Energy Management Action Plan

prepared for

Port of Los Angeles
Los Angeles, CA

July 2014

Project No. 75019

prepared by

Burns & McDonnell Engineering Company, Inc.
Brea, California

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<tr>
<td>AB</td>
<td>Assembly Bill</td>
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<tr>
<td>AC</td>
<td>Alternating Current</td>
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<tr>
<td>ACT</td>
<td>Automated Container Terminal</td>
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<tr>
<td>AMP</td>
<td>Alternative Maritime Power</td>
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<td>CARB</td>
<td>California Air Resources Control Board</td>
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<td>CEC</td>
<td>California Energy Commission</td>
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<tr>
<td>City</td>
<td>City of Los Angeles</td>
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<tr>
<td>CHP</td>
<td>Combined Heat and Power</td>
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<tr>
<td>CIKR</td>
<td>Critical Infrastructure &amp; Key Resource</td>
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<tr>
<td>City</td>
<td>City of Los Angeles</td>
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<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DHS</td>
<td>Department of Homeland Security</td>
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<tr>
<td>DOE</td>
<td>Department of Energy</td>
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<tr>
<td>EERE</td>
<td>Energy Efficiency and Renewable Energy</td>
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<td>EMAP</td>
<td>Energy Management Action Plan</td>
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<tr>
<td>ESCO</td>
<td>Energy Service Company</td>
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<tr>
<td>eTAP</td>
<td>Energy Technology Advancement Program</td>
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<tr>
<td>FiT</td>
<td>Feed-in Tariff</td>
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<tr>
<td>FY</td>
<td>Fiscal Year</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>Harbor Department</td>
<td>Los Angeles Harbor Department</td>
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<tr>
<td>HPS</td>
<td>High Pressure Sodium</td>
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<tr>
<td>ITC</td>
<td>Investment Tax Credit</td>
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<tr>
<td>kW</td>
<td>Kilowatt</td>
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<tr>
<td>kWh</td>
<td>Kilowatt Hours</td>
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<tr>
<td>LA</td>
<td>Los Angeles</td>
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<tr>
<td>LADWP</td>
<td>Los Angeles Department of Water &amp; Power</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
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<tr>
<td>MVA</td>
<td>Megavolt Amps</td>
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<tr>
<td>MW</td>
<td>Megawatt</td>
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<tr>
<td>NPGS</td>
<td>Naval Post Graduate School</td>
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<tr>
<td>PACE</td>
<td>Property Assessed Clean Energy</td>
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<tr>
<td>POLA or Port</td>
<td>Port of Los Angeles</td>
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<tr>
<td>POLB</td>
<td>Port of Long Beach</td>
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<td>PPA</td>
<td>Power Purchase Agreement</td>
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<td>PSGP</td>
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<td>Production Tax Credit</td>
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<td>PV</td>
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<td>RFP</td>
<td>Request for Proposal</td>
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<td>RPS</td>
<td>Renewable Portfolio Standard</td>
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<tr>
<td>SAIDI</td>
<td>System Average Interruption Duration Index</td>
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<tr>
<td>SAIFI</td>
<td>System Average Interruption Frequency Index</td>
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<tr>
<td>SCAQMD</td>
<td>South Coast Air Quality Management District</td>
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<td>SCE</td>
<td>Southern California Edison</td>
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<tr>
<td>SGIP</td>
<td>Self-Generation Incentive Program</td>
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<td>TAP</td>
<td>Technology Advancement Program</td>
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<tr>
<td>TEU</td>
<td>Twenty-foot Equivalent Unit</td>
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<tr>
<td>UCLA</td>
<td>University of California, Los Angeles</td>
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<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
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<tr>
<td>U.S.</td>
<td>United States</td>
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<tr>
<td>USC</td>
<td>University of Southern California</td>
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EXECUTIVE SUMMARY

Energy management has become a critical issue for the Port of Los Angeles (Port) and the Southern California region. This is due to a number of factors including:

- Rapidly increasing energy demand and associated costs
- Aging electrical infrastructure and concerns about reliability
- Concerns about system resiliency in the event of a major incident
- Geographically based power network and distribution design.

Electricity demands are projected to double and potentially triple at the Port over the next decade due to anticipated increases in throughput, expanded use of alternative maritime power (AMP), and terminal automation.\(^1\) This growth will not only strain the existing infrastructure, it will also contribute to the anticipated growth in electricity costs from approximately $36 million in 2012 to as high as nearly $207 million for the Port by 2024.\(^2\)

The Los Angeles Harbor Department (Harbor Department) recognizes the importance of energy management and is taking a proactive leadership role in developing this Energy Management Action Plan (EMAP). The EMAP provides a roadmap for how the Harbor Department, working closely with the Los Angeles Department of Water and Power (LADWP), can contribute to the provision of secure and reliable electricity for its customers’ terminal operations. The EMAP also considers the importance of secure, reliable, and resilient energy to regional emergency preparedness through the sustained capacity to transport cargo, emergency supplies, and fuel to the region.

A review of existing studies and interviews with Harbor Department staff were used to evaluate the electrical infrastructure and energy usage of Port operations. Key considerations and recommendations are provided as follows for each of the Energy Pillars.

**Resiliency** – Ability to maintain business continuity during power outages and resume operations after a catastrophic event. The Harbor Department is in the process of establishing cargo and fuel movement capacity goals that are to be maintained (or rapidly regained) in the event of a disaster. Currently, the Port energy system does not have any backup power sources, control systems, or contingency plans to maintain or rapidly regain operations in the event of a loss of power from the grid. *Distributed generation that is incorporated into a microgrid is one proven model that can be used to enhance Port energy resiliency, while also benefiting all other Energy Pillars. Microgrids can be established at the utility level, working in partnership with LADWP, and at the user level by terminals.*

**Availability** – Access to sources of electricity necessary for present and future power demands of Port operations through generation, transmission, and distribution. LADWP provides electricity to the Port through three transmission lines that were designed and built in the 1950s and 1960s. There is concern that future peak energy demands, potentially as high as 136 to 162 megawatts (MW), will significantly strain this aging transmission and distribution system.\(^3\)

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1. Port energy demand is projected to increase from 55 megawatts (MW) to 136 MW (with 80 percent AMP participation by 2020 and four automated container terminals) and 162 MW with AMP and automation of six terminals (EMAP Section 3.2.1).
2. Annual energy cost projections are provided in EMAP Section 3.2.3.
3. Energy growth projections for container terminal automation scenarios are presented in EMAP Section 3.2.1.
Studies are needed to improve electricity load growth projections and evaluate the capacity of the system to handle future demand.

Reliability – Availability of high-quality, consistent electricity that meets predicted peaks in demand. The power quality and reliability issues that have repeatedly stopped cargo terminal operations appear to be due to utility line switching and voltage outages resulting from various physical disturbances to the system. These electrical anomalies largely go unnoticed for the majority of the LADWP Southern Region service area users; however, modern electrical cargo handling equipment, such as container cranes, are more susceptible to power fluctuations, resulting in terminal shutdowns that can last hours. A partnered effort between LADWP and the Harbor Department is needed to improve the reliability and quality of electricity to the Port. Refeeding the Port with a higher transmission voltage would provide the single greatest improvement in reliability. This could be accomplished through a dedicated transmission line to the Port.

Efficiency – Reductions in energy demand through management practices and technologies that maximize operational productivity and cost-effectiveness. Incorporation of new technologies, such as electric cargo handling equipment, AMP, and terminal automation will result in substantial increases in electricity demands at a time when electricity rates are projected to grow by over 70 percent over the next decade. Energy conservation measures are needed to reduce the strain on the existing electrical infrastructure and control rising energy costs.

Sustainability – Integration of energy management practices and renewable power generation to minimize the depletion of natural resources and provide economic, social, and environmental benefits. Opportunities exist to strategically reduce greenhouse gas (GHG) emissions from terminal operations by either importing green electricity from LADWP renewable energy sources or generating clean energy at the Port. Local generation options that reduce GHG emissions can include natural gas-fired combined heat power (CHP), solar, wind, and offshore wind and wave energy.

Based on this evaluation, the EMAP recommends next steps and programs that can be implemented through Short (0-1 year), Medium (1-2 years), and Long-term (2+ years) Actions to improve energy management within the Port, as summarized in Table 1.

Short-term Actions: Actions to be completed within the first year of the program include developing the Port energy management organizational foundation, including establishing the internal policy and team structure and metrics and goals; building collaboration with key stakeholders, most notably LADWP and tenants; and performing studies that will inform the development of an Energy Master Plan. Some actions, such as the conversion to light emitting diode (LED) high mast lighting and conducting a Port operational resiliency assessment, have begun concurrent with the development of this EMAP. Facility-specific improvements, such as inclusion of roof-top solar, emergency power generation, and a small-scale microgrid pilot project, could be initiated in the first year.

Medium-term Actions: These actions will be informed by the findings of short-term studies, which will be synthesized in the Port Energy Master Plan. While all EMAP-recommended programs can be started in the first two years, major infrastructure improvement projects will

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Assumes growth in electricity rates of 6.5 percent annually from 2014 to 2019, 5 percent in 2020, 4 percent in 2021, and 2.5 percent thereafter based on LADWP projections in the 2013 Power Integrated Resource Plan (EMAP Section 3.2.3)
require coordination, planning, design, permitting, and funding that will extend project start dates beyond this period.

**Long-term Actions:** Major energy infrastructure improvement projects can be phased to coincide with terminal redevelopment projects and electrical generation, transmission, and distribution system upgrades. Examples of these projects include retrofits to the Harbor Generating Station for inclusion in a Port microgrid that is operated by LADWP; reconfigurations of terminal electrical distribution systems from radial to ring configurations as terminal redevelopment projects are pursued; and development of an LADWP owned and operated, high-voltage, power distribution system dedicated to the Port. Other long-term projects may include renewable generation that incorporates new and developing technologies and implementation of energy efficiency measures associated with terminal automation. All EMAP recommended programs include long-term actions.

Infrastructure investments and improved energy management are profoundly needed to enhance the continued competitiveness and security of North America’s busiest container port. Once the organizational foundation of the Port energy program has been established, the following three next steps are recommended to enhance the Port’s energy infrastructure and management.

1. **Study:** Prepare an Energy Master Plan that includes an energy demand study to validate future use claims and assess electrical infrastructure; results of studies will inform decision makers and prioritize infrastructure investments.
2. **Reduce:** Develop a cooperative program with tenants for conducting energy assessments to identify ways to immediately achieve energy savings that will reduce operational costs and demands on the existing electrical system.
3. **Secure:** Work with LADWP, Port tenants, and other stakeholders to implement improvements that will enhance reliability and resiliency, such as developing a secure and reliable power source (or sources) that can power terminal operations and adjacent refineries.

There are many improvements that can be made at very little cost, and others that will require substantial investments; therefore, funding strategies need to be developed. While a multi-million-dollar investment in infrastructure improvements may be substantial, it pales in comparison to the multi-billion-dollar financial impacts of a Port-wide shut down due to a major power failure.
Table 1. Benefits of EMAP Recommended Actions to Port Energy Pillars

<table>
<thead>
<tr>
<th>Action / Benefit</th>
<th>Availability</th>
<th>Reliability</th>
<th>Efficiency</th>
<th>Sustainability</th>
<th>Resiliency</th>
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<tr>
<td><strong>Organizational Foundation:</strong> Establish the Port Energy Management Team, Port energy policy, and metrics and goals.</td>
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<td><strong>Collaboration and Outreach:</strong> Engage key stakeholders to plan, design, fund, and implement projects and programs.</td>
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<td><strong>Energy Master Plan Studies:</strong> Conduct energy demand and infrastructure assessments to inform the development of an Energy Master Plan, which will present a total resource loaded schedule for recommended projects that details timing, costs, and funding sources.</td>
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<td><strong>Terminal Assessment &amp; Efficiency Program:</strong> Incorporate technologies and operational measures to reduce energy use and costs.</td>
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<td><strong>LED Lighting Program:</strong> Convert high mast lighting to LED fixtures to reduce lighting energy demands by 50 percent at terminals.</td>
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<td><strong>Energy Technology Advancement Program:</strong> Fund the development of technologies and businesses that enhance Energy Pillars.</td>
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<tr>
<td><strong>Transmission &amp; Distribution System Improvement Program:</strong> Partner with LADWP to conduct studies and projects that enhance the reliability and resiliency of the electrical system.</td>
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<td><strong>Resiliency Program:</strong> Collaborate with LADWP and terminal operators to incorporate distributed generation and microgrids into the Port to sustain cargo and fuel transport during a grid outage.</td>
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<td><strong>Renewable Energy Program:</strong> Evaluate and incorporate solar, wind, and other renewable generation to enhance Port sustainability.</td>
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1 Microgrids can incorporate renewable energy generation to enhance sustainability and resiliency.
1.0 INTRODUCTION

The Los Angeles Harbor Department (Harbor Department) recognizes the importance of taking a leadership role in energy management at the Port of Los Angeles (Port or POLA) due to the increasing need for secure and reliable electricity for Port operations and regional emergency preparedness. As a first step, this Energy Management Action Plan (EMAP) was developed to identify possible actions that can be taken to improve energy management in support of the continuity and competitiveness of Port operations, as well as regional recovery from natural and manmade disasters. It is anticipated that the results of the actions identified in this document will lead to better service for Harbor Department customers and more secure and resilient operations. The EMAP evaluates and provides suggestions to assess and improve the five Port Energy Pillars:

**Resiliency** – Ability to maintain business continuity during a power outage and resume operations after a catastrophic event.

**Availability** – Access to sources of electricity necessary for present and future power demands of Port operations through generation, transmission, and distribution.

**Reliability** – Availability of high-quality, consistent electricity that meets predicted peaks in demand.

**Efficiency** – Reductions in energy demand through management practices and technologies that maximize operational productivity and cost-effectiveness.

**Sustainability** – Integration of energy management practices and renewable power generation to minimize the depletion of natural resources and provide economic, social, and environmental benefits.

Energy is a fundamental part of our society. Some of the biggest challenges facing the nation, such as security and climate change, revolve around the efficient and innovative use of energy. Likewise, energy is critical to the current and future security and prosperity of the Port. With the gradual move away from fossil fuel-based terminal operations, the Port is going to increasingly rely on electricity to move goods. This requires sustainable energy production to protect our resources, safe and secure distribution networks, and efficient and flexible facilities that minimize consumption while supporting Port operations. Energy management has become a critical issue for the Harbor Department, its customers, and the Southern California region for the following reasons.

**National Energy Reliability Concerns**: As the United States’ (U.S.’) electrical grid continues to age, power reliability and quality continue to decline. This was exemplified during the 2003 Northeast blackout, which was the result of unreliable and inadequate electrical infrastructure that caused a cascading failure of 508 generating units at 265 power plants and resulted in the loss of power to 50 million customers. The Port is also serviced by an aging electrical system that is in urgent need of upgrade and repair. The reliability of the Port’s electricity supply is currently a major concern to the Harbor Department and its terminal customers, since power variations have repeatedly shut down terminal operations over the past two years.

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**Regional Disaster Preparedness:** Energy reliability and resiliency have increasingly come into focus throughout the country due to major outages resulting from natural and human causes. The loss of power for 8.66 million customers from North Carolina to Maine in 2012 following Hurricane Sandy and the November 2012 Nor’easter have highlighted grid dependence and energy vulnerability as significant issues. In the wake of these storms, it took approximately two weeks to restore power to 99 percent of the customers who could receive power. This resulted in fuel shortages and significant loss of commerce throughout the region, including reduced operations at the Ports of New York and New Jersey for over seven days. If a regional disaster was to shut down Port operations for a week, the national economy would lose in the range of $7 to $14 billion. Additionally, the Southern California region would be subject to fuel and goods shortages.

**Projected Growth in Port Electricity Demand:** Power demands are projected to double and potentially triple at the Port over the next decade due to anticipated increases in throughput and expanded use of alternative maritime power (AMP), electric equipment, and terminal automation. Additionally, terminal operations are increasingly reliant on modern electric cargo handling equipment that requires uninterrupted sources of high quality power. Operational, system, and infrastructure improvements are urgently needed to meet this growing demand.

**State Legislation:** California Assembly Bill 628 (AB 628), which was signed into law October 11, 2013, requires a harbor or port district to develop an energy management plan to be eligible for California Infrastructure Development Bank funding of projects that promote economic development. AB 628 calls for a port to work in collaboration with an electrical corporation, gas corporation, or publicly owned electric utility to develop an energy management plan that contributes to reduced air emissions and promotes economic development. By developing this EMAP in coordination with the Los Angeles Department of Water and Power (LADWP), Port energy projects may be eligible for this and other potential funding.

**Increased National Competition for Port Business:** While environmental programs, such as AMP and the Renewable Portfolio Standard (RPS), provide substantial environmental benefits, they also increase the cost of cargo operations for the customers of California ports due to increased energy demand and electricity costs. Cost-effective, reliable, high-quality, and resilient energy is needed to maintain the Port’s competitiveness nationally.

The EMAP is intended to result in actions that will efficiently and effectively improve the overall power profile of the Port, in a manner that is protective of the natural environment, and helps to secure the continued economic viability and competitiveness of the busiest container port in the U.S. To accomplish this, a high-level review was conducted of the Port’s energy landscape, including baseline conditions and growth projections. This information was then used to provide an evaluation of Port operations relative to the Energy Pillars. Based on this evaluation, Short, Medium, and Long-term Actions were suggested to improve energy management within the Port.

A concurrent study of Port resiliency is being conducted by the Naval Post Graduate School (NPGS) Center for Infrastructure Defense. NPGS is assessing vulnerabilities of the Port to disruptions in container and fuel transport, as well as options for enhancing the reliability and resiliency of container and fuel throughput operations.

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6 Department of Energy (DOE) Office of Electricity Delivery and Energy Reliability. 2013. Overview of Response to Hurricane Sandy-Nor’easter and Recommendations for Improvement (February 26, 2013)

7 Energy growth projections are presented in E-MAP Section 3.2.1.
2.0 PORT OF LOS ANGELES OPERATIONS

The Harbor Department serves as the agency overseeing the Port. As a landlord port, the Harbor Department develops and leases its property to tenants who then, in turn, operate their own facilities. The Port encompasses 7,500 acres, 43 miles of waterfront, and features 3 cruise terminals and 24 cargo terminals, including dry and liquid bulk, container, break bulk, and automobile facilities (Figure 1).
The Port is a key asset that is vital to our regional and national security and the economy. It is the primary point of entry for goods and fuel coming into the Southern California region, the State of California, and the nation. It is also the busiest container port in North America. Accordingly, the Port is viewed as one of the U.S. Critical Infrastructure and Key Resources (CIKR) by the Department of Homeland Security (DHS). CIKR are essential to the nation’s security, public health and safety, economic vitality, and way of life.\(^8\) It has been estimated that each day of non-operation at the Port can result in a loss of up to $1 to $2 billion for the national economy.

The Port plays a crucial role in receiving goods and fuel. In the case of a regional disaster, the San Pedro Bay Port Complex could serve as a lifeline to the second most populated metropolitan area in the nation—the greater Los Angeles area. The Port’s role in receiving fuel is particularly crucial because Southern California operates as an energy island without pipeline connections to other petroleum fuel sources. The Southern California area only has an estimated eight-day supply of fuel in reserve; therefore, the loss of power to the Port and its associated terminals and refineries would significantly affect the entire region. It is of the utmost importance that the Port has a reliable, secure, and resilient supply of electricity to ensure business continuity and regional disaster preparedness.

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\(^8\) DHS. 2014. [http://www.dhs.gov/critical-infrastructure-and-key-resources-support-annex](http://www.dhs.gov/critical-infrastructure-and-key-resources-support-annex)
3.0 PORT ENERGY DEMAND

The energy demand of the Port is substantial, currently costing an estimated at $30,000,000 annually, and is projected to double and potentially triple in the coming decade, as detailed in this section.

3.1 BASELINE ENERGY DEMAND

Energy demand at the Port is directly proportional to the movement of cargo. Port terminals handle approximately 175 million metric revenue tons of cargo annually. In 2012, the Port moved close to 8.1 million twenty-foot equivalent units (TEUs), maintaining its rank as the number one container port in North America. The University of California, Los Angeles (UCLA) Luskin Center for Innovation performed an assessment of energy demand and energy growth projections in its 2013 report *Moving Towards Resiliency.* The Luskin Study estimated in fiscal year (FY) 2012, the Port consumed 200,000 to 250,000 megawatt hours (MWh) of electricity, at a cost of approximately $30,000,000.

The Harbor Department does not manage overall electricity use of the Port; rather, the electrical system at the Port is comprised of multiple interconnected systems with individual electricity billing meters that are managed by individual tenants. The major energy consumers at the Port include container terminals and bulk terminals, followed by operations conducted by the Harbor Department (Figure 2).

![Figure 2. Port of Los Angeles Relative Energy Demand (Source: 2013 Luskin Study)](image)

The typical cargo terminal operator uses 15,500 to 23,300 MWh and pays approximately $2,000,000 to $3,000,000 in electricity charges annually. Combined, these container terminals consume electricity according to the breakdown presented in Figure 3.

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A percentage breakdown of energy consumption at cruise terminals and bulk terminals has not been completed. Electricity demand at cruise terminals is predominantly from air conditioning of buildings, AMP, passenger gangways, terminal and parking lighting, and electric fork lift chargers. Fuel terminals’ electricity demand also includes terminal lighting, air conditioning of buildings, electric fork lift chargers, as well as pumping equipment. It is estimated that the typical demand at fuel terminals is in the range of 1 to 1.5 MW, with annual consumption ranging from approximately 1,000 to 2,000 MWh.\(^{10}\)

Peak hourly demand is a key metric that helps utilities and facilities determine required levels of power generation and assess the adequacy of the transmission and distribution infrastructure. Both LADWP and Port electrical infrastructure must be sufficient to meet projected peak hourly demands. Estimated FY 2012 Port electricity demands are presented in Table 2.

### Table 2. Estimated 2012 Port of Los Angeles Electric Power Demand

<table>
<thead>
<tr>
<th>Port Electricity Demands</th>
<th>Megawatts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Hourly Demand(^{1})</td>
<td>55</td>
</tr>
<tr>
<td>Minimum Hourly Averaged Demand</td>
<td>17</td>
</tr>
<tr>
<td>Annual Average Hourly Demand</td>
<td>27</td>
</tr>
</tbody>
</table>

\(^{1}\) Assumed an apparent power of 65 megavolt amps (MVA) and power factor of 0.85

\(^{10}\) Demand estimates were provided by the Port Engineering Division, prior to the installation of the most current AMP facilities.
3.2 GROWTH PROJECTIONS

Port energy use is projected to double and potentially triple over the next decade due to anticipated increases in throughput and expanded use of AMP, electric cargo handling equipment, and terminal automation. At the same time, energy rates are predicted to increase by approximately 40 percent over this period, as detailed in Section 3.2.3. This section provides a summary of projected energy demands of the Port and the surrounding communities of Wilmington and San Pedro over the next decade, as well as growth in energy costs.

3.2.1 Future Port Energy Demand

The Luskin Study calculated that the Port could consume between 400,000 to 500,000 MWh of electricity annually by 2020, which would equate to a doubling of Port energy consumption. Growth in electricity demand was based on increased cargo throughput, greater use of AMP, and transitions to electric cargo handling equipment. The Luskin Study may not have taken into account the full extent of energy demand growth due to future terminal automation because automation increases electricity demand to a greater extent than only electrification of cargo handling equipment alone.

In 2007, the California Air Resources Board (CARB) approved the At-Berth Regulation, which requires vessel operators to reduce emissions at California ports by shutting off auxiliary engines and connecting to grid power, referred to as AMP, or using alternative control measures. The regulation sets targets for 50 percent of vessels to use AMP by 2014 and 80 percent by 2020. Increased use of AMP is projected to a grow peak electricity demand by 30 MW by 2020.

Automation of container terminals has the potential to be the biggest driver of increased Port electricity demands over the next decade. Depending on the level of automation, electricity demand at the terminal can increase by roughly two to three times. The TraPac Container Terminal is the only Port terminal that currently is undergoing automation. Automation plans for the five other container terminals have not been determined; however, a possible Port automation scenario includes a total of four automated cargo terminals (ACTs) in the next decade. While increases in electricity demand due to terminal automation vary according to the size of the terminal and the automation approach, automation is preliminarily estimated to result in an average increase in peak electricity demand of 12.75 MW per terminal.

Annual electricity demand was modeled for three ACT scenarios. All scenarios assumed the current peak electricity demand to be 55 MW, and that AMP participation would reach 80 percent by 2020, as required by regulation. The low scenario assumed that only one container terminal at the Port would be automated, the mid scenario included four ACTs, and the high scenario included six ACTs. For the purposes of this analysis, electricity demand from growth in cargo throughput and electrification of cargo handling equipment at non-automated terminals were excluded. With the combined increased use of AMP and automation of container terminals under the three ACT scenarios, container terminals are preliminarily projected to increase peak electricity demands from 55 MW to 96 MW (1 ACT), 135 MW (4 ACT), and 161 MW (6 ACT) (Figure 4). This would equate to a near doubling or potential tripling in demand, particularly when considering growth in cargo throughput.

The Luskin Center Study served as an important first step that provided a high-level assessment of terminal energy usage. Further studies of existing infrastructure, operations, and energy use are required to design cost-effective energy management projects that meet the Port’s energy resiliency, reliability, and sustainability needs. Additionally, since terminal automation is such a significant factor in the overall growth of the load at the Port, and the first terminal automation project within the Port is just underway, these projections will need to be updated as that project is completed and put into operation. As with any projection, accuracy diminishes with time. Thus, these power demand projections should be revisited at least every four years for recalibration based on actual growth and use of new technologies.

### 3.2.2 Wilmington and San Pedro Energy Demand

Along with the projected growth in electricity demand within the Port, the U.S. Census estimates that the State of California peak electricity demand is expected to grow by 10 percent between 2010 and 2020.\(^{14}\) The California Energy Commission (CEC) estimates an average annual growth of 0.34, 0.93, and 1.43 percent for the low, medium, and high scenarios, respectively, for the area surrounding the Port.\(^ {15}\) The CEC growth projections equate to increases in peak electricity demand from approximately 2,750 MW in 2012 to 6,000 MW (low growth case) and 6,800 MW (high growth case) in 2024 (Figure 5). Since the Port is served by LADWP electrical infrastructure that also supports the surrounding communities of San Pedro and Wilmington, the additional demand placed upon the grid due to growth from these neighboring communities is a major concern for the Harbor Department and its customers. The combined increase in demand from the Port and the surrounding communities in the LADWP southern region service area has the potential to strain the existing transmission and distribution system and adversely affect power quality and reliability to the Port.

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3.2.3 Energy Costs

The Harbor Department and its large commercial tenants purchase electricity from LADWP under the A3-A rate schedule. The costs of electricity under this rate schedule are greatly impacted by the time of day and season in which energy is consumed. Additionally, electricity costs are also strongly influenced by Maximum Demand, which is the average kilowatt (kW) load measured during the 15-minute period of greatest use during a billing period. The demand charge is based on the Maximum Demand recorded during each billing month, and the facility charge is based on the highest Maximum Demand in the last 12 months, with a minimum charge of 30 kW. Energy charges fluctuate based on season and peaking periods and are charged on a dollar per kilowatt-hour (kWh) basis. The energy charge includes an energy cost adjustment factor, which is charged based on total kWh usage within a billing period. In addition, a reactive energy charge is assessed based on the High Peak period power factor. Therefore, Port energy costs are strongly influenced by the time of day and season in which energy is used, as well as the 15-minute periods of monthly and annual Maximum Demand.

LADWP’s A3-A rate structure incentivizes electrical consumers to implement load shifting and peak shaving measures. Load shifting does not refer to the reduction of overall energy usage within a given month; instead, it refers to moving load from a high priced peaking period to a lower cost, off-peak period. For example, electricity costs include a demand charge of $9.70/kW during the High Peak period (1:00 PM to 5:00 PM, Monday through Friday), $3.30/kW during the Low Peak period (10:00 AM to 1:00 PM and 5:00 PM to 8:00 PM, Monday through Friday), and no charge during the Base period (all other times). Additionally, during the High Season (June through September), energy charges within the Base period are 45 percent the cost of usage occurring during the High Peak period on a dollar per kilowatt-hour basis. Advanced or smart metering combined with operational changes can provide opportunities for load shifting, which can be used to reduce the peak demand or change the period in which Maximum Demand occurs, drastically reducing the cost of energy.

The growth in the Port electricity demand will occur as LADWP electricity prices continue to grow. Due to investments in renewable generation and infrastructure improvements, LADWP projects that electricity rates will increase by 6 to 7 percent annually from 2013 through 2019, then gradually reduce over 2020
and 2021, before remaining in the 2 to 3 percent range thereafter.\textsuperscript{16} The model incorporated LADWP rate increases of 4-6 percent per year in 2012 and 2013, 6.5 percent annual increases from 2014 to 2019, 5 percent in 2020, 4 percent in 2020, and 2.5 percent per year thereafter. These per-unit rate increases were then applied to growth projections of Port electricity demands.

The annual peak electricity demand model (Section 3.2.1) was used to project growth in annual electricity costs for the three ACT scenarios. Based on this model and its associated assumptions, annual energy costs at the Port are projected to more than triple under the low scenario and increase by more than five-fold under the high scenario between FY 2012 and 2024, with FY 2024 annual electricity costs ranging from approximately $120 million to nearly $207 million as compared to $36 million in FY 2012 (Figure 6).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure6.png}
\caption{Figure 6. Ten-Year Projection of Annual Port Electricity Costs}
\end{figure}

4.0 PORT ENERGY PILLARS

This section evaluates the existing energy system at the Port relative to the five Energy Pillars. The Harbor Department developed these pillars to focus energy management evaluations and actions on priority areas of concern. Potential impacts of energy demand growth projections on Port operations are also evaluated.

4.1 RESILIENCY

The DHS National Infrastructure Protection Plan defines resiliency as “the ability to resist, absorb, recover from, or successfully adapt to adversity or a change in conditions.” For the Port, energy resiliency can be considered to be the ability to maintain business continuity during a power outage and resume operations after a catastrophic event, such as a natural or manmade disaster.

The Port is a key national asset vital to security and the economy. It serves as the primary entry point for goods coming into the Southern California region, the State of California, and the U.S. The Harbor Department desires to maintain (or rapidly regain) the capacity to transport cargo and fuels to support regional resiliency in the event of a disaster. This capacity is dependent upon the ability to provide reliable electricity to container, dry bulk, and fuel terminals, as well as associated refineries.

During a prolonged grid outage, DHS is expected to supply the Port with portable emergency power generators. However, as demonstrated in past regional disasters, this process may take several days, delaying the Port’s ability to provide critical resources to the region and undermining Port resiliency. Port resiliency is impacted by the following factors:

Physical Threats to Overhead Transmission and Distribution Lines: Electricity is delivered to the Port and the surrounding communities of Wilmington and San Pedro by a transmission system that consists of overhead and underground sections. Overhead portions of the transmission lines are particularly susceptible to power disruptions due to a variety of factors, including interactions with animals and metallic balloons, wind, wildfire, and lightning damage, as well as automotive collisions with power poles that can down lines. Substations have also recently come under attack, as illustrated by the sniper attack that disabled the Metcalf substation in San Jose, California. Therefore, Port operations are susceptible to accidental and malicious attacks to this transmission system.

Cyber Security Threats: The security and reliability of the electrical grid is further challenged by cyber-attacks. Former Secretary of Defense Leon Panetta highlighted national security concerns when he stated, “...the next Pearl Harbor could be a cyber-attack.” On February 12, 2013, President Obama released Presidential Policy Directive 21: Critical Infrastructure Security and Resilience. The policy is to strengthen the security and resilience of the nation’s critical infrastructure against both physical and cyber threats. Consequently, military installations, hospitals, university campuses, and industrial facilities have begun to invest in on-site energy systems, as well as physical and cyber security systems that support energy independence and security.

Lack of Sufficient Redundancies: Although the three existing LADWP transmission lines feeding the Port are designed to provide the required utility-level redundancy, there are no backup power sources currently configured to power the Port’s critical terminal operations in the event of a loss of LADWP power. The currently available Port emergency power supply is reported to include small diesel generators that are located at terminals to provide short-term emergency
power for lighting and limited systems support. These emergency generators are only intended to facilitate evacuations in the event of a power loss or disaster, and do not have the capacity to power terminal equipment. Therefore, there is no meaningful backup power capable of moving goods and fuel until portable generators are brought into the Port.

**Electrification of Cargo Handling Equipment:** The projected increase in the use of electric equipment for terminal operations, while effective in reducing air pollution and GHGs, has the unintended consequence of greatly increasing the Port’s dependence on electricity as its primary utility. The current portfolio of cargo handling equipment includes a combination of diesel, gasoline, and electric-powered equipment, while future cargo handling equipment will be largely electric. Consequently, terminal operations could be more greatly affected by even minor electrical disruptions, and the time to recover from an outage would likely be greater as well.

As electrification of terminal operations progresses, Port resiliency will become increasingly dependent on the availability of multiple distributed sources of electricity to permit the Port to operate when LADWP’s primary distribution system is unavailable. While the current electrical system configuration is not capable of sustaining terminal operations under any service-disruption scenario, alternative power options for Port operations are discussed in the Availability section.

**4.2 AVAILABILITY**

Energy availability refers to access to electricity sources necessary to meet present and future power demands of Port operations through generation, transmission, and distribution. The Port obtains its electricity from LADWP—the largest municipal utility in the U.S. The Port’s current electricity demand of 55 MW is less than 1 percent of the LADWP generating capacity of 7,200 MW, and its future projected demand of 136 to 167 MW is approximately 2 percent of the generating capacity.

Port terminals purchase power for all non-AMP operations under the large commercial A3-A rate schedule. With the exception of AMP, Port operations are precluded from rolling blackouts. This means that LADWP will provide power to the Port except during unforeseen losses of power to the grid. Power for AMP is purchased at a lower rate since a ship’s onboard power system is designed to feed the vessel with required electricity, allowing it to stay operational during a rolling blackout.

The Port and the communities of San Pedro and Wilmington are located in the southern section of the LADWP service area (Figure 7). Electricity is delivered to the Port by a series of three power circuits that were originally designed and constructed in the 1950s and 1960s. While the projected growth in Port energy demands over the next decade would largely be insignificant to the LADWP generating capacity, there is concern that future energy demands will significantly strain the existing transmission and distribution system to the southern section service area.
In the event of an electricity service disruption due to the loss of LADWP generation capacity or a disturbance to the transmission and distribution system, the Port currently does not have access to any other major sources of energy to power terminal operations. There are, however, other available sources of electricity that the Port could use if the right operating agreements and systems were developed. These include the Harbor Generating Station and potential interconnections with the Southern California Edison (SCE) grid.

**Harbor Generating Station:** The nearest LADWP generating facility is the Harbor Generating Station, which is a natural gas-fired electric generating plant. It occupies an area of approximately 20 acres in the Inner Los Angeles Harbor Complex in the City of Wilmington. The facility’s total capacity is 472 MW. This facility has sufficient capacity to power the Port’s current and future energy demands. LADWP’s Harbor Generating Station provides regional system support and could serve as a key component of the Port’s resiliency strategy during major disasters through its incorporation in a Port microgrid.

**Southern California Edison Grid:** SCE is the exclusive supplier of electricity to the Port of Long Beach (POLB) and its tenants. The transmission and distribution system of SCE is located immediately adjacent to the POLA complex; however, there are no mechanisms in place for sharing power between the Ports. This means that neither Port has a redundant available power supply even though the utility infrastructure of LADWP and SCE are located immediately adjacent to each other. Since such a connection would need to be accomplished at the utility level, the two utilities will need to evaluate if there is an opportunity for an interconnection for mutual support.

An assessment is needed of the capacity of the existing LADWP southern section transmission and distribution infrastructure to reliably support the Port’s future energy demands. Studies and modeling
Simulations can be an effective tool to demonstrate the need for installation improvements and enhancements of the transmission infrastructure. Outages at the Port not only could affect the entire regional economy, they also could adversely impact the reliability of the LADWP electricity supply to the entire southern section and the broader region, through cascading events.

### 4.3 RELIABILITY

Energy reliability refers to the availability of high-quality consistent electricity that meets predicted peaks in demand at frequencies and voltages within tolerances of the equipment being operated. Grid reliability is essential for stable Port operations, which are in turn essential to maintaining and bolstering the Port’s competitiveness nationally. LADWP acknowledges that the “power system is aging rapidly and needs accelerated repair and replacement,” as depicted in the LADWP grid-wide growth in service disruptions (Figure 8).

![Figure 8. LADWP Increases in System-wide Service Disruptions and Total Outages](Source: LADWP Power Reliability Program)

LADWP maintains a detailed chronological event log of outages. In 2012, six significant power disruptions to the Port were reported, and in 2013, there were two. The frequency of outages experienced by the Port can be compared using two common measures of power quality for the overall power system—the System Average Interruption Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI). LADWP’s SAIFI and SAIDI met the general requirements of power quality. In fact, LADWP’s SAIFI and SAIDI were below the national median at less than ½ outage per year per

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customer (versus 1¼ outage per year for the SAIFI national average) and less than an average duration of 72 minutes per outage (versus 143 minutes for SAIDI). However, these metrics do not adequately capture the very significant and costly effects of very short-duration disruptions in the power system to Port operations. While the numbers of these short-duration power disruptions have decreased recently, these events need to be monitored on an ongoing basis to assess changes in the recent trend. Additionally, an assessment is needed of the adequacy of the LADWP and Port electrical system to accommodate projected increases in electricity demand.

Power quality and reliability issues that the Port is currently experiencing appear to be due to two factors:

- Service disturbance due to utility line switching and voltage collapses caused by physical disturbances to the transmission and distribution infrastructure
- Use of modern electrical cargo handling equipment that is more sensitive to power fluctuations.

It has been reported that electricity frequency and voltage variations occur when LADWP transfers power from a primary to a secondary line over a period of approximately 2/3-1 second (40-60 cycles). In the past, these variations would have gone largely unnoticed; however, modern terminal cranes have solid-state electrical systems, including alternating current (AC) drives and alternating current / direct current (AC/DC) converters, that can shut down during a disruption as short as 1/6 second (10 cycles). Once an outage has occurred, it is reported by terminal operators that it takes approximately 30 to 45 minutes to replace the protection fuses on the cranes and bring each crane back on line. These disruptions negatively impact the Port and the local economy, and can cost $75,000 in damages for the first hour of delay. 19

Although power quality issues have been experienced by Port tenants in the past, the increasing dependency on electricity for cargo terminal operations has the potential to exacerbate these issues. As the LADWP transmission infrastructure continues to age and the Port’s electricity demands increase, power quality and reliability issues are anticipated to increase.

On a grid-wide basis, LADWP recognizes the need to improve the reliability of its electrical infrastructure and has implemented the Power Reliability Program, which is funded through a power reliability surcharge. LADWP plans to invest more than $1 billion in the program over the next 5 to 15 years. The program includes efforts to rebuild infrastructure and perform maintenance in order to achieve the following goals:

- Reduce temporary circuits
- Replace distribution transformers, poles, and underground cable
- Reduce frequency and duration of system interruptions
- Train electric distribution mechanics, electric mechanics, steam plant assistants, and electric station operators.

Planned infrastructure improvements to the southern section of the LADWP service area are not publicly available; therefore, it is unknown if the Power Reliability Program will meet the current and future electricity demands of the Port. Greater communication with LADWP will help ensure that infrastructure improvements are sufficient to meet the Port’s future energy needs.

It is important to note that each user has a different concept of reliability, which is largely dependent on organizational needs. In industrial applications, such as in ports and terminals, significant costs are

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19 Attributed to terminal representative planning study figures in the Luskin Center Study.
incurred as a result of a power failure. When operating costs are $50,000 to $75,000 per hour per terminal, there is an expectation of a higher level of equipment, power, and work force reliability than in many other environments. The impact of energy reliability on the Port’s national competitiveness also needs to be taken into consideration as competition among ports increases.

4.4 EFFICIENCY

Energy efficiency includes reductions in energy demand through management practices and technologies that maximize energy conservation, operational productivity, and cost effectiveness. As stated in the Harbor Department’s Environmental Management Policy, “The Port of Los Angeles is committed to managing resources and conducting Port developments and operations in both an environmentally and fiscally responsible manner.” Energy efficiency is not only critical for cost-effectiveness and national competitiveness, but also plays an important role in the Harbor Department’s commitment to green growth. Higher levels of energy use result in increased production of GHG emissions even if they do not contribute to local air quality impacts. Additionally, unnecessary energy use unnecessarily increases operational costs and unduly stresses the electrical system.

One of the key factors that drives efficiency is awareness of energy consumption patterns. This is typically accomplished through a smart grid or meter system. Because of its landlord status, the Harbor Department lacks a central clearinghouse for the entirety of the meter data collected within the Port. This limits the ability to trend and track usage of the Port. LADWP is initiating a Smart Grid program in its service area and has identified 52,000 electric customers as “Smart Power Partners”. These Smart Power Partners are located in three Demonstration Project Areas – UCLA and USC communities and the Chatsworth community near the Castaic Power Plant. It is recommended that the Port participate in the Smart Grid program.

Port participation in the Smart Grid program will benefit the Port’s energy users and LADWP for the following reasons:

- Provide data on best energy conservation opportunities to reduce energy demands
- Verify available capacities in existing systems
- Enhance the ability to accurately forecast future usage and demands, which are crucial for determining future energy availability
- Provide information to the utility regarding vulnerable spots in the system, which can be used to target corrective actions.

Incorporation of new technologies, such as terminal automation and AMP, are resulting in substantial increases in electricity demands. This magnifies the need to implement measures to substantially improve energy efficiency. For example, one Short-term Action that can have a substantial impact on Port energy demand is the conversion of high mast lighting from high pressure sodium (HPS) to light emitting diode (LED) fixtures. This measure alone has the potential to reduce energy demand of lighting at terminals by approximately 50 percent. In addition, the Port has a large number of intelligent power meters already installed throughout its distribution system. It is recommended that the data from these meters be aggregated to predict future energy issues and more quickly identify causes of events within the Port. This will provide a much higher resolution of the Port’s overall electrical infrastructure and give the Port much quicker access to the necessary data than the LADWP Smart Grid program can offer alone. These measures along with other energy conservation measures are detailed in the Energy Management Strategy Section.
4.5 SUSTAINABILITY

The Harbor Department has adopted a green growth strategy of expanding operations while aggressively reducing impacts on the environment. As detailed in the 2013 Port of Los Angeles Sustainability Report, the Harbor Department is committed to balancing economic, social, and environmental considerations in the provision of essential goods movement services.

The City of Los Angeles released its climate action plan, Green LA: An Action Plan to Lead the Nation in Fighting Global Warming, in May 2007. The Plan sets forth a goal of reducing the City’s GHG emissions to 35% below 1990 levels by the year 2030, one of the most aggressive goals of any big city in the country. In addition, CARB has set statewide greenhouse gas emission reduction goals of 1990 levels by 2020 and 80 percent below 1990 levels by 2050. The actions outlined in and resulting from the EMAP, including efficiency measures, renewable resources, and new and advanced technologies, will align with these goals.

Energy and Resource Conservation is identified as one of the five material issues in the Harbor Department’s 2013 Sustainability Report. This issue considers practices to conserve energy, as well as water and land-based resources, through responsible stewardship, adaptive planning, technology advancement, and operational best practices. It also addresses opportunities to use renewable energy to power Port operations. The Harbor Department is committed to strategically expanding its renewable energy portfolio by either importing green electricity from LADWP renewable energy sources or generating clean energy at the Port to reduce GHG emissions. Current Port energy sustainability initiatives include:

- Renewable energy power purchase agreement between the Harbor Department and LADWP, through which the Department purchased approximately 23 percent of its electricity from green sources, as of 2011. In 2012, the Harbor Department purchased 3,703 MWh of renewable energy.
- Commitment by the Harbor Department to generate 10 MW of solar energy within the Port, which currently includes 1.6 MW of installed solar photovoltaic (PV) generation
- Planned installation of a 300 kW fuel cell system in the Harbor Administration Building
- Wind power feasibility study
- Technology Advancement Program to promote and demonstrate zero-emissions technologies
- Support of PortTech Los Angeles mission to serve as a commercialization center and incubation program dedicated to creating sustainable technologies for ports and beyond.

Currently, the Port obtains approximately 23 percent of its power from LADWP renewable sources, which include hydroelectric, solar, and wind power (Figure 9). Future incorporation of renewables into LADWP’s energy portfolio will have important ramifications for Port sustainability. In March 2013, LADWP entered into a contract to transition out of coal power. This will be accomplished through the conversion of the Intermountain Power Plant from coal to natural gas and divestment of interests in the coal-fired Navajo Generating Station. Additionally, LADWP is on track to meet an interim target of 25 percent renewable energy by 2016 and the 33 percent by 2020. Consequently, the Port will obtain a minimum of 33 percent of its energy from renewable sources by 2020. Additional investments in Port renewable generation can increase this percentage.
Figure 9. LADWP Renewable Generation Forecast by Technology
(Source: LADWP 2013 Power Integrated Resource Plan)
5.0 ENERGY MANAGEMENT STRATEGY

This Energy Management Strategy section recommends studies, projects, and programs to improve the overall power profile of Port operations in a manner that is protective of the natural environment and the Port’s continued economic viability and national competitiveness. This section details the process of implementing the EMAP through the development of the organizational foundation, establishment of partnerships through collaboration and outreach, conducting studies that contribute to the development of an Energy Master Plan, and execution of programs and projects that enhance the Port’s five Energy Pillars (Figure 10).

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1. Organizational Foundation

2. Collaboration & Outreach

3. Energy Master Plan Studies

4. Implement Actions

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Figure 10. Overview of the Energy Management Strategy

The EMAP has been developed with three categories of Actions—Short (0-1 year), Medium (1-2 years), and Long-term (2+ years).

**Short-term Actions:** Actions to be completed within the first year of the program include:

- Develop the Port energy management organizational foundation, including establishing the internal policy, team structure, as well as metrics and goals
- Build collaboration with key stakeholders—most notably LADWP and Port tenants
- Conduct studies that will inform the development of an Energy Master Plan.

Some actions, such as the conversion to LED lighting and conducting a Port operational resiliency assessment, have begun concurrent with the development of this EMAP. Additionally, facility-specific improvements, such as inclusion of roof-top solar, emergency power generation, and terminal-scale microgrid pilot projects, could be initiated in the first year.

**Medium-term Actions:** These actions will be informed by the findings of short-term studies, which will be synthesized in the Port Energy Master Plan. While all EMAP-recommended programs can be started in the first two years, major infrastructure improvement projects will require coordination, planning, design, permitting, and funding that will extend project start dates beyond this period.
**Long-term Actions:** Major energy infrastructure improvement projects can be phased to coincide with terminal redevelopment projects and electrical generation, transmission, and distribution system upgrades. Examples of these projects include:

- Retrofits to the Harbor Generating Station for inclusion in a Port microgrid that is operated by LADWP
- Reconfigurations of terminal electrical distribution systems from radial to ring configurations during terminal redevelopment projects
- Development of an LADWP owned and operated, high-voltage, power distribution system dedicated to the Port.

Other long-term projects may include renewable generation that incorporates new and developing technologies and implementation of energy efficiency measures associated with terminal automation. All EMAP recommended programs include Long-term Actions.

Energy management is an ongoing process that must be adapted to changes in operations and development of new technologies. It is recognized that ongoing analysis will be needed to assess the effectiveness of programs and inform specific follow-up actions since they will be contingent on the findings and impacts of prior studies and programs. Therefore, it is recommended that the Harbor Department employ an adaptive management approach for continually improving and developing new EMAP actions, programs, and projects. An overview of the benefits of EMAP recommended actions relative to the five Port Energy Pillars are presented in Table 3.

### Table 3. Benefits of EMAP Recommended Actions to Port Energy Pillars

<table>
<thead>
<tr>
<th>Action / Benefit</th>
<th>Availability</th>
<th>Reliability</th>
<th>Efficiency</th>
<th>Sustainability</th>
<th>Resiliency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Foundation</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Collaboration and Outreach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Energy Master Plan Studies</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Terminal Assessment &amp; Efficiency Program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Energy Technology Advancement Program</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>LED Lighting Program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Transmission and Distribution System Improvement Program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Resiliency Program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Renewable Energy Program</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

1. Microgrids can incorporate renewable energy generation to enhance sustainability and resiliency.

### 5.1 ORGANIZATIONAL FOUNDATION

Development of the organizational foundation is needed to provide leadership and a cohesive approach to implement studies, projects, and programs that improve energy use and management. This includes the establishment of the Port Energy Policy and formation of an Energy Management Team. This will build on and leverage existing Port sustainability related programs, including the Clean Air Action Plan,
Sustainable Lease Agreements, Environmentally Preferable Purchasing, Green Technology Development Programs, and Green Design and Construction Programs.

### 5.1.1 Port Energy Policy

The Energy Policy will establish the vision for energy management at the Port. The EMAP provides a basis for the development of the policy through the evaluation of the five Energy Pillars. The policy will provide a commitment by the Harbor Department to work with key stakeholders to implement studies, programs, and projects that improve energy resiliency, availability, reliability, efficiency, and sustainability.

### 5.1.2 Energy Team

An Energy Team will be formed to provide a consistent approach to implement the interrelated projects of the EMAP. The team will include a dedicated Program Manager that will serve as the team lead, and will be responsible for developing a plan to engage key stakeholders in the development, implementation, and refinement of EMAP programs, strategies, and actions. Other team members will include individuals from the Harbor Department Executive Team; appropriate Divisions including Business Development, Construction and Maintenance, Engineering, Environmental Management, Government Affairs, Homeland Security, Information Technology, Planning, Legal, and Real Estate; and experts knowledgeable in energy management and port operations.

Potential roles of the Energy Management Team include:

- Coordinate with LADWP to plan, develop, finance, and implement energy infrastructure improvements
- Collaborate with POLB on joint Port energy efforts
- Develop and manage stakeholder outreach
- Work with local, state and federal regulatory agencies
- Oversee and manage studies and modeling efforts required to develop an Energy Master Plan
- Manage energy-based technology programs
- Develop and manage Port incentive plans
- Serve as the Port interface with electricity and gas providers
- Evaluate the findings and recommendations of energy-related studies
- Develop education and outreach programs to increase energy awareness
- Develop energy management best practices and training programs
- Evaluate projects based on alignment with Port Energy Pillars
- Identify and secure funding opportunities
- Adaptively manage the EMAP to take advantage of lessons learned, new technologies, and operational approaches.

### 5.1.3 Metrics and Goals

Specific measurable metrics and goals are crucial to prioritizing actions and tracking progress. For each of the Energy Pillars, measureable metrics will be developed to benchmark existing conditions. From the metrics, the Energy Management Team will develop specific and achievable goals for each Energy Pillar. Examples of potential Energy Pillar goals and metrics are presented in Table 4.
### Table 4. Examples of Port Energy Pillar Goals and Metrics

<table>
<thead>
<tr>
<th>Energy Pillars</th>
<th>Goals</th>
<th>Metrics</th>
</tr>
</thead>
</table>
| Resiliency     | Port operations are resistant to electrical outages and have the capacity to rapidly recover from regional disasters or grid outages | • Percentage of cargo and fuel that can be moved during a grid outage or regional disaster  
• Time to recover operations from an outage  
• Duration facilities can operate independent of the grid |
| Availability   | Electrical infrastructure meets future power demands                 | • Ability of electrical system to support peak demands                  |
| Reliability    | Minimize disruptions of terminal operations                           | • Frequency and duration of terminal equipment outages/disruptions (SAIDI and SAIFI) |
| Efficiency     | Reduce energy usage and costs where practicable                       | • Energy usage by operation (e.g., lighting)  
• Per unit and annual energy costs |
| Sustainability | Renewable generation is used to reduce GHG emissions                 | • Port renewable percentage  
• GHG emissions reductions (including impacts of electrification) |

The most critical metric to develop at this time is for the Port to have the ability to identify when power events occur that affect its tenant’s operations. Until these events can be both identified and recorded, there is no way to verify that any of the modifications being made are having the desired effect on the overall system.

It is also strongly recommended that the Harbor Department and its tenants begin tracking the data available from all existing metering within the Port. To the greatest extent possible, these data need to be tied to operations served by the meters so that benchmarks for consumption can be established. The aggregation of Port electricity data will allow LADWP and the Harbor Department to evaluate the merits and effects of planned and implemented changes to the transmission and distribution system.

The goals and metrics developed will be a key component of tracking progress in each of the Energy Pillars. At a minimum, an annual dashboard will be developed to display progress of each energy goal. More frequent reporting may be possible depending on the metric and methodology for calculating improvements. Information gained will be used to identify best practices, set new performance goals, and update the EMAP.

### 5.2 COLLABORATION AND OUTREACH

In order to improve the overall Port power profile, stakeholder engagement and outreach will be important and on-going components throughout the entire program. A Technical Working Group can be established to engage the following key partners and stakeholders.

**Los Angeles Department of Water and Power:** The Harbor Department has a distinct advantage in coordinating with LADWP because both are sister proprietary departments within the City of Los Angeles (the City). The leadership of both organizations, as well as City leadership, recognizes the uniquely important role that the Port plays as an economic engine for the region, generating $35 billion in annual wages and taxes and supporting 830,000 regional jobs. Like LADWP, the Harbor Department also plays an important role in maintaining the safety of the region and the nation from day-to-day threats and potential disasters. The Port’s effectiveness in sustaining and growing these services is dependent on secure and dependable power.
Coordination with LADWP will be critical to meeting the requirements of AB 628 and implementing key elements of a number of Port energy strategies, including studies, system enhancements, and infrastructure improvements that are supported by existing LADWP programs and initiatives. Additionally, LADWP has established a number of relevant programs that could be used to support Port power profile enhancements, such as Smart Grid, Power Reliability, Power Supply Program, Solar Incentive, Feed-in Tariff, and Energy Efficiency.

**Port Tenants:** Approximately 93 percent of the energy consumed at the Port is for tenant operations; therefore, tenant engagement is critical to the successful and sustainable implementation of the EMAP. The intent of the EMAP is to enhance continuity of Port business operations and improve energy efficiency and cost effectiveness. Port tenants would be engaged in all energy strategies from studies to project implementation.

Coordination and partnering with cargo and fuel terminal operators will be crucial to the Port’s ability to enhance regional resiliency to a disaster. It is not enough merely to offload the cargo and fuel, continued operation of on-land transportation and refineries are also critical.

**Port of Long Beach:** Energy management for national competitiveness and regional resiliency are issues that are shared in common across the San Pedro Bay Port Complex. As has been the case in the Clean Air Action Plan and the Water Resource Action Plan, POLA and POLB have much to gain through collaboration. This includes sharing best practices and lessons learned, as well as working together to increase resiliency of terminal operations in the event of regional disasters. This may be accomplished through the design and construction of an inter-port power connection. The Ports initiated this collaboration with a joint energy workshop in 2013 attended by staff, utilities, customers, Port commissioners, elected officials, and other stakeholders. The Ports may consider entering into a memorandum of understanding (MOU) to work together on energy issues.

**Other Utilities:** Coordination with SCE and Southern California Gas Company will be important for the purposes of developing redundant back-up power sources for critical operations. Coordination with SCE will be needed if POLA and POLB decide to pursue an inter-port power connection. Coordination with Southern California Gas Company will be important in the consideration of on-site power generation solutions, since natural gas is currently the cleanest energy source for dispatchable generation assets. Southern California Gas Company would also be engaged in the potential development of liquefied natural gas (LNG) facilities, since shipping lines are beginning to consider the use of LNG as a viable fuel source for ships. LNG is currently being used as a fuel for approximately 900 drayage trucks operating in the San Pedro Ports, with LNG primarily coming from a natural gas liquefaction facility in Boron, California.

**Other Stakeholders:** There are a large number of additional important stakeholders who will be engaged on project or program-specific basis. They include the City of Los Angeles Mayor’s Office and other City departments, DHS, key regulators, the surrounding community, and other local, state, and federal government entities.

### 5.3 ENERGY MASTER PLAN STUDIES

While the Luskin Center Study provided an initial high-level assessment of terminal energy usage, further studies of existing infrastructure, operations, and energy use are required. It is important to realize that studies are only snapshots in time; they must be revisited periodically to remain relevant when decisions
are being made within the Port. The interval between studies will vary depending upon the study’s focus and the changes within the Port and the industry as a whole, but no studies should be left dormant for more than eight years. All terminal assessments will be conducted on a voluntary basis, with financial benefits provided to tenants in the form of optimizing their energy efficiency and associated infrastructure. Study findings and recommendations will provide the basis for the development of a Port Energy Master Plan, which will detail projects that will improve the power profile of the Port.

5.3.1 Baseline and Forecast Energy Study

A follow-on, more granular assessment of energy usage at the Port is required. This study will be a detailed, field-validated, and terminal-focused analysis of the existing Port facilities, and it will establish a baseline energy model for the various Port facilities. An energy forecast will be developed from this baseline that will help to estimate future energy demand. Since some assumptions will be made on what specific equipment will become electrified, a range (conservative, moderate, aggressive) of forecasts is recommended. Similar to other Port documents such as the Cargo Forecast and Emissions Inventory, this in-depth look into future energy use will serve as a foundation for future studies and decision making.

As-Built Documentation: A comprehensive infrastructure list detailing the major infrastructure assets at the Port and its terminals, inclusive of energy demands, is needed. In order to make recommendations on future condition assessments, the full portfolio of assets must be well known and understood. Along with an infrastructure list, an inventory of known performance issues can prove valuable. Any known problems, including weak points in the energy distribution system, deferred maintenance issues, and other items of note should be inventoried and incorporated in the study.

Load and Distribution Analysis: The next step will be to tabulate utility loads for each terminal or building based on size, use, occupancy, and engineering judgments. An analysis of the electric utility infrastructure distribution can be performed to determine any sizing deficiencies, bottlenecks, or distribution concerns based on tabulated loads. Recommendations for locations and metering specifications for each utility at each terminal, building, or other load can then be provided.

- Loads Development: Load models for existing terminals, buildings, and other Port facilities will be developed. Next, future growth load projections will be assessed for future equipment and facilities with respect to load, location, and timing. This can provide a significant benefit and value to the Port because it supports the design of systems that are right-sized for expansion and provides adequate lead time for the planning and implementation of utility projects.

- Distribution Analysis: Electrical models provide a comprehensive look at the electrical system. As it is the most critical utility for the Port, this enhanced analysis and system understanding can be significantly beneficial. Modeling or load profile development can help to identify system weaknesses, trends, or opportunities for improvements that would otherwise go unnoticed. This can include an evaluation of LADWP providing service to the Port at a higher transmission voltage.
5.3.2 Resiliency Assessment

As a regional and national strategic asset, it is vital that the Harbor Department and its tenants understand the Port’s current level of resiliency and improve it where needed. A Resiliency Assessment will be performed to baseline the current ability of the Port to absorb changes in operating conditions such as power outages or service disruptions due to natural or human-caused events, as discussed in greater detail in the Resiliency Program. Additionally, many resources have been expended by the Harbor Department Homeland Security Division to enhance cyber security, and it will be important that studies and recommended actions are coordinated as energy and cyber security are closely related and critical to Port resilience.

5.3.3 Distributed Generation Analysis

Once the capacity of the distribution system to handle current and future loads has been determined and resiliency goals have been established, the viability of alternative distributed energy strategies can be analyzed. This assessment will determine requirements and savings related to energy, resiliency, operations and maintenance, and capital costs. Important considerations include existing utility contracts and current requirements and constraints of Port operations. Production simulation models can be developed to provide projections of energy usage. Simulations can include CHP, PV, wind, biomass, and other local generation, as well as energy storage options, as detailed in the Resiliency Program.

5.3.4 Funding Assessment

Assessments of potential project financial considerations and funding initiatives will be performed to help prioritize projects. Local, state, and federal funding opportunities will be evaluated for Port energy projects along with various other financial and market incentives that can help improve the overall economics of energy investments. Funding options are reviewed in the Program Funding Section.

5.3.5 Energy Master Plan

The results of the energy studies will be summarized into a Port Energy Master Plan. The Master Plan will detail the specific actions that can be taken to reduce energy-related operating costs and environmental impacts while providing high-quality, safe, and reliable energy delivery for Port operations. The Master Plan will provide a total resource loaded schedule for recommended projects, and it will include the associated total cost, cost spread over development and construction phases of the projects, and the project schedules. The Energy Master Plan will provide detailed information on future project timing, overall capital budget needs, and project funding sources.

5.4 LED LIGHTING PROGRAM

Outdoor high mast lighting is critical for continuous and uninterrupted cargo handling operations at Port terminals. It is also, currently, the single largest category of electricity consumption at the Port, representing 34 percent of the total electricity usage at a container terminal. There are an estimated 500 high mast lighting poles with about 6,000 light fixtures (12 per pole) at container terminals. With the recent advancements in LED high mast lighting technology, significant energy efficiency and cost savings can be achieved by replacing the existing High Pressure Sodium (HPS) high mast lighting. The highly advanced LED lamps developed for port environments offer over 50 percent savings in direct electricity consumption, which corresponds to 50 percent reductions in energy cost. Other advantages of these LED lamps include: five times longer life (25 years compared to 5 years), improved color rendering, longer
maintained brightness, much faster time to full illumination, more durable (resistant to shock or vibration), virtually maintenance free, and free of toxic chemicals. LED lighting also presents opportunities for advanced controls, such as motion sensors, which can further reduce the energy consumed by lighting at the Port.

The initial estimated capital cost for replacement of HPS high mast with LED lighting is $20 million Port-wide. Given LED’s significant energy/cost savings and their extended life, the return on investment is anticipated to be seven to eight years, after which savings would continue throughout the 25-year life of LEDs.

The LED Lighting Program will assist in deploying LED lighting at terminals. The switch to LED lighting would use energy more efficiently and reduce lighting costs for terminal operators. The program will explore incentives, financing, or grants to fund the lighting replacements, such as those described in the Program Funding Section.

5.5 TERMINAL ASSESSMENT & EFFICIENCY PROGRAM

Many of the equipment and electrical systems used at terminals have been designed to move heavy containers and large amounts of petroleum, in most cases assuming the worst case load scenarios. As a result, the energy efficiency of the equipment and the systems has been subservient to power availability, reliability, and future capacity management goals.

This program would begin with assessing how energy is used by the terminal and identifying areas of improvement. A series of best practices and technologies would be developed and suggested as options to improve efficiency at cargo and fuel terminals. Implementation of any options would be at the discretion of the operator. Energy efficiency options include:

**Smart Metering:** Participation in Smart Metering will allow terminals to proactively manage their energy use to realize cost savings and other energy management goals. LADWP is initiating a Smart Grid program that could provide the following benefits to the Port electricity consumers and LADWP.

- Provide data on best energy conservation opportunities to reduce energy demands
- Verify available capacities in existing systems
- Enhance the ability to accurately forecast future usage and demands, which are crucial for determining future energy availability
- Provide information to the utility regarding vulnerable spots in the system to target corrective actions.

**Terminal Lighting Control Strategies:** Incorporation of LED lighting provides an opportunity for new lighting control strategies offered by the instant-on capability of LED systems. Advanced control systems provide the ability to account for seasonal changes in day length and adjust lighting to meet operational requirements. For example, as terminal operations are automated, lighting levels can be reduced since operations will be less dependent on human control and oversight. This would allow for lighting energy reductions in areas when people are not present.

**Demand Response.** Tenants may participate in demand response programs offered by LADWP to shed loads during periods of high stress on the transmission system. There is the potential opportunity for the Harbor Department to coordinate the efforts of several tenants in order to share the rewards of these programs while simultaneously reducing each tenant’s risks. Loads could be
prioritized by the amount of time they can be turned off before they impact operational productivity. The Harbor Department can work with LADWP to evaluate the potential benefits of creating a virtual power plant using the demand response capabilities of the tenants within the Port.

**Energy Efficient Cranes:** Wharf cranes have the second highest energy demand at container terminals, consuming 26 percent of terminal energy. New crane technologies generate electricity during the container lowering cycle, recovering approximately 18 minutes of power for each hour of crane operation. Additionally, crane operations can be synchronized to enhance energy efficiencies by reducing the overall peak demand on the Port’s electrical infrastructure. Energy efficient wharf cranes have been verified by CARB to reduce air emissions.

**Cogeneration:** While each of the tenants currently purchases all utility services independently from LADWP (electricity and water) and Southern California Gas Company (natural gas), efficiencies may be gained from the collective development of Port energy and heating infrastructure. Development of CHP facilities provides a means for generating electricity, while simultaneously capturing otherwise wasted thermal energy, which can then be used to heat or cool buildings or provide process heat to associated industries, such as refineries. In situations where thermal energy is not needed, a combined cycle energy plant may be employed. This type of plant generates electricity and uses the waste thermal energy to produce additional electricity, thus increasing generating capacity and efficiency. Additionally, waste heat that may be produced by one tenant’s operations can be captured for use by other tenants.

**Building Energy Efficiency:** The Harbor Department’s Green Building Policy encourages the use of building design and construction guidelines based on the Leadership in Energy and Environmental Design (LEED) Green Building System. This system includes considerations for improving energy efficiency. Under this program, new developments of 7,500 square feet or greater must achieve a minimum of a LEED Silver Rating and incorporate solar power and best available technology for energy and water efficiency. The program also requires existing buildings of 7,500 square feet or greater be inventoried and evaluated for their applicability to the LEED Existing Building Standards.

**Off-peak Charging:** Implementing charging schedules for electrical equipment that take into account differences in electricity rates throughout the day and the effect of peak demand charges can substantially reduce costs. Some facilities have gone a step beyond and have installed bidirectional chargers for electric equipment, allowing the equipment to function as batteries that provide peak-shaving opportunities.

**Power Factor Improvement:** Power factor is defined to be the ratio of real power to the apparent power in the circuit, with values ranging from 0-1 when electricity is flowing from the generation source to the load. Consuming power at a low power factor is expensive and inefficient, and many utility companies charge penalties for power factors below 0.95. Harbor Department staff has indicated that the average power factor at terminals is 0.85, with cranes operating at power factors as low as 0.35 to 0.45. Low power factor also reduces the electrical system’s distribution capacity by increasing current flow and causing increased voltage drops. Therefore, power factor improvements can provide benefits to energy efficiency and reliability.

**Power Quality Improvement:** In addition to potential improvements to the utility transmission and distribution system, reliable Port electronic system performance also requires stable and dependable system wiring within the Port. An initial inspection of the wiring and grounding system of terminals can help identify or rule out Port-related causes of reoccurring electrical problems. Once the integrity of the wiring is established, power conditioning products, such as transient voltage surge suppressors,
isolation transformers, voltage regulators, and uninterruptible power supply, can be applied at the terminals to protect critical equipment and processes.

_Operational Efficiency Options:_ Terminal assessments will provide detailed information on cargo handling equipment, the electrical infrastructure and energy loads and demands of terminal buildings, as well as overall operations. The findings of these assessments will be used to develop recommendations to improve energy management. The Harbor Department will conduct assessments of successful operational efficiency improvements implemented or planned by other ports and will provide this information to tenants. Increases in efficiencies reduce energy consumption, costs, and GHG emissions.

### 5.6 TRANSMISSION AND DISTRIBUTION SYSTEM IMPROVEMENT PROGRAM

In light of perceived issues with reliability and quality of power provided by LADWP to the Port, a system planning study is recommended that involves system modeling, fault analysis, and mitigation/upgrade analysis. A follow-on system vulnerability assessment can be used to identify vulnerable points of the system, collect system operational data, and field test recommendations. These simulations can be used to:

- Review the potential for the consolidation of functions to reduce the number of service points
- Optimize redundancy and efficiency opportunities
- Assess the feasibility of energy conservation measures and retrofits
- Evaluate alternative power supply options

#### 5.6.1 Enhanced Transmission System

Higher transmission voltages inherently provide more reliable service due to the additional physical protection, electrical isolation, and source redundancy utility companies design into these systems. In addition to seeking higher quality of power, this also provides a path to allowing LADWP to serve the anticipated dramatic growth in power demand at the Port in the foreseeable future.

#### 5.6.2 Electrical Distribution Configuration

Most terminals in the Port currently have a star (or radial) electrical distribution configuration. This configuration is more susceptible to system-wide outages than a ring configuration. The star distribution system has only one power source for the entire terminal, so a power failure, short-circuit, or a downed power line could disrupt power to an entire terminal. A more resilient configuration is the ring (or loop) electrical distribution system. A ring system would loop through the terminal and return to the original connection point. The ring can be tied into an alternative power source, and by placing switches in strategic locations, power can be provided to the terminal in either direction. The ring system is more expensive than the star system because more switches and conductors are required, but results in substantially improved system reliability and greatly facilitates planned and unplanned maintenance of the electrical system.

### 5.7 RESILIENCY PROGRAM

The Port is a valuable asset that is crucial to Southern California’s subsistence and the nation’s economy. It is vital that the Harbor Department and its tenants collectively understand the Port’s current resiliency and make improvements where needed. Detailed studies are needed to determine the appropriate
approaches to maximize operational resiliency. Under this program, the Port will be assessed for ways to improve its ability to absorb changes in operating conditions such as power outages or service disruptions. The methodology will include mapping of existing interdependencies, identifying existing threats and vulnerabilities, and providing options to enhance energy security and resiliency. This assessment is scheduled to be completed September 2014.

5.7.1 Resiliency Assessment

The Harbor Department has established an agreement with the Naval Postgraduate School Center for Infrastructure Defense to perform an assessment of the vulnerabilities of the Port to disruptions in container and fuel transport. The assessment will also evaluate options for enhancing the reliability and resiliency of Port container and fuel throughput operations.

5.7.2 Microgrids

Microgrids that incorporate distributed generation and energy storage provide one of the best options for enhancing Port resiliency. Many large utility customers, including military installations, hospital campuses, and universities, are designing and constructing microgrids to better manage energy usage and enhance power quality and system reliability. A microgrid can be designed that integrates and controls multiple local generation and storage assets (e.g., PV arrays, wind turbines, diesel generators, combustion turbines, fuel cells, battery systems, and CHP) to provide on-site generation for local loads in both grid-tied and islanded modes of operation. Even if a microgrid is not to be implemented immediately, it is advantageous to plan all modifications and additions to the electrical system with a microgrid mindset to allow for increased resiliency.

Since the Harbor Department desires to achieve a level of resiliency that allows for the sustained (or rapidly regained) capacity to continue cargo and fuel terminal operations, it is worthwhile to first consider approaches to powering the entire Port, including immediately adjacent fuel refineries. Both terminal and fuel refining operations will be crucial for regional recovery from a disaster. Microgrids can also be considered for individual terminals and refineries.

**Port Microgrid:** As the electricity provider to the Port and the owner and operator of the Harbor Generating Station, LADWP can play a significant role in enhancing the resiliency of the busiest container port in the U.S. through the development of a Port microgrid that is powered by the LADWP Harbor Generating Station. The LADWP Harbor Generating Station is located immediately adjacent to the Port, and has the capacity to generate 472 MW, which is sufficient to power all Port operations, as well as those of adjacent oil refineries. A retrofit of the Harbor Generating Station and incorporation of the station in the Port microgrid can provide a mechanism for LADWP to provide the Port power directly from the station in the event of a broader LADWP service disruption. It may also be possible to retrofit one of the generators with the ability to use a fuel source normally stored within one of the bulk terminals in order to provide power even if the natural gas supply is cut off. While this will require extensive coordination with LADWP, multiple utilities across the nation have taken on the role of providing reliable power to major energy consumers through the development of microgrids and facility-specific on-site generation that can be used to power other service areas as well.

LADWP is implementing repowering projects of its coastal power plants to eliminate ocean water cooling. Repowering of Unit 5 of the Harbor Generating Station is scheduled to begin in 2019 and extend through 2026. While incorporation of the Harbor Generating Station into a microgrid would not require major retrofits to the station and can be feasibly implemented well in advance
of the current repowering schedule, microgrid retrofits should be considered as a component of the redesign project.

**Terminal and Refinery Microgrids:** Microgrids can be designed and built for individual terminals and refineries. Since the peak demand of most fuel and cargo terminals range from 1-8 MW, there are multiple power sources that can be utilized to form microgrids to power all critical terminal operations. A cost-benefit analysis can be performed to determine the most cost-effective solution to providing grid-independent, reliable power to terminals. Refineries generally require much more electricity (50 MW or more), as well as heat and steam. As a consequence, CHP facilities should be evaluated for on-site generation solution for refineries.

### 5.7.3 Distributed Generation

Once the capacity of the distribution system to handle current and future loads has been assessed, the viability of alternative distributed energy strategies can be analyzed to determine requirements and savings related to energy use, resiliency, operations and maintenance, and capital costs. Important considerations include existing utility contracts, as well as requirements and constraints of Port operations. Production simulation models can be developed to provide projections of energy usage. Simulations can include CHP, PV, wind, biomass, and other local generation, as well as energy storage options. Potential power sources are described in Table 5.
### Table 5. On-Site Power Options

<table>
<thead>
<tr>
<th>Power Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Solar</strong></td>
<td>Although solar power takes many forms, the most applicable form for the Port is silicon-based PV cells that can directly convert sunlight into electricity. These are an excellent “no local emissions” source of electricity but are very space intensive and do not provide a dispatchable source of energy for contingencies. Dispatchable generation includes power sources that can be turned on or off or can adjust their power output on demand.</td>
</tr>
<tr>
<td><strong>Wind</strong></td>
<td>Windmills or wind turbines that convert the motive power of wind to rotational movement of an electrical generator provide a “no local emissions” source of electricity that may be available at any time of day. As with solar power, wind is not a dispatchable resource. Commercially available turbines have the capacity to produce 1-3 MW of power, with adequate wind.</td>
</tr>
<tr>
<td><strong>Biomass</strong></td>
<td>Biomass energy is derived from five distinct energy sources: garbage, wood, waste, landfill or wastewater treatment gasses, and alcohol fuels. The gasses given off by these products can be burned to produce heat for generation of electricity or other process requirements. Biomass is the most environmentally sound dispatchable energy resource, but it requires relatively close proximity to its source to be cost-effective.</td>
</tr>
<tr>
<td><strong>Natural Gas Generators</strong></td>
<td>Natural gas generators produce electricity on demand through internal combustion engines or turbine engines. They are fully dispatchable and provide one of the cleanest forms of fossil fuel energy conversions. Also, many natural gas generators may be configured to burn diesel during natural gas service disruptions.</td>
</tr>
<tr>
<td><strong>Diesel Generators</strong></td>
<td>Diesel generators produce electricity on demand through internal combustion engines or turbine engines. They are fully dispatchable and offer the advantage of being able to easily store many days of energy for contingency planning.</td>
</tr>
<tr>
<td><strong>Fuel Cells</strong></td>
<td>A fuel cell is a device similar to a battery that converts the energy from a fuel into electricity through a chemical reaction with oxygen or other substances. Hydrogen is the most common fuel, but natural gas and alcohols may be used. Fuel cells are dispatchable, but work best with slowly changing loads.</td>
</tr>
<tr>
<td><strong>Combined Heat and Power</strong></td>
<td>CHP provides a means for generating electricity, while simultaneously capturing thermal energy, which can be used to heat or cool buildings or provide process heat to associated industries, such as refineries.</td>
</tr>
<tr>
<td><strong>Energy Storage</strong></td>
<td>Although batteries are not truly an on-site power source by themselves, they are becoming an integral part of renewable energy solutions. This is due to the uncontrollable nature of most renewable sources of power and the negative effects they have on the electrical grid at large. Batteries are available in a variety of technologies each of which has unique advantages and challenges.</td>
</tr>
<tr>
<td><strong>Uninterruptible Power Supply</strong></td>
<td>As with energy storage, uninterruptible power supply (UPS) power is not an on-site power source per se, but it does provide power when the commercial power system is unavailable. Due to the relatively high cost of UPS power, it is typically used in targeted applications. For example, instead of providing power to an entire terminal, UPS modules are placed at dedicated pieces of equipment (e.g., computer servers) to ensure those individual components of the system do not experience power outages.</td>
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5.8 RENEWABLE ENERGY PROGRAM

The Harbor Department is committed to facilitating growth in trade while reducing GHG emissions. Significant progress has been made in reducing locally generated GHG emissions through the electrification of cargo handling equipment and implementation of pollution control programs, such as the Clean Truck Program. To reduce the overall carbon footprint of Port operations, it is important that the electricity the Port uses is derived from renewable and cleaner energy sources.

LADWP is making significant progress to meet the RPS goal of 33 percent renewable energy by 2020 and is phasing out the use of coal generation. These efforts reduce the GHG emissions for each unit of electricity used to power Port operations. However, cargo throughput and overall container operations are projected to continue to grow over the coming decades, increasing electricity demands. This trend of continued operational growth requires the Port to implement additional measures over and above those of LADWP to grow green.

The Port’s Renewable Energy Program could include developing and implementing the following measures:

Renewable Power Purchase Agreement: The Harbor Department has established a power purchase agreement with LADWP to pay a renewable surcharge to contribute to the development of LADWP renewable sources for power used by the Department. The Harbor Department could look at potential ways to further assist in the development of renewable power at the Port or in adjacent areas in partnership with LADWP.

Cap-and-Trade Program: A significant statewide initiative to reduce GHGs is the implementation of a cap-and-trade scheme as a part of AB 32. While AB 32 was passed and signed in 2006, the cap-and-trade aspect of the legislation was adopted in 2011. The program puts in place a declining emissions cap for the state that is backed up with a market system. The Harbor Department can look into ways to participate or facilitate participation in the program.

Solar Generation: On a local basis, the Harbor Department currently generates a total 1.6 MW of electricity from solar PV system at 8 locations and is partnering with LADWP to develop an additional 8.4 MW of solar power within the Port and suitable adjacent properties in order to fulfill a 10 MW commitment contained in a memorandum of understanding with the California Attorney General. While solar energy is not the most cost-effective or space-efficient means of generating on-site energy, it provides a highly visible example of the Harbor Department’s commitment to renewable generation and green growth. Additionally, warehouse rooftops provide ideal locations for solar arrays provided that the buildings and roofs are structurally sufficient to bear the additional weight. The Port also has ample parking lots and buffer areas that could support solar installations.

The Harbor Department and its tenants are working with LADWP under its Feed-in Tariff (FiT) program to install 5.7 MW of solar, improving the economics of solar-generated power within the Port. The Harbor Department is planning to use requests for proposals (RFPs) as a means of funding the installation of PV systems within the Port at no cost to the Harbor Department or tenants. The initial RFP will require the proposers to construct their PV systems under the terms of the LADWP FiT program, which will serve as the source of income for the developers. The Harbor Department submitted 12 applications before the program’s third tier deadline, of which, five received priority under the FiT lottery selection process and one may receive priority in the future. Additional RFPs are planned for subsequent tiers of the FiT Program. RFPs will also be used to fund additional PV systems outside of the FiT program, including RFPs for other alternative energy projects using traditional financing methods.
**Wind Generation:** A feasibility analysis of wind power potential is currently being planned at the Port. A meteorological tower is planned to be installed at Pier 400, along with other meteorological stations throughout the Port, to collect wind data. The study, which is scheduled to be completed in late 2016, will evaluate the feasibility of incorporating wind generation at the Port, and will analyze the most favorable locations to install wind towers within the Port.

**Offshore Wind and Wave Generation Feasibility:** The Harbor Department could initiate feasibility studies for offshore wind and wave farm projects in partnership with federal, state, and regional agencies and other stakeholders. The studies could assess the technical and economic feasibility of various technologies for the Southern California offshore environment, as well as the potential impacts of the projects on the environment and human uses, including commercial shipping and recreational boating. If feasible offshore wind or wave opportunities are identified, the Harbor Department could begin the process of engineering, design, and demonstration of a test system.

**Geothermal Power Feasibility:** The Harbor Department could initiate feasibility studies for the installation of true geothermal power generation within the Port. This would consist of fluid coils drilled thousands of feet into the earth to use the Earth’s internal heat as a power source. If successful, this would provide a no-emissions source of power to the Port that is completely dispatchable and truly independent of any outside supply system.

### 5.9 ENERGY TECHNOLOGY PROGRAMS

Technology advancement has been a priority at the Ports of Los Angeles and Long Beach for several years. Previous efforts, such as the jointly administered Technology Advancement Program (TAP) and PortTech Los Angeles, have been focused on technologies that reduce environmental impacts, particularly as they relate to air emissions. Energy management is recognized as a growing concern for ports nationwide, resulting in the expansion of the breadth of port technology programs into energy generation and management.

To complement each Port’s energy efforts, POLA and POLB could collaborate through an Energy Technology Advancement Program (eTAP) to identify and demonstrate energy technologies that would benefit both Ports. The eTAP would accelerate the development and commercial availability of new energy technologies and strategies that could ultimately improve the overall energy profile of the Ports in an efficient and effective manner. The eTAP would be developed and administered jointly between POLA and POLB, with funding allocations up to the discretion of each individual Board of Commissioners.

PortTech LA is a business incubator dedicated to developing and promoting businesses with clean technologies that help companies and industries resolve their environmental and regulatory challenges and meet their environmental, energy, security, and transportation goals. Serving as a commercialization center and incubation program dedicated to creating sustainable technologies for ports and beyond, PortTech LA can play a vital role in bringing innovative energy technologies and services to the Ports.
6.0 PROGRAM FUNDING

Improving energy management at the Port will require a significant investment in studies, programs and infrastructure improvement projects. The studies described in this EMAP will cost in the hundreds of thousands of dollars. Additionally, implementation of programs and projects, particularly generation projects, can cost tens of millions of dollars, potentially more. The Harbor Department and its tenants along with LADWP will want to seek and leverage any funds with outside monies from federal, state, and local agencies with aligning goals. Private industry funding may also be explored as well as creative financial tools such as loans, research partnerships, and service contracts. In addition, financial and market incentives that exist within California and the U.S. can help improve the overall economics of clean energy investments. Recurring assessments of potential project financial considerations and funding initiatives will be needed as the program progresses.

6.1 TYPES OF FUNDING

There are various funding approaches available to the Port. Many federal, state, and local agencies have policies that align with one or more of the Energy Pillars. Given the limited Harbor Department budget, grant funding will be critical in moving forward with the actions outlined in the EMAP. Since energy issues touch upon many topic areas, there will be opportunities to obtain grant funding from a variety of sources. Grants focused on security, emergency management, efficiency, on-site generation, and sustainability among others can all assist the Harbor Department and Port tenants in improving the Port’s energy profile. In addition to these approaches and sources of funds, the Harbor Department may wish to take steps to develop its own funding or financing sources, such as creating an energy revolving fund or an excise tax or fee-based program. Below is a short list of sources of funding and financing available from the government and the private sector that can help fund the implementation of the EMAP.

6.1.1 Federal Funding

The Federal government offers a wide range of grants, loans, bond programs and tax incentives for energy efficiency and renewable programs. The U.S. Environmental Protection Agency and the Departments of Commerce, Homeland Security, and Transportation have programs for sustainability and energy related security that may be sources of funds for planning and demonstration projects. Examples of these programs are presented as follows.

**Energy Efficiency and Renewable Energy (EERE) Program:** The Department of Energy offers annual solicitations to industry, government, and universities for demonstration projects in efficiency, vehicles, and renewables (e.g., bioenergy, wave, solar, and wind). The EERE program’s solicitations are generally between $500,000 and $10 million and often require matching funds (including in-kind). The funded projects must advance the state of a technology, such as biofuels, advanced vehicle technologies, and building technologies.

**Federal Business Energy Investment Tax Credit:** The Federal Business Energy Investment Tax Credit (ITC) offers corporate investment tax credits of 10 percent of all CHP projects and 30 percent for all solar expenditures. This incentive is currently available and would apply to the CHP projects and solar PV projects when owned by a private for-profit entity. For solar PV projects this credit has no maximum. Eligible solar energy property includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a facility, or to provide solar process heat. The CHP ITC also has no maximum limit. Eligible CHP property
generally includes systems up to 50 MW in capacity that exceeds 60 percent energy efficiency, subject to certain limitations and reductions for large systems.

**Port Security Grant Program (PSGP):** The DHS Federal Emergency Management Agency PSGP funds are available to the Harbor Department and its tenants, and are intended to improve port-wide maritime security risk management, enhance maritime domain awareness, support maritime security training and exercises, and to maintain or reestablish maritime security mitigation protocols that support port recovery and resiliency capabilities. PSGP funds may be used for energy projects provided that projects are aligned with the annual priorities.

### 6.1.2 State of California Funding

State agencies, such as the California Energy Commission, have particular interest in efficiency and renewables. State funding can come in the form of grants, financing, in-kind contributions, mutually beneficial research, and information sharing.

- **Alternative Fueled Vehicles and Vehicle Technologies:** The CEC offers annual solicitations of more than $80 million during the fall and winter that can be used to fund projects associated with hydrogen fueling infrastructure, biofuels manufacturing, and electric and other alternative fueled technologies.

- **Energy Efficiency Financing:** The CEC offers 1-percent, fixed rate loans of up to $3 million per loan for commercial projects on a first come, first served basis. Public agencies are eligible. Agencies may be able to obtain free or discounted assistance from the State for a project feasibility study, which can then be included in the funding application.

- **Self-Generation Incentive Program (SGIP):** Initiated in 2001, SGIP is a ratepayer-funded program, overseen by the California Public Utilities Commission, which offers incentives to customers who produce electricity with wind turbines, fuel cells, various forms of CHP and advanced energy storage. For 2014, the incentive payments range from $0.46/W - $1.83/W depending on the type of system. Gas customers of Southern California Gas are eligible for the SGIP. Funding is scheduled to be available through January 1, 2016.

- **California Air Resources Board Cap-and-Trade Investment Plan:** The 2013 – 2016 draft Cap-and-Trade Investment Plan evaluates opportunities for GHG emission reductions and identifies priority State investments to help achieve reduction goals and yield co-benefits. The plan is still pending approval by the California legislature. At least 25 percent of program funding must be allocated to projects that benefit disadvantaged communities and at least 10 percent of program funding must be allocated to projects located in disadvantaged communities, such as Wilmington. The first auction in February 2013 yielded $163 million for the fund. Examples of priority projects for this program that may apply to the Port include: low-carbon freight equipment and zero-emission passenger transportation, necessary fueling/charging infrastructure, and industrial energy efficiency improvements.

- **Legislature:** Energy management at ports has even reached the attention of the California legislature. AB 628 requires the California Infrastructure Development Bank “to fund projects to finance projects to promote economic development in harbor and port districts that are developed pursuant to energy management plan[s].” This bill will not only finance energy focused projects, but also allows streamlined permitting for eligible projects.
6.1.3 Local Funding

LADWP is both an important partner and a potential source of local funding for Port energy management programs through assessment, efficiency, and renewable programs. There are also existing local financing programs and grant opportunities that can support the implementation of the EMAP.

**Commercial Energy Efficiency and Solar Rebate Programs:** LADWP provides rebates for lighting, refrigeration, chillers, new construction, retro commissioning, custom projects and purchasing or leasing solar panels. Businesses must apply for a rebate and show proof of installation to receive funds. Incentives are generally provided by unit (e.g., $5 per LED lamp). The custom program, for example, offers incentives for the installation of energy saving measures, equipment, or systems that exceed Title 24 or minimum industry standards, but are not specifically featured on any of the LADWP’s commercial rebate programs.

**Feed in Tariff (FiT) Program:** LADWP offers a FiT program to support the development of renewable energy projects in its territory to help meet the RPS goal of 33 percent renewable generation by 2020. All technologies accepted by the California Renewables Portfolio Standard are eligible for the FiT. This program will cap at 150 MW of generation. The Harbor Department and its tenants are working with LADWP under its FiT program to install 5.7 MW of solar, while improving the economics of solar-generated power within the Port.

**Property Assessed Clean Energy (PACE):** The County of Los Angeles offers a PACE program businesses interested in efficiency or solar projects. Under a PACE program, local governments can create property tax finance districts to issue loans for energy efficiency and renewable energy such as solar PV systems. PACE allows local governments to provide low-cost, 20-year loans to eligible property owners seeking to install these technologies. The customer then pays more on the annual property tax bill to repay the loan. The loans are permanently fixed to real property, so that businesses need not worry about their system’s break-even point and can pass the loan payments on to subsequent buyers of the property.

**South Coast Air Quality Management District (SCAQMD):** SCAQMD provides grants and incentives to reduce emissions from diesel vehicles and fleets (e.g., the Carl Moyer program). The District also provides incentives to invest in new mobile or stationary technologies. The Carl Moyer program offers grants for the electrification of construction and cargo handling equipment.

**Harbor Department and City of Los Angeles:** The City of Los Angeles, like other cities, issues municipal bonds to finance City projects. Funds may be available to the Port through the City’s or the Harbor Department’s capital improvement programs. The Harbor Department may also access bond funding through federal or state sponsored programs, such as the federal Qualified Energy Conservation Bonds program.

6.1.4 Private Funding

Energy service companies (ESCOs) and energy developers may serve as private funding sources for Port energy projects. State and federal tax incentives can help make these types of funding strategies more attractive.
Energy Service Companies: ESCOs develop, install, and fund projects designed to improve energy efficiency and reduce operation and maintenance costs in their customers' facilities. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project. ESCOs are set apart from other firms that offer energy-efficiency improvements by performance-based contracting. When an ESCO undertakes a project, the company's compensation is directly linked to the cost savings from energy actually saved.

Power Purchase Agreement (PPA): PPAs can be used to finance energy infrastructure projects and fix the cost of energy used by the Harbor Department and its tenants. Under a PPA, a third party owns and maintains the energy system, selling the kilowatt-hours back to the customer. Thus, customers who opt for a PPA (solar or otherwise) typically have low capital costs and pay only for the electricity their systems generate.

Solar Leases: By leasing a solar PV system, businesses can get the benefits of owning a PV system without the capital costs. Solar customers opting for solar leases simply rent the PV system from a company as they would any other home appliance while earning the benefits from the electricity the system produces. Solar leases are attractive options for business owners that plan to be at their business for less than five years.
There is a substantial opportunity for the Harbor Department to take a leadership role in energy management while providing added value to its customers, the surrounding community, the Southern California region, and ports nationwide. Like never before, the Port’s operations are becoming increasingly dependent on secure and reliable electricity, as AMP and electric cargo handling equipment are incorporated into terminal operations to enhance environmental stewardship, efficiency, and competitiveness. This is projected to result in at least a doubling and possibly a tripling in electricity demand over the next decade, while at the same time, electricity rates are predicted to increase by 40 percent. Furthermore, threats to the electrical grid from natural and manmade disasters will become increasingly problematic to Port operations. While Port-wide increases in annual electricity costs from approximately $36 million in FY 2012 to as high as $207 million in FY 2024 are staggering, they pale in comparison to the multi-billion-dollar financial impacts of a shutdown of the Port due to a major power failure. Therefore, infrastructure investments and improved energy management are profoundly needed to enhance the continued competitiveness and security of North America’s busiest container port.

Once the organizational foundation of the energy program has been established, the following three steps are recommended to enhance the Port’s energy infrastructure and management.

1. **Study:** *Conduct energy demand and infrastructure assessments.* This will serve as the first step to inform key decisions on infrastructure investments. These studies should focus on the most critical and energy intensive Port resources – the terminals – and assess the benefits of management practices and infrastructure improvements relative to costs and the goals of the five Energy Pillars. These assessments will lead to the development of an Energy Master Plan of prioritized projects with detailed financial breakdowns, schedules, and funding strategies.

2. **Reduce:** *Implement energy efficiency measures* to reduce operational costs and limit demands on the aging electrical system. For example, terminal lighting has been found to consume approximately 33 percent of electricity at Port container terminals, conversion to LED high-mast lighting would provide the greatest immediate reduction in energy consumption at Port terminals. There are also a number of opportunities the Harbor Department and its customers can pursue to realize significant operational cost savings, such as peak shaving and load shifting strategies. Many of these strategies require greater awareness of energy usage, which can be gained through smart metering.

3. **Secure:** *Develop secure and reliable power sources* that can power critical Port terminal operations and adjacent refineries. This is crucial to both the national competitiveness of the Port and the resilience of the Southern California Region to potential disasters. One of the best opportunities to enhance the security of the Port energy supply is the incorporation of the Harbor Generating Station into a microgrid that could power critical terminal and refinery operations. This partnership with LADWP will allow the Harbor Department to meet its goal of maintaining its ability to transport cargo and fuel to the Southern California region, while at the same time improving power reliability.

While the level of energy management presented in the EMAP is new to ports, there are multiple models to follow and proven approaches to build on from the military, universities, hospitals, and industry. Energy reliability, security, and resiliency are common concerns across these sectors, where just like at the Port, the cost of a power outage can result in significant losses of products, services, and even lives. Where the consequences of a power loss are so substantial, significant investments in energy reliability, security, and resiliency are an absolute necessity.