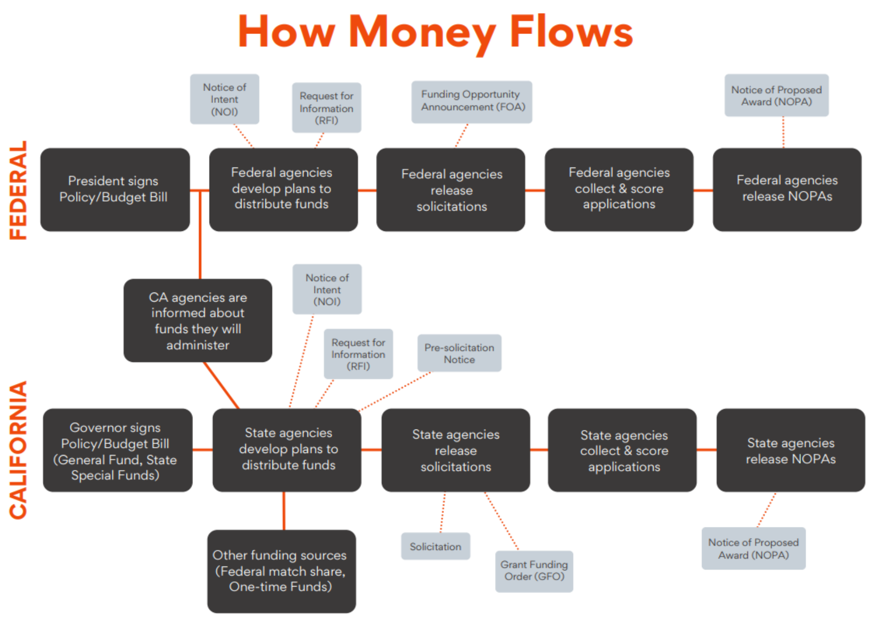


Figure 6: How federal and state money flows.

While public agencies provide a key source of early-stage funding, many offer other ancillary services and resources such as:

a. Project and partner development support, including alignment with overarching agency goals

b. Identification of priority communities and their unique challenges and opportunities, including providing resources to support capacity building
c. Project site identification and prioritization
d. Delivery of planning and action-oriented reports, data reporting and metrics, data synthesizing, and other technical assistance functions
e. Thought leadership on long-term government investment, including local, regional, state, and federal-level planning and coordination and other advisory services
f. Ability to serve as a prime or sub applicant on a grant, incentive, or technical assistance application

Additionally, continuously relating to 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 that also act as partners invested in project 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 way to achieve this goal is through participation in proactive and "pre-capture" activities (activities that take place leading up to a solicitation release or other firm outcome or decision 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.

Figure 7 outlines steps entities can take to continuously engage with key agencies that relate to their work, while responding to an evolving clean transportation sector landscape:

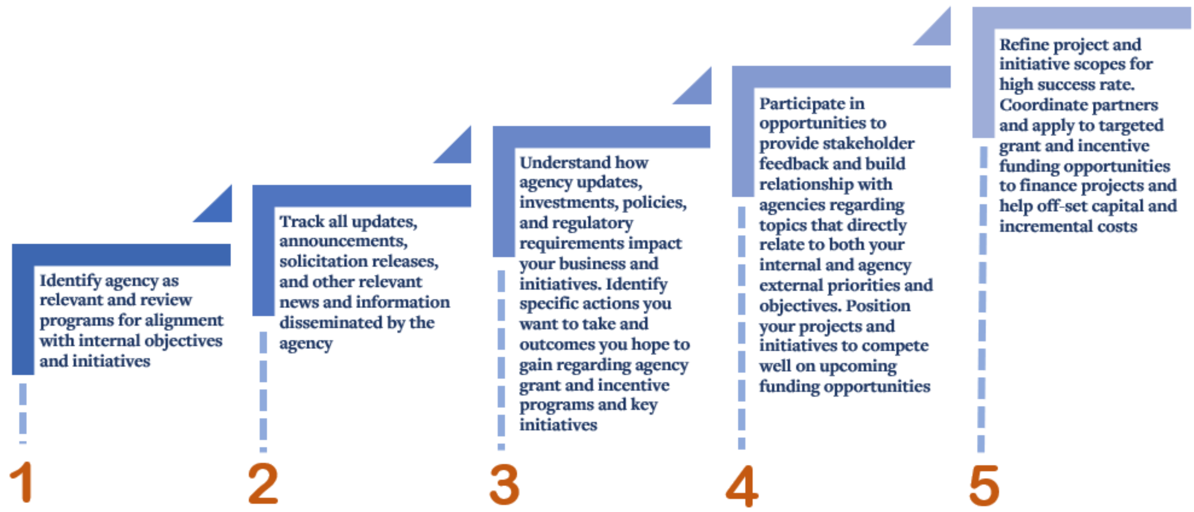


Figure 7: Steps to take to engage with agencies for funding.

Pre-capture activities lay a foundation for downstream activities, including grant and incentive capture, grant application and proposal development, award, and implementation or grant management service (GMS), shown below in **Figure 8**. 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 as well as in additional activities (including attending workshops, meetings, conferences, and site tours) throughout the year to maintain active engagement with agency partners.

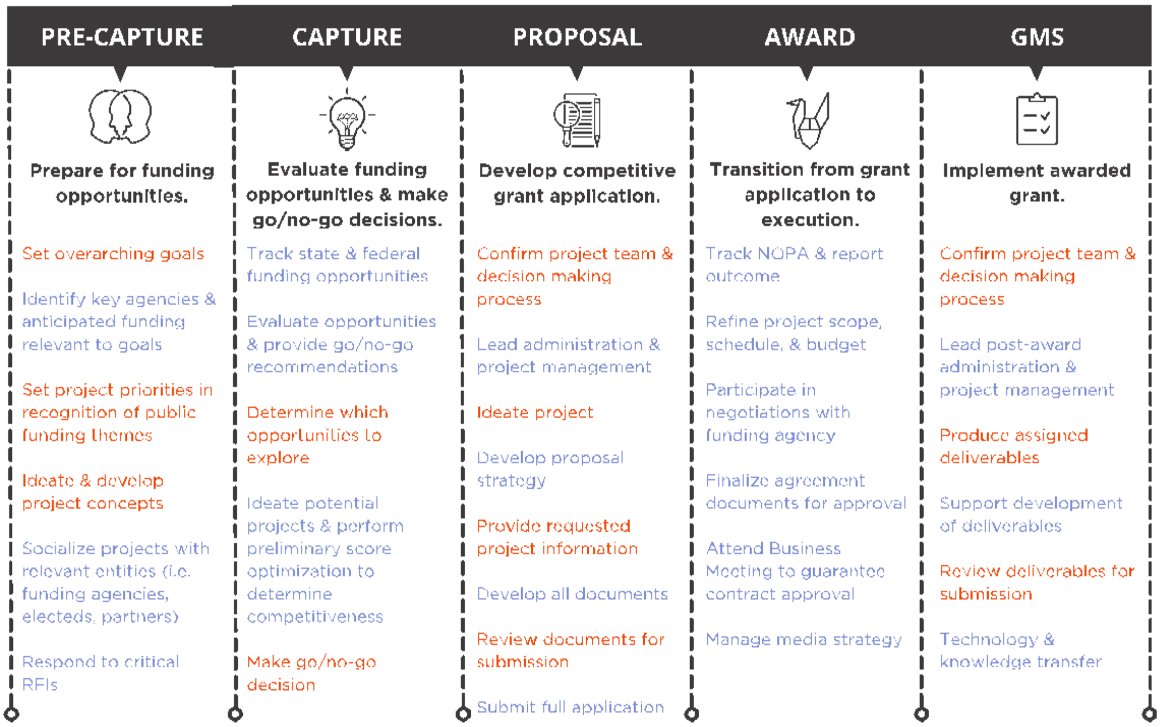


Figure 8: Project funding stages.

California MHD Clean Transportation Agencies and Programs

To advance its many environmental and clean energy policies, California has developed a well-established ecosystem of incentive opportunities, funding programs, and financing mechanisms to offset the capital and operational expenses associated with the deployment of advanced energy and zero-emission transportation technologies. California's cleantech funding ecosystem is rather unique in that it extends beyond state-level incentives to include many opportunities at the local and regional levels.

See Appendix F for an overview of the relevant funding, research, and investment programs under each of the following agencies as well as descriptions of how each agency interacts with the clean transportation ecosystem and to organizations and blueprints:

- California Energy Commission
- California Air Resources Board & Local Air Quality Management Districts
- California Public Utilities Commission and Utilities
- California Transportation Committee
- California Department of Transportation
- California Alternative Energy and Advanced Transportation Financing Authority
- California Pollution Control Financing Authority
- California Infrastructure and Economic Development Bank
- Local Utility Programs
- Office of Business and Economic Development
- Governor's Office of Research and Planning
- California Labor and Workforce Development Agency

5.8 Financial Partners/Investor Partners

Financial partners /investor partners can vary from government agencies to traditional financial institutions to specialized financial business to individual investors and more. Others, including economic development agencies, may be valuable secondary financial partners/investor partners as projects move forward. The Blueprint team focused outreach on private investor firms and asset management firms, including those that are planning to offer Trucking as a Service (TaaS) models.

The team conducted a high-level survey with targeted financial partners. The team met virtually with a market leader in energy technology/asset management firm and with a leading investor firm to discuss following:

- Investment appetite for the ZEV infrastructure market
- Core drivers for ZEV infrastructure investments
- Outlook on growth in MHD ZEV investment opportunities
- Barriers to the MHD ZEV charging market
- Risk pertaining MHD ZEV investments
- Importance of federal and state funding in the investment decision-making process
- Importance of utility partnerships for investors
- Examination and views on funding mechanisms to finance capital upgrades for large scale MHD ZEV fleet conversions in both the private and public sector
- Barriers to concurrent MHD ZEVs and EVCS procurement
- Examination of public private procurement methods to purchase fleet vehicles using public funding and private financing.

Through outreach, the Blueprint team learned that:

- The primary drivers for ZEV infrastructure investments include:
    - Return on investment
    - Sustainability driven company mission
    - Federal and state regulations
- The biggest market barriers to the MHD ZEV charging market include:
    - Vehicle availability
    - Cost of entry
    - Complexity of electrical system integration
    - Vehicle range
    - Fueling integration with fleet operations
    - Space constraints
    - Operational inertia
- The perceived risks of ZEV financing include:
    - Technology obsolescence
    - Performance of unproven technology
    - Unrealistic performance and cost expectations
    - Proliferation of early-stage technology providers.

5.9 Vehicle and Equipment Manufacturers

There are a wide variety of vehicles and equipment (e.g., charging and refueling) manufacturers with products that support the ZEV transition. Each product under development has different abilities and capabilities which are expected to develop over the next decade as battery and fuel cell technologies advance. Engagement with OEMs and Distributors on the best way to evaluate these technologies is critical to the successful ZEV transition. Momentum conducted outreach to a wide variety of OEMs and service providers through meetings, calls, webinars, and engagement at the 2022 Advanced Clean Transportation (ACT) Expo ("ACT Expo").

Outreach to these stakeholders included discussions on the following topics:

- Technical specifications, today and future technology iterations

- Product development efforts
- Demonstration partners and references
- The level of integration, coordination, or collaboration the OEM has with advanced technology developers
- Supply chain constraints
- Warranty offerings
- Repair and maintenance capabilities

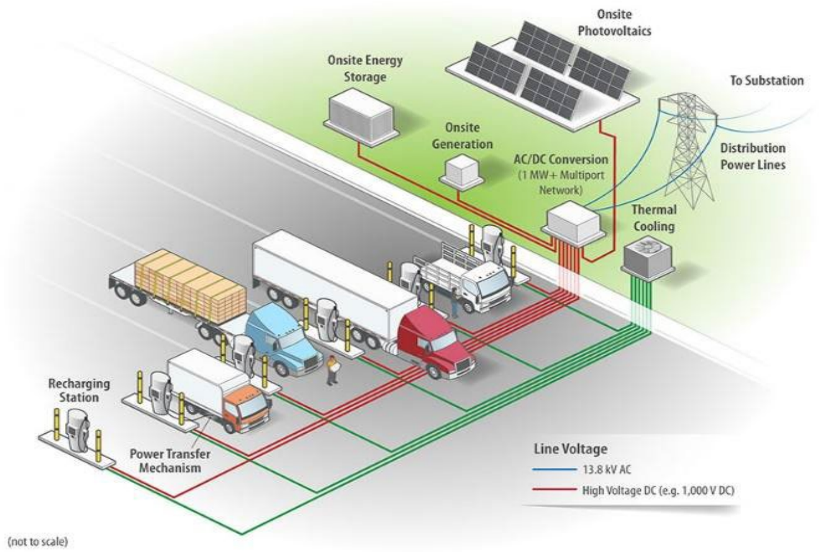


Figure 9: EV charging infrastructure (NREL).

MHD ZEVs: At least 12 companies have MHD ZEVs ready for deployment in 2023. Advertised tractor ranges are between 100 and 500 miles per vehicle, with charge times ranging between 60 and 270 minutes. Tesla unveiled its tractor trailer with a range of 500 miles in December 2022. ZEV battery capacities range from 280 to 800 kilowatt hours (kWh), with an average of 450 kWh. Many OEMs sales representatives stated that supply chain challenges will delay the availability of most tractors/trucks until 2023.

Nearly all trucks use CCS1 charging ports, while some have dual ports that offer CCS1 and CHAdeMO. High curb weights resulting from the large battery packs in electric trucks remain a concern for truckers hauling heavy loads. Range limitations combined with long charge times and limited public DC high-powered chargers limit the usefulness of many trucks to short haul or drayage operations, which aligns with the IOO drayage use cases envisioned in this Blueprint.

Heavy-duty ZEVs are significantly more expensive than existing diesel models but the cost can be partially to fully offset by incentives and vouchers such as the California Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP).[15] Nearly all OEMs interviewed provide warranties for their vehicles. In general, OEMs are motivated to support uptake of their new technologies and address this by including service contracts to allay consumer concerns over implementing a new system. For example, the Port of San Diego partnered with TransPower, Efficient Drivetrains, and BYD on electric vehicle and equipment demonstration projects through a CEC grant.

[15] https://californiahvip.org/

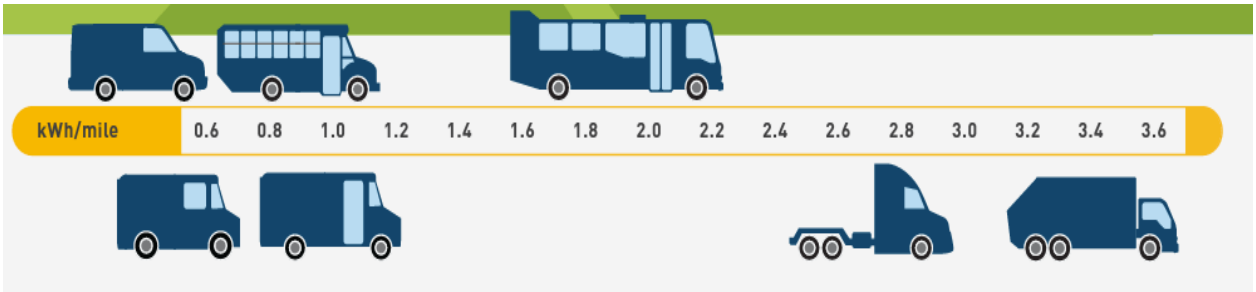


Figure 10: Typical EV energy consumption rates for medium and heavy-duty vehicles (PG&E).

MHD Charger Providers: Charger OEMs and service providers are working to develop faster and higher-powered chargers but are limited by the inability of trucks to accept high charge rates. Most manufacturers create chargers that can supply more power than existing EV batteries can handle. Manufacturers' current high-power chargers range from 120 kW to 500 kW, with an average among those interviewed for the Blueprint of 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 expect to incorporate this standard into their systems as soon as possible, most vehicle OEMs contacted have not provided a deadline for when battery-electric trucks will be able to accept this rate of charge.

Charger providers employ a range of business models ranging from selling chargers, to installation, to third-party operations and metering. Nearly all charger providers offer or require a maintenance contract and warranties. Most charger OEMs said their products are available for installation on demand. Vehicle-to-Grid (VGI) capabilities are not widely available on the market yet. Multiple charging companies are, however, developing or undergoing pilot programs for utilizing this technology with fleets.

5.10 Industry Partners

Industry partners are defined in this Blueprint as external private-sector organizations that are expected to interact with proposed ZEV technologies. These can be business partners, supply chain partners, and customers. Outreach to these stakeholders included:

- Value of ZEVs to business models and sustainability efforts
- Opportunities to collaborate on charging/fueling infrastructure
- Opportunities for shared investment

San Diego Working Waterfront

Formed in 1989, the San Diego Working Waterfront (formerly the San Diego Port Tenants Association) is a coalition of businesses and industries dedicated to enhancing trade, recreation, commerce, and tourism on San Diego Bay's tidelands, while protecting the area's environment.

An analysis on the "Economic Impacts of the San Diego Unified Port District" for FY2017 reported the Port's direct and indirect contribution to regional employment is 70,000 jobs, making it the second largest employer in San Diego County. The businesses located within the Port District's boundaries generate $9.4 billion annually in regional economic impact. Working Waterfront membership includes representatives of manufacturing, ship building and repair, shipping and trade, marinas, commercial and sports fishermen, energy, the cruise ship industry, yacht clubs, aerospace and airport industries, the hospitality industry, and the U.S. Navy.

The Working Waterfront won a $6 million grant in 2016 from the CEC to electrify cargo handling vehicles being operated by six working waterfront port tenants and to develop an ITS for trucks on terminal adjacent roads. The San Diego Port Sustainable Freight Demonstration Project has been successful in reducing travel time and GHG emissions and will continue to enhance market acceptance and deployment of a range of advanced vehicle technologies that provide environmental and socioeconomic benefits for disadvantaged communities.

The Working Waterfront team was enthusiastic about the STC Traffic Blueprint effort and made suggestions for siting considerations and funding opportunities. It also offered to inquire with their tenants about possible sites for charging infrastructure installation and to review technical tasks.

Teamsters Local 542

The Teamsters is the largest union in the United States. In 1903, the Teamsters started as a merger of the two leading team driver associations. Today, the Teamsters are known as the champion of freight drivers and warehouse workers, but they have also organized workers in virtually every occupation—professional and non-professional, private sector and public sector.

Local 542 represents workers in the San Diego region with significant representation of freight drivers and port workers. The Blueprint team reached out to the organization via email for input in the Blueprint process. A representative called a Blueprint team member and asked to not be identified in any documents. His concerns were largely with the misclassification of some drivers as IOOs as it relates to Assembly Bill 5 which went into effect in June 2020 and extends employee classification status to some workforce participants that were previously considered independent. The bill, the Teamsters representative said, was aimed at gig workers like Lyft, Uber, and DoorDash, and has been widely criticized in the freight and global logistics industry.

San Diego Regional Economic Development Corporation

San Diego Regional Economic Development Corporation (SDEDC) is an independently funded, non-profit economic development organization that mobilizes business, government, and civic leaders around an inclusive economic development strategy to connect data to decision making, maximize regional prosperity, enhance global competitiveness, and position San Diego effectively for investment and talent.

Launched in 2018 and informed by a partnership with the Brookings Institution, SDEDC's Inclusive Growth Initiative informs San Diego's economic priorities and makes the business case for economic inclusion. SDEDC believes the innovation economy will continue to make San Diego more prosperous than many of its peers, but it is not accessible to the fastest-growing segment of the region's population. SDEDC has identified the mismatch between its regional assets and the future needs of the economy as a cause of erosion of the region's competitiveness. To fuel San Diego's recovery and growth, SDEDC is committed to developing a regional coalition of diverse stakeholders who are likewise committed to programs that are demand-driven, employer-led, and outcomes-based.

SDEDC offers business services free of charge to companies looking to expand, stay, or locate in the San Diego region. Business services offered include:

- Regulatory/Permitting Support
- Economic Incentive Consulting
- Strategic Partnerships
- Inbound Investment Support
- Talent Pipeline Development
- Marketing/Visibility
- Export/Logistics Consulting
- Expansion Services/Site Selection
- Intelligence/Research
- Market Strategy

SDEDC's Manager of Economic Development and Inclusive Growth expressed interest in continuing to engage with this Blueprint project, and to support IOOs and small fleet owners in the HD ZEV transition. She agreed to discuss the broader heavy-duty ZEV transition in San Diego with her team for strategic development of support services.

CALSTART

CALSTART is a national nonprofit that works with its member companies and agencies to build a high-tech clean-transportation industry that creates jobs, cuts air pollution and oil imports, and curbs climate change. CALSTART works with the public and private sectors to knock down barriers to innovation and progress and to drive the transportation industry to a clean and prosperous future. CALSTART accelerates the pace of technology and is a market-building organization. The organization worked with CARB to design and launch HVIP, which provides point-of-purchase incentives (vouchers) that discount the purchase price of advanced technology trucks and buses to California fleets. CALSTART serves as administrator for HVIP, issuing thousands of vouchers for advanced technology vehicles in the state every year.

CALSTART's Fleet Technical Assistance team met with the STC Traffic Blueprint team to discuss a new initiative they are rolling out in support of small-fleet owners and independent owner-operators across California as they navigate incentive programs like HVIP and Energiize (Energy Infrastructure Incentives for Zero-Emission) Commercial Vehicles Project. CALSTART also assists in the integration of financing tools for drayage fleets and the buildout of financing programs tailored toward small drayage fleets. CALSTART staff further expressed dedication to increasing engagement with smaller fleets, community-based organizations, and disadvantaged communities through its Transforming Trucks Transforming Communities (TTTC) initiative. While CALSTART is currently in the process of building out these programs, it agreed to follow up with the Blueprint team once they have developed materials to share with drivers and fleet owners.

The CALSTART team expressed concerns that public-facing MHD ZEV infrastructure facilities might not be accessible to IOOs and small fleet owners and urged the Blueprint team to consider a recommendation that the State consider funding the deployment of charging stations on private lots where many IOOs park overnight. More details on this recommendation are expected in the materials CALSTART is developing for public use.

5.11 Stakeholder Engagement Conclusions

The large number of stakeholders involved in the Port of San Diego's operations presents a challenge and an opportunity for transitioning to a zero-emission future. The independent and decentralized nature of the IOO trucking industry elevates the importance of continued engagement with community and industry stakeholders.

The following have been identified as primary challenges for IOOs and small fleet owners to make the ZEV transition:

1. Economic barriers for IOOs. The upfront cost of trucks is exceedingly prohibitive to this demographic. Support programs such as those being developed by CALSTART, and innovative financing models such as Trucking as a Service, will help overcome this barrier.
2. Uncertainty and confusion regarding such issues as reliability, operations and maintenance, and costs of ZEVs .
3. Logistical challenges of EV operations (charge times, range limitations, infrastructure siting).
4. Uncertainty surrounding the effect of technological developments on the value of initial investments in charging infrastructure and vehicles.

The good news is that a myriad of public and private project partners, manufacturers, agencies, and organizations expressed commitment to accelerating the transition to zero-emission MHD vehicles in a way that works for all. The thoughtful insights and recommendations that were used to shape the Community and Stakeholder report will help turn these commitments into tangible benefits for IOOs and all the communities they pass through day in and day out.

6 MHD ZEV Technologies

6.1 Battery Electric Heavy-Duty Trucks

6.1.1 Battery Energy Density Trends

EV battery capacity is measured in kilowatt-hours (kWh). EV battery weight increases with capacity and can impact allowable freight truck limits (the gross weight limit in California = 82,000 pounds (lbs.) for BEVs or 95,000 lbs. along a heavyweight corridor). Current industry average battery packs have a density of 66 lbs./kWh. [16] Lithium-Ion battery energy densities have tripled, and prices have fallen 90% since 2010.[17] In the next five years, commercially available battery technologies are not expected to change drastically, but incremental improvements in energy densities are likely. A wide range of battery chemistries under development could result in energy densities increasing from 2 to 4 times in the next several decades. The charging rate of an EV battery is limited by battery chemistry. Most class 8 truck batteries can currently charge at a rate of 100 to 250 kW and cannot accept charge rates available at the high end of current charging station capacity (500 kW or more) without the vehicle's software capping the rate of charge or the battery degrading at a faster rate.

6.1.2 Battery-Electric Truck Weight and Range

Because battery capacity and weight are directly linked, and capacity determines range, electric trucks have a tradeoff between range and maximum payload. Battery-electric trucks (BETs) weigh between 20,000 and 40,000 lbs., with heavier batteries needed for longer ranges. [18] Conventional trucks typically weigh around 17,000 lbs.,[19] and most BET model equivalents are around 5,000 to 8,000 lbs. more than a conventional truck. BETs with smaller batteries (and therefore ranges) will have comparable payloads to conventional trucks, while trucks with larger battery capacity will have longer ranges but will require smaller payloads and take longer to fully charge. Because short- and regional-haul BETs can carry larger payloads, they are expected to reach cost parity with diesel trucks before long-haul trucks.

6.2 Charging Technologies

A variety of chargers with varying specifications have been developed to support EVs. Traditional chargers rely on manual input to physically connect vehicles to power supplies and are the most common form of EV charging. Traditional charging uses either AC or DC power.

[16] https://insideevs.com/news/528346/ev-weight-per-battery-capacity/

[17] https://cleantechnica.com/2020/02/19/bloombergnef-lithium-ion-battery-cell-densities-have-almost-tripled-since-2010/

[18] https://news.bloomberglaw.com/environment-and-energy/battery-powered-trucks-bring-weighty-questions-to-climate-fight

[19] https://www.jdpower.com/cars/shopping-guides/how-much-does-a-semi-truck-weigh

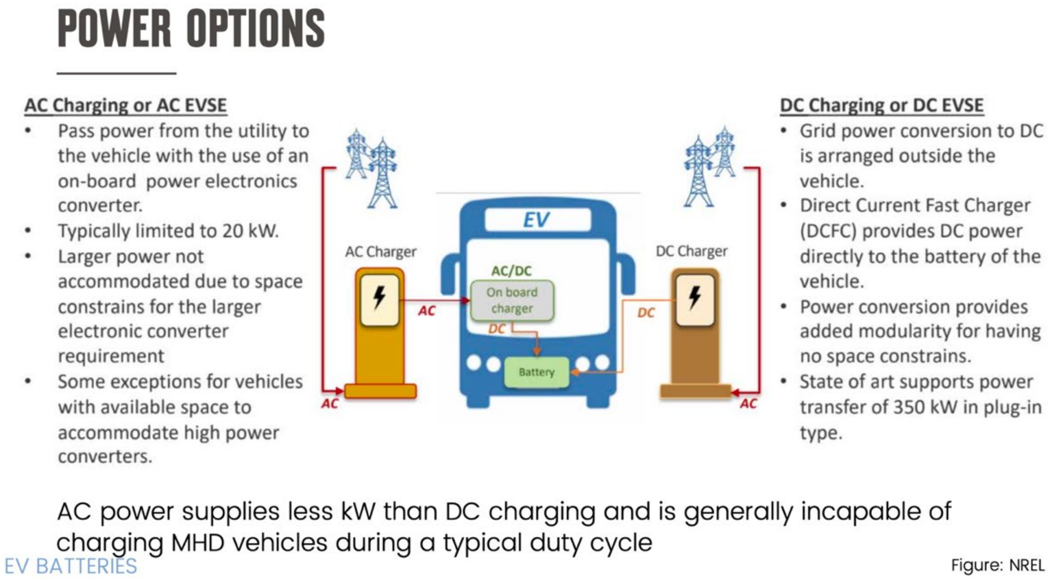


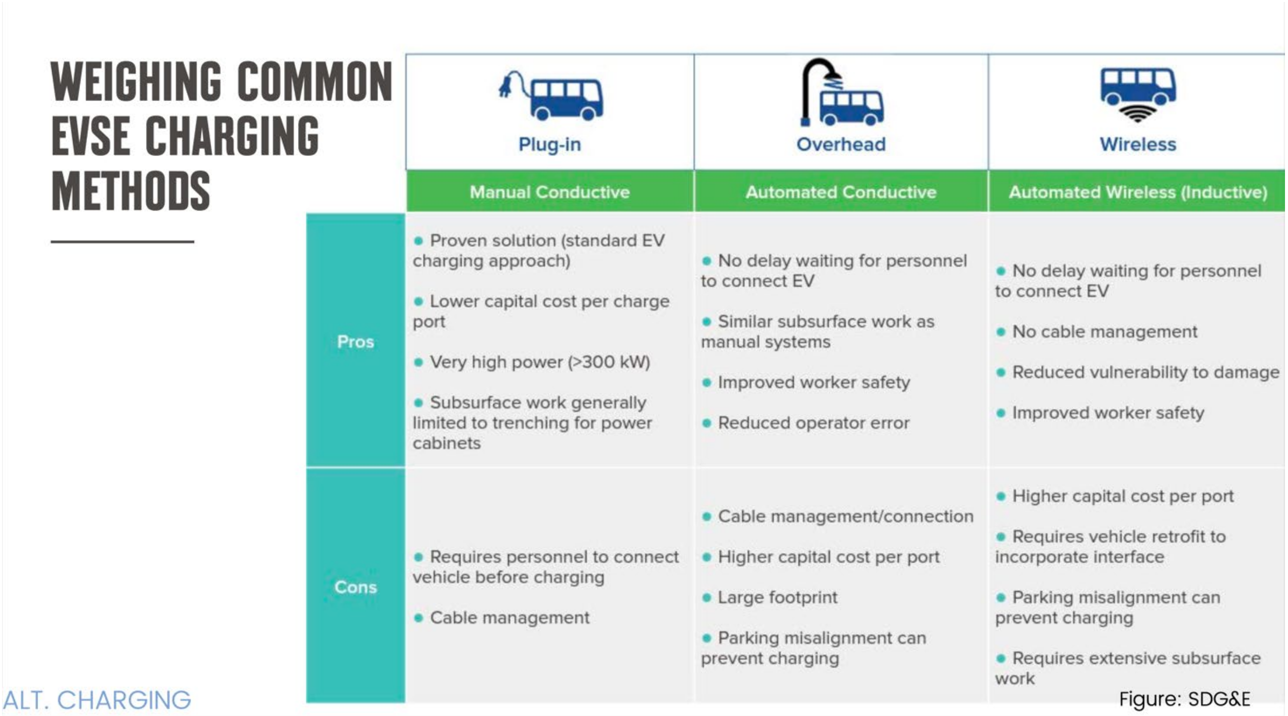
Figure 11: Comparison of AC and DC charging options.

6.2.1 Charger Capacity and Energy Requirements

Higher power output (kW) results in faster charging. Due to MHD EV battery sizes, Level 3 charging (between 50-500 kW) is considered the only viable charging option for most commercial operations using MHD vehicles. The required level of power at charging sites is equal to the maximum rate of discharge per port multiplied by the number of ports. Vehicles with less available time to charge will require more energy per unit of time to deliver the same amount of energy as those vehicles that can be charged over longer periods of time. Faster charging is typically more expensive because it requires a higher power demand on the grid, resulting in higher utility demand charges. A variety of EV charger connectors exist on the market, and many are equipped with CCS and CHAdeMO connectors. CHarIN is a global association dedicated to standardizing charger connectors. CHarIN sponsored the creation and use of the CCS 1 and 2 connectors, and released the MegaWatt (MW) charging system in June 2022.

6.2.2 Alternative Charging Methods

Outside of traditional chargers, there are two market-ready EV charging methods that don't require physical labor to charge: wireless charging and overhead catenary charging. These automated features are already widely implemented to power other technologies such as cellphones and tram systems. Wireless charging is commercially available for MHD vehicles, with capacity ranges between 125 and 500 kW. Wireless charging is a promising option for drayage operations, as trucks could charge while waiting in line to load or unload freight at the port. Similarly, wireless charging infrastructure could be built throughout the San Diego region at distribution centers and warehouses served by drayage trucks. Overhead catenary systems can charge vehicles while they are moving but require existing roadways to be covered with infrastructure.



WEIGHING COMMON EVSE CHARGING METHODS

	Plug-in Manual Conductive	Overhead Automated Conductive	Wireless Automated Wireless (Inductive)
Pros	• Proven solution (standard EV charging approach) • Lower capital cost per charge port • Very high power (>300 kW) • Subsurface work generally limited to trenching for power cabinets	• No delay waiting for personnel to connect EV • Similar subsurface work as manual systems • Improved worker safety • Reduced operator error	• No delay waiting for personnel to connect EV • No cable management • Reduced vulnerability to damage • Improved worker safety
Cons	• Requires personnel to connect vehicle before charging • Cable management	• Cable management/connection • Higher capital cost per port • Large footprint • Parking misalignment can prevent charging	• Higher capital cost per port • Requires vehicle retrofit to incorporate interface • Parking misalignment can prevent charging • Requires extensive subsurface work

ALT. CHARGING

Figure: SDG&E

Figure 12: Comparison of EVSE charging methods.

There are a variety of alternative EV charging methods that are not yet widely available or still under development, including battery swapping, vehicle to grid integration, autonomous charging, hydrogen storage, and solar and wind charging systems. These methods are either modifications of existing mainstream chargers that leverage unique power sources or refueling methods that provide new capabilities:

- Battery swapping allows trucks to change out batteries, substantially reducing downtimes and allowing for slower, controlled charging of offloaded batteries, extending battery life.
- Vehicle-grid integration (VGI) couples an EV battery to the power grid in a bidirectional manner, enabling renewable energy storage, grid services, and backup power. VGI enables batteries to be used for energy storage in addition to transportation.
- Mobile charging involves portable, human-operated devices that function as a mobile battery with charging capabilities, allowing electric vehicles to be charged anywhere.
- Autonomous charging utilizes automated infrastructure to find and charge vehicles while parked. Curbside charging enables EV charging at public, street-side parking spaces.
- Off-grid EV Charging solutions use solar paired with battery energy storage systems (BESS) to charge EVs. Off-grid charging solutions can reduce or eliminate grid connection costs and electrical infrastructure costs, provide resilience from outages, and be deployed rapidly.
- Solar panels can be used to offset energy costs for EV charging, and on-site wind turbines can be used to charge EVs, with excess energy directed to facilities or storage.

6.3 Hydrogen Vehicles and Infrastructure

Hydrogen is a ubiquitous energy vector, much like electricity. It bodes well for energy storage, and like electricity must be derived from primary energy sources such as solar, wind energy, or natural gas. Unlike electricity, which gets its usefulness from electrons, hydrogen stores energy in chemical form in its molecules.

A fuel cell is an electrochemical conversion device that uses hydrogen and oxygen to produce electricity and water. Fuel cells allow hydrogen and oxygen to flow in, then capture and release electrons, and transport water out of the system. Releasing the electrons is the valuable part of the process that allows the system to do electrical work or produce electricity.

Hydrogen vehicles have existed for decades. Commercially available MHD applications are, however, only now becoming available. Hydrogen vehicles can have significant range and weight advantages over BEVs. As a first step in the journey, there must be hydrogen fuel cell electric vehicles (HFCEV) available, and there also must be sufficient functional hydrogen re-fueling infrastructure to make widespread adoption of these transportation technologies a reality.

Roughly eight serious competitors exist in the heavy-duty hydrogen fuel cell electric truck (HD-HFC) space. There are some familiar names along with several joint ventures and a few startups: 1) Toyota + Kenworth, 2) Hino Trucks (owned by Toyota), 3) Cellcentric, a joint venture between Daimler Truck and Volvo Group, 4) Cummins, 5) Hyundai Motors, 6) Hyzon Motors, 7) Nikola Motors, and 8) Symbio, a joint venture between Faurecia and Michelin. These companies are in varying stages of development, from research to full-scale demonstration projects such as the "Shore-to-Store" project at the Port of Los Angeles featuring Kenworth and Toyota.

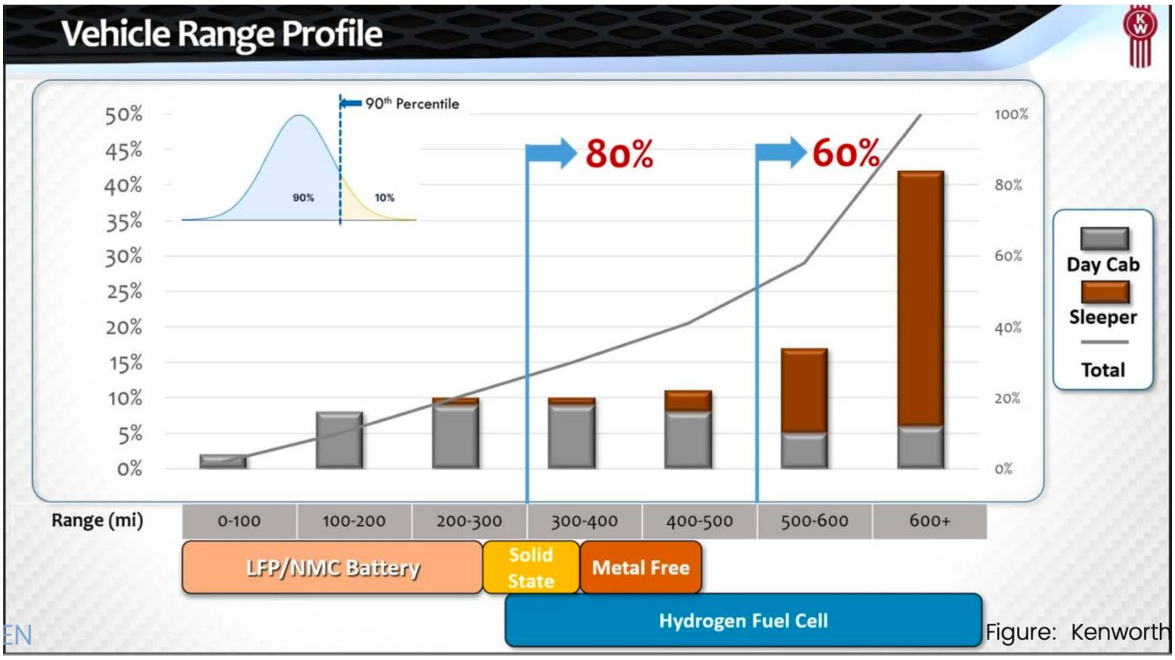


Figure 13: FCEV and BEV MHD range estimates, provided by Kenworth Trucks.

6.3.1 Hydrogen Re-Fueling

Hydrogen re-fueling stations and supporting supply infrastructure are needed to fuel each vehicle with a quantity of hydrogen at certain specifications. Like electricity, hydrogen can be converted from many sources into its pure form, thus allowing for a transition from lower-cost yet carbon-intensive energy sources to lower-carbon inputs. This strategy could enable hydrogen infrastructure to be built out and supplied by more abundant and lower-cost resources such as natural gas or biogas. In the future, a transition to green hydrogen supplied by water electrolysis—the use of renewable electricity to split water into pure hydrogen and oxygen—could occur since all supporting infrastructure would already be in place.

The fueling station is the front-line system of the hydrogen value chain when it comes to supplying hydrogen to any MHD fleet. Several common configurations are defined by 1) the source of hydrogen, whether delivered or generated on-site; 2) the hydrogen handling system, if it incorporates cooling or compression; and 3) the hydrogen delivery method, whether it's low- or high-pressure hydrogen gas or liquid. The overall customer experience has been designed to be as close to that of gasoline as possible. The customer only sees a monolithic structure that can look like a gasoline pump or a pillar similar to an electric vehicle charging station. There is a hose that enables the hydrogen to flow and a nozzle that connects to a receptacle on the car for safe and secure fuel transfer.

The different station configurations become important when considering what sort of vehicles a customer wants to fill and what their desired carbon footprint might be. The fuel is only carbon-free if it is produced using carbon-free methods. One possibility is to use renewable electricity supplied either on-site or by the electric grid, coupled with an electrolyzer to synthesize hydrogen and supply it to the storage system at the fueling station. Another configuration is to deliver pure hydrogen to the station with a heavy-duty truck, where the hydrogen fuel has been created at a large, centralized facility, which can have advantageous capital and operational features, such as economies of scale. Finally, when massive volumes of hydrogen need to be consumed in the future when there are many heavy-duty trucks on the road, the stations can be configured to accept liquid hydrogen. That liquid hydrogen can be expanded so that it becomes gaseous and then compressed before it is put into a vehicle. Liquid hydrogen (LH2) could also be placed directly into a truck for ultra-long-range capacity. Some truck manufacturers are looking to integrate LH2 so that these vehicles can travel up to 1,000 miles between fills.

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.[20]

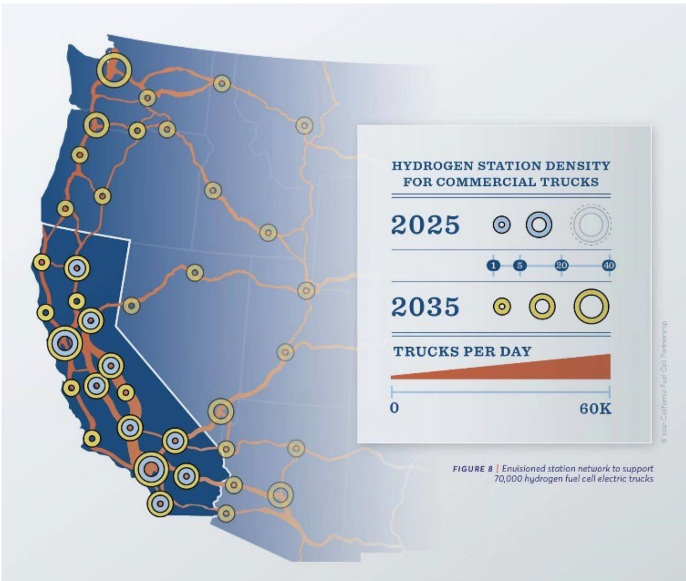


Figure 14: Envisioned hydrogen station network to support 70,000 trucks.

6.3.2 Hydrogen for MHD Fleet Vehicles

Key advantages for hydrogen in MHD fleet applications include:

6.3.2.1 Known, Repeatable Routes

Due to the high capital cost, land area requirements, and construction intensity for large-scale, high-capacity hydrogen fueling stations, building one larger facility is beneficial compared to several smaller

[20] https://www.cityofwestsacramento.org/Home/Components/News/News/2149/1159?arch=1&npage=2

locations. The nature of fleet vehicle routing is complementary to a large centralized fueling station that can be located where the vehicles are domiciled.

6.3.2.2 Long Travel Distance Between Fills

Hydrogen and fuel cells have distinct efficiency advantages over typical internal combustion vehicles. This feature allows a hydrogen-powered MHD vehicle to travel long distances between fills ranging between 150 and 300+ miles depending on installed hydrogen storage capacity, payload, and driving profile (the driver's style and terrain). In the future, this distance could reach 1,000+ miles for long-haul trucks that leverage LH2. Hydrogen per kilogram has about the same energy as a gallon of gasoline. However, the hydrogen fuel cell can convert that hydrogen into electricity with about 60% efficiency as compared to a gasoline engine converting its fuel into mechanical work at about 30% efficiency. The electric drivetrain is about 95% efficient as compared to the mechanical drivetrain of a typical internal combustion vehicle being about 90% efficient.[21]

6.3.2.3 High Energy Density per Unit of Mass

Hydrogen retains a higher energy density per unit mass (gravimetric energy density) than batteries. This means that when hydrogen and fuel cells are used as the electricity source in an all-electric drivetrain, the vehicle will give up less of its available payload to carry the energy storage system than in an all-battery configuration. It should be noted that almost all hydrogen fuel cell drive systems are hybrid in nature, meaning they have a small onboard battery that helps prevent the drive cycle's frequent changes from impacting the durability of the fuel cell.

6.3.2.4 Comparable Fill Times to Diesel

Because hydrogen molecules are transferred instead of electrons, the physical limitations are much lower when refilling a hydrogen storage tank than when recharging a large battery-electric vehicle. Hydrogen fueling stations can be configured so that high mass flow rates can be achieved to reduce the time needed to fill an empty vehicle to be comparable to current diesel refueling times. The fast fill times allow nearly continuous duty cycles to be achieved by the vehicles in operation. This strategy allows for the number of fleet vehicles to be optimized for near-constant use.

6.3.2.5 All Electric, Emission Free Drivetrain

As mentioned earlier, hydrogen fuel cells are an alternative to battery-electric technologies that leverage a nearly identical electric vehicle drivetrain. The primary difference is that hydrogen is placed into a storage tank instead of using electricity to charge a large battery pack. When the vehicle needs electricity, hydrogen in a storage tank is converted to electricity. With a higher energy density per unit mass and a nearly non-existent leakage—as occurs when batteries lose charge when not utilized—hydrogen can provide very similar electric drivetrain performance and environmental impacts to those of an all-battery option.

6.3.2.6 Grid De-Coupled

Depending on the hydrogen generation and handling method, the refueling station can be largely decoupled from the local electrical grid. This fact provides a distinct advantage compared to a purely electric vehicle charging strategy. The hydrogen system can be designed to be mainly dependent on a renewable fuel like biogas or a local distributed energy source like wind or solar. Local hydrogen generation and storage can also support the grid due to their ability to capture and store energy and then either dispense it as hydrogen fuel or convert it to on-site electricity or heat. If configured properly, the refueling station can provide grid services like consuming otherwise curtailed (wasted) renewable electricity or

[21] https://www.fueleconomy.gov/feg/evtech.shtml

consuming low-cost electricity and storing it as hydrogen. This strategy permits decoupling of when electricity is needed and when a vehicle can be "charged."

6.3.3 When will Hydrogen Technology be Ready for Deployment?

Regional commercial transit represents the largest source of hydrogen demand in the long term, largely stemming from legislative zero-emission requirements and the inherent technological benefits—energy density and hauling capability—of hydrogen over battery-powered trucks. Assuming that state and regional legislation and incentives continue to support the adoption of hydrogen technologies and subsidize the price of hydrogen production and fuel cell vehicles, it is anticipated that [in California alone], hydrogen demand associated with heavy-duty transit will reach 192-416 kilotons (kT)/year by 2035. [22]

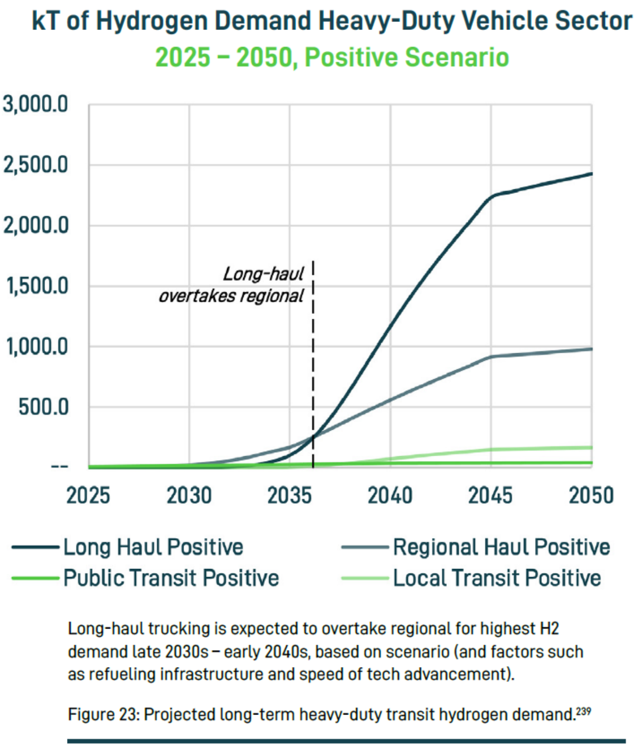


Figure 15: Hydrogen Demand in the Heavy-Duty sector.[23]

[22] https://www.socalh2.org/vision
[23] https://www.socalh2.org/vision

7 Public-Access Heavy Duty ZEV Infrastructure Site Evaluation

The STC Traffic ZEV Blueprint project team aligned its evaluation of public opportunity charging sites with sites being evaluated by POSD. POSD issued an RFI in May 2022 for design concepts and business plans for public ZEV hydrogen fueling and/or electric charging infrastructure at numerous sites in proximity to the port, including four sites along Tidelands Ave. in National City.

The POSD RFI sought information to facilitate the Port District's ("District") deployment of infrastructure to support the transition to zero-emission (ZE) truck trips to and from the District's marine cargo terminals in San Diego and National City (Tenth Avenue Marine Terminal and National City Marine Terminal, respectively). The District sought to identify opportunities to deploy public-facing infrastructure for both battery-electric and hydrogen fuel cell ZE technologies for heavy-duty (HD) trucks. The District indicated information received would guide the development of public ZE infrastructure facilities to serve the District's marine cargo terminals before June 30, 2026. The STC Traffic ZEV team developed site designs for three of the four Tidelands Avenue sites identified in the POSD RFI. Two of the sites—#3 and #4—rose to the top based on the evaluation criteria described below (MHD ZEV Potential Sites Evaluation). These sites were also the top two choices submitted by the 18 respondents to the POSD RFI (**Figure *16***).

Figure 16: Port of San Diego Request for Information

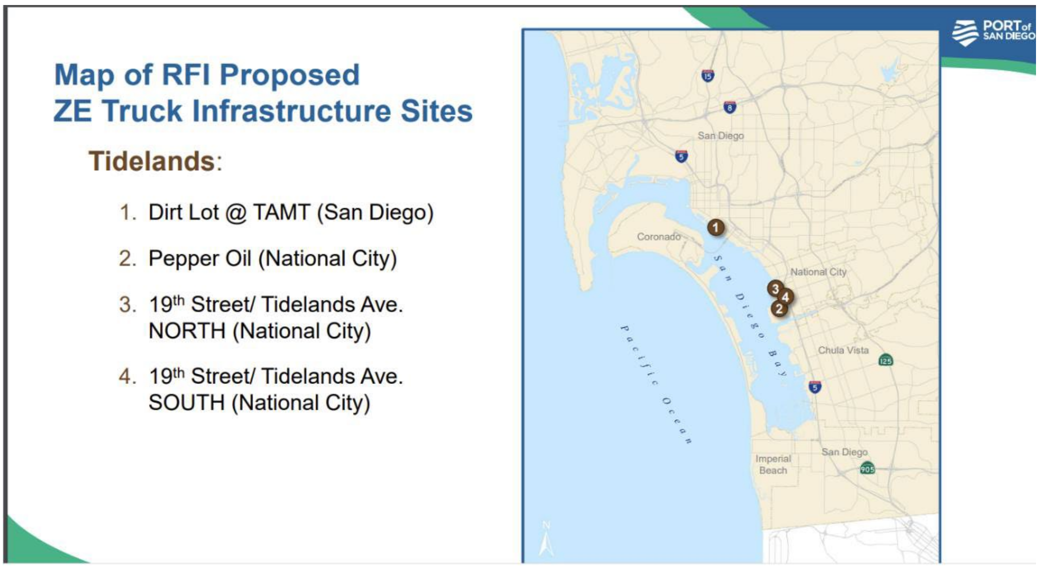


Figure 17: Port of San Diego map of proposed public charging sites along Tidelands Ave.

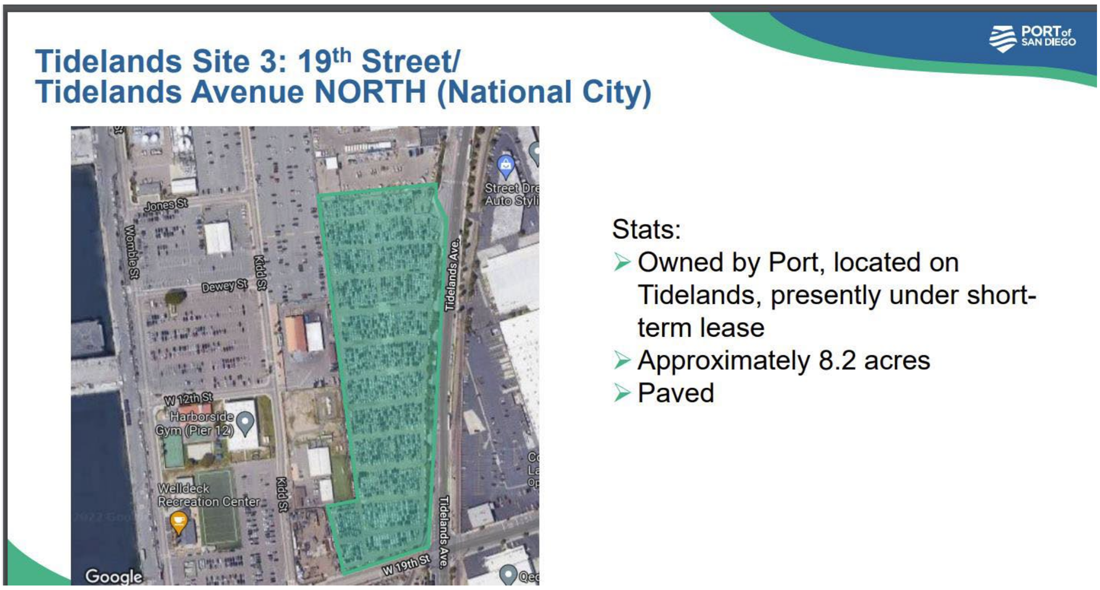


Figure 18: Port of San Diego map of Tidelands Ave. Site 3.

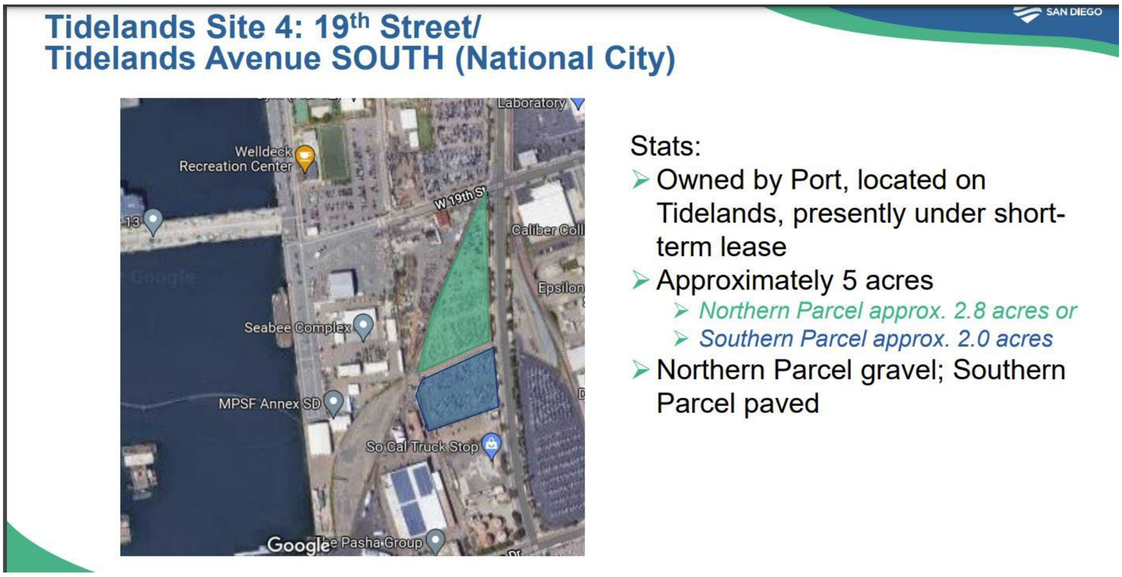


Figure 19: Port of San Diego map of Tidelands Ave. Site 4.

Site Development Interest

Proposed Tidelands Sites and Regional Locations	Approximate Acreage *(if applicable)*	Number of Interested Respondents
Tidelands Site 3 – NW 19th / Tidelands	8.2	12
Tidelands Site 4 – SW 19th / Tidelands	5	11
Regional 2B – Otay Mesa (Pasha)	5	11
Regional 2A – Otay Mesa (CalTrans)	N/A	10
Regional 4 – CalTrans I-15/I-76	N/A	10
Tidelands Site 1 – TAMT Dirt Lot	1	7
Tidelands Site 2 – Pepper Oil	2.75	7
Regional 3 – I-8 Corridor*	-	6
Regional 1 – Adjacent to Tidelands*	-	6

* Respondents expressed interest in All Sites, with no specific site information provided.

Figure 20: Port of San Diego RFI respondents by site.

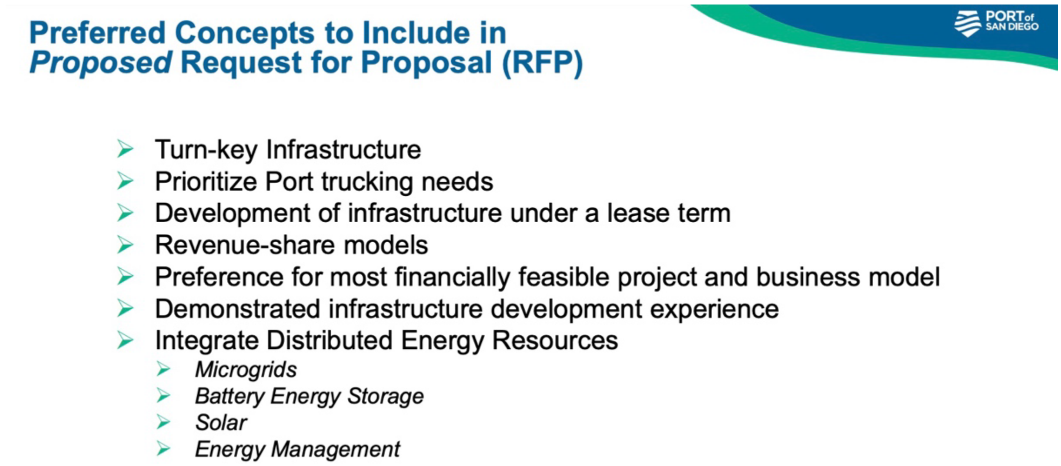


Figure 21: Preferred concepts to include in POSD RFP.

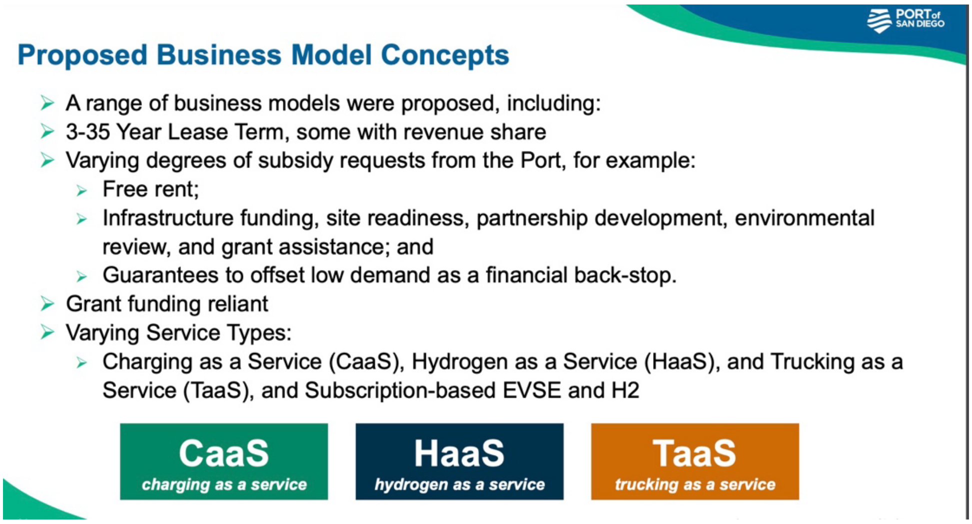


Figure 22: Proposed business model concepts in POSD RFP.

7.1 MHD ZEV Potential Charging Sites Evaluation

Existing Roadway Network

Tidelands Avenue within the project area is a two-lane undivided roadway classified as a collector in the City of National City General Plan. The roadway consists of Class II buffered bike lanes and parallel parking on both sides of the roadway. The bike lanes are temporary and will be removed upon completion of new bike facilities further west near the I-5 freeway. The roadway has a speed limit of 35 MPH. Tidelands Avenue is designated as a primary truck route in the City of National City General Plan.

Bay Marina Drive within the project area is a four-lane undivided roadway classified as a Collector in the City of National City General Plan. Parking is permitted on both sides of the roadway at intermittent locations. The roadway has a speed limit of 30 MPH. The west end of the roadway provides access to the National City Marine Terminal, while the east provides access to the I-5 freeway. Bay Marina Drive is designated as a primary truck route in the City of National City General Plan.

19th Street within the project area is a four-lane undivided roadway classified as a Collector in the City of National City General Plan. The roadway has a speed limit of 30 MPH. The west end of the roadway provides access to Naval Base San Diego.

The study area roadways experience truck traffic servicing the National City Marine Terminal throughout the day and commuter traffic associated with Naval Base San Diego during early morning and afternoon peak periods.

Potential MHD ZEV Charging Sites

The three sites selected for evaluation are located on the west side of Tidelands Avenue, as shown in **Figure *23***. The parcels are owned by POSD and are currently leased to various port tenants that support maritime operations.

Figure 23: Three Tidelands Ave. sites for public charging evaluation.

District Tidelands Site 2

This 2.75-acre site is located at the northwest corner of Tidelands Avenue/ Bay Marina Drive intersection. The northern portion of the site currently serves as a diesel fueling station, while the southern portion is occupied by large storage tanks and support facilities. The evaluation focuses on the potential for installing ZEV charging on the northern portion of the site only, since the timeline and costs associated with removal of the storage tanks, environmental remediation, and monitoring for the southern portion of the site would be prohibitive.

District Tidelands Site 3

This 8.2-acre site is located on the northwest corner of Tidelands Avenue/ 19th Street intersection. The site is paved and does not include any structures. The site currently serves as a vehicle storage lot.

District Tidelands Site 4

This 5-acre site is located on the southwest corner of Tidelands Avenue/ 19th Street intersection. The southern portion of the site is paved, while the northern portion of the site is unpaved. The site does not include any structures and serves as a vehicle storage lot.

Evaluation Criteria

The following evaluation criteria were developed for each of the three proposed sites for ZEV charging:

- Number of charging stations and hydrogen dispenser the site can accommodate
- Proximity to proposed off-site charging stations along Tidelands Avenue (convenience for truck drivers to access on-site amenities)
- Proximity to truck routes, freeway, National City Marine Terminal, goods, services, and amenities (such as restaurants and hotels)
- Level of electrical infrastructure upgrades or new connections required and construction timeline
- Existing site conditions and level of effort required to prepare the site, including the potential need for environmental remediation.
- Capacity to include amenities on-site (such as restrooms, showers, locker rooms)

Public access ZEV infrastructure GIS maps for the three sites are included in Appendix G and Appendix H. The schematic designs and truck turning simulations for the three sites are included in Appendix I and Appendix J.

A point system was established to rank sites based on the criteria. While a phased approach to the deployment of ZEV charging is proposed, the site evaluation is based on build-out conditions for each site to show maximum benefit.

Table 1: Evaluation Criteria and Ranking System.

Criteria	Points
Number of Opportunity Charging Stations (build-out)	0-10=1, 11-30=5, >30=10
Number of Overnight Charging Stations (build-out_=)	0-10=1, 11-30=5, >30=10
Proximity to Off-Site Charging Stations (convenience of access to on-site amenities)	Less than 500 feet=5, 500-1000 feet=2, >1000 feet=0
Roadway Network - Proximity to Truck Route	<0.5 Mile=2, 0.5-1 Mile=1, >1 Mile=0
Roadway Network - Proximity to Freeway	<0.5 Mile=2, 0.5-1 Mile=1, >1 Mile=0
Roadway Network - Proximity to Marine Terminal	<0.5 Mile=2, 0.5-1 Mile=1, >1 Mile=0
Proximity to Goods, Services, and Amenities	<0.5 Mile=2, 0.5-1 Mile=1, >1 Mile=0
Electrical Infrastructure Upgrades/Connections and Construction Timeline	Substantial=0, Moderate=5, Minimal=10
Driveway	Utilize existing driveways=1, New driveway=0
Pavement Rehabilitation	Rehabilitation=0, Slurry seal=5, Not required=10
Conflicting Structure Demolition	Substantial=0, Moderate=5, No Work=10
On-site Amenities – The site has the capacity to include modular facilities (showers, restrooms, locker rooms)	None=0, Restrooms only=1, Restrooms with shower/locker rooms=5
Environmental Remediation	Yes=0, No=10

Site Evaluation summaries are located in Appendix K within the ZEV Infrastructure Feasibility Study and Technical Report.

7.2 MHD ZEV Potential Charging Site Designs

Site Buildout Goals

The Blueprint team developed a two-phase site development plan, including site layouts, EVSE and hydrogen infrastructure installations, and truck turning simulations for each of the three Tidelands Ave. sites. Each site was designed for one-way truck flow in and out of the charging areas. Overnight and opportunity charging and hydrogen refueling was separated, with overnight charging located furthest from Tidelands Ave for a quieter experience for truckers sleeping in their cabs. Each charging and hydrogen refueling stall was designed to accommodate a Class 8 truck, utilizing distinct charging space recommendations for opportunity and overnight charging, as developed by the Starcrest Consulting Group for a Port of Long Beach public charging study. Each site has space allocated for power supply equipment. Sites 3 and 4 include room for restroom facilities. Overnight charging stations were also modeled along Tidelands Ave. adjacent to Sites 2 and 4. Site EVSE and hydrogen infrastructure deployments, layouts, and truck turning simulations are provided below.

Site 2

Phase 1 (2024-2026)

- Deploy four 200-kW simultaneous charging stations, intended for overnight charging.

Phase 2 (2027-2028)

- Deploy four 200-kW simultaneous charging stations, intended for overnight charging.

Utilization of the charging stations is expected to increase over the five-year period. Peak electrical demand at build-out will be 1.6 MW (eight charging sessions occurring simultaneously at 200 kW/truck). For this peak demand level to be reached, trucks charging would all need to be able to accept a 200 kW rate of charge, and no trucks would be charging simultaneously on the same charger.

Build-Out Demand

Eight overnight charging sessions @ 200 kW/truck = 1.6 MW Peak Demand

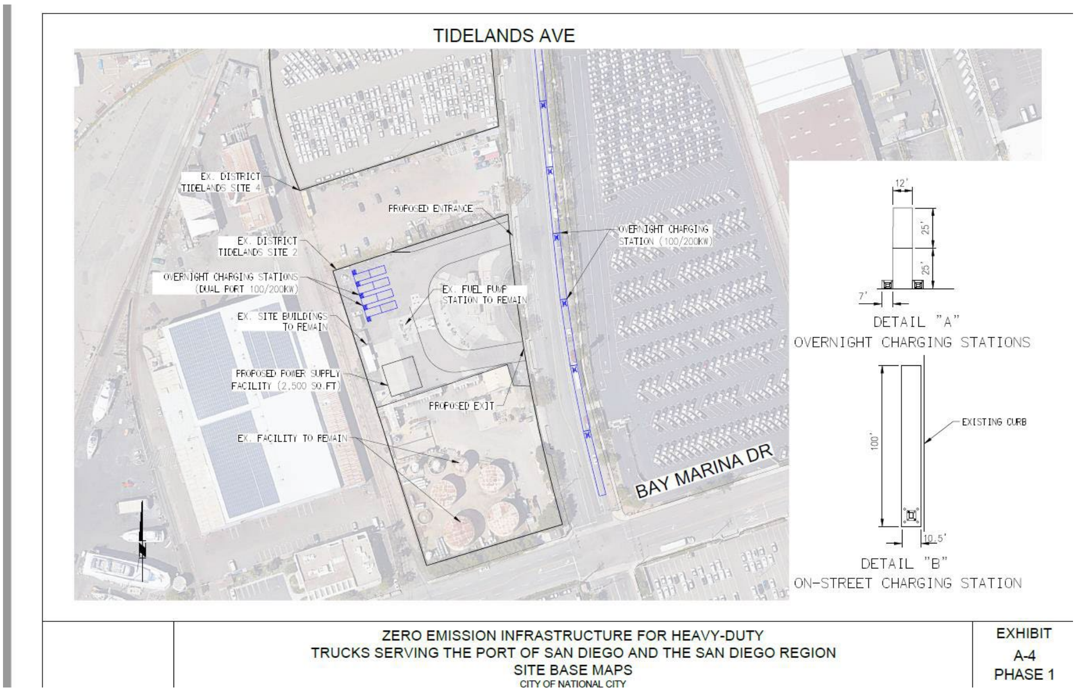


Figure 24: Tidelands Ave. Site 2, Phase I EV Infrastructure Deployment Plan.

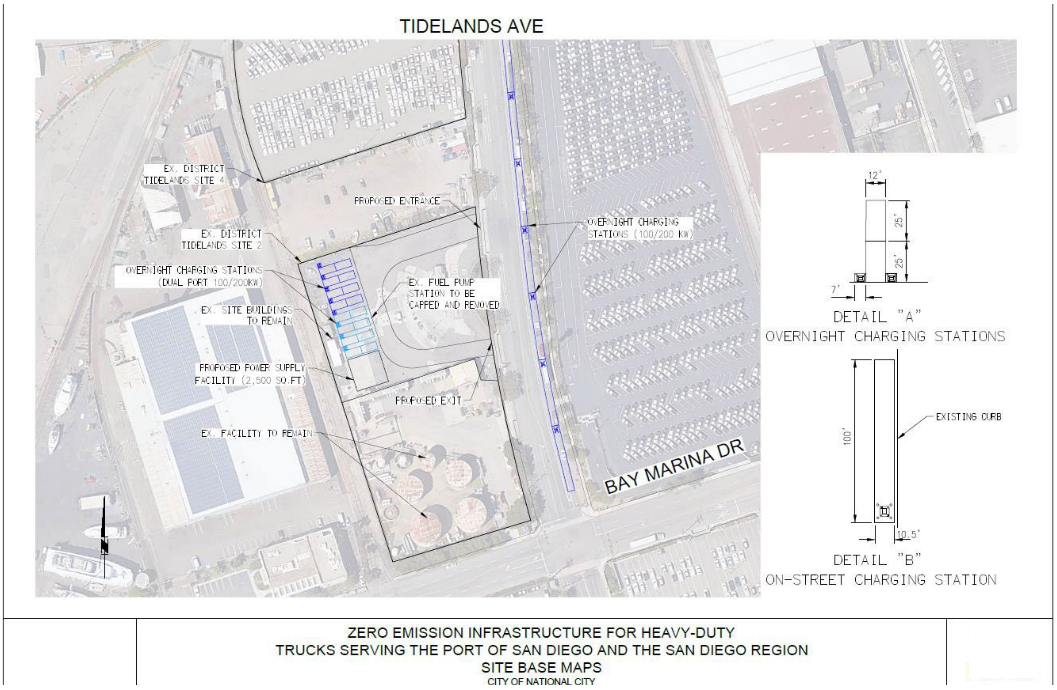


Figure 25: Tidelands Ave. Site 2, Phase 2 EV Infrastructure Deployment Plan.

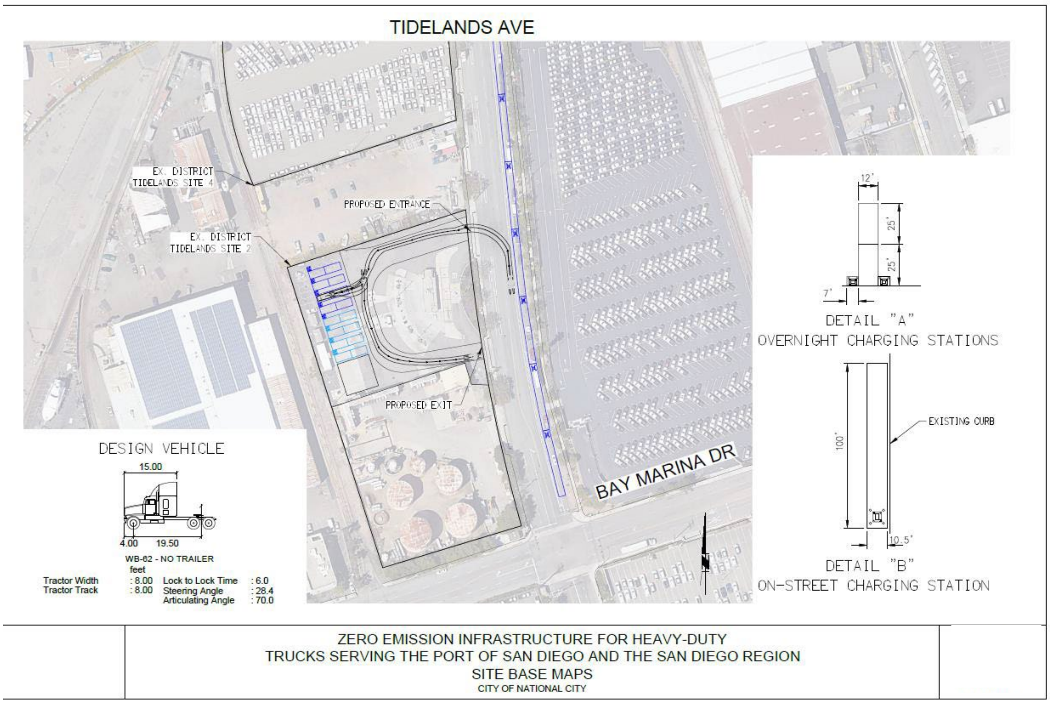


Figure 26: Tidelands Ave. Site 2, Phase 2 Truck Turning Simulation.

Site 3

Phase 1 (2024-2026)

- Deploy 10 200-kW simultaneous charging stations, intended for overnight charging.
- Deploy 10 350-kW simultaneous charging stations, intended for opportunity charging.

Phase 2 (2027-2028)

- Deploy 16 200-kW simultaneous charging stations, intended for overnight charging
- Deploy six 500-kW simultaneous charging stations, intended for opportunity charging.
- Deploy six hydrogen dispensers for opportunity refueling

Utilization of the charging stations is expected to increase over the five-year period. Peak electrical demand at build-out will be 11.7 MW (26 overnight charging sessions occurring simultaneously at 200 kW/truck. 10 opportunity charging sessions at 350 kW/truck, and six opportunity charging sessions at 500 kW/truck). For this peak demand level to be reached, trucks charging would all need to be able to accept a 200-kW rate of charge for overnight charging and between a 350-kW and 500-kW rate of charge for opportunity charging). In the peak demand scenario, no trucks would be charging simultaneously on the same charger.

Build-Out Electrical Demand

26 overnight charging stations at 200 kW/truck = 5.2 MW Peak Demand
10 opportunity charging stations at350 kW/truck = 3.5 MW Peak Demand
6 opportunity charging stations at 500 kW/truck = 3 MW Peak Demand

Total Peak Electrical Demand: 11.7 MW

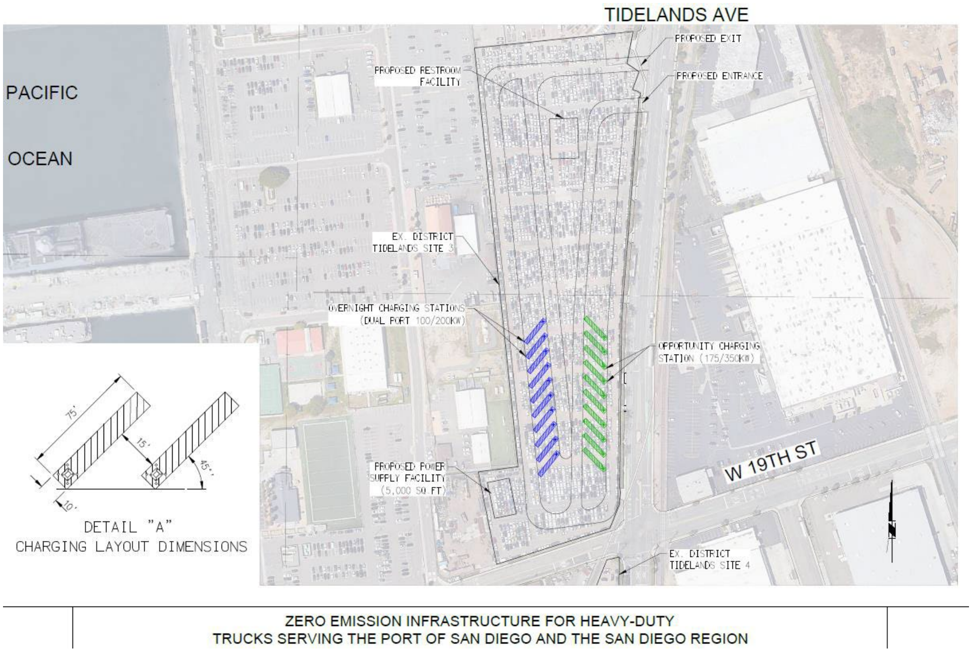


Figure 27: Tidelands Ave. Site 3, Phase 1 EV Infrastructure Deployment Plan.

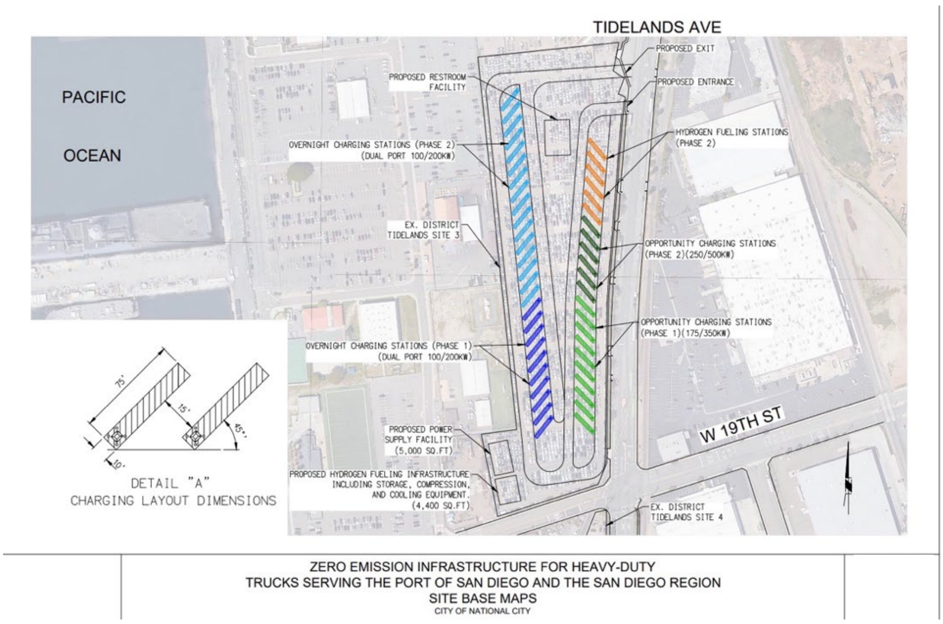


Figure 28: Tidelands Ave. Site 3, Phase 2 EV & Hydrogen Infrastructure Deployment Plan.

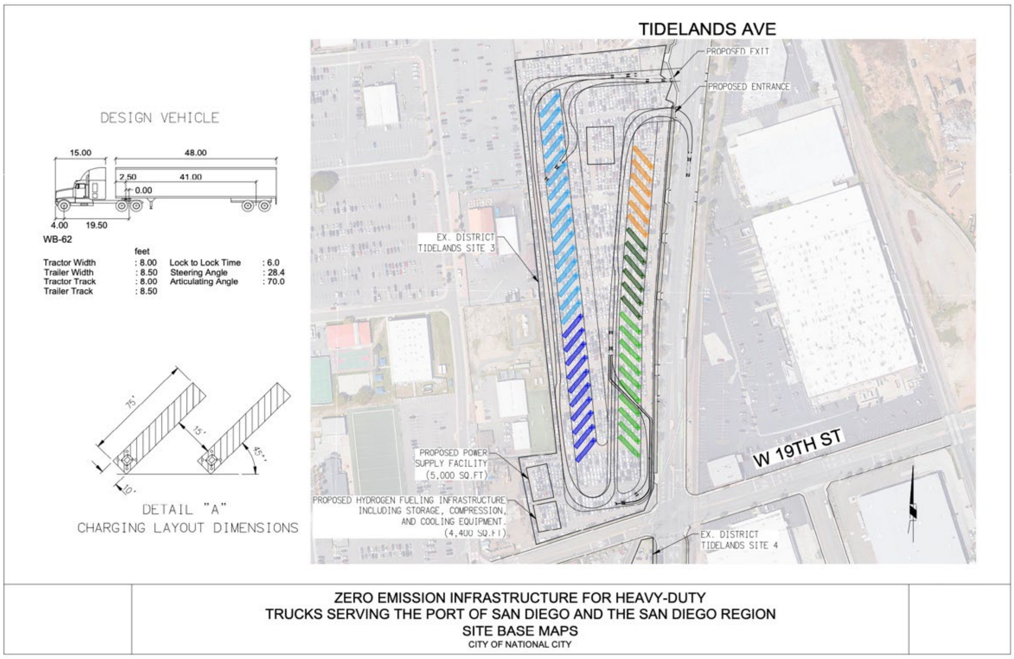


Figure 29: Tidelands Ave. Site 3, Phase 2 Truck Turning Simulation.

Site 4

Phase 1 (2024-2026)

- Deploy 10 200-kW simultaneous charging stations, intended for overnight charging
- Deploy 11 350-kW simultaneous charging stations, intended for opportunity charging

Phase 2 (2027-2028):

- Deploy three 1-MW charging stations, intended for opportunity charging.
- Deploy three hydrogen dispensers for opportunity refueling

Utilization of the charging stations is expected to increase over the five-year period. Peak electrical demand at build-out will be 10.5 MW (10 overnight charging sessions occurring simultaneously at 200 kW/truck. 10 opportunity charging sessions at 350 kW/truck, and 5 opportunity charging sessions at 1 MW/truck). For this peak demand level to be reached, trucks charging would all need to be able to accept a 200-kW rate of charge for overnight charging, and between a 350-kW and 1-MW rate of charge for opportunity charging). In the peak demand scenario, no trucks would be charging simultaneously on the same charger.

Build-Out Demand

10 overnight charging stations at 200 kW/truck = 2 MW Peak Demand
11 opportunity charging stations at350 kW/truck = 3.85 MW Peak Demand
3 opportunity charging stations at 1 MW/truck = 3 MW Peak Demand

Total Peak Demand 8.85 MW

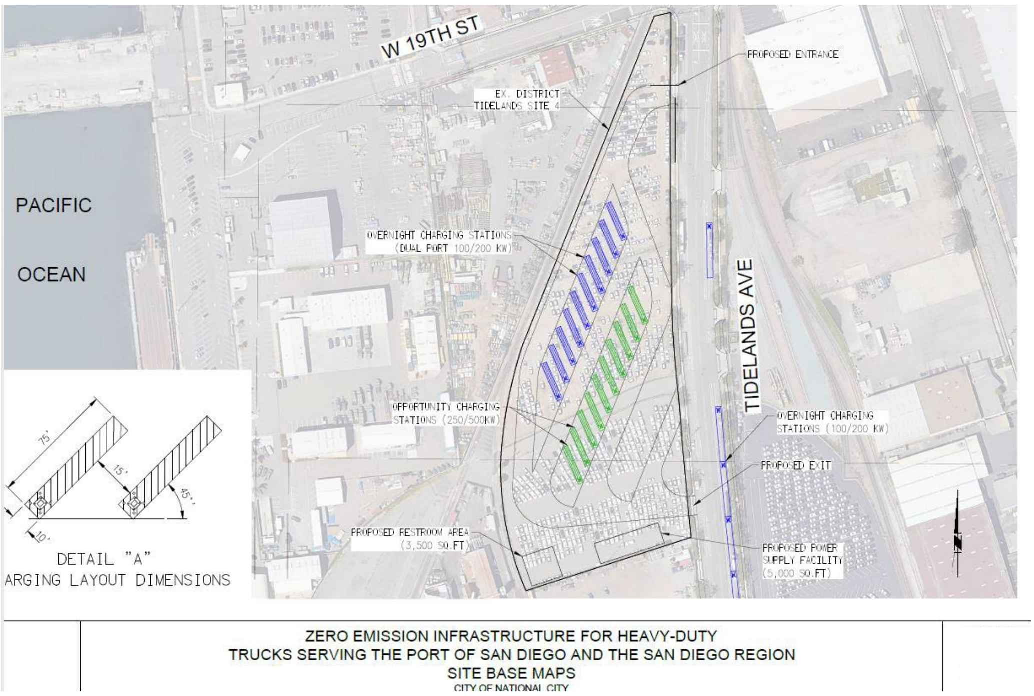


Figure 30: Tidelands Ave. Site 4, Phase 1 EV Infrastructure Deployment Plan.

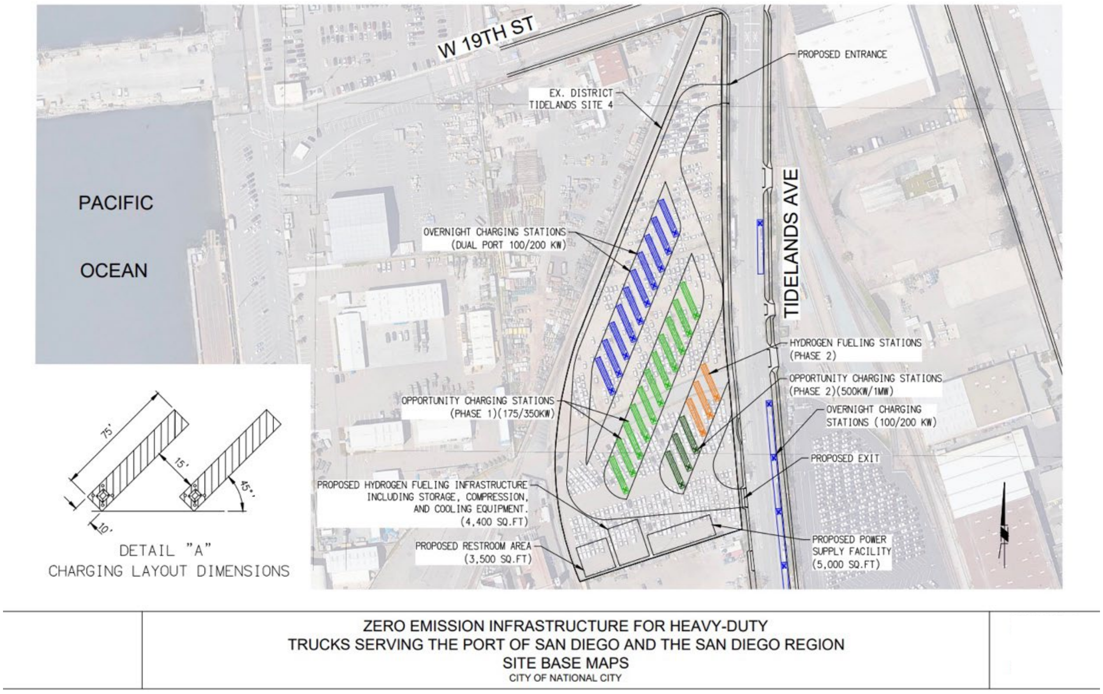


Figure 31: Tidelands Ave. Site 4, Phase 2 EV & Hydrogen Infrastructure Deployment Plan.

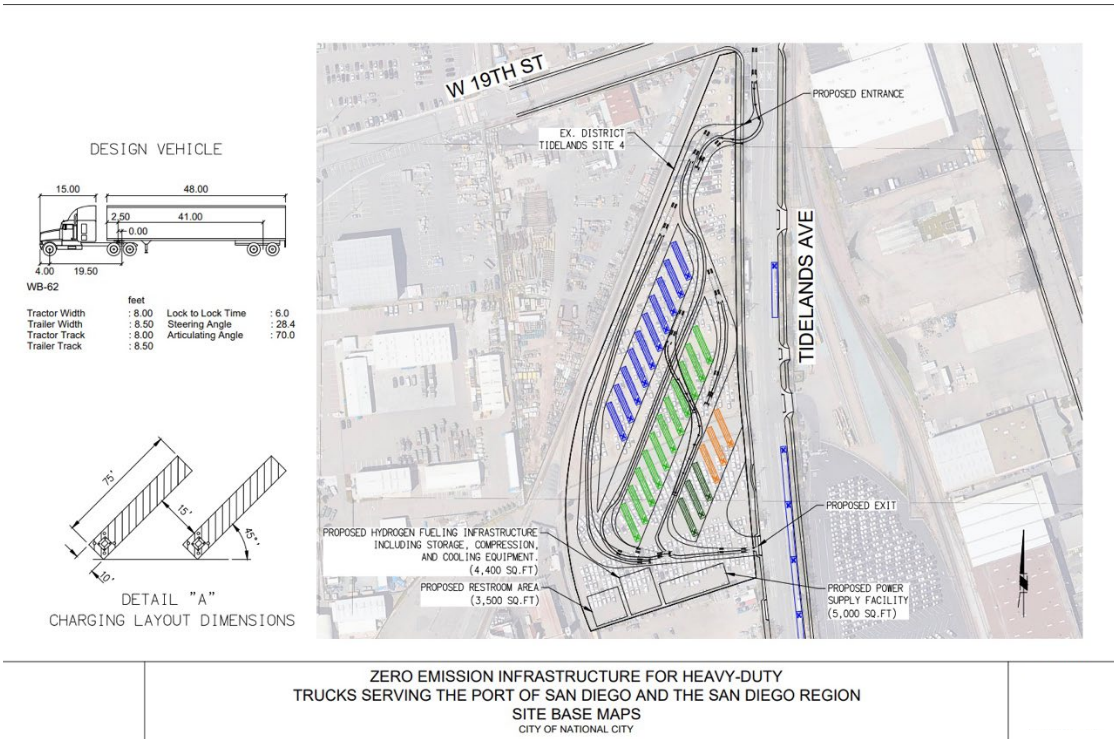


Figure 32: Tidelands Ave. Site 4, Phase 2 Truck Turning Simulation.

7.3 Hydrogen Applications for Trucks Calling on the Port of San Diego

The POSD Maritime Clean Air Strategy analyzed the type and number of vehicles that call on the port, along with the percentage of trips that fall within different mileage ranges.[24] The trip distance categories and associated truck counts are shown in **Table *2***. The Blueprint team used this data to estimate the potential energy consumption that will be required to power battery electric and hydrogen full cell trucks.

Table 2: POSD VMT Analysis.

VMT Case	**Truck Count**	**Estimated Vehicle Miles Attributed to VMT Segment**	**Percentage of Trips in the VMT Segment**
<100	36,625	3,662,473	42%
100-150	25,147	3,143,350	29%
151-250	4,206	843,307	5%
251-400	7,398	2,408,108	9%
>400	12,836	5,134,400	15%

The Blueprint team assumed that any port trip of 250 miles or below will be covered by a battery-powered electric truck, and hydrogen fuel cell trucks would be utilized for trips greater than 250 miles. There is a considerable difference between trip count and vehicle miles traveled (VMT) percentages above and below 250 miles. There are many more short trips conducted by count, but the total VMT generated by truck trips above and below 250 miles is equivalent. This makes energy consumption similar for the two categories.

The results in row eight of **Table *3*** shows that using hydrogen-powered vehicles for the 251+ mile category would require about 2,300 kilograms of hydrogen per day, which would be about two and a half times larger than the nation's largest hydrogen station located at SunLine Transit in Thousand Oaks, California (900 kg/day capacity), but still smaller than the world's largest station in Canada, which is capable of

[24] Data from MCAS TRK-B Table 8 on page B-29 were utilized for the analysis

supplying up to 3,250 kilograms of hydrogen per day.[25] This scenario would allow for either three smaller stations or one large station to meet this part of the fleet's demand.

The results also show that using battery-electric vehicles for up to 250 miles of travel would require about 37 MWh per day of energy consumption, the equivalent of adding 1,279 new houses to the electrical grid.[26] Hydrogen can be supplied to locations with insufficient electrical capacity for charging electric trucks. Hydrogen produced on-site with electrolyzers requires grid-connected electricity to synthesize the hydrogen.

Table 3: Two VMT Cases

VMT case	**Under 250 miles**	**251+ miles**	**Unit**
Percentage of trips in each of two categories by trip count	77	23	%
Estimated total VMT attributed to each category	7,649,130	7,542,508	Miles
Percentage of trips in each of two categories by estimated VMT	50	50	%
Efficiencies for electric and hydrogen-powered HD trucks	1.1 kWh/km[27]	9 miles/kg[28]	
Estimated electricity demand for the two categories (Annual Average)	13,541,056	13,352,305	Annual kWh
Estimated electricity demand for the two categories (Daily Average)	37,099	36,582	Daily kWh
Estimated hydrogen demand for the two categories (Annual Average)	849,903	838,056	Annual kg H2
Estimated hydrogen demand for the two categories (Daily Average)	2,329	2,296	Daily kg H2

In conclusion, hydrogen fuel cells are viable for decarbonizing and electrifying MHD transportation applications. Hydrogen refueling infrastructure should be strongly considered for deployment at Port of San Diego sites to support truck trips greater than 250 miles.

7.3.1 Hydrogen Next Steps

7.3.1.1 Conduct a Feasibility Study

1) **Evaluate regional hydrogen demand and production:** Is enough hydrogen produced in the area to satiate the need created by implementing heavy-duty applications in the region?

[25] https://hydrogen-central.com/hydra-energy-breaks-ground-worlds-largest-hydrogen-refuelling-station-heavy-duty-trucks/#:~:text=Hydrogen%2Das%2Da%2DService,in%20Prince%20George%2C%20British%20Columbia
[26] https://shrinkthatfootprint.com/average-household-electricity-consumption/
[27] https://chargedevs.com/newswire/volvos-fh-electric-heavy-duty-truck-proves-range-and-energy-efficiency-in-independent-testing/
[28] https://www.mdpi.com/2571-8797/3/2/28

2) **Evaluate HD vehicle technology readiness level**: Reach out to potential fuel cell-powered HD truck suppliers to better understand the state of their technologies and what the lead times look like with their current order book.
3) **Evaluate HD hydrogen fueling station technology**: Reach out to potential suppliers of high-capacity hydrogen refueling stations. Seek to understand technology and economics with a special focus on possible equipment footprints. Potential equipment configurations and resulting footprints, in conjunction with fueling capacity, are critical aspects in selecting a feasible location at the site and understanding the full economic impacts of the project. For example, a station with a larger footprint will likely have a larger storage capacity and can be designed to attain a higher throughput. This change might increase or decrease the appeal of the economics involved in such a project.

7.3.1.2 Seek Funding

1) Create a funding plan for a combination of grants, equity, and loans required to design, build, commission, and operate the hydrogen fueling stations and fuel cell trucks.

7.3.1.3 Design and Build

1) Leverage funding to design appropriate future hydrogen infrastructure for the site.
2) Purchase the required number of trucks for the fleet.
3) Order long lead items for the hydrogen fueling station.
4) Hire an engineering, procurement, and construction (EPC) company to take on the bulk of the engineering design and construction.
5) Ensure the permitting process is started and going smoothly.

7.3.1.4 Commissioning and Operations

1) Once the station has been fully constructed, a team of experts must start and validate the equipment's operations, often called commissioning.
2) Once the equipment has passed all operational checkpoints, it can be used.
3) When the station is in use, it will need preventative maintenance. A third-party provider can conduct that if that seems to be the best option. Otherwise, building expertise and an organization that can handle this regular maintenance will be important.

7.4 Electrical Capacity and Timeline

Sites 3 and 4 combined would have total peak demand, the equivalent demand for approximately 10,000 homes, the size of a small California city.

Given the large peak electrical demand that would accompany Sites 3 and 4 at build-out, planning for adequate electrical capacity is critical. STC Traffic staff researched the capacity available on the circuit and substation feeding these sites, but discovered the data is not available. Upon further investigation, the team was informed during a video meeting on July 13, 2022 by Dinah Willier, Sr. Customer Solutions Advisor in the SDG&E Clean Transportation department, that "the data is showing zero available capacity on the circuit because SDG&E complies with the 15/15 rule, that states: If a customer takes 15% or more of the total load of the circuit OR if a circuit holds 15 customers or less, then the data will qualify for data redaction." However, Willier said that "if a request for service is submitted and the capacity to serve the load does not currently meet the needs of the request, we will design the electrical infrastructure to accommodate the request for service. This may require a circuit from the substation or offloading and transferring load from circuits to meet the request for service."

Figure 33: SDG&E electrical infrastructure in the study area.

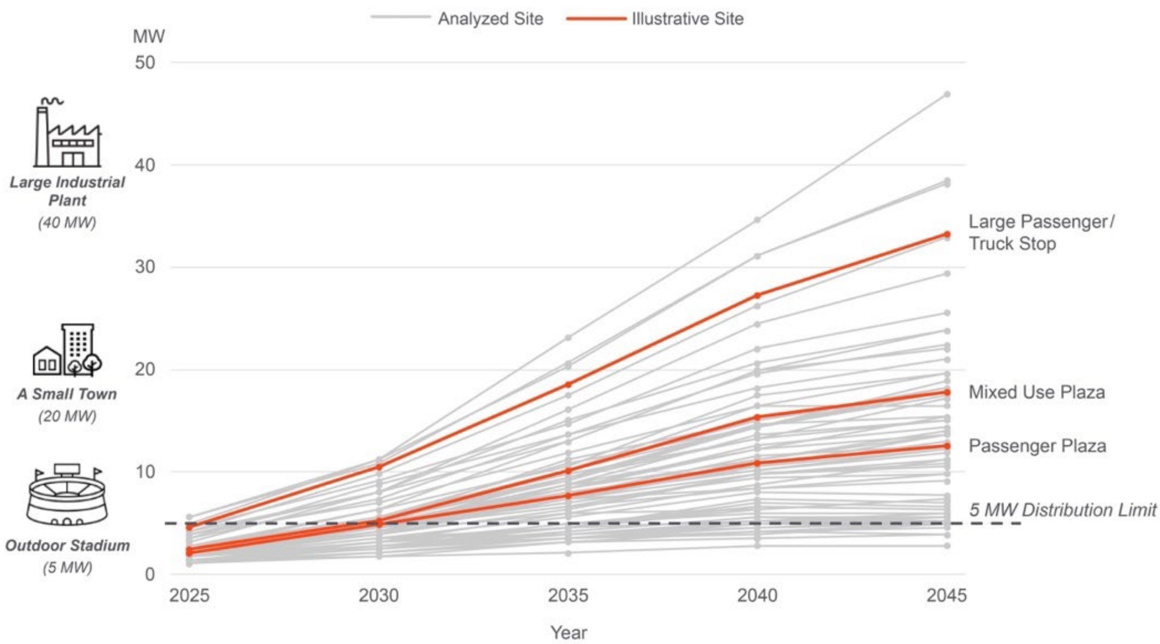


Figure 34: Capacity required to meet annual peak demand at each site compared to other large energy users. Source: National Grid study, Accelerating and Optimizing Fast-Charging Deployment for Carbon-Free Transportation.

SDG&E has several clean transportation programs including PYDFF (described above in Section 5.3). PYDFF was designed to support charging infrastructure for medium and heavy-duty (MHD) electric vehicles. More information about the PYDFF program can be found in Section 5.3. To qualify for a charger rebate of up to 50% of the cost of the charger, the charger must be used for school buses and transit buses or be at sites located in disadvantaged communities. The three sites evaluated in the STC Traffic ZEV Blueprint are located in disadvantaged communities. Chargers of the size required for heavy-duty vehicle charging (150+ kW) qualify for a rebate of up to $75,000.

Electrical Infrastructure Timeline

If the site developer chooses to utilize the customer-owned infrastructure pathway, the timeline estimated by EV infrastructure company InCharge for the development of the site would fall within the 9-13 month timeframe of the Power Your Drive for Fleets program. InCharge offers turnkey solutions for MHD fleet electrification.

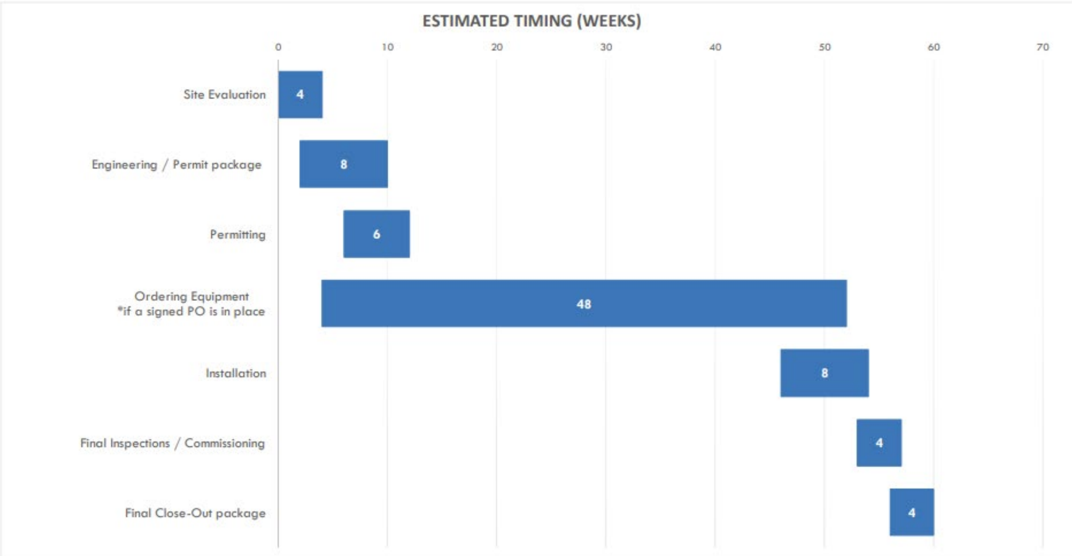


Figure 35: InCharge estimate for installation of customer-side electrical infrastructure.

7.5 Analytical Tools, Software, and Data

A variety of analytical tools and software applications are deployed by EVSE companies and infrastructure development providers such as InCharge, EVgo, and Powerflex. In addition, the National Renewable Energy Lab (NREL) has developed a modeling suite to inform the development of large-scale electric vehicle charging infrastructure deployments.

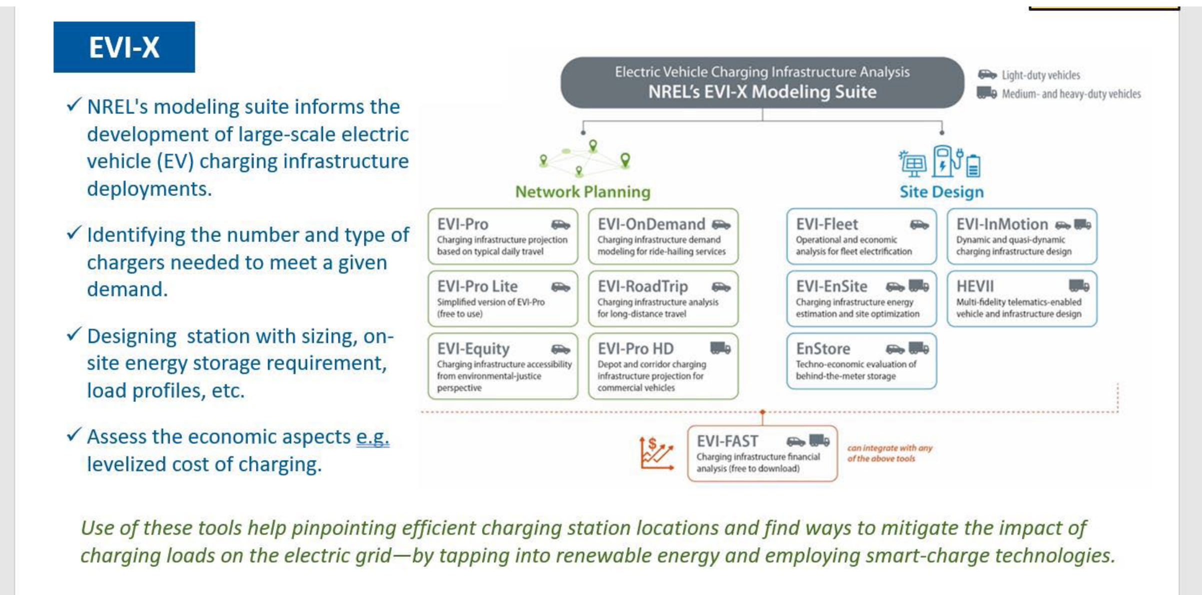


Figure 36: NREL EVI-X Modeling Suite.

7.6 Site Evaluation and Design Conclusion

The two sites on Tidelands Avenue in National City identified by the STC ZEV Blueprint team as top candidates for development are aligned with the top sites chosen by respondents to POSD's RFI. Key issues for proceeding to the development stage include completing an assessment of available electrical capacity on the circuit feeding the two sites and the timeline for SDG&E to make any necessary electrical upgrades to support the first phase of development. The proposed Business Framework for developing the sites to serve the intended IOOs is discussed in Section 0 below. A business model that gets IOOs in trucks connected to the Tidelands Ave. sites could be a win-win-win solution for truckers, POSD, and the site developer.

8 Financial and Business Considerations

8.1 Project Delivery Business Model

The Business Model shown in **Table 4**, presents a map of the key players and project pieces that can be customized to deliver any charging infrastructure project. As shown in the diagram, the related components of the charging infrastructure system, (i.e., the chargers, grid upgrades, and on-site renewable energy production) may be procured as a bundled system by a single private developer or separately through multiple private developers.

In the National City scenario developed in this Blueprint, the primary role of POSD will be to provide land, either free or with a lease, to a private site developer or private developer. The private developer will provide a complete project at no charge to the port and will manage the return on investment through LCFS credits, and well as the rate charged to IOOs and other truckers once the chargers once chargers are in the operating phase. Grid upgrades in this case will be paid for and deployed by SDG&E through the Power Your Drive for Fleets program,[29] and/or new CPUC Rule 29[30].

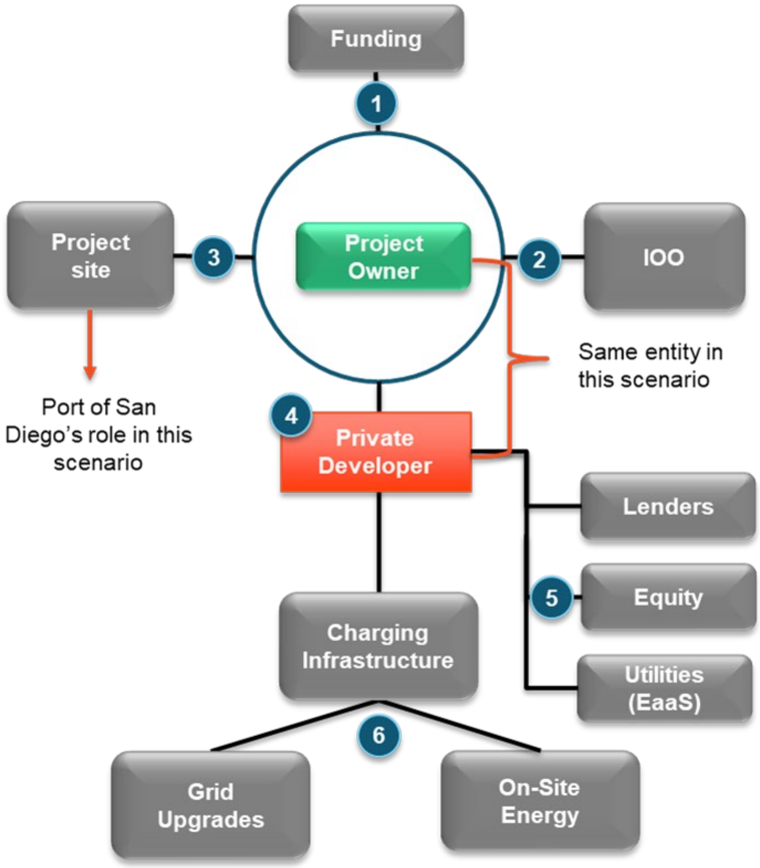


Table 4: Charging Infrastructure Delivery Business Model.

Key	Description
1	The Project Owner should apply for funding opportunities to fund the capital cost of charging infrastructure.
2	The IOOs will pay the Project Owner through a fuel rate that the Project Owner can use to pay back the Private Developer over time and to cover the cost of the energy.
3	The Project Site must be either owned or under a long-term lease. The Port of San Diego is providing the land in this case.

[29] https://www.sdge.com/business/electric-vehicles/power-your-drive-for-fleets
[30] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M413/K061/413061495.PDF

4	The Project Owner may design, build, finance, operate, and maintain the charging infrastructure and related components as needed and determined by their risk appetite.
5	A combination of debt, equity, and Utilities (Energy-as-a-Service (EaaS)) financing may be used in conjunction with public funding obtained to finance capital costs for the delivery of the site and charging infrastructure.
6	If needed as part of the design specifications, the Private Developer will work with the electric utility to identify any needed grid upgrades, and potentially deploy on-site renewable energy and/or energy storage system resources.

Debt and equity investors and utilities offer third-party financing for Energy-as-a-Service (EaaS) to pay for upfront capital costs. Additionally, Power Purchase Agreements (PPAs) can be utilized in the case of renewable energy microgrid deployment on-site (See Section 8.4.2.2 for more details). Market appetite will be informed by the terms of the financing, such as the interest rate and the payback period.

When the capital expenditure is fully paid by the project owner (i.e., POSD), the upfront capital will be paid back to the project owner over time. The project owner will receive revenue from the users of the charging stations, primarily IOOs, through the fuel rate and LCFS credits to cover the cost of the infrastructure and make a return on investment. Alternatively, the cost recovery model for deploying charging infrastructure can be tied to truck leases in the form of a Trucking as a Service model (see Section 8.1.3 below).

Increasingly, utilities are providing upfront capital to finance grid improvements and/or microgrids, although SDG&E is not currently offering this service, known as EaaS. In this model, customers will pay back the utility's upfront capital investment over time through an increased energy rate for a specified period. This service may expand in the future to include this project site.

A utility funding program that will be applicable for this site is SDG&E's Power Your Drive for Fleets program, which currently funds 100% of infrastructure on both sides of the customer meter. At this point, there is not a funding cap per program site. Thus, until the program expires in 2025 and/or a funding cap is instituted, grid improvements needed to provide required energy to the site will be 100% funded by SDG&E and will not require payback in an EaaS model.

8.1.1 System Bundling

If the Project Owner has a lower risk appetite and is willing to pay a risk premium, it may procure a single bundled system.

The **advantages** of the system bundling model may include:

- Reduced interface risk between system elements.
- Bundling systems may facilitate third-party financing and may improve the terms of financing.
- Simplified contractual management by the agency.
- Charging system providers may have easier access to financing due to ongoing relationships to debt and equity investors and EaaS providers.

The **challenges** of the system bundling model may include:

- Few private players have full-service capabilities in current market.
- There may be limitations on agencies to procure complete operations scope due to union arrangements or preexisting contractual agreements.
- Possible risk premium for items that the Project Owner could handle in-house.

8.1.2 Independent Asset Procurement

Independent Asset Procurement is a model in which each of the identified services may be delivered and financed separately. The Project Owner should determine its risk appetite and commercial and operational limitations if it is considering an independent asset procurement.

The **advantages** of the independent asset procurement model may include:

- Allowing the project owner to work around existing commercial and/or operational limitations, such as traffic management, and to remain compliant with existing contractual agreements (labor, operations, etc.).
- It may accelerate delivery of discrete elements of the system that may be more critical.

The **challenges** of the independent asset procurement model may include:

- Integration risk of the independent elements is retained by the project owner. If project elements are delayed, the project owner will have to manage the challenges of schedule impacts and cost overruns.
- This increases the project management and counterparty coordination responsibilities of the project owner.

8.1.3 Trucking as a Service

In addition to the models above, Trucking as a Service (TaaS) is an emerging business model. In the TaaS model, the third-party developer develops, owns, and operates EV chargers, as well as owns and maintains EV Trucks. IOOs would lease the trucks from the developer for a fixed monthly fee. The truck lease package offering may also be inclusive of low cost/free charging for a limited period. At the end of the lease period, IOOs will have the option to either extend the lease at a reduced rate, buy the vehicle at fair market value with option to lease the parking space and extend their charging plan, or terminate the lease. This model will benefit IOOs who might struggle with high upfront costs of purchasing electric trucks.

As the TaaS market is in its infancy at the time of report publication, the number of participants offering this service is growing.

8.2 Roles and Responsibilities

8.2.1 Project Delivery Structure

A recommended project delivery structure for charging infrastructure is presented in **Table 5**. Operations and maintenance (O&M) are presented to highlight the importance of developing projects with the end objective in mind. The project structure, or commercial model, should achieve the ultimate O&M objectives. Commercial and procurement considerations will help the project delivery team define what is needed, communicate the project requirements to the market, define required performance, and enforce contractual specifications.

The project owner should consider its risk appetite to determine if it should maintain ownership of the whole process, contract out the project as a turnkey solution, or contract out specific portions of the project.

Table 5: Project delivery structure and responsibilities.

Operations & Maintenance ("End Objective")		
Integration	Cost of Energy	Personnel Operations

Technical ("Delivering the Infrastructure")		
Construction	Design & Equipment	Approvals and Permitting

Commercial & Procurement ("Defining & Communicating Requirements, Measuring Performance")	
Defining Specifications	Compliance with KPIs

8.2.2 Operations & Maintenance

The O&M phase begins once the charging infrastructure is installed and ready for use. For HD EV vehicles, operations will include opportunity charging and overnight charging. The goal of opportunity charging is to provide a quick refuel to minimize the downtime of the vehicle. Overnight charging is used when vehicles are not actively in use. In such cases, slower charging times are acceptable. Maintenance includes maximizing charger availability through minimal repair times.

Table 6: Operations and maintenance.

Topic	Description	Stakeholder
Software	There is often software associated with the chargers. This software may help the operators manage demand with the utility and/or microgrid capacity, reduce power capacity for overnight charging, and allow customers to remotely view stations to integrate with scheduling and logistics. The OEM should provide training to the software users to ensure proper operation.	OEM
Charger O&M	Minor O&M can be performed by the project owner. The OEM should provide the proper materials, such as manuals, to ensure that the owner can perform light O&M. For more extensive O&M, the OEM should be made available through a contractual agreement such as a warranty.	OEM
Vehicle Manufacturer O&M	The manufacturer should provide the proper materials, such as manuals, to ensure that the owner can perform light O&M. For more extensive O&M, either the vehicle manufacturer should be available through a warranty, or the vehicle must be able to undergo repairs at a local mechanic.	Vehicle Manufacturer
Driver Training	If the vehicle requires specialized knowledge for operation, this should be made clear at the time of vehicle delivery.	Vehicle Manufacturer
ZEV Owners/Leasers	The IOOs should own or lease ZEVs in accordance with the specifications identified during charger procurement.	IOOs
IOO Vehicle O&M	The IOOs should undertake	IOOs

	necessary training to ensure that they can operate and perform light maintenance on their vehicles. At this time, there is no market standard for safety training or signage. As the market develops, it will be important to track safety requirements or proactively engage in best practices.	
Charger Operations	The IOOs should undertake necessary training or be provided with appropriate signage to ensure that they can operate the electric vehicle charger properly.	IOOs

8.2.3 Technical

The technical phase includes items related to construction, design and equipment selection, approvals, and permitting. This is the project delivery phase to bring the project to fruition.

Table 7: Technical phase

Topic	Description	Stakeholder
Charger Delivery/Installation	The OEM should deliver the chargers to site according to specifications and schedule. The OEM should install the chargers which includes connecting with the power grid and testing.	OEM
Permits	Relevant governmental entities must approve the necessary permits for site improvements, grid upgrades, microgrids, zoning approvals, and/or any other activities that require permitting.	Government Groups
Grid Upgrades	Once the scope of the grid upgrades is determined, the developer or utility should carry out the grid upgrades according to specifications and schedule. For the POSD sites, SDG&E will complete the grid upgrades.	Utilities

8.2.4 Commercial & Procurement

The commercial and procurement phase develops projects to achieve the objectives set by the project owner. These objectives translate into key performance indicators (KPIs) that can be used to guide design and contract specifications.

Table 8: Commercial and procurement phase.

Topic	Description	Stakeholder
Charger Suitability	Through research, experience, and interviews, Arup has determined there is currently not an industry standard for HD ZEV chargers. Currently, there are two charger connection types for DC fast chargers. The procurement team and the OEM should work together to ensure that the technology is suitable for HD vehicles that will utilize the chargers.	OEM
Integration with the Grid	The OEM should work with the project owner to ensure that the power grid can handle the high capacity of the chargers. If not, the OEM can work with the project delivery team to determine the required grid upgrades. For the San Diego region, SDG&E will evaluate and perform any required grid upgrades.	OEM
Manufacture and Deliver Vehicles	The vehicle manufacturer should manufacture and deliver vehicles to IOOs according to specifications and schedule.	Vehicle Manufacturers
Charger Integration	The IOOs should work with the vehicle manufacturer to ensure that the vehicle model integrates with the identified charger specification deployed at the project site and other chargers along the route to the extent possible.	Vehicle Manufacturers
Grants	To fund the project, grants may be obtained from government sources including the DOE, CARB, Department of Transportation (DOT), and others discussed further in the funding section of the report.	Government Groups
Provide Upfront Capital	Procurement of HD EVs, charger technology, grid upgrades (in this particular case, it will be covered by the utility), and/or a microgrid requires a large upfront investment that results in reduced O&M and fuel costs over time. Investors may be crucial in providing upfront capital to the	Investors

	relevant stakeholders to finance technology and upgrades. Market appetite will be informed by the terms of the financing (i.e., interest rates and payback period).	
Provide Upfront Capital (EaaS)	Increasingly, utilities are providing Energy-as-a-Service (EaaS) to finance grid improvements and/or microgrids. In this model, customers will pay back the upfront capital investment over time through an increased energy rate for a specified time period.	Utilities
Grid Connections	The utility, along with the relevant jurisdiction, should provide the necessary permitting, technical expertise, and on-site activities to connect the charging infrastructure to the grid. Typically, the utility will be responsible for activities up to the meter. For the San Diego region, SDG&E will cover 100% of infrastructure costs for truck charging on both sides of the meter. SDG&E covers all costs to the stub out of the charger.	Utilities
Grid Upgrades	The utility should work with the project delivery team to determine the scope of grid upgrades needed to provide the capacity required by the system.	Utilities
Estimate HD EV traffic	To design the charging infrastructure to fit the needs of the site and users, the project owner should estimate the volume, size, composition, and type of traffic for the site. This should include estimated peak demand windows.	Project Owner
Assessment of Microgrid Suitability	After the energy demand and scope of grid upgrades are identified, the project owner should consider if a microgrid, typically a solar panel installation paired with batteries, is a feasible solution to reduce electricity costs over the project lifecycle and provide a more resilient system.	Project Owner

8.3 Funding

8.3.1 State Sources

As California and local jurisdictions pass legislation seeking to mitigate the effects of climate change, funding resources are essential to enact these changes statewide. Public funding opportunities and incentive programs provide resources that encourage widescale adoption of cleaner technologies, which can make meeting these goals possible.

One of California's goals for 2030 is to decrease GHG emissions by 40%.[31]Because the transportation sector accounts for such a large proportion of these emissions – 27% nationwide and roughly 50% in California – the state aims to end sales of internal combustion passenger vehicles by 2035.[32] To reach this goal, many state funding resources are dedicated specifically to electrifying the transport sector to reduce carbon emissions associated with standard combustion engine vehicles. This shift requires replacing or repowering the vehicles themselves while also investing in resilient charging infrastructure.

Funding opportunities that can be used for investment in ZEVs are especially important for certain agencies, tribal entities, or small businesses that may not have the resources to support the transition on their own. Additionally, certain areas such as those located near or along freight corridors experience comparatively worse air quality levels exacerbated by gasoline and diesel-powered vehicle air pollution emissions. To address these needs, there are many funding opportunities dedicated to disadvantaged communities to ensure that improvements in air quality and access to ZEVs are distributed equitably across the state.

There are several active and forecasted/upcoming funding opportunities available to support local agencies, tribal entities, and small businesses in their transitions to ZEVs. Grants, incentives, and tax credits are available through state and local agencies. The following agencies offer a variety of programs designed to make ZEVs and associated infrastructure more accessible to the public:

Table 9: Public agency list.

Agency	Description
California Air Resources Board	CARB is a department within the California Environmental Protection Agency (EPA) dedicated to protecting public health, welfare, and ecological resources by reducing air pollution through various programs. Many of these programs are specifically related to ZEV expansion and fleet electrification.
Air Quality Management Districts (AQMDs) or Air Pollution Control Districts (ACPDs)	AQMDs or ACPDs are local agencies under CARB that are responsible for distributing funds regionally as well as tailoring programs to fit the needs of the area. In alignment with CARB's mission, these efforts also target emissions reduction and air quality improvement.
California Energy Commission	The CEC is California's primary energy agency and thus plays a critical role in advancing the state's energy practices with the goal of reaching 50% clean energy usage by 2030. Incentive programs, grants, and research funding opportunities are some of the ways the CEC works to wean the state off its reliance on energy from fossil fuels.

[31] https://ww2.arb.ca.gov/our-work/topics/climate-change#

[32] https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/

California Department of Transportation (Caltrans)	Caltrans oversees the state highway system and supports transit systems across the state. Caltrans provides resources for sustainable planning. Certain ZEV projects would be eligible for these grants due to their impact on clean energy and resilience. In addition, Caltrans is the recipient of $384 in National Electric Vehicle Infrastructure (NEVI) funding to be deployed along top priority transportation corridors over the next five years.
California Public Utilities Commission	CPUC is the agency that reviews and approves utility transportation electrification programs, including the recent approval of Rule 29, which allows utilities to collect from ratepayers the cost of deploying utility-side electrical infrastructure. CPUC has also approved recent Vehicle-to-Grid pilot programs and has approved a $200 million Microgrid Incentive Program.

Most active opportunities are awarded on a first-come, first-served basis. See Appendix L for funding programs available as of June 20, 2022. Forecasted/upcoming opportunities in Appendix L represent programs that are not currently open. These opportunities are either expected to solicit applications within the next two fiscal years or are recurring programs that offer funding opportunities in multiple rounds.

The following links may act as a resource for verifying active opportunities and discovering future opportunities:

- CEC Solicitations
- CARB – Clean Transportation Incentive funding program
- CARB – Volkswagen Mitigation Trust Grant Management System
- CARB – HVIP Daily Updates
- California Truck Loan Assistance Program
- Carl Moyer Air Quality Standards Attainment Program
- U.S. Department of Energy's Alternative Fuels Data Center
- Inflation Reduction Act's energy and infrastructure provisions
- Federal Highway Administration webpage on implementation of the Infrastructure Investment and Jobs Act

CARB approved its $2.6 billion Clean Transportation Incentives program budget on November 17, 2022. The bulk of these funds come from California Climate Investments, a statewide initiative that puts billions of cap-and-trade dollars to work reducing greenhouse gas emissions, strengthening the economy and improving public health and the environment, particularly in disadvantaged communities. One of the top goals of CARB's investment plan is "supporting small owner/operator fleets' transition to zero-emission in support of equitable investment goals."[33]

Relevant components of CARB's investment plan for public opportunity charging include:

- **HVIP standard funding: $265 million**

[33] https://www.caclimateinvestments.ca.gov/

- **Zero-Emission Drayage Trucks: $157 million**

According to CARB, "in FY 2021-22, a $75 million set-aside was established to support the deployment of zero-emission drayage trucks. Within the first 24 hours of HVIP reopening the drayage truck set-aside was fully subscribed, though drayage trucks continued to be funded through standard HVIP voucher requests. As of May 31, 2022, there were 530 requests totaling over $80 million for zero-emission drayage trucks. Of the vouchers requested, 70 percent were for trucks domiciled in disadvantaged communities and over a quarter of requests were from fleets with fifty vehicles or less." The approved CARB Clean Transportation Investment plan extends the 25 percent voucher enhancement for zero-emission drayage trucks."

- **Innovative Small E-Fleets: $35 million**

According to CARB, "innovative Small e-Fleets is designed to support small fleets and individual owner/operators making the transition to zero-emission trucks. Innovative Small e-Fleets will pilot innovative mechanisms such as all-inclusive leases, peer-to-peer truck sharing, truck-as-a-service, assistance with infrastructure, and individual owner planning assistance, as well as other mechanisms. Since the Board's adoption of the funding plan, staff held additional work groups to develop requirements and launched the pilot in summer 2022. Staff anticipates that the lessons learned from Innovative Small e-Fleets will be used to inform changes to HVIP and CARB's broader heavy-duty incentive policies as we continue to target smaller fleets. As of August 31, 2022, privately-owned or non-profit trucking fleets with 20 or fewer trucks and an annual revenue of less than $15 million can access flexible financing options for zero-emission trucks through the HVIP Innovative Small e-Fleet Pilot (ISEF). This funding allows small fleets to access flexible financing, lease, rental, and truck-as-a-service options with enhanced incentives and fueling support."[34]

- **Truck Loan Assistance Program: $28.6 million**

According to CARB, "the Truck Loan Assistance Program helps small-business fleet owners secure financing for upgrading their fleets with newer trucks. Small business truck owners with 100 or fewer employees, $10 million or less in annual revenue averaged over 3 years, and fleets with 10 or fewer heavy-duty vehicles subject to the In-Use Truck and Bus Regulation are eligible to seek financing under this program. The proposed FY 2022-23 allocation for the Truck Loan Assistance Program is expected to enable financing for about 3,000 new truck purchases. This will help small business truckers comply with the In-Use Truck and Bus Regulation and result in an estimated 450 tons of NOx and 16 tons of ROG emission reductions."[35]

- **Zero Emission Truck Loan Pilot: $5 million**

According to CARB, "the Zero-Emission Truck Loan Pilot Project is a new project that is designed to combine financing for both heavy-duty ZEVs and charging or fueling infrastructure. A comprehensive loan package that combines vehicle and infrastructure financing will provide additional access to zero-emission financing and create a streamlined lending process for small businesses that are transitioning to ZEVs. The Zero-Emission Truck Loan Pilot Project is currently under development and staff is considering stakeholder feedback to develop the pilot. Staff anticipates having a pilot in place by mid-year 2023."[36]

- **Flexibility for Small Fleets to Stack Incentives**

According to CARB, **"**currently, incentives for some technologies in HVIP may be "stacked" or combined with other local and federal incentives to further support fleet purchases decisions. Purchasers are not permitted to stack incentives with other state incentive dollars such as the Carl Moyer Program. To provide more flexibility for small fleets, staff proposes to allow fleets with ten vehicles or fewer to stack HVIP with

[34] https://californiahvip.org/program-updates/innovative-small-e-fleet-update/
[35] https://ww2.arb.ca.gov/our-work/programs/truck-loan-assistance-program
[36] https://ww2.arb.ca.gov/news/new-pilot-program-help-small-trucking-fleets-transition-zero-emission-technologies

other state incentive programs, so long as the other programs allow stacking, each incentive program is not paying for the same incremental cost and the non-HVIP incentive program is not required to generate greenhouse gas emission reductions."[37]

The following MHD funding information is provided by CARB in its overview of the draft ACF regulation:

- The Carl Moyer Memorial Air Quality Standards Attainment Program funds the replacement of old, high-polluting vehicles, engines, and equipment with new technologies that are cleaner than required, or earlier than what is required by rules and regulations. Grant amounts are based on the cost-effectiveness of harmful pollutants that will be reduced by the project. This program may also fund the installation of charging and fueling infrastructure. Carl Moyer's VIP program focuses on small fleet electrification. More information on this program is available at the Carl Moyer webpage. [38]
- Technical and financial assistance for infrastructure is also available through several programs. The CPUC has approved $690 million to support heavy-duty charging and hydrogen fueling infrastructure installation pursuant to *Senate Bill 350*. The CEC is also working to accelerate MHD vehicle infrastructure for both charging and hydrogen refueling and will invest $2.4 billion from the current state budget in infrastructure that will serve light-, medium-, and heavy-duty infrastructure. The recently launched *EnergIIZE* program provides energy infrastructure incentives for commercial vehicle fleets.

Other California MHD ZEV funding sources include:

- The CEC's Clean Transportation Program (CTP) provides MHD infrastructure investments focused on the infrastructure needs of medium- and heavy-duty ZEVs including charging and refueling for drayage trucks, grid integration, integrated storage solutions, and charging management.
- Volkswagen Settlement Programs generally require applicants to scrap older qualifying diesel engines in order to receive funding for the purchase of new battery-electric vehicles, including MHD (Class 5-8) trucks and cargo handling equipment.

8.3.2 Additional Local Resources

San Diego Air Pollution Control District (APCD) – Clean Air for All Grant Campaign

The Clean Air for All Grant Campaign combines multiple grant opportunities to streamline the process for businesses, nonprofits, and government agencies to apply for funding to replace polluting heavy machinery with electric or low-carbon emission alternatives. The solicitation considers applicants for funding available from the Carl Moyer Program, the Funding Agricultural Replacement Measures for Emissions Reductions, the Community Air Protection Program, and the Goods Movement Emission Reduction Program. Funding is currently closed but is expected to reopen once funds have been distributed for the next fiscal year.[39]

San Diego Gas & Electric (SDG&E) – Power Your Drive for Fleets

The SDG&E Power Your Drive for Fleets is one of the company's Clean Transportation Initiatives providing charging infrastructure support for MHD electric vehicles. With a budget of $107 million through September 2025, SDG&E installs make-ready charging infrastructure across San Diego to support California's goal of reaching 5 million ZEVs by 2030. Make-ready infrastructure includes all electrical infrastructure required to make a commercial site ready for EV charging including upgrades to transformers, concrete work, and increases to service capacity. The program covers up to 50% of charger costs in disadvantaged communities. The program seeks to build charging infrastructure to electrify at least 3,000 trucks, buses, forklifts, and other MHD vehicles at 300 sites. [40]

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[37] https://ww2.arb.ca.gov/news/new-pilot-program-help-small-trucking-fleets-transition-zero-emission-technologies
[38] https://ww2.arb.ca.gov/resources/fact-sheets/carl-moyer-memorial-air-quality-standards-attainment-program

[40] https://www.sdge.com/business/electric-vehicles/power-your-drive-for-fleets

Program Requirements
To be eligible for Power Your Drive for Fleets, the customer must demonstrate evidence of a commitment to procure at least two electric fleet vehicles as well as a long-term electrification growth plan and schedule of load increase. The customer must commit to providing data related to charger usage for a minimum of five years and either own or lease the property where chargers are installed. The customer is required to operate and maintain the vehicles and chargers for at least 10 years.

Eligible Vehicle Types
For on-road vehicles, eligible types include delivery and shuttle vehicles ranging from Class 2 to Class 6, transit buses of Class 7 or Class 8, school buses of Class 6 or Class 7, goods movement vehicles of Class 7 or Class 8, and other HD vehicles. Off-road vehicles may include transport refrigeration units, yard trucks, airport ground support equipment, and forklifts.

Installation & Ownership
SDG&E offers two options for installation and ownership for customers:

- **Option 1**: SDG&E pays for, constructs, owns, and maintains all infrastructure up to the charging station. This includes the power lines, transformer, meter, and electric panel and switchgear. The customer will own and pay for charging stations. SDG&E charger rebates may* apply.
- **Option 2**: SDG&E pays for, constructs, owns, and maintains infrastructure to the meter. This includes the power lines, transformer, and meter. The customer will pay for, construct, own, and maintain infrastructure behind the meter—the electric panel and switchgear—for a rebate of up to 80% of the costs. The customer will also own and pay for the charging stations, and charger rebates may apply.[41] Please note that Option 2 is required for primary service or associated distributed generation projects.

Electrification Process
There are five steps involved in SDG&E's electrification process, which typically takes 11-16 months.

- **Submit Interest (1-2 months):** Interested customers can begin the process by submitting an interest form. An SDG&E representative will be available to ensure the proposed site is eligible for the program and help throughout the application process.
- **Preliminary Design & Engineering (6-9 months):** After conducting a physical inspection of the site, SDG&E will create and finalize the specific infrastructure design package and obtain the necessary permits.
- **Construct Infrastructure (3-4 months):** SDG&E will construct the make-ready EV charging infrastructure according to the installation and ownership option chosen by the customer.
- **Activate Site (1 month):** The customer must commission the EV charging stations during this phase so that SDG&E can inspect and energize the equipment.
- **Closeout and Maintenance:** SDG&E will oversee a post-event job walk and assume responsibility for the ongoing maintenance of all SDG&E-owned infrastructure. The customer will assume responsibility for the ongoing maintenance of all customer-owned infrastructure and equipment.

Electric Vehicle-High Power (EV-HP) Rate
SDG&E offers a unique fixed monthly subscription charge to stabilize electricity prices for customers. This plan allows for EV fleet customers to select the amount of power needed to operate their vehicles and pay a flat monthly fee. The EV-HP rate complements the Power Your Drive for Fleets program by eliminating demand charges and providing fleets with simple, stable billing.

8.3.3 Federal Sources

Funding for ZEV infrastructure investments can also be sourced from federal agencies. This federal funding can either be distributed to state agencies as grants for further disbursement to local agencies through a formula or competitive process or through competitive/discretionary grants that can be won through solicitations that are open to local or specialized agencies.

ZEV funding programs typically run through the DOT, DOE, and EPA. These programs may be tailored specifically to ZEV investment or address national sustainability, energy, or air quality goals. The Infrastructure, Investment and Jobs Act (IIJA) has created additional funding opportunities for the electrification transition, as has the Inflation Reduction Act (IRA), which includes tax credits for heavy-duty trucks and charging infrastructure. Many federally sourced funding opportunities are released on an annual basis, and a regularly updated list of resources can be found at www.grants.gov. [42]

As described by CARB, "the federal *Inflation Reduction Act of 2022* provides complementary and substantial new funding for zero-emission trucks and related infrastructure. The federal *Infrastructure Investment and Jobs Act of 2021* provides $550 billion in new infrastructure investments, including for roads, bridges, public transit, water infrastructure, resilience, and broadband."

The EPA Diesel Emissions Reduction Act (DERA) program funds projects that significantly reduce diesel emissions, with priority given to fleets operating in Clean Air Act Non-Attainment areas. New and repowered class 5-8 heavy duty truck engine and vehicles, marine engines, and cargo handling equipment (CHE) are eligible.

The EPA Clean Heavy-Duty Vehicles program will provide $1 billion for grant and rebate programs to replace dirty heavy-duty vehicles with clean, zero-emission vehicles, support zero-emission vehicle infrastructure, and train and develop workers. $400 million will be set aside for projects to replace vehicles serving communities located in an air quality nonattainment area for any air pollutant.

A table of federal forecasted and upcoming opportunities can be found in Appendix L.

8.4 Financing

8.4.1 Public Sources

There are several avenues to obtain financing for ZEV investments through public sources in California. Financing opportunities enable the state to invest money into programs that will advance its GHG emission reduction goals including CARB's goal to reduce California's GHG emissions by 40% below 1990 levels by 2030[43]. In the case of ZEVs, California has a number of opportunities that businesses and agencies can apply to for assistance with the upfront investment cost of ZEVs and associated infrastructure. These programs differ from funding opportunities because in most cases the beneficiary is required to pay back the money that has been borrowed. Financing for ZEVs can make it possible for entities to actualize fleet electrification more quickly.

The California Office of the State Treasurer oversees two main financing authorities that can support the advancement of ZEVs: the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) and the California Pollution Control Financing Authority (CPCFA). Another source of public financing programs is the California Infrastructure and Economic Development Bank (IBank). These agencies offer several programs that provide loans, bonds, and tax exemptions to assist agencies and businesses in financing investments in alternative energy, advanced transportation, and pollution control. ZEVs and associated infrastructure are eligible for many of these programs. A table of active state funding opportunities can be found in Appendix L.

8.4.2 Additional Financing Opportunities

[42] https://www.grants.gov/web/grants/search-grants.html

[43] https://ww2.arb.ca.gov/our-work/topics/climate-change

8.4.2.1 Cost of Energy

Due to the comparatively low price of electricity when compared to gasoline or diesel, ZEVs result in overall savings in energy costs compared to fossil fuel vehicles. However, fleet managers have less experience in budgeting these costs over the long term. With increased energy demand and fluctuating energy rates based on Time of Use (TOU) rates and demand charges, it may be challenging to budget and account for energy costs. There are several potential strategies that a project owner may use to mitigate this risk. Below, we review some of the risks associated with energy costs and outline the challenges and possible mitigation strategies.

Table 10: Energy Cost Variability Mitigation Strategies.

Mitigation Approach	Description
SDG&E EV-HP Rate ***Fixed monthly subscription charge***	For entities eligible and located in an SDG&E region, SDG&E offers a unique fixed monthly subscription charge to stabilize electricity prices for customers. This plan allows for EV fleet customers to select the amount of power needed to operate their vehicles and pay a flat monthly fee.
Power Purchase Agreement ("PPA") ***Long-term agreement to ensure reliable power and costs***	PPA is a contractual agreement between an electricity generator and an off-taker (or "energy buyer"), that defines the commercial terms for the sale of electricity over a specified period of time (generally long-term). PPAs are common mechanisms to secure energy costs over the long term and are often a tool for financing capital projects in the energy sector.
Low Carbon Fuel Standard ("LCFS") Credits ***Credits generated through ZEV operations***	LCFS credits generated through ZEV operations can unlock access to additional funding. LCFS value can be maximized by contracting a third-party brokerage firm to trade the credits. In this case, LCFS credits will likely be used by the site developer/EVSE owner to provide a flow of revenue from credits to offset the upfront cost of the EVSE. However, we note that estimating the value of LCFS credits can be challenging if all project inputs have not been finalized.
Microgrid ***Solar and battery storage***	There may be grid upgrade costs if the grid does not have sufficient supply to meet the ZEV energy demand. A combination of microgrid on-site generation and grid energy supply may be a better solution than solely relying on the grid. SDG&E will cover any necessary grid upgrades. Additionally, microgrids can enhance system resiliency during blackouts or natural disasters ensuring that ZEV vehicles can continue to charge as needed. The use of on-site storage as part of the microgrid solution can help address TOU costs and peak load demands by providing grid-independent energy.

8.4.2.2 Power Purchase Agreements

PPAs are long-term agreements used to ensure reliable power and provide price certainty for a specified period. PPAs are used to deploy a microgrid or other power generation asset. When paired with Renewable Energy Systems, Renewable Energy Credits (RECs) may be generated as an additional source of revenue. With the recent passage of funding opportunities on the federal, state, and utility level, PPAs may be less attractive to project owners since they may result in higher electricity rates over time than without. There are two primary types of PPAs: Physical PPAs and Financial PPAs.

Renewable Energy Systems

PPAs are often used for renewable energy systems. If the PPA provides power from a renewable energy source, the project owner will receive Renewable Energy Credits (REC) in exchange for the clean energy produced. RECs are a claim to the renewable and environmental attribute for one unit of energy that is generated by a renewable energy source. These RECs may be sold in the open market to help companies achieve their sustainability goals.

Physical PPAs

When it comes to Physical PPAs, the project owner must either own or lease land to support the renewable energy asset. In this PPA, the power is physically delivered to the buyer (see **Figure** *37*). In exchange for the electricity, the buyer agrees to a fixed price that is paid throughout the contract term. The buyer's energy demand defines the terms of the PPA, such as capacity of the system and price.

The power generator typically builds, owns, operates, and maintains the renewable energy system for the duration of the contract, generally 15 to 25 years. Additionally, the generator retains any potential risks associated with owning and operating the asset.

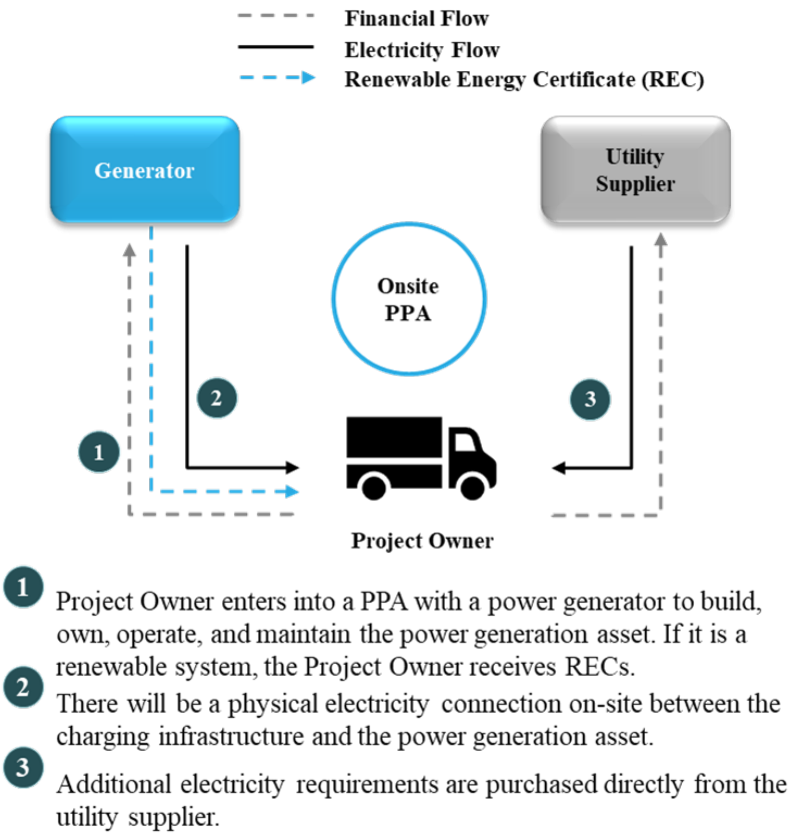
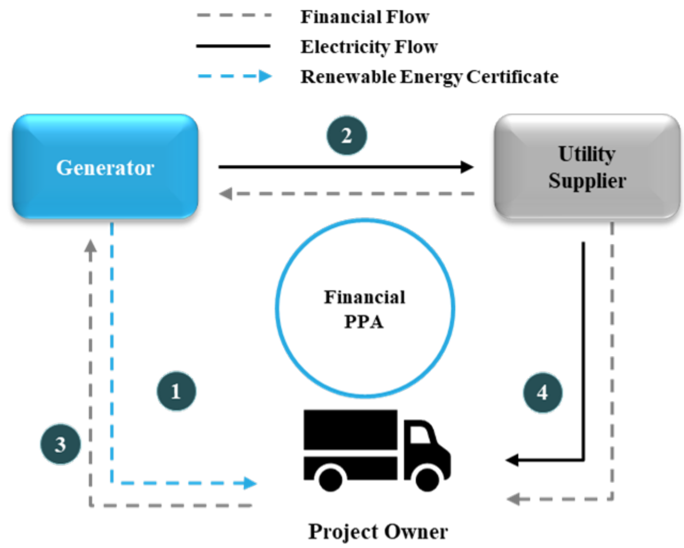


Figure 37: Physical PPA Model.

Financial PPAs

In Financial PPAs, there is no physical exchange of electricity (see **Figure** *38*). This model is a financial contract between the power generator and the project owner ("the buyer"), in which the buyer purchases the electricity at a fixed price and receives RECs. The power generator then sells the electricity into the wholesale grid at the floating market rate.[44] Thereafter, any monetary difference between the fixed price and wholesale market price is exchanged between the two parties, such that the power generator always receives the net fixed price for its sales of electricity.

The contract term may range from 10 to 20 years. Given that this model is a financial contract, the buyer will continue to purchase power from the local utility provider, and the generator will continue to sell electricity to the grid or wholesale market. The financial PPA provides price certainty against the market price for both parties.



1. Project Owner enters into a financial PPA with a power generator, agreeing to a fixed price for electricity.
2. Generator sells electricity to the grid and is paid the wholesale market price by the utility supplier.
3. Difference between fixed and market price is settled between the generator and Project Owner and the REC is delivered.
4. Project Owner continues to purchase electricity from its utility supplier at the market rate.

Figure 38: Financial PPA Model.

8.4.2.3 Low Carbon Fuel Standard

CARB implements and administers the LCFS program, which launched in 2009. The LCFS Program is designed to encourage the use of cleaner, low-carbon transport fuels in the transportation sector, which is responsible for about 50 percent of GHG emissions and 80 percent of ozone-forming gas emissions in California. [45]The LCFS program is also designed to increase renewable energy usage and reduce reliance on imported fossil fuels.[46]

LCFS standards are expressed in terms of the “carbon intensity” (CI) of gasoline and diesel fuel and their respective substitutes. Low-carbon fuels below a benchmark established by CARB (such as electricity, renewable diesel, renewable natural gas, and many others) generate credits, while fuels above the CI benchmark generate deficits. Credits and deficits are denominated in metric tons of GHG emissions and are

[44] Floating market rate means that the price changes reflective of market conditions. It may be difficult to accurately forecast electricity revenues due to future price uncertainty.

[45] https://www.energy.ca.gov/about/core-responsibility-fact-sheets/transforming-transportation

[46] https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

transacted on a private market.

In the case of electricity used as a fuel source, credit generation is relative to the CI of the electricity used and the quantity of electricity supplied to the equipment. Every quarter, energy consumption data is submitted, reports are developed and submitted, credits are generated, transacted, and transferred, and payments are issued to credit-generators.

The 2018 LCFS amendments added a ZEV infrastructure crediting provision to the program (Section 95486.2) designed to support the deployment of ZEV infrastructure. The ZEV infrastructure provision covers Hydrogen Refueling Infrastructure (HRI) and Direct Current (DC) Fast Charging Infrastructure (FCI). In addition to generating LCFS credits for dispensed fuel, the eligible hydrogen station or DC fast charger can generate infrastructure credits based on the total “capacity” of the station or charger minus the quantity of dispensed fuel. That is, credits are issued based on how much theoretical energy can be supplied, not the actual fuel supplied.

The public opportunity charging deployment evaluation at Sites 3 and 4 on Tidelands Avenue in National City 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.[47]

All values are subject to change and can vary widely between equipment, deployment timelines, and a host of other external factors. This deployment evaluation is based on recent averages of LCFS Credit and REC prices.

The purchase of renewable, zero-emission electricity increases the total quantity of credits generated by 25-35%. There is a net-financial benefit, as the cost of procuring zero-emission electricity (via the Renewable Fuel Standard program) is less than the additional proceeds from extra credit generation. This process is called “Book and Claim.” The added benefit is that the electricity used to charge fleets can be counted as operating with zero emissions, a benefit to internal sustainability initiatives and goals.

Evaluation Summary: e-Mission Control estimates DCFC EVSE installation to generate a total five-year project credit value of approximately $3,535,776 for Site 3 and $3,234,312 for Site 4.

The tables below provide details on the project credit value and analysis assumptions.

[47] https://e-missioncontrol.com/

Table 11: Year on Year Project Value Calculation

e-Mission Control A MOMENTUM COMPANY **city Crediting Calculator**

	Year 1 – 2024		Year 2 – 2025		Year 3 – 2026		Year 4 – 2027		Year 5 – 2028	
Consumption Credit Generation	**350 kW EVSE**	**200 kW EVSE**	**350 kW EVSE**	**200 kW EVSE**	**350 kW EVSE**	**200 kW EVSE**	**350 kW EVSE**	**200 kW EVSE**	**350 kW EVSE**	**200 kW EVSE**
Credit Price ($/credit)	$90.00	$90.00	$98.00	$98.00	$105.00	$105.00	$125.00	$125.00	$125.00	$125.00
Annual Credits generated Per Unit	**120.13**	**120.13**	**118.06**	**118.06**	**115.98**	**115.98**	**113.91**	**113.91**	**111.82**	**111.82**
Value Per kWh	**$0.1175**	**$0.1175**	**$0.1258**	**$0.1258**	**$0.1324**	**$0.1324**	**$0.1548**	**$0.1548**	**$0.1519**	**$0.1519**
Fleet-Wide Generation										
Vehicles in Operation	3	3	4	4	6	6	10	10	10	10
kWh Delivered Per Year Per Site (kWh/year/site)	276,000	276,000	368,000	368,000	552,000	552,000	920,000	920,000	920,000	920,000
Value per Site	**$32,436**	**$32,436**	**$ 46,281**	**$46,281**	**$73,065**	**$73,065**	**$142,383**	**$142,383**	**$139,775**	**$139,775**
Uptime Percentage	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Quantity of Electricity Dispensed	92,000	92,000	92,000	92,000	92,000	92,000	92,000	92,000	92,000	92,000
Annual Credits generated	**151.63**	**91.13**	**149.02**	**89.56**	**146.38**	**87.98**	**143.77**	**86.41**	**141.14**	**84.82**
Value Per kWh	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**	**$0.1175**

FCI Credit Generation	350 kW EVSE	200 kW EVSE	350 kW EVSE	200 kW EVSE	350 kW EVSE	200 kW EVSE	350 kW EVSE	200 kW EVSE	350 kW EVSE	200 kW EVSE
Value Per Charging Station	$13,647	$8,202	$14,604	$8,777	$15,370	$9,238	$17,971	$10,801	$17,642	$10,603
Value Per Site	$136,467	$82,017	$146,037	$87,768	$153,702	$92,375	$179,713	$108,008	$176,421	$106,029
Total Value	$168,902.56	$114,452.55	$192,317.23	$134,048.85	$226,767.55	$165,440.49	$322,096.12	$250,390.80	$316,195.89	$245,804.09
Five Year Project Value										**$2,136,416.12**

Notes:

Low Carbon Fuel Standard (LCFS) Credits

Owners of DCFC EVSE earn LCFS credits based on the amount of fuel (electricity) dispensed in addition to credits generate
The installed EVSE capacity credit volume (Fast Charging Infrastructure (FCI) Credit Generation) has an inverse relationshi
(Consumption Generation) credits (i.e., the greater the fuel dispensed the lower the capacity credits that can be claimed).

kWH delivered

kWh delivered per year is the projected total electricity dispensed for opportunity charging (10 @ 350 kW) and overnight ch
value of 2.3 kWh/mile was used, with an assumption that trucks utilizing the public charging site travel 120,000 miles/year i
charging done at the site. The LCFS value per kWh delivered is $.1175. kWh delivered is assumed to increase over time as si

Credit price of LCFS

Credit price is impacted by typical supply and demand mechanics. Demand (purchasers) is correlated to the production and
that exceed the specified carbon intensity limits, and supply is correlated to the production or consumption volume of low-c
renewable diesel and electricity. When demand for credits exceeds the available supply, prices rise. When supply outstrips d
it's difficult to attribute recent sharp movement to any one particular influencing factor, ramped up production of renewabl
decreased demand for gasoline and diesel have the most meaningful impact on credit price. The price variable goes up over
CARB will implement more stringent requirements with forthcoming admendments to the LCFS regulation.

Credit Price Sensitivity

"Weak" credit pricing was assumed to be 85% of the "Normal" credit pricing trend. "Strong" credit pricing was assumed to b
credit pricing trend.

Table 12: Assumed Variable and/or Sensitivity Factors.

Site	Site 4	Site 3
Phase 1 ***(LCFS Generating period 2024-2026)***	- 10 200-kW chargers at $162,750 / charger[48] - 10 350-kW chargers at $173,750 / charger[49]	- 10 200-kW chargers at $162,750 / charger - 10 350-kW chargers at $173,750 / charger
Phase 2 ***(LCFS Generating period 2027-2028)***	- 5 1-MW charger at $548,625 / charger[50]	- 15 200-kW chargers at $162,750 / charger - 11) 500-kW chargers at $313,500[51] / charger

1. No major co-location of solar or other ability to generate RECs.
2. LCFS FCI Capacity Crediting Cap has not yet been reached (about 50% of the cap has been awarded as of mid-2022))
3. No other grant funding utilized for Direct Current Fast Charge (DCFC) deployment on EVSE or infrastructure (CARB will only credit for out-of-pocket expenses).

8.5 Market Outlook

The ZEV transition will require significant upfront capital investment. There are a variety of items necessary to procure a charging station. Similarly, investment partners are diverse and include, amongst others:

- Traditional investors
- Government
- Specialized financial businesses
- Individual investors

Interviews for a high-level market survey were conducted with targeted financial partners to explore the core drivers for ZEV infrastructure investments, market barriers, and perceived risks of ZEV financing (as discussed in Section 5.8). Investment firms are focused on ensuring that the investors see a return by investing in projects that will yield expected outcomes whilst also having aligned mission, such as sustainability. Full responses to the market survey are listed in Appendix L.

8.5.1 Risks

In considering the commercial structure and/or model best suited to deliver the charging infrastructure, project owners needs to understand their risk tolerance and desired risk profile for any given transaction. Certain parties are best suited to bear specific risks. As an example, a private partner may be better suited to bear construction risks than the project owner. As part of the analysis, we created a risk register aimed at capturing the critical risks related to the design, construction, and operations of charging infrastructure. The register considered the primary risk categories and their potential impact on the project's success. Additionally, the risk register recommends potential mitigation strategies. Below is a summary of the risk register categories considered in the evaluation.

48 Representative quotes from internal benchmarks
49 Representative quotes from internal benchmarks
50 Assumed 175% the cost of 500 kW charger.
51 Representative quotes from internal benchmarks

Table 13: Summary of the Risk Register Categories.

Risk Category	Description of the Category
Planning/Logistics	Risk related to the planning phase / process, including programming and defining charging requirements, alignment between charging schedule and customer demand.
Commercial / Procurement	Risks associated with executing a successful procurement of the infrastructure, primarily as it pertains to ensuring the desired contractual structure and risk allocation.
Operations & Maintenance	Risks related to the reliability of the operations and maintenance activities and management of costs including labor (managing in-house or third-party contracts) and energy cost predictability.
Design & Equipment	Risks related to the technical design of the project, technology performance and integration between different assets in the ZEV system.
Legislative/ Policy	Potential regulatory or policy changes impacting operations and technologies implemented as well economic profile of the project (i.e. changes in tax incentives).
Construction	Impact of potential delays (i.e. permitting, discoveries, etc.) on the construction schedule as well as integrating existing transit operations during conduction.
Funding / Finance	Changes in funding requirements (e.g., due to cost overruns), available funding, changing financing conditions (e.g., higher than expected variable rates).

Risk Category	Description
Commercial / Procurement	Risks associated with executing a successful procurement of the infrastructure, primarily as it pertains to ensuring the desired contractual structure and risk allocation.
Operations & Maintenance	Risks related to the reliability of the operations and maintenance activities and management of costs including labor (managing in-house or third-party contracts) and energy cost predictability.
Design & Equipment	Risks related to the technical design of the project, technology performance and integration between different assets in the Bus System.
Regulatory / Policy	Potential regulatory or policy changes impacting operations and technologies implemented as well economic profile of the project (i.e. changes in tax incentives).
Construction	Impact of potential delays (i.e. permitting, discoveries, etc.) on the construction schedule as well as integrating existing transit operations during conduction.
Funding / Finance	Changes in funding requirements (e.g., due to cost overruns), available funding, changing financing conditions (e.g., higher than expected variable rates).
Route Planning	Risk related to the planning phase / process, including programming and defining charging requirements, alignment between charging schedule, bus schedule, and passenger demand.

The table below summarizes the major risks, based on likelihood and impact of risk, to consider for each category. Please refer to Appendix L to view the risk register in detail.

Table 14: Risk register.

Risk Category	Summary of the Major Risks
Commercial/Procurement	Compliance with Key Performance Indicators (KPIs)—particularly if they are not sufficiently defined and/or the private developer does not comply with KPIs in the contract—is a major risk, which could result in increased cost and delays to the project schedule, as well as service disruptions. The potential mitigation approach to this risk is for the project owner to have an early understanding of its needs and the project definition. Additionally, technical specifications need to be clearly defined in procurement documentation i.e., O&M and the charging management Agreement. The other risk is performance specification, i.e., specifications ahat do not meet the requirements and needs of the project owner. For instance, energy demand and charging requirements may not be meet needs of the project owner. The potential mitigation approach is early programming and modelling to understand and define potential constraints that would inform performance specifications for the procurement documents, as well as incorporation of the project owner's needs into performance specifications.
Funding/Finance	One of the main risks to consider is timing of funding sources. Allocated funding may not be available to deploy when needed, which may result in delayed project delivery and/or commencement. Understanding of funding timelines during project inception and concrete analysis of sources and uses can be a mitigation strategy for this risk.
Legislative/Policy	Regulatory changes are an important risk to examine. Potential regulatory changes may impact existing technologies i.e., charging standardization. Public entities will also need to ensure that charging stations maintain compliance with existing regulations and codes, which may result in updating infrastructure. The consequences of this risk include cost increases and project non-performance. A possible mitigation to these risks is to consult relevant policy proposals and documents to monitor accordingly.
Operations and Maintenance	One risk during the O&M phase is the potential outsourcing of activities, which may be hindered by unionized labor and contracts. This can result in the project owner retaining O&M risk and associated costs. To address this, the project owner can negotiate with union staff in the early stages of the project regarding potential activities to outsource, and consider creating an apprenticeship program to train staff. Other risks include cost of energy, unexpected changes in energy and demand, and charging times impacting infrastructure. Mitigation strategies include executing long-term PPAs, controlling charging times, on-site generation and storage, and funding contingency. To address changes in energy/demand, charge/demand management may be implemented. Charging times can also decrease customer use and cause disruptions, which can be mitigated by selecting faster charging technology, scheduling operations, and "sipping" from the charger in short bursts.
Design and Equipment	For the Design and Equipment category, the useful life of the battery is a substantial risk. Battery disposal may be costlier or more complicated than initially expected, especially if there is an on-site storage/microgrid system. This could increase capital costs and result in contamination issues. The project owner should consider obtaining asset hand back and recycling assurances from third-party providers. Another risk is infrastructure resilience i.e., ensuring that charging service is not disrupted in case of charging infrastructure downtime from power outages. Strategies to address this risk are performance requirements (for party responsible for O&M in ownership structure), technical solutions that lead to redundancy (e.g., Microgrids, Grid Analysis), and acknowledging a percentage of downtime in the project development/revenue model.
Planning and Logistics	Some of the primary risks to consider are delay of environmental approvals,

	delay and /or material changes to the design of the charging location and change in charging demands. These can result in negative impacts to project costs and schedule, as well as redundancy in the infrastructure. To address delays in approvals, the project owner should identify project requirements and finalize project development work in a timely manner, as well as define and incorporate performance-based contracting and output specifications. For demand service change risk, it is important to have robust charge modeling to inform performance requirements and incorporate performance indicators.

8.6 Total Cost of Ownership

8.6.1 Funding Scenario 1

Funding scenario 1 assumes the SDG&E Power Your Drive for Fleets covers all capital of items up to the charger. This scenario includes SDG&E covering 50% of charger costs for sites in disadvantaged communities.

Assumptions

For this section, Arup conducted a cashflow analysis using high-level cost estimates to provide illustrative comparisons between two sites and three cost scenarios per site. This section is not intended to be used as a real-world cost estimate. The cashflow analysis considered capital and O&M costs for charging infrastructure, as well as revenues from LCFS credits. The model did not take financing into consideration.

The team developed a cashflow model to compare costs over a contractual time period for site 3 and site 4, which were selected in the *Public Access ZEV Infrastructure Feasibility Study and Technical Report* published as part of this Blueprint Grant. The assumptions for the cost estimate represent Arup's best estimates at the time of writing for current and future conditions. However, there is considerable uncertainty around the cost of charging stations. To test the sensitivity of the capital cost assumptions, +30% and -30% from baseline charger costs have been modeled.

Table 15: Funding Scenario 1 – Base Case Scenario Assumptions.

Topic	Description	Sensitized?
Contractual Term	16 Years	No
Construction Timeline	1 Year	No
Estimated Funding	This analysis assumes that SDG&E Power Your Drive for Fleets covers all capital of items up to the charger.	No
LCFS[52]	**2024**: \$283,355 **2025:** \$326,366 **2026:** \$392,208 **2027:** \$1,116,022 **2028:** \$1,105,874	No
Charger Unit Cost	To test the sensitivity of the capital cost assumptions, +30% and -30% baseline charger costs have been modelled.	Yes
O&M Unit Cost	\$10,000[53]	No
Discount Rate	8.5%	No
Consumer Price Index (CPI)	2.5%	No

[52] Values provided by eMC

[53] Representative quotes from internal benchmarks

Electricity Rate ($/kWh)[54]	$0.35	No

Table 16: Base Case Scenario Charger Configurations.

Site	Site 4	Site 3
Phase 1 ***(2023-2026)***	- Ten (10) 200 kW chargers at $162,750 / charger[55] - Ten (10) 350 kW chargers at $173,750 / charger[56]	- Ten (10) 200 kW chargers at $162,750 / charger - Ten (10) 350 kW chargers at $173,750 / charger
Phase 2 ***(2027-2039)***	- Five (5) 1MW charger at $548,625 / charger[57]	- Fifteen (15) 200 kW chargers at $162,750 / charger - Eleven (11) 500 kW chargers at $313,500[58] / charger
Total Energy Demand[59]	- 38,272,000 kWh	- 50,232,000 kWh

Results

The results of the cashflow analysis can be found below. The Present Value was used to consider the discounted value of money using the Discount Rate identified in **Table *15***.

The main drivers of the cost difference are the configurations of chargers procured in Phase 2. Site 3 tends to be more expensive given the difference in volume of chargers purchased (15 200-kW chargers and 11 500-kW chargers). However, the five 1-MW chargers identified for purchase in Site 4 do not currently exist on the market, so there is a higher level of price uncertainty than for the 200-, 350-, and 500-kw chargers.

Electricity costs are the single largest line-item cost. As this is a high-level analysis, the value was assumed to be constant over the next contractual term, although electricity rates will fluctuate in the future. Mitigation strategies such as the SDG&E EV-HP Rate program and PPAs can be used to lower or stabilize the electricity costs,.

Table 17: Funding Scenario 1 – Site 4 Total Costs (2022 US$ million).

Site	Site 4	Site 4 – Chargers 30% More Expensive	Site 4 – Chargers 30% Cheaper
Present Value of Project Cost (Capex + O&M + Electricity Costs – LCFS)	$12.5	$14.0	$11.0
Present Value of Capex	$5.1	$6.6	$3.6
Present Value of O&M	$2.2	$2.2	$2.2
Present Value of Electricity Costs	$7.4	$7.4	$7.4
Present Value of LCFS	$2.2	$2.2	$2.2
Present Value of Project Cost/Total Energy Demand ($/kWh)	$0.326	$0.366	$0.286

Table 18: Funding Scenario 1 – Site 3 Total Costs (2022 US$ million).

[54] This value depends on peak/TOU. A value was assumed using the rate for Small Commercial from SDG&E (https://www.sdge.com/sites/default/files/regulatory/Summary%20Table%20for%20Small%20Comm%206-1-22.pdf)

[55] Representative quotes from internal benchmarks

[56] Representative quotes from internal benchmarks

[57] Assumed 175% the cost of 500 kW charger.

[58] Representative quotes from internal benchmarks

[59] Values provided by eMC

Site	Site 3	Site 3 – Chargers 30% More Expensive	Site 3 – Chargers 30% Cheaper
Present Value Project Cost	$18.1	$20.4	$15.9
Present Value Capex	$7.4	$9.7	$5.2
Present Value O&M	$3.5	$3.5	$3.5
Present Value of Electricity Costs	$9.6	$9.6	$9.6
Present Value LCFS	$2.4	$2.4	$2.4
Present Value of Project Cost/Total Energy Demand	$0.361	$0.405	$0.317

As discussed above, the Phase 2 charger purchases and increased electricity demand drive the cost difference between the sites. The baseline Site 3 costs $18.1 million and the baseline Site 4 costs $12.5 million in Present Value 2022 US Dollars. This is about 45% more in project costs for the assumed contractual term of 16 years.

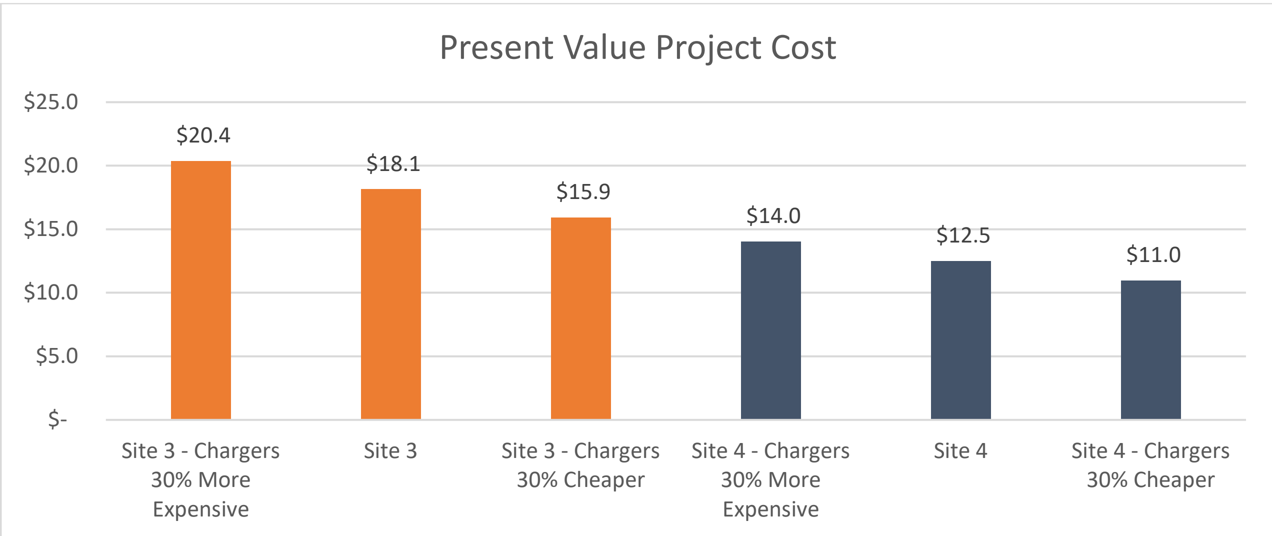


Figure 39: Funding Scenario 1 – Present Value Project Cost.

Phase 2

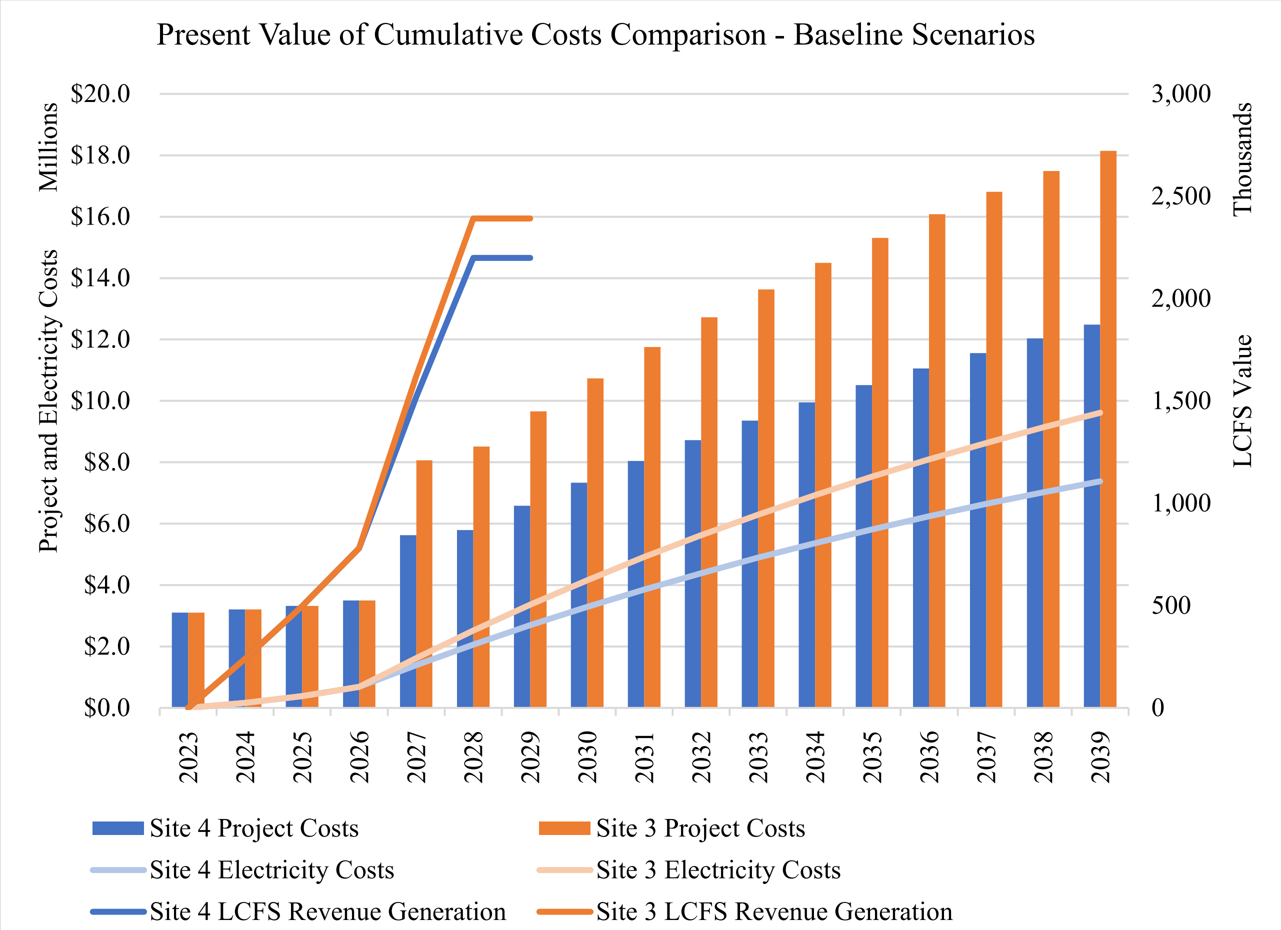


Figure 40: Funding Scenario 1 – Present Value of Cumulative Costs Comparison – Baseline Scenarios.

The graph above presents the cumulative project costs for the baseline scenarios for Site 3 and Site 4, LCFS revenue generation for both sites, and electricity costs. Both costs and revenue generation jump with the start of Phase 2 due to the installation of additional charger capacity.

8.6.2 Funding Scenario 2

Funding Scenario 2 assumes the SDG&E Power Your Drive for Fleets covers all capital of items up to the charger and the EnergIIZE: EV Public Charging Funding Lane program funding the lesser of 75% of charger equipment or $750,000 to be used towards charger equipment. This scenario **does** include SDG&E covering 50% of charger costs for sites in disadvantaged communities.

This model assumes that each program can fund charger costs independently of one another, meaning that the 75% or $750,000 from EnergIIZE is applied to the wholesale charger cost without the 50% SDG&E subsidy and vice versa.

This model assumes an electricity rate of 75% from Funding Scenario 1 to account for a possible configuration of the SDG&E EV-HP program.

Assumptions

For this section a cashflow analysis was conducted using high-level cost estimates to provide illustrative comparisons between two sites and three cost scenarios per site. This section is not intended to be used as a real-world cost estimate.

The cashflow analysis considered capital and O&M costs for charging infrastructure, as well as revenues from LCFS credits. The model did not take financing into consideration.

The team developed a cashflow model to compare costs over a contractual time period for site 3 and site 4, which were selected in the *Public Access ZEV Infrastructure Feasibility Study and Technical Report* published as part of this Blueprint Grant.

The assumptions for the cost estimate represent Arup's best estimates at the time of writing for current and future conditions. However, there is considerable uncertainty around the cost of charging stations. To test the sensitivity of the capital cost assumptions, +30% and -30% from baseline charger costs have been modeled.

Table 19: Funding Scenario 2 – Base Case Scenario Assumptions.

Topic	Description	Sensitized?
Contractual Term	16 Years	No
Construction Timeline	1 Year	No
Estimated Funding	This analysis assumes the SDG&E Power Your Drive for Fleets covers all capital of items up to the charger and the EnergIIZE: EV Public Charging Funding Lane program funding the lesser of 50% of charger equipment or $500k to be used towards charger equipment. This scenario does include SDG&E covering 50% of charger costs for DACs. This model assumes an electricity rate of 75% from Funding Scenario 1 to account for a possible configuration of the SDG&E EV-HP program.	No
LCFS[60]	**2024**: $283,355 **2025:** $326,366 **2026:** $392,208 **2027:** $1,116,022 **2028:** $1,105,874	No
Charger Unit Cost	To test the sensitivity of the capital cost assumptions, +30% and -30% baseline charger costs have been modelled.	Yes
O&M Unit Cost	$10,000[61]	No
Discount Rate	8.5%	No
Consumer Price Index (CPI)	2.5%	No
Electricity Rate ($/kWh)[62]	$0.26	No

Table 20: Base Case Scenario Charger Configurations.

Site	Site 4	Site 3

[60] Values provided by eMC

[61] Representative quotes from internal benchmarks

[62] This value includes an assumption 75% of Funding Scenario 1 to account for a possible configuration of the SDG&E EV-HP program. This value depends on peak/TOU. A value was assumed using the rate for Small Commercial from SDG&E (https://www.sdge.com/sites/default/files/regulatory/Summary%20Table%20for%20Small%20Comm%206-1-22.pdf)

Phase 1 ***(2023-2026)***	- Ten (10) 200 kW chargers at $162,750 / charger[63] - Ten (10) 350 kW chargers at $173,750 / charger[64]	- Ten (10) 200 kW chargers at $162,750 / charger - Ten (10) 350 kW chargers at $173,750 / charger
Phase 2 ***(2027-2039)***	- Five (5) 1MW charger at $548,625 / charger[65]	- Fifteen (15) 200 kW chargers at $162,750 / charger - Eleven (11) 500 kW chargers at $313,500[66] / charger
Total Energy Demand[67]	- 38,272,000 kWh	- 50,232,000 kWh

Results
The results of the cashflow analysis can be found below. The Present Value was used to consider the discounted value of money using the Discount Rate identified in **Table *19***.

The main drivers of the cost difference are the configurations of chargers procured in Phase 2. Site 3 tends to be more expensive given the difference in volume of chargers purchased (15 200-kW chargers and 11 500-kW chargers). However, the five 1-MW chargers identified for purchase in Site 4 do not currently exist on the market, so there is a higher level of price uncertainty than for the 200-, 350-, and 500-kw chargers.

Electricity costs are the single largest line item cost. As this is a high-level analysis, the value was assumed to be constant over the next contractual term though electricity rates will fluctuate in the future. Mitigation strategies such as the SDG&E EV-HP Rate program and PPAs can be used to lower or stabilize the electricity costs.

Table 21: Funding Scenario 2 – site 4 Total Costs (2022 US$ million).

Site	Site 4	Site 4 – Chargers 30% More Expensive	Site 4 – Chargers 30% Cheaper
Present Value of Project Cost	$6.8	$7.6	$6.1
Present Value of Capex	$1.3	$2.1	$0.5
Present Value of O&M	$2.2	$2.2	$2.2
Present Value of Electricity Costs	$5.5	$5.5	$5.5
Present Value of LCFS	$2.2	$2.2	$2.2
Present Value of Project Cost/Total Energy Demand	$0.179	$0.199	$0.159

Table 22: Funding Scenario 2 – Site 3 Total Costs (2022 US$ million).

Site	Site 3	Site 3 – Chargers 30% More Expensive	Site 3 – Chargers 30% Cheaper
Present Value Project Cost	$6.8	$7.6	$6.1
Present Value Capex	$2.5	$3.6	$1.4
Present Value O&M	$3.5	$3.5	$3.5
Present Value of Electricity	$7.2	$7.2	$7.2

[63] Representative quotes from internal benchmarks
[64] Representative quotes from internal benchmarks
[65] Assumed 175% the cost of 500 kW charger.
[66] Representative quotes from internal benchmarks
[67] Values provided by eMC

Site	Site 3	Site 3 – Chargers 30% More Expensive	Site 3 – Chargers 30% Cheaper
Costs			
Present Value LCFS	$2.4	$2.4	$2.4
Present Value of Project Cost/Total Energy Demand	$0.215	$0.237	$0.192

As discussed above, the Phase 2 charger purchases and increased electricity demand drive the cost difference between the sites. The baseline site 3 costs $10.8 million and the baseline site 4 costs $6.8 million in Present Value 2022 U.S. Dollars. This is about 60% more in project costs for the assumed contractual term of 16 years.

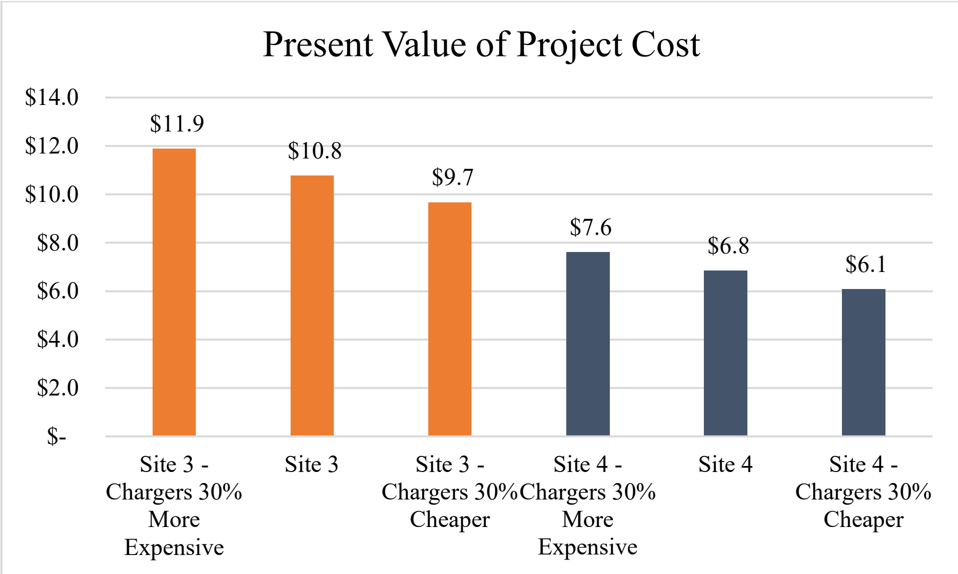


Figure 41: Funding Scenario 2 – Present Value Project Cost.

The graph below presents the cumulative project costs for the baseline scenarios for site 3 and site 4, LCFS revenue generation for both sites, and electricity costs. Both costs and revenue generation jump with the start of Phase 2 due to the installation of additional charger capacity.

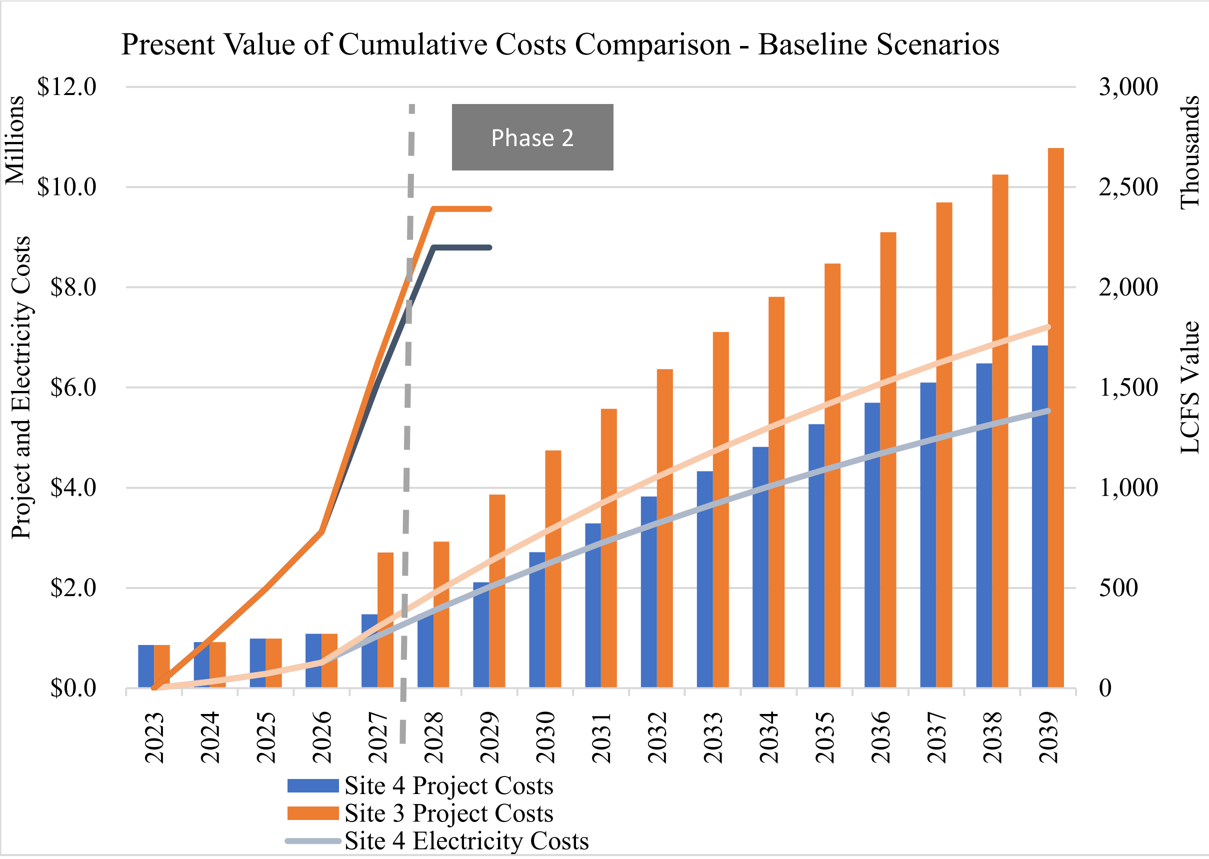


Figure 42: Funding Scenario 2 – Present Value of Cumulative Costs Comparison – Baseline Scenarios.

See Appendix L for the Business Case Development report, including the risk register, sample market survey responses, and site maps.

9 Community Benefits

9.1 Education and Workforce Development

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.

Workforce knowledge and capabilities essential to ZEV transitions at California ports have been identified by the Long Beach City College in collaboration with OEM's, labor representatives, and subject matter experts. Broadly, knowledge gaps exist in the following eight categories:

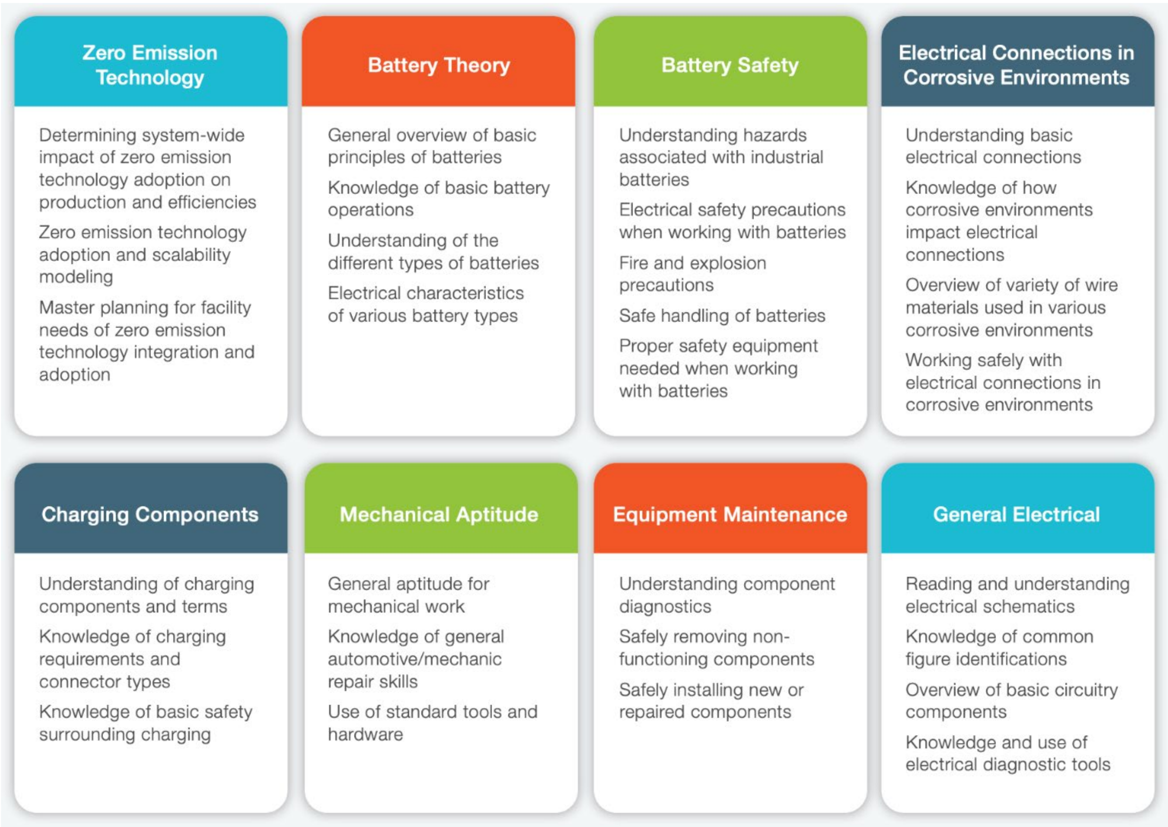


Figure 43: EV transition workforce knowledge gaps.

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. Port officials and other industry professionals have expressed concern that there will be a shortage of licensed electricians to install electrical infrastructure.

Workforce development potential associated with the electrification of STC MDHD fleets exists in three job categories: equipment vending, O&M, and infrastructure installation. Vendor and infrastructure workforce development will primarily be handled external of STC Traffic. Operations and maintenance of ZEV MDHD equipment will likely be accomplished through a combination of trainings, warranties, and 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.

Outreach with potential Education and Workforce Development partners was conducted 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?

The following key stakeholder groups were engaged:

- Regional community colleges
- Workforce development organizations
- Internal stakeholders
- OEMs
- Unions

9.1.1 Regional Community Colleges

The California Community college system is the largest and most accessible higher education system in the country. There are eight community colleges in the San Diego and Orange County area that provide certificates, degrees, and short-term trainings in trades related to automotive technologies and electrical infrastructure. EV vehicle and infrastructure training are considered supplemental at most programs. Automotive programs are more likely to offer dedicated coursework on EV technologies, while electricians will learn about EV infrastructure through post-graduate work and apprenticeships. Through engagement and research, Momentum identified five of eight San Diego community colleges, as well as three schools based in Orange County, that offered EV specific courses. The results of this analysis are included below.

REGIONAL COMMUNITY COLLEGES OFFERING TRANSPORTATION AND ELECTRICAL DEGREES			
San Diego City College (electrical)	San Diego College of Continuing Education (automotive)	San Diego Miramar College (automotive)	Cuyamaca College (electrical & automotive)
Southwestern College (automotive)	Santa Ana College (automotive)	Golden West College (automotive)	Saddleback College (automotive)

Analysis of survey data, interviews, and coursework available to review online found that of those eight colleges with transportation and electrical programs, five included zero-emissions technology in some coursework. None of the electrical degrees in the area offer EVSE-specific training. Interviews found that most of the programs focused on light-duty vehicles, with some emphasis on transferrable skills to other equipment types.

REGIONAL COMMUNITY COLLEGES OFFERING TRANSPORTATION DEGREES THAT INCLUDE ZEV CONTENT	
San Diego Miramar	Hybrid and EV Service Class as well as OEM partnership programs
Cuyamaca College	Hybrid and Electric Vehicles Operation and Diagnosis Courses
Santa Ana College	Alternative fuels and hybrid vehicles courses
Golden West College	Electric and hybrid technology courses
Saddleback College	Alternative Propulsion Systems as well as Hybrid and Electrics Vehicles Courses

Community College Pathways Programs

Pathways programs are set up at universities for students to gain particular skillsets in a technology or trade in a specific industry or even at specific organizations. Some San Diego colleges, such as San Diego Miramar College, partner with OEMs and other organizations. The school relies on tools, equipment, and knowledge from companies like Toyota and CAT to train students for in-demand jobs with the partner organization. According to their school representatives, pathway programs can be set up in one to two years and work best when focused on skills and knowledge not covered by existing programs. It is possible that San Diego business and organizations that use similar equipment, such as medium and heavy duty EVs, could collaborate on developing a pathways program with local community colleges. For more information on developing a transportation pathways program at San Diego Miramar College reach out to its recruitment coordinator John Loewenberg at jlowenb@sdccd.edu or 858-956- 4498.

9.1.2 Workforce Development Organizations

Outside of regional community colleges, the San Diego region hosts five training and apprenticeship programs tailored to transportation and electrical trades. Of these, three are tailored to electricians, one for auto mechanics and EVSE, and two for construction and photovoltaic (PV) installation.

ELECTRICIAN, TRANSPORTATION AND PV WORKFORCE DEVELOPMENT ORGANIZATIONS		
Electrical Training Institute (ETI)	Western Electrical Contractors Association (WECW)	Associated Builders and Contractors of San Diego (ABCSD)
Automotive Training Group (ABG)	Center for Employment Training (CET)	Grid Alternatives

Electrical Training Institute
San Diego ETI is affiliated with IBEW San Diego locals. They offer trainings to IBEWp members in EV infrastructure through the Electric Vehicle Infrastructure Training Program (EVITP . More about ETI and IBEW can be found in Section 9.1.5.
Contact: Marcus McGhee. phone: 858-569-6633 - email: info@sdett.org

Associated Builders and Contractors of San Diego (ABCSD)
The San Diego Chapter of the Associated Builders and Contractors (and its Apprenticeship Training Trust) offers a construction training facility featuring workshops and classrooms. ABCSD trains people in safety, electrical, and electronic systems technician trades every year. ABCSD does not currently offer EV infrastructure-specific programs but are looking to add it to their program.
Contact: Liz Drummond, workforce development manager: 858-391-0401, Email: liz@abcsd.org

Automotive Training Group
The Automotive Training Group (ATG) offers technical courses, technical information, and training experience. to vehicle mechanics and operators. ATG hosts seminars, workshops, and specific trainings on vehicle safety and services. ATG recently published a training manual on hybrids and electric vehicles tailored to light-duty vehicle operations but compatible with MHD applications. Heavy-duty EV or brand-specific, customized courses are offered on request for up to 25 people per class.
Contact: Heather Fitzgerald, Office Manager. Phone: 858-309-6595. Email: Heather@atgtraining.com

Center for Employment Training (CET)
CET offers a job training program in green construction that includes job preparation in construction electricity and photovoltaic (solar) systems. CET does not offer EV infrastructure-dedicated programs.
Contact: San Diego Region: 619-527-4895

Grid Alternatives
Grid Alternatives is a national nonprofit that helps economic and environmental justice communities get solar power and solar jobs. Its program includes hands-on solar training to connect people to clean energy jobs. STC Traffic has existing and planned solar power development projects for EV charging that could be supported by Grid Alternatives.
Contact: Shameka Dixon, Greater LA Area Director of Workforce Development

9.1.3 Internal Stakeholders

Momentum conducted multiple meetings with internal stakeholders to assess concerns, needs, and strategies for developing ZEV workforce expertise.

Generally, IOO truckers maintain their own vehicles and are concerned that the transition to EVs will leave them incapable of performing their own repairs. There are additional concerns that, should they be unable to repair their own vehicles, it will be even more difficult and/or expensive to find technicians capable of repairing their vehicles.

POSD is still considering multiple business models for its HD charging sites. It is likely that POSD will rely on existing employment networks with electrical and infrastructure organizations for implementation. Additionally, a high level of integration with charger OEMs and service providers is likely to ensure that its workforce needs are filled.

9.1.4 OEMs and Charging-as-a-Service Providers

OEMs are highly driven to provide initial O&M support to allow employees time to become familiar with new technologies without jeopardizing operations. In most cases, maintenance responsibilities will shift to vendors. Some OEMs indicated that maintenance contracts may become less common after widespread adoption in the next 5-10 years.

Some ZEV and Charger OEMs indicated they have or will create programs that host customers and relevant industries to showcase the technology as well as O&M practices. Some EVSE companies have indicated their products will come with required warranty and O&M contracts for their products.

9.1.5 Unions

IBEW Local 569, 465, and the Western Electrical Contractors Union represent thousands of electrical power industry professionals in the greater San Diego area. IBEW trains apprentices and also retrains and upskills existing members of the union and offers an EVITP. The program partners with vehicle OEMs, and regional utilities to teach EV charger installation and support. IBEW 569 representatives estimate that 50% of their journeymen are EVITP-certified.

IBEW representatives expressed confidence that while there may be a nationwide shortage of certified electricians, there are more than enough in the greater San Diego area. The Electrical Training Institute can be contacted to host EVIPT courses for IBEW electricians, which can be held on short notice if necessary.

9.1.6 Conclusion

Workforce gaps for POSD are primarily installation-, operations-, and maintenance-related. Charger installation expertise is expected to be provided by utility companies (SDG&E) and vendors. Broadly, workforce managers agree that competencies need to be enhanced in battery technologies and electrical and charging equipment, as well as in general electrical and ZEV knowledge.

Stakeholders largely agree that a significant portion of the workforce risk associated with new technology adoption will initially be covered by vendors through warranties as well as O&M contracts. Vendors are incentivized to cover initial risk to encourage adoption of their products and develop brand recognition in the workforce. While some internal stakeholders expressed concerns over a shortage of available certified electricians, IBEW representatives are confident that they have enough trained members to fulfill workforce needs. Union members' familiarity with advanced technologies and early adoption positions them as a critical resource for workforce needs. Continued engagement with IBEW for workforce needs should be a top priority for ZEV infrastructure development.

Long term, POSD is situated geographically to access professionals from multiple community colleges and a variety of CBOs and unions. During initial adoption, most OEMs contacted mentioned that product-specific trainings and seminars would be available to train employees to operate EV equipment and identify maintenance issues that will be covered by either a warranty or O&M contract.

POSD should continue to engage workforce development organizations for long-term staffing needs. Its programs provide focus to environmental and social justice in the workforce and can help ensure that the port creates new community opportunities through its ZEV transition.

Continued engagement and partnership among the stakeholders identified in this report will help ensure that workforce needs related to a ZEV transition are met. OEMs and Unions should be relied on for immediate needs while community colleges and workforce development organizations should be engaged to ensure that entry-level employees are provided with the skills and knowledge to join a zero-emission transportation workspace.

10 Blueprint Conclusions and Recommendations

Putting people in trucks creates demand for charging and hydrogen refueling infrastructure. Zero-emission truck drivers, particularly Independent Owner Operators, need access to convenient charging stations and hydrogen dispensers, as well as places to park trucks overnight. ZEV infrastructure developers need truckers to utilize the stations and dispensers.

Tying deployment of trucks to public charging and refueling infrastructure, such as proposed in the Trucking as a Service model, reduces the risk of deploying under-utilized assets that deter potential investment. The TaaS model offers a promising solution to the challenge of how to best help IOOs participate in the ZEV transition by financing formidable upfront capital costs with operational savings and Low Carbon Fuel Standard credits over time. The TaaS model also provides a way to ensure that proposed POSD ZEV infrastructure sites will be accessible and cost-effective for IOOs. Developing a successful model connecting affordable access to both zero-emission trucks and ZEV-supporting infrastructure for all truck drivers, including IOOs, will set the stage for replication across the state.

In addition to models such as TaaS, funding programs offered by the state of California are increasingly focused on helping IOOs meet forthcoming regulatory requirements to drive ZEVs. In particular, CARB's Innovative Small E-Fleets, Truck Loan Assistance, Flexibility for Small Fleets to Stack Incentives, Zero Emission Truck Loan Pilot, and Zero Emission Drayage Truck funding programs are all designed to be of benefit to IOOs and small fleets. Outreach and technical assistance are needed to make IOOs aware of these opportunities, and to help IOOs take advantage of them.

The electrical system buildout required to support charging infrastructure at the recommended POSD sites in National City is substantial. The proposed deployment of 66 overnight and opportunity chargers would have a combined peak demand of 19.55 MW—enough to power a small city. Therefore, early planning with the electric utility, SDG&E, is crucial. Otherwise, time spent waiting for sufficient electrical system upgrades will significantly delay the full proposed project build out.

The STC Traffic Blueprint team recommends the following next steps:

1. Consider responding to the POSD RFP for ZEV infrastructure deployment at the two National City sites evaluated in this Blueprint.
2. Evaluate deployment of hydrogen refueling infrastructure to supplement electric vehicle charging infrastructure (see hydrogen next steps, Section 7.3.1).
3. Follow up with IOOs to determine interest in the TaaS model, and to support participation in relevant funding opportunities provided by CARB and other agencies.
4. Develop a team that includes a site developer, TaaS provider, fundraising expertise, and other key roles.
5. Perform further outreach with EHC, Barrio Logan, and other community partners around the proposed site development plans.
6. Refine site design and other recommendations developed by STC Traffic.
7. Explore and deploy workforce development and education strategies.