Energy Research and Development Division

FINAL PROJECT REPORT

An Advanced, Zero-Net-Energy Community Plan for the City of Carson, California

Renewable Generation, Battery Energy Storage and Demand Management, Energy Use Reduction Through Efficiencies, and a Comprehensive EV Charging Infrastructure

California Energy Commission

Gavin Newsom, Governor

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PREPARED BY:

Primary Author(s):
David Bliss
Jon Harding

Charge Bliss, Inc
8 Argonaut, Suite 160
Aliso Viejo, Ca 92656
Phone: 323-364-9936
http://www.chargebliss.com

Contract Number: EPC-15-055

PREPARED FOR:
California Energy Commission

Josh Croft
Project Manager

Erik Stokes
Office Manager
ENERGY DEPLOYMENT and MARKET FACILITATION OFFICE

Laurie ten Hope
Deputy Director
ENERGY RESEARCH AND DEVELOPMENT DIVISION

Drew Bohan
Executive Director

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Finally, the team expresses its gratitude to the community of Carson who have been enthusiastic supporters of the project. We sincerely hoped to bring renewable energy, vehicle electrification, significant energy efficiency, and a better environment for the citizens of Carson. While the goal of project construction was not achieved, the citizens provided unwavering support for which we will always be grateful.

PREFACE

The California Energy Commission's Energy Research and Development Division supports energy research and development programs to spur innovation in energy efficiency, renewable energy and advanced clean generation, energy-related environmental protection, energy transmission and distribution and transportation.

In 2012, the Electric Program Investment Charge (EPIC) was established by the California Public Utilities Commission to fund public investments in research to create and advance new energy solution, foster regional innovation and bring ideas from the lab to the marketplace. The California Energy Commission and the state's three largest investor-owned utilities – Pacific Gas and Electric Company, San Diego Gas and Electric Company and Southern California Edison Company – were selected to administer the EPIC funds and advance novel technologies, tools and strategies that provide benefits to their electric ratepayers.

The Energy Commission is committed to ensuring public participation in its research and development programs which promote greater reliability, lower costs and increase safety for the California electric ratepayer and include:

- Providing societal benefits.
- Reducing greenhouse gas emission in the electricity sector at the lowest possible cost.
- Supporting California's loading order to meet energy needs first with energy efficiency and demand response, next with renewable energy (distributed generation and utility scale), and finally with clean conventional electricity supply.
- Supporting low-emission vehicles and transportation.
- Providing economic development.
- Using ratepayer funds efficiently.

An Advanced, Zero-Net energy Community Plan for the City of Carson, California is the final report for the Advanced, Zero Net Energy Communities project (contract number EPC-15-088) conducted by the EPIC Division of the California Energy Commission. The information from this project contributes to Energy Research and Development Division's EPIC Program.

For more information about the Energy Research and Development Division, please visit the Energy Commission's website at www.energy.ca.gov/research/ or contact the Energy Commission at 916-327-1551.

ABSTRACT

New technologies in clean energy are continually emerging, yet few are being implemented on a community scale. This situation is especially true in low-income areas, which are more severely impacted by poor air quality and pollution and often unable to generate funding to initiate the installation of cleaner, cost-saving technology. To meet California's clean energy goals, these technologies must be widely incorporated into all types of California cities.

Charge Bliss, Incorporated was awarded grant funding from the California Energy Commission to design an advanced net-zero-energy community. Charge Bliss selected Carson in the Los Angeles region. Carson is one of the most socioeconomically and ethnically diverse communities in California and has some of the poorest air quality.

The team developed a master advanced energy community plan that touches all areas of a city's energy consumption from electric vehicle supply equipment, to building efficiency, to energy demand management and response, all while demonstrating cost savings. A case study specific to the designated community showed the effectiveness of the plan in community engagement, engineering, oversight, and finance. Charge Bliss analyzed the utility data, current electrical systems, major load items, and site operational needs for 18 municipal properties and 15 parks. The team also engaged a comprehensive array of community stakeholders to receive and incorporate input regarding project priorities, designs, and obstacles. Through this process, the Charge Bliss design team and the City of Carson were able to agree on a master advanced net-zero-energy community plan. Final systems include the installing electric vehicle chargers and improvements in solar, battery storage, lighting chiller systems, and load control architecture. Project financial modeling and serial discussions with city officials led to energy services power purchase or lease models, allowing the city and investors to each realize adequate returns while constraining risks.

Keywords: Distributed energy resources, advanced energy communities, microgrids, net zero

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EXECUTIVE SUMMARY

Introduction

California is frequently one of the first to recognize emerging social, economic, environmental, and health trends. Clean, renewable, distributed energy resources such as photovoltaic (PV), wind, geothermal and others significantly reduce most environmental impacts of energy generation, but also introduce complexities for overall management of the energy generation and delivery systems. Use of these resources has led to rapid swings in total power requirements necessary from traditional energy generation resources. In many energy markets the peak demand occurs after sunset, when solar power is no longer available.

To overcome the limitations of distributed energy resources, tools to smooth power quality and provide reserve capacity for dispatch are necessary. Energy storage technologies and smart power conditioning systems have emerged to fill the technological gaps. These systems regulate distributed energy resource performance, store and send power as needed, and respond to dynamic conditions either at the local or system level. Despite these advantages, however, adoption has been slow and has hampered the greater use of distributed energy resources. Business owners, municipalities, and other entities remain skeptical that such deployments will be safe, cost-effective, durable, and reliable; therefore, they are reticent to invest in what may be perceived as "experimental" technologies. Moreover, key stakeholders in the build-out of capital-intensive energy infrastructure, third-party investors, have been concerned about systems performance and reliability, as well as the absence of definitive finance and business models to support deployments.

Disadvantaged communities are the most likely to benefit from advanced energy communities but frequently lack the necessary resources. Seeking to meet community needs, city leaders often prioritize short-term goals, however, California regulations will soon require that all communities adopt these technologies.

Project Purposes

Charge Bliss, Inc., proposed research methods to develop and design a replicable comprehensive advanced energy community for a disadvantaged community in Southern California. Through the engagement of a relevant community, comprehensive evaluation, design, engineering, and financial research, the team intended to fill these gaps in knowledge and address barriers to execution.

The project sought to investigate and document advanced energy community development from initial stakeholder engagement by producing the documentation required to start construction. A roadmap for stakeholders to consider launching advanced energy communities consisting of:

- The essential stakeholders required to initiate and execute an advanced energy community,
- Methods for stakeholder engagement, data gathering, and collaborative design,
- The method for characterizing the community with respect to location selection, profiling of existing energy systems and loads, utility communication and an evaluation

of supply systems, site options and limitations for developing microgrid systems, and community uses of sites that might affect advanced energy community construction.
- Developed business and finance models that would be appropriate for municipal and investor participation and could serve as models for future deployments.

Project Approach

Successful design of an advanced energy community requires four critical steps. First, the team must identify communities with the characteristics that will maximize potential benefits. These include cities with:

- Low amounts of already installed advanced energy technology to achieve greater gains and potentially amortize costs of efficiency system upgrades across the project,
- Alignment between elected and employed city staff on clean energy goals to avoid later conflicts over value and priority, and
- Favorable renewable resources (sun exposure) and enough space for the necessary hardware to achieve technical feasibility.

Second, the team must engage stakeholders such as community members, city planners, and political figures to participate. Third, the team must evaluate each proposed physical site comprehensively to inform optimal designs of physical systems and appropriate sizing for necessary performance objectives. Lastly, to attract third-party investment, city leadership may need to be trained in or already aware of common energy project finance models.

The team selected 18 properties owned by the City of Carson including the city hall, community center, corporate yard, and 15 city parks based on a hierarchy of energy use, peak demand, space available for solar, battery and electric vehicle supply equipment systems, and city priorities. Nearly 50 percent of the total utility bill results from demand charges, and there are no building energy management systems. Much of the important energy infrastructure of these locations is aging and inefficient. Like Carson, other disadvantage community cities would benefit by increased efficiency, decreased base and peak loads, reduced operations costs, and sharing of cost between revenue generating renewable energy installations and nonrenewable systems such as heating ventilation and air conditioning, which do not produce revenue.

To address social, political, and economic issues, the team engaged with city government officials, advocacy groups, and community leaders. The team made presentations at public meetings, community events, and meetings with area community leaders to receive input regarding the current and future uses of target buildings, community perspectives on renewable energy and electric transportation, and goals for community development. This input helped avoid designs that would otherwise have interfered with major regional events such as annual festivals at several parks and the community center that required unobstructed parking lot space.

During the ongoing engagement with city personnel, the team attempted to educate the leadership on the social, environmental, and economic benefits of the project; but focus was dismissive from the distressed financial circumstances of the city, the disposition of the elected and employed leadership, or other factors that are unknown as of this time. Significant time was required to educate all parties on financial projections, conventional metrics for evaluating investments such as net present value and internal rate of return, and finance options.

Project Results

While the team was ultimately not successful in negotiating a mutually agreeable pathway to finance and build the project, it learned valuable lessons. There must be shared understanding of the financial goals, resources available, and metrics to apply. Early agreement on the finance model is essential. Determining early the acceptable principles frames systems sizing, equipment, materials, and labor to meet city and investor requirements is critical. Finally, having municipal support for the noneconomic benefits from the outset may overcome other limitations. Leadership that does not value environmental impacts, for example, are less disposed to value renewable energy projects as a whole.

In this circumstance, new finance and business models were required as part of project development. While power purchase agreements are well-established tools for delivering energy services, there is no clarity, to date, as to how to value services of a comprehensive microgrid. In the Carson project, the team proposed a master community plan including energy and load efficiencies (four new chillers, full lighting replacement with light-emitting diode (LED), and new variable-speed pumps); distributed energy generation (solar); battery energy storage (demand reduction, demand response, backup power); a comprehensive electric vehicle supply equipment network; and the power conditioning and controls architecture. However, the city rejected any model where the city and investors would share resulting savings.

The team is pleased to report several successes. The team formulated a comprehensive master community design plan. Final project specifications included 2.4 megawatts of largely parking lot canopy solar; 4.1 megawatt-hours of battery, power conditioning and control systems to manage power flows to optimize technical and economic value; four new chillers; nearly 3,000 lighting fixtures to be converted to LED; and 40 Level 2 and four 150 kilowatt direct current fast EVSE distributed across 15 independent city properties. If executed, this design could render selected city facilities net-zero energy consumers of energy from Southern California Edison (SCE). Moreover, the city would be able to deliver electric vehicle charging services to residents, employees, and visitors throughout the city, including cutting-edge ultra-fast direct current charging. These charging services will also reduce peak demand by about 40 percent and substantially decrease total energy consumption through lighting and cooling efficiencies. Moreover, the project could receive new value streams. For example, participation in grid services and power quality regulation from stored battery energy could yield payments and savings from the utilities or California Independent Systems Operator (California ISO). The iterative approach to design is a replicable and reliable method to arrive at comprehensive outcomes that meet initial technical and financial performance parameters.

Based upon the city's responses to several financial and business models, as well as the input of potential investors, several options can either be eliminated or considered less likely to be viable.

While shared savings models were common when renewable microgrids were proposed, the city viewed this model as "giving up" revenue that should be retained, while the investors raised concerns about the complexity of monitoring and reconciliation that would significantly increase administrative costs and diminish returns. Lease agreements were considered viable alternatives by the investors but met with sufficient opposition from the city as to render them not feasible.

City officials had concerns that the lack of guaranteed demand reduction could result in savings being less than predicted and lease payments could exceed net savings. Throughout the more than two-year process, the city had stated that capital contribution was not possible or desirable. Finally, all parties agreed on a power purchase agreement concept where the cost paid for services would be the sole expense for the city and would be sufficient to realize investor returns. This construct proved to be attractive, in principle, because of financial simplicity, a track record as a finance model for solar only, and ease of monitoring and reconciliation. The method could be agreed upon, but the key parties could not agree upon other key provisions such as who is liable for site defects, guarantees on battery reduction of peak load, and added expenses required by the city that could not be included in the budget. This outcome underscores the critical work required to show a track record of technical and financial performance of advanced energy communities to support developer assertions, confirm the yield of a power purchase agreement architecture for investors and the city, define how unknown site defects that may be encountered after project initiation should be addressed to limit risk for investors and the city, and develop more complex financial models to promote shared capital expense for city and investors to improve the communication of how the power purchase agreement price is beneficial to the community.

The project team made several observations that may assist future teams. Cities generally have dual governance consisting of employed and elected officials. In addition, they may rely upon outside consultants and attorneys to conduct business on their behalf while retaining the right to fully evaluate and alter agreed-upon principles and terms. This requires interaction with all parties while attempting to respect lines of communication. Moreover, depending upon the financial and technical expertise of city officials and consultants, the team may have to provide more education for the parties. This education includes understanding how proposed systems will function individually and collectively, how projections are arrived upon, what risks may be constrained or will remain indeterminate, and how to compare options based on common metrics.

Similarly, the team engaged with multiple community stakeholders to understand the current state, goals and objectives, and potential conflicts of design intent with facility usages. The area council of governments, community advocacy groups, city employees, and residents provided valuable information that resulted in design modifications. The team determined that written polls were particularly helpful in deciding upon electric vehicle station equipment architecture, while presentations to community groups, city council meetings, and communitywide events garnered public support but uncovered factors that had not been considered. For example, community leaders drew the team's attention to annual events at several target sites where initial solar canopy designs would have prevented normal event conduct. While public buy-in and contribution to design are not necessarily sufficient to convince city leaders to proceed, lack of such engagement is undoubtedly a critical error.

Early determination of shared principles, negotiation of mutually beneficial compromises upon areas of disagreement, and acceptance of limitations are essential to project success. While reasonable expectations and requirements are not necessarily definable, it is likely imperative to project fruition that all parties arrive at shared principles in this regard before embarking on the endeavor.

Market Adoption – Advancing the Research to Market

On a local level, the project team disseminated information through presentations to the city council, meetings with community leaders, and booths at annual community events. The team also contacted regional media outlets, including the local and regional newspapers and television stations. At a national level, several articles were published by Microgrid Knowledge™, reaching perhaps thousands of stakeholders. Simultaneously, the team has sought to develop commercial renewable microgrids in communities throughout California with a particular emphasis upon disadvantaged communities. Charge Bliss was recently tapped to design and build a renewable energy microgrid for a hospital facility and expects to be awarded a contract to design a large system for a food processing plant in Central California. However, the lack of a final agreement among the city, development team, and investors to accept project terms and conditions and proceed with project construction will undoubtedly hamper efforts to disseminate project principles.

Public response to proposed designs has been uniformly positive. Many community residents, advocates, and educators spoke at council meetings and provided letters of support. The project received formal letters of support from SCE and California ISO. The lead team engineer for the Stone Edge Farms microgrid, Craig Wooster, flew from Northern California to support the project. Since the project conclusion, several community advocacy groups from across the State have communicated interest in understanding the project and possible applicability to their regions.

Benefits to California

California utility energy ratepayers are subject to ever-increasing energy cost, power quality variability and outages, and pollution due to the combustion of fossil fuels. Advanced energy communities leverage renewable energy generation, intelligent energy storage and deployment, maximal load efficiency through upgrades, transportation electrification, and sophisticated controls to provide an alternative. If built, the system could offset all energy consumption from the utility ("net zero"), decrease peak load, participate in automated demand response to decrease critical peak system load, decrease vehicle emissions, and delay or forestall the development of additional utility fossil-fuel based energy generation.

The processes described in this report are repeatable and adaptable from single building to large groups of geographically distinct properties. Indeed, the processes can be scaled to include residential, commercial, industrial, municipal, and other applications. As the methods described are universally available, there is not only no added cost to the application to the full range of scenarios, but arguably a cost benefit through avoidance of pitfalls and expenses that might arise otherwise. Based upon the findings of this project, full communities may be rendered net zero and can decrease peak load by as much as 50 percent even while incorporating new load items such as ultrafast electric vehicle chargers. This has significant implications for site cost savings, investor returns, utility generation and transmission needs, overall energy system stability and reliability, opportunity to significantly expand the deployment of renewable generation in California, environmental quality, and improvement of disadvantaged communities.

CHAPTER 1: Project Significance

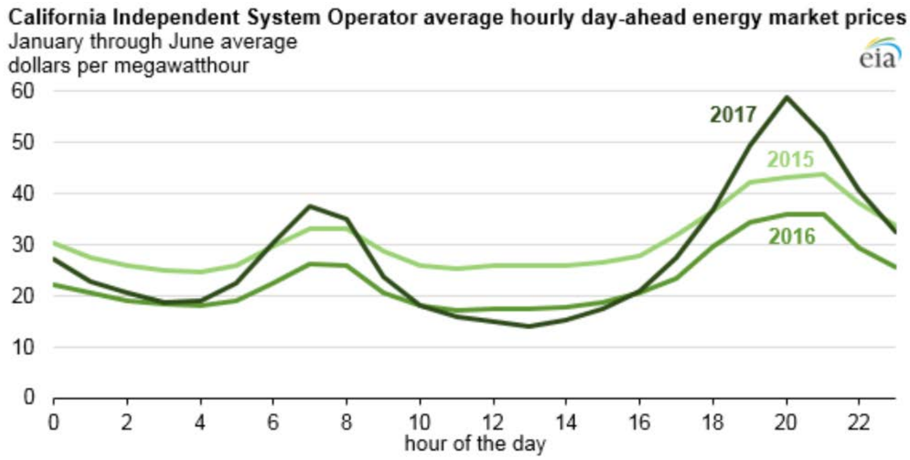
This project incorporates solar, storage, energy efficiency, electric vehicle charging, and smart monitoring systems at a community scale. Each technology brings its own advantages and challenges. Disadvantaged communities stand to attain the greatest gains from adopting renewable energy and the related technologies. Historically, these communities have not had the resources to acquire clean energy, energy efficiencies, control systems, and electric vehicle (EV) charging. At the same time, burdened by disproportionate impacts of fossil-fuel production, transportation, and energy generation. Understanding community selection, key processes, and expected outcomes will assist state and local officials, developers, and investors in disseminating renewable energy systems throughout California and country.

1.1 Background

Photovoltaic (solar) generation has numerous benefits to the producer and the community. As an unlimited and renewable resource, this technology causes less pollution, greenhouse gas emissions (GHG), and is not dependent upon complex fuel harvesting, transport, processing, storage, and combustion systems. One of solar generation's challenges is the energy suffers from immediate/seasonal intermittency and power quality variation creating the peaks and valleys in the production of energy from minute-to-minute changes of sun exposure. The utility energy grid alleviates the various impacts by providing flexibility in energy consumed. As solar generation grows with unconstrained export to the utilities, the deviations can have unpredictable impacts on grid energy quality (voltage, frequency) leading to aggregated system load profiles. In California, this scenario is the "Duck Curve" where system loads drop precipitously during hours of solar production, even to the point of negative pricing periods, curtailment, or other ineffective forms of energy management, and rise even more precipitously in the evening as shown in Figure 1.

Wide swings in electricity generation require inefficient operation of fossil fuel peaker plants and pose challenges to maintaining frequency and voltage within the parameters of optimal system operations. Therefore, if photovoltaic installations continue at the current pace this "duck curve" problem and its impacts would only increase. One major strategy for averting these consequences is on-grid or distributed energy storage. Even regions with "saturation" of existing circuits by solar systems could benefit from optimized timing of use of stored energy at times when solar is otherwise inactive.

Figure 1: California ISO Loads



Source: United State Energy Information Administration

1.1.1 Battery Energy Storage

Batteries may serve a variety of purposes for all stakeholders including end-users and the grid. When they are paired with site-based renewable generation, the energy may be used to supplant utility supply when power is more expensive (arbitrage) or to mitigate peak load either locally (demand management) or systemically (demand response). This has value to the local systems through cost savings and to the region and beyond by mitigating the need for polluting discretionary utility resources. Batteries may also be used to balance power on phase as well as regulate local electrical voltage, frequency, and real and reactive power. In turn, sites may realize increasing site efficiency from operation of load items through improved power quality. Whether the batteries are purchased directly by the disadvantaged community or incorporated as part of a third-party investment, the energy and environmental cost savings can be substantial.

For the grid, batteries add value passively and actively. For example, the option to limit and control photovoltaic energy export helps address the "duck curve" described earlier and promote more widespread adoption of renewable energy as required by statute and executive branch directives. Additionally, batteries provide options for a variety of system needs such as frequency and voltage regulation, demand response, and other contributors to system strain. These services will provide substantial value to the grid and the battery system owner. If these revenues are shared with the purchaser of energy services ("off-taker"), cities may realize even greater value from third-party advanced clean energy technology investment.

The economic and environmental benefits are noteworthy for disadvantaged communities. Many such cities suffer not only from poor air-quality conditions but also from lack of social services, deferred infrastructure maintenance, diminished public safety personnel and systems, and other limitations. Converting the "fixed cost" of utility energy to a source of savings and, in the case of grid services, additional revenue can be a critical step to revitalizing communities.

Finally, from a ratepayer perspective, distributed battery energy storage has several potential values. With stabilization of grid power quality and supply as well as deferral of peaker plant generation, ratepayers may avail themselves of greater power reliability, safety, and cost-effectiveness while simultaneously experiencing better environmental quality. In addition, power reservoirs at critical infrastructure such as hospitals, first responders, cooling centers, and others can support their continued operation despite disruption of grid function by any number of natural and man-made events.

1.1.2 Smart Inverters

Smart power conditioning (inverter) technologies, as defined by the Smart Inverter Working Group (SIWG)[9], are requisite to extract the maximal value from combinations of renewable generation and battery energy storage. These inverters are the "hub" of energy systems-monitoring and directing power flows to optimize performance based upon the requirements of the specific application. They control the timing and intensity of power applied to lower peak demand or reduce the severity of the evening ramp up of demand. While many smart inverter vendors claim to be capable of automated demand response and other grid services, these capabilities are more often future roadmap items than current day options.

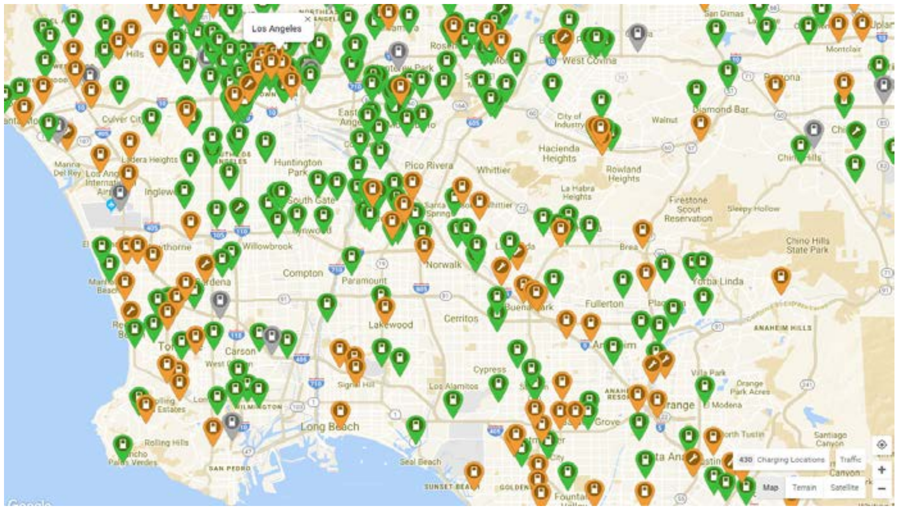
1.1.3 Energy Efficiency Items

Energy efficiency tools include optimized lighting, air-conditioning and environmental systems, insulation, refrigeration, pumps and motors, and other ways to improve a building or site's overall efficiency. LED lighting, daylighting, and dimming can improve energy cost, lower secondary cooling needs, and still maintain excellent illumination. When compared to fluorescent systems, LED may achieve 80% reduction in base load and total energy use and the bulbs may last up to twenty years compared to the 12-24-month lifespan of fluorescent bulbs. With respect to commercial environmental systems such as those that are used in most cities (chillers, heating, ventilation and air conditioning [HVAC], air-handlers), new devices may achieve upwards of 20% improvement in energy consumption and commensurate reduction in peak and base loads while maintaining or improving occupant satisfaction with working conditions. Similarly, variable speed pumps, dynamic building energy management systems, and best practice system operation and maintenance can improve efficiency, reliability, and durability. In addition to reduced energy consumption, these tools lower ongoing hard and soft maintenance costs. All told, though these efficiencies may be capital-intensive, the return on investment is substantial for financially strained communities.

1.1.4 Electric Vehicle Supply Equipment (EVSE)

Public electric vehicle supply equipment (EVSE), also referred to as EV charging infrastructure, have been used throughout California, though far fewer systems have been installed in disadvantaged regions. As shown in Figure 2, communities such as Carson, Compton, South and East Los Angeles, and others appear to have few devices while surrounding wealthier areas such as the coastal communities, West Los Angeles, Beverly Hills and Northern Orange County appear to have numerous installations.

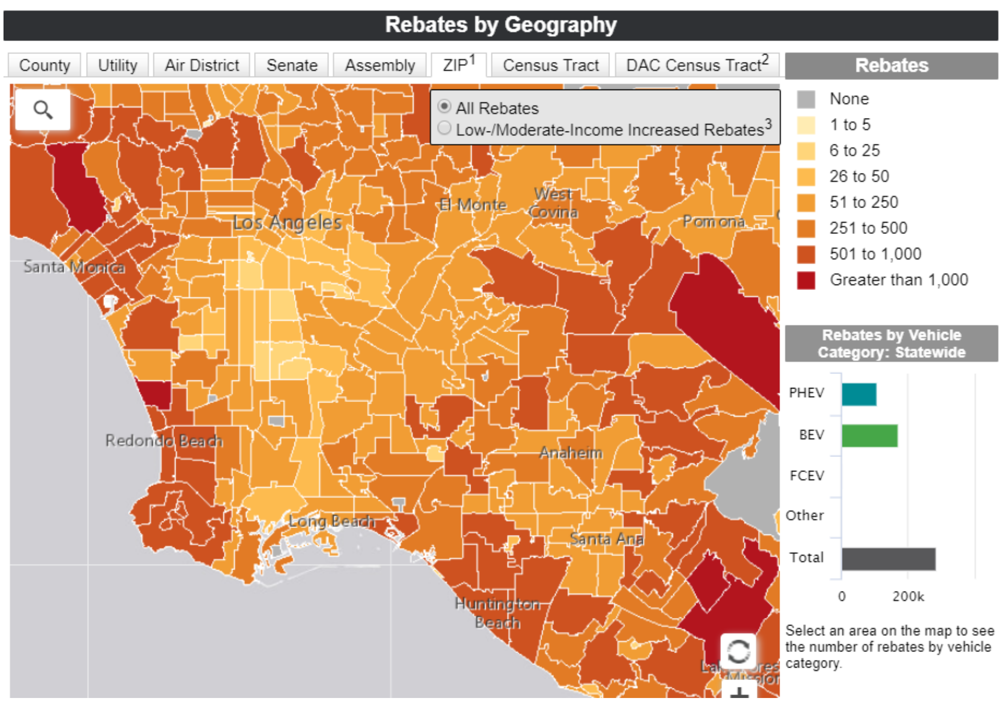
Figure 2: PlugShare® Map of Public Charger Installations, Los Angeles



Source: www.plugshare.com

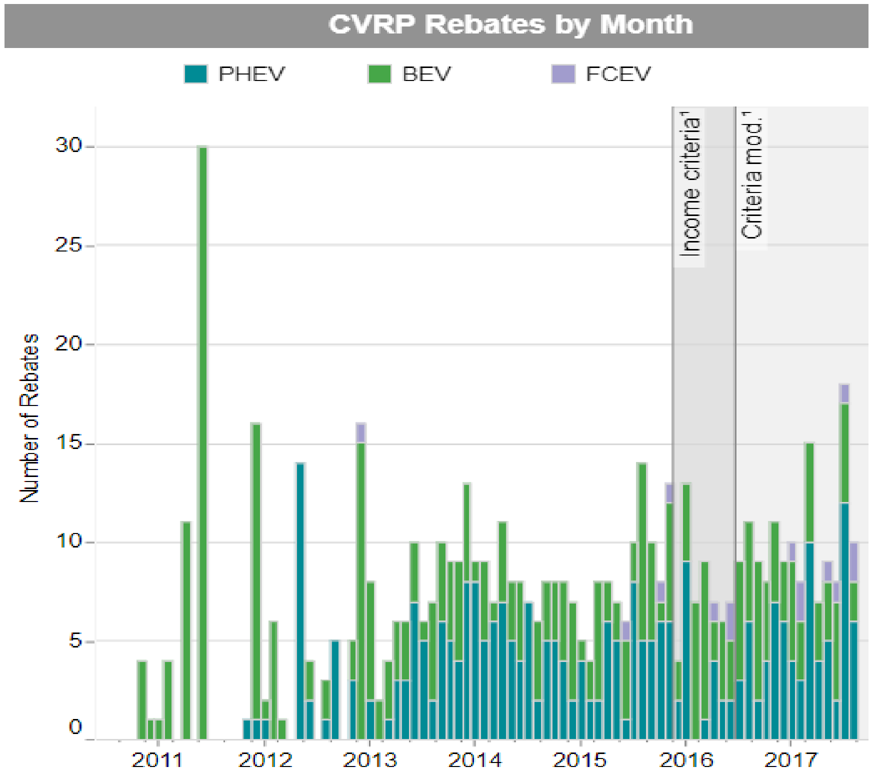
While some studies suggest that majority of EV charging is accomplished at home or the workplace,[4, 14] acknowledgment of public infrastructure is an important driver of EV adoption in certain communities. Corresponding to the lack of public EVSE, EV adoption has lagged in communities like that of Carson, California as shown in Figures 3 and 4:

Figure 3: Regional Rebates



Source: California's Clean Vehicle Rebate Project, https://cleanvehiclerebate.org/eng/cvrp-rebate-map

Figure 4: Rebates for Carson, California



Source: California's Clean Vehicle Rebate Project, *https://cleanvehiclerebate.org/eng/rebate-statistics*

Query of clean vehicle rebate applications shown by region/concentration (3) and as a function of time in the City of Carson (4). Note the paucity of EV adoption in the South Los Angeles and South Bay communities most affected by poor air quality as well as the flat trend of EV adoption in Carson, California specifically.

Multiple reports suggest that additional factors are contributing to the delayed adoption of EV in disadvantaged communities beyond the lack of charging infrastructure. Despite incentives totaling nearly $29,000 available to communities such as Carson including the Replace Your Ride program from the Southern California Air Quality Management District,[16] Clean Vehicle Rebate Project (CVRP) value up to $7,000, and federal tax credits up to $7,500, many residents of these communities are unaware of these opportunities. Moreover, concerns persist about vehicle costs, operating range, ability to achieve highway speeds, and perceived lack of amenities. Perhaps most importantly, there has been little effort made by major automobile manufacturers or regional dealerships to sell or lease EV in disadvantaged communities.

As was discovered through the intensive evaluation of the Carson Community, extensive community education and engagement is necessary to bring these opportunities to the attention of residents in disadvantaged communities. However, as is discussed in this monograph, participation in community events, creating specialized events to showcase EV, and determining baseline community interest through surveys may demonstrate a highly favorable response that may surprise many community leaders and EV manufacturers alike.

1.1.5 Energy Systems Monitoring and Visualization

AEC community designers must consider monitoring and visualization tools to follow and adjust DER functions. Revenue grade metering may be used at a variety of locations, from the output of solar arrays to the power flows through inverters and onto a site's electrical supply. These devices are typically current transformers that provide a range of power variables on phase that can be organized into a visualization and analytics tool such as that of the Smart Panel 3000™ shown in Figure 5. While utility energy and demand data may provide good insight into the general energy and power needs of a whole building or campus, it does not capture the component parts. Cities may discover that certain elements account for greater use or poorer efficiency than might have been anticipated and may, therefore, elect to service or replace those items with more efficient devices. Similarly, it such systems can detect poor power quality, fixing this problem may improve the efficiency of all electrical systems.

Figure 5: Smart Panel 3000™ Power Variable Visualization

Source: Charge Bliss Smart Panel 3000™ Visualization tool

The system dashboard tracks and reports real-time energy and power variables to allow analysts to determine the patterns of usage and demand, power quality, and load item performance.

Such tools calculate energy consumption (kWh), peak load (kW), real and reactive power, and frequency. However, the absence of phase angle data forestalls true synchronization. Thus, the impact of power modulation at one point upon another may only be examined retrospectively and qualitatively. Emerging technologies may introduce real-time power quality regulation at a distance from the point of interconnection that is not currently possible.

1.2 Project Purposes

The California Energy Commission sought project designs to achieve Zero Net Energy consumption, defined as renewable generation equal to or greater than the annual consumption of utility energy (kWh). The simplest scenario would be to match energy generation at each of multiple sites to the energy consumption. However, municipalities may have significant mismatch between the sites that are intensive energy consumers and where there is sufficient space for energy generation and storage. For example, though two properties in the same municipality may share a parking lot, such as was the case with the City of Carson, they may be prevented from directly sharing power. Specifically, if building A has higher consumption and load but its property lines contain a small percentage of the property line, it may appear logical to simply direct power from solar canopies on the adjoining property (Building B) to Building A in order to balance the location of energy use to more accurately balance each building individually. However, California Public Utilities Commission (CPUC) regulations specifically preclude this. Certain utilities will allow facilities to aggregate multiple meters under one master meter for the purposes of "Virtual Net Metering," wherein generation is credited across all individual meters to eliminate generation/usage mismatch. However, this is generally limited to residential metering, such as in multifamily housing, and could result in expensive legal, technical, and tariff costs for commercial and municipal facilities on separate land parcels.

Without a method to aggregate multiple sites to share generation credits, communities would be forced to size generation based solely upon the space available for that asset on each individual property up to the amount that would zero out all energy consumption on an annual basis. Facilities with large load and space limitations would receive significantly undersized generation systems while facilities with lower usage and more significant space for generation would have adequate sizes of renewable systems but would be unable to assist in offsetting the impacts of properties owned or administered by the same entity.

Fortunately, for municipalities in California, while retail value Net Energy Metering (NEM) is disappearing, under the RES-BCT tariff, cities may aggregate all solar generation over several properties to offset their total energy usage regardless of their respective timing or locations. This allows cities to capture the full retail value of solar energy produced whether or not it is matched by location or timing to energy usage by the city. Therefore, a key intent of this process is not only to offset all energy usage with renewable generation but to do so in a cost-effective manner with meaningful economic benefits to the interested parties.

Solicitation GFO-15-312 directs specific funding for development of ANE-AEC in disadvantaged communities to address environmental quality. Because clean energy production reduces greenhouse gas (GHG), sulfur oxide (SOx), and nitrogen oxide (NOx) emissions, it improves regional air quality and decreases pressure on utilities to build additional, polluting generation infrastructure. While there are significant, proscriptive State requirements for rapid adoption of renewable energy systems and improvement in air quality, it is particularly pressing in cities such as Carson which frequently suffer from exposures to noxious air several standard deviations worse than their surrounding communities. Poor air-quality is associated with numerous health problems including "minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy."[17] Unfortunately, these diseases already affect minority and socioeconomically disadvantaged communities disproportionately.[18] Moreover, because air-quality is regional, as demonstrated by the CalEnviroScreen3.0 mapping tool,[1] geographically proximate locations may have disparate impacts. Finally, poor air-quality and its impacts also affect perceptions of the community, real estate values, and attractiveness for redevelopment. In the sum, these factors speak to uneven realization of environmental and economic justice despite decades of efforts to improve the quality of both for all citizens of the State.

Third, the project intends to illuminate a pathway to rapidly develop renewable generation while not exacerbating the "duck curve" problem. As discussed previously, the simultaneous deployment of smart inverter and control systems and site-based energy storage allow for the intelligent redeployment of power at any time of day that best serves local, regional and system needs. In this manner, solar and other forms of generation could be adopted rapidly and without the negative impacts of energy export to the utilities.

The fourth objective is the review of potential impacts upon utility, California ISO, and overall grid performance by advanced energy community (AEC). Although the United States electrical grid is one of the most reliable machines on the Earth, its centralization, aging infrastructure, and reliance upon fossil fuels raises concerns for its future viability. Indeed, the American Society of Civil Engineers has given the grid a grade of D+.[19] Moreover, the author estimates that grid replacement would cost up to $5 trillion without consideration of on-grid energy storage. Distributed energy resources (DER) represent a move towards decentralization of the grid with possible benefits and risks. In the era before digital communications technologies, fast computing and controls, a centralized system was required in order to have coordination, uniformity, and reliability. At the same time, this approach created large points of vulnerability where large segments of the generation, transmission, and distribution system can be easily disrupted.

AEC design must consider the quantity, quality, timing, and duration of power export as well as the ability of the AEC to serve as a discretionary resource for the utility, California ISO, and grid. energy storage systems with controllable dispatch as well as demand responsive load items may serve to decrease peak system load (automated demand response), provide a reservoir for surplus on-grid generation (spinning or non-spinning reserve)[20], and modulation of grid power quality (frequency, voltage regulation). Project objectives include understanding which of these options are available to both the AEC and the grid.

Electric vehicle supply equipment (EVSE) is an interesting addition to an AEC. In one sense, EV batteries are unpredictable load items that require discretionary supply. Conversely, they can serve as a reservoir to accept excess on-grid power that is then convertible to transportation without further emissions. When active controls are superimposed upon EVSE use, as intended in the current project design, directing power to electric vehicles can optimize grid performance. Indeed, as utilities shift focus from generation to transmission and distribution services, they increasingly establish their own grid-connected electrical services like EVSE.

Exploring ratepayer value is a statutory requirement of Energy Commission EPIC funding. As the beneficiaries, and customers of utility services and residents of the corresponding community ratepayers are a logical focus of EPIC benefits. AEC hold the potential for several possible values:

- **Cost savings:** The significant reduction of both net utility energy consumption and peak demand lowers costs for disadvantaged communities thus opening up financial resources to support under-capitalized community needs.
- **Decreased GHG, SOx, NOx, VOC, and PM emissions:** The substitution of renewable generation for fossil fuels eliminates substantial emissions. Moreover, the support of EV transportation *in lieu* of internal combustion engines impacts one of the most significant sources of polluting emissions. This in turn improves air-quality and thus reduces the risk of health problems associated with poor air quality.
- **Improved resilience and reliability of the energy supply:** The DER have the capacity to improve power quality, augment or substitute for utility energy supply, regulate, and coordinate loads to optimize performance, further ensuring reliable power for residents
- **Growth of clean energy transportation:** Communities that have historically been excluded from clean technologies and their environmental and economic benefits can realize these values through the increasing adoption of EV.
- **Support of critical community infrastructure:** AEC, particularly with both generation and power reserve capacities, can support key community resources such as health facilities and cooling centers.

Exploring AEC has important implications for the State of California. In addition to improving air quality, contributing to meeting RPS goals, and deferring costly on-Grid generation construction, these developments contribute to regional economic growth through job creation, technology innovation, and capital infusion and create energy security through decreased reliance upon fossil fuels. AEC can deploy far larger renewable generation systems including large energy reservoir capacity. This can position California to sustain critical operations despite natural disasters, disruption of fuel supplies, or failure of centralized generation resources. Moreover, the potential for rapid dissemination of AEC will create opportunities for rapid growth in a variety of job sectors from tradespersons and construction to engineers, manufacturing, financial services, and many others.

Economic development for disadvantaged communities may raise concern for changes in area identity including gentrification. While this has not been an express concern of the City of Carson or the residents and other stakeholders involved, it is logical to assume that improving the environmental quality, economic stability, and governmental operations could lead to a rise in property values, decrease in low-cost housing, and influx of higher income individuals. This has certainly been noted in the wake of other community redevelopment efforts. However, we also note that the savings and value of the proposed project largely accrue to the municipal government. In turn, this will allow the City of Carson to once again provide infrastructure and services particularly targeted at the most underserved populations. Indeed, in recent years the city has been forced to curtail after school and community recreation programs and other support services which could be reestablished with the savings realized herein.

An additional benefit to the community is the engagement of high school students. Carson High School teachers and students have been involved in project creation and teaching modules have been used to merge classroom subjects with next generation energy technologies. It is our expectation that this will encourage students to pursue fields that will further drive the clean energy economy, improve their own community, and raise overall standard of living.

1.3 Targeted Communities

By the nature of the solicitation, the general target is disadvantaged Southern California communities. However, the meaning of “community” is necessarily broad and could be interpreted in numerous ways. Charge Bliss explored municipalities not by way of limitation, but as entities concerned with community benefit through public service. While the City of Carson is an incorporated municipality, this methodology is applicable to any geographically organized entity, non-profit, or other community service provider. There are over 2000 such communities that qualify as disadvantaged (CalEnviroScreen3.0 score greater than 75th percentile) in California, mostly in Southern California.[20]

Specific features of the City of Carson are relevant to project development and may illuminate issues and opportunities for other AEC development. At baseline, Carson is a medium-sized, urban community nestled between wealthy bedroom communities and major regional transportation routes. In addition, it contains significant industrial manufacturing and fossil-fuel refinery sites. There were no electric vehicle charging locations, one small solar array on the Community Center, and virtually no LED lighting throughout the city. Due to budget constraints, there is considerable deferred municipal maintenance, a hiring freeze, and many community programs that have been curtailed or terminated for lack of funding. The city offices are open four days per week in an effort to save operational cost. The City of Carson and surrounding areas have poor air quality as shown in the Calenviroscreen3.0[1] tool and significant ground pollution rendering at least one 500-acre site unusable due to health and safety considerations.

Despite these limitations, the city had previously engaged a private firm to examine opportunities for the deployment of solar across their portfolio of properties. Although details of the business arrangement and outcome are protected by confidentiality agreements, it was apparent that this effort was neither successful nor did it result in a positive view from city personnel of commercial renewable energy projects. However, as a result of this experience, city personnel made several requirements clear and absolute from the outset of the current project. First, the team was informed that the city had no capital to invest in the project and would expect it to be fully financed by other parties. Second, the city required that any project design reduce their total energy annual utility energy expense irrespective of which technologies were provided. Third, the city was not amenable to cost escalators or other adjustment factors that might, in the view of city personnel, erode their absolute dollar savings.

Notably, the city did not have personnel resources sometimes enjoyed by other municipalities. While similar sized cities frequently employ or contract with a full-time engineer or similarly professionally-trained individual that they designate to coordinate with the development of large energy projects, Carson either did not employ such a person or they were not designated to participate. Similarly, the city manager acknowledged that neither he nor his staff had adequate knowledge or training in finance to interpret the models presented and he, therefore, elected to engage an outside consultant near the end of the project for these purposes. To our knowledge, none of the city council members, who have the final decision-making authority for such matters, had significant experience in or knowledge of renewable DER and limited comfort with finance metrics such as Net Present Value and Internal Rate of Return prior to project initiation.

Despite these apparent limitations, the city management team and city council were interested in determining whether a renewable energy advanced energy community could be designed for city properties at no up-front cost to the city. They expressed the need to reduce their utility expenses and had some interest in providing electric vehicle charging to their citizens, employees, and visitors. Environmental improvement did not appear to be a significant driver of the city's willingness to participate in the project. Though all parties acknowledged the dearth of clean energy systems in the city and the apparent lack of prior interest in public or private entities in developing such projects within the city, this disparity from surrounding communities was not an express, prime consideration for city personnel.

1.4 Anticipated Obstacles

California municipalities face significant social and economic challenges that restrict participation in AEC development. Decreasing tax bases, deferred infrastructure costs, and rising operational costs limit capital for energy projects. Moreover, as tax-exempt entities, they cannot capitalize on subsidies such as PACE lending, tax credits, or depreciation. Therefore, project success requires unifying investors, municipal leadership, and developers behind the common cause of sustainability while recognizing the need for financial returns. This may be particularly challenging as each party must simultaneously seek maximum returns while recognizing the need for other parties to participate and receive sufficient value.

Community engagement is essential to understand needs and priorities but may be challenging depending upon the degree of resident interest. While communities such as Carson have a very involved, long-term resident population, other communities may less political involvement. This is particularly important when considering the merits of electric vehicles, methods to foster their adoption, and determination of needs for public charging infrastructure. Moreover, despite accepting the benefits of renewable energy, many disadvantaged communities do not perceive an immediacy of need. Indeed, urgent matters such as community safety and security, economic development, transportation, and others take precedence. Establishing both the short and long-term merits of AEC and fostering community understanding and support is essential to project development.

Given the complexities and vicissitudes of utility and ISO collaboration, interconnection and organization of grid services may be problematic. This includes tariff selection, options for export of power and related pricing, tolerances of utility service equipment, contemporaneous development of regional energy resources (utility and distributed), CPUC policies, and new legislation. Early engagement of utility or California ISO personnel or both is critical to identify potential obstacles and solutions and avoid delays or expensive project redesigns. Increasingly, specialized expertise is required to balance and optimize tariff selection and grid services participation with local community needs.

Finally, physical limitations may dictate project specifications and resulting value. Existing electrical infrastructure may require expensive upgrades that degrade project returns on investment (ROI). Space may not be available for the renewable generation tools, batteries, or EVSE or may require costly site modifications. City management must have a clear and unified vision of the long-term plans for site usage as development of such infrastructure projects assumes extended time windows to realize adequate ROI. Early interrogation of transformer capacities, major electrical systems, wiring, and controls may uncover significant infrastructure limitations that must be addressed *prior* to consideration of AEC development.

It is important for communities, political and employed leadership, developers, and financiers to consider not only what may be desirable for a specific city but what is achievable technically, financially, and socially. While each municipality will have unique features, many of the obstacles encountered herein are potentially generalizable and should be considered by stakeholders as they evaluate the suitability of proposed projects.

CHAPTER 2: Project Execution

2.1 Master Community Plan, Processes, Findings, and Results

The Charge Bliss project funded through California Energy Commission GFO-15-312, Southern California Disadvantaged Community group was a design-only process intended to demonstrate the methods to produce a Zero Net, advanced energy community (AEC). This section addresses the development of a Master Community Plan, Case Study, and Comprehensive Construction and Finance Plans.

A hierarchical approach to project execution illuminated both a linear pathway to project execution and a variety of challenges that persist for final project construction. The team identified candidate communities, encountered one who was willing to participate, created agreements for design project execution, gathered relevant data from the utility (SCE), City, building operators and users, potential suppliers, and area stakeholders to determine the baseline and opportunities for deployment of the designated energy systems. Detailed interrogation of potential sites narrowed the number to those that were technically feasible and would achieve benefit to the city and investor alike. Finally, collaborative design between specialty teams for solar, batteries, EVSE, chillers, LED lighting, and controls iteratively refined the scale and distribution of systems until a final, nearly permit-ready system design was complete.

Time delays are a virtually invariable part of construction design, though the reasons and sources may differ. In this circumstance, there was surprisingly little delay related to obtaining utility data, engaging utility personnel in design review, or determining tariff options. Similarly, internal team processes to analyze data, create initial designs, distribute and refine systems, and arrive at agreed-upon solutions proceeded without significant difficulty. However, two key matters proved to be the source of considerable delay and, ultimately, the inability of the project to proceed to construction. First, arriving at contractual agreement between the developer and city to design the initial system expended approximately six months. Challenges arose with respect to document review by in-house and consultant attorneys for the city, review by elected and employed arms of municipal governance, and provisions within the document that did not apply to a design-only project, but which created potential liability that required compromise by both parties. Second, negotiation of financial terms delayed completion of engineered drawings because of the direct connection between the finance model and systems sizing. For example, battery capacity that does not directly contribute to energy generation but facilitates tariff cost optimization and demand reduction, required multiple revisions to arrive at power purchase agreement pricing that approximated city requirements. Because final financial terms could not be agreed upon, the project did not reach permit-ready status.

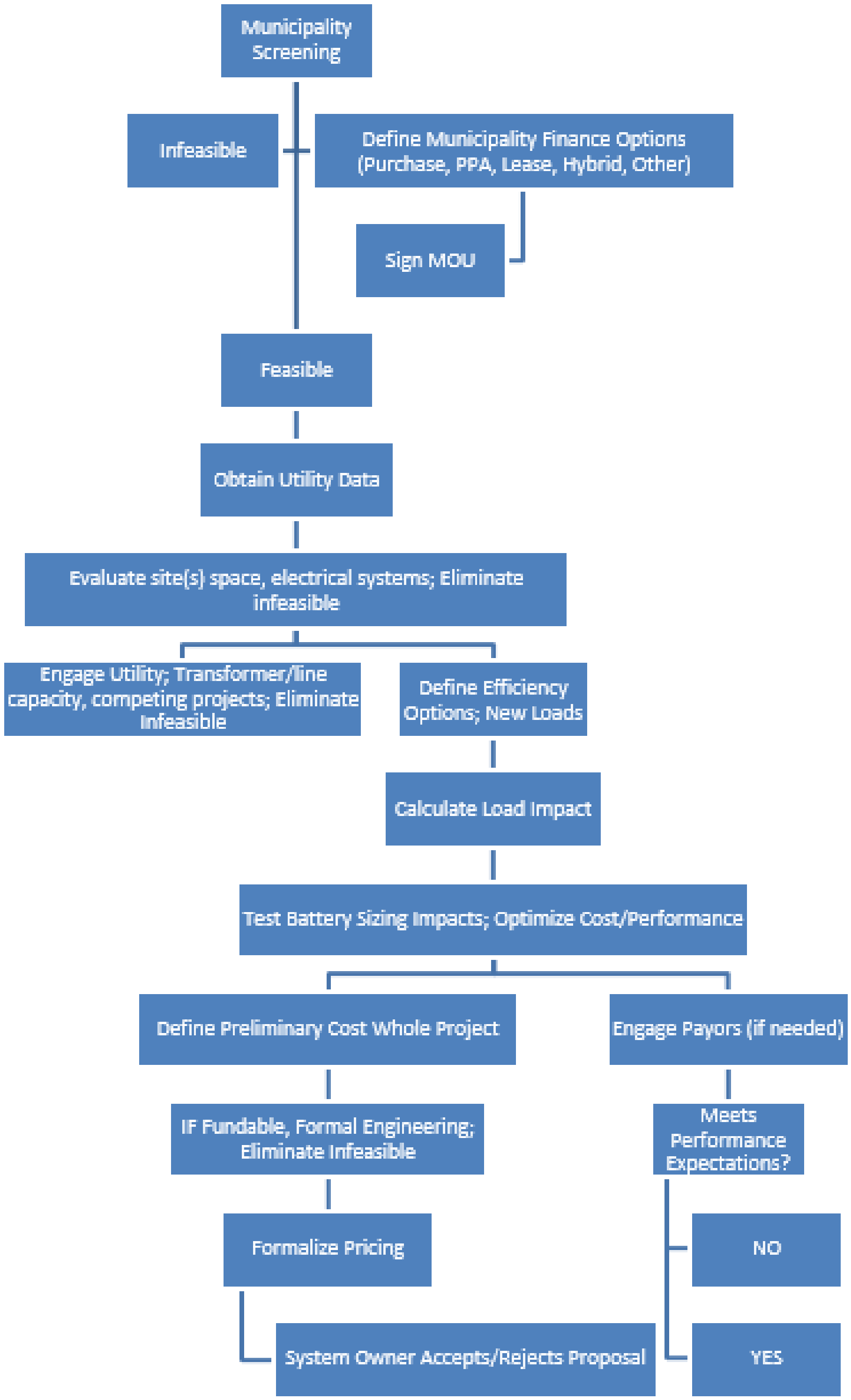
The team considered several alternative routes and methods as the project evolved. During the initial protracted negotiation phase, the team considered offering project development to an alternative municipal entity. However, investigation of this option suggested that they time required to develop such a relationship and reach completion of initial contracting would have likely added delay. Because of the complexities of specific project elements, the team considered curtailing or eliminating one or more. While the proposed design intent was to incorporate a comprehensive EV charging network, several obstacles arose that threatened project completion. First, none of the existing EVSE providers would agree to own and operate the level II EVSE. Each expressed that "there is no successful business model" for level II charging, despite the option of hardware and installation being paid for by another party. In addition, the remained uncertain throughout the process as to whether it would be willing to own and operate the EVSE or, if not, whether they would allow the non-profit Adopt-a-Charger to do so. Third, it became apparent that many sites had to have the number of chargers reduced to remain compliant with the Americans with Disabilities Act and because many of the designated locations would not be available after 9 pm. This led to a reduction in the EVSE from a planned 100 level II to approximately 40 with the majority concentrated at the city hall and community center.

Battery sizing proved to be more controversial than was anticipated. Throughout the process, the design team was challenged by the city or its consultants to significantly reduce or eliminate the battery energy storage. This would have reduced the project to a solar and efficiency project and not comport with the objectives for an AEC. By way of compromise, the team reduced the total battery capacity specified by 40% from initial amounts. While this reduced the options for load management and participation in utility ancillary services markets, it was a necessary compromise to meet city requirements. It is anticipated that increasing numbers of battery deployments and growing track records of their value within microgrids and AEC will lead future cities to consider allowing the specification of larger arrays.

Finally, the team also considered significantly reducing the overall project to include only the community center and city hall. In so doing, the team and city could focus on less complex designs, tariff implications, engineering, and cost. However, this would have rendered the ratio between efficiency cost and renewable systems outlay unfavorable and would not comport with the objectives for a comprehensive AEC design.

A final process flow chart shown in Figure 6:

Figure 6: Process Diagram for Advanced Energy Community Design

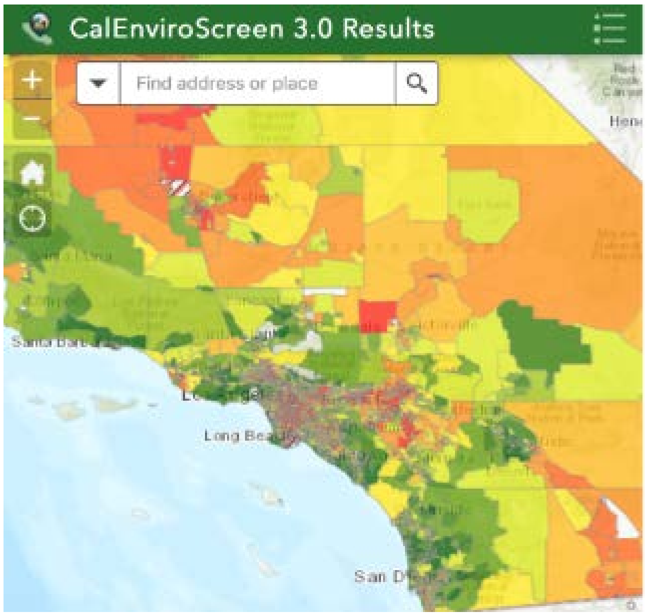


Source: The Charge Bliss Team

General

In California, the term "disadvantaged community" definition is by the CalEnviroScreen3.0 site (https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30). California Energy Commission criteria require that a community have a percentile value of 75% or greater, with numerical values being inversely proportional to air quality. As shown in Figure 7, signified by colors orange through red, these areas are concentrated in urban communities in the Los Angeles Area, Bakersfield, the Inland Empire (Riverside and San Bernardino Counties). As the color spectrum moves from green to red, this represents worsening air-quality. Stakeholders may interrogate this public website to determine the air-quality ratings of highly specific portions of California.

Figure 7: Calenviroscreen3.0 Mapping



Source: The Office of Environmental Health Hazard Assessment (OEHHA), *https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30*

Within disadvantaged regions, Charge Bliss considered a variety of community types including residential (single family, multi-family, mixed-use), commercial (retail, entertainment, manufacturing), governmental (city, state, federal), and special communities such as Native American reservations, healthcare, non-governmental community service providers. While evaluation of each type was beyond the scope of this project, a few observations may be of value to stakeholders considering the development of DER in these communities. First, the aggregation of innumerable independent individuals or groups to contract together to form an AEC such as might be required in residential or commercial circumstances is excessively technically and legally complex and prohibitively difficult to finance. In contrast, municipalities represent a single contracting agency, control multiple geographically distinct properties, are significantly underserved and under-resourced, and stand to realize the greatest benefit from AEC.

Further differentiation of favorable versus unfavorable locations requires understanding the relationships between the intensity of energy usage and the space available for DER. Traditional energy infrastructure developments have been centralized and could, therefore, be located at considerable distance from the end-users. Therefore, project developers could select sites with favorable characteristics for large generation plants. However, distributed generation requires adaptation to the built environment including considerations of constraints of space, exposure to the principal energy source (solar, wind, hydrological, wave, etc.), and the intensity of local power requirements. Moreover, the most commonly deployed resources (wind, solar) only produce energy during discrete times and cannot be relied-upon as a continuous resource.

As the Charge Bliss team considered the characteristics of communities that could most readily approach net-zero utility energy consumption, it became clear that such communities would bifurcate into two types of developments: 1) Distributed and 2) Centralized. Because many buildings either have higher intensity energy and power requirements than can be met through co-located renewable generation or because the space available for generation and storage is far less than required, many communities will need geographically distinct, centralized renewable generation for purposes of energy offset. For example, as the project team considered high-density housing, manufacturing, and healthcare facilities, it was readily apparent that operational and space limitations would preclude site-based generation and storage. These are better served by large renewable generation facilities, generally interconnected to the transmission and distribution architecture of the utilities. While this approach can, indeed, offset all utility energy usage of a designated community, more complex control architectures would be required to address variations in target community demand (load).

Such centralized systems also forego other potentially valuable functions of more distributed systems. First, a utility-facing interconnection is subject to continuity of grid performance. During periods of grid dysfunction, such systems would, by rule, have to shut down in order to allow safe work upon utility systems. Conversely, distributed systems could form "islands" to sustain operations of critical systems- improving public health, welfare, and safety. Second, generation and energy storage systems that are distant from the end user cannot participate in site demand reduction, power quality regulation, or demand response events. As Charge Bliss has already demonstrated through a separate Energy Commission project at the Kaiser Permanente facility in Richmond, California, site-based renewable energy DER are perfectly suited for these purposes. Finally, centralized renewable systems recapitulate the single point of vulnerability that all centralized systems represent. Natural or man-made events can lead to complete disruption of centralized system up to and including complete grid failure while geographically distributed systems may function autonomously.

Given these considerations, municipalities and public schools emerged as the preferred targets. City buildings and school districts tend to have a small number of high energy use sites and many more low intensity locations. In addition, these entities frequently have ample space to build the necessary physical systems. Third, many face significant financial challenges and are facing drastic reductions in services if they do not identify means to reduce operational costs. Fourth, municipalities and public schools are symbolically important for their ability to both serve and lead their communities and, in particular, to preserve and improve their environment.

Finally, the scale of municipalities and school districts is such that they will more likely have a significant impact upon regional power consumption. As such, converting such institutions into zero net utility energy consumers and reducing their peak load has the greatest chance to benefit community air quality, power availability, and economic development.

One unexpected obstacle that the Charge Bliss team encountered was the pre-existing contractual commitments of Los Angeles Unified School District (LAUSD) to energy services contracts that would bar them from participation in the grant. While the team saw an opportunity to achieve significant value for schools within disadvantaged communities, it was determined to be infeasible. LAUSD has established contractual relationships with other engineering, procurement, and construction (EPC) entities and requires lengthy processes to become a supplier or developer in addition to requirements for extended public bidding. Notably, bonding requirements for many public entities also effectively exclude smaller developers and builders. Such companies must demonstrate multi-million-dollar bonds but can only qualify for these bonds when they have demonstrated consistent performance on large projects. In addition, bond costs can render smaller public works projects too expensive for small firms to compete with larger firms that can spread the cost over multiple projects. More generally, so-called ESCO contracts generally limit a community from contracting for any energy services from a party other that the signatory of the prior agreement. This can preclude a community from participating in projects that do not originate with or at least include the contracted provider of services.

Nevertheless, the team continued to engage with LAUSD Science, Technology, Engineering, and Mathematics (STEM) teachers and students to foster education regarding renewable energy, power engineering, and finance. Charge Bliss personnel participated in Science faculty education days at Carson Senior High School, composed and executed a math competition for Algebra II, and participated in the California State University Dominguez Hills "GPS Your Future" Science and Technology presentations to multiple area high schools. While the team had hoped to integrate area students into the process of designing zero net energy systems for their own schools, this was stalled by LAUSD as described.

The elimination of the major area school district allowed the team to turn its focus to municipalities. After considering all communities that met the Energy Commission requirements for a disadvantaged community, only a small number of cities remained. Of those contacted, several were either not interested due to the perceived complexity of the grant process, felt they did not have the internal resources to participate, or were unresponsive to repeated attempts to communicate. Intergovernmental agencies such as the Southern California Association of Governments and the South Bay Cities Council of Governments proved to be valuable resources to contact local city representatives and identify those who are interested and eligible. Arguably, these third-party resources can be essential to act as a first "filter" for the target community, to present the potential project in a dispassionate manner, and to provide person-to-person introductions. As we discovered, cities are frequently approached by many vendors purporting to have ways to save them money and have grown increasing wary. In particular, municipalities are very concerned that there are hidden costs or future risks that developers and vendors may not make clear at the outset.

Through serial interactions with potential host cities, the Charge Bliss team determined a set of additional criteria for potential AECs. While some of the following matters may be surmountable with detailed, long-term engagement, education, and/or revision of governing agreements and processes this would be either impractical, costly, or time consuming.

1. Does the community have an existing energy services contract? If so, does this address the development, design, construction, or operation of DER?

Such prior relationships may preclude cities from turning to a new developer for renewable energy projects or introduce added complexities from multi-party relationships. In addition, new DER applications may impact the functions of pre-existing systems governed by prior contracts and must be considered prior to new project development. For example, Charge Bliss encountered such contracts when it attempted to include the Los Angeles Unified School District. Prior agreements restrict the District's participation to projects with previously named contractors. In other scenarios, commitments to specific programs (Proposition 39) and technologies may constrain available sites, capital, or development options.

2. Does the community have a clean air, sustainability, or energy modernization plan? Does this consider renewable energy and DER?

Existing plans may already address many of the investigatory elements required for AEC development. Indeed, prior inventories of existing load items, structured plans for upgrades or re-engineering, and identification of items reaching their end-of-life can save considerable time and effort. In addition, these plans often articulate city and community priorities and goals, which if aligned with the principles of renewable AEC design, may streamline communications and planning. The City of Carson had previously engaged consultants to examine key load items. In addition, the South Bay Cities Council of Governments, a regional intergovernmental organization, had formulated plans for EVSE and other energy infrastructure in the region.

3. Does the community have other commitments, policy or statutory limitations, or processes that would prevent its participation in a DER development project?

Because of financial constraints, many California cities are continuously re-evaluating the merits of property disposition (sale or lease), maintenance and repair versus full-scale reconstruction, or major modification of use. As real estate prices rise exponentially, particularly in Southern California, cities face increasing pressures to sell valuable land or buildings. However, the development of long-term DER is predicated upon their continuous usage under the original specifications and cannot be relocated or significantly changed. One option is to include the option for the host city to purchase systems at a defined interval. However, this approach introduces multiple other complexities that may serve to confuse the involved parties and delay contract signing.

Similarly, some municipality statutes require a public bidding process for all capital projects and, therefore, cannot participate in a non-bid project development such as the California Energy Commission grant-funded methodology. While there are statutory exceptions for public entities in California such as school districts, cities must abide by their own regulations. Potential conflicts arise if funders have identified suppliers or contractors and do not wish to go through the risk and delay of public bidding. A desirable municipality should have dispensations for projects being developed, constructed, and funded by third-parties.

4. Who are the key stakeholders and which individual(s) or entity(ies) have the capacity to enter into agreements? Is the disposition of these key groups favorable or unfavorable to renewable energy and DER?

While most Californians express positive feelings regarding renewable energy, sustainability, environmental quality, and related matters, this may not be true of city officials. Whether it is because they face more immediate threats such as financial insolvency or they don't believe it's worth the time and effort required, many communities are not interested in renewable energy projects, even when they are grant or investor-funded. Furthermore, while some city officials may express interest, they may be unable to promptly enter into agreements for project development or may need approval from less enthusiastic parties.

5. Does the community have financial resources or willingness to work with the developer to identify resources to acquire DER?

Many disadvantaged communities in California are also economically disadvantaged. Therefore, their respective municipalities may lack funding for existing programs, much less large, long term capital projects. At the same time, these communities are frequently skeptical of external investors- fearing that their city will be undervalued or face large, long-term financial risks. Despite resource shortages, host cities must collaborate on project designs to meet the technical and financial performances necessary to satisfy all parties.

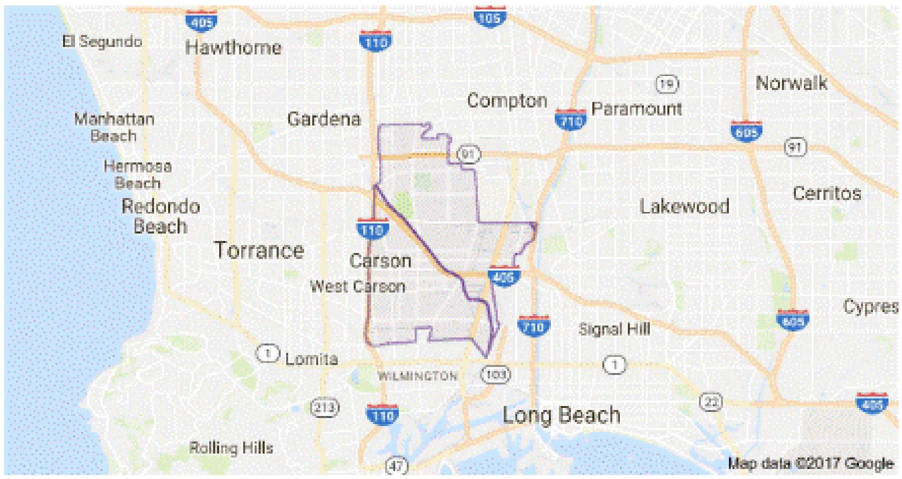
Stakeholders must have reasonable expectations for outcomes of externally funded projects. Investors, state and federal agencies, and others have specific requirements for system design, technical, and financial performance. While city personnel may wish to extract the maximum value for the lowest possible price, they must balance these objectives with the reasonable requirements of the funders.

By this method, Charge Bliss was able to identify the City of Carson, as discussed in the following section.

2.1.1 City of Carson

Of the municipalities considered, the City of Carson emerged as the preferred candidate for project participation. In addition to fulfilling the requirements for being a disadvantaged community, Carson has several other features that make it generalizable to other municipalities. First, as demonstrated in Figure 8, several critical North-South and East-West transportation arteries pass through the community as well as through other surrounding and similar cities including Long Beach, Lakewood, Paramount, Compton, Gardena, and Hawthorne. More generally, this replicates the findings of many disadvantaged communities that adjoin or contain major transportation routes. Second, Carson contains a large number of high intensity fuel refineries, chemical plants, and manufacturing facilities. Much like Richmond, California in the East Bay of San Francisco, this is an industrial community interspersed with relatively high-density residential population. In addition to sharing characteristically poor air quality, such communities also have higher percentages of socioeconomically disadvantaged people. While detailed demographic information regarding Carson may be found in Appendix D, it is worthy of note that Carson reflects the diversity of California communities and the South Bay, in general, has been determined by U.S. Census data to be one of the most diverse in the U.S..

Figure 8: City of Carson, California Map



Source: Google® Maps

Though Carson is frequently viewed as an industrial city due to the significant presence of oil refining and chemical facilities, it is also home to the only California State University in the region (Dominguez Hills), a large entertainment facility (StubHub Center), and destination shopping (Southbay Pavilion, Carson Towne Center). Moreover, significant community redevelopment is underway including a new outlet mall and large multi-use commercial/residential complex near the city center. The proximity to major transportation corridors, major entertainment venues, and shopping supports the principle that Carson is a representative community for innumerable urban and suburban communities across California and underscores the replicability of an Advanced Zero Net Energy project in this community.

2.1.2 Stakeholder Engagement and Key Principles

There are two principle manners by which AEC developers and candidate cities engage one another- either the developer initiates the process by contacting city personnel who are then formally or informally charged with oversight of energy systems or the city personnel create a request for bids. Cities with limited financial and personnel resources may not have the capacity to seek such projects in an organized and coordinated fashion. They frequently must rely upon being approached, which in turn requires that the city is noticed by developers or funders. It has been the general impression of the Charge Bliss team that many disadvantaged cities and communities would be benefitted significantly by resources such as ombudsman, content experts, and consultants to broker these relationships, assist in project development, and advocate for the best outcomes for the municipalities.

A related, but separate issue faced by cities is the lack of standardized municipal processes for energy systems management. Each city builds its own management architecture which may be robust and detailed or as limited as one individual charged with managing all aspects of properties operation. This is made more complex by the diverse nature of electrical supply equipment and load items as well as the characteristics of property use and environment. In the absence of a dedicated team or advocate examining energy systems, most disadvantaged municipalities must assume a reactive posture- addressing system problems as they arise, minimizing present day capital outlay, and considering systematic changes only when an outside consultant can provide comprehensive and trustworthy information. Given the inevitable concerns of municipal personnel regarding the interests of for-profit entities such as developers, there is a high degree of skepticism that limits access to city personnel. Municipalities need accurate, reliable information from trusted resources and proof-of-concept projects to both illustrate the effectiveness of AEC and assist them in pursuing opportunities.

Having chosen the City of Carson for the development of AEC, Charge Bliss proceeded with serial meetings with the employed leadership. Though key personnel vary by community, critical representation includes financial management, engineering, building operations, and system-specific specialists such as electricians. The city manager or equivalent generally relies upon these staff members to investigate and report upon their respective aspects and synthesize options into a cogent summary. Once these personnel were identified and allocated to project discussion, Charge Bliss and officials first established principles for a development contract. Critical matters included the sites of interest, data to be shared, scope of work for both, obligations and opt-outs to build or develop, and governing principles from the EPIC Terms and Conditions document.[23]

Notably, several areas of hypothetical concern emerged from ongoing discussions. First, city officials expressed significant reservations regarding the inclusion of a third-party investor. Despite having neither the cash resources nor the debt facility to fund the 50% of project required in the solicitation, city officials were concerned that investors may be receiving financial returns at the city's expense. The city has historically owned and operated all systems upon their properties. While this has afforded the city complete discretion over systems, it has also burdened the city with the ongoing operation and maintenance costs including the deferred and unbudgeted costs of large capital equipment replacement. One specific concern was that third-party ownership of energy systems could limit the city's options to sell or otherwise dispose of city buildings or land in the future. Such discussions underscore the importance of defining the needs of each party (long term contracts for optimal investor returns versus purchase or other options to ensure flexibility of city assets). It is essential that all parties are clear on what properties may be included in the project and what conditions or limitations may apply.

Understanding the priorities of the parties was essential to progress. Key principles upon which the two teams agreed included:

1. Financial: Technical and performance capabilities must yield net savings for the city as compared to baseline and must yield reasonable and sufficient return on investment for third-party financiers.
2. Site Disposition: The city remains in control of property ownership and may elect, after a defined period, to purchase or relocate systems at their own expense in the event they wish to proceed with property sale
3. Safety and Feasibility: All parties agreed that designs must meet or exceed all relevant code, safety, permitting, and interconnection standards and comport with the operational needs of each proposed physical property.
4. Collaborative Processes :Because of the cooperative nature of project execution, whereby one or more parties fund the design, engineering, construction, operation, and maintenance of systems upon the property of the recipient city, there must be serial communications between all parties to evaluate proposed technical and financial performances.

Once principles of engagement in the project were agreed upon, team members determined what additional stakeholders were needed and what their respective roles would be. Like most municipalities in California, the City of Carson has a dual governance structure. While elected city council members must approve all policy, rules, regulations, and financial decision, daily operations are overseen by city employees under the direction of the city manager. Though they are generally in agreement with respect to City goals, priorities may vary between groups and individuals. Therefore, the Charge Bliss team elected to engage with both lines of governance and all of the key team members within each. In addition, the Charge Bliss team incorporated the South Bay Cities Council of Governments to coordinate communications, ensure that all critical inputs were obtained, and to provide perspective on community history, culture, pending plans, and future objectives.

Interestingly, through the process of stakeholder engagement, the design team learned that the operations of individual properties vary widely. While the community center is open nearly 24-7 throughout the year, city hall only operates Monday through Thursday of business weeks. While some city parks are open at all times, many close to the public between 6-10pm. Nevertheless, exterior lighting and security remain a substantive concern on public properties even when the buildings are not in use as sporadic but noteworthy property and personal crimes have occurred.

Although it was not immediately apparent, engagement of community activists became manifestly essential. Many residents of the city are passionately involved in its operation and bring decades of residency experience to discussions. In addition to public interactions through city council presentations, Charge Bliss team members met directly with community groups and individual activists. These discussions revealed a genuine and nearly uniform enthusiasm for renewable energy, energy efficiency, transportation electrification, and cost savings, but also identified obstacles to project success that would otherwise have been missed. For example, when team leader, Dr. David Bliss, toured the city with long-time community activist Ms. Diane Thomas, he learned that many of the city parks are closed at night and had small parking lots where only one or two spaces could be allocated for EV charging only. Direct discussions revealed that initial proposals for solar canopies would adversely impact annual community events by using space allocated for event equipment. Fortunately, early intersection with these important stakeholders allowed the team to direct designs early in the process and avoid expensive late revisions.

Determination of community priorities and goals was essential to appropriate design progress. While the city welcomes the concepts of sustainability, resiliency, and air-quality, dominant objectives are cost-savings, constraint of financial risk, community development, and area safety and security. Carson faces considerable financial hardship including financial reserves that are less than three months of operating costs. There is a city-wide hiring freeze and vacated positions are intentionally not filled. Total utility bills approach $1 million per year with nearly 50% accounted for by demand charges. Aging building infrastructure such as lighting and cooling systems require costly ongoing maintenance and will soon require significant capital outlays for replacements. Therefore, the design team quickly understood that the first priority is to achieve a sound financial result that, in turn, is derived from optimal technical design.

Community development, safety, and aesthetics played a more significant role than might otherwise have been anticipated. City officials were pleased to learn that solar canopies are required, by code, to have underside LED lighting and were further gratified to understand that Charge Bliss has explored a comprehensive security system to integrate with the Los Angeles Sheriff's Department. The latter will include real-time visual and sound monitoring near critical equipment that can export warnings or give first responders immediate access to information at the affected sites through broadband internet connectivity in Sheriff vehicles. In addition, the attractive appearance of solar canopies, battery/inverter containers, and EVSE were important to city council members as well as city staff.

2.1.3 Electric Vehicle Supply Equipment Design

The Charge Bliss team formed a sub-group to lead the design of EVSE. The group was composed of Charge Bliss representatives (David Bliss, Jon Harding), the UCLA SMERC team (Rajit Gadh PhD and Peter Chu PhD), Electric Vehicle advocacy (Adopt-a-Charger, Kitty Adams), Mr. Edward Kjaer (former Director of SCE Transportation Electrification), and representatives of the South Bay Cities Council of Governments (Aaron Baum and Jacki Bachrach). The team developed an iterative process that can be replicated by similar stakeholders in any municipality. First, the team set six priorities:

1. Determine the baseline infrastructure.
2. Survey residents and city workers to determine the baseline use of electric vehicles, knowledge of incentives for EV usage, and appetite for EV adoption.

3. Devise and execute a community education and engagement strategy.
4. Analyze all potential city sites based upon need as indicated from survey data, proximity to major transportation arteries, primary and secondary site uses, tolerances of energy delivery equipment for the peak load from EVSE
5. Model the use and load patterns of proposed systems to calculate the necessary additional solar required to reach net zero utility consumption and batteries to mitigate demand.

Potential EVSE allocations were repeatedly brought before elected and employed city officials to ensure that designs comported with municipal objectives, did not disrupt the intended purposes of each site, and considered environmental justice and fairness.

Notably, the involvement of diverse voices elicited critical information that informed overall system design. The elected officials provided insight into the concerns of their constituents as well as vital information about public safety, limitations on parking space availability and access, handicapped accessibility, and other matters. Employed city management assiduously examined cost-effectiveness and contributed to decision making about the number and location of systems-particularly the proposed bank of ultrafast DC chargers. The sub-group members above each provided critical information about essential matters from the role and limitations of SCE, interaction with potential EVSE providers and operators, patterns of EVSE usage and load, and the impact of the EVSE upon overall zero net energy design. Assigning sub-groups to EVSE is imperative to ensure that designs meet community objectives, drive adoption of EV, but also support existing energy infrastructure and encourage the adoption of renewable energy generation.

Electric vehicle supply equipment and advocacy for EV adoption proved to be valuable to stakeholders as well. Charge Bliss developed tools and surveyed City employees as well as community residents to determine the baseline need and appetite for electric vehicle charging, existing desire for more charging infrastructure and/or acquisition of EV, and the impact of knowledge regarding EV subsidies. Using electronic distribution services, 593 City of Carson residents were surveyed and 81 responded demonstrating a substantial unmet need (see Appendix B). In addition, Charge Bliss hosted a booth and EV education at the annual Carson Jazz festival, presented at multiple city council meetings, and held a community "Drive and Ride" EV event at the community center with several hundred residents and employees attending. These forms of community engagement are essential for developers to learn from residents and provide vital information about electric vehicles, charging systems, and their role in the environmental future of the region.

Community member engagement revealed several issues that may be necessary to consider for similar municipal developments. First, key stakeholders raised significant concerns about the loss of parking spaces to be designated "EV Only" at public parks. While they lauded the principle of making EV charging widely available, they preferred either flexible use of the parking spots or fewer chargers. After considerable discussion, all parties agreed to a smaller number of spaces to preserve park access to non-EV drivers. Second, residents wanted to see a "fair" distribution of charging systems throughout the parks in the community. While factors such as traffic patterns, population density, proximity to major transportation arteries, and others might have dictated a more clustered pattern of EVSE deployment, both the community and its leaders felt strongly that fairness dictated as equal geographic distribution as possible.

Interestingly, Charge Bliss discovered that none of the current EVSE providers were willing to invest in or own level II EVSE in the City of Carson. The team interacted with virtually all major providers and each felt that such a development did not fit with their overall business model, would not have adequate return on investment, or would not permit the team to regulate charging timing and intensity. PlugShare® (formerly Recargo®) did agree to provide the hardware for four (4) ultrafast DC devices to be located at the Community Center and the non-profit Adopt-a-Charger expressed willingness to own and operate the level II systems throughout the community. The team notes that many such disadvantaged communities throughout California are charging device "deserts." Indeed, this phenomenon has been recognized and attempts have been made to address this through EPIC grants, CPUC funding, and legal settlements with both NRG® and Volkswagen®. Despite these efforts, communities like Carson have inadequate charging resources to support the level of interest in EV demonstrated in the Charge Bliss survey results and public participation in EV events.

Modeling use patterns, load characteristics, and methods of dynamic control are noteworthy. The team from SMERC (UCLA) extended their prior work on EV charging infrastructure (Appendix E). Their report describes in detail the range of possible scenarios, control options, and expected impacts upon the overall community. Prior generation EVSE installations were relatively haphazard and failed to use objective measures to optimize deployments and their impacts. The methodology described here allowed the team to meet all stakeholder objectives, provide EV charging optimized for resident, visitor, and employee uses, all while mitigating utility energy usage and demand. The team believe this more sophisticated approach will be critical to successful, broad deployments of EVSE in California and beyond.

The team recognized from the outset that EVSE may add substantial peak load and potentially exacerbate both facility and utility strain. Level 2 devices charge at a uniform rate as low as 3.3kW and as high as 9.9kW depending upon device type. Direct current systems (DCFC) charge vehicles in a non-linear fashion using algorithms that respond to the state of charge at initiation, critical parameters of battery health, and the target final state of charge (SoC). These devices may draw between 25kW to more than 150kW. Assuming that multiple devices connected behind the same meter may, at times, operate at peak intensity simultaneously, teams must grapple with whether to target the maximum possible demand or size battery systems based upon more real-world usage patterns. Given the likely exponential growth in EV adoption, particularly in previously underserved communities, the team suggests that the former strategy is preferable. While additional batteries are expensive at the outset, they offer several advantages. First, under circumstances of less intense use than expected, the battery systems may be expected to have longer lifespans. While many vendors purport to have significant cycle life even with regular cycling from 100% SoC to 0%, they will also add that less frequent and significant depths of battery discharge can extend battery system health. Second, while oversizing of battery arrays is a relatively simple design, engineering, and installation process, the addition of batteries later represents an entirely new project with all of the attendant complexities and costs. Third, failure to plan for the wide variation in load can have deleterious impacts upon local power quality, building electrical device performance, and site costs in addition to adding to the need for utilities to provide discretionary, load-following generation.

In addition to load management through battery energy discharge, the team considered dynamic controls. The UCLA SMERC previously developed a user-interactive platform that can sequence, throttle, or curtail EV charging to maintain aggregate load within specified limits. This was particularly attractive to the purveyors of DCFC who often face demand cost charges that subsume any revenue they might obtain from end-users. Indeed, in the specific scenario proposed with four (4), 150kW DCFC and 5-minute charging intervals, active control can realize significant savings and load reduction. Specifically, if four cars attempt to charge simultaneously without constraints, the total load would be 600kW for 5 minutes. Because utilities generally charge for the average peak load during a 15-minute interval, this would be read as 200kW for the purposes of peak demand cost. Alternatively, all four devices could be throttled to 50kW and, thus, reduce the peak load for demand cost calculation to 67kW. Or, if two users are willing to wait to charge in exchange for decreased per kW fee, two could be charged at full power in the first 15 minutes while the other two are fully charged during the next 15-minute interval. In the platform designed and operated by the SMERC team, automated algorithms track aggregate load and message EV drivers with options to receive discounted services if they will allow throttling or sequencing in addition to specifying rate of charge based upon the end-user's estimate of likely dwell time and the initial SoC. In the proposed Carson project, the Charge Bliss team has elected to deploy redundant systems – batteries and active device management to realize the optimum reduction in peak demand while providing fast charging services.

More broadly, the findings described above suggest that other disadvantaged communities may have a greater call for EVSE than might otherwise be anticipated and that this may be achievable through a rigorous process that meets all stakeholder needs. Communities throughout the State may use the six principles described herein to achieve logical, cost-effective EVSE deployments that best serve their residents, workers, and visitors.

2.2 Property Characterization

Prior to site evaluation, the development team must formalize a contractual relationship with the target city. While the contractual specifics will vary depending upon the funding source, municipal financial circumstances, state of existing site systems, and project goals, the developer, financier, and city must reach agreements in principle to achieve success. Because of the complexities of municipal governance, the need for input from multiple other stakeholders, competing priorities, and potential aversion to "novel" concepts such as renewable DER, a development team should budget considerable time to reach agreement upon the evaluation and design process. In the case of Carson, California, it took all sides more than six month to reach agreement to proceed with the design-only phase. Defining roles and responsibilities, options to terminate, circumstances under which the teams will proceed to finance and build the project, and ownership of work product are some of the core matters that may delay progression to the design phase.

Once agreements were in place, the first step was to inventory existing properties to determine which should be included in the project. Several variables related to the project as well as the sites had to be considered and are relevant to similar developments in the future. First, if there is a specific budget limit, the team must select a reasonable number and type of sites for which the project development is feasible and will fall below the cost ceiling. Second, the total space available for renewable generation sets the ceiling for the number of sites that can be included. In the case of Carson, for example, limitations on usable space for photovoltaic deployment required capping the number of sites at 18- many of which are smaller parks with low energy usage. Third, it is important to stratify sites by their utility tariffs to determine a) whether the tariffs are eligible for inclusion in programs such as SCE RES-BCT, b) whether change to one of the renewable tariffs will be financially beneficial or harmful, and c) whether the site tariffs include demand costs and may, therefore, benefit from the co-location of battery and control systems. In Carson, a small number of sites are intensive users of power and pay high demand fees, while many other locations are on tariffs with low energy cost and no demand fees. Finally, it is equally important to determine what efficiencies may be found to reduce overall energy usage, lower base and peak demand, and deepen the impact of the renewable DER. Carson has had considerable deferred maintenance and was discovered to have four (4) inefficient chillers past the end of their standard useful life as well as fluorescent or incandescent lighting throughout the city. So-called “investment-grade” energy audits may uncover substantial site deficiencies which, if corrected, can improve project performance significantly. Replacement of the Carson chillers and switchover to LED lighting was calculated to potentially reduce current overall energy usage and peak demand by approximately 20%.

In total, the City of Carson has 384 meters and uses 8,081,076 kWh per year of utility energy. Data gathered for each property included one-year of Southern California Edison energy bills, one-year of 15-minute demand data, major existing load item types and number (lighting, heating/cooling, pumps, other), additional load items under consideration, inspections of major electrical panels, determination of roof or parking lot space available for solar arrays, and identification of space for battery/inverter containers. Potential sites for EVSE including parking lots, adjoining streets, and private property were considered.

The properties agreed upon for inclusion in the project account for approximately 63% of the total energy consumption by the City and include the largest properties and most critical building infrastructure. A summary of property energy characteristics is shown in Table 1. Notably, nine properties and 10 meters currently have time-of-use, demand tariffs while the remainder have tiered, non-demand tariffs. However, only seven of the properties with demand tariffs have site characteristics that would permit the co-location of battery and solar for optimal technical performance (city hall, community center, and Carson, Mills, Stevenson, Hemingway, and Veterans Parks).

Table 1: Summary Characteristics of Carson Properties

	BASELINE ENERGY CONSUMPTION (KWH/YEAR)	BASELINE HIGHEST PEAK DEMAND (KW)	BASELINE ENERGY CONSUMPTION* (KWH/YEAR, LIGHTING)	BASELINE ENERGY CONSUMPTION *(KWH/YEAR HVAC/PUMPS)	BASELINE AVERAGE PEAK DEMAND* (KW, LIGHTING)	BASELINE AVERAGE PEAK DEMAND* (KW, HVAC)	BASELINE ANNUAL UTILITY COST ($)	BASELINE TARIFF	RES-BCT TARIFF ELIGIBLE (YES/NO)	NUMBER OF LIGHT BULBS
City Hall	996,379	277	333,320	413,620	66	100	$ 142,348.00	TOU-GS3-B	YES	620
Community Center	1,193,958	377	307,273	659,000	121	223	$ 185,103.00	TOU-GS3-B	YES	500
Corp Yard	377,039	179	61,685	16,477	14	5	$ 65,492.00	TOU-GS2B	YES	140
Anderson Park	143,596	0	138,000	0	0	0	$ 11,445.65	AL-2-A	NO	258
Calas Park	108,610	0	78,358	0	0	0	$ 7,683.00	AL-2-A	NO	162
Carriage Crest	48,316	0	17,515	0	0	0	$ 3,563.00	AL-2-A	NO	88
Carson Park*	257,265	147	81,795	0	45	0	$ 45,011.00	TOU-GS2B	YES	170
Del Amo Park	137,999	0	115,311	0	0	0	$ 10,516.00	AL-2-A	NO	206
Dolphin Park	177,248	216	50,000	0	15	0	$ 55,878.00	TOU-GS3-A	YES	280
Dominquez Park	54,043	0	22,000	0	0	0	$ 4,098.00	AL-2-A	NO	521
Hemingway Park	300,137	48	213,950	0	20	0	$ 33,678.00	TOU-GS2B	YES	185
Mills Park	78,764	29	54,399	0	15	0	$ 14,228.00	TOU-GS2A-AE	YES	70
Scott Park	321,613	0	232,691	84,972	0	0	$ 23,181.00	AL-2-A	NO	238
Stevenson Park	255,434	161	216,602	0	45	0	$ 2,520.00	TOU-GS2B	YES	288
Veterans Park	640,066	251	276,797	0	50	0	$ 109,922.00	TOU-GS3-B	YES	296
WALNUT, FRIENDSHIP, AND REFLECTIONS PARKS	8,381	0	8,000	0	0	0	$ 1,573.00	AL-2-A	NO	40
TOTAL	5098848	1685	2,207,696	1,174,069	391	328	$ 716,239.65			4062
*ESTIMATED										

Source: The Charge Bliss Team

With respect to parking spaces available for EV charging, the team determined that inadequate numbers existed at Calas, Del Amo, Friendship, Perry Street, Reflections, and Walnut parks. While the remainder have many spaces, evaluation with community leaders revealed that these are broken into multiple smaller lots where more than two dedicated EV spaces would be considered onerous for local residents.

As discussed previously, when project elements may significantly alter the physical environment and, in particular, access of residents, workers, or visitors to key locations, it is essential that these stakeholders contribute to design decisions. Community discussions revealed that City parking lots are used for multiple annual events that would preclude the building of parking lot canopy solar in those locations. The City of Carson, like many such tight-knit communities, holds large gatherings for common holidays such as July 4th but also holds an annual Jazz festival, Juneteenth celebration, and other community events. These are integral to the culture and history of the community and can neither be relocated nor altered in the interest of the proposed renewable systems. Similarly, these discussions yielded relevant information about the use of adjoining sports facilities and the potential impact upon new systems. Specifically, residents pointed out that baseball/softball fields could lead to strikes upon solar panels. This led to design modifications to prepare for such possibilities. Finally, community representatives expressed concern about aesthetics and public safety. City Councilmembers alerted the team to the fact that specific City locations have had trouble with crime and other public safety matters that would profit from improved lighting including additional LED lighting along specific pathways and the under-canopy lighting required by code for the parking lot solar.

Interaction with local law enforcement also proved to be fruitful and is recommended for future municipal projects. The Los Angeles Sheriff patrols the City of Carson. Indeed, the main station is across the street from the city campus (city hall and community center). The sheriff alerted the team to impending technology changes, public safety concerns, and opportunities to collaborate. Given the cost and value of publicly-located renewable energy systems and EVSE, it is important that public safety personnel be alerted to the impacts of potential vandalism and also contribute to design features to optimize the health and safety of community members.

Lastly, the team discovered that knowledge of transportation routes and tolerances for location disruptions is essential. Whereas initial solar canopy designs were performed to maximize solar at the main city campus, it came to light that this would block delivery truck access. In addition, the city expressed concerns about disruption of building operations and planning for the sequencing and duration of disruptions is important to preserve City functions.

2.2.1 Power Quality Monitoring

Centralized utility energy systems have been designed to respond to variable demands for power at all times and under nearly all circumstances. grid “inertia”, whereby large generation systems modulate power supply to maintain voltage and frequency within tight tolerances, permits large fluctuations in demand on a macroscopic scale. However, when power quality is examined locally, significant variations are observed in these parameters. In turn, this can result in device “flickering” as might be seen with lighting or can go as far as to cause electrical breakers and other protective relays to open and interrupt circuits. Across the spectrum of power quality variance, electrical load devices have variable efficiency and may waste considerable power. Therefore, understanding baseline power quality characteristics at proposed AEC sites may contribute to systems designs to improve power quality.

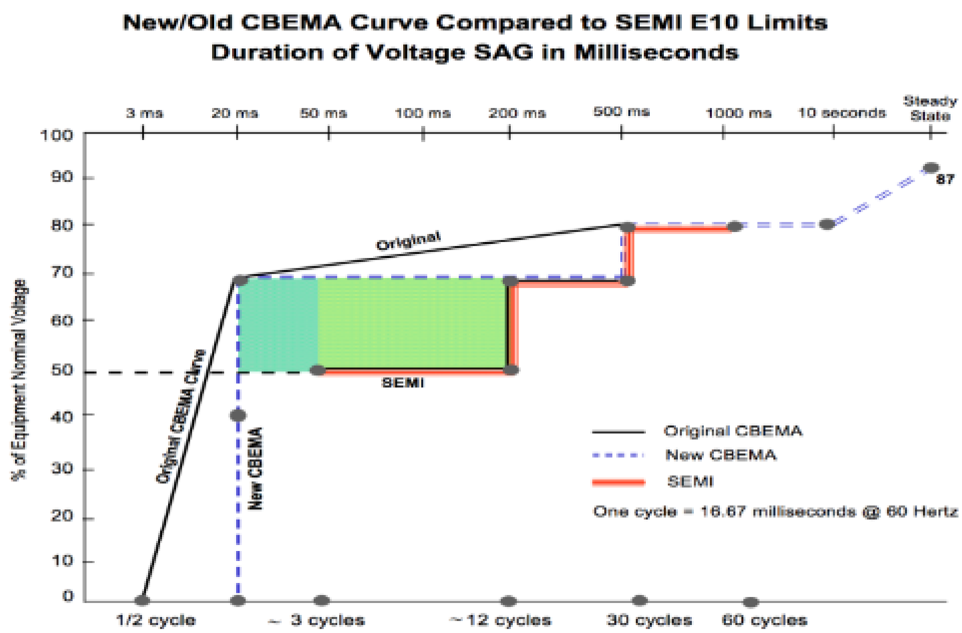
The Charge Bliss Smart Panel 3000™ is a monitoring tool capable of recording the full range of power variables at any accessible electrical site. With one-minute resolution, the device improves upon the 15-minute interval reporting of utility meters and provides additional data that is otherwise unavailable. Charge Bliss installed several Smart Panels to study power quality in the Carson properties- the results of which are reported.

City Hall Chillers: Commercial cooling systems (“chillers”) can require large power inputs (“draw”) which may cause transient fluctuations in local voltage and frequency. As is shown in Figure 9, there is up to a 3% variance of voltage between phases. In general, up to 4% difference from the lowest voltage phase considered acceptable balance. Using the standard calculation for imbalance yields an acceptable value of 1.3% (less than 2% is acceptable). In addition, voltages are erratic throughout the day and may vary as much as 3% from baseline. The prevailing standard, the American National Standard for Electric Power Systems and Equipment- Voltage Ratings (60 Hertz), allows for fluctuations of up to +6% and -13% in steady state voltage and more significant sags over shorter durations as shown in Figure 10. Nevertheless, these “acceptable” voltage variations may still contribute to load item inefficiency and may be amenable to power quality modulation by battery systems.

Figure 9: Voltage on Phase at City Hall Chillers

Source: The Charge Bliss Team

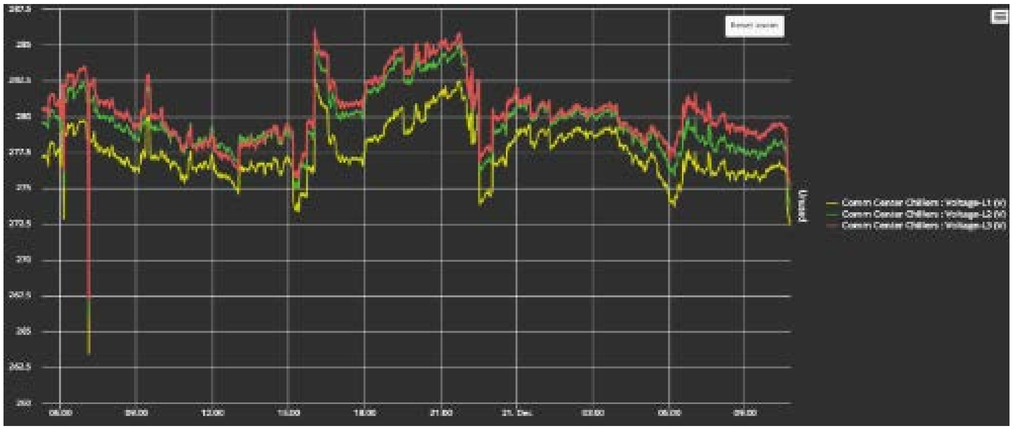
Figure 10: Voltage Variation Tolerances by Time Interval



Source: Pacific Gas and Electric Company,
https://www.pge.com/includes/docs/pdfs/mybusiness/customerservice/energystatus/powerquality/voltage_tolerance.pdf

Community Center Chillers: Charge Bliss monitored the cooling systems at the other large, main campus building as shown in Figure 11. The voltages on phase are significantly closer than those at the city hall, though there are larger transient sags in voltage. These findings illustrate opportunities to a) balance voltage on phase and b) buffer variations in voltage to achieve more consistent power quality and higher device energy efficiency.

Figure 11: Community Center Voltage Variations



Source: The Charge Bliss Team

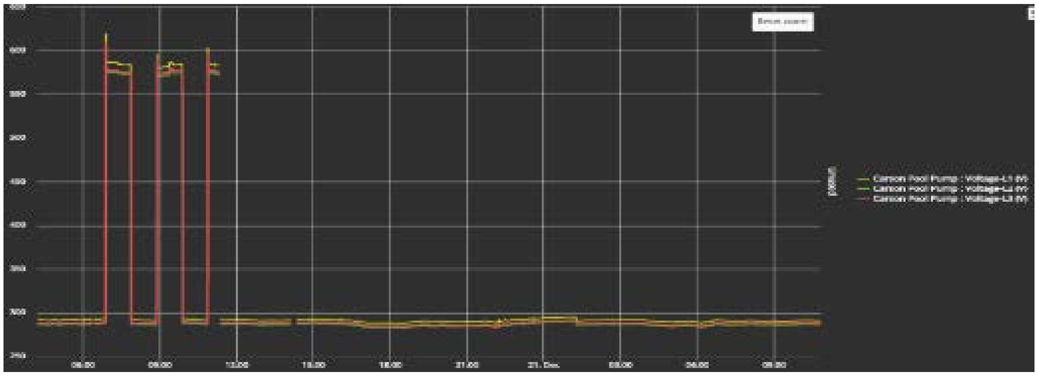
Community Center chiller voltages on phase demonstrating closer, more acceptable operating ranges and timing of operation.

Carson Pool Pump: To understand elements that might induce larger swings in power quality, the Charge Bliss team placed Smart Panel monitoring upon the line serving the pool pump. Large motors are known to induce rapid and sometimes significant changes in power quality and this is manifest in the representative graphs shown in Figure 12 (Voltage) and Figure 13 (Power Factor). The notable spikes in voltage are sustained for significant periods suggesting either monitoring error, significant increased current, significant increase in resistance, or some combination of the three.

Similarly, the findings of significantly low and variable power factor (ratio of real power to reactive power) suggest that considerable energy is being expended for other than the production of device work. This is characteristic of traditional inductive motors such as pumps. However, it can be significantly ameliorated by variable speed drives and/or the modulation of both real and reactive power by localized power supply systems.

If the observed phenomena are real, additional interrogation of energy systems may be required. If this cannot be addressed by repair or replacement, battery capacity may be applicable to buffer the prolonged power quality fluctuations.

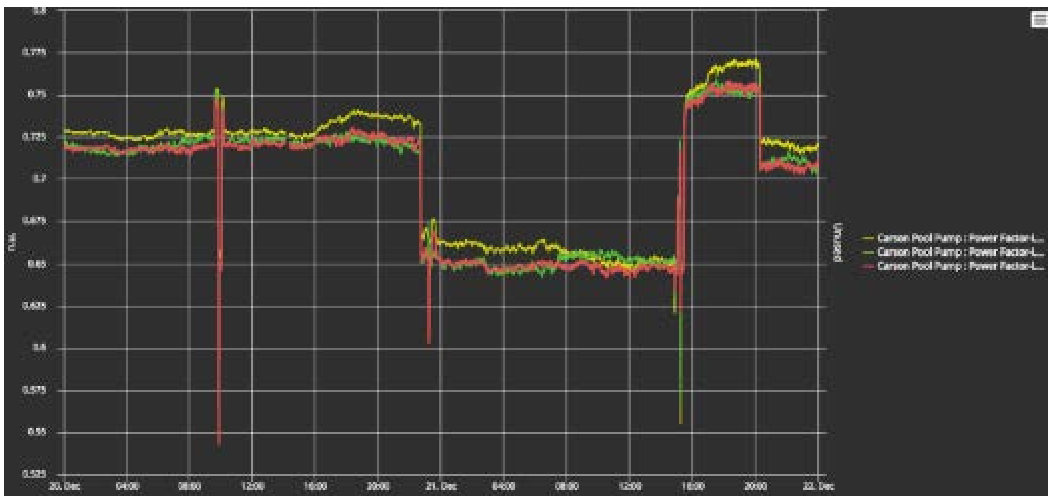
Figure 12: Voltage Variation Over Time On-Phase



Source: The Charge Bliss Team

Well-balanced voltage on phase, but large spikes due to pump start-up and shutdown.

Figure 13: Power Factor

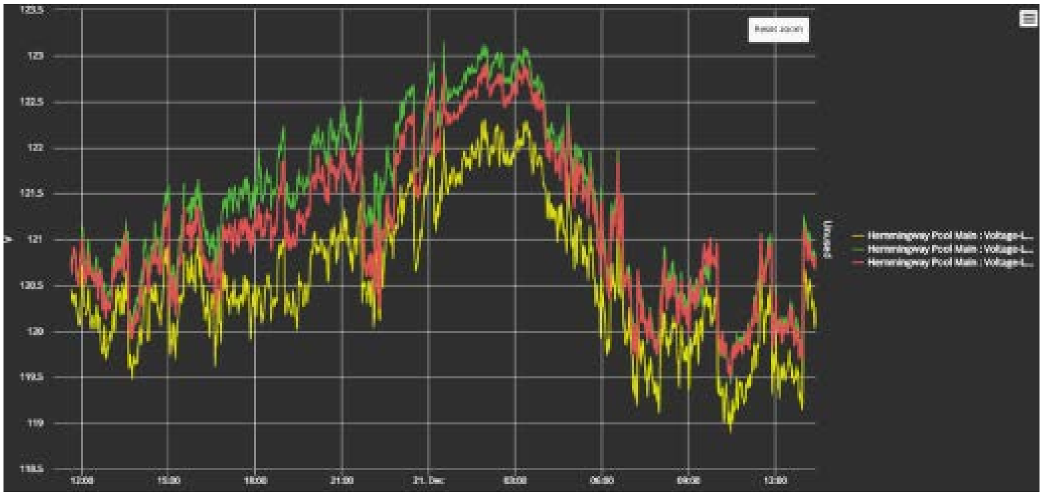


Source: The Charge Bliss Team

Power factor is the ratio of real and reactive power and is a standard measure of power quality. Values above 0.85 may be considered acceptable, while values above 0.9 are optimal. Decreased power factor contributes to energy inefficiency and losses.

Hemingway Pool: In contrast to the Carson Pool, the Hemingway pool has far better electrical quality performance. This suggests that there is superior equipment or performance as compared to the Carson Pool and less likelihood of meaningful impact upon power quality by battery systems. Figure 14 and Figure 15 shows the predicted impact on the power quality:

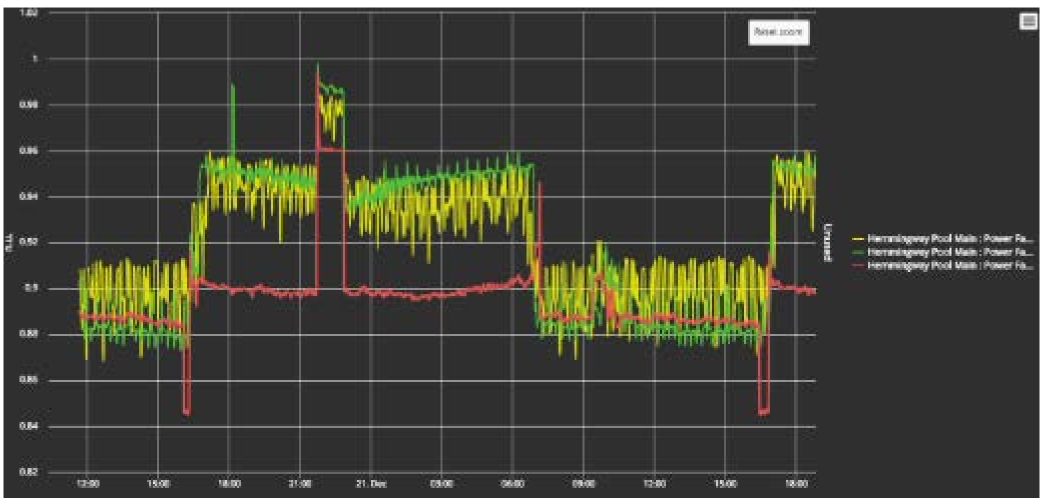
Figure 14: Voltage Variation on Phase at Hemingway Pool



Source: The Charge Bliss Team

Voltage well balanced on-phase with acceptable variation.

Figure 15: Power Factor at Hemingway Pool



Source: The Charge Bliss Team

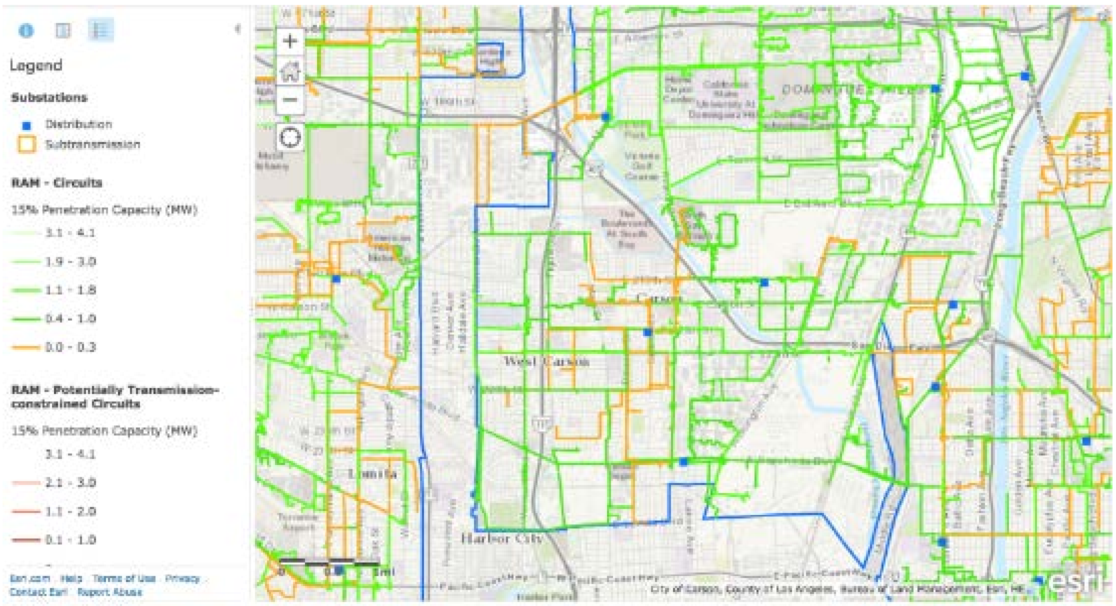
Power factor remains in the acceptable to very good range despite variation and should result in improved electrical systems performance.

Additional data gathering from the key monitoring sites will be used to determine the need for infrastructure upgrades (new pumps, wiring) or power quality modulation by the proposed Distributed Energy Resources (DER).

2.3 IOU Collaboration

After cataloguing city meters, main electrical panels, related site equipment, the team turned its attention to SCE supply equipment. In collaboration with SCE, Charge Bliss has evaluated area switchgear, transformers, power requirements, and projected power export in addition to the new loads from electric vehicle supply equipment (EVSP). As is shown in a map of the City of Carson using the Distributed Energy Resources Interconnection Map (DERIM), the team interrogated existing generation systems in area circuits as seen in Figure 16:

Figure 16: DERIM View of Carson Circuits



Source: ArcGIS, *http://www.arcgis.com/home/webmap/viewer.html?webmap=e62dfa24128b4329bfc8b27c4526f6b7*

SCE mapping system to interrogate circuits, transmission, and distribution capacities in the target community permits users to determine local capacity and gauge likelihood of successful interconnection.

While there are some circuits with only limited capacity, preliminary examination suggests that the proposed project generation amounts fall within the acceptable range for power export. Moreover, because project design incorporates substantial battery energy storage as well as significant electric vehicle charging, both may be used to take “excess” power generation rather than allow unconstrained export. Total project capacity includes 2.8MW of photovoltaic generation (nominal), 7.1MWh/1.75MW battery, forty-two (42) level 2 EVSE, and four ultrafast DC chargers. Notably, system capacities change regularly as new systems are interconnected. DERIM also contains data regarding substation and circuit capacities. For example, if one clicks upon the blue squares shown in the DERIM map, this provides current and pending development of generation and remaining capacities. As shown in Figure 17, individual circuits may also be interrogated:

Figure 17: DERIM Image of Carson City Hall and Community Center Circuits

Source: ArcGIS, http://www.arcgis.com/home/webmap/viewer.html?webmap=e62dfa24128b4329bfc8b27c4526f6b7

Single-site specific electrical service capacity mapping for SCE. Note the significant existing capacity of local circuits suggesting adequate reserve to accept interconnection of proposed renewable DER.

Using these DERIM inputs, the Charge Bliss team obtained transformer identification numbers, provide system sizing and matched site load data, and projected usage plans for the SCE interconnection team to study (Appendix E). Thus far, it appears that system capacities are sufficient for the proposed system sizing. Considerable design complexity and resultant cost may be avoided if future teams interrogate existing circuitry tolerances. While large renewable generation may be desirable in principle, inadequate circuit capacity could trigger the need for expensive interconnection studies, service or transformer upgrades, and/or electrical isolations systems.

It is worthy of note that several utility teams may need to be involved in multi-DER renewable energy microgrids to achieve project success. While each is not necessarily involved directly in the interconnection process, they bring added value and perspective to ultimate system design. In addition to the renewable generation/Rule 21 team, there is a microgrid development group and electric vehicle supply equipment team. In addition, SCE has a CPUC-regulated arm as well as an unregulated arm that can, under certain circumstances, participate in project development.

The collaboration with SCE also examined tariff structures and agreed in principle that the Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) method will apply to all of the sites with time-of-use rates. The tariff allows the city to use generation at any of the included properties to offset usage at the other properties gathered for this purpose. This applies solely to energy usage cost. Demand cost structures continue to apply at each individual property only. Moreover, participation in RES-BCT may forestall city participation in certain grid services programs. The latter value may be sufficient that the city could elect to forego the aggregation method inherent to RES-BCT in favor of receiving value for grid services.

Criteria for RES-BCT participation include:

- A customer must be a city, county, special district, school district, university, political subdivision or other local public agency.
- The maximum generator size is 5MW, and multiple arrangements are allowed.
- The benefiting account may be at remote locations within the same city or county.
- Generating and benefiting accounts in the "arrangement" must be on a time-of-use rate schedule.

Additional detail for the SCE RES-BCT is attached as Appendix C. The RES-BCT program, previously labelled AB 2466, was established in 2009 and is codified in Section 2830 of the Public Utilities Code. It allows a Local Government with one or more eligible renewable generating facilities to export energy to the grid and receive generation credits to benefitting accounts of the same Local Government and was expanded to include universities in AB 1031. In 2012, AB 512 increased the generator size limit to 5 MW per generation account. Each utility has been assigned a cap, though none have reached it to date. As this is a relatively new and not widely known option, only small numbers of customers have been able to use this pathway.

Additional information regarding SCE interconnection processes may be found at www.sce.com/wps/wcm/connect/a27eb130-a6b0-44b9-8f64f253741b620f/Introduction+to+SCE%27s+Generator+Interconnection+Processes.pdf?MOD=AJPERES. The Charge Bliss Team can attest from experience with several utilities that early notification of relevant personnel, interrogation of publicly-available information, and iterative design verification may avoid costly missteps.

2.4 Energy Use Reduction

Having determined that the RES-BCT tariff is operant for the City properties under time-of-use rates and that properties with non-demand rates would be eligible for a form of net metering, the design team turned to first determining how consumption and load may be reduced through improving site efficiencies. As noted above in Figure 9, lighting accounts for a significant proportion of current state energy consumption and a smaller proportion of peak load. Similarly, the chiller systems at the City Hall and Community Center account for between 25-33% of both energy consumption and peak load. Interestingly, during the evaluation of these load items, the team discovered that there is virtually no LED lighting throughout the 18 properties and the four chillers at the main campus are past their expected useful lifespan and in need of replacement. After analyzing options for replacement systems, the following estimates for savings were calculated. As shown in Tables 2&3, over 1,213,645 kWh of annual consumption, or approximately 24% of baseline, can be eliminated by chiller replacement and lighting conversion to LED. Furthermore, base load may be reduced by as much as 414kW with LED conversion and peak load reduced by 35kW by chiller replacement. These actions alone result in an estimated savings of approximately $225,400 in energy and demand fees per year or nearly 30%. The impact of chiller replacement including calculated reduction of consumption and cost is shown in Table 2. This action would result in overall energy consumption savings as compared to baseline of approximately 7%.

Table 2: Full Chiller Replacement at City Hall and Community Center

Facility Name	Proposed Consumption (kWh)	Proposed Cost ($)	kWh Savings	Dollar Savings
City Hall VAV Conversion	349,821	$46,143	146,832	$19,368
City Hall New Chiller	284,375	$37,510	58,901	$7,769
Community Center VAV Conversion	209,290	$32,952	128,760	$20,273
Community Center New Chiller	178,893	$28,166	25,837	$4,068
TOTALS	1,022,379	$144,771.00	360,330	$ 51,478.00

Source: The Charge Bliss Team

The calculated impact of lighting replacement with LED systems upon energy usage and cost at all target sites is shown in Table 3. Estimated savings from new lighting systems as compared to baseline is nearly 20% of total energy consumption at all targeted city sites.

Table 3: Lighting Inventory, Impact of LED Replacement

Facility Name	New kW	New kWh	kW Savings	kWh Savings
City Hall	40.35	113,249.45	48.16	145,585.32
Community Center	44.75	140,744.29	36.22	126,776.10
Veterans Park	171.16	165,110.48	76.75	175,333.88
Scott Park	123.81	126,742.87	38.84	58,393.02
Dominguez Park	8.58	14,222.00	4.73	11,160.52
Stevenson Park	180.68	113,564.72	23.53	31,657.59
Dolphin Park	144.49	135,398.62	24.12	24,490.09
Anderson Park	32.58	66,735.22	56.47	69,253.97
Hemingway Park	84.88	104,603.40	29.77	76,497.36
Corporate Yard	69.44	120,287.39	23.5	92,377.62
Del Amo Park	137.11	71,112.46	11.53	22,017.60
Calas Park	96.04	56,244.94	14.91	15,962.44
Dr. Mills Park	8.18	22,743.96	7.93	25,379.61
Carriage Crest Park	74.28	31,866.16	4.7	3,503.33
Carson Park	60.05	43,449.87	10.64	21,584.38
Walnut Mini Park	0.89	3,887.52	1.24	5,403.22
Perry Mini Park	0.44	1,219.68	0.66	1,840.61
Reflection Mini Park	0.14	628.99	0	0
Friendship Mini Park	0.18	90.72	0.2	98.78
Totals	**1,278**	**1,331,903**	**414**	**907,315**

Source: The Charge Bliss Team

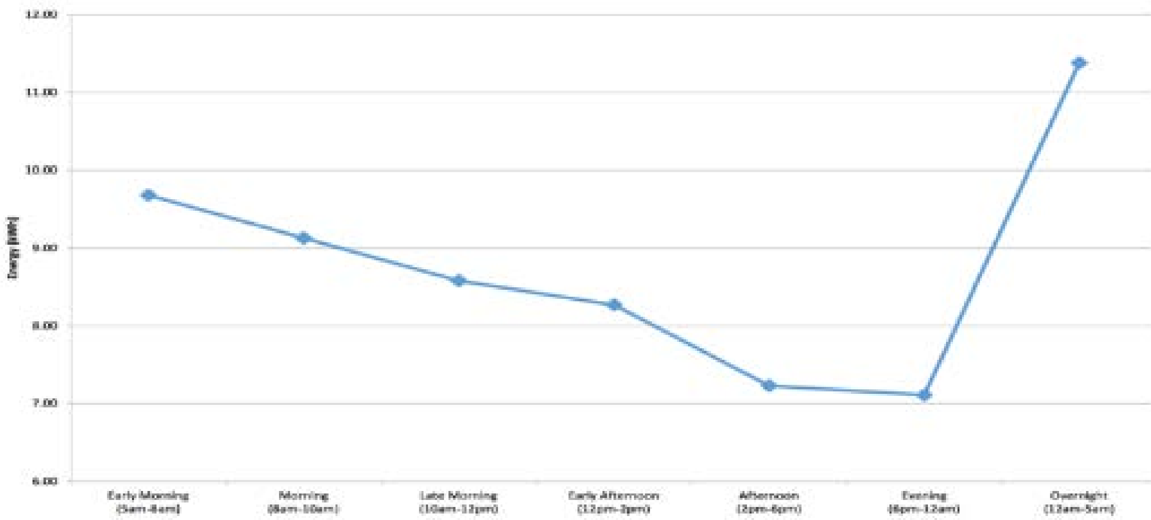
2.4.1 Energy Use Impacts of EVSE

The upfront calculation of adjustments to energy consumption and load must be considered prior to projecting the capacity requirements for renewable generation and battery energy storage. Therefore, the addition of new load items such as EVSE is the next step in iterative project design. Though EV charging infrastructure has the salutary impacts of reducing fossil fuel consumption for transportation, in order to achieve the primary goal of zero net utility energy consumption, the energy and peak load requirements of these devices must be addressed.

In evaluating the needs of the Carson community beyond the baseline survey of the resident and employee populations, Charge Bliss undertook in-depth research regarding electric vehicle supply equipment needs. There are four groups that may, at any time, operate electric vehicles in the Carson region including local residents, employees, business clientele, or visitors. The transient nature of business clientele and visitors makes it very challenging to assess the numbers of current users and their charging behavior. This is exacerbated by the relative lack of charging infrastructure in the city. These individuals may charge at home or in surrounding areas and go to and from Carson without being detected by any currently available methodology. Therefore, models of future use will have to consider an unmet burden of current need as well as the invariable growth in usage once charging infrastructure is available in keeping with the survey results discussed previously in this monograph.

Given the lack of charging behavior data from existing infrastructure in the region, Charge Bliss has elected to use data sets from Adopt-a-Charger, UCLA, the California Plug-In Electric Vehicle Collaborative, the Department of Energy, and others. According to the Luskin Report,[14] "the highest demand for workplace charging occurs in the morning hours (up to 10 am) and then decline throughout the remainder of the day. Overall, approximately 47% of all analyzed transactions occur before 10 am, a total of almost 61% of transactions before noon, and 76% cumulatively before 2 pm." Graphical detail from the same report is shown in Figure 18 and Figure 19:

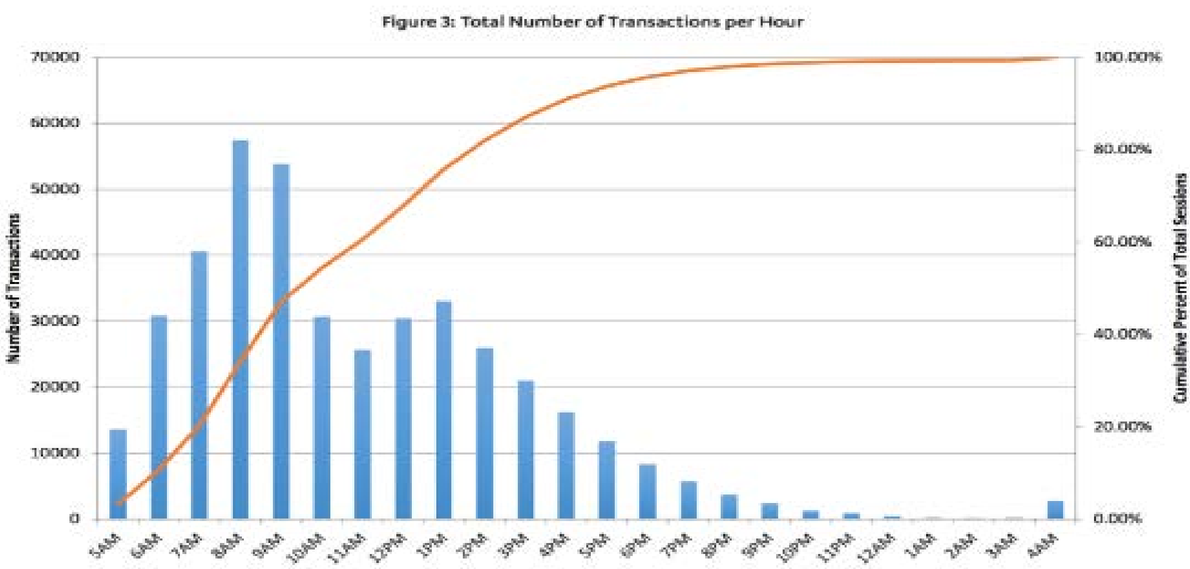
Figure 18: EVSE Energy Consumption by Hour of Day



Source: Impact Report 2016. UCLA School of Public Affairs Luskin Center for Innovation.

Pattern of level 2 EVSE charging energy consumption by time of day. The bimodal distribution (early morning and evening) suggest a combination of workplace and home charging.

Figure 19: EV Charging Transaction by Hour of Day



Source: Impact Report 2016. UCLA School of Public Affairs Luskin Center for Innovation.

Number of EVSE charging transactions at public stations by time of day. Note that the most significant usage occurs early in the day- consistent with destination charging such as at the workplace.

The report also offered deep detail about the impact of pricing structures on charging behavior. While free charging results in increased use, it also engenders leaving sites occupied far longer and less efficiently whereas paid systems (TOU, time, kWh, hybrids) lead to different forms of usage optimization. Figure 20 compares this impact:

Figure 20: Comparison of Free and Paid Charging Usage

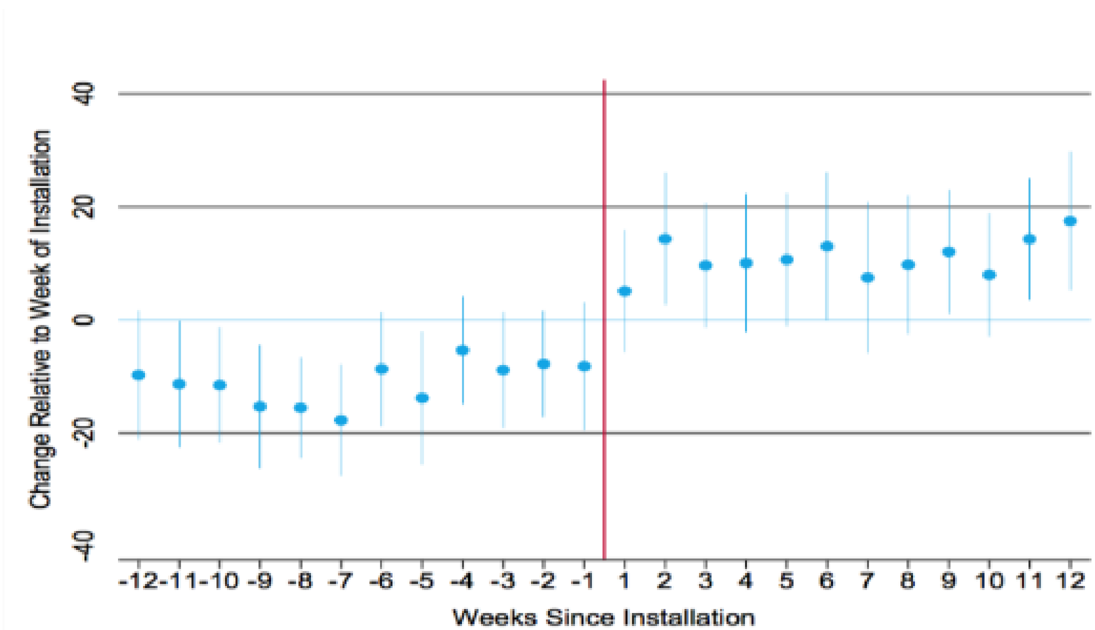
	(5AM-8AM)		(8AM-10AM)		(10AM-12PM)		(12PM-2PM)		(2PM-6PM)		(6PM-12AM)	
	Paid	Free	Paid	Free	Paid	Free	Paid	Free	Paid	Free	Paid	Free
Duration (mins)	215	238	215	234	195	191	181	183	150	163	150	182
Dwell (mins)	50	93	59	100	47	66	41	63	32	56	43	74
% Charging	83.2%	72.7%	79.1%	70.6%	82.5%	77.0%	81.7%	76.8%	85.1%	79.6%	85.9%	80.0%
Energy (kWh)	10.35	8.65	9.82	8.11	9.51	7.63	9.02	7.34	7.74	6.67	7.20	7.05

Source: Impact Report 2016. UCLA School of Public Affairs Luskin Center for Innovation.

Impact of free versus paid charging on behavior on charging device usage. Free charging does not appear to increase the amount of energy obtained but increases dwell time- suggesting that users are more likely to leave a car occupying a space after charging is completed if there is no associated cost.

Interestingly, the Luskin report goes on to show that the addition of charging equipment has predictable impacts (See Figure 21 below). While individual charging behaviors do not change, there is an immediate increase in the number of sessions and, therefore, the aggregate energy usage. Moreover, the timing of use across the workday remains stable, suggesting that increases in aggregate load are linearly related to the number of EVSE.

Figure 21: Impacts of New EVSE on Charging Behavior



Source: Impact Report 2016. UCLA School of Public Affairs Luskin Center for Innovation.

Impact of new EVSE on charging behavior. Note rapid initial increase in charging followed by leveling-off of usage rates in the early period.

According to the DOE's Workplace Charging Challenge, Mid-Program Review (2015), employers who offer charging at work have six times the number of EV drivers in their employee base than the average employer.[24] Moreover, while 80% of Nissan Leaf and Chevrolet Volt owners will charge their vehicles at home, up to 43% will ***require*** workplace charging intermittently.[25]

Based upon these resources as well as several others,[26-29] and in collaboration with EVSE design team members Kitty Adams (Adopt-a-Charger), Edward Kjaer (Former Director of Transportation Electrification SCE), Jacki Bachrach (South Bay Cities Council of Governments), Michael Anderson (Efacec, Inc.), and the SCE EVSE team, Charge Bliss assembled the specifications shown in Appendix F. While the end result may appear to be a simple distribution of level 2 EVSE throughout the community with centralized DCFC, this design is informed by the comprehensive data sets, stakeholder engagement, and contingency analyses. The team recommends that future developers consider regional demographics, transportation patterns, evolving use patterns for EVSE, intensity of EVSE power demand, and ability to offset energy and demand using co-located renewable DER.

2.5 Calculation of Solar and Battery Requirement

The net impacts on use and demand caused by the introduction of efficiencies followed by EVSE are then used to determine the amount of solar energy required to reach net zero utility consumption over the course of each year and to specify the amount of battery needed to manage demand. In parallel, the expert EVSE load control team from UCLA devised a plan for active load management to mitigate peak demand. Total remaining usage is calculated to be approximately 4,300,00 kWh/year. In aggregate, using SunPower® high-efficiency solar panels, a derating percentage of 0.8, and an average period of insolation of five hours per day, the estimated requirement for solar is 2,945 kW. When this is tested in more accurate tools such as PVwatts® or Geli®, the refined estimate stands at 2,405 kW. This compares favorably to the calculated surface area available for solar development otherwise determined to have a total capacity of 4,382kW. Notably, the spaces available for solar construction are mismatched with the locations of most intensive utility energy consumption. In the case of the properties with time-of-use tariffs that may be aggregated into the SCE RES-BCT tariff, this mismatch may be exploited to design offsetting renewable generation at disparate locations to meet global need. For the remaining locations served by tiered, non-demand tariffs, solar designs were specified to equal the residual net energy consumption at each individual site. Using serial optimizations in the Geli®, StorageVet®, and Homer® tools, the team then determined the amount of Tesla® battery that would optimize demand reduction while achieving acceptable financial returns. Future design teams must consider each generation, efficiency, and consumption element both separately and holistically to arrive at a design that meets zero net energy objectives.

The Charge Bliss team observes that using redundant, confirmatory design tools allows for more accurate system sizing and performance projections. In turn, these are critical to determining project cost, investment requirements, and potential investor yields. For example, the choice of photovoltaic vendor may be determined by space available, cost, and rate of deterioration of productivity. While high efficiency, durable panels may perform well in space-constrained circumstances or when long-term productivity is a specific concern, less efficient, inexpensive panels may have better performance in situations where investment dollars are limited. Finally, the rapid improvement of solar technologies combined with rapidly decreasing cost requires that teams revisit design principles regularly.

Energy storage sizing and selection is equally complex. As of this time, there are multiple possible tools including a wide range of battery chemistries and manufacturers, mechanical batteries, compressed air, pumped hydro, thermal storage and many others. Each differ with respect to tolerances such as charge and discharge rate, depth of discharge, cycle life, rates of deterioration, energy and power density, and many others. As such, there is no standard technology that may be deployed in all applications. Though there are many factors to consider, cost, maximum discharge rate, and durability are essential. For purposes of uniformity, maximum discharge is frequently reported as a ratio of the battery's total capacity. Thus, a 1kWh battery that can discharge up to 1kW would be rated as 1C. Expressed differently, higher ratings equal faster discharge rates. For example, lithium titanate batteries are up to three times more expensive than other lithium-based chemistries but may tolerate discharge rates up to 12C. Most battery manufacturers permit discharge rates from C/12 to C/2 with the majority listed as C/4. High intensity batteries may be cost effective in applications that require relatively short interval, high power output while batteries that are suited to prolonged outputs are best used in applications to provide stable energy amounts such as might be needed in residential or off-grid applications.

Battery cost is a rapidly evolving factor. As of this point in time, many chemistries are available for between $250 to $700 per kWh. However, developers must be aware of significant additional costs that may arise. While some vendors will provide a fully integrated solution at this price including power conversion systems (inverters) and controls, others simply provide the battery systems alone. In addition, the choice of power conversion system (PCS) type and controls may be critical. Through the grant process, the Charge Bliss team evaluated several PCS devices and found a relatively wide range of functionalities and speeds. While applications that intend to store and redeploy energy in either a timed fashion or in response to a narrow range of conditions such as peak demand exceeding a defined threshold do not require significant speed or sophistication, others may seek to provide grid services, regulate power quality, create isolated electrical "islands", and more. The latter requires very high-speed monitoring, communications, control, and execution. The Smart Inverter Working Group has laid out a roadmap for this process, but inverter and control systems have yet to meet the requirements.

Because the proposed Carson application seeks to provide demand management, demand response and other grid services, ability to island and support critical infrastructure, and, possibly, regulate local power quality, the team sought a vendor with a demonstrated ability to meet these objectives. However, the team recognizes that the rapid evolution of technologies, manufacturing, vendors, and cost will mean that future developers will have to fully re-evaluate options to select the best tool for their specific application.

2.6 Iterative Communication and Community Engagement

After completing the preliminary analysis of tariffs, demand profiles, usage data, City and SCE energy equipment, and space available, the Charge Bliss design team generated preliminary specifications. However, after serial review by City staff, City Council members, and City residents, it became apparent that several proposed designs would conflict with established uses and operations of several sites. For example, it was determined that some of the proposed parking lot solar canopies would obstruct the routes of delivery trucks to both the City Hall and Community Center as well as Community activities at several parks such as the "Juneteenth Fair" and annual Carson Jazz festival. In addition, community advocates raised concerns that the allocation of excessive numbers of parking spaces at community parks for EV charging only would meet with disapproval from area residents. Similarly, the discovery of a planned Caltrans drainage project at one of the parks as well as a variety of sporting events that might lead to inadvertent damage to energy equipment led to early re-designs. By considering the input of diverse stakeholders, the design team was able to avert several pitfalls which would otherwise be unknown to non-resident developers.

In a similar vein, the team found regular, formal communication with city staff and council members to be valuable to project progress. Throughout the course of the investigatory and design phases, members of the Charge Bliss team presented their findings and recommendations for approval from the two lines of governance. This included periodic review of California Energy Commission solicitation requirements, determinations of feasible and infeasible designs, selection of target properties, and evaluation of finance models. This transparent approach has been important to understand the evolving needs, priorities, limitations, and concerns of the city.

Participation in existing community events as well as creating new encounters has been invaluable to communicating with area stakeholders. In addition to presenting in open City Council meetings, Charge Bliss team members presented at numerous community forums, provided an educational booth at the annual Carson Jazz Festival and GPS your Future Program at California State University Dominguez Hills, engaged with STEM field (Science, Technology, Engineering, Mathematics) students and faculty at Carson Senior High School, and, with collaboration from the City, organized the first Electric Vehicle Drive and Ride event with over 500 area attendees to learn about and experience electric cars. Adopt-a-Charger, led by Ms. Kitty Adams, provided information about electric vehicles, subsidies and resources for Carson residents, and contact information for dealerships in the region. These episodes facilitated bidirectional communication to understand the community's views and current understanding as well as provide information regarding overall project objectives, the significance of transportation electrification, and the resources available to city residents. Representative information included purchase and lease costs as well as subsidies may be found in Appendix G.

It cannot be overstated that developers from outside of a municipality or community must solicit input from a wide range of stakeholders. In addition to being essential to garner project support, community engagement and iterative communication are critical to avoid infeasible designs. Moreover, third-party investors are looking to the host community to support project development and to commit to its successful construction, maintenance, and operation. As such projects involve multi-million-dollar investment, it is critical to give investors comfort that all potentially avoidable complications have been addressed up-front.

2.7 Detailed Solar and Battery Specifications and Estimated Outcomes

The final specifications shown in Table 4 reflect the design results after the collaborative, iterative process incorporating input from multiple City and community stakeholders. Distribution of photovoltaic installations and batteries is shown by target site with calculated impact upon peak demand. Note the proportionate reduction of peak demand with battery sizing.

Table 4: Final Solar and Battery Specifications by Site

	PHOTOVOLTAIC SIZE (KW)	BATTERY SIZING (KWH/KW)	NET PEAK LOAD REDUCTION (KW)*
City Hall	550	1044/520	169
Community Center	714	1044/520	100
Corp Yard	0	0	0
Anderson Park	60	0	0
Calas Park	65	0	0
Carriage Crest	43	0	0
Carson Park	185	1044/520	37
Del Amo Park	0	0	0
Dolphin Park	110	1044/520	130
Dominquez Park	35	0	0
Hemingway Park	160	378/174	37
Mills Park	45	174/87	20
Scott Park	183	0	0
Stevenson Park	175	1044/520	113
Veterans Park	313	1044/520	173
WALNUT, FRIENDSHIP, AND REFLECTIONS PARKS	0	0	0
TOTAL	2638	6816/3281	779
*ESTIMATED			

Source: The Charge Bliss Team

Based upon the projected performances of the aggregated Distributed Energy Resources (LED, chillers, solar, batteries, and control systems), the team estimates the following financial and environmental results.

1. **Use savings:** By achieving net zero energy consumption from the utility, the project reduces purchased energy by more than 5,000,000 kWh per year for a savings of approximately $372,000/year. This also includes the production of more than400,000 kWh per year of additional energy for electric vehicle charging.
2. **Demand savings:** The project achieves an estimated demand reduction of 46% from baseline despite the introduction of comprehensive electric vehicle charging and

including ultrafast devices. Depending upon the use of the ultrafast DC electric vehicle charging systems and the mitigation strategies employed, this is estimated to yield savings of $160,000-$200,000/year.

3. **Electric transportation savings:** Assuming an average driving distance of 3.3 miles per kWh of energy consumed by an electric vehicle, the 400,000 kWh per year is estimated to yield 1,320,000 miles driven without emissions per year. Assuming that the average vehicle achieves 25 miles per gallon of gasoline,[31] the annual averted use of gasoline will be 52,800 gallons and will rise as electric vehicle usage increases. With average gasoline prices in California currently at $3.19/gallon,[32] the averted usage accounts for net area resident cost savings of more than $168,000 per year. These calculations do not include the avoided costs of oil changes, tune-ups, smog testing and others inherent to operation of internal combustion engine vehicles.
4. **GHG and polluting emissions:** According to the United States Energy Information Administration, California energy generators produce 621 pounds of CO_2 per MWh, 0.8 pounds of NOx per MWh, and minimal SOx. Therefore, the reduction of utility generation by more than 5.5 GWh will reduce annual CO_2 emissions by 3,415,500 pounds and NOx by 4,400 pounds. This is the equivalent of planting over 71,000 trees per year.[34]
5. **Grid Services:** Investigation of options for grid services encountered both opportunities and limitations. Discussions with services aggregator and manager Olivine® suggested that while the RES-BCT tariff may allow generation at one facility to offset use at another, this may not be permissible with certain grid services. It remains to be determined whether Automated Demand Response (ADR), spinning and non-spinning reserve, or frequency regulation are either a) compatible with the RES-BCT tariff method or b) sufficiently valuable to disaggregate generation and consumption in favor of these services. ADR, for example, may be valued at up to $300/kW and may be combined with other demand response services.[35] With up to 3.2MW of battery discharge capacity for two hours, the specified system could be valued at up to $960,000 per year. However, the team assumes that a minimum of 50% of battery capacity will be reserved for local power quality and demand regulation or, perhaps, other ancillary services. As prices and programs for grid services evolve, it may become more valuable to offer services to the utilities or ISO *in lieu* of the site, however.

Some demand response programs may be combined. These options should be considered by developers as well as cities to determine the greatest return on investment as well as to inform critical designs such as site-based energy storage. Figure 22 below shows SCE's demand response program combinations at the time of the evaluation:

Figure 22: SCE Demand Response Program Combinations

If You Are Enrolled in This Program Today	You May Add One of These Programs
Agricultural and Pumping Interruptible (AP-I)	• CPP • DBP • RTP • SLRP
Base Interruptible Program (BIP)	• CPP • DBP • RTP • SLRP
Capacity Bidding Program (CBP) with "Day-Of" Option	• CPP • RTP • SLRP • DBP • AMP
Capacity Bidding Program (CBP) with "Day-Ahead" Option	• AMP with "Day-Of" Option
Critical Peak Pricing (CPP)	• AP-I • BIP • SDP • CBP with "Day-Of" Option • AMP with "Day-Of" Option
Demand Bidding Program (DBP)	• AP-I • BIP • SDP • CBP with "Day-Of" Option • AMP with "Day-Of" Option
Aggregator Managed Portfolio (AMP) "Day-Of" Option formerly DRC "Day-Of" Option	• CPP • DBP • CBP • RTP
Real-Time Pricing (RTP)	• AP-I • BIP • SDP • CBP with "Day-Of" Option • AMP with "Day-Of" Option
Scheduled Load Reduction Program (SLRP)	• AP-I • BIP • CBP with "Day-Of" Option • SDP
Summer Discount Plan (SDP)	• CPP • DBP • RTP • SLRP
Local Capacity Resource (LCR) Contracts	• CPP • DBP • RTP • SLRP
Preferred Resources Pilot (PRP) Contracts	• CPP • DBP • RTP • SLRP

Source: Southern California Edison, *AutoDR Program Guidelines*

Permutations and combinations of grid services programs within SCE territory to be considered for ancillary revenue generation. The ability to enroll in programs also depends upon DER capacity, resource type, speed, point of interconnection, site tariff, and other factors.

2.8 Finance Modeling and Business Case

For the city to capitalize upon the AEC options, the design team also formed a working group to examine finance options. While some public entities may have access to resources to directly fund such capital projects such as cash or debt instruments, many disadvantaged communities do not have such facilities. As is the case with the City of Carson, many such municipalities are already struggling to meet operational costs and have been forced to defer critical infrastructure maintenance, leave personnel positions unfilled, and curtail work hours. These circumstances also engender considerable skepticism towards innovative projects with indeterminate outcomes and conservative approaches to contracting for services without constraint on downside risk.

Introducing other resources such as subsidies, grants, or third-party investors are, therefore, virtual necessities, albeit with added levels of complexity that can impede project progress. While it may appear, at first, that intercalation of other parties would lead to diminished value for the off-taker (city) this is not entirely correct. First, tax-exempt entities such as cities, schools, universities, non-profits, healthcare organizations and others are unable to make use of tax equity that is currently available to for-profit organizations. The 30% federal income tax credit and accelerated MACRS depreciation substantially decrease net system cost and increase Net Present Value (NPV). Other incentives that may be obtained by non-profit or for-profit entities such as the Self-Generation Incentive Program Advanced Energy Storage (SGIP-AES) can significantly offset battery system expense but cannot be claimed if batteries are purchased with California Energy Commission grant funding. Countervailing effects include the taxable nature or payments from the off-taker to system owner and the tax consequences of capital equipment purchase with grant monies.

As the team sought to build the finance model, it became clear that the role of each DER within the system contributes to performance and had to be factored. In so doing, the team built a "Value Matrix Tool" to take comprehensive inputs to calculate the impacts of different strategies, circumstances, and variable adjustments. The design team gathered data from several resources to build knowns into calculation algorithms as shown in Appendix H.

In order to employ the Charge Bliss Value Matrix Tool, a user must first define a range of numerical possibilities for key elements. The Tool does not provide nor recommend specific capacities or ratings for DER elements such as photovoltaics, batteries, chillers, LED lighting, EVSE, or controls. Rather, it takes user configurations and calculates their impacts upon site technical and financial performance. Moreover, the tool does not examine whether potential configurations meet engineering, power flow, interconnection or other technical standards but assumes that the user will have ascertained whether sizes and ratings are technically safe and feasible. Tool designers expect that users will work iteratively between technical tools to determine safety and feasibility and the Charge Bliss Tool to examine projections for whole system performance and financial returns. Finally, it should be noted that the user has many input types and options. Though the Tool was configured to give the user maximum flexibility in systems performance projections, it also introduces potential error if the user fails to enter data correctly, does not choose correct inputs where drop-down menus are provided, or does not enter critical data elements.

Once the user has assembled preliminary sizing of both existing energy systems and those being considered for incorporation into a DER project, these are used as key inputs for the Value Matrix Tool. In addition, the user will need to provide a one-year, 15-minute column of data set to begin January 1 of the year selected at midnight. Third, the user will need to provide a PVWatts™ hourly output for 1kW of solar at the specific location being analyzed. Lastly, the user will need to provide inputs for the variables listed in the preceding Value Matrix Tool Development section. When incomplete, inadequate, or no inputs are provided for key data elements, output calculations will show a variety of errors or no results.

The Tool uses these inputs to produce detailed technical and financial projections for each DER individually and in several combinations, that are user-configurable. In addition, the user may manipulate financial inputs such as loan interest rate, discount rate, cost escalators, and can test tariff changes. An image of a financial projections shown in Table 5:

Table 5: Financial Projections Detail Through Year 6

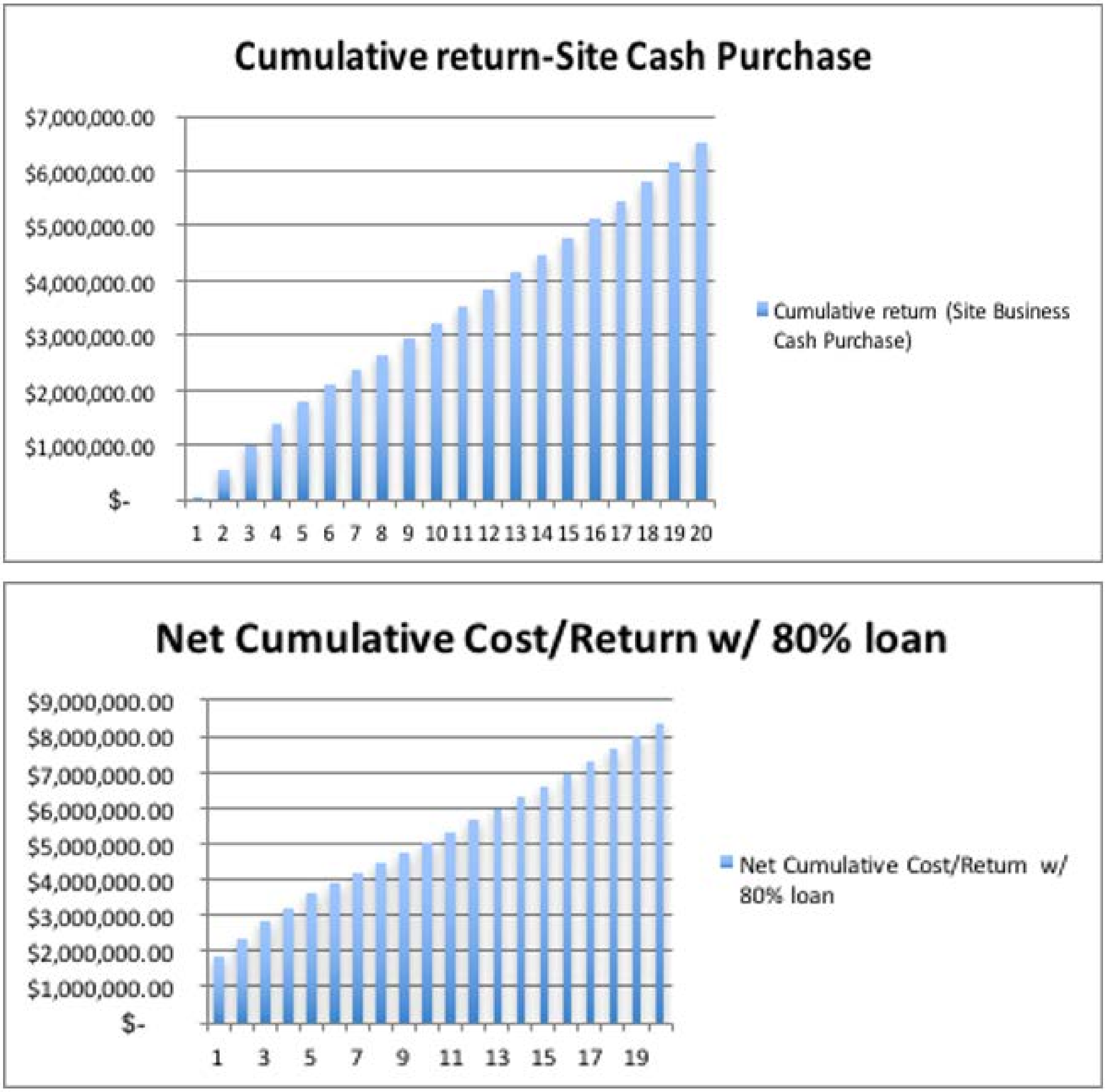
SITE OWNERSHIP	Year One	Year Two	Year Three	Year Four	Year Five	Year Six
System (INCLUDES SALES/USE TAXES)	$ (820,870.94)	$ -	$ -	$ -	$ -	$ -
State/local tax (gross-NOT INCLUDED IN FINAL CALCULATIONS)	$ (191,105.00)					
State/local tax (Net of Federal deduction; INCLUDED IN TOTAL PRICE)	$ (191,105.00)	$ -	$ -	$ -	$ -	$ -
Federal Tax Credit	$ 246,261.28	$ -	$ -	$ -	$ -	$ -
State Advanced Energy Credit (net of Federal + State Tax)	$ 289,144.50	$ 57,828.90	$ 57,828.90	$ 57,828.90	$ 57,828.90	$ 57,828.90
Federal MACRS (net value considering tax rate)	$ -	$ -	$ -	$ -	$ -	$ -
State MACRS (net value considering tax rate minus Fed tax)	$ 309,670.33	$ 185,802.20	$ 111,481.32	$ 66,888.79	$ 40,133.28	$ -
State Solar Tax Credit (after Fed and state taxes)	$ 30,063.23	$ 29,988.07	$ 29,913.10	$ 29,838.31	$ 29,763.72	$ -
Calculated Demand Cost Savings	$ 49,373.73	$ 123,323.65	$ 126,406.74	$ 129,566.91	$ 132,806.08	$ 136,126.24
Calculated Usage cost savings (net of Fed and State taxes)	$ 121,121.40	$ 123,846.63	$ 126,633.18	$ 129,482.42	$ 132,395.78	$ 135,374.68
Operation, Maintenance, Replacement (after tax deduction)	$ (8,208.71)	$ (8,208.71)	$ (8,208.71)	$ (8,208.71)	$ (8,208.71)	$ (8,208.71)
Annual Return	$ 25,449.82	$ 512,580.74	$ 444,054.53	$ 405,396.63	$ 384,719.05	$ 321,121.11
Cumulative return (Site Business Cash Purchase)	$ 25,449.82	$ 538,030.56	$ 982,085.09	$ 1,387,481.72	$ 1,772,200.77	$ 2,093,321.88
Gross Annual Return (%)- Cash purchase	3.10%	62.44%	54.10%	49.39%	46.87%	39.12%
Gross Cumulative Return (%)-Cash purchase	3.10%	65.54%	119.64%	169.03%	215.89%	255.01%
Modified Internal Rate of Return (%)- Cash Purchase						
Net Present Value of Savings/Loss					$ 1,659,045.63	
NPV of all discounts, rebates, incentives	$1,619,555.08					
Percent reduction of purchase price by NPV	160.04%					
TOTAL GROSS COST	$ (820,870.94)					
TOTAL NET COST	$ 798,684.14					
Annual Gross Financial Results (Cash Purchase)	$ 285,805.47	$ 681,977.28	$ 688,672.37	$ 695,528.86	$ 702,550.61	$ 680,052.24
Cumulative Gross Financial Results (Cash Purchase)	$ 285,805.47	$ 967,782.76	$ 1,656,455.13	$ 2,351,983.99	$ 3,054,534.60	$ 3,734,586.84
NPV					$2,863,530.96	
MIRR					39.50%	

Source: The Charge Bliss Team

The Finance and Return on Investment tool with a single site outcome demonstrates the automated calculation of tax credits, depreciation, taxes, revenue streams, and initial investment with investor yields shown as Net Present Value (NPV) and Modified Internal Rate of Return (MIRR). Numerous variables may be varied including turning incentives on or off to evaluate returns under different circumstances.

Graphical, Holistic Financial Projections: The tool automatically produces graphical representations of cumulative financial impacts to show simple payback periods and gross value over the project lifespan. Representative graphs are shown in the Figure 23, showing cash purchase and 80% finance respectively. Other graphical options include 100% or 70% debt financing, third-party ownership methods such as leases, power purchase agreements, and shared savings models. Users may independently test with and without tax equity, other incentives, different tax brackets, utility cost escalators, inflation and loan rates, and different rates of decay in system productivity, efficiency or other value forms.

Figure 23: Cash and 80% Financed Purchase Returns



Source: The Charge Bliss Team

Financial Outcomes Tool automated outputs with graphical representation of cumulative results of different investment methods. Loan term, interest rate, discount rate, reinvestment return rate, loan-to-value percentage, and loan amount, and financial incentives (tax credits, depreciation, SGIP) may be modified to examine the impact upon financial outcomes. In the specific scenario shown, loan to purchase results in greater net returns over a 20-year project lifespan.

Comparative Financial Analysis: The Tool produces side-by-side energy, demand and total utility bill cost according to the tariff selected. In addition, users may investigate the impact of tariff change to determine if there is added value and see the impacts upon the value of each technology alone or in combination. Similar comparative analyses may be performed with the financial reporting tools above. Representative images of DER financial impacts are shown in Tables 6 and 7. Representative images of the Value Matrix Tool outputs contrast current utility costs and the impacts of different combinations of possible energy tools. Note that the application of DER technologies raises the levelized cost of energy as compared to baseline due to the relative dominance of residual demand fees.

Table 6: Comparative Annual Utility Bill Impacts of DER

Cost type	NOW	LED	HVAC	CHILLERS	PV	PV+BATTERY +LED	PV+BATTERY	ALL
Annual Utility Expense ($)	$257,797.42	$249,016.01	$1,800.00	$259,429.23	$101,996.05	$95,206.15	$96,778.60	$87,302.29
Annual Energy Expense ($)	$132,659.47	$131,495.60	$0.00	$128,722.90	$17,700.88	$15,474.65	$16,638.52	$11,538.08
Annual Demand Expense ($)	$123,337.95	$115,720.41	$0.00	$128,906.33	$82,495.17	$77,931.50	$78,340.08	$73,964.22
Annual Fixed Fees ($)	1800	1800	1800	1800	1800	1800	1800	1800
Average Price/kWh ($)	$0.070377	$0.070345	#DIV/0!	$0.070154	$0.049868	$0.045396	$0.046663	$0.039681
Levelized Cost of Energy ($)	$0.14	$0.13	#DIV/0!	$0.14	$0.28	$0.27	$0.27	$0.29
Average Demand Cost ($/kW)	$24.76	$24.76	$24.76	$24.76	$24.76	$24.76	$24.76	$24.76

Source: The Charge Bliss Team

When no other inputs are changed other than to select a different utility tariff from a dropdown menu, the user may immediately see the impact upon cost or savings as shown in Table 7. In this fashion, future developers may evaluate nearly all combinations of the included technologies, tariffs, and resulting costs to empirically determine the optimal approach. A representative image of Value Matrix Tool outputs contrasts current costs and the impact of different combinations of possible energy tools in addition to elective tariff change. Note that the application of DER technologies raises the levelized cost of energy as compared to baseline due to the relative dominance of residual demand fees.

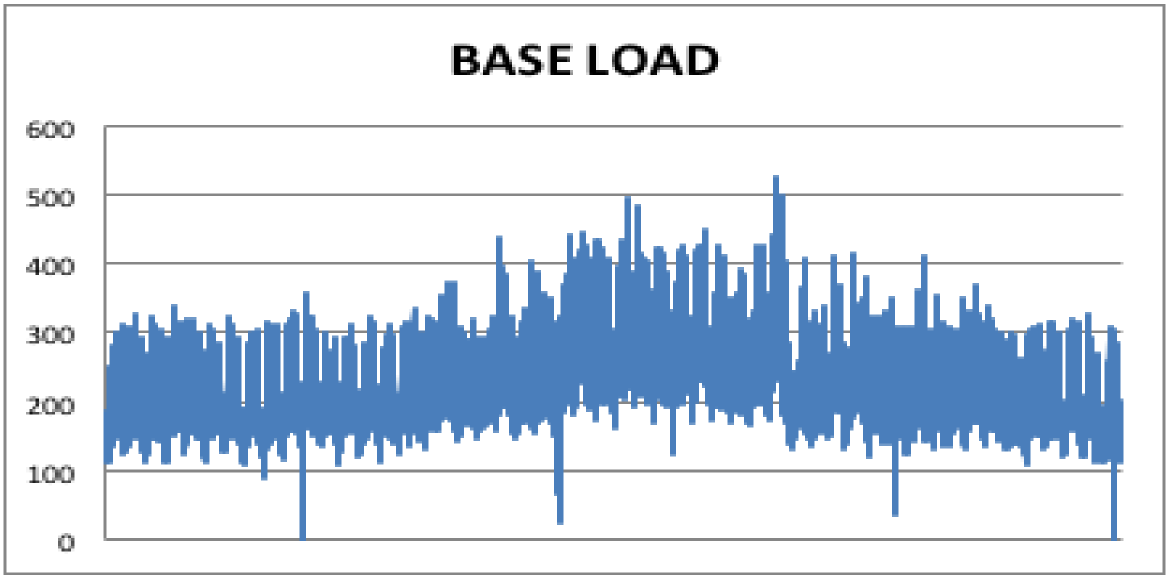
Table 7: Comparative DER Impacts with Tariff Change

Cost type	NOW	LED	HVAC	CHILLERS	PV	PV+BATTERY +LED	PV+BATTERY	ALL
Annual Utility Expense ($)	$248,641.26	$240,794.64	$1,800.00	$249,296.89	$94,324.80	$86,357.87	$87,936.15	$78,746.45
Annual Energy Expense ($)	$134,895.58	$133,709.16	$0.00	$130,876.29	$17,853.85	$15,538.96	$16,725.37	$11,519.67
Annual Demand Expense ($)	$111,945.68	$105,285.48	$0.00	$116,620.60	$74,670.95	$69,018.92	$69,410.77	$65,426.78
Annual Fixed Fees ($)	1800	1800	1800	1800	1800	1800	1800	1800
Average Price/kWh ($)	$0.071563	$0.071529	#DIV/0!	$0.071327	$0.050299	$0.045584	$0.046907	$0.039618
Levelized Cost of Energy ($)	$0.13	$0.13	#DIV/0!	$0.13	$0.26	$0.25	$0.24	$0.26
Average Demand Cost ($/kW)	$22.38	$22.38	$22.38	$22.38	$22.38	$22.38	$22.38	$22.38

Source: The Charge Bliss Team

Additionally, the Value Matrix Tool can produce technical performance metrics for load impacts of individual DER or DER in combination. This may assist a developer in assessing the relative significance of a specific DER or DER combination in context of its load impacts. Based upon these performance metrics, consultants, developers, builders and commercial building personnel may examine different scenarios nearly instantaneously by turning one or more DER on or off in the calculations section of the tool varying the capacity, number, other performance characteristics, or the timing of DER operation during different time intervals. Each variable may be tested independently until the user has reached what they believe to be optimal performance. Examples of graphs of 12-month, 15-minute interval load data are produced and re-calculated automatically and may be exported for review and reporting. Representative images are shown in Figures 24-32:

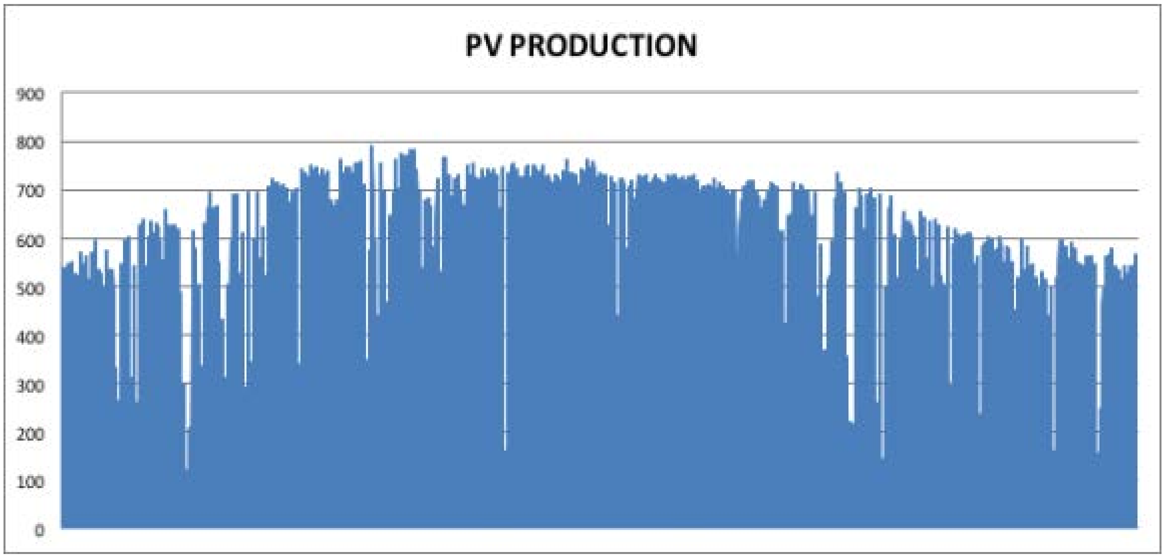
Figure 24: Site Base Load Profile (KW)



Source: The Charge Bliss Team

Example image of average load patterns over a 12-month period. Note the seasonal variation with highest peak loads during the system-wide highest demand in summer.

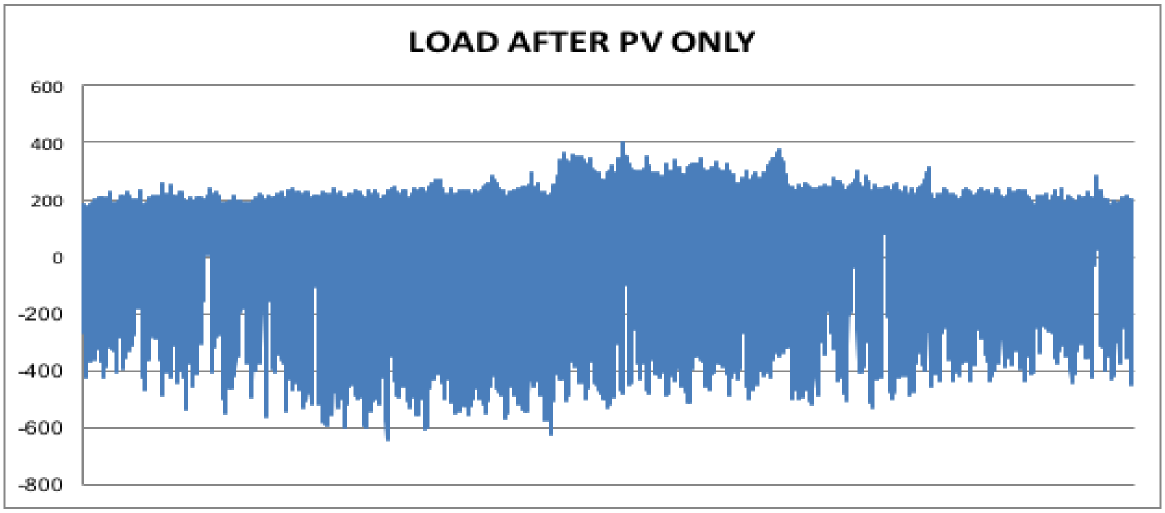
Figure 25: Estimated Solar Power Production (KW AC)



Source: The Charge Bliss Team

Projected solar energy productivity over 12 months demonstrating seasonal variability and intermittency. Intermittent productivity and variation in power quality can be ameliorated by co-location of batteries for power processing, storage and redeployment.

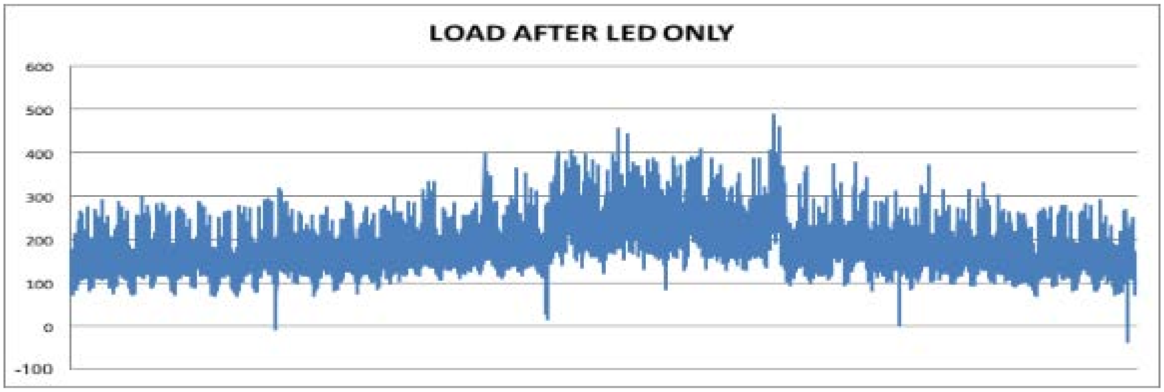
Figure 26: Impact of Solar Power Production upon Site Load Profile (KW)



Source: The Charge Bliss Team

Impact of solar productivity upon 12-month load profile. Note the flattening of peak demand, but the persistence of smaller demand spikes.

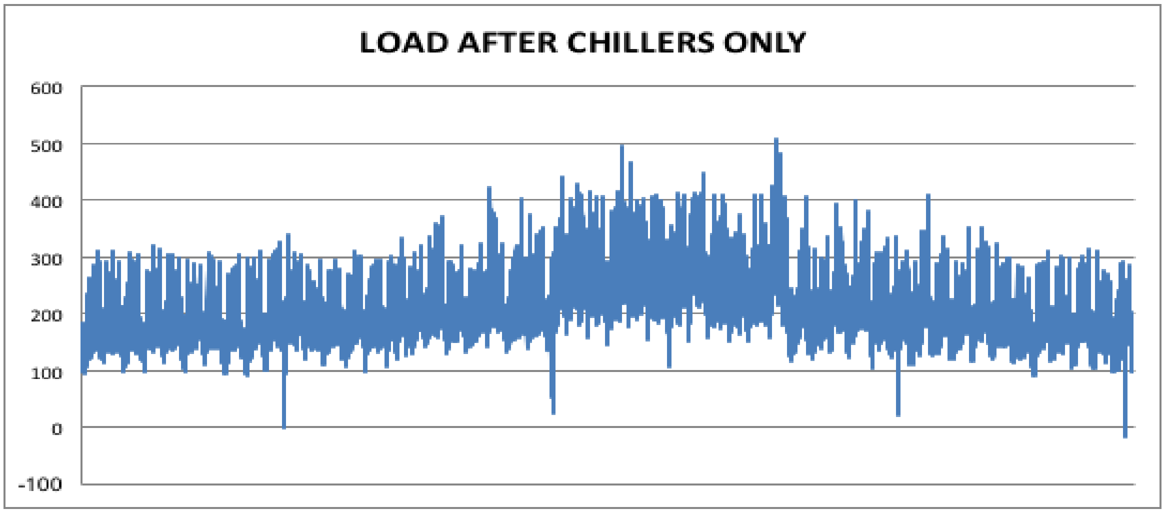
Figure 27: Residual Site Load Profile after Consideration of LED Impact Only (KW)



Source: The Charge Bliss Team

Impact on load profile over 12-month period with institution of LED lighting only. Note that lighting reduced base load and, therefore, peak load, but does not impact spikes in demand that occur with operation of other devices.

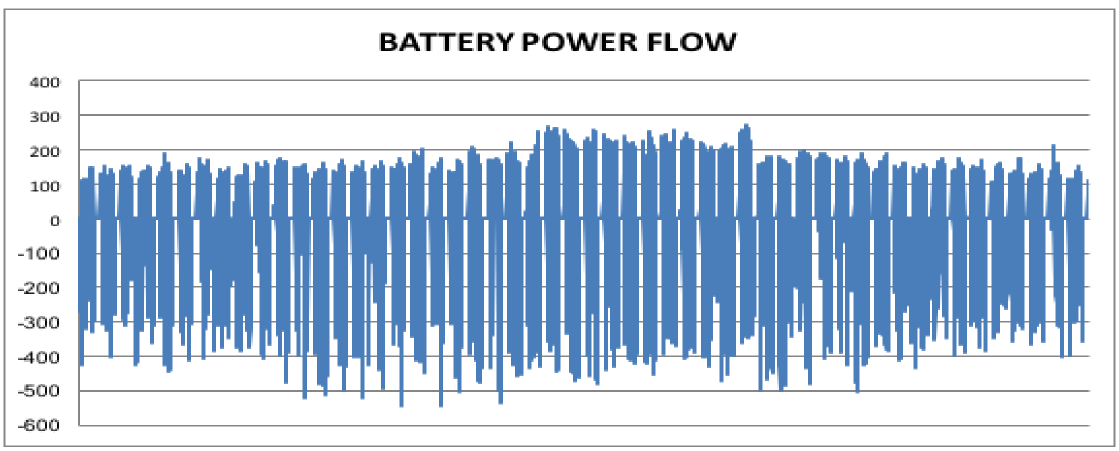
Figure 28: Residual Site Load after Consideration of Chillers Impact only (kW)



Source: The Charge Bliss Team

Impact on load profile over 12-month period with institution of new chillers only. Note the reduction of peak loads in Summer though the highest spikes persist.

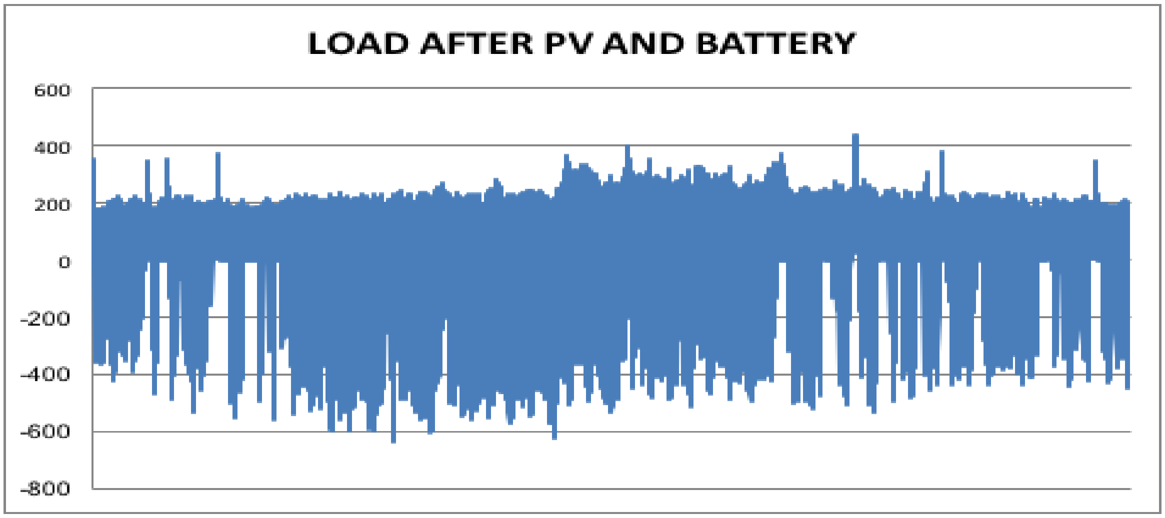
Figure 29: Power Flows to (-) and from (+) Battery (kW)



Source: The Charge Bliss Team

Projected power into and out of battery systems over a 12-month period to mitigate peak demand

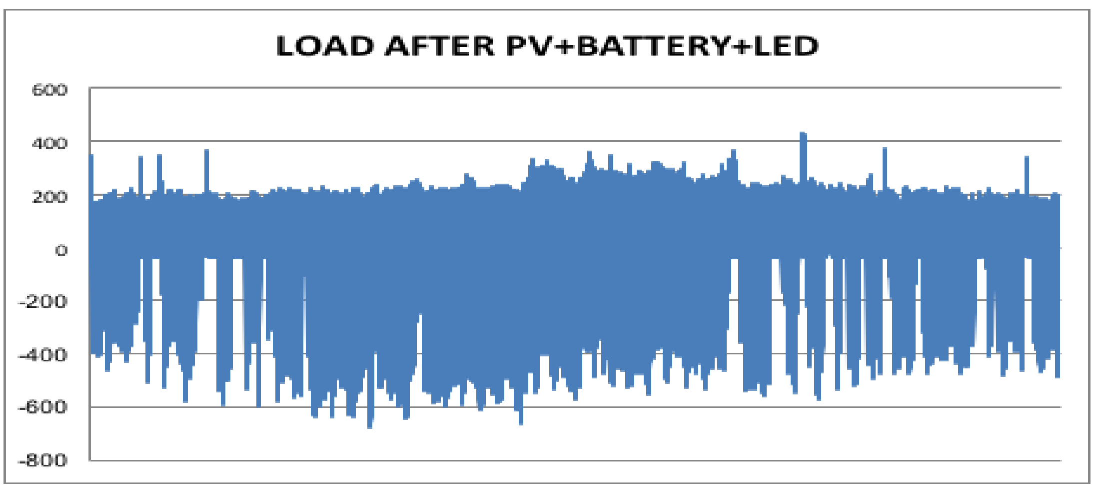
Figure 30: Residual Load Profile after Consideration of Photovoltaic and Battery (KW)



Source: The Charge Bliss Team

Projected impact of combined solar and batteries to levelized demand profile over a 12-month period

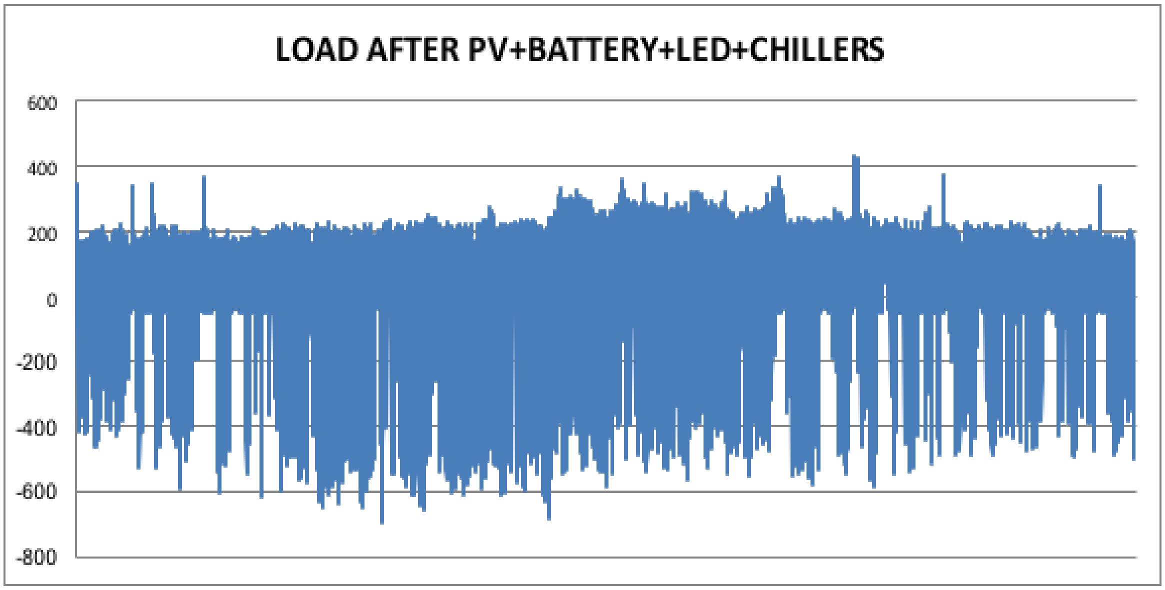
Figure 31: Residual Load Profile after Consideration of Photovoltaic + Battery + LED (KW)



Source: The Charge Bliss Team

Projected impact of combined application of solar, batteries, and LED lighting upon 12-month load profile

Figure 32: Residual Site Load Profile after Consideration of Photovoltaic + Battery + LED + Chillers (KW)



Source: The Charge Bliss Team

Projected impact of all energy systems combined upon 12-month load profile demonstrating most significant reduction. Note persistent spikes may persist based upon solar intermittency and estimated battery SoC. This may contribute to a degree of performance unpredictability and may impact financial modeling and outcomes for system owner and end-users.

2.9 Funding Options

As discussed previously, municipalities are frequently unable to participate in the capital expense of AEC-type projects and alternative sources of funding may be required to bring the project to fruition. In addition, municipal fiscal health may change during the period of project development depending upon the reliability of revenue sources and/or changes in operational cost. Perhaps most importantly, clarity between project participants as to what is financially feasible and direct discussion with final decision-makers may be critical to success.

Through the numerical and graphical representations such as those above, the team was able to validate the additive value of DER as well as investigate the modification of numerous variables. In Figure 32, the compiled value of all elements results in significantly levelized demand, particularly in expensive Summer months, optimizes the application of solar generation, and realizes considerable value for all parties.

Once technical and financial projections had been fully determined, The Charge Bliss team engaged with multiple regional, national, and international clean energy investors as well as experts in banking and finance to examine existing and emerging models for project funding. Financial constructs considered the presence and absence of subsidies including tax equity and other incentives and determined that there are four larger categories with multiple sub-categories:

Off-taker purchase: In this model, the site owner or operator purchases the proposed system using either cash, debt instruments, or a combination. Cities are unable to use the tax equity but may receive other incentives without tax consequences. The purchaser assumes all responsibility for system operation, maintenance, and repair. Debt instruments may include:

a) State or Federal lending: these typically offer interest rates well below market as well as more extended payback periods. For example, the California energy Commission will lend up to $3 million at 1% interest for 15 years to be paid from savings.36 This equates to $226,000 in payments per year.
b) PACE lending: this allows building owners to receive capital as a lien against the building and to pay over 10 years at a fixed rate on their property tax bill. This is not available to tax-exempt entities such as cities.
c) Municipal lease: specialty lenders will provide below market interest rate finance for municipal capital projects in exchange for tax write-offs specific to this facility. Though it is termed a "lease," this functions like a financed purchase of equipment by the city.
d) Bond issue: A city may elect to issue bonds to defer debt payment until bond maturity. According to Moody's, the City of Carson has an Aa3 bond rating.
e) Conventional loan: Cities with good credit, adequate non-liquid assets, or other collateral may obtain conventional loans but cannot realize tax benefit from interest expense.

Shared savings: In this model, the party who owns and operates the project provides energy services to the off-taker. Options for payment include a fixed monthly fee not tied to a specific metric such as kWh production combined with a variable component for system performance beyond the baseline guarantee, a variable baseline fee per unit of energy produced and a second variable component for value of additional services, or a fully variable model in which payments are solely based upon off-taker savings. The system owner generally assumes all responsibility for its operation, maintenance, and repair, though shared cost models can also be created.

Lease: The off-taker pays the system owner a fixed fee, with or without price escalation over time, and the system owner provides minimum system performance guarantees. System operation, maintenance, and repair may be performed by the owner with commensurate increase in lease rate or may be assumed by the off-taker to reduce lease cost.

Power purchase agreement (PPA): The off-taker pays the system owner a fixed fee per unit of energy produced (kWh) with or without cost escalation over time. The PPA rate typically exceeds the simple cost of energy per kWh but is less than the levelized cost of energy (energy + demand cost/total kWh consumed). The system owner typically provides minimum performance guarantees to reflect mitigation of demand costs, improvement in power quality, provision of backup power or islanding, or other services. In the scenario where efficiencies or other services are added into a DER project, a specialty sub-model emerges:

a) Averted energy use PPA: In this scenario, the PPA price is paid for all energy (kWh) not purchased from the utility. This includes energy produced by the solar or not used due to efficiency items such as LED lighting, HVAC, or building management tools.

b) Averted energy use PPA + shared grid services revenue: In this scenario, the system may be employed to deliver grid services at additional value. These revenue streams may be taken entirely by project ownership or shared with the off-taker.
c) Energy produced PPA: Like a standard solar PPA, the off-taker (City) pays a defined value per kWh of energy produced by the solar only. Averted cost from other systems (chillers, LED) is not directly included but PPA rates reflect overall savings from the entire system.

While each of these models is currently in use in the marketplace or under consideration, it is becoming increasingly apparent that more simple, streamlined, and verifiable methods are emerging as most desirable to all parties. While at-risk models such as the "Shared Savings" approach were considered ideal when solar microgrids and complex DER were first being offered due to the perceived unpredictable value and performance, subsequent validation of their reliability has led investors to move away from these more complex tools. Simultaneously, off-takers find these arrangements to be difficult to understand and even more difficult to reconcile. For example, when a site or multiple sites changes its operations and, therefore, its energy profile, all parties must have sophisticated methods to rebalance calculations of costs and savings.

Another point of concern and potential controversy are the use of payment escalators. From the investor perspective, these adjustments are needed to account for the impacts of inflation and to preserve desired returns on investment (ROI). However, cities such as Carson variably view these as a risk that future payments to the DER owner will exceed what otherwise would be paid to the utility. Despite historical evidence that both energy and demand costs rise over time at a rate equal to or greater than payment escalators, City staff express the preference to pay higher initial rates than have an escalator over time.

Finally, performance guarantees are valuable tools for all parties to ensure minimum acceptable service while not obligating excessively onerous outcomes. Municipalities want to see guarantees that their power expense will be less *in toto* while investors are seeking guarantees of a minimum acceptable return on investment to participate. The vehicle that seems to meet all of these imperatives is the "Averted energy usage PPA." Using this approach, private public partnership of partial grant funding, subsidies with tax equity and SGIP-AES, and investor capital allow the city to use zero capital outlay but receive the benefits of nearly $19 million in energy infrastructure including critical upgrades that are needed immediately, regardless. The investor and developer form a joint venture through which all project aspects are executed, and which then owns and operates the project. The joint venture assumes the tax consequences of grant funding but also receives the tax equity and incentives from project execution. The city pays a fixed fee for each kWh not consumed either due to efficiency or renewable production and the joint venture provides a minimum guarantee of system performance such that the city does not pay more than it otherwise would have to the serving utility.

Over roughly 18 months evaluating financial options, the city was offered a pure shared savings model, PPA, PPA plus shared savings, lease, or hybrids. All forms of finance that involved capital investment by the city were avoided due to the categorical requirement of city staff that the project not require such expenditure. All "shared savings" models were rejected by the City as they viewed such methods as taking away savings or revenue that should, in the city's estimation, belong to the city. The investors were equally disposed to reject this model as their perception was that such a model would require excessively complex monitoring and reconciliation processes in addition to unconstrained risk. The city also rejected leases including hybrid versions such as a PPA for energy and lease for battery performance. This was based upon the persistent concern by city staff and their technical consultant that a guarantee of demand cost reduction could not be provided. In the estimation of the city, this constituted excess risk that the city would pay more for battery services than would be delivered in savings. Extensive discussions were held to demonstrate to city personnel what the impacts will be on city capital expenditures if the project is not executed including the imminent need for more than $1million in chiller replacements and the multi-million-dollar cost of lighting replacement with LED. The investors offered to pay for these systems and wrap the finance model around all aspects. However, the city remained focused on seeing an absolute reduction in annual total energy cost irrespective of what other services or cost reductions were provided.

As a consequence of these discussions, the only potentially viable option for all parties was a PPA with a price that was less than the current levelized cost of energy (LCOE) for the city. Incorporating all project costs to be paid by the developers and investors, the city was offered $0.14/kWh as compared to the current LCOE of $0.156/kWh. Despite the inclusion of chillers, full lighting replacement with LED, EVSE, and all operation and maintenance cost, the city effectively rejected this proposal. As the teams approached the end of the time-frame to negotiate a mutually satisfactory financial model, several previous issues re-emerged as well as many new matters that ultimately rendered the project infeasible. The city continued to express concern that no guarantee of reduction of demand cost would be provided by the investor and wanted to include additional costs and liabilities that were unacceptable to the investor. By way of example, towards the end of negotiations, the city consultant and staff asked that the design team provide a PPA model that incorporated the city paying for the execution of efficiency items upgrades, or approximately $4 million of project value. Given the consistent directives that city capital would not be expended, this was unexpected. Nevertheless, the team provided a separate proposal reflecting this change with a PPA cost of $0.085/kWh. At the final stages of negotiations, including direct discussions with the city council, it remained unclear whether the city was indeed willing to participate in project cost and, if so, what the source of the capital would be.

Negotiations were ultimately terminated when the investor informed the team that the additional terms and conditions set by the City created excess risk and liability and caused the cost of the project to drive returns below an acceptable threshold.

The negotiation process suggests several probable avenues for improvement of future negotiations. First, a track record for AEC performance in municipalities will likely be needed to give city leadership adequate comfort that systems will provide the projected savings. While the team provided examples from a hospital, schools, and island installations, city personnel did not view this as relevant to a municipal installation. Second, early discussions of how battery storage systems function and agreement upon their purpose, value, and limitations may be essential to later negotiations. Until or unless investors are willing to guarantee demand performance or the city accepts a certain measure of risk, this will remain a point of contention between stakeholders. Third, if project finance will wrap around efficiency items, all parties should agree at the outset how this will be factored into a finance model. The project team recommended a model in which the capital cost that would otherwise be incurred by the city is reduced by an acceptable percentage such as 20% and amortized over the first ten years of the project. This was unacceptable in the current circumstance, but this or other methods will need to be included in early modeling to avoid later disagreement on value. Finally, it was observed that identifying a finance expert within the city personnel or consultants may be essential to project execution. The combination of several technologies with different technical and financial performances that must be rolled-up into a single finance method requires understanding of moderately sophisticated metrics that are most likely found in personnel with formal finance training. Simply put, as capital projects rise to the level of cost seen within this project, expert financial advice is indispensable and is best obtained at the outset.

2.10 CEQA and Permitting

While each CEQA jurisdiction must make its own determination, the Charge Bliss team has developed three California Energy Commission-related renewable energy microgrids, two of which are in SCE territory. In all three cases, the CEQA or equivalent entity has provided preliminary approval for systems designs. As of the writing of this final report, Charge Bliss has been informed that the signed document from the City of Carson CEQA officer attesting to this proposed approach being considered “not a project” should arrive within two weeks. The design principles that appear to have been instrumental in receiving these approvals include:

a) **Focus on built environment:** CEQA presents particular challenges when projects involve previously undisturbed, natural environments, or ecologically sensitive areas. While work upon previously built environments can trigger Environmental Impact Reports (EIR) when they may affect surrounding vegetation, wildlife, water or air-quality, or noise, this is far less likely when the projects involve modification and/or upgrades of existing systems (lighting, HVAC, pumps, and other loads), mounting of new devices on current structures (rooftop or canopy solar, battery/inverter containers, EVSE), and when these elements are each intended to improve environmental quality.

b) **Identification of environmentally sensitive areas:** Care must be taken when considering building near, much less upon, natural environments, waterways, or wildlife habitats. Charge Bliss considered these factors when investigating the location of systems at City parks. However, by focusing upon modifying the existing built environment at these locations and causing minimal disruption to the natural environment, the team was able to avoid extensive review.

c) **Project purpose:** While not expressly a CEQA criteria, it is notable that renewable energy DER explicitly seek to improve environmental quality. By decreasing GHG, NOx, VOC, and PM emissions and by deferring additional fossil fuel generation, these systems directly contribute to sustainability, environmental health and safety, and improvement of the surrounding communities.

With respect to the project progress towards permitting, Charge Bliss elected to pursue planning up through "plan check" with the City of Carson, but not to proceed to official permitting until funding is guaranteed. By its nature, the proposed project is solely directed at city properties over which the city exercises control as the ownership and permitting agency. As designs have been executed to date in direct collaboration with city staff, the prevailing sentiment is that permitting will be achievable but may be lengthy and beyond the budget allocated for this project Phase. In particular, with fifteen sites, LED lighting, HVAC, solar, batteries, EVSE, and control systems, the number of permits required, and their respective cost cannot be borne by the involved parties until funding is secure to build the project. Nevertheless, the team believes that plan check through the city will validate plan completeness, sound principles, and the order, type, number, and costs of permits required. Based upon experiences with similar projects in cities throughout the State, the team believes all necessary permits will be obtainable immediately at the outset of Phase II.

2.11 Project Drawings

See Appendix A.

2.12 Case Study and Replicability

The California Energy Commission through Grant Funding Opportunity 15-312 is seeking to build case studies to demonstrate the feasibility and effectiveness of Zero-Net Advanced Energy Communities (AEC) in Disadvantaged regions. Charge Bliss, one of the Phase I grant recipients, has documented the process of AEC development from community identification through formalized system design, engineering, and financial modeling.

After communicating with several Los Angeles area municipalities as well as the Los Angeles Unified School District, the Charge Bliss team developed selection criteria to determine host suitability (pgs. 22-23). Notably, the school district had to be eliminated from consideration due to their pre-existing contractual obligations, bidding processes, bonding requirements, and long-time horizon for administrative decision-making. The City of Carson, in the South Bay region of Los Angeles, emerged as the best candidate and, after a period of approximately 6 months of contract negotiations, agreed to proceed. Notably, a great deal of the time required to reach contractual agreement was for the city to understand the EPIC Terms and Conditions and to structure mechanisms for the city to approve or deny project progress up to and including submission of completed designs for Phase II funding.

Carson is a socioeconomically diverse, disadvantaged community ringed by major transportation routes, chemical refineries, and manufacturing facilities. Due to fiscal constraints arising from an inadequate revenue base to meet all financial needs, the city has been forced to defer significant infrastructure maintenance and repair including important energy systems at city facilities. Prior investigations into lighting upgrades, new cooling systems, and renewable energy did not come to fruition due to the costs proposed by the respective developers and the perceived lack of adequate return on investment.

Engagement of a non-profit, civic entity revealed several characteristics that are notable for future development projects. Like most cities in California, Carson has a dual governance model with daily operations carried out by employed staff and supervisory decision-making, policies, procedures, regulations, and contracts being made by the elected city council. This required that the team develop relationships with all parties to ensure consensus regarding process, reporting, and outcomes. Second, as cities exist to serve their citizenry, engagement of community members is essential to project success. Charge Bliss achieved this through formal presentation to open city council meetings, electronic communications including surveys to city employees and residents, participation in community forums, community events, and student activities, and pioneering the first electric vehicle "Drive and Ride" event at the main city campus. Moreover, the team met multiple times with community activists to tour city properties, understand current and future priorities, and the pitfalls of particular design strategies. Third, the team assembled working groups of stakeholders from diverse backgrounds to participate in the investigatory, design, and coordination aspects including EV advocacy (Adopt-a-Charger), utility collaboration (Edward Kjaer- former Director of SCE Transportation Electrification, SCE representatives), political collaboration (South Bay Cities Council of Governments), industry (SunPower®, Trane®, TRC®, Tesla®, Efacec®), and academia (Drs. Rajit Gadh and Peter Chu). Fourth, the team met regularly with city staff and leadership to maintain bidirectional communication and iterative approvals for approach. This due diligence phase led to the selection of target properties, determining the tolerances of serving utility equipment, understanding tariff options, prioritizing the location of electric vehicle supply equipment, and eliminating types and locations of designs that might conflict with normal operations of each property. The following key determinations were made:

Space available: Whether for the purposes of solar, batteries, or EVSE, proposed sites must have adequate space for their deployment without disrupting essential functions during construction or altering the operations for purposes valued by the community. This includes, but is not limited to, not blocking pathways for delivery to buildings with parking lot canopies, not taking "excessive" numbers of parking spaces for "EV only" use, and not locating potentially fragile equipment next to areas where harm is more likely such as from sports equipment.

Cost/benefit: While some sites may benefit from solar or batteries, the technical challenges and costs to achieve this may outweigh their value. For example, while the Corporate Yard consumes considerable energy and has high peak load, the building structures are inappropriate for rooftop solar and there is inadequate space available for other equipment. Fortunately, the RES-BCT option allows for generation at other sites to offset one or more sites where generation cannot be place.

Availability: For equipment that is designed for community use such as EVSE, understanding whether locations will be open and available can impact value of placement. In many cases, Carson city parks are closed at night and overnight parking is not allowed. While these policies are being reconsidered including evaluation of a paid license to charge overnight, design teams should consider whether such changes will come to fruition.

Occasional use: Though certain spaces may only be used once per year for community events, these traditions and expectations may obviate placement of permanent structures such as solar canopies. Charge Bliss encountered this with part of the community center parking lot and at two community parks.

City priorities: Because most disadvantaged communities in California also lack discretionary financial resources, averting unexpected new costs is a primary objective followed closely by the desire to reduce existing costs. Carson was resolute throughout that project development should not cost them existing resources beyond the standard participation of city personnel in capital projects and the project go-ahead would be contingent upon demonstration not only of putative savings but protections against costs exceeding those experienced currently.

In parallel to building the relationships and communication lines, the team obtained essential data to analyze the prospective sites, utility supply equipment, utility tariff options, projected need for electric vehicle charging and estimated energy performances, and area Science, Technology, Engineering, and Mathematics (STEM) students and faculty. In the case study of Carson, the team encountered 18 eligible properties of which fifteen were amenable to the build of solar and EVSE and eight that could benefit from batteries. Utility engagement revealed that all serving circuits were capable of receiving the estimated power export and that properties could be aggregated into the RES-BCT tariff to allow pooling of energy usage and generation for purposes of offsets. Load inventory revealed central chillers that have gone past their useful life and virtually no LED lighting- the replacement of which could yield substantial savings in energy efficiency. Finally, comprehensive interrogation of site capacities, resident and City employee needs, and achievable offsets of energy usage and demand revealed that level II EVSE could be built at fifteen properties and ultrafast (150kW) DC fast charging at the community center.

While not exhaustive, a representative list of useful information includes:

Utility data: Existing tariffs and future tariff options, one year of utility energy bills and 15-minute load (demand) data, and current meter types (TOU or other).

Utility equipment: Transformer numbers, location, ratings, DERIM map information, and export capacities.

Site equipment: Current state of major panels and wiring, busbar capacities at possible points of interconnection, inventory of number, type, and quality of load items (lighting, HVAC, air-handling, pumps, motors, manufacturing equipment), hours and days of operation, discretionary versus non-discretionary load items, remaining lifespan of key equipment.

Site characteristics: Transportation routes, parking spaces available for designation as "EV only" and/or for canopy solar, existing electric vehicles, projected future acquisition of EV, charging behavior (energy, power intensity, timing, duration).

Financial resources: Access to cash or debt facilities, acceptance of third-party investor imperatives, options for philanthropy.

STEM: Teachers, students, industry interested in participating.

The information gathered from community engagement and technical investigation led to the formulation of preliminary designs that were refined through iterative processes between the Charge Bliss design team and the City until all parties approved of overarching designs as well as specific allocations by property. This includes 2.47MW of SunPower® solar distributed over 14 of the 18 properties, 7.25 MWh/3.26MW Tesla® batteries, inverters, and controls, four (4) new chillers; two at each of the City Hall and Community Center, comprehensive interior and outdoor lighting substitution with LED

Next, the technical data and design specifications were entered into financial modeling tools including the Charge Bliss Value Matrix Tool, Geli®, and others to determine impacts upon energy usage and demand, cost, and financing options. Charge Bliss determined that the proposed project will save well over $500,000 per year at the outset and may generate additional revenue from grid services such as Automated Demand Response (ADR). Because the city does not have the resources to purchase the system, the team developed a third-party investment model based upon the value of averted energy use. This treats usage reduction from efficiencies equally to energy generated by solar or other renewable generation and sells services to the city at a cost well below existing levelized cost of energy (LCOE). This averted use power purchase agreement (PPA) provides excellent financial returns to the involved parties. The Carson opportunity drew five major investor groups to compete to provide energy services. Key factors to financial model success are:

Recognition of diverse DER value: Each DER element brings value to the project whether in the form of usage reduction (efficiency, renewable generation), demand reduction (load item power efficiency, battery load management), backup power (batteries), electric vehicle adoption (EVSE), or reduction of soft costs for maintenance of existing systems.

Simplicity and replicability: The finance model must be readily understood by all parties, depend upon simple and verifiable metrics such as kWh averted, have performance guarantees to ensure adequate savings for the City and sufficient rates of return for the investor, and transparency regarding roles and responsibilities of the parties.

Address availability or lack of subsidies: The model must be able to show or eliminate tax equity, grants, rebates, and incentives depending upon the current law and the tax status of the owner.

Allow adjustment of key variables: The model should allow parties to discuss and agree upon escalators for PPA payments, estimated future utility costs, discount rates, tax rates, agreement term, and others.

Successful project development may depend substantially upon successful interactions with CEQA, permitting, and interconnection authorities. Designing the project to cause minimal site disruption and to largely modify the built environment mitigated the risk of triggering an EIR and the consequential costs and delays. While permitting has not been completed, collaborative design with the City of Carson using pre-engineered systems matched to site electrical system engineering tolerances minimizes the likelihood of unexpected delays and demonstrates a path to streamline the process. Finally, early involvement of the serving utility (SCE) interconnection and Rule 21 teams gave the team insight into ongoing developments in the region, utility priorities and limitations, tariff options, and added resources to bring to bear for specific matters such as EVSE. The optimal timing for discussions with the utility is after the investigatory phase and early in the preliminary design phase before formal engineering. This allows for plan review and modification as necessary, identification of potential interconnection limitations, and determination of the correct data, paperwork, and other submissions to provide to the utility.

The methodology described within this case study of the City of Carson is replicable at any municipality, particularly other disadvantaged communities. This provides a roadmap to identify target communities, engage key stakeholders, and determined their needs and priorities in a cost-effective and expeditious manner. Once developer and city achieve consensus on the process for project development, collaborative due diligence by both parties with regular communication and refinement of conclusions serves to identify the optimal locations for DER deployment and any previously undiscovered challenges or opportunities. Iterative design beginning with efficiency, progressing to EVSE, and culminating in generation and load management systems is a streamlined, linear process that can be applied to any commercial property. Finally, serial refinement of designs through financial and technical optimization can arrive at maximal energy usage offset (net zero), peak load reduction, increased adoption of electric vehicles and support of their use, power resiliency, quality, and safety with financial yields that can meet the needs of cities without significant access to capital through third party investment. This comprehensive, but easily repeated process may be applied to any municipality considering becoming a net zero, advanced energy community regardless of geography, experience, or financial resources.

Despite overall success of the case study, there were a few challenges and limitations that bear discussion. First, with respect to benchmarking building performance the team encountered a number of unexpected obstacles. Monitoring tools can either gather data locally or report data through web portals such as the Smart Panel 3000™. While the team had expected to use existing internet communications architectures at City sites, after protracted discussions the city would not allow the use of their network. Neither time nor budget would allow the team to build a parallel network. Thus, the team was forced to turn to cellular communication tools which have proven to have technical limitations and challenges that have further delayed data acquisition. While this has forestalled obtaining meaningful and granular power quality data, this is currently underway and sufficient data will be available at the point of Phase II funding to configure power quality regulation from batteries. Second, though Charge Bliss and the EVSE workgroup spent well over twelve months working with Electric Vehicle Supply Providers (EVSP) in an attempt to garner a team to own and operate the network of level II EVSE, all ultimately declined. Though all parties acknowledged the sociological value of deployment in an disadvantaged community and further recognized the proximity of sites to major transportation arteries, the prevailing opinions were that there is no adequate business model (profit) in level II operations in general and in Carson specifically. Even entities that are being compelled to provide EVSE infrastructure in disadvantaged communities ultimately declined to participate. The team was left with the option of Charge Bliss or the city owning the level II EVSE. After lengthy discussion and financial modeling of EVSE ownership costs, the City agreed to consider assuming ownership of the level II EVSE and providing free or low-cost charging to area residents. Two EVSP expressed willingness to participate in deployment of fast DC charging. One team was eliminated as they required that there be no active management of their charging devices and that at least twenty (20) devices be deployed in one location. PlugShare®, however, committed to providing the hardware for four (4), 150kW ultrafast DC chargers at the Community Center and expressed enthusiasm for active load management as well as load buffering with battery energy. Third, though the team had productive discussions with the Science faculty at Carson Senior High School, the International Trade Education Program (ITEP), and with a senior Engineering professor at the area university, California State University Dominguez Hills (CSUDH), the team was unable to incorporate students directly into the design process. However, team members were able to participate in educational events such as Science faculty retreat at Carson High School, GPS Your Future at CSUDH, and the winter algebra II class project at Carson Senior High. Given the timing of Phase II in Summer of 2018, it is our expectation to incorporate students from the ITEP program as paid interns. Fourth, while the team did develop productive relationship with SCE personnel, the utilities continue to have siloed approaches to DER development that require recursive communication with multiple parties. Unfortunately, there are no centralized or streamlined guidance tools to direct developers to the correct personnel or paperwork and teams must rely on first-hand experience or consultants with knowledge of utility processes. Arguably, one of the most challenging issues is determination of what grid services can be integrated, what tariffs are compatible with these services, and how services will be valued. Fortunately, aggregator/manager entities such as Olivine® have arisen to fill this gap. Nevertheless, these determinations can be time consuming and financially costly in the face of somewhat uncertain revenue streams. Though automated demand response has more concrete criteria, others such as resource adequacy (RA), frequency regulation, spinning and non-spinning reserve, and more are still being defined. Significantly greater clarity on what services may be delivered by entities such as cities, what the technical requirements are, the potential revenues or penalties, and how to integrate with these programs is needed.

2.13 Benefits to California

Creating a replicable model for development of AEC is critical for California to realize several important benefits. By demonstrating a roadmap for similar project development in communities which a) suffer with the poorest air-quality in California and b) frequently lack the resources to pursue such projects, the methodology allows for far more widespread, robust, and impactful results. Second, the scalable approach permits far higher penetration of renewable generation than would otherwise be achievable by virtue of pairing it with energy storage and active management tools. In order to meet California's ambitious RPS goals, businesses, municipalities, schools, and other commercial buildings will need to build significantly more sustainable generation. However, the growing “Duck Curve” problem suggests that methods are necessary to time-shift generation and power export to the utilities and ISO in order to stabilize grid performance, provide steady, reliable, safe, and high-quality power to ratepayers, and minimize the need for compensatory use of polluting fossil fuel peaker plants.

The proposed project reduces annual net utility energy consumption by more than 5.1GWh and lowers peak demand by 46% despite the addition of a comprehensive network of EVSE. This will reduce annual CO_2 emissions by 3,415,500 pounds and NOx by 4,400 pounds. This is the equivalent of planting over 71,000 trees per year.[34] Assuming an average driving distance of 3.3 miles per kWh of energy consumed by an electric vehicle, the 400,000 kWh per year that will be produced by the solar allocated specifically to EV charging is estimated to yield 1,320,000 miles driven without emissions per year. Assuming that the average vehicle achieves 25 miles per gallon of gasoline,[31] the annual averted usage of gasoline will be 52,800 gallons and will rise as electric vehicle usage increases. With average gasoline prices in California currently at $3.19/gallon,[32] the averted usage accounts for net area resident cost savings of over $168,000 per year. These calculations do not include the avoided costs of oil changes, tune-ups, smog testing and others inherent to operation of internal combustion engine vehicles. According to the U.S. Energy Information Administration, consumption of one gallon of non-ethanol containing gasoline releases 19.6 pounds of CO_2.[38] Therefore, the averted gasoline consumption from EV charging in Carson is estimated to decrease CO_2 emissions by an additional 1,034,880 pounds per year. As such, total project reduction of CO2 emissions is calculated to crest 4,450,380 pounds per year and over 44,500 tons in the course of a twenty-year project lifespan. This is the equivalent of planting 92,512 trees that live twenty years each.

Replication of this process across the over 2,000 disadvantaged communities produces impressive positive environmental and grid impacts. This will eliminate 10.2TWh of annual grid energy consumption, decrease peak system load by 1.56GW, and reduce CO_2 emissions by 8.9 billion pounds per year. This implies the opportunity to defer or even completely eliminate the need for substantial new fossil fuel generation due to a robust, distributed energy supply that is safe, reliable, and secure from the disruptions that may occur with a centralized system.

Even if only a 10% penetration of AEC is achieved in the near future, the impacts would be profound. In addition to the calculated benefits noted above, similarly scaled batteries could deliver 640MW of additional demand response to further buffer variations in system load.

2.14 Obstacles

Not surprisingly, a number of obstacles and challenges arose during the conduct of the project that were expected, unanticipated, or which achieved a level of significance that exceeded predictions.

2.14.1 Finance

While the team had anticipated that it would be difficult to find third-party financiers to fund a public works project in a disadvantaged city, the converse was true. Indeed, a surprising breadth and depth of resources became available and underscored the general perception among investors that municipalities are good to excellent risk. However, Charge Bliss was surprised by the challenges encountered while negotiating possible finance models with City staff. For example, city representatives were overtly displeased with concepts such as “shared savings”, cost “escalators”, and what they perceived to be unrealistic investor expectations for return on investment. Nevertheless, the City was also unable to commit financial resources to participate in project cost.

As discussed previously, the complexity of encompassing new efficiency items, EVSE, renewable generation, energy storage, arbitrage, solar time-shifting, demand reduction, and other services proved to be an insurmountable challenge. Lack of agreement on how to value efficiency and whether this savings should be considered as part of the finance mechanism created significant gaps in the interpretation of project value. Furthermore, lack of agreement upon the reliability of battery performance, projected value of demand reduction, and degree of risk further prevented reaching a mutually acceptable outcome between investor and city. Finally, lack of consensus regarding metrics for project valuation led to significantly disparate viewpoints on project worthiness.

While the finance obstacles proved to be prohibitive in this circumstance, the team believes this illuminates alternative pathways for improved outcomes in the future. First, an early written agreement that sets forth goals and objectives, metrics, and terms and conditions is essential to create a framework for development and discussion. If, for example, the city is unwilling to accept the term duration required for standard investments to reach required returns and is also unwilling to buy systems at said point at fair market value, consideration should be given to terminating further project development. Similarly, if there is explicit understanding of the economic value of each project tool and their value collectively, this will inform a common language for systems valuation at completion. Finally, seeking a method to value non-economic benefits in addition to measurable financial outcomes may set a more favorable context for overall project evaluation.

2.14.2 Property Use/Project Term

Plans for property disposition was another unanticipated and significant obstacle. Once the team was already far into the design process, the city raised concerns that they may wish to sell city properties in the future and wanted to understand what the implications were of agreeing contractually to host the project. Interestingly, the city has entertained the sale of the main campus property at various times for over a decade but neither has a current viable proposal nor one in the offing in the near future. A compromise solution was that the city would agree to operate any systems for the minimum time required by both the California Energy Commission and project investor and/or be willing to relocate all systems to any new buildings or purchase the systems at market price in the event relocation is not possible. Nevertheless, the prevailing opinion of the community is that no sale or redevelopment is likely to occur because of the expense, disruption, and community reaction to such an event.

Ultimately, however, the parties could not reach agreement upon the consequences of early contract termination, disposition of a property upon which AEC systems are operating, or decision by the city to reconfigure a given property and request termination of energy services at one or more sites. Though standard PPA contract language for such circumstances was provided, these provisions were unacceptable to the city. At the same time, the investors were unable to agree to the city's requirement that the city be able to terminate some or all of the contract or request removal of systems from one or more properties without penalty, requirement to pay for lost future revenue, or systems buy-out at fair market value. This proved to be one of the key matters that resulted in termination of negotiations.

Notably, standard provisions for energy services contracts when a third-party carries the capital and operating expenses is for the end user to pay penalties for early contract termination or have the option to purchase systems at the fair market value to be determined at the time of the event. Because system returns on investment are non-linear and market value is uncertain and determined by future costs of systems, revenue loss, operational performance and numerous other variables, it is generally well-understood that this value cannot be set for all time intervals from system commissioning.

2.14.3 EVSE

The team was surprised to encounter the significant difficulties securing sites for EVSE and one or more EVSP to own and operate devices. While initial design intent included locating fast EV charging systems at area private properties including entertainment venues, retail, and commercial sites, none of these locations were willing to consider EVSE. In all cases, Charge Bliss proposed that these systems would be built, owned, and operated at zero expense to the site ownership and provided as an amenity to their clients and employees. Furthermore, the team was surprised to encounter virtually no enthusiasm from EVSP to build EVSE in the City of Carson. While several express publicly that they wish to provide infrastructure to disadvantaged communities, each communicated that they believed a) there is no business model for EV charging in Carson, b) there are inadequate numbers of EV drivers in the city and they want to see more interest before investing in charging systems and c) they do not currently have funds for hardware. When presented with options for building of fast EV charging infrastructure, only one team (PlugShare®) agreed to participate without pre-conditions that eliminated other teams.

In a related, but separate issue, the team discovered that the City of Carson does not permit overnight parking and closes access to many of the parking lots considered for EV charging. Initial modeling suggested that many residents would charge cars at night and that many would rely upon public infrastructure for this purpose. In the same vein, Carson residents expressed deep concerns about allocating "too many" spaces at public parks for EV charging only. Alternative suggestions were made to create street parking systems mounted on light poles.

Unfortunately, the vast majority of these streetlights are not owned by the city and tapping into these power supplies would be prohibitively difficult. These issues led the team to decrease the number of level II EVSE from initial goals of approximately 80 to 42, with the majority concentrated at the main city campus.

2.14.4 Special Considerations

Serial, extended meetings between Charge Bliss, the City of Carson, and the South Bay Cities Council of Governments had to be held to clarify the contractual and financial rules required by the non-modifiable EPIC Terms and Conditions including, but not limited to the following principles:

1. The Grant Recipient (PI) is the sole recipient of payments from the California Energy Commission and cannot redirect payments to the city.
2. As a taxable entity, the Recipient must account for the tax consequences of California Energy Commission payments in the construction of the business and finance models.
3. The grant requires that a minimum of 100% match funding be provided for project development. In the absence of the city providing the capital, a third-party investor is required and, in turn, will expect returns on investment that meet common standards.

2.14.5 Expected Obstacles Not Encountered

While multiple parties raised concerns about the willingness of the utility (SCE) to collaborate and the complexity of the interconnection process, the team found SCE to be helpful, communicative, and interested in project fulfillment. Indeed, the SCE team helped Charge Bliss identify tariff options, DERIM resources, and documentation required. Nevertheless, issues do remain within the communications and documentation systems that present challenges to development teams. First, there is no clearinghouse for information, guidelines, and mentorship through the process. Developers must rely upon prior experience or outside consultants to contact appropriate groups within the utility including Rule 21 interconnection, EVSE, and, in certain cases, the unregulated investment arm of the utility. Second, many of the documentation processes are not yet electronic and require serial hardcopies and iterative modifications. Third, due to the size of the utility, there are multiple siloes each of which must be contacted to ensure adequate approvals.

The team was initially concerned that competing priorities between multiple stakeholder groups combined with traditional governmental inertia would create excessive delays and conflicts that would threaten project success. Though this did require far more meetings and efforts to address the concerns of many parties, the process achieved an acceptable pace that ultimately delivered all products in a timely fashion. The team found it critical to find the leadership and decision-makers in each realm, ensure their full understanding at each critical step, and confirm approval for continuation based upon compromises to suit all parties.

The replicable strategies to potential obstacles that emerged from this process include:

1. Early identification and frequent communication with key stakeholders and decision-makers.

2. Identification of city priorities and sensitivities.
3. Messaging value in terms that comport with city objectives.
4. Early identification and engagement with all utility groups with oversight and involvement in interconnection, EV charging infrastructure, and grid services.
5. Allocate longer development times than other commercial projects to allow for the multiple lines of communication and approval.

2.15 Successes

The Charge Bliss team achieved several notable successes during the development and design of the Carson AEC. In addition to completing designs to achieve zero net energy consumption, EV charging, and demand reduction for eighteen properties in an disadvantaged team, Charge Bliss pioneered a new Value Matrix Tool for DER evaluation, inventoried and developed a cutting-edge funding model to achieve optimal financial outcomes for all parties, and documented methods to streamline the entire process from community identification through systems engineering. This fully integrated model serves as a replicable framework for the development for a diverse number and type of AEC in California and the nation as well as a generalizable approach that can be applied to all non-profit, governmental, healthcare, and other tax-exempt commercial properties. In the final analysis, this illuminates a path for rapid penetration of renewable energy to meet Renewable Portfolio Standards and meet the goals of the EPIC program for the betterment of California's environment, health, safety, and energy supply.

2.16 Changes

In the original proposal, the Charge Bliss team had hoped to include Los Angeles Unified School District campuses and their respective students in the project. As discussed in this report, the former proved to be unachievable and the latter was limited. In addition, the team hoped to build a larger EVSE network including private properties along the major transportation arteries but were unable to acquire the necessary interest and collaboration from area property owners. Third, the team intended to integrate the EVSE network into an existing EVSP in the interest of making charging systems more visible and part of a larger system. Unfortunately, all of the major EVSP declined to participate in level II charging. This required reduction of total numbers of chargers, though still throughout the city. Fortunately, none of these changes were ultimately significantly consequential with respect to the overarching project goals. The team was able to design a comprehensive, Zero Net-Advanced Energy Community for the City of Carson and demonstrate the feasibility, financial value, and societal benefits of a replicable approach.

Chapter 3: Summary of Results

3.1 Final Project Specifications

Eighteen City of Carson properties were included in final project plans. All lighting systems at these locations will be replaced with LED. Of the 18, 13 have site characteristics that permit the construction of either rooftop or parking lot canopy solar and seven have sufficient load and appropriate tariffs to warrant the design of battery energy storage. Illustrations of designs by location and the impacts upon loads are shown in Appendix A.

3.1.1 EVSE Analytics

Please refer to Appendix E, Technical Report on Cloud Based Smart EV Charging Control Center, UCLA Smart grid Energy Research Center December 05, 2017.

3.1.2 Project Engineering Drawings

Detailed engineering drawings may be found in Appendix A

3.1.3 Final Project Technical Performance Specifications

In addition to the representative load found in Appendix A which illustrate demand management, the quantitative results are seen in Table 8.

Based upon the projected performances of the aggregated Distributed Energy Resources (LED, chillers, solar, batteries, and control systems), the team estimates the following financial and environmental results:

Use savings: By achieving net zero energy consumption from the utility, the project reduces purchased energy by over 5,000,000 kWh per year for a savings of approximately $372,000/year. This also includes the production of over 400,000 kWh per year of additional energy for the purposes of electric vehicle charging.

Demand savings: The project achieves an estimated demand reduction of 46% from baseline despite the introduction of comprehensive electric vehicle charging and including ultrafast devices. Depending upon the usage of the ultrafast DC electric vehicle charging systems and the mitigation strategies employed, this is estimated to yield savings of $160,000-$200,000/year.

Table 8: Final Solar and Battery Specifications by Site

	PHOTOVOLTAIC SIZE (KW)	BATTERY SIZING (KWH/KW)	NET PEAK LOAD REDUCTION (KW)*
City Hall	550	1044/520	169
Community Center	714	1044/520	100
Corp Yard	0	0	0
Anderson Park	60	0	0
Calas Park	65	0	0
Carriage Crest	43	0	0
Carson Park	185	1044/520	37
Del Amo Park	0	0	0
Dolphin Park	110	1044/520	130
Dominquez Park	35	0	0
Hemingway Park	160	378/174	37
Mills Park	45	174/87	20
Scott Park	183	0	0
Stevenson Park	175	1044/520	113
Veterans Park	313	1044/520	173
WALNUT, FRIENDSHIP, AND REFLECTIONS PARKS	0	0	0
TOTAL	2638	6816/3281	779
*ESTIMATED			

Source: The Charge Bliss Team

Electric transportation savings: Assuming an average driving distance of 3.3 miles per kWh of energy consumed by an electric vehicle, the 400,000 kWh per year is estimated to yield 1,320,000 miles driven without emissions per year. Assuming that the average vehicle achieves 25 miles per gallon of gasoline,[31] the annual averted usage of gasoline will be 52,800 gallons and will rise as electric vehicle use increases. With average gasoline prices in California currently at $3.19/gallon,[32] the averted usage accounts for net area resident cost savings of more than $168,000 per year. These calculations do not include the avoided costs of oil changes, tune-ups, smog testing and others inherent to operation of internal combustion engine vehicles.

GHG and polluting emissions: According to the United States Energy Information Administration,[33] California energy generators produce 621 pounds of CO_2 per MWh, 0.8 pounds of NOx per MWh, and minimal SOx. Therefore, the reduction of utility generation by over 5.5 GWh will reduce annual CO_2 emissions by 3,415,500 pounds and NOx by 4,400 pounds. This is the equivalent of planting over 71,000 trees per year.[34]

3.2 Final Project Finance Plan

Charge Bliss and the investor group will form a joint venture to act as Phase II grant recipient. The investor will capitalize the joint venture with $9.9M, approximately $500,000 match funding will be provided from other project participants and the remaining project cost of $10.4M will be provided by Phase II California Energy Commission grant funding. Chillers, LED lighting, and

EVSE infrastructure will be donated to the City of Carson. The JV will receive payment from the City of Carson based upon the amount of solar energy produced in a traditional PPA model.

The joint venture will charge the city approximately $0.13/kWh with a 2.5% annual escalator. Between years 15-20 the city will have the option to purchase the system at a contractually specified value or sign a new contract for additional services.

3.2.1 Final Project Ownership and Operation Plan

The joint venture will own the system except those elements ultimately donated to the city and will carry out all activities of ownership, operation, and maintenance.

3.3 Final Project Execution Team Plan

Actual permits will be obtained to begin the project. The drawings will have already been through the city plan check, delays in receiving permits are not anticipated.

The batteries and the solar canopy will be long-lead items so ordering these items early will be critical. Until the project is funded, it is not known for certain the delivery dates for materials and equipment. At this point, the plan is to divide the project into six phases. Work will begin on three parks at a time and continue this approach until 12 sites are completed. City Hall and community center will be their own phase. Six of the sites receive no solar. An additional electrical team will be installing the EV charging network working in coordination with the solar and battery team. The LED contractor will be phased in a similar manner; however, the LED replacement work is short, so this contractor will complete the retrofit much earlier than the rest of the project. The chiller replacement contractor will be scheduled in coordination with the work at city hall and community center. The construction stages are detailed in Appendix I.

Chapter 4: Final Determination for Phase II

4.1 Finances and Cost Models

One of the areas of greatest challenge was the formulation of the financial model and cost arrangements between the city and investor. Original grant requirements included a minimum 100% match threshold with a maximum grant request amount of $10 million. As total estimated Phase II project execution costs reached nearly $20 million, finance modeling was performed based upon approximately $10 million of investment, donations, and concessions.

4.1.1 Donations and Concessions

PlugShare® agreed to provide approximately $250,000 in 150kW DC fast electric vehicle charging systems to be installed at the City of Carson Community Center. Additional concessions, discounts, and value-in-kind equal to approximately $500,000 were offered to the project without expense to either the grantor or investor (127 Energy).

4.1.2 Grant Exclusions

Because EPIC-funded grants may not pay for any costs of interconnection, this was specifically budgeted as an investor expense. Although initial project cost modeling called for grant funding of both the efficiency equipment (chillers, LED lighting) and the level II EVSE, it later became apparent that tax impacts render purchase of these hardware systems through grant dollars infeasible. This is discussed in more detail in the tax section below.

4.1.3 City Cost Participation

City of Carson staff were definitive and consistent throughout nearly the entirety of the grant period that the city could not participate in any capital cost of project development, design, engineering, permitting, interconnection, or construction. In addition, the city indicated that cost “escalators,” or programmed rises in incremental cost, were not going to be viewed favorably. Both of these matters would later appear to change as will be discussed further in subsequent sections.

4.1.4 Investor Cost Participation

In the absence of cost participation by the host city, the project team had to seek investors that could supply the balance of capital needed to meet project execution requirements and meet or exceed the match funding threshold. Given the reported inability of the city to participate in the project capital cost, Charge Bliss and 127 Energy determined that nearly $9 million of investor resources would be required. As the budget and finance models were originally configured, investor capital was to be directed towards the following costs:

- Battery Hardware

- Solar Hardware
- Interconnection
- Operation and maintenance

Later clarifications and changes by the energy Commission immediately prior to the deadline for the Phase II submission altered what was assumed to be allowable and achievable and would require adjustments that are described.

4.1.5 Funds Flow and Ownership

During the course of Phase I, Charge Bliss was unable to obtain clarification from the CEC whether or not other project participants could assume the role of the Recipient (Principal Investigator) or whether funds or both, could flow directly to entities other than the Recipient. Because of the tax implications discussed in the Tax Impacts section (4.2) below, Charge Bliss had to make certain assumptions:

- The Investor could be permitted to become the Recipient
- The Investor could donate certain equipment (EVSE, chillers, LED lighting) to the host city OR the grant dollars earmarked for this purpose could flow directly to contractors on behalf of the City of Carson
- The Investor would retain ownership of solar, battery, and controls systems and could sell services to the city

The Charge Bliss team attempted several times to query whether proposed approaches to the allocation of EPIC funds would be permissible. Because the Question and Answers document was not provided until August of 2018, the team was continued with design and finance assumptions, several of which would later prove to be incorrect including:

- Completion of engineering, permits could be paid by grant funding in Phase II
- Chillers, LED lighting, and EVSE could be purchased with grant funding and immediately donated to the city
- If a project partner could not be made the Recipient, that the Phase I recipient could form a joint entity with another party to become the Phase II recipient

As the project designs matured, it became apparent that both energy conservation projects and the EVSE required special analysis and handling to address tax impacts, ownership and operation costs, and claim upon resulting savings and incentives. As originally conceived, the project team allocated $3.864 million of grant funding in Phase II for the completion of designs (structural engineering, geotechnical), permitting, and construction for four new chillers, full lighting switch to LED throughout the properties, replacement of inefficient pumps with variable speed systems, and the installation of 40 level II EVSE and four 150kW DC fast EVSE.

4.2 Tax Impacts

4.2.1 Safe Harbor Statement

The information provided in this section and throughout this report should not be construed as financial advice nor definitive tax interpretation. Readers must consult their own tax, financial, and legal consultants before choosing any course of action and should not, under any circumstances, rely upon the observations in this report of related decision-making. Observations, opinions, and recommendations contained within this report, whether explicit or implied, should only be considered the views of the project team members and should not be considered definitive or conclusive.

4.2.2 Grant Funds Paid in Arrears

Based upon research done by team attorneys and accountants, grant monies may have different impacts depending upon whom is the grant recipient, what the nature of purchases reimbursed by grant dollars are, and how the Recipient elects to treat them. For example, non-profit entities may make use of EPIC funds without tax consequences, but also may not claim any related tax incentives such as Federal Income Tax Credits (ITC) or depreciation. Second, any entity which uses State of California funding to purchase batteries for an otherwise SGIP-AES qualified project may not claim the incentive. The purchase must be made by the entity that owns and operates the battery.

A taxable entity may experience far more complex consequences from the receipt of grant funding. Expert review suggests that grant funds used in California have no impact upon State income taxes. Purchasers of goods and materials must still pay use or sales taxes. However, Federal income tax law is potentially more challenging. It appears that for-profit entities have the option to treat grant funding as a) entirely as income, b) partially as income, or c) not as income at all. In reality, option b seems to introduce accounting and tax complexities that may make it difficult to execute and at the potential risk of significant penalties and expenses.

How the grant funding is treated with respect to federal income has direct implications for the determination of the cost basis of systems eligible for cost-based incentives. Consider the following two scenarios, based upon a hypothetical $10MM total cost solar array 50% ($5 million) of which is reimbursed by grant funds:

	Income	Basis for ITC	ITC*	Depreciation
Scenario a (grant as income):	$5 million	$10 million	$3 million	$8.5 million
Scenario b (grant not as income):	$10 million	$5million	$1.5 million	$4.25 million

Depending upon the tax structure of the recipient, income, and tax liability, one scenario or the other may be more favorable. However, for public-private partnerships such as those envisioned by the Energy Commission to have the maximum value and, therefore, the lowest cost to the end-user, greater capture of tax equity is essential. This has the ability to lower project cost, increase project net yield, and decrease the incremental cost to the host City or site in ways that cannot be realized by non-profit entities.

When the question and answer document was issued by the Energy Commission, multiple adjustments were required. These including shifting all remaining engineering and permitting cost to the investors, moving funding for chillers, LED lighting, and EVSE from the grant to the investors, and moving payment for solar hardware from the investors to the grant. It remains unclear whether 127 Energy would have been an acceptable grant recipient in Phase II, though this was rendered moot by the inability to agree upon terms with the City of Carson.

4.3 PPA Negotiations

Approximately six months before the original date provided by the CEC for submission of Phase II applications, City of Carson staff, Charge Bliss, and the investors agreed that that agreement upon a financial structure was essential. Multiple different models had been discussed and were ultimately rejected by city staff. Most notably, the city was unwilling to consider any proposal that contained "shared risk," performance payments to the investor, or increased annual total energy cost when compared to current costs. The only model that city staff would consider was a conventional Power Purchase Agreement with the price set below the current City levelized cost of energy (LCOE) and with a low or zero percent escalator. Embedded within all proposals was project provision of new chillers, LED lighting, and EVSE to be donated to the city at no cost.

As part of this discussion, Charge Bliss provided multiple analyses to support the assertions that project purchase and donation of new chillers, LED lighting, and EVSE, particularly when combined with significant solar generation at a price below LCOE was sufficient to realize substantial annual, long-term and net present value savings. Specifically, the team offered the following terms:

- $0.14/kWh PPA with 1% annual escalator for 20 years. General PPA legal provisions were provided in December 2017
- All costs of ownership, operation, and maintenance of solar and batteries solely at the investor's expense
- Donation of chillers, LED, EVSE
- No requirement to share demand savings

Despite prior declarations that the city could not participate in project capital cost, the city-contracted third-party consultant, Mr. Jai Agaram (Digital Energy, Inc.), in collaboration with city Staff, required that the Charge Bliss team provide a second option wherein the City would purchase the chillers and LED lighting in an effort to receive a lower per-unit PPA price in June 2018. The investor offered $0.081/kWh, a 1.5% escalator, and 25-year term. Though 127 Energy met the financial objectives set forth by Mr. Agaram, this proposal was not accepted by the City of Carson.

In approximately June of 2018, the city's contracted attorney began negotiations of PPA terms with 127 Energy. These continued into late August 2018 when it became apparent to all parties that agreement could not be reached on several key principles and the 127 Energy and Charge Bliss teams chose to withdraw the offer for project submission in Phase II. The city suggested that it might consider providing 50% match funding, eliminating the investor, and assuming the grant recipient role, however, insufficient time remained to re-examine all costs, specifications, designs, and budgets and submit a competitive response for Phase II. The grant contract manager, Mr. Josh Croft, was notified immediately.

4.4 Communication with Decision-Makers, Project Documentation, Necessary Agreements

As the deadline approached for Phase II project submission, the Charge Bliss team met with the full City Council to discuss project designs, financial models, and options. Charge Bliss provided over 1000 pages of designs, analytics, and narrative discussion of these matters. In addition, support letters from Southern California Edison, California ISO, SunPower®, local educators, Adopt-a-Charger and others were provided to encourage the City to participate in project execution. Charge Bliss requested that the City of Carson provide a Letter of Commitment in the fashion required by the Energy Commission, a memorandum of understanding for construction of the chillers, LED lighting, and EVSE, and a signed PPA with 127 Energy contingent upon grant funding. When it became apparent that the PPA terms could not be agreed upon and, therefore, that none of these documents were forthcoming in the time-frame needed to complete the Phase II submission, the process was terminated.

ABBREVIATIONS AND ACRONYMS

TERM	
AEC	Advanced Energy Community
California ISO	California Independent Service Operators
Energy Commission	California Energy Commission
CEQA	California Environmental Quality Act
DER	Distributed Energy Resource
GHG	Greenhous Gas
HVAC	Heating Ventilation Air Conditioning
kW	Kilowatt
KWh	Kilowatt-hour
LED	Light Emitting Diode
SCE	Southern California Edison
SIWG	Smart Inverter Working Group
ZNE	Zero Net Energy

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APPENDICES

These appendices are posted under separate publication number CEC-500-2019-028-APA-I

Appendix A: Final Design Specification

Appendix B: City Employee and Resident Surveys

Appendix C: Southern California Edison Tariff RES-BCT

Appendix D: Caron Demographics

Appendix E: Substation Electrical Service

Appendix F: Proposed Charging Device Deployments by Location

Appendix G: Electric Vehicle Types and Incentives

Appendix H: Value Matrix Input Variables

Appendix I: Proposed Construction Process and Management