

PROJECT NARRATIVE

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Notes:

1. The Port of Los Angeles Harbor Department has reviewed the ARFVTP Terms and Conditions (Attachment 9) and previously committed to these in past grant agreements.
2. No confidential material is provided in this application.

PROJECT NARRATIVE

PROJECT DESCRIPTION

Under the Zero Emission Freight Vehicle Advanced Infrastructure Demonstration (AID), the Port of Los Angeles (Harbor Department), together with our project demonstration partner West Basin Container Terminal (WBCT), are proposing to model elements of a system that could ultimately electrify a major container terminal at the United States' busiest container port. WBCT recently received a co-funding grant to demonstrate 10 battery-electric yard tractors, which are planned to be charged using conventional charging equipment, in spite of their operational limitations. This California Energy Commission grant funding opportunity provides the Harbor Department and its demonstration partner, WBCT, with the opportunity to propose an advanced charging technology for the 10 yard tractors that would provide even better capability to complete two full 8-hour shifts each day a proof of concept to install additional chargers and deploy more vehicles.

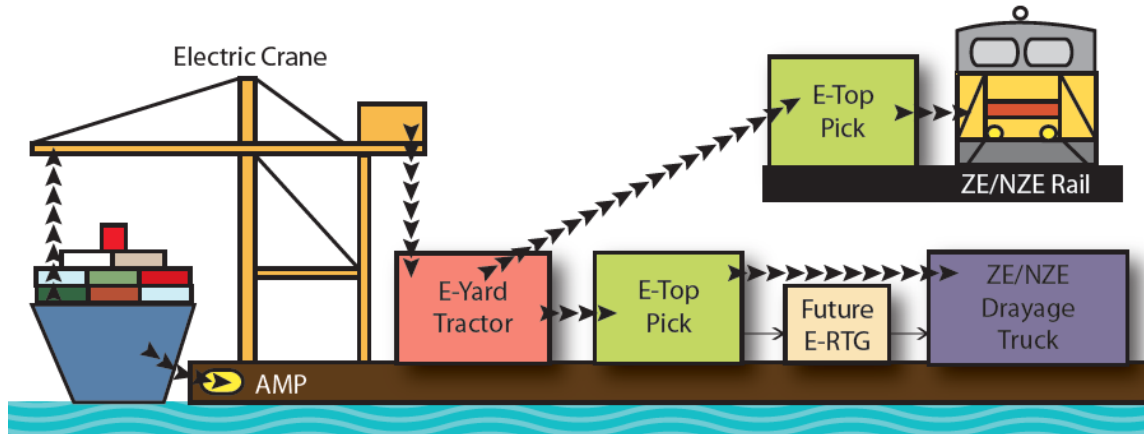
The Harbor Department is proposing to team with Wireless Advanced Vehicle Electrification, Inc. (WAVE) to design and demonstrate inductive charging technology to support each of the 10 yard tractors at WBCT's equipment corral as well as two opportunity charging stations at the central break location where the yard tractors can obtain a quick (10-15 minute) top-off mid-shift. The project will also include a battery storage system (BSS) designed by BYD Motors, Inc. to receive and store energy from the electrical grid when grid power is more available and costs are low, and provide it to the yard tractors when costs are higher (i.e., peak shaving to reduce demand charges). This multi-faceted project is designed to be scalable to support additional zero emission equipment as the WBCT fleet moves toward its goal to operate a zero-emissions cargo handling equipment (CHE) fleet. Ultimately, this project will not only demonstrate a series of prototype electrified equipment and charging mechanisms, but will showcase a model of how to fully realize the vision of a zero emission container terminal, also referred to as the zero emissions *pathway*.

The Harbor Department's zero emissions container terminal concept, also referred to as the "zero emissions pathway", provides a model for how a non-automated zero emissions terminal operation would be established, including the kinds of engagement that will need to be developed and produced in the coming years to make this concept work. The pathway begins at ship side, with an existing all-electric ship to shore crane moving a container off the ship. The container is then moved away from the dock by a zero emission yard tractor, where it is then off-loaded onto the container stacks by a zero emission top handler. Finally, the container is loaded by a zero emission top handler onto a train or a drayage truck to be moved on towards its destination. The AID demonstration project, especially with the WAVE inductive systems and opportunity charging infrastructure, will play a key role in the ultimate establishment of this kind of zero emission terminal operation. Figure 1, below, provides a graphic of this proposed pathway.

A primary barrier to the adoption of zero emission technologies at Port terminals is charging infrastructure to support a fleet of zero emissions equipment. In addition, current yard tractor operations at a port terminal can require up to 16 hours of work per day, which most (if not all) current zero emissions models struggle to accomplish using typical battery arrangements and charging installations. An electric yard tractor need to be able to charge for some time during an active shift or between back-to-back shifts, which can often be impossible if required to return to a set charge point and have a particular class of employee handle the actual connection. Finally, a terminal operator's overall electrical demand (and the costs associated

with it) could increase exponentially as the fleet moves towards zero emission equipment, especially if all equipment is charging at the same time.

Figure 1: Port of Los Angeles Zero Emissions Pathway Concept



To address these concerns, working together with WBCT and WAVE, the Harbor Department is proposing to install and demonstrate an innovative charging system. The primary innovation is WAVE's wireless charging pads, which allow completely hands-free connection for equipment to charge without a physical connection to the power source (i.e., charging with no plug). These systems are extremely efficient in their power transfer, and each 250 kilowatt (kW) system can charge two trucks at up to 125kW each. For this project, WAVE would install five systems at WBCT's equipment corral to charge 10 BYD battery-electric yard tractors while off-duty. Additionally, to increase runtime for the electric yard tractors, an opportunity charging station will be installed at a centrally located break facility on WBCT's terminal that can charge two yard tractors. This site will allow the zero emission tractors to receive a considerable charge (125 kW/hr) whenever there is a break opportunity, such as 30-minute lunch breaks, or between-shift changes. Finally, a battery-storage system will be installed at the base charging stations so as to minimize peak-demand charges that could result from a sudden influx of 10 high-power yard tractors all charging off the electrical grid at once.

Targeting yard tractors for this advanced technology charging demonstration maximizes the opportunity for increased penetration of zero-emission technology into the CHE source category. In 2016¹, yard tractors contributed a combined 32% of NO_x and 43% of PM₁₀ from the CHE source category at the Port of Los Angeles. Yard tractors are the most common type of CHE at the Port of Los Angeles, accounting for nearly half of CHE. They are also one of the most important and versatile types of CHE in today's terminal operations, and the ability to reliably integrate this equipment into terminal operation in a zero emissions configuration is something that is of great interest to operators. While WAVE has already demonstrated success in integrating wireless charging on electric top loaders through projects at APM Terminal and Eagle Marine Services, yard tractors are a great proving ground for the WAVE technology because there is very little space available on-board the units for additional components needed for the charging connection compared to other types of CHE. Successful

¹ Port of Los Angeles Inventory of Air Emissions – 2016, Table 5.7.

https://www.portoflosangeles.org/pdf/2016_Air_Emissions_Inventory.pdf Accessed February 6, 2018.

integration of the advanced charging technology within the tight confines of the yard tractor platform would validate the feasibility to migrate the WAVE technology to a broader portfolio of CHE, including side picks, stackers, etc.

Future steps envisioned for the zero emission pathway demonstration will include zero-emission drayage trucks that would move cargo off the terminal to nearby staging, or peel off yards, where cargo can be more easily retrieved by long haul truckers, thus improving efficiency at terminal gates. Several ongoing projects throughout the San Pedro Bay are demonstrating various types of zero emissions drayage trucks, alongside different charging infrastructure to power them. If this project is successful, it is reasonable to expect that trucking companies utilizing battery-electric drayage trucks will evaluate installing a similar inductive charging system to improve their operational efficiency. As an alternative to zero emission drayage trucks, the zero emission pathway could include cargo being moved off terminal via rail, and to that effect, the Harbor Department, along with partners VeRail and Pacific Harbor Line, recently applied for a grant from the California Air Resources Board (CARB) to expand an existing demonstration of a near-zero switcher locomotive to include zero-emission track mile capability within the San Pedro Bay Ports complex.

The direct benefits of the proposed project will accrue from the replacement of 10 WBCT's propane-fueled yard tractors with battery-electric yard tractors. The zero emission replacement equipment provides a 100% reduction for all tailpipe pollutants. The reductions in petroleum fuel use and tailpipe emissions are important from a localized emissions perspective, helping to reduce the pollution burden on local communities. However, additional indirect benefits reach beyond the discreet emission reductions that will result from the 12-month demonstration. The environmental benefits from successfully demonstrating the application of the proposed advanced induction charging technology, along with the system enhancements of opportunity charging and peak shaving, will have long-lasting and widespread benefits throughout the maritime industry as zero-emission CHE is fully commercialized.

Over the past few years the Harbor Department has begun several major demonstrations and deployments of zero-emission vehicles along the zero emissions pathway. As these projects have progressed, the critical need for major infrastructure upgrades and improved efficiency solutions has become apparent. The Harbor Department and our project team are very excited about the potential of this Zero Emission Freight Vehicle Advanced Infrastructure Project and proud to be able to submit this Application your consideration.

Operational Goals and Objectives

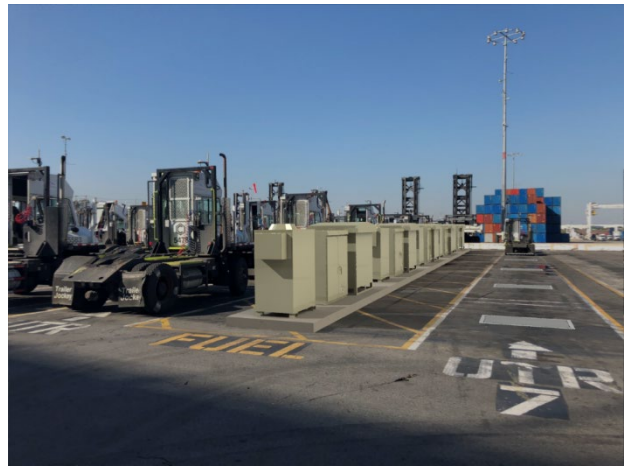
Project Goals

The primary goal of this project is to enhance market acceptance of advanced zero-emission vehicle technology in CHE applications by means of the successful demonstration of advanced battery-electric equipment charging technology. WAVE's inductive charging system is state of the art in the port terminal application, and successful demonstration of its feasibility, capability and scalability would accelerate implementation of zero emission CHE throughout the Port of Los Angeles and beyond to other ports. Figure 2 depicts the current layout at WBCT with the fuel lane taking up significant space between the yard tractor parking lanes. Figure 3 depicts the completed installation of the WAVE technology at WBCT. This artist rendering overlays the WAVE components onto the existing fuel lane, visually depicting the improved spatial layout, which is more efficient than the existing propane fueling layout (i.e., takes up less real estate).

Figure 2: Current Layout at WBCT



Figure 3: Improved Layout with WAVE (Artist Rendering)



The secondary project goal is to demonstrate the operational efficiency benefits from installing an opportunity charging station on a port terminal. As current models of electric CHE typically struggle to match their traditionally fueled counterparts, an opportunity charging station could solve the “range” concerns of terminal operators.

Finally, the project team expects that the proposed project will provide real-world operational and cost data that will support the future business case for an electrified terminal that focuses on feasible integration with terminal operations, while minimizing costs (i.e., battery storage system to facilitate peak shaving).

This project is designed to establish the framework for establishing what the Harbor Department believes to be the ideal system for a fully zero emissions container terminal. WAVE’s inductive charging systems provide greater flexibility for drivers and equipment managers without sacrificing charging time. WAVE’s connection time is just a few seconds to ramp from zero to full power and full power to zero, as compared to the time it takes to plug and unplug charge cords. The installation of strategically placed opportunity charging stations will improve overall efficiency in electric equipment operation. Battery storage and distribution systems can serve as a buffer between the grid and the equipment, allowing for greater overall control and reduced peak demand costs. Brought together, this project will provide solid evidence that a zero emissions container terminal is not only possible, but economically viable.

These technologies will be used in equipment that transports freight in the Port of Los Angeles by WBCT. A comprehensive 12-month demonstration will be conducted to collect and analyze real-world operating data to assess effectiveness and lifecycle cost of the WAVE inductive charging infrastructure in the port terminal environment. These data will document operational costs as well as project benefits including GHG and criteria and toxic pollutant emission reductions and reduced petroleum use from the 10 yard tractors powering at the WAVE charging stations. These improvements are expected to provide a direct benefit to the local disadvantaged communities surrounding the Port in the form of tangible emissions reductions, in addition to the long-term benefits of proving the efficacy of the zero emissions port terminal.

Project Objectives

The objectives of this Agreement are to support accelerated market acceptance of zero emission charging technology while achieving measurable reductions in port CHE petroleum use and emissions in accordance with the broader objectives of the Alternative and Renewable Fuels and Vehicle Technology Program and reducing port impacts on local disadvantaged communities. Specific measurable objectives are:

- Design and build advanced inductive charging technology for field demonstration in order to verify operational performance and to collect in-use performance data based on the operation of a 10-unit fleet of zero emission yard tractors.
- Design and build an Opportunity Charging Pad to allow zero emission yard tractors to continue operation beyond current operational expectations.
- Design and build the peak shaving battery storage system, and integrate it with the overall system.
- Document reductions in GHG and criteria pollutant emissions compared with conventional CHE performing similar terminal work.
- Document energy cost savings and the reduction in petroleum fuel consumption, compared to cost and fuel used in comparable propane powered equipment in operation at the terminal.

Project Implementation

The AID project's goals and objectives will be implemented via the task-by-task breakdown of activities planned to successfully complete the proposed project. The proposed SOW was informed by preliminary scoping by the Harbor Department's electrical engineering team, engagement about the project with POLA's sister city department, Los Angeles Department of Water and Power (LADWP), early review of layout options for the system locations at the WBCT terminal and an initiation of California Environmental Quality Act (CEQA) review requirements.

The project tasks were established to ensure that each of the above project objectives has the best opportunity for a successful outcome. The Harbor Department and WBCT worked with the demonstration partners, WAVE and BYD, to develop a comprehensive project plan (via both the SOW and Schedule) that reflects POLA's demonstrated success in meeting the milestones of similar grants and the team's clear vision of the specific tasks that need to be accomplished to implement this demonstration, laying the groundwork for larger scale deployments and successful commercialization.

The task sequence of the proposed SOW reflects a basic progression of activities we use to varying degrees in nearly all demonstration programs to maximize efficiency both in project duration and project cost. The project plan is provided in full detail in *Attachment 2, Scope of Work*. The project schedule provided in *Attachment 4, Schedule of Products and Due Dates* was carefully planned to ensure successful project completion based on the project team's experience with many complex advanced technology projects implemented by our team members over the past decade (see Section A for additional information on this experience.) The proposed project tasks include:

- Task 1 – Administration, including all project meetings, reports and documentation.
- Task 2 – Design and Development, including both the WAVE and BYD systems, as well as POLA's bid solicitation package for on-site construction for the project. The project will include remote monitoring and control, such that charge sequencing, power level, and performance tracking can be monitored.

- Task 3 – Build, Install and Commission, including final commissioning of the project equipment and receipt of the 10 yard tractors that will be used during the 12-month demonstration.
- Task 4 – Demonstration Data Collection and Analysis, including 12-months revenue service operation of the project equipment.

Successful implementation of this task progression will culminate in a 12-month demonstration to collect and analyze real-world operating data. These data will document project benefits including operational effectiveness as well as GHG and criteria and toxic pollutant emission reductions and reduced petroleum use, with a direct benefit to the local disadvantaged communities (DACs) surrounding the Port. Additional project detail is provided throughout the Project Narrative and Scope of Work (Attachment 2).

SECTION A: TEAM EXPERIENCE AND QUALIFICATIONS

The Harbor Department has carefully assembled an industry-leading team of OEMs and implementation partners to provide the Energy Commission with a scalable zero-emission equipment charging solution that is designed to enhance market acceptance. This team has the qualifications, expertise, and educational credentials to provide relevant solutions that are comprehensive and contain technically advanced work of the utmost quality. The Harbor Department's partners include West Basin Container Terminal (WBCT), Wave Wireless Inductive Chargers (WAVE) and BYD Motors, Inc. (BYD). The project team is well positioned to successfully implement the proposed SOW as documented on a task-by-task basis in Attachment 2.

Project Team Experience

Harbor Department: Extensive Technology Demonstration Experience

The Harbor Department has extensive experience developing, implementing, and administering technology demonstrations and projects that require detailed and active project management and coordination with technology providers, equipment and vehicle manufacturers, equipment operators, as well as other project stakeholders. The Ports of Los Angeles and Long Beach's landmark joint Clean Air Action Plan (2017 CAAP Update²) guides the Harbor Department in its commitment to reduce the health risks and air emissions associated with port-related operations, while allowing port development and growth to continue. A key element of the CAAP is its Technology Development Program (TAP), which accelerates the verification and commercial availability of new, clean technologies through evaluation and demonstration to move towards an emissions free port. Active since 2007, the TAP has considered numerous technology proposals covering a broad range of different port sources, ultimately approving over 35 projects for TAP funding. To date, 20 TAP projects support, or have supported, technology development and demonstration of reduced-emission, on-road and off-road cargo vehicles and equipment.

West Basin Container Terminal: Container Terminal Operations

West Basin Container Terminal (WBCT) is a leading global container carrier providing shipping services worldwide. As a major container terminal tenant of POLA, WBCT operates 180 propane fueled yard tractors at its Port of Los Angeles terminal. For this project, WBCT will operate 10 battery-electric yard tractors powered by the proposed AID charging equipment

² <http://www.cleanairactionplan.org/>

throughout the demonstration, working to integrate the advanced inductive charging technology into its current operations. The AID project demonstration units will be operated alongside the standard propane fueled yard tractors and WBCT will assist in collecting operability data for in-use container terminal service. This will provide a “real-world” evaluation of performance and costs of the WAVE technology that would be otherwise impossible to duplicate.

Wireless Advanced Vehicle Electrification, Inc. (WAVE)

WAVE is the premiere developer of inductive charging solutions for medium- and heavy-duty vehicles and equipment in the United States, and has demonstrated the capability to develop and integrate high power charging systems onto heavy-duty electric vehicles. WAVE has several 50kW wireless chargers for buses deployed throughout California, Texas, and Utah, and has recently introduced a 250kW solution. The first commercial deployment of the 250kW system is scheduled to be installed at the Antelope Valley Transit Authority in California in Q2 of 2018. Once released, the 250kW units will be the highest power commercially available standard for wireless charging of heavy-duty vehicles. WAVE has solidified a product platform with scalability up to a megawatt (MW) to accommodate future applications that are even more demanding.

WAVE has also recently begun transitioning its technology to additional markets, including two POLA projects to demonstrate zero-emission range extension technology by integrating wireless charging on electric top loaders. By partnering with Hyster-Yale Group, the largest forklift manufacturer in the US, WAVE is delivering a high power wireless charger for the first ever demonstration of an all-electric container handler at POLA’s APM Terminal, which is the largest terminal operator at POLA. These wireless chargers will significantly accelerate the adoption of zero emission electric trucks, allowing truck operators around POLA to meet their zero emission targets as well as allowing POLA to meet the new zero emission targets imposed by the State of California.

This includes the California Sustainable Freight Action Plan³ (part of Executive Order B-32-15⁴) target to transition to zero-emission technology by deploying over 100,000 freight vehicles and equipment capable of zero-emission operation. Targets also include those outlined in SB 32⁵, which codifies a 2030 GHG emissions reduction target of 40% below 1990 levels.

For this project, WAVE has assembled a highly-experienced team with a large portfolio of successful commercial deployments across the country. Some of the notable key innovations include complete “hands-free” wireless charging initiation, automated and safe charging shutdown integrated with key vehicle and charger parameters, and novel pad designs that enable scalability to extreme high power. WAVE’s facilities include a test bay reserved for high voltage testing that can accommodate an entire vehicle plus pads and primary electronics for testing the integration of those system components. WAVE has test equipment capable of measuring efficiencies and probing high voltage nodes to observe behavior of the electronics. Further, testing of thermal properties of the system can be done on-site at WAVE. Specific relevant projects that have received State of California grant funding for WAVE technology include:

³ http://www.casustainablefreight.org/documents/PlanElements/Main%20Document_FINAL_07272016.pdf

⁴ <https://www.gov.ca.gov/2015/07/17/news19046/>

⁵ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32

- California Energy Commission GFO-16-604 (Sustainable Freight Transportation Projects): WAVE will be delivering a 250kW wireless charger to support the South Coast Air Quality Management District's plan to deploy and demonstrate a pre-commercial Hyster zero-emission electric top handler at APM Terminals at POLA.
- California Air Resources Board Grant Solicitation for Off-Road Advanced Technology Demonstration Projects: WAVE will deliver a 250kW wireless charger, compatible with an electric top loader with a fuel cell range extender and wireless charging for demonstration at Eagle Marine Services at POLA. Preliminary award pending grant agreement negotiations.

BYD Motors, Inc.: Electric Vehicle and Zero Emission Technology Specialists

BYD Company Limited (BYD) is a global original equipment manufacturer (OEM) of battery, consumer product, and vehicle technologies with more than \$17 billion in revenue, 12,000 patents and 20,000 engineers worldwide. BYD's North American headquarters is in Los Angeles and their manufacturing facilities are in Lancaster, California. The company was founded on the strength of its battery products—BYD manufactures approximately 25% of the world's rechargeable batteries for technologies ranging from consumer products to vehicles and energy storage systems. BYD's iron phosphate (Fe) battery was purpose built for vehicle electrification and has gained a 7-8% increase in energy density year over year, for the last five years.

More than just a battery company though, BYD is the world's largest producer of battery electric buses, with more than 35,000 buses in operation around the globe. The next focus area for BYD is electric trucks and to date the majority of BYD's North American sales are the port market.

BYD has installed over 300 megawatt-hours (MWh) of battery storage systems across the globe, including 20 MWh in the United States. Past installations have been used for peak shaving, frequency regulation, and backup systems. The Fe batteries in the storage systems maintain their charge longer than other battery chemistries, giving BYD installations unprecedented lifespans.

BYD's electric truck division is proud to be partnering with the CEC on several projects, including:

- GFO-15-604, San Diego Port Sustainable Freight Demonstration Project: BYD is demonstrating 3 electric yard tractors and 2 electric drayage trucks with Dole, Pasha, and Cemex. All of the vehicles for this project have been built ahead of schedule and are scheduled to be deployed in the first half of 2018.
- GFO-15-604, Port of Los Angeles Advanced Yard Tractor Deployment and Eco-FRATIS Drayage Truck Efficiency Project: BYD is demonstrating 5 electric yard tractors with the Everport terminal. These vehicles have been built ahead of schedule and have been approved by the customer. They are scheduled to be deployed by end of March, 2018.
- GFO-16-604, Port of Long Beach Zero-Emissions Terminal Equipment Transition Project: BYD will be building 12 electric yard trucks for demonstration at the ITS and LBCT terminals.

- GFO-16-604, Port of Long Angeles' Everport Advanced Cargo Handling Demonstration Project: BYD will be building 3 electric yard trucks and 2 electric top handlers for the Everport terminal.

These projects will serve to validate BYD's electric yard tractors for marine terminal environments and any lessons learned from these demonstration projects could easily be incorporated into the vehicle design for the 10 electric yard tractors for WBCT, should BYD be selected as the yard tractor supplier. Also, the same WAVE charging method that is proposed in this project could be used to charge the electric drayage trucks and top handlers that are being demonstrated in the other CEC projects.

Project Team Qualifications

An expert team of individuals has been assembled from the Harbor Department, WBCT and their OEM project team, WAVE and BYD. An overview of key team member's background and qualifications is provided below and a resume was uploaded to the Energy Commission's online submission system for a more detailed summary of each team member's qualifications.

Port of Los Angeles

Christopher Cannon (Chief Sustainability Officer) offers more than 26 years of experience in the environmental services industry, including 20 years as a technical manager of large multi-jurisdictional environmental projects. His experience includes serving as the Director of the Harbor Department's Environmental Management Division (EMD) and the Port's Clean Truck Program. He will have overall responsibility for the project, and will be supported by the Harbor Department's Environmental Management Division's Project Manager, Jacob Goldberg.

West Basin Container Terminal

Willy Won serves as the Regional Maintenance & Repair Manager for Ports America with his office at WBCT. He will be WBCT's primary contact for this proposed project. Willy offers almost 19 years of equipment fleet management and terminal operations experience. Willy's role will be to identify the location of the charging infrastructure along with managing the data collection and maintenance requirements for the new zero emission yard tractors.

Wave Wireless Inductive Electric Chargers (WAVE)

Michael Masquelier has a Master's Degree in Electrical Engineering from Arizona State University and a Bachelor's Degree in Electrical Engineering from University of Illinois. He has successfully led products from groundbreaking research through commercialization. Michael has experience in prototyping, operational design, and manufacturing levels. He is currently Chief Executive Officer (CEO) of WAVE. Michael is co-chair of the SAE J2954-2 Wireless Charging of Heavy Duty Electric Vehicles, so he is in a position to facilitate communications with the standards body; this is important to ensure the project installation meets all applicable codes and standards.

Marcellus Harper is WAVE's Lead System Architect and is responsible for managing the design effort and deployment of WAVE's systems, including writing real time embedded systems code and implementing design controls. Marcellus has experience in system level hardware and software design as well as vehicle integration.

BYD Motors, Inc.

Jack Symington is a graduate from the University of Michigan with degrees in both Business Administration and Economics. He has previously executed projects in the consulting and

policy research industry, giving him experience organizing multi-faceted projects. Jack is BYD's Project Manager responsible for the administrative and business side of all grant-funded projects and those pertaining to specialty vehicles.

Christiaan Petrie is a graduate of California Polytechnic State, with certificates in project management and sustainable business from UCLA and UCSD. Christiaan has spent his entire career in alternative energy, developing, planning, and executing solar and storage projects with commercial and industrial applications. These experiences included organizing land acquisition, structuring PPAs, and coordinating interconnection. Christiaan is BYD's lead project manager for all Battery Storage System projects.

A.1: Describe how the project team's experience and qualifications are well-rounded and suitable to the tasks described in the proposed Scope of Work.

The above introduction, supported by the uploaded resumes, summarizes the project team and its key personnel roles and responsibilities. The key personnel were selected for this team based on their ability to expertly carry out the tasks of the proposed scope of work that is consistent with the technical approach summarized throughout Section A. The partner OEMs are critical members of the team, without which the Harbor Department would not be able to conduct the proposed demonstration. These OEMs are established and well-respected manufacturing companies, with experienced engineering and product development professionals well-matched to this project and technical approach. See also Section A.2 for a summary of projects demonstrating that the Harbor Department's experience is well-matched to implement the proposed scope of work for this project. In addition, each team is supported by additional well-qualified and experienced experts. Resumes or Bios for the below individuals have been uploaded with our Application in order to document our team's depth of experience. Below is a summary of each team member's lead and support staff.

Port of Los Angeles

- Jacob Goldberg - Port of Los Angeles Environmental Specialist II will serve as Technical Project Manager for this project.
- Shaouki Aboulhosn, PE – Senior Electrical Engineer II will manage engineering and design for the project equipment charging infrastructure. Shaouki will also manage the contractor selected to conduct on-site construction to prepare the site.

West Basin Container Terminal

- Willy Won serves as the Regional Maintenance & Repair Manager for Ports America with his office at WBCT. He will be WBCT's primary contact for this proposed project. Willy offers almost 19 years of equipment fleet management and terminal operations experience. Willy's role will be to identify the location of the charging infrastructure along with managing the data collection and maintenance requirements for the new zero emission yard tractors.

Wireless Inductive Electric Chargers (WAVE)

- Michael Masquelier, CEO: will lead the WAVE team providing project management and technical support. Marcellus Harper, System Architect: Marcellus is assigned to the project to ensure smooth integration of the WAVE technology onto the fleet of 10 yard tractors as well as the integration of the charger with the electric utility feed.
- Evans Griego, Lead Mechanical Engineer: Evans leads the mechanical system design and validation specifications for cooling systems, electronic enclosures, cabling, conduits, primary and secondary pad sub systems.

- Ryan Calder, Senior Electrical Engineer: Ryan is an expert in power electronics. He is responsible for construction planning for installation of new chargers and is a key contributor to development of WAVE 250kW wireless charger.
- Steve Ball, Principal Systems Engineer: Steve develops control systems for high power wireless inductive charging systems including Android interfaces, Linux systems, and interfaces for multiple OEM vehicle CAN networks. He is also experienced in field installation and system level validation at site.
- Robert Eisert, Engineering Technician: Robert is skilled in all aspects of component evaluations, circuit prototyping, printed circuit board design and complete documentation.

BYD Motors, Inc.

- Jack Symington, Project Manager, Trucks Division: Jack is a key account manager for BYD's strategic projects and is the lead for BYD on this project.
- Christiaan Petrie, Project Manager, Energy Storage: Christiaan is BYD's project manager for energy storage and will be the lead for all scheduling, permitting, and integration efforts related to the BSS.
- Luke Zheng, Director of Project Management, Trucks Division: Luke is a trained engineer and is the point of contact for the design, manufacturing, and performance of the BYD yard tractors.
- Michael Li, Product Development Engineer Electrical, Trucks Division: Michael is the lead electrical engineer for BYD's electric truck division and will be the point of contact for all electrical integration efforts with WAVE.
- Lingjia Tao, Mechanical Engineer, Trucks Division: Tao is a mechanical engineer and will be the lead contact for designing the layout of the WAVE receiving pad and rectifier on the BYD yard tractors.
- Jacob Panachaveettil, Testing & Validation Engineer, Trucks Division: Jacob is the lead testing engineer for BYD's electric trucks in North America and will be responsible for testing the electric yard tractors prior to delivery and throughout the demonstration.
- Larry Goemann, Customer Support Manager: Larry is the primary point of contact for customer training and any issues that arise during the demonstration for the yard tractors.
- Michael Liu, North America Regional Manager, Energy Storage: Michael is BYD's business manager for energy storage in North America and will be the sales and design lead for the BSS.

A.2: Describe demonstrated ability to meet project deadlines and milestones.

The Harbor Department's ability to meet project deadlines and milestones is demonstrated by its rich history of successful implementation of a wide variety of similar major projects. The Port currently supports or has supported technology development and demonstration of increasingly advanced on-road drayage truck and off-road CHE technologies over the past decade. Sample Technology Advancement Program (TAP) projects relevant to this proposed project are summarized below:

- Near-Zero Emissions Locomotive Demonstration Project – This TAP demonstration project is being conducted with SCAQMD, US EPA and the Port of Long Beach. The objective is to modify an existing diesel locomotive to operate on CNG to achieve near-zero emissions. The Harbor Department applied to CARB for a grant to add zero-emission track mile capability to this project (pending).
- Foss Maritime Green Assist™ Hybrid Tugboat – In 2009, the Harbor Department contributed to the Foss Maritime Diesel Electric Hybrid Tugboat project. Christened the Carolyn

Dorothy, the hybrid tug reduces particulate matter (PM), nitrogen oxide (NOx) and carbon dioxide (CO₂) by 73%, 51% and 27%, respectively. To date, the Carolyn Dorothy has accumulated more than 8,000 operating hours. The project was funded in part by a \$1,000,000 grant from the CARB's AB 118 Air Quality Investment Program.

In addition to the TAP, the Harbor Department is active outside the TAP to further demonstrate new technologies in port applications. Relevant examples include:

- Port of Los Angeles' Everport Advanced Cargo Handling Demonstration Project – In 2017, the Energy Commission awarded \$4,524,000 for the demonstration of two zero-emission top handlers and three next-generation zero-emission yard tractors. The yard tractors will be “fueled” by a state of the art Automated SmartCharging System (ASCS) to demonstrate a safe and efficient future approach for charging zero emission CHE. All subrecipient agreements are fully executed and the equipment production has begun.
- The Port of Los Angeles Advanced Yard Tractor Deployment and ECO-FRATIS Drayage Truck Efficiency Project – In 2016, the Energy Commission awarded \$5,833,000 for the demonstration of 25 advanced technology on- and off-road port vehicles and equipment. This project is well-underway with all sub agreements executed. Five BYD battery-electric yard tractors have been built and are awaiting infrastructure completion, the order for Capacity's 20 renewable natural gas (RNG) fueled yard tractors has been placed and initial design work is underway. The first two units will be delivered in May 2018 with the last unit scheduled for July 2017 delivery. Fueling infrastructure for the natural gas yard tractors is currently in the permitting stage and is expected to be fully operational well before the first RNG yard tractor is delivered.
- The Port of Los Angeles Green Omni Terminal Project – In 2016, the California Air Resources Board awarded \$14,500,400 for a multi-unit CHE demonstration, that include four electric yard tractors, two electric (Class 8) on-road trucks, three electric hi-tonnage forklifts retrofits, and an at-berth vessel emission control system. An additional project component is the construction of a solar powered microgrid, which will be supported by 2.6-megawatts of backup battery storage intended to provide critical power to the charging units for the plug-in electric equipment as well as terminal systems during a grid power outage. All aspects of this project are well-underway.
- Electric Yard Tractor Demonstration Project – In 2013, the Harbor Department was awarded \$1 million from ARB's AB 118 Air Quality Improvement Program to integrate TransPower's electric drive technology into two off-road yard tractors. The two yard tractors are currently being demonstrated by port tenants. The project was completed in May 2015.
- Shore Power Program – In 2012, the Harbor Department was awarded \$23.5 million by ARB to co-fund shore power installation. All 10 berths were completed by November 2014.
- Eco-Crane – U.S. Environmental Protection Agency (USEPA) awarded a \$731,298 Emerging Technologies grant to the Harbor Department to successfully demonstrate the Eco-Crane, a diesel-electric hybrid rubber tire gantry crane.
- Early Shore Power – USEPA awarded \$1.2 million in June 2010 to supply electricity generated from a Flex-Grid System to container vessels while at berth. The final report was accepted by USEPA.
- Vehicle Retrofits – In 2009, USEPA awarded \$2 million from the American Recovery and Reinvestment Act to retrofit 27 vehicles including harbor vessels, trucks, sweepers, loaders, cranes, and forklifts. The final report was accepted by USEPA.

The Harbor Department has six active cooperative agreements with the Federal Emergency Management Agency (FEMA) valued at \$3.75million, as well as 22 other federal and state

grants. All government grants active at this time total nearly \$160 million. The Harbor Department is consistent in its quarterly reporting and has successfully completed cooperative agreements with approved final reports submitted on time. In addition, the Harbor Department has a long history of implementing successful government grant partnerships.

These include:

- The Air Quality Mitigation Incentive Program (AQMIP), a \$29 million program that provided grant funding to port operators to reduce emissions that are surplus to existing regulations or other mandates. A wide range of projects were implemented under the AQMIP, including marine vessel and CHE repowers, truck and non-road equipment replacements, diesel emission reduction retrofits, and a number of innovative research and development projects.
- The Vessel Main Engine Fuel Incentive Program, which provided monetary incentive for the use of low-sulfur marine fuel in vessel main engines prior to state regulation.
- In July 2012, the Harbor Department launched the Environmental Ship Index Program to provide incentives to ships that obtain certain clean ship scores using an international rating system developed through the International Association of Ports and Harbors and World Ports Climate Initiative.
- The Harbor Department successfully manages the Vessel Speed Reduction (VSR) Program, an incentive program for vessels to reduce speeds in the designated VSR zone. In 2017, the compliance rate was 92% at 20 nm and 84% at 40 nm.

The Harbor Department, as part of CAAP, oversees the Clean Truck Program, which calls for drayage truck owners to replace about 17,000 polluting trucks working at the ports, with the assistance of a port-sponsored grant or loan subsidy. The Harbor Department has contributed close to \$70 million in funding to the Clean Truck Program, including grants.

These programs represent a voluntary, collaborative effort between Harbor Department, equipment owners and technology providers that spans decades. In addition, these projects demonstrate the Harbor Department's ability to successfully implement cooperative agreements, manage resources, meet reporting requirements, evaluate projects/initiatives, and document progress. Its extensive history implementing grant projects from both sides (grantor and grantee) uniquely positions the well-rounded Harbor Department for this proposed project in that it has both managed and implemented technology development and demonstration programs for zero-emission vehicles and equipment.

A.3: Describe demonstrated ability to respond to and mitigate project delays and issues that may arise during the proposed project.

The Harbor Department will hold weekly, bi-monthly or monthly meetings with the project team throughout the project term, with frequency determined based upon project stage. Active communication with the team will ensure that potential delays or issues are identified early and plans can immediately be made to address delays or issues. The team member organizations are staffed by technology experts that are ready to provide additional support should it be needed for any reason. Key personnel have worked with their companies for a number of years, indicating low turnover at our partner organizations.

WAVE, the advanced inductive charging technology manufacturer, and BYD, the battery-electric technology provider for the battery storage system are both well-capitalized OEMs that are in good standing with vendors, thus no delays are expected with regard to sourcing or production.

Furthermore, each has local personnel support for high-priority projects like this one. WAVE currently has five projects with customers located in the LA area. This allows for easy deployment of local support staff already available in the area. Any delays will be addressed by dynamically allocating personnel resources to make sure that this project is well-supported and on schedule, and the companies are experienced with developing customized emerging battery charging equipment and vehicle technologies for grant-funded initiatives and customer demands alike.

A.4: If Applicant has received an award(s) from a previous Energy Commission solicitation, Applicant must describe how the requirements of the agreement(s) have been successfully fulfilled or are being successfully fulfilled.

In 2016, the Harbor Department was awarded Energy Commission funding in the amount of \$5,833,000 for the *Port of Los Angeles Advanced Yard Tractor Deployment and ECO-FRATIS Drayage Truck Efficiency Project*. All sub agreements are executed and work is underway. All original project partners are fully committed to the project and there have been no changes to the match funding commitments or the scope of work. The Project Kick-Off meeting was held on January 31, 2017 at the Everport Terminal, five BYD battery-electric yard tractors have been built and are awaiting infrastructure completion, the order for Capacity's 20 renewable natural gas (RNG) fueled yard tractors has been placed and initial design work is underway. The first two units will be delivered in May 2018 with the last RNG unit scheduled for July 2017 delivery. Fueling infrastructure for the natural gas yard tractors is currently in the permitting stage and is expected to be fully operational well before the first RNG unit is delivered.

In 2017, the Harbor Department was awarded Energy Commission funding in the amount of \$4,524,000 for the *Everport Advanced Cargo Handling Demonstration Project*. This project is just getting underway with all sub agreements executed. The objective of this project is the demonstration of two zero-emission top handlers and three next-generation zero-emission yard tractors. The top handlers will be charged with standard infrastructure and the yard tractors will be "fueled" by an Automated SmartCharging System (ASCS). All subrecipient agreements are fully executed and the equipment production has begun and the project is on schedule and within budget.

In addition, please refer to the above discussion titled "Project Team Experience" for a summary of Energy Commission awards for additional projects that include team members WAVE and BYD (pages 7 and 8).

SECTION B: INNOVATION

B.1: Describe how the proposed infrastructure project will lead to strategic, cost-effective solutions for future deployment of electric or hydrogen infrastructure for freight vehicles.

This infrastructure project provides a blueprint for an innovative charging strategy that can be replicated in a few different ways:

- Demonstrate the feasibility to convert all yard tractors at POLA to zero emission technology.
- Interoperability and standards based design will facilitate future deployments in other CHE types.

- The project is a template to be replicated at other terminal operators.
- The project considers ACES (autonomous, connectivity, electrification, shared) framework: allowing port operators to keep ahead of emerging/disruptive technologies. Wireless charging of electric CHE paves the way for autonomous flow of information, ease of operation, and scalable connected systems.

Additional important detail regarding the technology market is provided in the Problem Statement section of the Scope of Work (Attachment 2, barriers and challenges).

This project incorporates a peak shaving strategy to minimize the extra cost of demand charges in the form of the BSS that will be designed by BYD. Understanding and addressing demand charges is becoming increasingly important as the volume of electric-powered equipment is placed in service.

B.2: Demonstrate how the proposed project incorporates on-site renewable integration.

This project does not propose on-site renewable power generation. While several options were investigated, at this time the renewable systems do not provide enough power to feed the inductive charging system. WAVE is coordinating with several solar companies to find compatible solutions. Discussions with a commercial provider of photovoltaic integrated with stationary storage and a recently released level 3 charger, indicate that a next generation system that could be deployed in this style of operation, can provide the 480V 3-phase input and sufficient battery capacity to integrate with WAVE in the next generation product.

B.3: For ITS projects, describe how the ITS is innovative, supports increased freight efficiency, and includes enhancing features that are not found in current demonstrations of ITS technologies.

This project does not include an ITS component.

SECTION C: IMPLEMENTATION

The port has assembled an industry-leading team with direct experience with a number of related technology development and demonstration programs. The tasks described in the scope of work are based on multiple successful prior deployments of related systems, thereby minimizing the risk to project success. For the project demonstration, zero-emission yard tractors will be integrated into the existing fleet for in-use testing of the WAVE inductive charging technology, with opportunity charging and BYD's BSS for peak shaving at WBCT during routine revenue service operation. By incorporating these technologies into one integrated demonstration, this project will provide a scalable and replicable model for sustainable goods movement.

C.1: Applications must include information documenting vehicle populations that will utilize infrastructure upon installation and include plans for future vehicle acquisitions beyond project closeout. Applications must also include information documenting total number of freight vehicles within the fleet that have the potential of being replaced with a plug-in hybrid electric vehicle (PHEV) or zero-emission vehicle (ZEV).

As documented in the attached letters of support, a joint project between POLA, SCAQMD, WBCT and US EPA will provide full funding for 10 zero emission yard tractors. The units will meet WBCT specifications that result in an electric tractor that meets or exceeds the current specifications of the current tractor technology. Upon successful completion of the

demonstration, WBCT intends to continue to operate the project equipment for its full useful life, which is anticipated to be 10 years. Existing and new funding programs, including the Carl Moyer Program, the Hybrid Vehicle Incentive Program and the planned Zero Emission Freight Voucher Program are examples of funding assistance that WBCT will look to access for support in the procurement of zero emission equipment to replace existing petroleum fuel CHE in operation at the terminal.

According to the Port of Los Angeles' Inventory or Air Emissions for 2016 (Table 5.3), there are 2,202 pieces of CHE in operation at POLA terminals, of which 1,048 are yard tractors. A successful outcome of this project will support the continued transition of port terminal operations, beyond WBCT, to zero emission technology. Efficient charging strategies that balance capital and operating costs, along with agency grant funding programs to offset initial incremental costs of infrastructure and equipment technology have the potential to reach 100% zero emission operation at POLA terminals, which is a key target under the 2017 CAAP Update. As noted in Section A, this project will result in valuable information that will support a transition to zero emission CHE fleets across California ports, but the WAVE technology's continued implementation will also support growing use of the technology in drayage truck applications at ports and warehouse distribution locations throughout California. According to POLA's 2016 Emissions Inventory (Table 7.5), over 6.4 million miles of on-terminal heavy-duty truck operation has the potential to transition to zero emission operation.

Beyond the San Pedro Bay Ports, BYD estimates the total market for yard tractors is 5,000 units per year in North America with 10% for ports, 20% for railyards, and 70% for distribution centers. These yard tractor markets have strong potential to transition to zero emission operation. Successful completion of demonstrations such as the proposed project will accelerate this transition, as operational experience and real-world cost data are analyzed to show advanced equipment charging strategies enhance the market potential of the zero emission operation.

C.2: Describe how the equipment to be deployed is appropriate for the proposed project and leads to successful deployment of ZEV freight vehicles. Applications shall describe equipment manufacturers, connector/refueling standards, fuel delivery methods (for hydrogen projects), security measures, and safety standards.

WAVE's advanced inductive 50kW wireless charging technology has been on the market with over five years of operation in three states. WAVE also has a 250kW design in final production qualification that is on target to be deployed in California in Q2 of 2018. The proposed design, including opportunity charging and peak shaving BSS, considers the rigorous port terminal operating environment and specifically meets WBCT requirements to ensure the technology will meet operational needs on a day-in, day-out basis. Further, the proposed technology is well-matched to the port terminal environment since it will provide wireless, fast, safe charging in a smaller footprint than the current fueling method (wet-hose fuel lane) in use today at WBCT.

WAVE high power chargers will be standards-based (SAE J2954-2) and interoperable with multiple vehicle types and OEM's. In terms of safety and security, compared to petroleum fuel, utilizing WAVE technology means there are no flammable materials to handle and no potential spills to be concerned about. Also, compared to plug in charging, WAVE's wireless technology does not expose operators to High Voltage DC and has no connectors or cables that could be damaged or fail.

The equipment manufacturers for this project include WAVE, BYD and a yard tractor manufacturer that will be specified under a separate grant, but is listed as “BYD, or equivalent”. Detailed descriptions of the equipment manufacturers’ capabilities and experience are provided in Section A. It should be noted that the zero emission yard tractors used in this project should be the equivalent of a third-generation design, intended to successfully replace petroleum-fueled designs on a one-for-one basis. As mentioned earlier, yard tractors represent nearly half of all CHE in use at the Port; hence, it is the perfect testing ground for this innovative charging technology.

C.3: Describe how the tasks in the Scope of Work and the dates in the project schedule are complete, sequential, and will lead to successful and scheduled completion of the project.

The proposed Scope of Work, as presented in Attachment 2, Scope of Work, allocates project resources for the engineering design and development, as well as manufacturing of the WAVE induction charging systems (ten spaces in the equipment corral, and two spaces for opportunity charging), as well as BYD’s Battery Storage System, under Task 2. Task 2 will also include POLA Engineering’s efforts to assess available power for the project, design the installation, develop construction plan and subcontract the construction work via a bid solicitation process.

Task 3 is allocated to managing the installation commissioning of the charging infrastructure, as well as the commissioning of the 10 battery-electric yard tractors that will use the infrastructure. These high level tasks are designed to ensure a logical separation between engineering design and development of the equipment and the installation and commission of the project equipment. Prior to the project kick-off meeting, detailed GANTT chart(s) will be submitted to further detail and track the project approach. Please refer to Attachment 4, Schedule of Products and Due Dates, for specific project deliverables and due dates. These dates balance the required design and build time with the time needed for the 12-month equipment demonstration, ensuring completion well in advance of March 31, 2022.

C.4: Applications must describe the proposed project site and document site control. Site control includes, but is not limited to: leases, ownership, or access rights.

The proposed project will be implemented in its entirety on POLA property under the day-to-day control of West Basin Container Terminal. Project partners, including POLA staff, WAVE and BYD will be granted onsite access in accordance with POLA and terminal security protocols during the project term to provide technical and operations support for the advanced technology electric vehicle charging equipment. POLA and its project partners will also conduct onsite vehicle and infrastructure monitoring and data collection in coordination with WBCT. POLA engineering has determined sufficient power supply is available from LADWP to support the project equipment. The infrastructure equipment is being designed such that it will integrate with existing operations at WBCT, specifically; these units will not require opportunity charging to meet daily shift requirements, but an innovative aspect of this project is to provide an area for two opportunity charging “stations” on the terminal near the break area. Under Task 2, the fuel supply availability will be finalized and design specifications will be developed to match project equipment charging and operational requirements. At WBCT, the project yard tractor energy consumption is projected to average 33,440 kWh per unit. The WAVE chargers for the yard tractors are 125 kWh per unit. During the demonstration, fuel consumption and cost of electricity, as well as operational metrics detailed in Task 4 will be included as part of the Data Collection Plan.

C.5: Include information documenting progress towards achieving compliance under the California Environmental Quality Act (CEQA). If CEQA compliance has not been obtained, applications must include a schedule to complete CEQA activities for the proposed project.

The proposed action is approval of agreements for testing and demonstration of charging technology that will support the in-service demonstration of 10 zero emission yard tractors. Charging technology will include inductive charging, as well as opportunity charging stations for equipment charging during short shift breaks. As an activity involving data collection, research and resource evaluation that does not result in a serious major disturbance to an environmental resource, the Director of Environmental Management has determined that the proposed action is exempt from the CEQA in accordance with Article III, Class 6 of the Los Angeles City CEQA Guidelines.

C.6: Applications must include information documenting planned equipment service support that will be deployed to address issues in the field when they arise.

The proposed projects will benefit from longstanding customer support programs provided by the project partners. WAVE is experienced in providing timely field service support to customers in the Los Angeles area from Salt Lake City, Utah. WAVE is also actively pursuing an LA county focused office to further enhance support. A trusted network of local subcontractors is also available to provide support as needed.

BYD has a Southern California Customer Support Manager for trucks, Larry Goemann, who would be the first point of contact for all support services. The company also has a team of After Sales engineers, who are based in Lancaster and can resolve any BYD issues. Parts will be stocked at the Lancaster facility. This combined local team is available 24-7, and will provide responsive phone and in-person support for any issues that arise. The team will also be developing commercial-scale maintenance schedules based on in-use operations, and will be highly engaged with data monitoring and ongoing service. This team will also help train WBCT technicians on standard maintenance practices to support long-term operations.

C.7: Applications must discuss how proposed equipment will continue to operate beyond the term of the Energy Commission's funding agreement.

Following successful demonstration, the OEM team members will transfer ownership of the equipment to WBCT, where the project equipment will continue to operate in on-terminal container movement operations. WBCT will assume responsibility for the ongoing operation and maintenance of WAVE's advanced inductive charging technology, as well as the zero emission yard tractors for the useful life of the equipment.

SECTION D: BUDGET

D.1: Applications must discuss how the proposed budget implements cost-saving strategies that reduce the amount of Energy Commission funding necessary for project completion.

An important cost-saving strategy this project provides is the commitment of \$3,405,784 in cost sharing, over 30% of the total project costs. This exceeds the minimum cost share requirement for public agencies by 30%. The project is very cost-effective for the Energy Commission since no project team costs are allocated to indirect costs or profit. Also noteworthy is that POLA's Environmental Management Division (EMD) and WBCT are not charging to the project any administrative, labor or overhead costs for project management as the Recipient or subrecipient demonstration partner, even though significant costs will be incurred in order to successfully implement the project. Both WAVE and BYD have significant development (R&D) costs that are

not included in the project pricing, and are justified through a larger, long-term business plan for the respective companies related to the technologies. Fundamentally, these R&D costs are being absorbed through the wider corporate business model and are not included in this project budget.

D.2: Applications must demonstrate that Administration and Overhead expenses are minimized.

As noted in Section D.1, POLA's EMD and WBCT are not claiming any administrative or overhead costs to participate in the project as the Recipient or subrecipient demonstration partner, even though these costs will be incurred in order to successfully implement the project; therefore Administration and Overhead expenses are minimized to \$0.00!

D.3: Applications must explain why state funds are necessary for the successful completion of the proposed project. Applicant must describe all funding options that were considered for the project, including SB 350 funding (if applicable).

This advanced infrastructure project will not be implemented without the requested Energy Commission ARFVTP funding. The barriers and challenges detailed in the project Scope of Work (Attachment 2) document the need to support the demonstration of this state of the art advanced charging infrastructure. This demonstration will allow the proposed technology to be tested by a marine terminal operator in order to address uncertainty regarding advanced technology performance while minimizing investment risk for the terminal. It is fully expected that successful demonstration of the proposed advanced technology will accelerate the adoption of zero emission CHE at the Port of Los Angeles, other California ports, and beyond.

ARFVTP funding under this GFO for pre-commercial *infrastructure* at the ports is unique and not available from other sources at this time⁶. In fact, this is the first funding program that supported infrastructure without also requiring the inclusion of vehicles or equipment as a direct part of the project scope. In addition, the project partners are providing substantial resources, both as official and unofficial match, to the proposed project and are not able to increase their share of match funding. Finally, it is important to keep in mind that equipment operators have already invested tens of millions of dollars to comply with stringent CARB regulations (i.e., Cargo Handling Equipment Regulations, Drayage Truck Regulation, Heavy-Duty Truck and Bus Regulation, etc.), achieving impressive emissions reductions from these vehicles and equipment. The cost of zero emission technology, which not only requires vehicle and equipment technology, but significant infrastructure modifications, is extremely expensive. The cost-effectiveness of reducing the last increment of equipment emissions is harder and harder to justify. Energy Commission and other government funding assistance is critically important to support efforts to clean-up the last increments of tailpipe emissions, and reduce petroleum fuel consumption – providing valuable GHG reductions.

D.4: Applications must include information documenting the source, type, availability, and amount of match share funds committed to the proposed project.

As documented in the Letters of Commitment uploaded to the online system, the following project stakeholders commit to:

- Port of Los Angeles - \$312,500 in cash match for the ten electric yard tractors that will demonstrate the project equipment;

⁶ The 2017 revision to the Carl Moyer Program Guidelines expanded eligibility to include infrastructure projects, but at this time, such funding is not available to the Port of Los Angeles (SCAQMD's program is not currently open).

- West Basic Container Terminal - \$1.1 million in cash match to cover WBCT's share of the 10 zero emission yard tractors they will operate using the proposed infrastructure. No labor is being charged to the project to complete the one-year demonstration of these units.
- WAVE - \$126,885 in-kind labor match funding
- BYD Motors, Inc. - \$78,889 in-kind labor match funding
- SCAQMD – SCAQMD received \$1,344,750 from US EPA for the ten zero emission yard tractors that will operate in this project's demonstration. SCAQMD is contributing an additional \$442,750 to the cost of these units. The combined cash contribution from SCAQMD and US EPA for the electric yard tractors is \$1,787,500⁷.

Combined, the above project team match commitments provide 30% cash and in-kind match funding, which exceeds the minimum Energy Commission requirement for this program by 30%. There are significant engineering and development costs being contributed to this project that are not being claimed as match funding. These costs represent the project team's commitment to the project and the anticipated market potential for the technology in port applications.

SECTION E: ENVIRONMENTAL AND ECONOMIC BENEFITS

Demonstration of this innovative battery-electric CHE solution will result in direct and positive benefits to the goods movement industry and the local communities impacted by freight operations. In the longer term as the technology's market share grows, the proposed technology has the potential to reduce congestion; improve freight flows; promote safety, mobility, reliability, service life, environmental protection, and sustainability; and positively impact air quality and livability in cities and urban areas surrounding the transportation network.

E.1: Describe how the proposed project will benefit disadvantaged communities (DACs). Applicants should use the CalEnviroScreen 3.0 Tool to identify DACs and provide all zip codes for the proposed project.

The project equipment will be used solely at the WBCT Terminal (zip code 90731), in the heart of the Port of Los Angeles. As discussed above, the zero-emissions equipment to be deployed will perform identical duties to liquefied petroleum fueled-equipment already routinely utilized at the WBCT terminal, resulting in a net improvement in emissions at the Port, which benefits adjacent neighboring communities. The emission reduction benefits of this project will have a direct positive impact on the WBCT workers and adjacent neighbors by reducing harmful petroleum fuel emissions at the Port and the surrounding local community. According to the Office of Environmental Health Hazard Assessment's CalEnviroScreen3.0 tool, the communities closest to the Port score in the highest CES Deciles, indicating they are designated as the most impacted Disadvantaged Communities. The project site has proximity with a number of census tracts that are inside zip code 90731 and zip code 90744, directly adjacent to the project site. CalEnviroScreen3.0 results for the project location census tract, as well as those directly neighboring the project site, indicated that most of the neighborhoods surrounding the demonstration site have CalEnviroScreen3.0 scores in excess of 90%. Reducing emissions in these neighborhoods will have a positive effect on CalEnviroScreen3.0 scores indicating an improvement for affected DACs. It is evident from the above CalEnviroScreen3.0 results that reducing criteria and toxic emissions within the Port will provide a "net positive benefit" to the local community in terms of health impacts. Please refer to **Attachment 8 (Local Health Impacts)** for a detailed discussion of this project's DAC benefits.

⁷ Note that SCAQMD's letter of support included POLA's yard tractor cost share into their \$2.1 million match total. Our summary above clarifies the cost share breakdown.

E.2: Describe how the proposed project reduces lifecycle greenhouse gas (GHG) emissions (expressed in annual metric tons CO₂ reduced).

The complete replacement of 10 propane-fueled yard tractors with zero-emission equipment will result in significant lifecycle GHG reductions for this project. Lifecycle GHG reductions are estimated by subtracting the power plant GHG emissions that will result from generating power to charge the battery-electric demonstration equipment from the baseline GHG emissions that result from propane fuel combustion. According to POLA's 2016 Emissions Inventory, each WBCT baseline propane-fueled yard tractor emits⁸ 77.85 metric tonnes of CO₂ emissions per year; the fleet of 10 units will emit 778.5 MT/yr. These baseline emissions must be offset by the power plant emissions associated with the power that is projected to be used by the project equipment. Power plant emissions are calculated from the power requirements of the 10 demonstration units using the Los Angeles Department of Water and Power's emission factor of 1,132 lbs. CO₂e/MWh.⁹

The calculation steps for the power plant emissions for the 10-unit fleet are provided below.

- Estimated kWh/year per unit: 33,440 kWh/yr
- Estimated kWh/year for the fleet: 334,400 kWh/yr
- Convert to MWh by dividing by 1,000: 334.4 MWh/yr
- Multiply by emission factor (1,132 lb/MWh): 378,540.8 lb/yr
- Convert to Metric Tonnes (2,205 lb/MT): 171.67 MT/yr

The net lifecycle reduction for this project is: 778.5 – 171.67 = 606.82 MT/yr

E.3: Applications must discuss how the proposed project results in a higher Benefit/Cost score defined as the ratio of grams CO₂ equivalent reduction per dollar of Energy Commission investment. Provide calculations and assumptions.

There are one million grams in a Metric Tonne. The Project's Benefit/Cost (B/C) score is:

$$1,000,000 \text{ grams/MT} * 606.82 \text{ MT/yr} / \$7,842,270 \text{ ARFVTP funding} = \mathbf{77.38 \text{ gCO}_2\text{e}/\$ARFVTP}$$

Without consideration of lifecycle power plant emissions, i.e., tailpipe reductions, the B/C score is 99.27 gCO₂e/\$ARFVTP. This is 20% better than the lifecycle B/C score. The lifecycle score will come closer to the tailpipe score as the mix of power provided by LADWP evolves toward more renewable sources such as wind, solar and hydro power. If 100% renewable power is one day available, the lifecycle B/C score will match the tailpipe score.

E.4: Describe and calculate the volume of petroleum transportation fuel(s) displaced annually by the proposed project in terms of diesel gallon equivalents (DGEs).

WBCT currently operates 180 petroleum-fueled yard tractors in their CHE fleet. For this project, 10 propane units will be replaced (the old units will be destroyed as a requirement of the SCAQMD/US EPA equipment project) with 10 zero-emission yard tractors (one for one replacement). WBCT reports the following metrics for 2017 LPG fuel consumption, converted to units of DGE:

- Total LPG Gallons/Hour/Tractor – 4.36 gallons/hour
- Total Average Hours/Tractor for 2017 – 1,600 hours/tractor

⁸ 2016 EI, Table 5.7: 14,013 CO₂e MT / 180 LPG tractors = 77.85 MT CO₂e per tractor (these are annual emissions).

⁹ Appendix C, Table C-1 - 2016 Final Power Integrated Resource Plan

- Total Average LPG Consumption/Tractor for 2017 – 6,976 gallons x 10 Tractors = 69,760 gallons of LPG per year for the fleet.
- $DGE = 69,760 \text{ gallons}_{LPG} * (87,500 \text{ BTU/gallons}_{LPG}) / (128,100 \text{ BTU/gallon}_{diesel})$
= **47,650 DGE**

E.5: Describe and calculate the annual criteria pollutant emissions reduced, including tons of oxides of nitrogen (NOx) and tons of particulate matter (PM), as a result of the proposed project. Discuss how the proposed project maintains or improves upon emission reductions and air quality benefits in the State Implementation Plan for Ozone, California Phase 2 Reformulated Gasoline standards, and diesel fuel regulations.

Estimated Demonstration Activity

The estimated activity for the 12-month demonstration is based on the actual baseline activity experienced by WBCT in 2017 and considers growth in business. WBCT’s yard tractors are projected to average 1,600 hours/year.

Estimated Emissions Reductions for the Proposed Project

The tailpipe criteria and toxic emissions that would be emitted directly to the environment if we do not conduct this 12-month demonstration are easily quantified. For this project, the demonstration equipment would be deployed in a manner that would perform identical duties to petroleum fueled equipment already in daily use at WBCT.

Quantification of the emissions that would result if this project is not approved is based on the Port of Los Angeles emission inventory (EI) data¹⁰ in 2016 (the most recent inventory available). The Port’s EI, titled the “Inventory of Air Emissions” is conducted on an annual basis. This activity-based emissions inventory serves as POLA’s primary tool to track efforts to reduce air emissions from maritime industry-related sources. Development of the annual air emissions estimates undergoes rigorous review and is coordinated with a technical working group comprised of representatives from the Harbor Department, the Port of Long Beach, and the air regulatory agencies: U.S. Environmental Protection Agency, Region 9, California Air Resources Board, and the South Coast Air Quality Management District. The EI’s base emission factors rely on CARB’s EMFAC and OFFROAD emissions Models; the LPG fleet consists of 23 off-road engines and 157 on-road engines. The oldest engine is MY2000 and the newest is MY2011, with an average of MY2007. Table 5.7 of the EI reports CHE Emissions by Equipment and Engine Type; dividing the LPG yard tractor results by 180 LPG yard tractors provides the average, per-unit emissions for each LPG yard tractor. This is provided in the first row of Table 1 below. The second row is simply multiplies the first row by 10 to project the benefits of the 10-unit fleet over the 12-month demonstration.

Table 1: Estimated Project Emissions Reductions

	PM ₁₀ (tpy)	DPM _{2.5} (tpy)	DPM (tpy)	NOx (tpy)	SOx (tpy)	CO (tpy)	HC (tpy)
Average LPG-Fueled Yard Tractor	0.008	0.008	0.0	0.321	0.0	1.736	0.137
Average Fleet of 10 LPG Yard Tractors	0.078	0.078	0.0	3.211	0.0	17.36	1.37

¹⁰ Port of Los Angeles Inventory of Air Emissions–2016,
https://www.portoflosangeles.org/pdf/2016_Air_Emissions_Inventory.pdf
Accessed February 15, 2018

Since this is a zero emissions technology project, the estimated emissions of the fleet of 10 propane-fueled yard tractors in Table 1 also reflect the project’s tailpipe emission reductions.

According to the Port’s 2016 Emissions Inventory, there were 2,202 pieces of cargo handling equipment (CHE) in operation at the Port in 2016. This includes 180 propane¹¹, 17 liquefied natural gas and 851 diesel fueled yard tractors, as well as a wide variety of other CHE in operation at the Port, of which over 66% are diesel fueled. Successful demonstration of the advanced charging technology has the potential to significantly reduce emissions from Port of Los Angeles’ yard tractor fleet, which contributed between 43% and 53% of the Port’s CHE emissions in 2016, depending on the pollutant. POLA’s CHE fleet emissions contribute approximately 5% of all criteria and toxic¹² emissions, and 18% of greenhouse gas emissions to POLA’s EI.

Table 2 provides the fleet average diesel yard tractor emissions for 851 units, as well as the overall CHE fleet emissions; eventual transition to 100% zero emission technology will completely eliminate this air pollution.

Table 2: POLA Yard Tractor vs. Overall CHE Fleet Emissions¹³

	PM ₁₀ (tpy)	DPM _{2.5} (tpy)	DPM (tpy)	NOx (tpy)	SOx (tpy)	CO (tpy)	HC (tpy)	CO ₂ (metric tonnes)
Diesel-Fueled Yard Tractors (includes 851 units)	1.4	1.3	1.4	79.6	0.9	151.1	8.4	68,134
Propane-Fueled Yard Tractors (includes 180 units)	1.4	1.4	0.0	57.8	0.0	312.4	24.6	14,013
LNG-Fueled Yard Tractors (includes 17 units)	0.0	0.0	0.0	1.1	0.0	0.1	3.6	745
Overall CHE Fleet (all fuels)	6.5	6	4.8	434.7	1.7	752.5	69	159,658

Upon successful completion of the demonstration period, WBCT intends to operate the project equipment for the full useful life, which is at expected to be ten years. This will provide many additional benefits at the annual emission reduction rates documented in Table 1. Further, successful completion of this project will take the goods movement industry a major step closer to zero emissions operation, greatly expanding the local health benefits for the Port’s neighbors.

Note that WBCT’s existing CHE fleet is already in full compliance with the California Air Resources Board’s Cargo Handling Equipment regulation. As such, this project will definitively result in emission reductions that are surplus to current local and state regulatory requirements.

¹¹ All 180 LPG units are in operation at WBCT.

¹² Note that toxic emissions such as formaldehyde, benzene, 1,3 butadiene, acetaldehyde are not regulated as part of CARB’s engine certification process, and are therefore not readily available. However, to the extent that LPG tailpipe emissions include such toxics, it is assumed these will be eliminated for the project’s electric yard tractors.

¹³ Table 5.7, Port of Los Angeles Inventory of Air Emissions–2016,
https://www.portoflosangeles.org/pdf/2016_Air_Emissions_Inventory.pdf
Accessed February 15, 2018

This application directly addresses short- and long-term needs identified in multiple California state policy goals and programs. Many of these initiatives are complimentary, and all seek to ensure the state can meet critical environmental and public health goals via the transforming the transportation system to a low-carbon, low-emission, energy secure future. In particular, California has adopted several aggressive goals for reducing GHG emissions, including:

- A near-term goal of reducing GHG emissions to 1990 levels by 2020.
- An interim goal of reducing GHG emissions to 40 percent below 1990 levels by 2030.
- A long-term goal of reducing GHG emissions to 80 percent below 1990 levels by 2050.

Achieving these goals will require significant technological and market changes within the transportation sector, which accounts for well over a third of state GHG emissions. In recognition of this, and given the multi-agency integrated action plan coordination underway via Sustainable Freight Action Plan efforts that grew out of the Governor's Executive Order B-32-15, the Energy Commission's own Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) has shifted focus in recent investment plans on longer-term market transformation goals of 2050. This proposed project directly supports those ARFVTP priorities by laying the groundwork for zero-emission operations at marine terminals that will plug into the state's increasingly low-carbon, non-petroleum electric grid.

This project also directly supports the guiding principles and goals of the Sustainable Freight Action plan, including:

- Invest strategically to accelerate the transition to zero and near-zero emission equipment powered by renewable energy sources, including supportive infrastructure. This effort supports commercialization of advanced charging infrastructure and new zero-emission equipment to operate at the new infrastructure.
- Growing the number of well-paying employment opportunities in the freight sector via a focus on transformative zero emission technologies.
- Reduce or eliminate health, safety, and quality of life impacts on communities that are disproportionately affected by operations at major freight corridors and facilities.

The zero-tailpipe emission technologies proposed under this project also help the Air Resources Board meet criteria pollutant air quality standards necessary to meet our State Implementation Plan goals, particularly in an environment where incremental emissions are harder to achieve, based in large part on the success of the state's emission reduction programs and improved technologies over the last several decades.

E.6: Describe how the proposed project will result in jobs within California as a direct result of the proposed project. Applications must indicate whether the jobs are temporary and/or permanent. Include assumptions and background information to support any multiplier effects being claimed.

Should this demonstration project prove successful, the jobs created by this project are permanent; in that continued success of advanced zero emission technology will support growth of this industry. California is leading the industry by accelerating demonstration and implementation of zero emission technology and this Port project directly benefits from this leadership. Local fleets and businesses are gaining valuable training, experience and market share by participating in these innovative public-private partnerships.

WAVE is actively working with the Energy Commission and GoBiz to partner with an existing entity in California for manufacturing and set up an extended office in the LA County for further

support of this proposed project. Proposed staffing for the WAVE California-based entity provided to the California GoBiz office predicts a staffing level of 15 people. WAVE estimates that approximately 10% of the project budget will be allocated to California based entities. WAVE anticipates that as much as 90% of the system could be manufactured in California by the time of the award.

BYD currently employs 851 employees in California, the vast majority of which are located in Los Angeles County. Final assembly of the trucks will be completed at BYD's facilities in Lancaster. Each yard tractor that BYD builds requires roughly 1,000 hours of direct labor; thus, this project will create 10,000 hours of direct labor for Los Angeles County employees. This project will also result in job creation for indirect employees, including electrical engineering support for the design and integration of the WAVE systems, mechanical engineers to reconfigure the layout of the on-board components, validation and testing engineers to create a testing plan to validate the new charging method, logistics professionals to coordinate the procurement, project managers to coordinate scheduling and manufacturing, and sales support to oversee the project. Additionally, if this project is successful in spurring adoption of zero-emission technology, more jobs would be created to ensure that production can keep up with demand.

E.7: Describe how the proposed project directly increases local and regional economic activity.

As a result of the proposed project, an increase in economic activity is expected to local, regional, and statewide economies. In addition to the jobs creation discussion in Section E.6 that specifies the new jobs resulting from this project, there will also be a flow-down of economic activity because WAVE and BYD will procure 3rd-party components from suppliers as part of the localization effort. Local maintenance and service support will also be required for this project.

Simple Schematic of WAVE with BYD Tractor

