CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

City of Long Beach Blueprint for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure

Prepared for: California Energy Commission

Prepared by: Build Momentum, Inc.

September 2023 | CEC-600-2023-052

California Energy Commission

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ACKNOWLEDGEMENTS

The City of Long Beach would like to thank several partners and participants that aided in the development of the blueprint:

Project Partner Arup, Inc.

Project Partner Build Momentum, Inc.

Southern California Edison, including Ramiro Lepe, Charge Ready Medium- and Heavy-Duty Transportation Electrification senior advisor, and Brian Bustamante, senior advisor, Government & Institutions, Business Customer Division.

The many Long Beach stakeholders and community members who provided valuable insight and information to the project, including Central Coast Community Energy staff and member agencies; Long Beach public works and fleet staff, including Justin Beck, Carlos Ramirez, and John Seevers; partner agency fleet staff; and Municipal Equipment Maintenance Association members.

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 titled "Blueprints for Medium-and Heavy-Duty (MHD) Zero-Emission Vehicle Infrastructure" to accelerate the deployment of medium-and heavy-duty zero-emission vehicles and zero-emission vehicle infrastructure with a holistic and futuristic view of transportation planning. In response to GFO-20-601, the City of Long Beach submitted Proposal #7, which was proposed for funding in the CEC's notice of proposed awards April 8, 2021, and the agreement was executed as ARV-21-007 on September 3, 2021.

ABSTRACT

The City of Long Beach Blueprint for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure explores challenges, considerations, and best practices associated with the city's transition to a zero-emission fleet.

The blueprint determined that a largely zero-emission medium- and heavy-duty fleet can be achieved by the early 2030s. The blueprint anticipates the city will meet its primary medium- and heavy-duty zero-emission vehicle fleet needs with battery-electric vehicles. Other key finding of the Long Beach Blueprint include the following:

- The full conversion of the city's medium- and heavy-duty fleet to zero-emission vehicles, excluding public safety vehicles, is estimated to incur an additional $86.5 million in capital costs relative to the costs for internal combustion engine replacement vehicles. Based on the 2038 horizon year for full conversion of the fleet, this amounts to about $5.76 million in annual capital costs over 15 years (2023–2038) in present value dollars.
- The city is estimated to achieve $600,000 in annual maintenance cost savings (in present value dollars) for its non-public safety fleet upon full conversion to zero-emission vehicles, and additional operating cost savings.
- Air quality benefits are estimated to include a 740-metric-ton reduction in annual greenhouse gas (GHG) emissions and a 5,500-kilogram reduction in annual criteria air pollutant emissions upon full fleet conversion to zero-emission vehicles.

Infrastructure demands such as number of charging stations, electrical requirements, and hydrogen storage capacity will vary based on specific vehicle makeup at each depot, number of battery-electric vehicles versus hydrogen fuel cell vehicles at each depot, and operational characteristics of each vehicle. The city has developed a four-phase charging infrastructure deployment plan which represents the long-term vision and estimate of future charging station requirements throughout the city. The phasing plan is subject to change based on coordination with Southern California Edison related to utility impacts and actual progress of deployment.

Please use the following citation for this report:

May, Bonnie, and John Friedrich. 2023. *City of Long Beach Blueprint for Medium- and Heavy-Duty Zero-Emission Vehicle Infrastructure.* California Energy Commission. Publication Number: CEC-600-2023-052.

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EXECUTIVE SUMMARY

The City of Long Beach team, composed of the city, Arup, and Momentum, was awarded a California Energy Commission grant to develop an implementation strategy for converting municipally owned medium- and heavy-duty vehicle fleets to zero-emission vehicles, with corresponding charging, hydrogen, or both refueling infrastructure.

The blueprint sought to develop and implement a replicable strategy for accelerating the planning, adoption, and deployment of medium- and heavy-duty zero-emission vehicles and zero-emission vehicle infrastructure that directly targets municipal fleets and aims to support private fleets. Key objectives of the blueprint included the following:

- Engage a broad stakeholder network to develop a comprehensive, economic, and equitable approach to rapidly deploying medium- and heavy-duty zero-emission vehicle infrastructure.
- Establish a baseline fleet energy demand model used to estimate municipal fleet facility impacts and City medium- and heavy-duty zero-emission vehicle infrastructure needs, and potential extent of distribution system upgrades.
- Develop a phased, holistic approach to regional infrastructure planning and deployment that maintains flexibility to react to changes in a nascent market with rapidly evolving technology while providing for equitable outcomes.
- Identify critical performance criteria important to medium- and heavy-duty zero-emission vehicle operators.
- Identify workforce education and training resources to prepare maintenance technicians for medium- and heavy-duty zero-emission vehicles as well as zero-emission vehicle charging and refueling infrastructure.
- Coordinate with public and private partners to identify financing mechanisms and funding sources that enable further progress in planning for and deploying medium- and heavy-duty zero-emission infrastructure.
- Develop a replicable and actionable medium- and heavy-duty zero-emission vehicle infrastructure Blueprint enabling the City of Long Beach's transition to 100 percent zero-emission vehicle operations.

A central component of the Blueprint, the Fleet Transition Plan, identifies optimal zero-emission replacements for the City's fleet vehicles. The Regional Zero-Emission Vehicle Refueling Infrastructure Demand Analysis evaluates recharging and refueling technologies and infrastructure needed – and electrical capacity required – to support the proposed zero-emission vehicle fleets.

The Blueprint evaluated both battery-electric and hydrogen fuel cell technologies. Each of these technologies is advancing quickly, though battery-electric vehicles are more common and have a more widely developing charging network to support operations. Hydrogen fuel cell vehicles present a good opportunity for converting larger vehicles with more intensive duty cycles, particularly those whose operations would be restricted by long charging times, and which need fast refueling similar to gasoline or diesel vehicles today.

The City has strong existing policies to enable municipal medium- and heavy-duty zero-emission vehicle fleet conversion, which is further supported by state policy and funding and financing programs. The City is well positioned to proceed with implementation of recommendations provided in this Blueprint to transition to medium- and heavy-duty equipment, supported by new charging infrastructure. Key Blueprint findings and opportunities are presented in Chapter 8 of this final report.

CHAPTER 1: Background

1.1 Problem Statement

Cities like Long Beach have made significant strides in planning for and deploying charging and fueling infrastructure for light-duty passenger zero-emission vehicles (ZEVs), yet substantial challenges, gaps, and barriers remain to enable the widespread deployment of infrastructure for medium- and heavy-duty (MHD) ZEVs. The City of Long Beach (COLB, Long Beach or City) is uniquely positioned to plan for, support, and enable an accelerated MHD ZEV transition for privately-owned and municipal fleet operations because of many factors that express replicability to other cities and the State as a whole, including:

- Proximity to and jurisdiction over major transportation corridors and infrastructure in Los Angeles County and the San Pedro Bay Ports—I-710, I-405, SR 1, SR 19, and SR 103
- Operation of its own municipal oil and gas utility service—Long Beach Energy Resources
- Operation of its own municipal water utility—Long Beach Water
- Operation of an international airport—Long Beach Airport
- Operation of a major transit fleet—Long Beach Transit
- Jurisdiction over one of the state's most popular convention centers—Long Beach Convention & Entertainment Center
- Ownership of 390 MHD vehicles, including material handling equipment, emergency services vehicles, street sweepers, transit buses, school buses, ambulances, fire trucks, tow trucks, and refuse trucks.

1.2 Recipient Background

The COLB intends to deploy holistic solutions to convert its MHD fleets to ZEV. Regulatory, technical, social, and financial aspects of ZEV conversion will be considered, at all scales, and for all stakeholders in the City's vibrant and diverse communities. With the breadth of COLB departments involved in the Blueprint scope – from airports to utilities to public transit – the COLB can serve as a representative model for other municipalities across California.

Long Beach has consistently been ranked the city with the worst air quality out of the nation's 100 largest cities. The primary artery for goods distribution from the second busiest port in the nation is the I-710 corridor, which is nicknamed "Asthma Alley" for the disproportionate health impacts on the surrounding low-income and disadvantaged communities, caused in part by air pollution from heavy truck traffic and industrial operations. Tackling air quality and environmental justice issues through deployment of medium and heavy-duty Zero Emission fleets is a top priority for the City of Long Beach.

The COLB will organize and convene its departments that are operating municipal MHD fleets, along with community-based organizations, industry stakeholders, utilities, and policy makers, to develop and undertake a coordinated, holistic implementation strategy—the Blueprint—for a phased deployment of MHD ZEV fueling and charging infrastructure.

1.3 Project Need and Technical Merit

As a major tourist hub in California, City vehicle operations have an impact not just on its 462,000 residents, but also on the millions of tourists it attracts annually. The Long Beach Convention Center, Aquarium of the Pacific, Queen Mary and the annual Toyota Grand Prix of Long Beach, plus a wide variety of other attractions serve to draw six million visitors a year.[1] Hospitality and tourism are the second largest job sector in the City: In 2018, the industry generated $687 million in labor income and $1.8 billion in total economic impact.[2] Thus, addressing the chronic air pollution and equity issues from the City's industrial operations is crucial to residents' and visitors' health and well-being.

According to research compiled by the UCLA Fielding School of Public Health, climate change is not only already impacting health in LA County, but will continue to impact its social, cultural, and natural resources as extreme climate events—heat waves, floods, storms, and droughts—become more frequent and powerful. The City adopted a Climate Action & Adaption Plan (CAAP) in 2020 to help prepare and protect Long Beach from climate change while reducing future greenhouse gas (GHG) emissions. The CAAP provides a roadmap for Long Beach to continue towards its goal of a more environmentally healthy, economically prosperous, and equitable city. The plan includes a prioritized list of policy, infrastructure, and programmatic needs that will be pursued to reduce the city's carbon footprint and prepare for the impacts of climate change, including transportation actions to reduce GHG transportation emissions and new efforts to achieve greater reductions.

Long Beach uniquely operates its own municipal oil and gas utility service (Long Beach Energy Resources), water utility service (Long Beach Water), international airport (Long Beach Airport), and major transit fleet (Long Beach Transit). This purview over an unusually wide scope of public services has allowed the City to approach its interdisciplinary problems with integrated and innovative cross-departmental solutions.

For a complete ZEV transition, Long Beach recognizes the need to ready its fleets along with its electric and gas grid infrastructure. The City collaborates closely with its electric utility, Southern California Edison (SCE), as it has done for the partnership for electric vehicle infrastructure and plans to do so again for its ongoing MHD fleet transition efforts. Furthermore, as one of only three cities in California with a municipally owned gas utility, the City is poised to make swift progress in hydrogen infrastructure development by overcoming historical barriers such as permitting, regulatory, public acceptance and utility-jurisdiction coordination challenges. Leveraging this coordination to progress the hydrogen-related ZEVs and infrastructure could serve as an example for other municipalities who do not have the opportunity of intimate utility-municipality collaboration.

Through the Blueprint process, the City is identifying strategies to deploy holistic solutions to convert its MHD fleets to ZEVs. Regulatory, technical, social, and financial aspects of ZEV

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[1] 2023. About the City of Long Beach, available at https://www.visitlongbeach.com/meetings/about-the-cvb/. The Long Beach Convention & Visitors Bureau.

[2] Dean, Dennis. 2019. "Hospitality & Tourism Industry Makes $1.8 Billion Mark On Long Beach.", available at https://lbbusinessjournal.com/news/hospitality-tourism-industry-makes-1-8-billion-mark-on-long-beach. *Long Beach Business Journal*.

conversion are being considered. With the breadth of City departments involved in the Blueprint scope—from airports to utilities to public transit—the City can serve as a representative model for other municipalities across California. The conversion of municipal MHD fleets to ZEVs, and the implementation of supportive MHD ZEV infrastructure will contribute to improved local air quality and support the CAAP targets to increase access to additional electric vehicle charging and refueling stations.

CHAPTER 2:
Municipal and Stakeholder Engagement

The goal of this task was to convene the City's MHD fleet operating municipal departments to coordinate the development of 100 percent zero-emission fleet transition strategies, and planning horizons. The City engaged community and industry stakeholders to establish a comprehensive knowledge base to inform and guide future planning and vehicle retirement efforts.

2.1 Summary of Engagement

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 final Blueprint. Much of what the team learned in outreach and engagement was described in detail in various technical tasks and deliverables required to develop the Blueprint, Community and stakeholder engagement included:

- Partner Agency Workshop Agenda and Summary
- Financial Institution Engagement Summary
- Utility Engagement Summary
- Draft Community Outreach Plan
- Summary of Identified Workforce Development Gaps and Strategies

The City developed a Community Outreach Plan (Plan) to identify key stakeholder groups to include in Blueprint implementation. Community organizations and stakeholder groups identified include internal stakeholders such as departments or operating groups impacted by the ZEV transition, electricity and hydrogen providers, community-based organizations (CBOs), policymakers and regulatory agencies, financial institutions and funding agencies, education and workforce development partners, and industry partners.

2.2 Lessons Learned

Partner Agency Workshops

To gather input from internal City of Long Beach stakeholders, as well as partner agencies, the Blueprint team hosted two meetings featuring live surveys to gain a baseline understanding of current views on the transition to MHD ZEVs.

A meeting with COLB staff responsible for fleets of various City departments (BEV Task Force) was held on April 12, 2022. A meeting with partner agencies, including Long Beach Transit and CSU Long Beach, was held on April 13, 2022. Meeting participants were surveyed in real time to gain a baseline understanding of the current views regarding the transition to MHD ZEVs.

Themes that emerged from the two workshops include:

- Most survey respondents in both groups believe MHD ZEVs will have the range and power to meet needs of their fleet. Just one respondent believes ZEVs currently have the range and power to meet fleet needs.
- Results were mixed in both groups on the question of whether the cost of purchasing/leasing zero emission equipment is less than traditional equipment.

- COLB department reps were mixed on the question of whether outside funding is needed to purchase ZEVs, while partner agencies strongly indicated the need for outside funding to add ZEVs to their fleets.
- Most respondents in both groups believe they do not have enough trained mechanics to service MHD ZEVs.
- A sizeable majority in both groups agree that it is difficult to decide which ZEVs options are best for their fleets.
- On the question of reliability, most partner agency survey takers believe ZEVs are as reliable as internal combustion engine vehicles, while most COLB department fleet staff have the opposite view, that "the way we use our Medium and Heavy-Duty fleet makes it hard to rely on ZEVs".
- Both groups rated improving air quality and reducing greenhouse gas emissions as the top reasons to make the transition to ZEVs.
- The useful life of the equipment and the requirement that Long Beach Transit has for using a 12-year span versus what may be a shorter actual life of a ZEV vehicle.
- Range limitations, charging times, ability to effectively charge in the field – a particular problem for buses that are carrying passengers.
- The need to understand the demand on the street and the miles on the route. There may be a need to replace one traditional vehicle with two EVs to cover the mileage requirements associated with the current routing.
- The necessity of Original Equipment Manufacturers (OEM) training.

The second partner agency workshop was held on February 7, 2023. There were 25 attendees, primarily from the Municipal Equipment Maintenance Association (MEMA), together with fleet and sustainability managers from municipalities throughout California, including Oakland and South Lake Tahoe. Stuart Hamre with Arup prepared and presented slides, together with Justin Beck, COLB. The City coordinated outreach with MEMA. Momentum introduced the webinar and facilitated audience participation.

Financial Engagement Report

The Project Team conducted outreach to explore:

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

The Project Team conducted outreach to a selected cross-section of potential funding and financial partners such as federal and state agencies, state lending and financial assistance programs, traditional financial institutions, alternative financial institution, non-traditional lenders, local and state economic development experts, federal lending and financial assistance programs, and other financing experts. Financial engagement revealed that multiple

state and federal agencies are providing funding for clean transportation programs in California that the City of Long Beach may be eligible for. Public agencies have dual purposes of serving constituents to provide public welfare benefits and advancing goals across varying levels of government and interest sectors. Relevant programs identified through the financial engagement process include the:

- Clean Transportation Program
- California Electric Vehicle Infrastructure Project (CaleVIP)
- Clean Transportation Incentives Programs
- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
- Low Carbon Fuel Standard
- Carl Moyer
- Vehicle to Grid Integration (VGI) Commercial Pilot Projects
- Energy Infrastructure Incentives for Zero- Emission (EnergIIZE)

Utility Engagement Report

Electric utility and hydrogen provider engagement was a component of the City's municipal and stakeholder engagement. Southern California Edison (SCE) is the City of Long Beach's electric utility provider. SCE offers the "Charge Ready Transport" program, which provides program funded EV infrastructure upgrades for private and public sector fleets. To inform this Municipal Coordination and Stakeholder Engagement Summary, Momentum held numerous conversations with SCE to clarify the range of offerings available to the COLB to support MHD infrastructure and fleet plans. Outreach was also done to hydrogen fleet and fuel companies to inform understanding of this ZEV option.

Outreach included a discussion of SCE program offerings with Brian Bustamante, Senior Advisor for Government & Institutions, and Justin Beck, COLB Capital Projects Coordinator for the Department of Public Works, on April 1, 2022. Momentum held an in-person meeting with Ramiro Lepe, SCE's Charge Ready Medium & Heavy-Duty Transportation Electrification Sr. Advisor, at the ACT Expo in Long Beach on May 10, 2022, and on video calls May 16, and May 20, 2022. Outreach to hydrogen industry representatives was conducted at the ACT Expo, May 9-12, 2022, and at the California Hydrogen Leadership Summit on June 7, 2022.

Workforce Development Report

Engagement with community colleges, labor unions, internal stakeholders, vehicle and equipment OEMs, and workforce development organizations explored the following topics:

- 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?
- What opportunities exist to engage the workforce within the community to support the transition to ZEVs?

Workforce engagement concluded that workforce gaps for the City of Long Beach are primarily installation, operations and maintenance related. Charger installation expertise is expected to be provided by utility companies such as SCE, and vendors. Broadly, workforce managers agree that competencies need to be enhanced in battery technologies and electrical and charging equipment as well as general electrical and ZEV knowledge. The following themes were identified through engagement:

- Stakeholders largely agree that a large portion of the workforce risk associated with new technology adoption will initially be covered by vendors through warranties as well as Operation and Maintenance (O&M) contracts.
- Long term, the City of Long Beach is well situated geographically to have access to professionals from a wide range of community colleges and one of the nation's largest electric and engineering unions.
- During initial adoption, the majority of 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.
- The International Brotherhood of Electrical Workers (IBEW) and Engineers and Architects Association (EAA) provide an electric vehicle infrastructure tailored program for existing professionals and are well represented in the greater LA area workforce.
- The City of Long Beach should continue to engage workforce development organizations for long-term staffing needs.

CHAPTER 3:
Multilateral Policy, Zoning, and Planning Gap Analysis

The goal of this task was to develop a comprehensive understanding of existing policies, zoning codes, ordinances, and regulations that influence the deployment of ZEVs and ZEV infrastructure. This information gathering effort will be leveraged to identify pathways and actionable strategies to best support rapid MHD ZEV adoption and ZEV infrastructure deployment.

This section contains material from the following deliverable:

- Draft Summary of ZEV Policy Barriers and Best Practices

3.1 Report Overview

The Multilateral Policy, Zoning and Planning Gap Analysis explores existing ZEV policies and plans and identifies policy barriers and best practices that can help enable ZEVs to achieve the following objectives:

- Evaluate city, county and state policy and plans to understand the local ZEV policy landscape, and to ensure that the fleet conversion analysis conducted in Task 4 and 5 aligns with local and regional ZEV targets.
- Identify barriers and best practices in ZEV policies to assess opportunities for City policymakers to further enable ZEVs.
- As funding and financing is key to the deployment of ZEVs, and closely related to policy recommendations, summarize funding and financing opportunities available to municipal fleets.

3.2 Existing ZEV Policies and Plans

Long Beach has been recognized as a leader in green fleet innovations, ranking third in the American Public Work Association 2020 Leading Fleets competition. The City's efforts to convert municipal vehicles to zero-emission or alternative-fuel vehicles demonstrates the City's commitment to sustainability. These efforts are embedded in various plans initiated by the City, including the City of Long Beach Climate Action and Adaptation Plan (CAAP), the General Plan Mobility Element, and various Specific Plans. A review of existing city, county and state level policies and plans indicate the following key takeaways:

- ZEV planning and policy documents at city, county and state scales have varying scopes (e.g. public vs. private, light-duty vs. MHD, electric vehicles vs. zero-emission vehicles), granularity (e.g. goal-setting vs. initiatives) and ambition (i.e. aggressiveness in the ZEV transition). Generally, the focus of plans at a city and county level lean towards light-duty vehicles and electric technology options. State plans have a focus on public fleets, and MHD vehicles in addition to private and light-duty vehicles. Additionally, state plans set the most ambitious targets for ZEV conversion, as explained in further detail below.
- As the primary planning document guiding decarbonization efforts across the city, the City of Long Beach CAAP (planned adoption 2022) is the policy document best suited for establishing broad city-level ZEV targets. Given the plan's imminent approval,

inclusion of these goals may be best adopted in future updates to the plan. Additionally, to ensure goals are not superseded by more stringent state regulations, citywide ZEV goals should be set in alignment with county and state ambitions.

- The City's EV Infrastructure Master Plan will act as the primary policy planning document that will guide implementation actions. Findings of best practices from this report should be considered for inclusion in the master plan. Additionally, to ensure the master plan comprehensively covers the various technology options considered across the City, it would be advised to ensure 'ZEV' is inclusive of both battery and fuel cell electric vehicles.
- Across all city, county and state level policies and plans, the draft Advanced Clean Fleet (ACF) regulation would set the most aggressive timeline for municipal MHD ZEV fleet conversion. Given this, the team has agreed that the Blueprint analysis should use the ACF Rule to guide phasing of municipal fleet conversion.

3.3 ZEV Policy Gap Analysis

Municipalities can leverage various policy levers (plans, zoning ordinances, building codes, permitting etc.) within their authority to help enable public and private fleet conversion across a city. Internal policy mechanisms – e.g. bylaws, which are rules adopted by an organization to govern its members and regulates its affairs – can also be used to integrate ZEVs into operations across municipal departments. The Blueprint team conducted a gap analysis of how existing City of Long Beach policy actions compare against best practices in enabling a ZEV transition. The gap analysis was limited to policies impacting the scope of the Blueprint, thus focusing on policies that directly enable municipal MHD fleet conversion, and tangentially considers policies that can help cultivate a citywide ZEV ecosystem to support the fleet conversion. Results from each gap analysis are summarized below.

Internal Organization Policies Gap Analysis

- Establishing High-Level ZEV Goals in Planning Documents – Minor Gap: There is a minor gap in policies as ZEVs are already integrated into current planning documents. However, it is recommended to include ZEV goals for the broader citywide ZEV conversion (public and private, light-duty to heavy-duty), as well as clear targets for municipal MHD fleets. It is also recommended to generalize language and focus from electric vehicles to zero emission vehicles more broadly, in order to provide flexibility to the City in considering other technology options (e.g. hydrogen-based technologies).
- Form a ZEV Policy Committee – No Gap: The City has already created a cross-departmental ZEV committee in the form of the Battery Electric Vehicle Task Force. It is worth consideration, however, to extend the remit of the task force to include zero emission vehicles broadly, and even potentially to broader private fleet or passenger vehicle support.

Municipal Fleet Policies Gap Analysis

- ZEV-First Purchasing Policy – Minor Gap: The City does not have a formal ZEV-First Purchasing Policy but through internal champions and planning for state mandates, the City has proceeded in prioritizing ZEV fleet conversions where feasible. The City can formalize their efforts, including outputs from the Blueprint fleet conversion analysis, in a cross-departmental purchasing policy.

- Standardized ZEV Procurement – Minor Gap: City fleet bylaws include items such as telematics in new vehicles for data collection. The City can go further in specifying or recommending provisions to streamline procurement, such as creating a preferred vendor list for fleet types.
- Establish Internal Financing Programs – Major Gap: The City does not currently have an active green bond program to fund municipal ZEV capital expenditure projects.

Municipal Infrastructure Policies Gap Analysis

- Streamlined Electric Vehicle Charging Station (EVCS) Permitting – No Gap: The City adopted an expedited and streamlined EVCS permitting process in January, 2022, in compliance with California Government Code.
- EVCS Parking Requirements – Minor Gap: Current specific plans are behind building code EVCS requirements and should be updated to reflect or exceed upcoming code requirements. The City should also consider exceeding upcoming code requirements (e.g. striving for voluntary Tier 1 or 2 code requirements) for municipal facilities to lead by example.

ZEV Ecosystem Policies Gap Analysis

- ZEV Partnerships – Minor Gap: The City has already established ZEV partnerships, but collaboration can be expanded further to more stakeholders in the ZEV market (state agencies, fleet manufacturers, green investment companies etc.).
- Shared Infrastructure for Public Use – Minor Gap: Part of the Blueprint scope is exploring opportunities and next steps for utilizing municipal infrastructure for public charging. This minor gap will be filled when determinations are made during the Blueprint implementation regarding which fleet charging stations are to be made available for public use.

3.4 Funding and Financing Opportunities

A key barrier to ZEV fleet conversion is the high capital expenditures – and operational expenditures depending on factors such as the fuel type – associated with procuring a ZEV system (including the vehicle, depot and refueling infrastructure changes). Policy actions, such establishing a green bond program, can help alleviate this barrier. While funding and financing opportunities are discussed in more detail in the Financial Institution Engagement Summary in Task 2, potential grants, public-private partnerships, and financing programs from The Governor's Office of Business and Economic Development (Go-Biz) are explored in the report.

3.5 Lessons Learned

Long Beach has strong existing policies to enable municipal MHD ZEV fleet conversion, which is further supported by state policy and funding & financing programs. A ZEV policy gap analysis highlights predominantly minor gaps between existing policies and best practices. This finding underscores that though the City is leading the charge in green fleet conversion, additional policy actions can be undertaken to ease the ZEV conversion process for municipal fleets, as well as the broader ZEV ecosystem.

CHAPTER 4:
Municipal Fleet Vehicles Demand and Gap Analysis

The goal of this task was to evaluate the existing energy demands of municipal fleet operations and identify optimal technology replacements for transitioning fleet vehicles to ZEVs in alignment with desired co-benefits. Projections of existing and proposed energy demands at fleet facilities will also inform subsequent tasks related to infrastructure.

The Municipal Fleet Vehicles Demand and Gap Analysis identified optimal zero-emission replacements for the City's fleet vehicles. The selection of preferred replacement vehicles will ultimately depend on the preferences of the City and factors such as actual availability, negotiated price, and detailed review of specifications. The Municipal Fleet Analysis included a fleet vehicle replacement plan, categorization of fleet vehicles, logistical and operation requirements, fleet replacement timing and phasing, and key performance indicators for the fleet conversion process.

Contains material from:

- Draft Summary of Fleet Type Logistical and Operational Requirements
- Draft Baseline Fleet Energy Demand Profiles
- Draft Blueprint Fleet Energy Demand Profiles
- Draft Fleet Vehicle Replacement Plan

4.1 Report Overview

To be suitable to replace an existing fleet category, each ZEV had to meet logistical and operational requirements based on the current model's attributes and duty cycle. On a vehicle-specific basis, more detailed specification review may be required to ensure the suggested ZEV replacement meets detailed performance requirements. Each category of vehicle's average and maximum daily mileage were identified through telematics processing using the Geotab platform, the City's fleet management software. 2021 Geotab data was used, as data from 2019 and 2020 were incomplete. The City's telematics consultants, ATI Telematics, created a custom report that generated total, average, and maximum daily mileage for the given report period. With a 100,000-row limit, the maximum period was four months. Quarterly reports were generated using the average and maximum results from each quarter to understand the annual average and maximum mileage respectively. For any vehicles not connected to Geotab, the average and maximum daily mileage were estimated based on the characteristics of the next closest category of vehicle.

The high-level logistical and operational requirements were based on:

- Each category of vehicle's maximum daily mileage, which is used to determine whether the battery-electric vehicle (BEV) range is suitable to meet the vehicle's mileage without requiring charging midway through the workday.
- Each category of vehicle's average daily mileage.

- Gross vehicle weight rating (GVWR), i.e. the maximum weight a vehicle is designed to carry including the net weight of the vehicle, plus its accessories, passengers, fuel, and cargo.
- Attributes such as frame construction, usage characteristics, typical cargo, and auxiliary equipment.

ZEV replacement vehicles for the current fleet were identified, where available, for each category of vehicle in the combined fleet. Suggested replacement vehicle analysis was based on vehicles currently available on the market, or vehicles which will have been announced and are available for order in 2023 or earlier. The analysis focused primarily on BEVs which are generally preferred in light- and medium-duty applications due to their lower purchase and operating costs, greater access to charging, and availability for purchase/lease. Hydrogen vehicles were identified for some applications with severe duty cycles but are not considered a focus for fleet conversion due to their more limited availability and greater infrastructure requirements.

The identification of Key Performance Indicators (KPIs) and assessment of the performance of the Fleet Vehicle Replacement Plan against these KPIs is intended to weigh technically feasible pathways to ZEV adoption to determine an optimal path to fleet conversion which aligns with stakeholder interests. KPIs evaluated included capital cost savings, maintenance cost savings, GHG emissions reductions, and criteria air pollutant reductions.

4.2 Conclusions

The Municipal Fleet Vehicles Demand and Gap Analysis highlighted the following:

- The City of Long Beach has made substantial progress in reducing the emissions of its MHD fleet by transitioning to renewable compressed natural gas (CNG) and liquified natural gas (LNG) in the past decade. However, there are still emissions associated with this fuel source, and switching vehicle to battery-electric propulsion (and assuming a 100 percent carbon-free energy grid in California by 2045) will achieve further emissions benefits.
- There are many opportunities to begin converting the existing fleet to ZEV, particularly for light and medium-duty vehicles. There are fewer alternatives currently available for heavy-duty (Class 7 and 8) vehicles.
- The average age of the fleet is eight years, with an average in-service date of 2014. Based on an average vehicle lifespan of 10 years, a largely ZEV MHD fleet could be achieved, market permitting, by the early 2030s. Full conversion of the fleet could occur by 2038, assuming increased availability of ZEVs for models with ZEV alternatives not yet available and active ZEV procurement beginning immediately.
- Some municipal departments, such as Fire and Police, may retain non-ZEV vehicles given more complex operating requirements such as high daily mileage and the need to ensure adequate response capacity during long-term power disruptions. These public safety vehicles have been excluded from future capital and maintenance cost projections as a result.
- The proposed ACF Mandate, which may require the purchase of 50 percent MHD ZEVs beginning in 2024 and 100 percent MHD ZEVs by 2027, indicates strong regulatory

interest in advancing public fleet conversion. Beginning fleet conversion in anticipation of this mandate is recommended.

Based on the KPI analysis, the City of Long Beach can expect:

- Greater capital costs for vehicles, averaging an additional estimated $5.4M per year for non-public safety vehicles until full fleet conversion is achieved (based on current market conditions and price factors).
- An estimated $600,000 in annual maintenance cost savings for its non-public safety fleet upon full conversion to ZEVs, and additional operating cost savings.
- A 740-metric ton reduction in annual GHG emissions upon full fleet conversion to ZEVs.
- A 5,500-kg reduction in annual criteria air pollutant emissions upon full fleet conversion to ZEVs.

CHAPTER 5:
Regional ZEV Refueling Infrastructure Demand and Gap Analysis

The goal of this task was to outline a plan for MHD ZEV refueling infrastructure deployment by evaluating refueling technologies and utility demands of the proposed ZEV fleets. This task also aimed to map refueling site areas on a regional level to highlight optimal placement and facilitate coordination with utilities.

The ZEV Refueling Demand analysis includes fleet energy demand profiles, utility infrastructure implications, market-ready and emerging charging technologies, hydrogen fueling options, charging station requirements, public utilization of MHD ZEV charging/fueling infrastructure, and an infrastructure deployment plan.

5.1 Report Overview

The Regional ZEV Refueling Infrastructure Demand and Gap Analysis explored fleet energy demand profiles based on mileage data for the existing fleet, utility infrastructure implications of MHD vehicle charging, market-ready and emerging charging technologies, hydrogen fueling options, charging station demands, and non-municipal resource demands.

The City developed a charging infrastructure deployment plan for depot charging stations it plans to deploy throughout the city, which will be influenced by a variety of factors, including:

- Actual progress of charging station deployment as saturation of charging stations increases and demand for charging from public and private fleets grows
- Grid capacity and ongoing coordination with SCE
- State of the nascent hydrogen market and advancement of hydrogen vehicle technology, particularly for heavy-duty vehicles with significant auxiliary power requirements
- State of the battery-electric vehicle market and advancements in battery technology, including charging times, vehicle ranges, and electric power take off (ePTO) technology
- Availability of federal, state, and local funding for infrastructure deployment and fleet transition

To address these potential gaps, ongoing engagement with SCE, vehicle and charging station manufacturers and vendors, and monitoring of funding opportunities will be conducted as part of the City's fleet transition efforts.

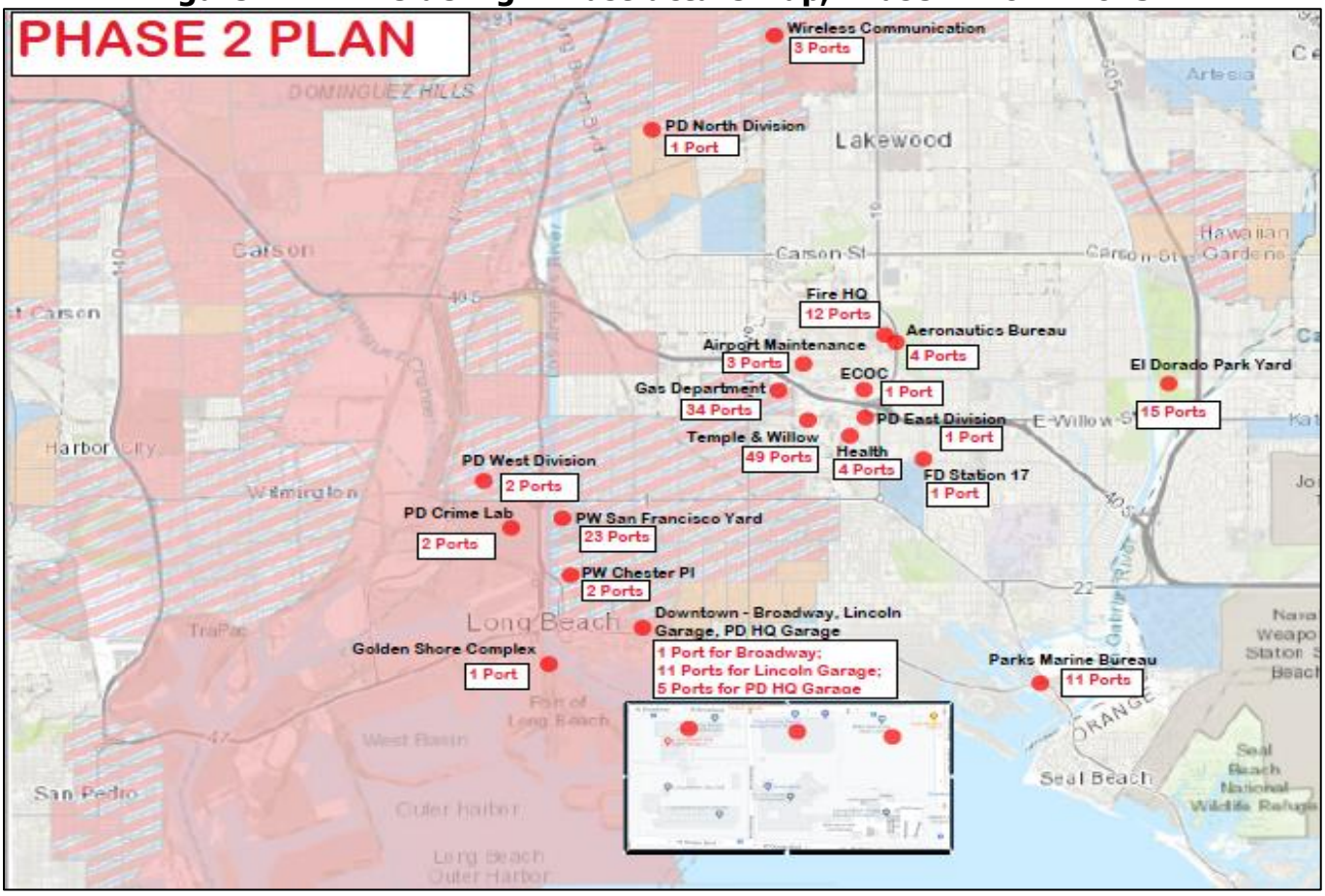
5.2 Refueling Infrastructure Maps

The City developed a four-phase charging infrastructure deployment plan for depot charging stations it plans to deploy throughout the city. The phasing plan represents a long-term vision and estimate of future charging station requirements. The phasing plan is subject to change based on coordination with SCE related to utility impacts, and actual progress of deployment.

1. Phase 1 (prior to 2022): Active
2. Phase 2 (2022-2025): See Figure 1
3. Phase 3 (2025-2030): See Figure 2

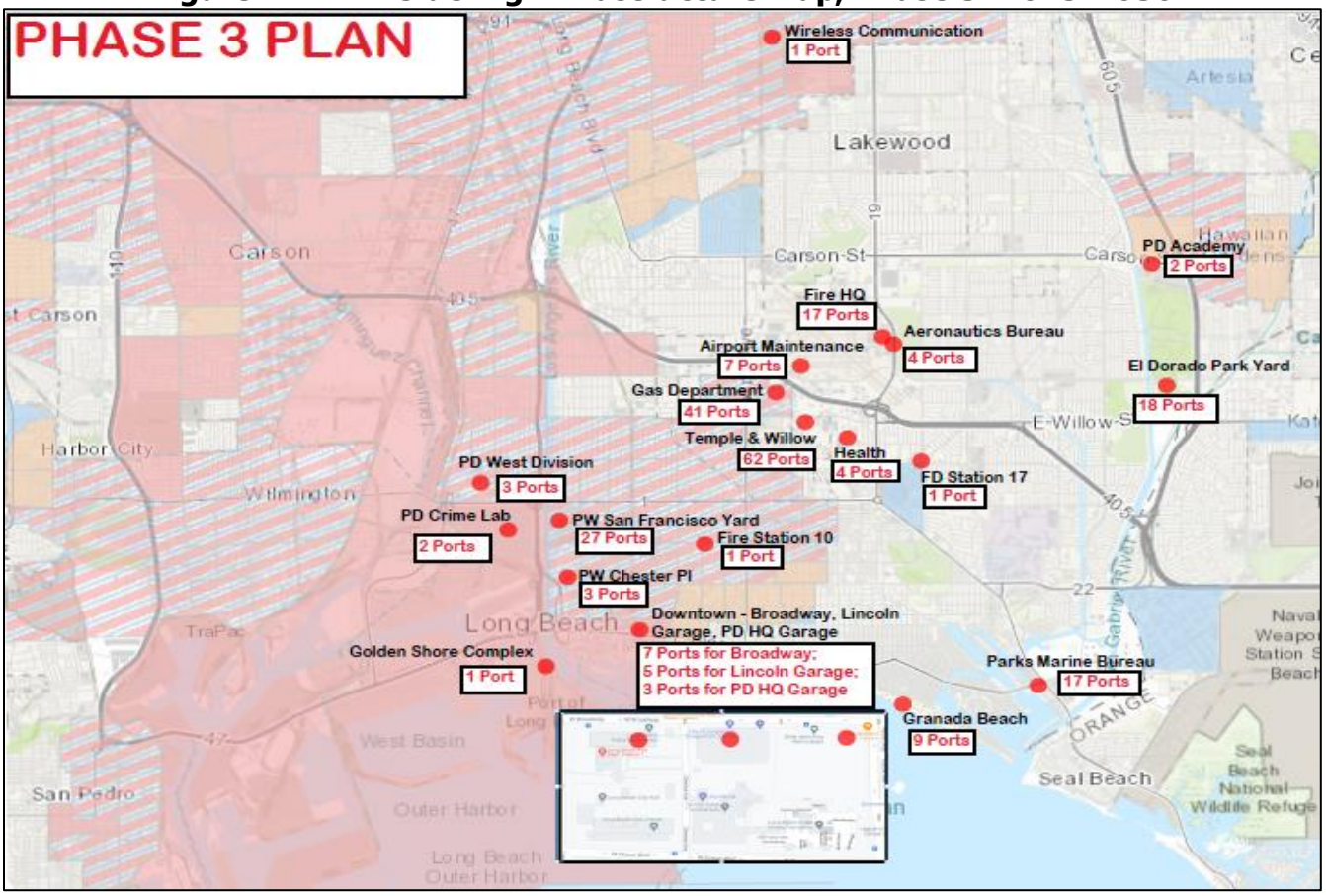
4. Phase 4 (2030-2035): See Figure 3

Figure 1: ZEV Refueling Infrastructure Map, Phase 2: 2022-2025



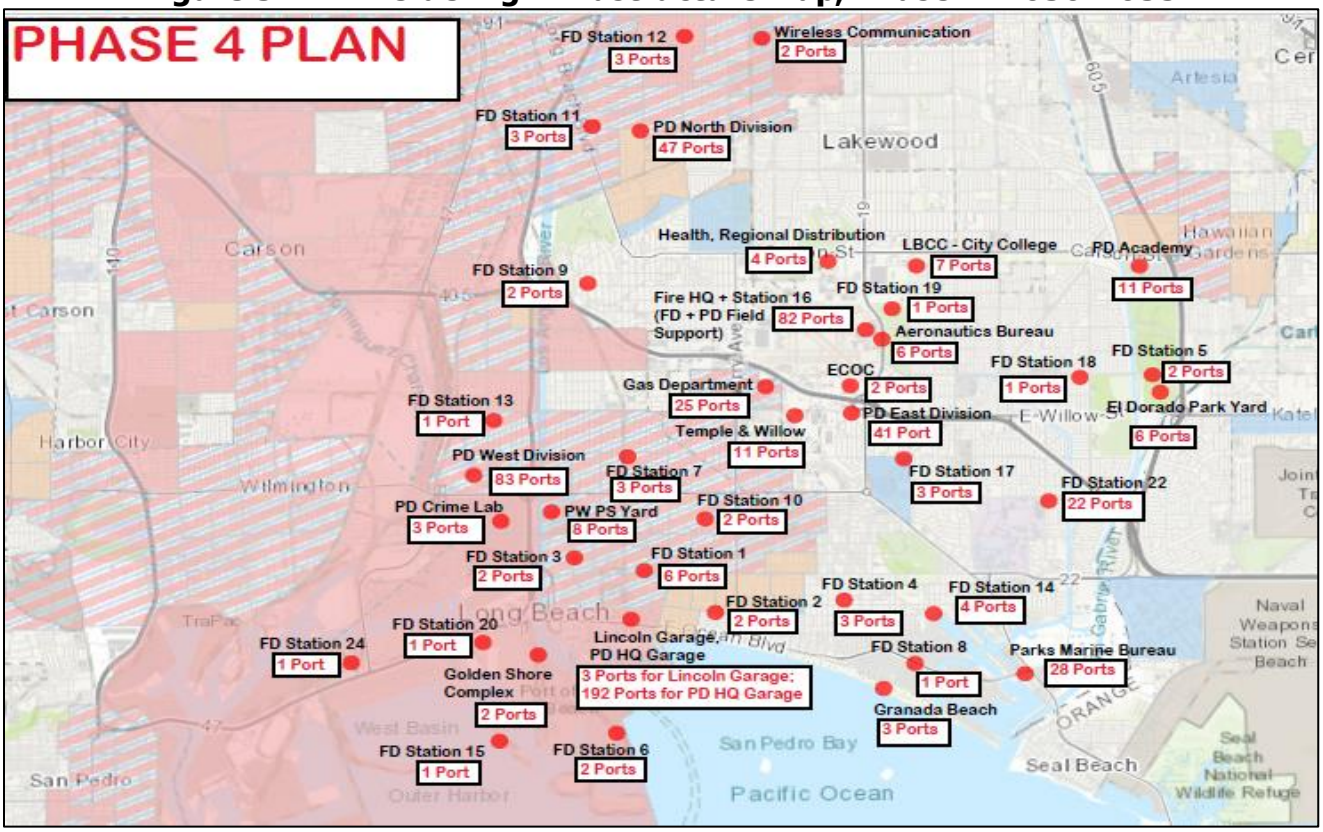
Source: City of Long Beach

Figure 2: ZEV Refueling Infrastructure Map, Phase 3: 2025-2030



Source: City of Long Beach

Figure 3: ZEV Refueling Infrastructure Map, Phase 4: 2030-2035



Source: City of Long Beach

5.3 Conclusions

The Regional ZEV Refueling Infrastructure Demand and Capacity Analysis highlighted the following key conclusions:

- **Fleet energy demand profiles:** The fleet energy demand assessment indicates that based on daily vehicle mileage, a future all-electric MHD fleet would require approximately 12.6 megawatt hours (MWh) of energy per day, and 3,013 MWh per year, with an estimated connected load of 4.1 megawatts (MW) to 6.6 MW depending on type of charging employed. Additional demands could be imposed due to unassessed requirements including auxiliary equipment charging and idle time, though the deployment of hydrogen vehicles could minimize utility demands. The ultimate fleet mix between battery-electric and hydrogen vehicles will impact overall energy demands.
- **The ultimate makeup of the future MHD fleet and proportion of battery-electric versus hydrogen fuel cell vehicles will impact utility-level infrastructure considerations.** A greater proportion of battery-electric vehicles may require additional utility upgrades, while on-site hydrogen storage or production to support hydrogen fuel cell vehicles could be space intensive. Based on current and forthcoming market offerings, it is likely that more MHD fleet vehicles will be battery-electric than hydrogen fuel cell.

- **Market-ready and emerging charging technologies:** A wide range of Level 2[3] and Direct Current Fast Chargers[4] (DCFC) charging stations are available on the commercial market from many suppliers. Though Level 2 charging stations will be deployed most commonly, some DCFC stations will be required for City of Long Beach vehicles, such as those with high intensity duty cycles that will deplete onboard batteries more rapidly or vehicles which require rapid charging to return to service more quickly. Hydrogen vehicles are a more nascent technology with more limited options across all vehicle classes, though options are expected to grow as the MHD vehicle market matures. Hydrogen vehicles will be desirable for high intensity duty cycle applications. Hydrogen fueling, if onsite, will require a substantial amount of space. Alternatives such as delivered hydrogen or on-route hydrogen could be considered as an interim measure as the ZEV fleet scales.
- **Charging station requirements:** By the end of 2035, 1,031 Level 2 and 66 DCFC charging stations are expected to be deployed to fleet depots and facilities to enable fleet charging. The City is pursuing a 1:1 ratio of Level 2 charging stations to fleet vehicles to ensure adequate charging station access. Sharing of DCFCs will be required based on the number of vehicles relative to the anticipated charging station provision.
- **Non-municipal MHD resource demands:** As the non-municipal ZEV fleet scales alongside the municipal fleet, there will be additional demand for charging access by private fleet operators. However, private fleets are not subject to the same proposed State regulations as public fleets and are expected to convert to ZEVs more slowly. In general, the City MHD fleet will charge and refuel at municipal facilities, as is the case with the majority of operations today. To support operational resiliency, the City fleet operators should have convenient access to the public charging network.
- **Utility infrastructure implications:** The City has been engaged with SCE in communicating and developing its phased, long-term infrastructure strategy for MHD fleet charging. Due to early and ongoing engagement, there are no identified risks associated with the current Infrastructure Deployment Plan. Broadly, SCE does not foresee any utility capacity constraints within the City that would hinder MHD fleet conversion at the City or for other customers or the public. Continuing to actively engage with SCE will be key to successful fleet conversion and aligning infrastructure with the demands of the future fleet.
- **Infrastructure deployment plan:** The City has developed a four-phase plan to deploy Level 2 and DCFC charging stations throughout the city. The phasing plan is subject to change based on coordination with SCE related to utility impacts, and actual progress of deployment. Ongoing engagement with SCE, vehicle and charging station manufacturers and vendors, and monitoring of funding opportunities will be important

[3] Level 2 chargers use alternating current electricity to charge a plug-in electric vehicle at 208 to 240 volts and can provide about 14 to 35 miles of range per hour of charging.

[4] Direct Current Fast Chargers (DCFC) use direct current (DC) electricity at 480 volts to recharge an all-battery electric vehicle to 80 percent capacity in about 30 minutes, though the time required depends on the size of the vehicle battery and the power level of the charger.

to ensure that the deployment plan aligns with ongoing municipal and State priorities and remains current as ZEV and charging/fueling technologies develop.

- **There is no hydrogen refueling infrastructure currently deployed at any City depot,** and public hydrogen refueling infrastructure is limited in California. Significant gaps remain with respect to hydrogen refueling infrastructure development. The development of on-site hydrogen refueling capabilities should be a key priority of the City if it seeks to convert some vehicles to hydrogen. Coordination with other agencies to develop public hydrogen refueling stations that can be accessed by municipal MHD vehicles will be important to minimize infrastructure costs and maximize co-benefits.
- **A comprehensive hydrogen safety plan should be developed if hydrogen vehicles are procured,** including if delivered hydrogen is used. This safety plan should be based on code requirements for equipment location and include safe handling practices, vehicle parking requirements, regular testing of equipment, and staff education.

CHAPTER 6:
Supporting Electric and Hydrogen Grid Infrastructure Gap Analysis

The goal of Task 6, Supporting Electric and Hydrogen Grid Infrastructure Gap Analysis, was to understand and plan for how the local electric and gas utilities can position themselves to best support the ZEV transition in MHD applications.

6.1 Addressing Potential Gaps

To ensure the Infrastructure Development Plan is implemented successfully, various infrastructure development strategies have been developed to manage the proposed ZEV transition plan and ensure that infrastructure is aligned with needs from the MHD fleet. Table 1 summarizes potential infrastructure and policy gaps that may limit MHD fleet conversion, and strategies to help address these gaps.

Table 1: Potential Gaps and Infrastructure Strategies

Actual progress of charging station and hydrogen refueling infrastructure deployment: Charging station deployment may be impacted by various factors including availability of labor, actual demands imposed by MHD fleet vehicles, saturation of charging stations, and changes in capital plans.	Conduct ongoing engagement with MHD vehicle manufacturers and charging station suppliers to ensure order timelines for vehicles and equipment are suitable to meet the fleet replacement schedule. Evaluate utilization of early charging station deployments to ensure that infrastructure is not over- or under-provided, and that logistical and operational requirements can be met with available technologies. Advance planning for onsite hydrogen refueling infrastructure at the Fleet Services Yard and opportunities to partner with other agencies, including the Port of Long Beach, to leverage existing and planned hydrogen refueling infrastructure. Evaluate opportunities to refuel hydrogen vehicles at private hydrogen stations within the City of Long Beach. Re-distribute internal combustion engine vehicles not yet due for replacement to depots with more limited/delayed charging and refueling infrastructure, reserving ZEV fleet vehicles for depots with adequate charging and refueling capacity.

Grid capacity: As the number of charging stations increases throughout the City of Long Beach, additional demands will be imposed on the electrical grid.	Continue ongoing coordination with SCE to ensure utility infrastructure upgrades, if required, are completed ahead of vehicle in-service dates. As needed based on grid capacity and logistical and operational requirements, leverage hydrogen to minimize grid capacity impacts and meet severe duty cycle requirements for MHD vehicles, particularly those with significant auxiliary equipment demands.
State of the nascent hydrogen market, advancement of hydrogen vehicle technology, and hydrogen refueling infrastructure deployment: There are limited hydrogen fuel cell MHD vehicles available on the market today, and growth in models may be limited as the technology develops. This presents a risk particularly for heavy-duty vehicles with significant auxiliary power requirements that cannot be met with batteries. There are also no hydrogen refueling stations currently available within the City of Long Beach to accommodate MHD vehicles, nor depot refueling capabilities.	Conduct market assessment and engage with manufacturers and vendors to identify suitable replacement models to meet all logistical and operational requirements. Continue engaging with the Army Corps of Engineers related to the I-710 Corridor public hydrogen refueling site, and other entities to support shared hydrogen refueling infrastructure. Investigate the potential for onsite hydrogen at the Fleet Services Yard and other locations in alignment with the fleet transition plan and fleet conversion timelines.
State of the battery-electric vehicle market and advancements in battery technology: Though battery-electric vehicle technology is advancing rapidly, it is still maturing in the MHD segment. Advancements in battery storage capacities, charging times, vehicle ranges, and ePTO technology would benefit fleet logistical and operational requirements, but the degree of advancement in the next 5-10 years is uncertain and may impact early fleet conversions.	Conduct market assessment and engage with manufacturers and vendors to identify suitable replacement models to meet all logistical and operational requirements. As needed, leverage public and on-route charging opportunities to supplement depot charging if daily duty cycles are compromised by current battery-electric technologies.
Availability of federal, state, and local funding for infrastructure deployment and fleet transition: The cost of deploying infrastructure to support MHD fleet transition will be significant. The forthcoming ACF Mandate will regulate ZEV purchases for public fleets, including the City of Long Beach, and drive an accelerated timeline for ZEV infrastructure deployment.	Engage with State legislators related to the development of MHD ZEV regulations for public fleets. Collaborate with other public agencies to advocate for reasonable State policies and encourage appropriate funding to support fleet conversion efforts, including infrastructure deployment, vehicle purchases, and workforce development.

Source: Arup

CHAPTER 7:
City Deployment Strategy and Knowledge Transfer

The goal of this chapter was to leverage the outcomes of Tasks 2-6 to present a Preliminary Fleet Transition Plan to partner agencies to solicit feedback for revisions. The City will then disseminate findings in the revised plan to a diversity of stakeholders through electronic media, workshops, conferences and/or industry meetings. The other key deliverable included in this task is the development of a Roadmap for Citywide MHD ZEV Fleet Transition Planning. This roadmap will be publicly available once finalized and will explore challenges, considerations and best practices in city-wide ZEV fleet transitioning while utilizing the City of Long Beach as a case study.

Contains material from:

- Draft Preliminary Fleet Transition Plan
- Partner Agency Workshop 2 Agenda and Summary
- Draft Roadmap for Citywide MHD ZEV Fleet Transition Planning
- Blueprint Dissemination Engagement Summary

7.1 Fleet Transition Plan

The Fleet Transition Plan explores challenges, considerations, and best practices associated with the City's transition to a ZEV fleet. The Fleet Transition Plan included findings from the Municipal Fleet Vehicles Demand Analysis, which identifies optimal zero-emission replacements for the City's fleet vehicles, and the Regional ZEV Refueling Infrastructure Demand Analysis, which evaluates recharging and refueling technologies and infrastructure needed – and electrical capacity required – to support the proposed ZEV fleets.

The Fleet Transition Plan evaluates both battery-electric and hydrogen fuel cell technologies. Each of these technologies is advancing quickly, though battery-electric vehicles are more common and have a more widely developing charging network to support operations. Hydrogen fuel cell vehicles present a good opportunity for converting larger vehicles with more intensive duty cycles. The Fleet Transition Plan anticipates that the City will meet its primary MHD ZEV fleet needs with battery-electric vehicles. The City has been working with the local utility, SCE, to deploy charging infrastructure and prepare for infrastructure upgrades required to meet the significant demands imposed by a large fleet of battery-electric MHD vehicles. The City expects to procure some hydrogen vehicles and hopes to deploy a depot refueling station, in combination with access to public refueling stations, to support these vehicles. Because the hydrogen vehicle market is more nascent, infrastructure planning for hydrogen vehicles is less advanced.

Combining the results of the Municipal Fleet Vehicles Demand Analysis and the Regional ZEV Refueling Infrastructure Demand Analysis, the Fleet Transition Plan findings provide a pathway for the City to replace its existing MHD diesel and CNG fleet with zero-emission vehicles, and to deploy the requisite recharging and refueling equipment.

7.2 Roadmap for Citywide MHD ZEV Fleet Transition Planning

The Roadmap for MHD ZEV Fleet Transition Planning ("Roadmap") explored challenges, considerations, and best practices associated with the ZEV transition. The Roadmap includes findings from the Community and Stakeholder Engagement Plan, which identifies processes for stakeholder identification and outreach, the Municipal Fleet Vehicles Demand Analysis, which identifies optimal zero-emission replacements for fleet vehicles, and the Regional ZEV Refueling Infrastructure Demand Analysis, which evaluates recharging and refueling technologies and infrastructure needed to support ZEV fleets. The Roadmap evaluates methods and techniques relevant to fleet transition planning, concluding with a case study on the City of Long Beach Fleet Transition Plan. The Roadmap identifies important considerations in fleet transition planning based on common gaps in knowledge, capacity, and infrastructure. The Roadmap highlights the following key considerations for each step in ZEV transition planning:

- **Community and stakeholder engagement ensures that internal stakeholders, local businesses, organizations, technology providers, institutions, and community groups are aware of the transition to zero-emission medium- and heavy-duty vehicles, equipment, and infrastructure:** Engagement provides opportunities for stakeholders to discuss challenges, risks, opportunities, and collaboration potential to support the transition. Overall, meaningful two-way dialogue with stakeholders provides insight into ZEV transition planning by sharing community needs, desires, and collaboration opportunities.
- **Multilateral policy analysis establishes a comprehensive understanding of existing ZEV policies and plans, as well as identify policy barriers and best practices that can help enable ZEVs:** Through a comprehensive literature review, ZEV policy analysis includes the evaluation of city, county, and state policy and plans to understand the local ZEV policy landscape. A thorough review and analysis of city, county, and state level policies and plans provides context for the development of a ZEV transition plan and offers insight into existing gaps. Broad understanding of scaled levels of policy allows an organization to leverage municipal efforts to co-benefit the broader ZEV ecosystem.
- **Technology and infrastructure assessment and gap analyses determine existing composition, capacity, and demand to understand the potential impacts of the ZEV transition:** The process of technology and infrastructure analyses includes the establishment of existing and projected fleet energy demand profiles, research on market-ready and emerging charging technologies, estimation of charging station requirements based on logistical and operational considerations, and coordination with utilities to understand infrastructure implications and deployment needs. This data can inform ZEV transition planning through the identification of specific needs and demands, as well as projected growth or changes over time.

7.3 Blueprint Dissemination Engagement

The City of Long Beach Blueprint team gathered input on the Fleet Transition Plan in two ways. The first was an online workshop sponsored by the Municipal Equipment Maintenance Association (MEMA). The second was direct outreach to key City of Long Beach fleet and other staff. This document includes a summary of both outreach efforts previously described in Chapter 2.

CHAPTER 8:
Blueprint, Challenges, and Lessons Learned

The goal of task 9 (Blueprint) was to formalize the information gathered under Tasks 2 through 8, into a formal Blueprint that can be used internally by the project team and shared with key stakeholders. This chapter also discusses Blueprint key findings, benefits and risks identified during the Blueprint development process, and lessons learned.

8.1 Summary of Blueprint

For the Final Blueprint, the project team synthesized the significant outcomes and information derived from all technical tasks (tasks 2-7). The Final Blueprint includes key information from each technical task, including:

- Key stakeholder and CBO engagement takeaways from Task 2
- Key technological takeaways from Task 4
- A summary of design and implementation recommendations from Task 5
- A summary of the initial and remaining gaps and opportunities for ONT MHD ZEV infrastructure development from Task 6
- A discussion of the shuttlebus electrification and wireless charging case study with implementation suggestions from Task 6
- A summary of the financial models and LCFS impact summary from Task 7, as well as funding and financing opportunities from Task 2
- A summary of next steps and lessons learned

8.2 Challenges

The following are risks and challenges associated with the ZEV transition:

- ZEV technology is rapidly changing and generates risk of deploying equipment or vehicles that will soon become inferior (e.g. improved charging output; better battery range requiring less frequent charging).
- There are logistical and operational challenges associated with keeping electrical equipment charged within duty cycle constraints. Power demands for auxiliary equipment should be evaluated in addition to vehicle mileage and idle time.
- Space for ZEV charging/refueling infrastructure and available power need to be evaluated in relation to operational needs.
- The upfront cost of procuring MHD ZEVs is typically greater than conventional equipment (before grants, tax credits, and operational savings are factored), meaning that increased capital may need to be allocated in the early years of fleet transition relative to business-as-usual internal combustion engine fleet vehicle procurements.
- Changes to maintenance facilities may be required to safely service BEVs and FCEVs. Individual manufacturers should be consulted to determine what vehicle-specific maintenance requirements and safety practices may require facility retrofits and specialized workforce training.

- The workforce will need additional training and support for Operations & Maintenance (O&M) of ZEV fleets. The maintenance of ZEVs is likely to be less frequent than current internal combustion engine vehicles.

8.3 Key Blueprint Findings and Lessons Learned

The following includes a list of key findings from the Final Blueprint:

- Current progress: The City has already made significant progress towards reducing emissions of its MHD fleet by transitioning to renewable CNG and LNG in recent years. Further conversion to battery-electric and/or hydrogen fuel cell vehicles will achieve greater emissions benefits.
- ZEV conversion potential: The average age of the City's fleet is eight years, and a largely ZEV MHD fleet could be achieved, market permitting, by the early 2030s.
- Regulatory support: The California Air Resources Board Draft Advanced Clean Fleet (ACF) regulation, as currently proposed, will require the purchase of 50 percent MHD ZEVs beginning in 2024 and 100 percent MHD ZEVs by 2027, or adherence to a "ZEV Milestones Option," which demonstrates strong regulatory commitment to advancing public fleet conversion.
- Stakeholder concerns and opportunities: Stakeholders identified improving air quality and reducing greenhouse gas emissions as the top reasons to make the transition to ZEVs. Further, stakeholders broadly agreed that ZEVs have the range and power to meet fleet needs. Stakeholders indicated that the primary concern about the ZEV transition is a lack of trained mechanics to service zero-emission vehicles and equipment.
- Fleet energy demand profiles: The fleet energy demand assessment indicates that based on daily vehicle mileage, a future all-electric MHD fleet would require approximately 12.6 MWh of energy per day, and 3,013 MWh per year, with an estimated connected load of 4.1 MW to 6.6 MW depending on type of charging employed. The ultimate fleet mix between battery-electric and hydrogen vehicles will impact overall energy demands.
- The ultimate makeup of the future MHD fleet and proportion of battery-electric versus hydrogen fuel cell vehicles will impact utility-level infrastructure considerations. Based on current and forthcoming market offerings, it is likely that more MHD fleet vehicles will be battery-electric than hydrogen fuel cell.
- Market-ready and emerging charging technologies: A wide range of Level 2 and DCFC are available on the commercial market from many suppliers. Though Level 2 charging stations will be deployed most commonly, some DCFC stations will be required for City of Long Beach vehicles. Hydrogen vehicles will be desirable for high intensity duty cycle applications. Hydrogen fueling, if onsite, will require a substantial amount of space. Alternatives such as delivered hydrogen or on-route hydrogen could be considered as an interim measure as the ZEV fleet scales.
- Charging station requirements: By the end of 2035, 1,031 Level 2 and 66 DCFC charging stations are expected to be deployed to fleet depots and facilities to enable fleet charging. The City is pursuing a 1:1 ratio of Level 2 charging stations to fleet vehicles to ensure adequate charging station access, though low daily mileage suggests that daily charging will not be required for most vehicles. A lower ratio of Level 2

charging stations to fleet vehicles would likely be suitable for much of the fleet, with DCFCs supplementing some need when a vehicle does not have immediate access to a charging station. A lower deployment of Level 2 charging stations can help reduce capital costs and keep infrastructure utilization higher. Sharing of DCFCs will be required based on the number of vehicles relative to the anticipated charging station provision.

- Non-municipal MHD resource demands: As the non-municipal ZEV fleet scales alongside the municipal fleet, there will be additional demand for charging access by private fleet operators. To support operational resiliency, the City fleet operators should have convenient access to the public charging network.
- Utility infrastructure implications: The City has been engaged with Southern California Edison (SCE) in communicating and developing its phased, long-term infrastructure strategy for MHD fleet charging. Due to early and ongoing engagement, there are no identified risks associated with the current Infrastructure Deployment Plan. Continuing to actively engage with SCE will be key to successful fleet conversion and aligning infrastructure with the demands of the future fleet.
- Infrastructure deployment plan: Ongoing engagement with SCE, vehicle and charging station manufacturers and vendors, and monitoring of funding opportunities will be important to ensure that the deployment plan aligns with ongoing municipal and State priorities and remains current as ZEV and charging/fueling technologies develop.
- There is no hydrogen refueling infrastructure currently deployed at any City depot, and public hydrogen refueling infrastructure is limited in California. Significant gaps remain with respect to hydrogen refueling infrastructure development. Coordination with other agencies to develop public hydrogen refueling stations that can be accessed by municipal MHD vehicles will be important to minimize infrastructure costs and maximize co-benefits.
- A comprehensive hydrogen safety plan should be developed if hydrogen vehicles are procured, including if delivered hydrogen is used. This safety plan should be based on code requirements for equipment location and include safe handling practices, vehicle parking requirements, regular testing of equipment, and staff education.

In addition to an expected $600,000 in annual maintenance cost savings for its non-public safety fleet upon full conversion to ZEVs (in present value dollars), the City expects a 740-metric ton reduction in annual GHG emissions and a 5,500-kg reduction in annual criteria air pollutant emissions. Implementation of the Blueprint will help the City of Long Beach realize many additional climate and socioeconomic benefits, including:

- Providing abundant business opportunities to OEM manufacturers, Electric Vehicle Supply Equipment (EVSE) manufacturers, ZEV infrastructure site hosts, electricians, and general contractors.
- Creating new jobs in ZEV infrastructure engineering and installation, procurement, program management, and maintenance.
- Purchasing of ZEVs to generate new state sales tax revenue.
- Preserving natural resources by significantly reducing the numerous negative ecological impacts of automotive emissions.

- Reducing and eliminating climate pollutants, including Greenhouse Gas emissions. As the City is increasingly powered by renewable energy sources and hydrogen, climate pollutants associated with City will approach zero.
- Displacing the use of, and dependency on, petroleum.
- Improving air quality in low income and disadvantaged communities that are situated near heavy truck traffic.
- Improving air quality along "Asthma Alley" (I-710) and in other vulnerable City neighborhoods will improve health conditions for residents who have suffered disproportionate health impacts of MHD-related air pollution.

GLOSSARY

BATTERY ELECTRIC VEHICLE (BEV) - Also known as an "All-electric" vehicle (AEV), BEVs utilize energy that is stored in rechargeable battery packs. BEVs sustain their power through the batteries and therefore must be plugged into an external electricity source in order to recharge.

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 seven major areas of responsibilities are:

1. Planning and Policy Development
2. Renewable Energy Growth
3. Energy Efficiency
4. Energy Innovation
5. Cleaner Transportation
6. Responsible Electricity Infrastructure
7. Emergency Response

COLB - City of Long Beach

CTP - The Clean Transportation Program (CTP), also known as Alternative and Renewable Fuel and Vehicle Technology Program, invests up to $100 million annually in a broad portfolio of transportation and fuel transportation projects throughout the state. The Energy Commission leverages public and private investments to support adoption of cleaner transportation powered by alternative and renewable fuels.

COMPRESSED NATURAL GAS (CNG) - Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

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

ELECTRIC VEHICLES (EV) - A broad category that includes all vehicles that are fully powered by Electricity or an Electric Motor.

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

GROSS VEHICLE WEIGHT RATING (GVWR) - The maximum operating weight of the vehicle set by the manufacturer. This includes the empty vehicle weight, fuel, passengers, and cargo combined.

HYDROGEN FUEL CELL ELECTRIC VEHICLES (FCEVs) - A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

LNG (LIQUEFIED NATURAL GAS) - Natural gas that has been condensed to a liquid, typically by cryogenically cooling the gas to minus 260 degrees Fahrenheit (below zero).

LOW CARBON FUEL STANDARDS (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 (GHG) emissions. The LCFS standards are expressed in terms of the "carbon intensity" (CI) of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California to cut greenhouse gas emission and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

MEGAWATT (MW) - One-thousand kilowatts (1,000 kW) or one million (1,000,000) watts. One megawatt is enough electrical capacity to power 1,000 average California homes. (Assuming a loading factor of 0.5 and an average California home having a 2-kilowatt peak capacity.)

MEGAWATT HOUR (MWh) - One-thousand kilowatt-hours, or an amount of electrical energy that would supply 1,370 typical homes in the Western U.S. for one month. (This is a rounding up to 8,760 kWh/year per home based on an average of 8,549 kWh used per household per year [U.S. DOE EIA, 1997 annual per capita electricity consumption figures]).

METRIC TON - A unit of mass equal to 1000 kilograms.

MHD - Vehicles with a gross vehicle weight rating (GVWR) greater than 10,001 pounds. Includes weight classes 3, 4, 5, 6, 7, and 8.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) - Refers to the manufacturers of complete vehicles or heavy-duty engines, as contrasted with remanufacturers, converters, retrofitters, up-fitters, and re-powering or rebuilding contractors who are overhauling engines, adapting or converting vehicles or engines obtained from the OEMs, or exchanging or rebuilding engines in existing vehicles.

ZERO-EMISSION VEHICLE (ZEV) - Vehicles which produce no emissions from the on-board source of power (e.g., an electric vehicle).