California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

An Investment Blueprint for Heavy Duty Charging to Support Battery-Electric Drayage along the Interstate 710 Corridor

Prepared for: California Energy Commission

Prepared by: Los Angeles Cleantech Incubator

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PREFACE

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

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

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

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO 20-601 to identify actions and milestones needed for implementation of medium- and heavy-duty zero-emission vehicles and the related electric charging and/or hydrogen refueling infrastructure. The purpose of this solicitation is to accelerate the deployment of medium- and heavy-duty zero-emission vehicles and associated infrastructure, with a holistic and futuristic view of transportation planning. In response to GFO-20-601, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards dated April 8, 2021, and the agreement was executed as ARV 21-008 on July 15, 2021.

ABSTRACT

The Los Angeles Cleantech Incubator created an investment blueprint for heavy-duty charging depots adjacent to the busy Interstate 710 freeway freight corridor, supporting battery electric trucks serving the San Pedro Bay Ports. Following a selection framework that incorporated grid infrastructure and drayage duty cycles, the blueprint identifies priority locations for public and private heavy-duty charging infrastructure. It also provides a high-level budgetary assessment, based on specific site evaluations, which will include not only initial capital costs but also ongoing operational expenses for a few select sites, as well as estimated corridor-wide investments for reaching 40 percent zero emission drayage trucks by 2028 and 100 percent zero emission drayage trucks by 2035.

The blueprint first analyzed truck density data within the defined region at typical charging times to identify locations that can serve many fleets during standard charging windows. After identifying truck densities, the Los Angeles Cleantech Incubator worked with Southern California Edison and the Los Angeles Department of Water and Power to determine how existing transmission and distribution infrastructure can cost-effectively support depot infrastructure deployments. After completing the grid and traffic map layers, East Yard Communities for Environmental Justice and the Coalition for Environmental Health and Justice identified ideal locations for potential infrastructure deployments. The project team then constructed a top-level budget for the investment required to support large deployments of charging infrastructure at a representative sample of the priority sites. This assessment addressed not only operational needs for private, public, or shared depots, but also the business models required for sustainable energy management strategies.

The final step was estimating the total amount of the chargers along the Interstate 710 freeway corridor required to support 100 percent battery electric drayage to serve the San Pedro Bay Ports. With an understanding of how many chargers and depots the region will need to achieve 100 percent battery-electric drayage, the project team built off the budgets of the assessed sites to create a comprehensive depot investment plan that supports the San Pedro Bay Ports' key goods movement corridors.

Keywords: Drayage trucks, Interstate 710, zero-emission, heavy-duty vehicles, port electrification, Los Angeles County, Los Angeles Cleantech Incubator, charging infrastructure, battery-electric trucks, Class 8 trucks, 710 Corridor

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Introduction

As California experiences the impacts of climate change – unprecedented wildfires, heat waves, and related setbacks to air quality improvements in the region – there is an even more urgent need to fast-track efforts to reduce emissions and increase vehicle electrification across the transportation sector, especially for heavy-duty trucks traveling on one of the most heavily traveled freight corridors in the United States: Interstate 710 in Southern California. The Los Angeles Cleantech Incubator, with the public-private Transportation Electrification Partnership, identified in 2018 a critical need for charging infrastructure installation to catalyze battery electric truck deployments. Five years later, charging infrastructure installations have not kept sufficient pace. To catalyze the needed investment, LACI has developed an investment framework for the Interstate 710 freight corridor to address the charging infrastructure needs of a significant portion of the drayage trucks serving the combined Ports of Long Beach and Los Angeles (commonly referred to as the San Pedro Bay Ports).

The Los Angeles Cleantech Incubator, with partners Coalition for Environmental Health and Justice and BP Pulse (formerly AMPLY Power), and supported by regional stakeholders Southern California Edison, Los Angeles Department of Water and Power, and the Harbor Trucking Association, executed the California Energy Commission Medium- and Heavy-Duty Zero Emissions Vehicle Infrastructure Blueprint grant to evaluate the investment opportunities for siting drayage truck charging depots around the Interstate 710. Portions of this critical corridor support up to 39,000 truck trips daily (most associated with San Pedro Bay Ports freight), an amount that may increase as much as 50 percent by 2035. Furthermore, the San Pedro Bay Ports estimate that 30 percent of this drayage truck traffic stays within this area, delivering cargo to the local warehouses, transloading centers, and railyards.

To understand how to invest in the charging infrastructure to support this traffic, the Los Angeles Cleantech Incubator implemented a selection framework to identify specific locations primed to support charging depots based on the existing truck traffic, grid capacity, and community priorities. Prioritizing infrastructure at cost-effective sites with business models that can address fleets of all sizes, Los Angeles Cleantech Incubator has modeled a selection framework for infrastructure locations and financing mechanisms that can be applied to California's other freight corridors.

Project Overview

By sequentially narrowing potential sites, Los Angeles Cleantech Incubator developed a replicable system for identifying opportunities to deploy large charging depots by high traffic corridors. Structuring the tasks in the order below created a regional specific blueprint that funnels near-term priority site developments, only evaluating and budgeting those with the greatest potential while also creating a replicable blueprint for other intermodal areas.

Truck Mapping

First, the project team examined truck traffic data to determine locations amenable to overnight (or between-shift) and opportunity charges. The project team identified locations adjacent to the Interstate 710 freight corridor where trucks' absence of movement exhibits characteristics amenable to receiving a charge for a certain amount of time. The ultimate deliverables were a series of maps that showed densities of trucks at locations where existing drayage operations offered charging windows of certain lengths. While some operational adjustments can unlock the greatest benefits to electrification, the supply chain still needs to run every day throughout the transition to zero emissions. Therefore, the task's goal was to identify locations that could serve drayage trucks' existing operations to increase the near-term utilization necessary for justifying these investments.

Grid Analysis

The second tenet for building a viable investment thesis was calculating the cost of deploying infrastructure at specific sites and ongoing fueling costs for the fleet and required eliminating facilities lacking strong electrical infrastructure from consideration. This reduces the risks of costly investments or unsustainable operating costs, ensuring a viable depot development plan that would avoid the time and costs of large utility-side infrastructure upgrades. Los Angeles Cleantech Incubator collaborated with Los Angeles Department of Water and Power and Southern California Edison Company to analyze the estimated available resources, with the goal of illustrating the ideal grid circuits that could support heavy-duty charging based on grid transmission and distribution layouts and capacities.

Facility Identification

With the grid capacity and truck traffic maps created, the next step was for the Coalition for Environmental Health and Justice to identify the facilities they prioritized for electrification, adding the third factor into the selection framework. Los Angeles Cleantech Incubator also developed auxiliary map layers showing local points of interest (hospitals, parks, schools) to help the Coalition for Environmental Health and Justice in their selection process. The goal of this task was to develop a roster of facilities with the potential to host a truck charging depot while ensuring that any resultant investment in goods movement infrastructure would not come at odds with community priorities for improved air quality, public health, and overall quality of life for residents living along the Interstate 710 corridor.

Site Assessments and Business Model

The project team then reached out to the list of community-vetted sites to gauge interest in participating in the project, offering facilities a complementary site assessment to feature in final evaluations. After evaluating the facilities' interest in participating, the project moved forward to fulfill the task's goal of performing in-depth site walks to create a capital and operational budget for deploying infrastructure at four facilities. As an added benefit, the project team created desktop analyses – a stripped-down version of a site assessment conducted solely with satellite imagery – for those facilities deemed to have less interest in a near-term deployment.

Investment Blueprint

To complete the regional blueprint, Los Angeles Cleantech Incubator applied existing resources to the project-generated cost estimates to assess the high-level investment (both in finances and real estate) required to reach 40 percent zero emission drayage along the Interstate 710 by 2028, and 100 percent by 2035, including assumptions on the breakdown on depot types and business models.

Findings

Through this blueprint research, Los Angeles Cleantech Incubator has calculated that, for drayage trucks operating exclusively within the Interstate 710 to reach the 2028 target, charging infrastructure investment just within the Interstate 710 will need to total at least $280 million. Los Angeles Cleantech Incubator identified this funding as necessary to deploy at least 135 public chargers and 620 private chargers required supporting 1,760 drayage trucks that operate around the Interstate 710. In practice, this assumed ratio of public to private chargers may differ based on uptake of shared access or trucking-as-a-service business models and fleets' preference for relying fully on private charging in the early stages of the transition.

To reach the 2035 target, the total investment will need to be at least $700 million, an additional $420 million after 2028. This funding is needed to deploy at least 620 public chargers and 1,540 private chargers to support 4,400 trucks that operate primarily around the Interstate 710. Again, this only represents a third of the entire drayage fleet; thus, the entire fleet will require over $2 billion of infrastructure investment to meet goals of the San Pedro Bay Port's Clean Air Action Plan and Executive Order N 79-20. Long-term, the effects of Assembly Bill 5 implementation (which will limit Licensed Motor Carriers' ability to use independent contractors) and the high cost of capital associated with the transition to zero emission technology may affect the degree to which the ports drayage fleet is purpose-built (*i.e.*, the assets are more exclusively committed to drayage), which would in turn affect these estimates.

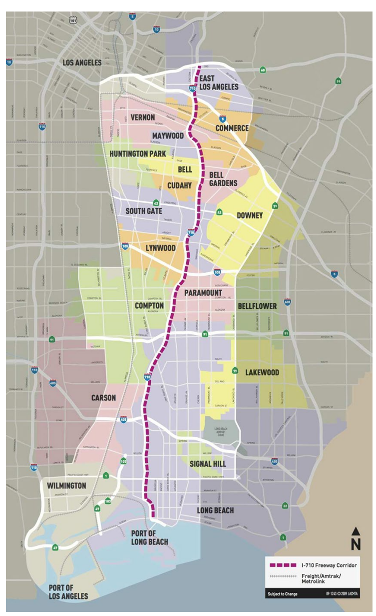
CHAPTER 1: Background

Introduction

As California experiences the impacts of climate change – unprecedented wildfires, heat waves, and related setbacks to air quality improvements in the region – there is an even more urgent need to fast-track efforts to reduce emissions and increase vehicle electrification across the transportation sector, especially for heavy-duty trucks traveling on one of the most heavily traveled freight corridors in the United States. The Los Angeles Cleantech Incubator (LACI), with the public-private Transportation Electrification Partnership, identified through a Request for Information (RFI) process in 2018 a critical need for charging infrastructure installation to catalyze battery electric truck deployments. Five years later, charging infrastructure installations have not kept sufficient pace. To catalyze the needed investment, LACI has developed an investment framework for the Interstate 710 (I-710) corridor to address the charging infrastructure needs of a significant portion of the San Pedro Bay Ports' drayage trucks.

LACI, with partners Coalition for Environmental Health and Justice (CEHAJ) and BP Pulse (formerly AMPLY Power) and supported by regional stakeholders Southern California Edison (SCE), Los Angeles Department of Water and Power (LADWP), and the Harbor Trucking Association, worked together to evaluate the investment opportunities for siting drayage truck charging depots around the I-710 (Figure 1). Portions of this critical corridor support up to 39,000 truck trips daily (most associated with San Pedro Bay Ports freight), an amount that may increase as much as 50 percent by 2035. Furthermore, the San Pedro Bay Ports estimate that 30 percent of this drayage truck traffic stays within this area, delivering cargo to the local warehouses, transloading centers and East LA railyards.

Figure 1: Map of 710 Corridor and Adjoining Gateway Cities



Credit: Los Angeles County Metropolitan Transportation Authority

To understand how to invest in the charging infrastructure to support this traffic, LACI implemented a selection framework to identify specific locations primed to support charging depots based on the existing truck traffic, grid capacity, and community priorities. Prioritizing infrastructure at cost-effective sites with business models that can address fleets of all sizes, LACI has modeled a selection framework for infrastructure locations and financing mechanisms that can be applied to California's other freight corridors.

Project Overview

By sequentially narrowing potential sites, LACI developed a replicable system for identifying opportunities to deploy large charging depots by high traffic corridors. Structuring the tasks in order created a regional specific blueprint that funnels near-term priority site developments, evaluating and budgeting only those with the greatest potential while also creating a replicable blueprint for other intermodal areas.

CHAPTER 2: Truck Traffic Analysis

Drayage Operations and Defining Duty Cycles

Given the initial high capital expense of battery-electric trucks, drayage fleets want to operate the trucks for two shifts per day to get an acceptable return on the asset. This section does not reflect the entire universe of drayage operations that exists today, but rather the ideal operational setup for fleets to economically deploy battery-electric trucks.

For employee-based fleets (the dominant fleet type of early-adopters), between the first and second shift, the truck may be stationary anywhere from 10 minutes to 60 minutes as the first driver finishes and second driver begins, traditionally occurring between 3:00 p.m. to 6:00 p.m. This window is not consistent, as fleets may 'slip-seat' trucks; in this arrangement, the same truck is used for two shifts by two different drivers, with a hand-off in between shifts. Although this arrangement keeps the truck in operation across two shifts, there can still be a half-hour between the first shift ending and second shift beginning. This has the potential for the truck to be opportunity charged, though the charger placement and charging process must be readily accessible to ensure success. Additionally, this charging should only be performed with a fast charger that has at least 250 kilowatts (kW), but preferably 500 kW to 1 megawatt (MW), to ensure ample energy transfer during this window.

After the second shift, the truck is typically parked overnight for 3-5 hours before the next day's first shift. This will serve as the option for an overnight charge. This window is plenty of time for a slower charger (150 kW) to fully recharge a truck before the next morning's shift. However, due to container volume at the ports or driver availability, not every truck during every workday operates two shifts, and trucks may sit idle for prolonged periods, where an even slower charge (50 kW) could fill a battery pack before the next driver needs a truck.

When considering charging mid-shift (right before or after picking up or dropping off a container at the ports or a warehouse–but not between first and second shift), the fleets expressed skepticism based on their current business models. Currently, fleets use a mobile diesel refueler that visits the fleet every other day to refuel the trucks at an overnight parking lot to avoid paying truck driver labor for non-driving activities (i.e. fueling).

With this setup, charging opportunities during a shift are limited for employee-based fleets. For any applicability, the chargers must be 1) as fast as the truck-side architecture will allow 2) located almost immediately adjacent to a popular warehouse or the ports. Essentially, drayage truck drivers cannot be expected to drive out of their way, and spend time, to charge during a shift. The calculus of time required may be different for owner-operator drivers, though the need to minimize time spent driving to a charger would remain the same.

When defining truck characteristic and data parameter needs, the project team identified the two best charging opportunities for employee-drivers, asset-based fleets:

1. Overnight "slow" (or trickle) charging, where the truck is stationary for at least three hours at any point during the day.

2. Opportunity “fast” charging, where the truck is stationary for thirty minutes at any point during the day.

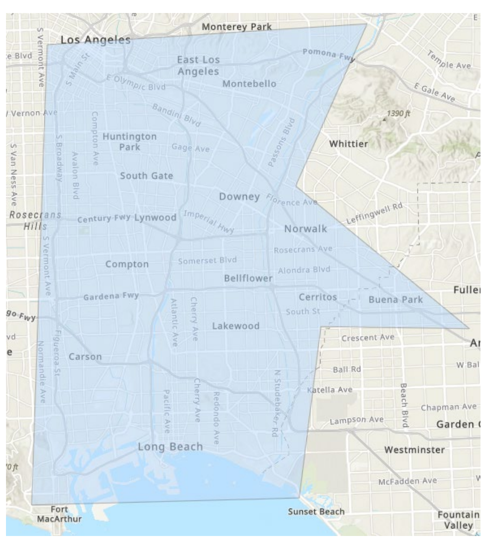
Project Boundaries

LACI first met with CEHAJ to solicit input and recommendations from community members on which locations to prioritize for evaluation and informing the truck traffic data LACI requested from GeoStamp, a company that leverages location data and predictive analytics on its geospatial platform to deliver throughput, optimization, and intelligence for the supply chain and logistics industry.

CEHAJ provided important feedback on what to look for in the truck traffic data that goes beyond just the time windows when a truck could charge. Specifically, CEHAJ identified the need to pay close attention to the corridors of heavy truck traffic that are adjacent to residential communities and how charging infrastructure could be installed to divert truck traffic away from these sensitive areas. Transitioning to battery-electric drayage is an opportunity to shift the traffic patterns that have historically made communities unsafe. In many areas close to the ports, industrial areas are directly adjacent to residential areas, causing truck traffic to cut through residential streets, which can create acute noise and air pollution while also risking accidents. By considering how charging infrastructure can draw truck traffic and reshape the previous deleterious land use decisions, the region can improve the lives of community members. CEHAJ provided the LACI team with some specific street sections that should receive attention, including areas adjacent to I-710 exits by the rail yards in Commerce.

Additionally, the CEHAJ team commented on the shape of the proposed boundaries within which the analysis should prioritize truck traffic. LACI had initially considered a rectangle bounded on all sides by the major freeways and the ports’ complex. CEHAJ noted that new warehousing developments are operating in an area east of Interstate 605 off of State Route 91, resulting in increased truck traffic. Therefore, LACI included this area in the evaluation, with the eastern border of analysis being adjacent to the Los Angeles County and Orange County border (Figure 2).

Figure 2: Geographic Boundaries of Project

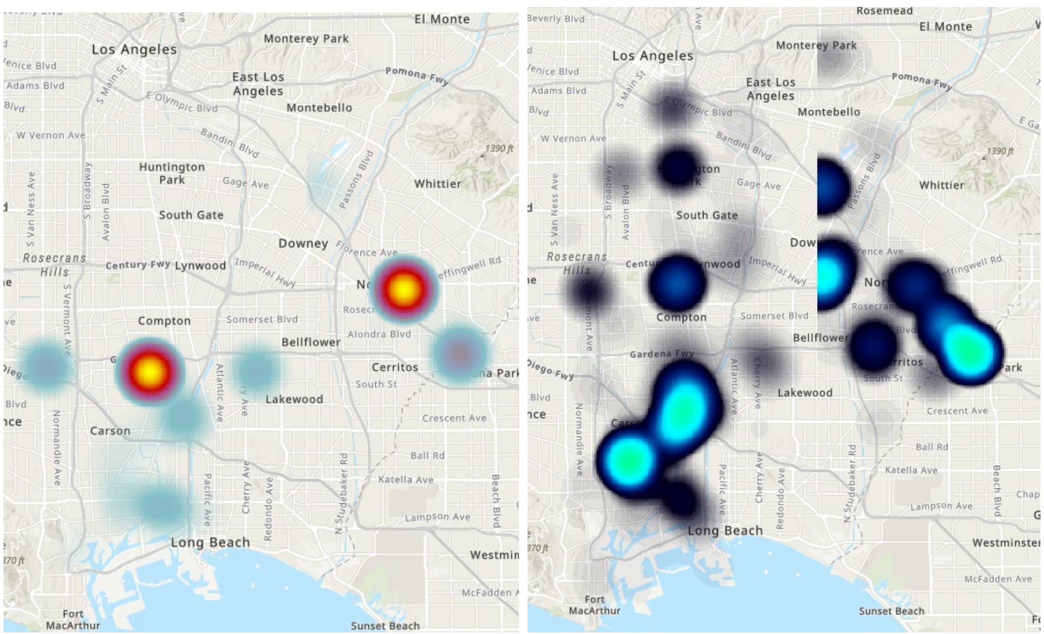


Credit: Los Angeles Cleantech Incubator

Heat Mapping

After procuring the raw truck data, creating the heat map involved coordinating with GeoDecisions, a partner organization of GeoStamp, to create new data points, primarily combining "Time," "Longitude," and "Latitude" to identify instances of a truck occupying the same 25-meter radius circle for at least thirty minutes or at least three hours, logging that location as an instance of a charging opportunity. GeoDecisions then turned these new data points into heat maps depicting the frequency and location of these instances of truck charging opportunities Figure 3).

Figure 3: Heat Maps of Truck Traffic



Maps show relative frequency of Slow (left) and Fast (right) charging opportunities in study area

Credit: Los Angeles Cleantech Incubator

LACI did not focus on a smaller radius to identify situations where trucks may be in dense traffic at a marine terminal gate or making small moves within a warehouse complex as opportunities to charge. This would require a form of en route charging by the ports or a disciplined operation to avoid small moves within warehouse complexes (and instead charge), but these opportunities must be considered by fleets, ports, and warehouses if stakeholders are to unlock the full potential of battery-electric trucks.

Ultimately, GeoDecisions provided LACI with shapefiles of two different map layers: one showing locations and frequencies of trucks stationary for at least 30 min (opportunity fast charging), and one showing locations and frequencies of trucks stationary for at least three hours (long-term slow charging). It is important to note that a truck stationary for two and a half hours would be reflected in the fast-charging map, though charging for that amount of time would significantly replenish a battery's energy.

On the interactive web map, the densities are shown based on the view considered. For instance, if looking at the entire geographic area considered, there seem to be few instances of slow charging opportunities in the northern half of the corridor. However, when zoomed into the northern half of the corridor, the locations of slow charging opportunities become apparent. Everything is portrayed on the online map with relative densities based only on visible territory.

Takeaways

Slow charging opportunities in the I-710 corridor region were far less geographically diverse than the fast charge opportunities. Stops that approach (but falling short of) three hours would explain some of this as, given the binary nature of the data visualization, stops on either side of the three-hour mark by just a few minutes would register as different data points. This means that some areas displaying a high density of fast charge opportunities could have trucks coming very close to meeting the criteria for a slow charge opportunity. Given data visualization parameters, the length of each stationary instance is not reflected in the heat map above but is viewable in a more granular analysis. Another factor is the dataset acquisition. By using one telematic provider, the dataset is self-selected for companies using that telematic provider. This is why a majority (roughly two-thirds) of total slow charge instances in the region (approximately 300,000) occur in two locations: near the intersection of Wilmington Avenue and State Route 91 in the center of the map and near the intersection of Interstate 5 and Imperial Highway. Given the anonymity of data, the exact identity of these fleets was not verified, though additional research shows there are warehouses and potential home depots for fleets at these locations. For other trucks and fleets using the Geostamp telematic service, it is likely that they garage outside of the zone contemplated by this study.

Fast charge opportunities are far more frequent and more geographically diverse. Any warehouse in the region is liable to have a truck stay on premise for half an hour. The ports were a popular location as well, with hundreds of instances over the course of the dataset received, seen in the maps in Figure 3. Additionally, some of these drivers may be on the side of the street eating lunch or waiting for their next load assignment, providing potential opportunities for innovative curbside or in-queue charging.

Though diverse across the region, a preponderance of these stops are situated in the square bounded by the ports to the south, I-710 to the east, State Route 91 and Interstate 110 to the west, including the cities of Carson, Rancho Dominguez, and Compton. This area on the heat map is full of industrial facilities and warehouses that are popular destinations for the short-haul drayage and transload activities.

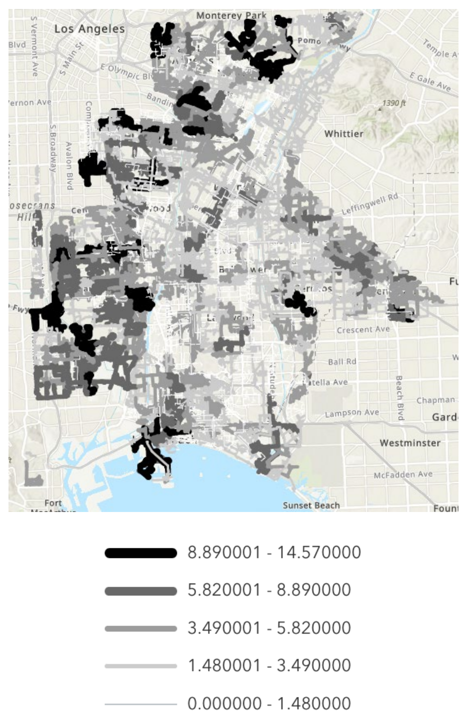
When considering this data for site selection, the importance of providing charging infrastructure within 10 miles of the ports for trucks looking (or able) to charge in a location not far from their ongoing operations is crucial for public or shared-access stations. For private deployments, there is no bad option given the fleets ability to control for a truck’s daily duty cycle and tailor operations accordingly. Even so, public charging near the ports would serve as a valuable safety net for those fleets.

CHAPTER 3:
Grid Analysis and Site Selection

SCE Grid and Interconnection Evaluation

As an investor-owned utility (IOU), SCE is subject to CPUC Rulemaking 14-08-13, which requires IOUs to create a Distribution Resources Plan, which is a plan that will "identify optimal locations for the deployment of distributed resources."[1] It defines "distributed energy resources" as "distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies."[2] Follow-on rulemaking led to SCE's creation of the Distribution Resources Plan External Portal (DRPEP), which provides circuit and subcircuit level data on the SCE electrical grid, a resource relied heavily upon for the purposes of this project. Specifically useful for this project was the Grid Needs Assessment (GNA) layer that showed the estimated available power on each circuit projected out for the next five years (Figure 4).

Figure 4: Map of SCE Grid in Territory



Circuit shades depict available power (in MW)

Credit: Los Angeles Cleantech Incubator

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[1] California Public Utilities Commission website (https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/distribution-resource-plan)

[2] *Ibid.*

LACI was able to create maps that highlighted circuits of a certain capacity up to four years into the future. The project team chose to evaluate estimated circuit capacity three years into the future to accommodate the anticipated time required for any resulting infrastructure deployments to be designed, permitted, constructed, and energized. Ultimately, the version of the map LACI provided to partners showed a gradation of circuit capacity (in MW) by geography, to provide context for where power capacity was strongest, while also not eliminating a circuit from consideration just because it was slightly below a threshold.

Additionally, various DRPEP resources could provide:

- Locations of substations and circuits connected to a specific substation.
- Substation capacity.
- Amount of distributed energy resources (DER) able to interconnect to the grid on any circuit.
- Transmission and subtransmission high-voltage lines.

LACI met with the SCE staff responsible for updating and maintaining DRPEP to confirm this interpretation of various attributes associated with a given circuit or substation. One important note is that attribute values represent a snapshot in time, in this case, the data reflects the grid's status as of the end of 2021. There may be interconnection projects in the pipeline that account for some portion of available capacity, but these are only reflected through yearly updates. It is also worth noting that SCE updated this resource most recently on January 24th, 2023, reflecting capacities as of the end of 2022. The site selection process of this project did not include this updated version of the resource, though LACI has updated the online map to reflect current realities.

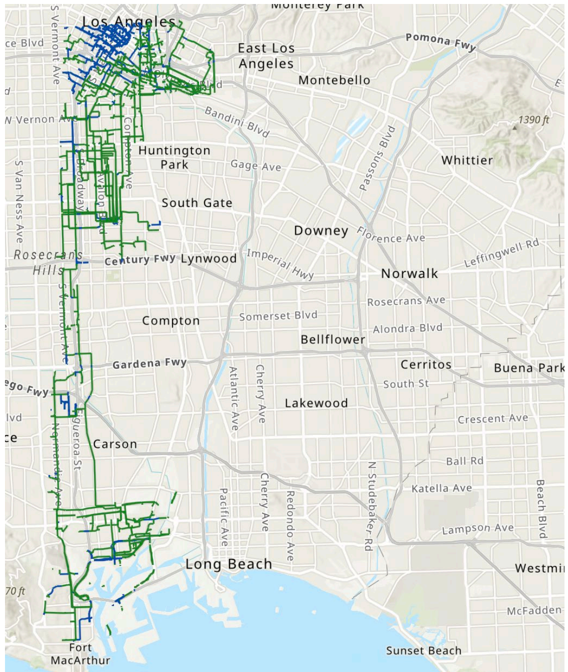
The GNA, interconnection capacity assessments, and other resources found in California IOU's distributed resource plans mandated by the CPUC are incredibly useful resources for developers and public agencies to survey potential truck depots.

LADWP Grid and Interconnection Evaluation

As LADWP is a publicly owned municipal utility and therefore not subject to CPUC rulemaking, it has not faced the same requirements to create a resource similar to SCE's DRPEP guide. However, the City of Los Angeles has been working closely with LADWP to make data available on the location of certain high-voltage networks, and LACI was able to use this resource in this research.

In the LADWP system, there are two primary grid networks from which a commercial or industrial customer could draw power. One is the distribution system, which operates on 4.8 kilovolts (kV), and the other is the subtransmission system, which operates on 34.5 kV. When considering the power requirements of a truck charging depot, and the desire to reduce the amount of expensive behind-the-meter equipment, LADWP recommended that LACI only consider the subtransmission system as adequate for interconnecting large (1+ MW) power draws (Figure 5).

Figure 5: Locations of LADWP Subtransmission Grid



Credit: Los Angeles Cleantech Incubator

Though not as detailed as the SCE DRPEP analysis, accessing the LADWP maps of potential circuits serves to narrow down the possibilities for depots in LADWP territory. The area of study was predominantly in SCE territory, and, as seen in the collection of site assessments and desktop analyses, only two sites are in LADWP territory.

Takeaways

The mapping demonstrates that there are few locations across the corridor that can host a large charging depot. Additionally, when considering that the tool does not account for interconnections requested over the last year, it's important to provide a buffer when evaluating circuit capacities. Additionally, LACI did not want to preclude certain sites from being selected by CEHAJ based on capacities and instead would adjust the recommended project size based on available power. Some facilities located on circuits with less than 4 MW may be well suited for a private depot with 10-20 trucks charging overnight. Once expanding the number of trucks located on any one circuit or planning for more than a few Megawatt Charging System (MCS) chargers, grid upgrades may become necessary. Alternatively, microgrids can provide additional load capacity, assuming there can be adequate space for any solar or storage.

Geographically, the ideal circuits for large overnight depot garages or multiple MCS opportunity chargers are located in regions containing large warehouse complexes and industrial facilities. This makes intuitive sense as SCE would have planned to provide more power to these facilities and less to residential or light commercial areas. In fact, along most of the I-710 corridor, especially the southern half of the corridor, the freeway creates a stark dividing line with higher capacity circuits to the west and lower capacity circuits to the east. Similar to the truck traffic patterns, the largest collective grouping of high-capacity circuits is south of State Route 91. Moving north, there are still patches of higher capacity circuits in South Gate with many more in the railyards of Commerce and East Los Angeles.

SCE's GNA model is helpful for identifying the capacities available at each particular substation as well. Even in the regions with circuits holding adequate capacity, competing demand for a limited supply of power from the connected substation could reduce capacity on any connected circuit. Data shows that multiple substations in the region do not have 20 MW of available capacity, an amount estimated by the West Coast Clean Transit Corridor Initiative as needed for one large-scale public medium- and heavy-duty (MDHD) charging station.[3] For the purposes of this study, 20 MW could adequately power no more than 130-200 drayage trucks charging overnight (assumed at 100-150kW). The adjacent map shows three levels of substations power availability: less than 5MW, less than 20 MW and more than 20 MW. The projected 4,400 battery-electric drayage trucks operating primarily in the I-710 by 2035 could require 440 MW of overnight charging. Looking at the substations best positioned to power the ideal locations for truck depots, there is a current aggregate capacity shortfall of over 200 MW, with many specific substations falling short of 20 MW capacity. Rapidly moving to upgrade substations, or install new ones, should be a regional investment priority.

Facility Identification

In identifying priority facilities, CEHAJ focused on community health along the I-710 corridor. As a starting point, it was noted that site selection should not induce more traffic in disproportionately impacted areas, that sites should improve air quality in areas where there is significant air pollution from goods movement infrastructure, and selected sites should not pose a safety risk for the community. CEHAJ also learned a lot about the grid capacity, which informed the priority areas. CEHAJ took these initial considerations to community members who amplified these factors. CEHAJ also wanted to use infrastructure decisions to actually divert traffic in areas that have health and safety issues, and it identified nearby facilities that would be impacted if infrastructure existed, such as schools, unhoused facilities, parks, residential areas, etc. Lastly, CEHAJ prioritized providing opportunities to support small trucking businesses who often do not have the resources to install this infrastructure. Many communities along the corridor have direct economic ties to the goods movement industry, and as the transition to zero emission technology ramps up, ensuring that smaller fleets with roots in the community have access to low-cost, high-availability infrastructure is a regional priority. CEHAJ then identified promising facilities distributed along the corridor.

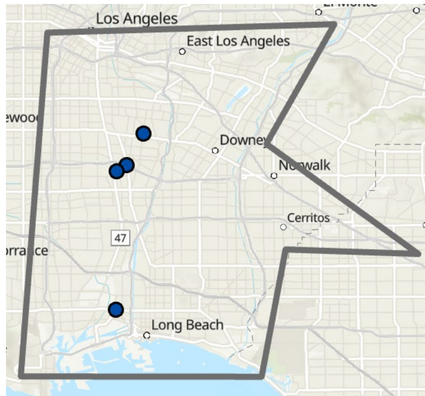
Facility Outreach

The project required four distinct site assessments to evaluate the different opportunities for business models available and charging investments needed. After CEHAJ selected the initial sixteen sites to prioritize for truck charging infrastructure deployments, LACI and BP Pulse collaborated to contact the property owners or managers of each facility with the following goals: 1) identifying a contact able to authorize capital improvements at a facility; 2) share the project background and purpose; and 3) gauge their interest in deploying MDHD infrastructure in the near-term. LACI and BP Pulse leveraged existing contacts, cold-called facilities, and knocked on doors to ascertain answers to the above three questions (Figure 6). In many cases, the fleet or tenant residing at the property was not the entity with ultimate authority to

[3] West Coast Clean Transit Corridor Initiative. 2020. *Interstate 5 Corridor Background Research Technical Memorandum*. (https://westcoastcleantransit.com/resources/Final%20Report%20Files.zip)

install charging infrastructure. Establishing contact with the owners of some properties turned out to be a challenge, and, without the use of subscription-based real estate information software available to BP Pulse, would have been challenging to even identify.

Figure 6: Locations of Selected Site Walks

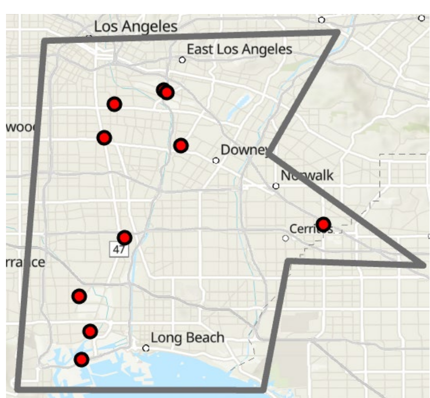


Credit: Los Angeles Cleantech Incubator

Through these efforts, LACI and BP Pulse identified three site candidates that fulfilled the aforementioned criteria; however, there was not a fourth and final facility confidently identified as interested in deploying charging infrastructure. Therefore, LACI presented the project team with additional facilities that LACI was aware met the above three criteria, in addition to fulfilling the truck traffic and grid capacity requirements. After presenting these options to CEHAJ and discussing their merits, the group chose the fourth facility to prioritize for a site walk.

Additionally, the project group decided that, in addition to the four in-depth site walks, BP Pulse and their subcontractor would perform a desktop analysis for the other facilities not chosen for a full site walk (Figure 7). These desktop analyses would provide an even higher-level estimate of the capital costs of deploying infrastructure, because there was no defined layout chosen. These analyses also did not receive an estimate of operating expenses, including energy costs and charging-as-a-service costs. Still, the project team felt creating and sharing these resources with the facilities could provide more knowledge to facility owners to help them move towards implementation.

Figure 7: Locations of Selected Desktop Analyses



Credit: Los Angeles Cleantech Incubator

CHAPTER 4: Site Assessments and Business Models

Overview

Through these site assessments and business model developments, the project team identified the nearest utility infrastructure primed for interconnection and the best spots for siting high-voltage electric vehicle supply equipment (EVSE). In addition to determining the best options for physical layouts, these site walks evaluated behind-the-meter capital costs of installations based on the deployment contemplated by the facility owner and operating costs based on observed truck traffic and estimated charging demand (Table 1).

Table 1: Assessed Infrastructure Deployment Example

EVSE Overview			
Equipment	**Description**	**kW**	**Quantity**
Chargers	All-in-one 150 kW max output EV Charger with CCS1 cable to enable charging for 1 electric truck	150	25
Site Controller	BP Pulse edge device that monitors site power in real-time and works in conjunction with BP Pulse Omega Cloud Service to optimize charging activity	N/A	2

Source: Los Angeles Cleantech Incubator

All-in capital costs have declined markedly since 2020. When LACI last conducted a series of site assessments, it found all-in capital costs to be approximately $200,000 to $250,000 per 150 kW charger deployed. Across the four site assessments and ten desktop analyses, the all-in charger costs for 175 kW chargers (the only chargers evaluated in these assessments) ranged from $125,000 to $150,000. This represents all of the costs associated with behind-the-meter equipment and construction. The bulk of this cost decrease stems from the decreased cost of procuring the EVSE equipment (Table 2).

Table 2: Assessed Infrastructure Capital Cost Estimate

Cost		
Category	**Description**	**Estimated Cost (US$)**
Design, Engineering, and Permitting	Create design documents for permitting, construction, and as-builts	$139,870

EV Chargers	EV Chargers and BP Pulse site controller	$1,565,688
Installation – Material	Conduit, wire, concrete pads, consumables, etc.	$125,000
Installation – Labor	Installation labor, equipment rentals, travel, etc.	$485,469
Utility Service	Cost to interconnect into new utility service. Costs for new utility service are excluded from this analysis	$31,250
Project Management	Project management and overhead	$35,835
Commissioning	Commissioning of EV chargers and configuration to charge management software	$62,500
	Total	**$2,445,612**

Source: Los Angeles Cleantech Incubator

Operational costs, though, have largely stayed consistent, as electric vehicle tariffs at SCE have not changed (all four site assessments were in SCE territory). However, as demand charges phase back into tariffs in 2026, there should be an expectation that fleets and infrastructure owners will need to adjust operations or pricing structures to avoid costly demand charges.

Importantly, incentives are still needed to subsidize the installation of both public and private charging infrastructure. Utility programs, such as SCE's Charge-Ready Transport Program, can fund much of the utility-side upgrades and construction, but only in select circumstances can fund the EVSE, which was found to be roughly half of most estimates. If fleets are subject to pay, whether directly or indirectly through an energy service provider, the full cost of infrastructure and amortize the costs over each kWh consumed, the fuel costs of a Class 8 battery-electric truck are only marginally better than a Class 8 diesel truck (assuming 8 miles per gallon diesel at $6 per gallon, amounting to $0.75 per mile) in this scenario. Fuel costs for battery-electric trucks are generally expected to be significantly lower than those for internal combustion engine trucks. However, the findings from this study show that the fuel price for battery-electric trucks is less competitive when you have to charge fleets the amortized capital costs in low-utilization investments. Paying more than $0.30 per kWh cuts into those fuel savings, and demand charges are expected to occur at facilities charging multiple, heavy-duty trucks. Drayage operations will also likely be unable to avoid charging during the 4:00 p.m. to 9:00 p.m. peak rate period if the fleet plans on getting two shifts out of the truck. This need for public funding is even more true for public charging, where lower utilization rates will increase the amortized cost per kWh consumed (Table 3).

Table 3: Example Site Assessment Operating Expenses

Charging-as-a-Service for Private/Public Charging			
	CAPEX + OPEX $/kWh	**Yr 1 Energy $/kWh**	**Total $/kWh**
Exp. Utilization	$0.2118	$0.2175	$0.4294
Max Utilization	$0.1082	$0.2175	$0.32

Source: Los Angeles Cleantech Incubator

Site Assessments

In four comprehensive site assessments, the project looked at a range of facilities: one storage yard, one private fleet, one warehousing complex, and one public parking lot. Each of these assessments include a breakdown of the types of capital costs associated with each deployment, a satellite image of each facility with potential charger locations, high-level site information, potential operating model analysis, and a qualitative evaluation of the site's prospective role in the region's charging network. One example site assessment and evaluation is below.

Example Site Assessment - Prologis

Prologis is the largest owner of logistics real estate in the world and a key stakeholder in ensuring the transition to zero emission freight; in Los Angeles County alone, Prologis operates over 28 million square feet of warehouse space. Prologis' core operations are to own warehouse space that it then leases to logistics companies. Part of these leases can include the equipment inside or outside the warehouse, as a form of infrastructure-as-a-service. Essentially, access to charging and electricity can be folded into a tenant's lease with Prologis. Prologis will work with its tenants to provide the needed infrastructure to support their transition to zero emissions by regulated timelines, but specific facility electrification will depend on the specific tenant's timelines. To that point, Prologis has already led installations of charging infrastructure for Class 8 trucks at two facilities in Southern California, one in the city of Commerce and one in the city of Santa Fe Springs.

With Prologis' large presence, it was unavoidable that the project team would want to examine an opportunity to evaluate infrastructure opportunities for such a consequential entity. In fact, without prior ownership knowledge, 3 of the 16 properties identified by CEHAJ as candidates for evaluation were Prologis properties. Two are along the Alameda Corridor warehousing district, and the third is in Long Beach at Technology Place.

The project group ultimately chose the Technology Place location for evaluation for three reasons: the first being the facility's proximity to the ports and the I-710, right off of the Pacific Coast Highway, and it is a main east-west street connecting the I-710 with the southern portion of the Alameda Corridor warehouse complex and Union Pacific's Intermodal Container Transfer Facility; second, the facility is unique among Prologis facilities for its ample parking lots that can hold charging trucks; and lastly, because of the facility's proximity to both a senior living community and a high school, the project team wanted to prioritize improving local air quality.

In general, Prologis is actively deploying charging infrastructure across Southern California both in anticipation of tenants' needs and in response to tenant requests. The project team did not identify a tenant at the Technology Place location that had actively requested an infrastructure installation; however, in conversations with Prologis, the facility is a candidate for an anticipatory installation. Ownership by the University of California (U.C.) system may present some additional inspections and safety protocols, though the U.C. system may be keen to contribute to advancing electrification and leveraging the facility for workforce training curriculum uses.

Desktop Analyses

To provide facility owners and stakeholders with an idea of what an infrastructure deployment would require, the project team provided a desktop analysis for ten of the remaining sites that could plausibly host charging infrastructure in either a public, shared, or private setting (Table 4). Ultimately, some of these locations may be able to move faster to deployment if interests can align, especially in the cases of privately held fleets, but the project team was not able to command sufficient interest from the facility owners to warrant creating an operating model or in-depth capital cost estimate for these facilities.

Because the evaluations did not account for specific location of the nearest utility interconnection, location of chargers on the property, or other site-specific details, BP Pulse and their subcontractor developed high-level capital costs applicable to all desktop analyses by using past experience to estimate an expected cost. For specific utility providers or municipalities, there were adjustments based on past experience. Additionally, BP Pulse and the subcontractor applied an additional 30 percent contingency on each project cost, given the larger unknowns at each site. Table 4 outlines the costs applied to the desktop analyses.

Table 4: Range of Costs for Desktop Analyses

Category	Estimated Cost (US$)
Design, Engineering, and Permitting	$37,546 - $225,275
EV Chargers (per unit)	$78,372
Installation – Material (per unit)	$6,500
Installation – Labor (per unit)	$28,000
Utility Service (per project)	$38,462 - $76,923
Project Management (per project)	$35,385 - $70,769
Commissioning (per unit)	$3,077
Total (5-40 units)	**$700,526 - $5,099,052**

Source: Los Angeles Cleantech Incubator

Public/Shared Charging Business Model Assessment

At this stage in the adoption of battery-electric trucks, public agencies have a pivotal role to play in providing public charging, both in siting and funding the equipment. For fleets to avoid the capital costs of installing infrastructure, and leverage exclusively public charging, the energy service provider must amortize the capital costs over each kWh delivered. Below a certain level of utilization, this amortized capital cost per kWh can be prohibitively expensive, thereby potentially negating the energy efficiency benefits of the electric powertrain. Additionally, once demand does pick up, uncontrolled public charging is liable to incur demand charges, both in LADWP territory and in SCE territory starting in 2024, and these charges have the potential to wipe out any cost savings. This downside risk makes private investment a difficult proposition – both for reserving the land for charging and investing in the charging hardware itself. DERs, such as solar and storage could mitigate demand charges, though deployment would add amortized capital costs to the unknown amount of kWh consumed. Fortunately, there are private sector business models developing to partner with public agencies in a manner that addresses these risks and provides public agencies with upside potential as well.

Private Charging Business Model Assessment

The business models and funding available for private fleets are somewhat more straightforward. With careful planning, fleets can calculate the exact optimization of chargers and thus control both the amount of capital cost amortization per kWh and the peak demand across the site. As observed in the ongoing Joint Electric Truck Scaling Initiative project, sophisticated fleets can tailor their operations to maximize utilization of chargers, deploying ratios of even one charger to three trucks. The two main options for a fleet would be to partner with an energy service provider to adopt an integrated charging-as-a-service model or keep the charging management in-house, procuring the needed hardware and software and project managing the installations. The latter would require far more time and attention on behalf of the fleet, though the benefits could include a lower overall capital cost, especially if the fleet has access to a lower cost of capital) and a lower operating cost based on the receipt of Low Carbon Fuel Standard (LCFS) revenue. Typically, energy service providers capture the LCFS revenue or provide a split of the revenue that can be opaque and variable, in no small part because of the fluctuating price of LCFS credits and energy service providers must hedge against downside turns in the market price. Ultimately, without a fleet purchasing a truck, there would be no LCFS credits generated, so fleets deserve some of the upside of LCFS revenue.

CHAPTER 5: Investment Blueprint

Quantity of I-710 Corridor Chargers

When LACI initially contemplated developing an infrastructure investment plan for this blueprint project, the intention was to use the CEC HEVI-Load tool, a modeling tool developed by the CEC per Assembly Bill (AB) 2127 to assess quantities and locations of MDHD infrastructure throughout California. LACI anticipated that the CEC would make this tool public during the Summer 2021; however, after conversations with the CEC team in charge, the tool will not be available until Q4 2023 and has not been made public as of this writing. However, that tool, while taking drayage truck traffic into account, would not be able to identify chargers needed specifically for the drayage industry.

In September 2021, the Port of Long Beach (POLB) published a study, "Fueling the Future of the Fleet" (POLB Study), with the goal of identifying specific properties on POLB land that could meet the criteria necessary to host a public charging depot. Included in that report are a set of assumptions, both drawn from additional literature and developed for the purposes of that report, that LACI adapted for the purposes of this blueprint. In most cases, LACI has made conservative assumptions that there will be more trucks requiring more chargers.

Using these assumptions, Table 5 outlines how many chargers of each typology the I-710 corridor study area will need to deploy to reach the 2028 target and 2035 requirement for zero-emission drayage trucks.

Table 5: Breakdown of Quantity of Corridor Chargers Estimates by Target Year

Year	BEV Trucks	BEV Trucks in I-710 South	BEV Trucks in I-710 South Using Public Chargers	BEV Trucks in I-710 South Using Private Chargers	I-710 South Public Chargers	I-710 South Private Chargers	Total I-710 South Chargers
2028 (40%)	5,900	1,760	530	1,230	135	620	755
2035 (100%)	14,700	4,400	1,320	3,080	330	1,540	1,870

Source: Los Angeles Cleantech Incubator

Cost of I-710 Corridor Chargers

When calculating the cost of installing all of these chargers, it is important to estimate the proportion of charging depots present in 2028 and 2035 that will be public, shared, or private, as well as their anticipated size. This last part is important, as deployments larger than 4 MW, if not located on a certain circuit, may require substation upgrades (or potentially microgrids).

For purposes of this modeling, LACI has assumed that any depot hosting more than 25 trucks will require a substation upgrade at a cost of $10,000,000 (an estimate from the West Coast Clean Transit Corridor). It is fair to assume that any similarly sized microgrid may have the same capital cost (the benefit would likely be reduced operating costs).

This blueprint project did not contemplate the presence of microgrids or DER at facilities, as the primary focus was identifying the specific locations that would be a good fit based on truck traffic, grid capacity and community priorities. Under the right regulatory structure, it is clear that rooftop solar and battery storage can reduce the maximum draw from the power grid and decrease operating expenses through forgoing charging from the grid at peak hours (avoiding charging from 4-9pm is a difficult requirement for drayage operations to abide by); however, these resources require more complicated engineering, project management as well as square footage, an asset of utmost importance in the I-710 Corridor.

LACI uses additional cost estimates of $340,000 for the high-voltage equipment, an estimate included in the POLB Study. For project management, the figures provided by BP Pulse do not address costs associated with the high-voltage equipment deployment; therefore, LACI will use the CPUC's estimate for project management in its MDHD transportation electrification budget, which is 10 percent of total project costs. A further 30 percent contingency has been assumed on top of the 10 percent contingency included in all of BP Pulse's assessment numbers.

As a last step, LACI estimated the total quantities of depots of the blueprint sites evaluated in this project would not get the region close to the number of chargers needed.

Thus, LACI has assumed the quantities of certain types of depots, assuming a mix of different sizes that may serve different purposes to be built between now and 2028, and now and 2035. With this hypothetical depot distribution and using the above calculations for chargers required throughout the I-710 corridor and estimated costs per charger installation, and additional equipment and auxiliary costs, LACI estimates the total cost of deploying charging infrastructure in Table 6 and Table 7.

Table 6: Estimated Breakdown of Capital Costs – 2028

Depot Size	# of Depots	Charger Cost (all-in)	High Voltage Equip.	Substation Upgrade	Project Management and Design	Contingency	Total Investment
10	10	$14,000,000	$3,400,000	0	$1,740,000	$5,742,000	**$24,882,000**
25	10	$35,000,000	$3,400,000	0	$3,840,000	$12,672,000	**$54,912,000**
50	8	$56,000,000	$2,720,000	$80,000,000	$13,872,000	$45,777,600	**$198,369,600**
Depot Total	**28**	**$105,000,000**	**$9,520,000**	**$80,000,000**	**$19,452,000**	**$64,191,600**	**$278,163,600**
Charger Total	**750**						

Estimated capital costs to reach 40 percent ZE Drayage at San Pedro Bay Ports by 2028

Source: Los Angeles Cleantech Incubator

Table 7: Estimated Breakdown of Capital Costs - 2035

Depot Size	# of Depots	Charger Cost (all-in)	High Voltage Equip.	Substation Upgrade	Project Management and Design	Contingency	Total Investment
10	25	$35,000,000	$8,500,000	0	$4,350,000	$14,355,000	**$62,205,000**
25	25	$87,500,000	$8,500,000	0	$9,600,000	$31,680,000	**$137,280,000**
50	20	$140,000,000	$6,800,000	$200,000,000	$34,680,000	$114,444,000	**$495,924,000**
Depot Total	**70**	**$262,500,000**	**$23,800,000**	**$200,000,000**	**$48,630,000**	**$160,479,000**	**$695,409,000**
Charger Total	**1,875**						

Estimated capital costs to reach 40 percent ZE Drayage at San Pedro Bay Ports by 2028

Source: Los Angeles Cleantech Incubator

Crucially, there are two additional cost factors not included in this total. The first is the cost of environmental report development. Though chargers should be encouraged as improvements on the environment, most large projects are likely required to undergo an EIR, which will add cost. Second, and relatedly, sites will likely require improvements, whether remediation or paving, striping, etc. that will increase costs. The POLB Study has an estimate of $275,000 per acre for previously unpaved lots. Which sites ultimately selected are paved or unpaved is hard to estimate.

Regional Funding Approach

Public (regional, state, and federal) funding will need to complement private sector funding in investing the $280M over the next five years needed to reach the goal of 40 percent zero-emission drayage trucks by 2028. Fortunately, there are sufficient funding programs available to achieve this target, though it will require cooperation among the stakeholders. Public agencies throughout Southern California have made funding for charging infrastructure a priority over the past few years, and there are multiple opportunities available for projects to get significant portions subsidized, which can reduce the need for capital cost amortization in the operating expenses. Additionally, Federal funding available over the coming years should be leveraged by these existing sources, especially as the region looks towards the investment required by 2035. Table 8 shows a proposed breakdown of stakeholder investments that can stack to reach the required investment.

Table 8: Hypothetical Funding Strategy for 2028 Target

Stakeholder and Source	Amount
Metro - ZE Truck Program	$25,000,000
CEC - Drayage Infrastructure Carveout Funding	$60,000,000
CEC - EnergIIZE	$10,000,000
MSRC - '21-'24 Work Program	$10,000,000
Ports - Clean Truck Fund	$25,000,000
Federal Funding (US DOT or DOE)	$30,000,000
LADWP	$5,000,000
SCE - Charge Ready Transport	$25,000,000
Private Capital - Fleets & Energy Service Providers	$90,000,000
Total	**$280,000,000**

Source: Los Angeles Cleantech Incubator

CHAPTER 6: Conclusions

Takeaways

Through this blueprint research, LACI has calculated that, for drayage trucks operating exclusively within the I-710 to reach the 2028 target, charging infrastructure investment within just the I-710 will need to total at least $280 million. LACI identified this funding as necessary to deploy at least 135 public chargers and 620 private chargers required supporting about 1,760 drayage trucks that operate around the I-710. In practice, this assumed ratio of public to private chargers may differ based on uptake of shared access or transportation-as-a-service business models and fleets' preference for relying fully on private charging in the early stages of the transition.

To reach the 2035 target, the total investment will need to be at least $700 million, an additional $420 million after 2028. This funding is needed to deploy at least 620 public chargers and 1,540 private chargers required to support about 4,400 trucks that operate primarily around the I-710. Again, this only represents a third of the entire drayage fleet; thus, the entire fleet will require over $2 billion of infrastructure investment to meet goals of the San Pedro Bay Ports Clean Air Action Plan and Executive Order N-79-20. Long-term, the effects of Assembly Bill 5 implementation (which will limit Licensed Motor Carriers' ability to use independent contractors) and the high capital costs associated with the transition to zero emissions technology may affect the degree to which the Ports drayage fleet is purpose-built for drayage, which would in turn affect these estimates.

In addition to financial commitment, deploying charging infrastructure requires significant real estate commitment. Building off previous studies on charging station footprints, this blueprint estimates that, to reach 40 percent zero emission drayage by 2028, the I-710 South Corridor will need to commit 877,700 square feet to charging infrastructure (about 20 acres), spread across an estimated 28 separate facilities.

To reach 100 percent zero emission drayage by 2035, that number will increase to 2,007,500 square feet (about 46 acres), spread across an estimated 70 separate facilities (ranging from 1 MW to 10 MW anticipated peak loads) within the corridor. While these allocations may seem daunting, it is worth noting that fleets can readily transform space currently used for truck parking into space used for truck parking and charging. Creatively taking advantage of space at different nodes in the goods movement network that trucks already visit is necessary to optimize space efficiencies and costs. It is also important to note that this real estate requirement only covers on-site space and does not include the space required for dedicated customers substations (if necessary) or expanded transmission and distribution infrastructure.

Reaching this funding threshold in the near term seems readily achievable given the public and private sector commitments made to invest in MDHD truck infrastructure. Below, LACI proposes a scenario and recommendations for how the region can collaboratively fund the necessary charging infrastructure. All amounts listed below represent realistic funding allocations to I-710 charging infrastructure based on total statewide or regional funding opportunities. The one exception would be the federal funding; however, accumulating match funding across all of these sources for a federal grant application should competitively position the region.

Recommendations

Geographic Recommendations

Deploying infrastructure to support battery-electric trucks is an opportunity to manage the drayage truck traffic patterns along the I-710 freight corridor by encouraging them to recharge in the industrial areas they already visit consistently.

Following from the above principle, charging infrastructure planning along the I-710 corridor should be approached in two ways: 1) a barbell approach, with sufficient charging infrastructure both near the ports and near the East Los Angeles railyards, and 2) along Alameda Street south of Interstate 105 adjacent to the warehousing and industrial facilities.

Certain substations and circuit capacities in these areas are adequate for now, but others with fewer than 10 MW of power will not be able to support more than two large (more than 50 trucks simultaneously) private overnight charging depots or one large (more than 20 trucks simultaneously) public opportunity charging depot without grid upgrades or DER, the implementation of both requiring significant extra time. Utilities will need to be proactive with investments in these areas to prevent over-crowded substations from slowing electric vehicle deployments in dense industrial areas.

Some cities along the corridor that have adjoining industrial and residential areas (such as Compton and South Gate) will need to upgrade the grid infrastructure to support charging and manage traffic patterns to avoid burdening the community if they wish to sustain industrial trucking activity.

Given space requirements to park Class 8 trucks, there are few areas in the corridor where the trucks stay for a prolonged period of time, given more high value uses (like container and trailer chassis storage). However, there are opportunities to identify where a truck naturally stops for shorter windows (e.g., at warehouse loading docks or marine terminals), and intermittent charging along each node of the goods movement network can increase the daily range of a battery-electric truck without requiring extra space.

Financing Recommendations

Public charging infrastructure that is deployed without a utilization contract (an agreement between a station operator and a fleet committing the fleet to purchase a given amount of energy) will require public investment in the form of not only financing the infrastructure but also providing the real estate. Privately funded charging infrastructure can require the operators to amortize the capital costs over each kWh dispensed at a rate too high to encourage adoption of battery-electric trucks. Public funding (with supportive policies) is needed to remove the utilization risks in the early stages of adoption. Public entities can require competitive leasing rates for property under their control, but public entities with a stake in securing the zero emissions transition will need to use existing holdings to provide a market signal to early adopters that there will be charging available for drivers, which will provide them with the flexibility in their operations that the drayage industry requires.

The region can affordably accelerate the investment in the necessary infrastructure if businesses (fleets, property owners, energy service providers or otherwise) procuring or converting their MDHD fleets to electric leverage SCE's Charge Ready Transport program, legislated through Senate Bill 350 in 2018. This program can cover a substantial portion of the estimated capital costs in most cases of private fleet deployments (the program is not available for public charging yet), drastically reducing the investment burden for other private sector stakeholders. The program can be constraining, as it is tightly regulated by the CPUC, and current program requirements include procuring at least two electric vehicles and ten-year agreements, among others. Funding is not guaranteed, but developing operations around the constraints can unlock the value of fleets transitioning to electric powertrains while halving the additional investment required for the region.

Additionally, innovative partnerships between public and private entities can unlock value and mitigate risk; specifically, allocating private real estate to public charging is a difficult proposition at this stage in battery-electric truck adoption. Allocating public agency land to charging infrastructure can bring private sector investment off the sideline and the two entities can structure agreements to appropriately allocate risk and upside.

With this information in hand, LACI aims for regional agencies and stakeholders to move quickly and cooperatively to deploy infrastructure that can support the region's goods movement transition with the endorsement of the I-710 communities.

Lessons Learned

Over the course of the 18 months, LACI worked with communities, fleets, and public agencies to develop a comprehensive understanding of the region's needs to successfully transition to zero emissions trucks. Below are some lessons learned about the process LACI and partners undertook in completing this blueprint:

- Prioritize community input.
  - The community should have an initiating and gatekeeping role in projects related to infrastructure planning. This means they are either driving the process or providing informed opportunities to dictate the direction of the project. For the purposes of our project, LACI was well aware that the community sought involvement in the process of infrastructure planning, and LACI entered into the project partially on the community's behalf. Then, LACI ensured the final decisions on which facilities to evaluate rested with the community. With this involvement throughout, the blueprint will be better prepared for implementation.
- Industry connections are key.
  - Rightfully so, the blueprint grants were made available to the public sector and non-profits; these are the entities with the most vested interest in the development of the immediate region under consideration. However, the zero emission vehicle industry changes quickly: the technologies, the costs, the corporate structures. Having close partnership with a private sector entity through our blueprint process allowed LACI to stay up to date on developments we could reflect in the final blueprint.
- Focus on entities interested in electrifying.

    - Some of the properties LACI evaluated did not show interest in participating and had not considered electrification at all; this could have been attributed to a lack of education or an active disinterest. Regardless, LACI could have saved time by moving on from a couple facilities and working with those more interested in joining the project. Striking the balance between pursuing ideal facilities to get on board and advancing with those committed to the project's goal is important.
- Plan a mechanism for resource updates.
    - A key part of LACI's blueprint were the two online interactive maps created to display both the grid capacities and truck densities in the region. Community partners reviewed them with community members and LACI shared them with public sector partners to provide a good visual reference for the project. Though interactive and detailed, the data aged quickly. For instance, the grid maps created used 2021 data from utility resources. As LACI continued to share the blueprint and related maps into 2023, the utility had issued new data reflecting 2022. Structuring the project to update those resources until the end (or finding funding to devote the time after project completion) can help the resources stay useful throughout the inevitable multi-year implementation timeline.

GLOSSARY

ASSEMBLY BILL (AB)—A proposed law, introduced during a session for consideration by the Legislature, and identified numerically in order of presentation; also, a reference that may include joint, concurrent resolutions, and constitutional amendments, by Assembly, the house of the California Legislature consisting of 80 members, elected from districts determined on the basis of population. Two Assembly districts are situated within each Senate district.

CALIFORNIA AIR RESOURCES BOARD (CARB)— The state's lead air quality agency consisting of an 11-member board appointed by the Governor, and just over thousand employees. CARB is responsible for attainment and maintenance of the state and federal air quality standards, California climate change programs, and is fully responsible for motor vehicle pollution control. It oversees county and regional air pollution management programs.

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

COALITION FOR ENVIRONMENTAL HEALTH AND JUSTICE (CEHAJ)—A coalition of organizations, associations and community groups working to achieve environmental justice, improving air quality, community health and overall quality of life for residents living in the Interstate 710 corridor in Southern California.[4]

CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC)—A state agency created by constitutional amendment in 1911 to regulate the rates and services of more than 1,500 privately owned utilities and 20,000 transportation companies. The CPUC is an administrative agency that exercises both legislative and judicial powers; its decisions and orders may be appealed only to the California Supreme Court. The major duties of the CPUC are to regulate privately owned utilities, securing adequate service to the public at rates that are just and reasonable both to customers and shareholders of the utilities; including rates, electricity transmission lines and natural gas pipelines. The CPUC also provides electricity and natural gas

[4] East Yard Communities for Environmental Justice website (https://eycej.org/index.php/about/collaboratives-and-coalitions)

forecasting, and analysis and planning of energy supply and resources. Its main headquarters are in San Francisco.

DIRECT CURRENT (DC)—A charge of electricity that flows in one direction and is the type of power that comes from a battery.

DISTRIBUTED ENERGY RESOURCES (DER)— Small-scale power generation technologies (typically in the range of 3 to 10,000 kilowatts) located close to where electricity is used (for example, a home or business) to provide an alternative to or an enhancement of the traditional electric power system.

DISTRIBUTION RESOURCES PLAN EXTERNAL PORTAL (DRPEP)—An interactive web portal providing public access to:

- General locations of Southern California Edison distribution circuits, substations, and subtransmission systems
- Grid Needs Assessment, Distribution Deferral Opportunity Report
- Load and DER Integration Capacity Analysis results (i.e., hosting capacity)
- Current, queued, and total distributed generation interconnection amounts
- Downloadable datasets for DER developers, with future application programming interface capabilities
- Locational Net Benefit Analysis results[5]

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)—Infrastructure designed to supply power to electric vehicles (EV). EVSE can charge a wide variety of EVs, including BEVs and PHEVs.

GRID NEEDS ASSESSMENT (GNA)—An annual filing by investor-owned utilities that identify, review, and select opportunities for competitively sourced distributed energy resources to defer or avoid utility traditional distribution capital investments. These filings propose a list of DER opportunities most likely to successfully defer a traditional grid investment.[6]

GROSS VEHICLE WEIGHT RATING (GVWR)—The maximum weight of the vehicle as specified by the manufacturer. Includes total vehicle weight plus fluids, passengers, and cargo.

INTERSTATE 710 (I-710)—A freeway in Los Angeles County that runs north-south from Interstate 10 to the Port of Long Beach.

INVESTOR-OWNED UTILITY (IOU)— A private company that provides a utility, such as water, natural gas, or electricity, to a specific service area. The investor-owned utility is regulated by the California Public Utilities Commission. In California the investor owned utilities supplying energy are:

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[5] Southern California Edison Integrated Distributed Energy Resources Partnership Pilot website (https://www.sce.com/business/savings-incentives/integrated-distributed-energy-resources-partnership-pilot)

[6] California Public Utilities Commission website (https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/distribution-planning)

- Canadian Pacific National Corporation
- Pacific Gas and Electric Company
- Pacific Power and Light Company
- San Diego Gas and Electric
- Sierra Pacific Power Company
- Southern California Edison Company
- Southern California Gas Company (The Gas Company)
- Southwest Gas Corporation

KILOWATT (kW)—One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon, a typical home—with central air conditioning and other equipment in use—might have a demand of 4 kW each hour.

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour.

KILOVOLT (kV)—One thousand volts of electricity.

LOS ANGELES CLEANTECH INCUBATOR (LACI)—A non-profit organization creating an inclusive green economy for the people of Los Angeles by: unlocking innovation by working with startups to accelerate the commercialization of clean technologies; transforming markets through partnerships with policymakers, innovators, and market leaders in transportation, energy and sustainable cities; and enhancing communities through workforce development, pilots, and other programs.[7]

LOS ANGELES DEPARTMENT OF WATER AND POWER (LADWP)— A municipal electric and water utility serving the city of Los Angeles, California.

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California that aim cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

MEDIUM- AND HEAVY-DUTY (MDHD)—Vehicles with a GVWR of more than 10,000 pounds.[8]

MEGAWATT (MW)—One million watts

SOUTH COAST AIR BASIN (SCAB)—A regional air basin designated by the State of California, for the purpose of air quality management and air pollution control in Southern California.

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[7] Los Angeles Cleantech Incubator website (https://laincubator.org/)

[8] United States Department of Energy Alternative Fuels Data Center website (https://afdc.energy.gov/data/10380)

SCAB includes all of Orange County and the non-desert regions of Los Angeles County, Riverside County, and San Bernardino County.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)—The air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. This area of 10,740 square miles is home to over 17 million people—about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

SOUTHERN CALIFORNIA EDISON (SCE)—One of the nation's largest electric utilities, which delivers power to 15 million people in 50,000 square miles across central, coastal, and Southern California, excluding the City of Los Angeles and some other cities.

TWENTY-FOOT EQUIVALENT UNIT (TEU)—An inexact unit of cargo capacity, often used for container ships and container ports. It is based on the volume of a 20-foot-long intermodal container, which is a standard-sized metal box which can be easily transferred between different modes of transportation, such as ships, trains, and trucks.[9]

UNIVERSITY OF CALIFORNIA (U.C.)—A system of public research universities located in California. There are 10 main campuses in the U.C. system.

[9] Wikipedia website (https://en.wikipedia.org/wiki/Twenty-foot_equivalent_unit)