

Energy Research and Development Division
FINAL PROJECT REPORT

Accelerating Advanced Energy Community Deployment Around Existing Buildings in Disadvantaged Communities

California Energy Commission

Gavin Newsom, Governor

January 2019 | CEC-500-2019-010



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Contract Number: EPC-15-061

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ACKNOWLEDGEMENTS

This report reflects the work of the entire project team, including UCLA, The Energy Coalition, Day One, the County of Los Angeles, and the Los Angeles Cleantech Incubator.

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 solutions, 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 & 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 that promote greater reliability, lower costs, and increase safety for the California electric ratepayer and include:

- Providing societal benefits.
- Reducing greenhouse gas emissions 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.

Accelerating Advanced Energy Community Deployment Around Existing Buildings in Disadvantaged Communities is the final report for the project (Agreement Number EPC-15-061, Solicitation Number GFO-15-312) conducted by Regents of the University of California, Los Angeles. The information from this project contributes to Energy Research and Development Division's EPIC Program.

All figures and tables are the work of the author(s) for this project unless otherwise cited or credited.

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

This project applied a unique set of tools and approaches, including the UCLA Energy Atlas, to develop an advanced energy community design for existing buildings in a disadvantaged community. An advanced energy community provides residents with access to energy efficiency and renewable energy technologies to reduce energy costs and GHG emissions, improves air quality, home comfort and resilience, and is financially attractive and replicable.

The project pilot site is Avocado Heights/Bassett, an unincorporated area of Los Angeles County within the San Gabriel Valley, which is predicted to experience more than 40 additional days of extreme heat per year by 2050.

The advanced energy community design and financing approach aims to address longstanding structural and programmatic barriers, including high levels of renters and lower-income and limited-English-speaking residents; lack of meter-based data for energy planning and effectiveness evaluations; lack of full community engagement; and inadequate business and financing strategies.

The success of this project derived from two overarching process components: the development and application of state-of-the-art data analytics and tools, including the UCLA Energy Atlas, which informed all aspects of the design and associated research; and the formation of an integrated, multidisciplinary collaboration among a local government, a community-based organization, an energy design firm, and an academic institution.

Knowledge derived from this research will inform state policy around energy planning, distributed energy resources deployment, and data access involving low-income and disadvantaged communities.

Keywords: Advanced energy community, energy systems analysis, LA Energy Atlas, net-zero energy, electricity, energy efficiency, building retrofit, distributed energy resource, energy storage, rooftop solar photovoltaics, Los Angeles, disadvantaged communities, outreach and education

Please use the following citation for this report:

Federico, Felicia, Stephanie Pincetl, Eric Fournier, Eric Porse, Yating Chuang, Magali Delmas, Rhianna Williams, Craig Perkins, Marc Costa, and David Diaz. 2019. *Accelerating .Advanced Energy Community Deployment Around Existing Buildings in Disadvantaged Communities*. California Energy Commission. Publication Number: CEC-500-2019-010.

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EXECUTIVE SUMMARY

Introduction

Despite the substantial progress Southern California has made in supporting, commercializing, and using clean energy technologies, the region continues to struggle to upgrade its existing buildings, particularly within disadvantaged communities. Although California's Building Standards Code, or Title 24, has improved the energy profiles of new buildings, existing buildings continue to account for 40 percent of energy use and greenhouse gas (GHG) emissions.

Not surprisingly, Southern California's stock of the worst performing (pre-1978) buildings is often concentrated in disadvantaged communities, where residents have the fewest resources to complete the retrofits themselves, and where there are high percentages of renters with little incentive or no authority to make such improvements. At the same time, retrofitting existing buildings is more energy- and materials-efficient compared to replacing existing buildings, reducing displacement of residents, and addresses disadvantaged communities more fairly. These structural barriers (building age, insufficient capital, and low home ownership rates), as well as programmatic barriers such as market delivery and data limitations, have limited adoption of energy efficiency measures in disadvantaged communities, and access to renewable energy.

Widespread adoption of advanced energy communities is poised to become a critical pathway to achieving the state's statutory energy and climate goals, but only if barriers to working with existing buildings in disadvantaged communities are addressed. An advanced energy community provides residents with access to energy efficiency and renewable energy technologies in a way that reduces energy costs and GHG emissions, improves air quality, home comfort and resilience, and is financially attractive and replicable.

Barriers to Disadvantaged Communities' Participation in the Renewable Energy Transition

The following are among the most critical barriers to disadvantaged communities' access to energy efficiency and renewable energy.

High levels of renters and lower-income, limited English-speaking residents. Disadvantaged communities tend to have higher percentages of renters, who lack the agency that owners have over building shell and appliances upgrades. This significantly limits or eliminates their ability to participate in energy efficiency upgrades and rooftop solar. For low-income building owners, the initial investment associated with energy efficiency or solar may be out of range, and rooftop structural inadequacies can create a further expense to overcome before on-site solar is possible. The percentage of residents who speak limited English also tends to be higher in disadvantaged communities, creating a barrier to understanding information provided by organizations promoting energy efficiency or solar installation.

Lack of effectiveness data. Billions of dollars have been spent on energy efficiency upgrades in California, however, there remain little meter-based data or meter-based before-and-after comparisons to prove the effectiveness of these expenditures or the distribution across income

groups, building age, and other characteristics. These barriers limit the ability to target locations most in need and to determine where specific programs have been most successful. Furthermore, this lack of data limits accurate quantification of ratepayer and financial market benefits, thereby creating risks and uncertainties around conducting and financing this work.

Lack of full community engagement. Homeowners and renters are for the most part isolated in their efforts to learn about energy efficiency products and services and to evaluate the competency and honesty of the contractors and real estate professionals from which they need help. A lack of community outreach means only the most aware and knowledgeable residents have the availability of incentive programs “on their radar.” Even for those individuals, the complexities and uncertainties involved in applying for help can be disincentives to action. These problems are amplified in disadvantaged communities, where education, language barriers, or both can inhibit knowledge transfer, and where greater portions of residents are renters with fewer connections to traditional pathways for this information. This does not mean, however, that these communities are unaware of their energy use or of the need to conserve.

Inadequate business and financing strategies. Implementing deep-energy efficiency building retrofits (substantial energy improvements to the building that persist across ownership or renter changes) are hampered as programs and contractors attempt to locate and execute projects one at a time. This prevents developing standardized product design and delivery at scale, suppresses pricing efficiencies, limits the number of retrofits per year, and hinders analysis of quality and effectiveness. While there are numerous financing programs available, there is a need for involvement from capital markets, which have been also been limited by the current “one-at-a-time” approach, as well as by the lack of effectiveness data. Furthermore, the range of financing programs and payment plans creates a confusing landscape of choices and uncertainty for building owners and contractors. This uncertainty intensifies in disadvantaged communities, where financial risks can have greater impact.

Project Purpose

This project applied a unique set of tools and approaches, including the *University of California, Los Angeles (UCLA) Energy Atlas*, to develop an advanced energy community design that aims to address the structural and programmatic barriers. The *UCLA Energy Atlas* is the only meter-level energy consumption dataset in California, the core of which is a geospatial relational database that connects address-level energy consumption to building characteristics and census information. Customer privacy is maintained through data aggregation. In addition to the pilot site design, this research is developing new insights and actionable knowledge on related questions, including how can replicating and using this type of advanced energy community design be made easier, and what are the regulatory barriers? How effective have energy efficiency programs been at reducing electricity consumption? How should installing distributed solar generation be prioritized? To what extent is it limited by current grid capacity?

Project Process

The success of this project derived from two process components: developing and applying state-of-the-art data analytics and tools that informed all aspects of the design and associated research, and forming an integrated, multidisciplinary collaboration among a local government, a community-based organization, an energy design firm, and an academic institution.

Developing and Applying State-of-the-Art Data Analytics and Tools

Critical information with high levels of confidence was developed for four components by leveraging the only meter-based energy demand, consumption, and multiyear energy efficiency program participation dataset in California (the UCLA Energy Atlas):

- Energy use profile of the project pilot community.
- Identification of candidate locations for community solar installation.
- Unprecedented evidenced-based analysis of energy-efficiency program effectiveness.
- A “Solar Prioritization Tool” to guide investments in disadvantaged communities.

By using meter-based data and understanding the link between energy consumption and building characteristics, the research team developed highly accurate values for baseline consumption, energy efficiency savings potential, and remaining demand to be met through solar PV generation, all while respecting confidentiality. This level of data increases confidence in the design and related financing decisions.

Formulation of an Integrated, Multidisciplinary Collaboration

A multidisciplinary team created a plan for energy transition in a disadvantaged community. The team included a community-based organization, Day One, with offices throughout the San Gabriel Valley, representing the project to the community while sharing information with other team members regarding community concerns, thereby helping the team shape its plan. The project team also included UCLA to provide project management, data, and data analysis, as well as an understanding California’s evolving energy policy.

The Energy Coalition, a leading non-profit in the energy field, brought extensive experience in building energy management and execution of energy efficiency and conservation programs, as well as building modeling expertise and a deep understanding of the financing of such programs. Finally, the County of Los Angeles was the local government sponsor and member of the planning team, connecting the team to Day One, coordinating access to county data and county land management departments, as well as lending institutional credibility to the potential of implementation vis-à-vis the community and the school district. This collaboration was based on mutual learning and respect, and each partner brought necessary information, experience, and insights to the planning process.

Project Results

Implementation-Ready Advanced Energy Community Design

The project pilot site is Avocado Heights/Bassett, an unincorporated area of Los Angeles County. Three major freeways and the (now closed) Puente Hills landfill surround this

community. Residents are affected by high levels of air pollution, including particulate matter, and ongoing concerns about harmful lead and arsenic emissions from the nearby Quemetco Battery Recycling Center. The team expects Avocado Heights/Bassett, in the San Gabriel Valley, to experience more than 40 additional days of extreme heat per year by 2050.

The Avocado Heights/Bassett advanced energy community design provides locally generated, GHG-free electricity from community solar and storage to offset electricity consumption of participants who “opt in” through an enrollment system. Participants also benefit from various in-home upgrades (energy efficiency retrofits, demand response, and energy management tools) at no upfront cost. The community solar installation is a 5.9 megawatt (MW) system designed to serve about 410 homes, 19 multifamily properties, and seven schools. The design also incorporates electric vehicle (EV) charging infrastructure and a community EV car-share program. The estimated total project cost is \$26 million. The design assumes the Clean Power Alliance of Southern California will sponsor the community solar and storage project and be responsible for the construction and operation of the project. A third-party contractor, managed by either Clean Power Alliance of Southern California or the county of Los Angeles, will implement the in-home upgrades. Overall, the project is projected to reduce electricity consumption by 21 percent and GHG emissions by 64 percent over a 25-year period.

A comprehensive community engagement component involved a yearlong program of outreach about the project plan and education on energy issues. The research team developed an extensive social media presence and website (<https://www.advancedenergycommunity.org/>) with bilingual information about the project and related information on the links between fossil fuels, air pollution, and climate change. The team participated by “tabling” at 20 community events throughout the area, as well as at four town hall meetings sponsored by the county supervisorial district. AEC project presentations were made at a town hall meeting and the Bassett Unified School District Board of Education. As part of the tabling activities, the project team collected more than 500 short surveys on people’s attitudes about, and interests in, energy issues. In addition, more than 60 participants attended two multi-hour focus group meetings to understand single-family and multifamily residents in the Avocado Heights/Bassett area. Forty detailed surveys were collected from the focus group meetings, which provided information on residents’ level of interest and willingness to participate, and on appliance types and ownership, to inform the design and implementation. This comprehensive community engagement has laid the groundwork for successful enrollment of the target number of participants once the project implementation period begins.

Advanced Energy Community Replication Toolkit

A robust data method was developed, and a technology selection analysis was conducted to support the design. A replication toolkit will allow interested municipalities and other community organizations to benefit from the lessons learned and work conducted under this project and streamline the advanced energy community planning process.

Local Implementation Challenges

Findings from the project team's review of local implementation codes and standards raise concerns about an uncertain regulatory environment that creates additional barriers to wide implementation of similar advanced energy community designs.

If implemented, this advanced energy community project design will operate within the context of the Clean Power Alliance of Southern California program, a community choice aggregation that is just coming on-line to serve Los Angeles County properties, county unincorporated areas, and dozens of member cities. However, to replicate this advanced energy community design within investor-owned utility (IOU) territories where there is not community choice aggregation, questions remain about whether existing virtual net-energy metering programs would support such an approach. To produce enough electricity for this type of advanced energy community program, solar will be installed on government buildings and schools within and around the project site. Each of these sites must submit an interconnection request under SCE's Rule 21 and pay the associated fees for the interconnection and accompanying study. Rule 21 establishes interconnection, operating and metering requirements allowing generation facilities to be connected to a utility's distribution system. Since solar production must offset the on-site electricity consumption and produce excess electricity for the other community sites, solar generation must be maximized at the generation sites. However, if solar generation is sized to the historical energy consumption of a site under SCE's net-energy-metering program, not enough electricity will be produced. This rule presents a problem for producing excess electricity to supply the all advanced energy community participants.

It is therefore essential that all solar generation must be interconnected as an exporting project and potentially serve as a solar development that could offer to sell shares to participants under the Enhanced Community Renewables program (one of SCE's offerings under the Green Tariff/Shared Renewables Program). However, the Enhanced Community Renewables program does not include energy storage as an eligible project component and requires participants to pay a separate bill to the renewable power developer while receiving a credit on their monthly electricity bill from SCE. In addition, there is no mechanism to arrange for on-bill repayment of energy efficiency and energy management upgrades to participants' homes, likely requiring yet another separate paperwork process. Such complexity would almost certainly create significant barriers to implementation.

Assessment of Energy Efficiency Program Effectiveness

The following are the key findings and recommendations from this analysis:

- Between 2010 and 2015, the overall adoption rate was about 8 percent, compared to 5.5 percent among the lowest income quartile.
- Compared to nonparticipants, energy efficiency program participants tend to live in newer houses and are more likely to be homeowners, rather than renters.
- Energy efficiency program participants live in neighborhoods with higher incomes, lower population densities, and larger rates of white, Asian, and highly educated populations.

Energy efficiency program participation among the highest income quartile is nearly twice of that among the lowest income quartile.

- Households whose houses were built after 1990 than before 1950 (around 9 percent and 5 percent, respectively) have high participation.
- In terms of electricity savings, the most effective programs were those providing incentives to upgrade pool pumps and refrigerators.
- Pool pump incentives led to, on average, 12 to 13 percent savings among participating households.
- Programs that promoted energy-efficient refrigeration also have statistically significant impacts, saving households on average 6 percent of electricity use.
- Lighting programs, despite high participation by households, yielded only about 1 percent savings.
- There was almost no significant change in electricity consumption among participants who got incentives for HVAC or whole-building retrofit programs.

The analysis was limited by the lack of differentiation within the HVAC program data between upgrades for heating services and upgrades for cooling services. For future evaluation, it is recommended that a more expressive classification field in the program tracking data be created that will differentiate between upgrades to heating and cooling services and better classify the details of those upgrades. This classification could be similar to the “technology category,” as defined in the Building Energy Data Exchange Specification, a dictionary of terms developed by the U.S. Department of Energy for stakeholders to make important energy investment decisions. Furthermore, within this classification scheme, the team recommends that categories such as HVAC, which represent a broad collection of energy services (heating, ventilation, cooling), should be broken down into separate categories. Each of these categories could then be separately analyzed for performance and effectiveness.

Solar Prioritization Tool

The Solar Prioritization Tool is an interactive, Web-based platform for visualizing the best locations for installing distributed solar PV throughout L.A. County to meet multiple energy planning goals, such as local energy system resilience, community-scale zero-net electricity, grid reliability, and prioritized investments in disadvantaged communities. The tool uses sophisticated data and methods to prioritize sites for solar at high geographic resolution within the SCE service territory. This capability has been previously unavailable.

Key findings from developing this tool include:

- The potential net export of solar electricity to the grid from net-producing circuits in SCE’s Los Angeles County territory is more than 3,700 gigawatt-hours (GWh) annually. The term “net-producing circuits” refers to circuits with associated properties that, over an annual period, could produce more electricity than they consume. This value requires nuance. The overall net solar generation potential for Los Angeles County is negative, meaning that over a year, buildings consume more than they could produce. However, many circuits in the Los Angeles County grid are associated with buildings that could be net producers. This figure is just as important for utility operations and the 3,700 GWh

represent that generation potential if installing solar in the correct locations could be harvested.

- The average peak net export for a circuit across the SCE Los Angeles County territory is 3.5 MW, while the average 15 percent penetration rate limit contained in SCE's Distributed Energy Resource Information Map (DERiM) dataset is 12.5 MW. Thus, on average, extra capacity exists on circuits. However, both the peak net solar export potential and the underlying Rule 21 export limits vary throughout the county. In some areas, the 15 percent penetration rate limit requires curtailing net generation potential. The total amount of curtailed power, calculated as the difference between the net potential and the 15 percent penetration rate value, was 1,507 MW. This amount represents unexploited solar potential for L.A. County imposed by the existing grid capacity regulations via Rule 21. This also points to the need for targeted upgrading of circuits, as a difference in circuits exists relative to the related penetration capacity.
- Rule 21 limits constrain potential net solar exports; grid upgrades could allow for more solar generation exports to the grid. Disadvantaged communities tend to have the smallest gap between annual solar generation potential and consumption, but they are subject to the greatest average curtailments of peak exports, potentially as a result of historic lack of grid infrastructure investment in these communities.

Discussions with stakeholders revealed that the datasets supporting the prioritization tool are in high demand but often inaccessible to the many users involved in energy planning. This report identified several critical policy recommendations related to open access to data:

- **Promote greater access to energy consumption data.** The CPUC should continue to broaden access to high-detail energy consumption data. Presently, many local governments have sporadic access to masked data, making comparisons and benchmarking across years difficult. Proceedings through the Energy Data Access Committee have been slow to produce results since the 2014 ruling. Energy Data Access Committee was formed by the CPUC to (among other functions) provide advice regarding a utility's protocols for reviewing data requests, and act as an on-going forum to discuss and review changes in protocols in response to changing technological abilities.
- **Improve and standardize county tax assessor data across the state.** The Energy Commission and CPUC should work with state agencies and legislators to fund openly available tax assessor and parcel data to ensure higher accuracy and consistency across the state.
- **Promote better grid capacity data for circuits.** The CPUC should continue working with IOUs to improve the quality of grid capacity data in support of increasing penetration of distributed generation. Further, state agencies should communicate with municipally owned utilities to promote similar access to data. The capacity constraints should be based on emerging procedures such as the integrated capacity analysis feasibility studies conducted by the IOUs, which assess actual grid capacity, rather than a standardized assessment of the 15 percent peak load penetration limit currently in place.

- **Compile and publish data for property-to-circuit relationships.** California regulators should work with IOUs to improve published data for attributing properties to individual circuits. With this information accessible, large-scale energy systems planning would improve from more directly understanding on-site consumption and grid constraints. In this analysis, researchers assumed that properties were associated with local circuits based on a shortest proximity calculation.
- **Prioritize solar installations to reduce climate change risks.** Climate change, combined with urban heat island effects, will likely increase temperatures. Urban heat island effects refer to the differential warming of urban areas compared to surrounding areas, due to changes in land surface that absorb rather than reflect heat, as well as waste heat generated by energy use. Higher local temperatures result in increased electricity demands for indoor cooling. Investments in distributed solar generation and electricity grid capacity should be prioritized to account for estimated increases in electricity use for indoor cooling. Households in disadvantaged communities often have less access to funds for home energy efficiency upgrades, which results in higher energy bills that disproportionately affect family incomes.

Benefits to California

The numerous products created and deep knowledge gained from this grant will accelerate the transformation of California's low-performing and energy-inefficient building stock and provide access to renewable energy to disadvantaged communities.

Benefits fall into several categories:

- Benefits from the advanced energy communities pilot design.
- Knowledge that can inform state energy policy and improve local planning efforts
- Tools to support advanced energy community replication and the siting of distributed solar generation
- Methodologies that set the groundwork for other studies and projects

Advanced energy communities project design benefits include:

- Reduced energy use and greenhouse gas emissions.
- Reduced health risks and air pollution through adoption of clean energy generation.
- Improved standard of living in households through more affordable energy services and increased comfort in homes.
- More affordable energy in residential and public buildings.
- Expanded access to affordable zero-emission-vehicle services and greatly enhanced mobility.
- Support for local clean energy jobs and a green workforce.
- Potential for increased resiliency and creation of community emergency centers in the event of a power outage
- Alleviation of local energy grid constraints with locally produced clean energy.
- Increased grid reliability and resiliency.

While many of these benefits, such as reduced energy/GHG emissions and improved air quality, have obvious links to the proposed design, benefits related to reliability and resiliency may be less evident. The proposed advanced energy community project design supports greater reliability and resiliency for community participants and the SCE distribution grid in the project area. The new dispatchable energy storage resources available to California Independent System Operator from the project will increase statewide electricity grid stability. The final locations for the community solar and storage assets will be determined by identifying weak points or constrained areas within the SCE electricity distribution system, thereby improving the overall reliability and resiliency of the system. Finally, a component of the final design will evaluate the feasibility of creating a powered emergency refuge center at a strategic school campus site(s). A powered emergency refuge center is a community facility that serves as a shelter in the event of a natural disaster or power outage and that can provide emergency power for heating/cooling, recharging communications, medical equipment, and other essential needs, using solar and storage.

CHAPTER 1:

Project Importance

Despite the substantial progress Southern California has made in supporting, commercializing, and deploying clean energy technologies, the region continues to struggle to upgrade its built environment, particularly within disadvantaged communities. Although California's Building Standards Code, or Title 24, has improved the energy profiles of new buildings, existing buildings continue to account for 40 percent of energy use and greenhouse gas (GHG) emissions.¹

Not surprisingly, Southern California's stock of the worst performing (pre-1978) buildings is often concentrated in disadvantaged communities, where residents have the fewest resources to complete the retrofits themselves. These communities also have high percentages of renters with little incentive or no authority to make energy efficient improvements.^{2,3} At the same time, retrofitting existing buildings is more energy- and materials-efficient compared to replacing existing buildings, reducing displacement of residents, and addresses disadvantaged communities more fairly.⁴ These structural barriers (building age, insufficient capital, and low home ownership rates), as well as programmatic barriers such as market delivery and data limitations, have limited not only uptake of energy efficiency measures in disadvantaged communities, but also access to renewable energy.⁵

Adopting and building advanced energy communities (AECs) is poised to become a critical pathway to achieving the state's statutory energy and climate goals, but only if barriers to working with existing buildings in disadvantaged communities can be addressed

This report describes the unique set of tools and approaches used and the final AEC design, which aims to address the following structural and programmatic barriers:

1. High levels of renters and lower-income and limited English-speaking residents
2. Lack of wide-scale meter-level data for energy efficiency assessments and energy planning
3. Lack of full community engagement
4. Inadequate business and financing strategies

1 EIA, 2015. *Monthly Energy Review November 2015*. U.S. Energy Information Administration, 504 Washington, D.C.

2 Pincetl, S., LA Energy Atlas Development Team., 2015. "LA Energy Atlas." California Center for Sustainable Communities. UCLA. Los Angeles, California.

3 California Energy Commission. 2015. *Existing Buildings Energy Efficiency Action Plan*. CEC-400-2015-013-F.

4 Reyna, J. L., and M. V. Chester. 2015. "The Growth of Urban Building Stock: Unintended Lock-In and Embedded Environmental Effects." *Journal of Industrial Ecology*, 19 (4), 524-537.

5 Scavo, Jordan, Suzanne Korosec, Esteban Guerrero, Bill Pennington, and Pamela Doughman. 2016. Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities. California Energy Commission. Publication Number: CEC-300-2016-009-CMF.

Barriers to Disadvantaged Communities' Participation in the Renewable Energy Transition

The following are among the most critical barriers to disadvantaged communities' access to energy efficiency and renewable energy.

High Levels of Renters and Lower-Income and Limited English-Speaking Residents

Disadvantaged communities tend to have higher percentages of renters, who lack the agency that owners have over building and appliances upgrades. This greatly limits or eliminates their ability to participate in energy efficiency upgrades and rooftop solar. For low-income building owners, the initial investment associated with energy efficiency or solar may be out of range, and rooftop structural inadequacies can create an additional expense to overcome before on-site solar is possible. The percentage of residents who speak limited English also tends to be higher in disadvantaged communities, creating a barrier to understanding information provided by organizations promoting energy efficiency or solar installation.

Lack of Effectiveness Data

While Californians have spent billions of dollars on energy efficiency upgrades, there remains little meter-based data or meter-based before-and-after comparisons to provide evidence on the effectiveness of these expenditures or the distribution across income groups, building age, and other characteristics. These barriers limit the ability to target locations most in need and to determine where specific programs have been most successful. Furthermore, this lack of data limits accurate quantification of ratepayer and financial market benefits, thereby creating risks and uncertainties around conducting and financing this work.

Lack of Full Community Engagement

Homeowners and renters are for the most part isolated in their efforts to learn about energy efficiency products and services and to evaluate the competency and honesty of the contractors and real estate professionals from which they need help. A lack of outreach in the community means only the most aware and knowledgeable residents have the availability of incentive programs "on their radar," but even for those individuals, the complexities and uncertainties involved in applying for help can be disincentives to action. Where energy efficiency education programs do exist, they are often operating in competitive, parallel silos, distributed over wide geographical areas, not local in flavor and not strategically coordinated, especially at the local level. These problems are amplified in disadvantaged communities, where education or language barriers or both can inhibit knowledge transfer, and where greater portions of residents are renters with fewer connections to traditional pathways for this information. This does not mean, however, that these communities are unaware of their energy use or of the need to conserve.

Inadequate Business and Financing Strategies

Implementing deep-energy building retrofits is also hampered as programs and contractors attempt to locate and execute projects one at a time. This prevents the development of

standardized product design and delivery at scale, suppresses pricing efficiencies, limits the number of retrofits per year, and hampers analysis of quality and effectiveness. While there are a growing number of financing programs available, there is a need for involvement from capital markets, which has been also been limited by the current “one-at-a-time” approach, as well as by the lack of effectiveness data as discussed earlier. Furthermore, the range of financing programs and payment plans creates a confusing landscape of choices and uncertainty for building owners and contractors. This uncertainty is amplified in disadvantaged communities, where financial risks can have more impact.

How This Project Addresses Barriers to Participation

The project pilot site for this planning grant is in the Los Angeles County unincorporated areas of Avocado Heights and Bassett (described in Chapter 3). The AEC model design provides locally generated, GHG-free electricity from community solar and storage to offset electricity consumption of participants who “opt in” to the AEC through a subscription system. It also enables participants to benefit from savings resulting from various onsite integrated demand-side management (IDS⁶) actions, including energy efficiency retrofits, demand response⁶, energy management systems⁷, and an energy education and support program.

This AEC model design addresses the barriers listed above, through the analytics and tools used, as well as in the proposed design components and business model, as follows:

Development and Application of State-of-the-Art Data Analytics and Tools

By leveraging the only meter-based energy demand, consumption, and multiyear energy efficiency program participation dataset in California (the UCLA Energy Atlas), the research team developed critical information with high levels of confidence for four components of the project:

1. **Energy use profile of the project pilot community.** By using meter-based data and understanding the link between energy consumption and building characteristics, the research team developed highly accurate values for baseline consumption, energy efficiency savings potential, and remaining demand to be met through solar PV generation, all while respecting data confidentiality. This level of data increases confidence in the design and related financing decisions.
2. **Identification of candidate locations for community solar installation.** The research team assessed the solar potential on rooftops and paved parking areas on L.A. County unincorporated properties in and around the pilot site, as well as on school district campuses to identify the best locations for a community solar installation. Local community solar allows renters/multifamily residents, as well others who cannot afford upfront costs, to access the benefits of renewably generated energy. In a related effort, a

⁶ Demand response is changes in electric use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

⁷ An energy management system is a conservation feature that uses mini/microcomputers, instrumentation, control equipment, and software to manage a building's use of energy for heating, ventilation, air conditioning, lighting, and/or business-related processes

solar prioritization tool was developed that will be useful for replication of such analysis throughout the region. The solar prioritization tool combines multiple data layers to compare building solar generation potential to building energy consumption throughout LA County at a grid circuit scale, and evaluates grid limitations on the export of excess solar generation (See Chapter 10 for more information.)

3. **Unprecedented evidenced-based analysis of energy efficiency program effectiveness.**

Monthly electricity usage and energy efficiency participation data were analyzed for 10 million accounts in Southern California Edison's (SCE) service territory, controlling for building vintage, square footage, and use type. This scale of analysis (more than 160 million monthly observations) ensures credible and generalizable results, the contribution of which will go far beyond this project as well. The research team also examined the geographic distribution of energy efficiency program participants across Southern California by income level, and energy efficiency program uptake within the project pilot community was quantified. Results informed the choice of energy efficiency measures incorporated into the AEC model design, as well as assumptions around energy efficiency opportunities and potential energy savings for the pilot site.

4. **Solar prioritization tool to guide investments in disadvantaged communities.** This tool combines the high-detail consumption data of the Energy Atlas for Los Angeles County with the county's solar potential map, SCE's Distributed Energy Resources Integration Map (DERiM)⁸, hourly demand and generation profiles, and socioeconomic data from CalEnviroScreen and the U.S. Census Bureau to support a variety of energy planning activities, with a focus on disadvantaged communities.

Establishment of a Replicable, Communitywide Organizational Infrastructure

The AEC program model includes the development of an organizational infrastructure that has been successful in other fields such as education and healthcare to provide the strategic, intensive, local engagement, education, and peer-to-peer outreach approach necessary to reach homeowners and renters in disadvantaged communities. This infrastructure promotes engagement and training of key community organizations, school districts, and residents. Spanish translations of information in handouts, at information booths, and on the website, are an integral component of the program model, as are Spanish-speaking members of the outreach team. Documentation and replication tools will support the accelerated adoption and deployment of the AEC program model in other communities.

Design and Financing to Maximize Access by Disadvantaged Communities

The AEC design addresses affordability and local economic benefits through multiple aspects, including:

- Energy efficiency retrofits to reduce energy use at no upfront cost.
- A virtual net-energy-metering approach to community solar participation, with no need for purchase or lease of a rooftop system.

⁸ SCE's DERiM provides data on multiple aspects of the utility grid. See <http://www.arcgis.com/home/webmap/viewer.html?webmap=e62dfa24128b4329bfc8b27c4526f6b7>

- Improved resiliency at the household and community scales.
- Support for local clean energy jobs through ongoing education and training programs.

How This Project Model Can Be Replicated

Work Products That Support Replication

The ability to translate and replicate the AEC project model in other disadvantaged communities throughout the state is a primary objective of this study and magnifies the effect of this work beyond just the pilot community site. The following work products specifically support replicability:

- Replication toolkit
- Data methodology report
- Solar prioritization tool
- Energy efficiency program analysis

The replication toolkit provided through the project report *AEC Program Model Documentation Portfolio*, and it includes information about the other products listed. This document compiles the approaches, methods, data sources, and lessons learned from the project team's work to reduce the time and effort required by others. By sharing this planning framework, the authors' aim is to accelerate the deployment of data-driven, community-supported AECs.

This document includes:

- A description of the goals and benefits of an AEC, as well as the major components of this pilot design.
- Key considerations that should inform any similar design.
- Discussion of the solar prioritization tool for AEC site selection.
- An overview of the data needs and analysis methodology used to create a community energy profile.
- A discussion of energy system modeling and the development of sizing requirements for a community solar installation.
- A discussion of the considerations involved in locating properties for the community solar installation and assessing solar canopy capacity at those sites.
- A roadmap to community outreach and engagement.
- A discussion of funding approaches.

Replication Challenges and Opportunities

One of the advantages of using real data in developing an AEC is the ability to tailor it to the community. Conversely, the disadvantage to such an approach is that it lays bare the shortfall of resources of various communities to collect, compile, and analyze data. UCLA researchers spent years compiling raw data sources from the Los Angeles County Assessor Office, Google, U.S. Census Bureau, U.S. Geological Survey, and IOU consumption data, which they then developed into the Los Angeles Energy Atlas. Researchers recently commenced expanding the information available through the *LA Energy Atlas* to other Southern California counties. The

solar installation prioritization tool developed for this project is also Los Angeles County-specific.⁹ For these reasons, replicating an AEC using this design will be easier to accomplish in Southern California than in the rest of the state.

This design also depends on the creation or the availability of a community choice aggregator (CCA) available for developing an AEC. A CCA is a governmental entity formed by cities and counties to serve the energy requirements of their local residents and businesses. This is desirable due to the ability to issue bonds for construction of the solar and storage assets, as well as to be able to implement virtual net energy metering (VNEM) in an AEC. VNEM is a tariff arrangement that enables a multi-meter property owner to allocate the solar system's energy credits to tenants.

CCAs will also have the same or more rough data than available in the *LA Energy Atlas*. Groups partnering with a CCA will be able to conduct robust integrated resource planning that is tied to public sector climate goals. However, for replicating this AEC design within IOU territories where there is not a CCA, questions remain about whether existing virtual net energy metering programs would support such an approach. Access to granular data will also be a limitation.

The methodology for data management, cleansing, and geospatial analysis is broadly applicable to load-serving entities, project developers, and disadvantaged community assistance. The system sizing and scenario planning for zero-net-carbon energy and electricity are new concepts that can extend to AEC and decentralized energy planning.

⁹ Solar Installation Prioritization tool available online at <http://solar.energyatlas.ucla.edu>.

CHAPTER 2:

Context and Project Team

Context

Meeting California's bold energy and environmental goals requires new strategies that will fundamentally transform the way energy is produced and consumed. The California Energy Commission has taken a leadership role by calling into action investments geared toward shaping low-GHG footprint communities. These investments include the Electric Program Investment Charge (EPIC) program that funds clean energy technology projects and offers California ratepayers greater electricity reliability, lower costs, and increased safety.

In November 2015, the Energy Commission issued GFO-15-312, EPIC Challenge: Accelerating the Deployment of Advanced Energy Communities (AECs). The solicitation defined AECs as communities that:

- Minimize the need for new energy infrastructure costs such as transmission and distribution upgrades.
- Provide energy savings by achieving and maintaining zero net energy community status (accounting for behavior and increasing loads from vehicle and appliance electrification).
- Support grid reliability and resiliency by incorporating technologies such as energy storage.
- Provide easier grid integration and alignment with the California Public Utilities Commission's (CPUC) Long-Term Procurement Plan, and the California Independent System Operator's local capacity requirements process.
- Can be replicated and scaled-up to further drive down costs.
- Are financially attractive from a market standpoint (developers, home buyers, renters).
- Provide affordable access to renewable energy generation, energy efficiency upgrades, and water efficiency and reuse technologies that reduce electricity consumption for all electric ratepayers within the community.
- Make use of smart-grid technologies throughout the community.
- Align with other state energy and environmental policy goals at the community level such as the Sustainable Communities and Environmental Protection Act (Senate Bill 375 (Steinberg, Chapter 728, Statutes of 2008) and Governor Brown's Executive Order B-29-15 for the drought.

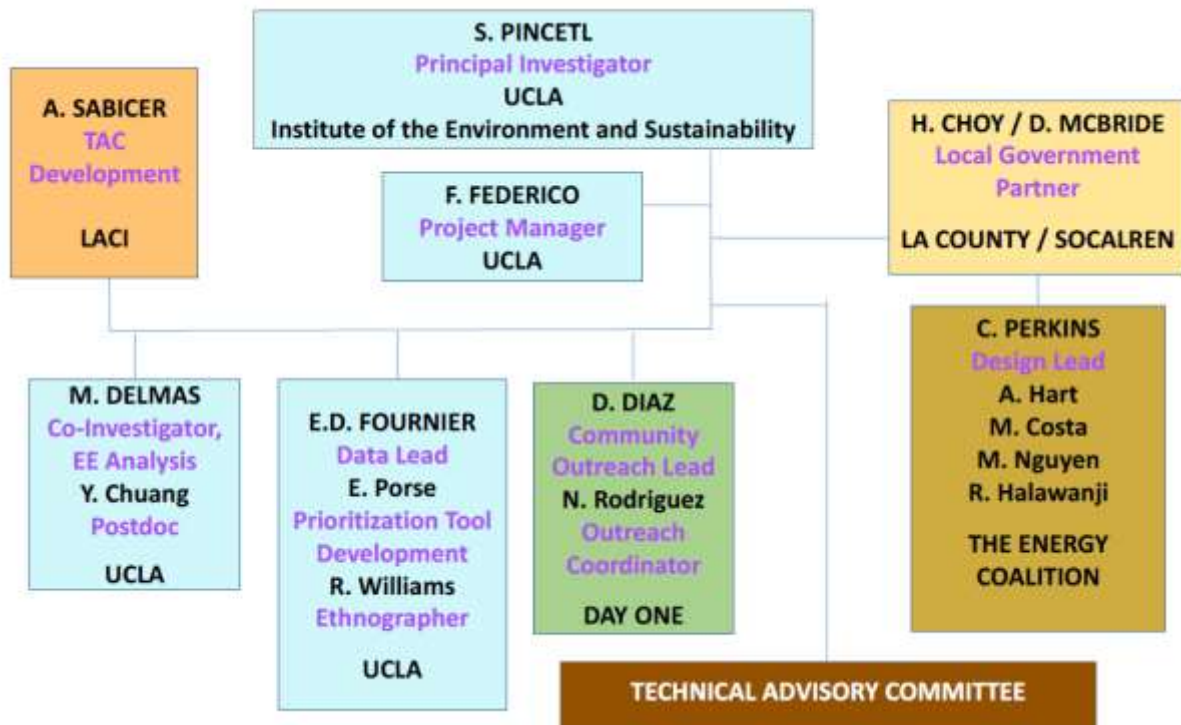
Per the GFO, projects will be funded in two phases. "Phase I focuses on the development of innovative planning, permitting, and financing approaches for Advanced Energy Communities, as well as the development of a real world conceptual design of an Advanced Energy Community. Recipients of Phase I funding will be eligible to compete for Phase II funding, which will support the build-out of an Advanced Energy Community that was proposed during Phase I."

The purpose of Phase I planning projects is to “demonstrate the feasibility of innovative planning, permitting and financing approaches at the local and regional levels to incentivize the development of Advanced Energy Communities.” Project site locations for the AEC design must be located within investor-owned utility (IOU) territory.

Project Team

The project team, led by the UCLA Institute of the Environment and Sustainability, partnered with the County of Los Angeles, The Energy Coalition (TEC), the Southern California Regional Energy Network (SoCalREN), Day One, and the Los Angeles Cleantech Incubator (Figure 1). The team was awarded a \$1.5 million Phase I planning grant to design an AEC within a disadvantaged area of Southern California.

Figure 1: Advanced Energy Community Project Team



CHAPTER 3:

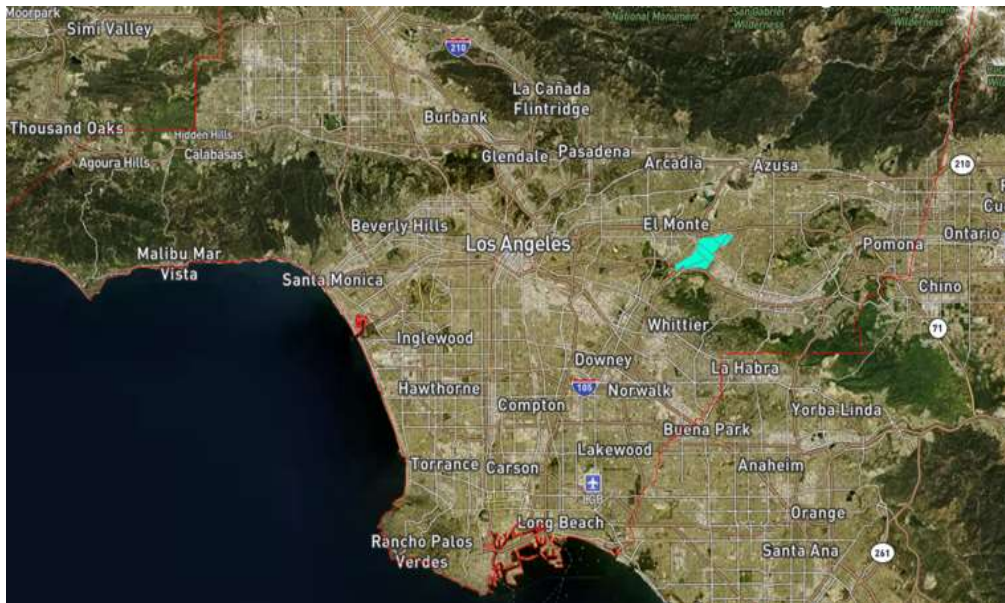
Target Community–Avocado Heights/Bassett

Overview

Avocado Heights and Bassett are adjacent neighborhoods located in an unincorporated area of the San Gabriel Valley in Los Angeles County, near the cities of Industry, South El Monte, La Puente, and West Covina (Figures 2 and 3).

Spanning six census tracts and 4.7 square miles, the communities are primarily residential and include an area zoned for agriculture, which contains a horse park. The combined population is nearly 28,000 people. High traffic density along three adjacent freeways is a major contributor to the pollution burden in these communities, which rank within the top 10 percent of disadvantaged communities in California. Lead and arsenic emissions from the nearby Quemetco Battery Recycling Center has been a continuing concern for residents, as have issues with the adjacent La Puente landfill, being converted into a regional park. These neighborhoods are predicted to experience more than 40 additional extreme heat days (days over 95 degrees F) per year by 2050.¹⁰

Figure 2: AEC Project Site



Location of Avocado Heights / Bassett AEC project site (highlighted light blue) in Los Angeles County

10 Sun, F., D. Walton, and A. Hall. 2015. "A Hybrid Dynamical-Statistical Downscaling Technique. Part II: End-of-Century Warming Projections Predict a New Climate State in the Los Angeles Region." *Journal of Climate*. (28). Pages 4618- 4636.

Figure 3: Detailed AEC Project Site



Detail of Avocado Heights/Bassett AEC pilot site, showing freeways and closed landfill just south of the site

Community Sociodemographics

The Avocado Heights/Bassett community is 84 percent Hispanic with an average median household income of \$60,000 annually. About 7.5 percent of the community population is unemployed, and about 60 percent have a high school education or less. Table 1 summarizes the key demographic data for this community.

**Table 1: Avocado Heights/Bassett Community Demographics
From American Community Survey 2016**

Average Median Household Income	\$60,481
Percent With High School Level of Education or Less	62.2%
Percent Renter Occupied Households	26.5%
Percent Hispanic or Latino Origin	84.1%
Percent Limited English Speaking Households	80.4%
Percent Unemployed	7.5%

Community Building Profile

Within the designated AEC project site, most homes were built between 1945 and 1960. (Figure 4.) These figures are consistent with trends for the residential sector across Los Angeles County. Within the residential sector, condominiums have been constructed more recently than

multifamily complexes, which tend to be more recently built than the stock of single-family homes (Table 2).

Figure 4: Parcel-Level Building Vintage Map



The building vintage map above plots the spatial distribution of building vintages within the proposed AEC project site using a colored spectrum ranging from brown (older) to turquoise (newer)

Table 2: Building Vintage and Square Footage by Use-Type Category

Use-Type Category	Average Vintage	Count	Average Square Footage	Total Square Footage
Mixed Use	2002	4	20,954	83,818
Single-Family	1960	5,477	1,422	7,788,389
Multifamily	1947	120	4,603	552,377
Condo	1986	10	30,084	300,843
Institutional	1962	17	16,265	276,515
Industrial	1973	152	48,418	7,359,668
Commercial	1968	113	3,874	437,806
Residential Other	1961	3	5,010	15,032
Other	1956	302	147	44,553

Construction vintage is critical in the characterization of a community within the context of energy projects, as the year in which a building was built is strongly correlated within features such as construction methods, construction materials, current weatherization state, and various other attributes that are intimately related to energy consumption intensity.

CHAPTER 4:

Community Outreach

The following is a summary of the key components of the community outreach process. Further details are contained in the project deliverable Case Study Report at this link:

<https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/Overview>.

The community infrastructure and outreach provides the intensive local engagement, education, and peer-to-peer strategy approach necessary to reach homeowners and renters in disadvantaged communities, and that has been successful in other fields such as education and healthcare. Most communities have neither the expertise nor the resources to piece together complex energy projects that will maximize savings and minimize investment risks. This AEC program model involves education on energy issues, outreach about the project plan, and surveys/focus group meetings to assess residents' level of interest and willingness to participate and to gain feedback on the design and implementation approach. This work lays the groundwork for successful enrollment of the target number of participants once the project implementation period begins.

Government and Community Partnerships

The following government and community partnerships comprised the community infrastructure.

Los Angeles County First Supervisorial District

To develop an AEC, approval and coordination with local government agencies are imperative. Los Angeles County was a project partner from the start and helped create the concept for the grant proposal. Coordinating with First Supervisorial District provided the team with an important social and political resource for the outreach efforts. The First District Supervisor had recently begun outreach to unincorporated areas by hosting a series of town halls at local venues. These town hall meetings provide an easier way for constituents to communicate with their district representative; otherwise, they must travel to the county offices in downtown Los Angeles almost 20 miles away. The First Supervisorial District has provided space for AEC project outreach at monthly town hall meetings. Being able to advertise the First District Supervisor's endorsement of the planning process drew people to meetings on the project. Table 3 summarizes the various roles the county had in the project.

Table 3: Los Angeles County Roles in the AEC Project

Position	Participation
L.A. County 1 st District Supervisor (Hilda Solis)	Provided overall project endorsement and made staff available to meet with and support the project team
L.A. County 1st District, Deputy of Environment/Public Works	Recommended project pilot site and community outreach partner
L.A. County 1st District, Director for the San Gabriel Valley	Provided outreach time and space during scheduled town hall meetings in the area
L.A. County Parks and Recreation	Provided information on park land easements and ownership for possible solar installations and shared previous potential solar generation studies for park areas near project area.
L.A. County Office of Sustainability	Project team collaborators. Provided project design input and match funds

Bassett Unified School District

In 1961, voters approved the creation of Bassett Unified School District (BUSD). BUSD includes the following schools: Bassett Adult School, Bassett High School, BUSD Child Development, Don Julian Elementary School, Edgewood Academy, Nueva Vista Continuation School, Sunkist Elementary School, Torch Middle School, and Van Wig Elementary School.¹¹ BUSD has 3,689 enrolled students, 30 percent of whom are English-language learners. The student ethnic makeup is 93.4 percent Hispanic or Latino, 3.4 percent Asian, 1.1 percent Filipino, 1.1 percent White, 0.8 percent African American, 0.2 percent American Indian or Alaska Native, 0.1 percent Pacific Islander, and no one reporting as two or more races.¹²

Local Community Organizations

Since the AEC business model depends on voluntary community participation, an effective outreach and recruitment effort is critical for program success. Engaging local community organizations is key to establishing the community infrastructure needed to provide the intensive local engagement, education, and peer-to-peer strategy approach that is necessary to reach homeowners and renters in disadvantaged communities. This “on-the-ground” approach is imperative to understanding community interests, values, and community willingness to participate in the AEC pilot, which includes implementing home energy efficiency measures.

¹¹ Bassett Unified School District website, <https://www.bassettusd.org/>.

¹² California Department of Education, district profile of Bassett Unified School District <http://www.cde.ca.gov/sdprofile/details.aspx?cds=19642950000000>.

Understanding these issues and incorporating them into the AEC design should boost voluntary community participation in the project.¹³

A discussion of Day One, which is both a local community organization, and a member of the AEC Project Team, is provided. Identifying a knowledgeable, on-the-ground outreach group familiar with the community was the first step in developing the community infrastructure for the AEC project.

This is followed by discussion of additional organizations that the team (led by Day One) identified as being part of the social network of trusted individuals and community leaders. Engagement with these organizations improves the credibility of the project and increases the range of residents who can be reached.

Day One

Day One is a community-based nonprofit organization in the San Gabriel Valley with a 25-year history of providing effective, high-quality, and culturally sensitive public health education and community facilitation. Most of Day One's staff members grew up in the San Gabriel Valley and are bilingual Spanish speakers. They are known in the community and able to communicate in the Avocado Heights and Bassett neighborhoods, which are composed of about 60 percent Spanish speakers. They have four office locations in the San Gabriel Valley, including an office in the City of El Monte on the western border of Avocado Heights and Bassett.¹⁴

The organization began in 1987 as a community response to the drug epidemic in Pasadena and Altadena. It has several ongoing community health programs focused on substance abuse prevention and control, youth leadership and advocacy, exercise, and healthy eating. Day One has also developed expertise in facilitation and outreach around transportation, water, and parks issues and has worked on the San Gabriel Valley Regional Bicycle Master Plan and Urban Greening Toolkit and the Puente Hills Landfill Park Master Plan for more than 10 cities within the San Gabriel Valley. For example, as part of its work on the Puente Hills Landfill Park, Day One created a website dedicated to the park project, as well as a social media presence. It led hikes for community members through the proposed park site, created videos, and organized focus groups to gather input on the park proposal. Day One provided facilitators in four languages; feedback and responses were posted to the project website. This strategy provided the basis for developing the AEC outreach program.

North Whittier Neighborhood Watch Avocado Heights Association

Local resident Ruben Hernandez formed the North Whittier Neighborhood Watch Group in 1989 after a family friend was left paralyzed in a random freeway shooting. Hernandez was blinded

13 Smith Korfmacher, K. and V. Garrison. 2014. "Partnering to Reduce Environmental Hazards Through a Community-Based 'Healthy Home Museum.'" *Environmental Justice*. 7(6) Pages 15-165.

14 Day One website, <https://www.godayone.org>.

by a drive-by shooting in 1974.¹⁵ Hernandez stated that he wanted to know his neighbors so that his children would feel safer.¹⁶

The organization works to build community, eliminate crime, and reduce graffiti. The Neighborhood Watch originally hosted a neighborhood “Night Out” every three months to encourage neighborhood relationships and an annual march to raise awareness about crime prevention. The organization now holds monthly meetings in the area and organizes an annual “National Night Out.” Hernandez leads neighborhood watch meetings in Spanish and English. The group became a registered 501(c3) nonprofit organization in 2011.¹⁷ The group has a lively Facebook discussion page with more than 400 followers.¹⁸

During the summer of 2017, the group focused on safety and led a petition to install speed bumps near an elementary school. In the fall, the group is organizing a “Hands Across Workman Road” event, focusing on a busy main thoroughfare that runs through the area. This year, 2017, marks the 28th anniversary of the creation of the North Whittier Neighborhood Watch group.

Clean Air Coalition of North Whittier and Avocado Heights

The Clean Air Coalition of North Whittier and Avocado heights is an all-volunteer community organization working to protect and enhance the environment and quality of life in the North Whittier and Avocado Heights area. Members regularly meet during the school year in the cafeteria of the North Whittier Andrews Elementary School.

The coalition’s most prominent campaign is for the closure of the nearby Quemetco lead-acid battery recycling plant. This summer, 2017, the Clean Air Coalition partnered with researchers from the University of Southern California Keck Medical program on a study evaluating levels of metals, including lead, arsenic, antimony, and cadmium, in children living within 2.5 miles of the Quemetco plant. The Clean Air Coalition is acting as community organizer for this study, alerting local parents and serving as a venue for study updates.¹⁹

Outreach and Infrastructure Building

Building Local Capacity Around Energy Issues

The current approach to the AEC design involves recruiting voluntary residential participants. The AEC pilot design is targeted to serve 422 single-family homes, 19 multifamily homes, and seven schools for energy efficiency retrofits and participation in a community solar project. An effective public information program that uses language and images appropriate for the

15 Stewart, Jocelyn Y. (1998, September 20). “March is a testament to victim’s recovery; Crime: Left blind after a 1974 drive-by shooting, Ruben Hernandez has made it his life’s work to help others who are cut down by violence.” Los Angeles Times.

16 Mzingo, Joe. (1999, June 18). “Blind man’s vision introduced neighbors and began a tradition of caring.” Los Angeles Times. Page Metro PART-B Metro Desk.

17 GuideStar non-profit database <https://www.guidestar.org/profile/27-3641277>

18 North Whittier and Avocado Heights Facebook Page: www.facebook.com/groups/16176147390372

19 Clean Air Coalition of North Whittier & Avocado Heights website: <http://www.cleanaircoalition.org/index.html>

targeted public's cultural and educational background is key to gaining the targeted participation.²⁰

Day One works as a grassroots organization and engages in “community-based action research” for its community health and substance abuse programs.²¹ The AEC project originates from a state initiative and, therefore, requires that outreach staff members be trained in the related technical and policy issues so they can engage knowledgeably with the community. Messaging for the AEC project required translating technical, industry, and policy language into materials that an individual with a fourth-grade reading level could understand, as well as translating into multiple languages using appropriate slang and dialects.²² Day One staff translated all surveys and website information into Spanish, and was available to read and translate information on the fly to visitors during event tabling and town hall meetings.

Capacity building took place through two main pathways:

1. **Internal training:** Day One staff learned about technical, policy, and financing issues, such as building energy analysis, renewable energy technologies, and state energy goals, through one-on-one discussions with other AEC team members and through participation in team meetings.
2. **Community training:** Day One staff members gained further knowledge through related discussions with community residents, BUSD Board meetings, town hall meetings, and other venues where they engaged with community members, county elected officials, and agency staff to gain broad knowledge and context for the project.

Outreach Approach and Philosophy

Key to Day One's success in outreach is the personal touch of talking to community members one on one and demonstrating interest in hearing what the community has to say.

By attending public meetings of local community groups and tabling at local events, Day One was able to glean important information that assisted in message crafting. For example, Day One found that the community does not associate solar panels with reducing pollution. Local community groups concerned with air pollution have focused on local problems, such as air emissions from the Quemetco lead battery recycling plant. In addition, they found residents were wary of solar panels due to previous door-to-door sales efforts by for-profit companies, and that community members were not familiar with the term “nonprofit.” Another concern raised during a town hall meeting related to the perception of energy reliability; residents asked, “What happens if the community solar does not produce enough electricity for everyone?” These findings prompted the team to develop materials to explain how the grid works, the relationship between energy generation using fossil fuels and air quality, and more.

20 Reaves, D., C. M. Clevenger, M. Nobe, and P. A. Aloise-Young. 2016. “Identifying Perceived Barriers and Benefits to Reducing Energy Consumption in an Affordable Housing Complex.” *Social Marketing Quarterly*. 22(3). Pages 159-178.

21 Day One website, <https://www.godayone.org>.

22 The average American is literate at the eighth grade level, and for immigrants, the literacy level will be in the fourth-to-sixth-grade range. Creating outreach material at the fourth-grade reading level will be accessible to the most people.

Branding, Website, and Social Media

For each project, the Day One team develops a recognizable brand (Figure 5) based on the project and establishes an online presence through social media and a Web page. The brand visually ties each medium together and makes the project easy to recognize.

Figure 5: AEC Project Logo



AEC project logo design by Day One and used on all promotional and educational materials

Developing a project specific website (<http://www.advancedenergycommunity.org/>) allowed community members to find information on the project and upcoming events. Notes from community meetings were posted to the website. Posting notes from community meetings is important to let the community know officials are listening to them. A social media presence further allowed the organization to post quick updates, as well as to parallel the real-life social network Day One members developed during their outreach. By networking with local community groups, Day One staff members could share their posts or post project updates directly with those community organizations' Facebook pages, such as the North Whittier and Avocado Heights Neighborhood Watch Facebook page.²³ This allowed the outreach organization to reach a larger audience through a trusted online source, instead of trying to build an online following from scratch.

The overall social media goals were to:

- Attract and excite a diverse audience to become advocates and ambassadors for the AEC, an endeavor that will bring positive benefits to the community and all who want clean energy.
- Promote the design in the community and surrounding areas and receiving community feedback.
- Generate relevant, shareable, and real-time engagement for followers by providing online content about the design plan.
- Post inspiring pictures and educational information about AEC design and spark conversation among the audience so they become enthused and interested.

As part of the AEC team's messaging plan, a social media calendar was drawn up to list daily posts for the team's social media page. The AEC outreach team wrote posts on methods for saving energy and water and on educational issues around solar energy. These posts were double-checked by others on the AEC team for technical accuracy.

²³ Advanced Energy Community Facebook page: <https://www.facebook.com/AdvancedECommunity/>.

Engagement and Deployment of Education Initiatives

Identification of Community Leaders and Events

The importance of engaging local community leaders cannot be overstated. Day One typically begins outreach efforts by “power mapping” community leaders and assets. This process involves identifying key community organizations and leaders within the community on issues related to the outreach topic and then mapping the connections between these leaders and additional organizations/people within the community. This process also helps identify local community events for future outreach. Having recently finished a park project in the area, Day One already had a “power map” that was appropriate for this energy project.

Day One staff members developed and maintained a connection with the local school district. They hosted a meeting between the project team and a BUSD board member who was willing to “sponsor” the project. This board member helped conduct a meeting with the school superintendent and secured a time and date for the AEC team to present the project at a school board meeting. After the initial presentation, which secured school board approval to collaborate and share information with the AEC team, Day One continued to attend board meetings regularly to stay up to date with district workings. Day One staff members also promoted the sharing of BUSD energy-related data with the AEC team. Board members have expressed appreciation for Day One’s continued involvement.

Tabling at Events

Day One attended numerous community events to reach as many people as possible. These included community organization meetings, government town halls, farmers’ markets, community festivals for Earth Day, Night in the Park events, and National Night Out events. Most of these events are planned six months to one year in advance. Participating in event planning early to turn in applications or attend planning meetings is most effective and may allow the project to be highlighted by the event by being included in event messaging. Because of a project location change at the end of 2016, Day One was brought into the project late and needed to spend extra effort to get on schedule. Beginning tabling events in April, Day One staff members worked to contact event organizers, explained why they were applying late, and had people write letters of recommendations for them to attend community events. Fortunately, at the community or neighborhood level, a great deal of communication still occurs by word of mouth. Once the outreach team members were able to find one event, they learned of others through the organizers or other attendees.

Tabling and outreach (Figure 6) occurred over the summer and into fall at a variety of events, allowing the AEC outreach team to reach a wide range of Avocado Heights and Bassett residents. Tabling at events such as the Los Angeles County First Supervisorial District town hall meetings allowed Day One to network with leaders of other nonprofits, community groups, and government departments. In addition, tabling at general community events including “Evenings in the Park” and “Earth Day” allowed Day One to reach a wider community, as each event had different target audiences.

Figure 6: Day One Tabling



Day One education and outreach table at the 2017 Downtown Street Market, Baldwin Park

Throughout the outreach process, Day One gathered emails and phone numbers of people who were interested in receiving more information or who would potentially participate in a focus group meeting later or both. Day One also encouraged people to connect with the project Facebook page (<https://www.facebook.com/AdvancedECommunity/>) to receive updates. Day One writes regular posts and updates to the Facebook page, including information on monthly raffle winners.

Too long a lag between informing the community of the possibility of an AEC project and development of the project risks putting the organizing that has taken place at risk in the sense that people will need to be mobilized once again. Outreach of this kind is highly labor-intensive, and trust building needs to be acted upon quickly or else needs to be started over.

Development of Surveys and Questionnaires

Six survey instruments were developed for the AEC project.

1. A short survey on energy efficiency and climate change to gauge community knowledge
2. Open-ended questions to gauge interest by single-family building occupants
3. A survey on home energy use by single-family building occupants
4. Open-ended questions to gauge interest by multifamily building occupants
5. A survey on home energy use by multifamily building occupants
6. Open-ended questions to gauge interest by apartment building owners

The short survey was developed at the beginning of the project to elicit information about current energy reduction behaviors and attitudes toward climate change on the part of local residents. Day One staff members used this survey while tabling at the community events discussed above.

The open-ended questions and longer surveys were used at the focus group meetings discussed below. Day One designed the questions to gain specific information for multifamily and single-family buildings, as well as for renters and owners. Questions covered a wide range of topics, including property characteristics, energy use, appliance types and ownership, heating and cooling practices, and interest in AEC participation. The longer surveys collected primarily quantitative data, whereas the shorter set of open-ended questions were developed to catalyze shared discussion at the focus group meetings and to collect qualitative data about people's attitudes toward the AEC project, including potential barriers to participation. Results from all the surveys (discussed below) supported the overall design and business model assumptions for this planning phase of the project and will inform decisions in the implementation phase.

Training and Developing Local Volunteer Leaders

If funded for implementation, the AEC project will involve work inside people's homes for energy efficiency retrofitting. This requires an extra level of trust in the sponsor organization that is not required when simply asking for people's opinions. To overcome this potential barrier and lay the groundwork for a transition to project implementation, Day One is recruiting "energy ambassadors." These energy ambassadors will be trained on the project and become a source of knowledge for local community members. In addition, the energy ambassadors will be the first to have an energy audit and energy efficiency retrofits done in their home. Videos of the energy audit and retrofit process in these community leaders' homes will be made available on the Web to improve transparency.

Recruitment of project energy ambassadors began with the initial survey. People who showed interest in the project were given additional information and an application to apply to be an energy ambassador; however, it may take some time to be successful in recruiting people to these positions. It was found infeasible to finalize selection of the energy ambassadors during this planning phase of the project, as funding was uncertain. However, if implementation funding is secured, final selection can be completed relatively quickly, given all the work that has been done to date, especially if there is not too long a lag time before it is known whether funding will be available.

Targeted Focus Group Meetings

Two focus groups were held as part of this planning phase: one for single-family homeowners and renters, and a second for multifamily building renters. Focus group attendees were recruited from the list of potentially interested people that Day One developed at the various tabling events, as discussed above.

Focus Group Recruitment

Community members were invited to participate in the focus groups through multiple media avenues. Day One emailed invitations to the list gathered throughout the summer, as well as used email lists of the North Whittier Neighborhood Watch Avocado Heights Association, Clean Air Coalition of North Whittier & Avocado Heights, and First Supervisorial District Hilda Solis. List sharing is evidence of the success at trust building by Day One. Individuals who preferred being contacted by phone were called, and information was posted to the Advanced Energy Community Facebook page.

Focus Group Format

The focus group agenda extended from 6:00 to 8:00 p.m. and included:

- Networking and dinner.
- Introduction.
- Presentation.
- Small group discussions.
- Questions/comments.
- Raffle.
- Group photo.

Dinner was provided to the attendees. The team was not allowed to use Energy Commission funds for this essential component of community outreach, but fortunately, one of the members of the project team donated the funds. In disadvantaged communities, providing meals at evening meetings makes a substantial difference not only in attendance, but in making people feel their participation is valued.

Day One also provided a daycare area staffed by two adults and activities for children, and interpretive services for Spanish speakers.

Two focus group meetings were held. The first was attended by 24 people, primarily single-family building residents. The second was held in the common room of a large apartment building and was attended by 41 people; all but one were residents of that building.

The second meeting included about 10 Spanish speakers. An interpreter provided interpretation services during the presentations and acted as a mediator at the Spanish-speaking table during the breakout sessions.

Apartment Building Owners

A majority of the multifamily buildings in the AEC pilot area are single-story structures on parcels with multiple buildings; there are only four large apartment buildings. Due to the small number of apartment building owners, Day One determined that a one-on-one approach would work better than attempting a group meeting. Day One staff members approached each of these buildings through phone calls and site visits, and each building was visited multiple times, but they were only able to make contact with the building managers. None of the owners lived on site.

All building managers seemed to support the concept of energy efficiency measures and the AEC project objectives. However, none of the managers had authority to answer detailed questions without permission from the owners. One manager indicated that the building did need energy efficiency upgrades, but the owner was not interested; however, the manager also mentioned that residents had taken advantage of a rebate program to upgrade their refrigerators just a few years ago.

The fact that many of the apartment building owners do not reside in the community where their buildings are located was a challenge for the outreach effort; however, under the proposed AEC design, apartment tenants will be eligible to participate in the AEC project with or without participation by the building owner(s). Indeed, this was a deliberate decision because of the known difficulty in engaging with apartment building owners. Therefore, the limited level of survey data from these owners is not considered significant related to the proposed design. The team would continue to work to connect with apartment building owners in the implementation phase of the project.

Summary of Survey Findings

Energy Efficiency Survey From Tabling Events

Day One developed a short survey at the beginning of the project to discover information about current energy reduction behaviors and attitudes toward climate change. Day One administered these surveys by from April to November 2017 at 20 community events (Figure 7) and four town hall meetings. The survey was completed by 523 people.

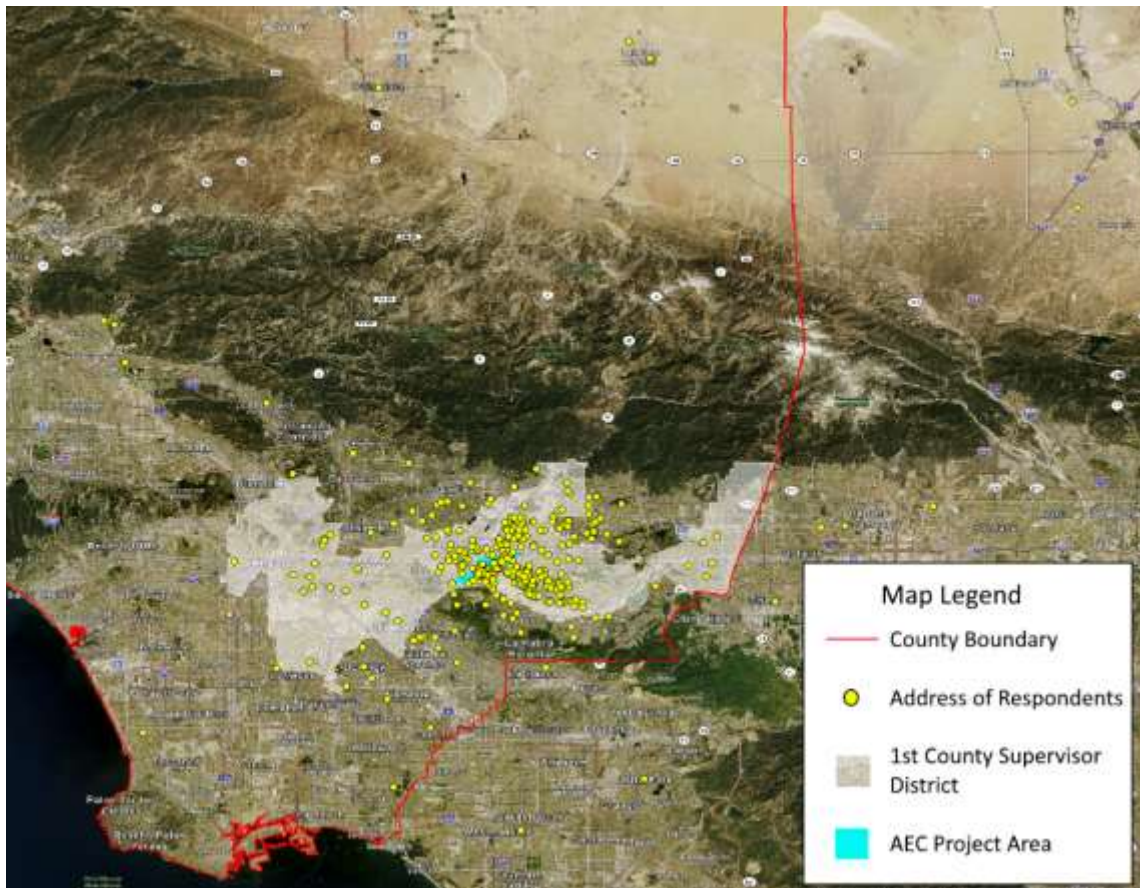
Figure 7: AEC Survey Participation



People visit the Day One table and take the short AEC survey at a local park event

The map in Figure 8 shows the distribution of respondents addresses. While this survey includes people from outside the specific Avocado Heights/Bassett project area, they are clustered in and around these neighborhoods and the results provide highly relevant information for the planning process.

Figure 8: Energy Efficiency Survey Respondents Map



Map of the home addresses (yellow dots) of respondents to the energy efficiency survey

Highlights of the results of the first half of the survey include the following:

- Of those respondents who specified their ownership status, 64 percent were renters, and 36 percent were owners.
- More than 60 percent of renters lived in single-family homes.
- The vast majority of survey respondents stated that they had already implemented energy-saving measures at home
 - Ninety-six percent said they turned off the lights when they were not needed
 - Ninety-one percent said they had already installed energy-efficient light bulbs.
 - Seventy-six percent said they bought ENERGY STAR® appliances.
 - Fifty-six percent said they installed (or had) a programmable thermostat.
 - Sixty-two percent said they insulated their homes to reduce heating and cooling costs.
- Respondents pay attention to their monthly electricity bill.
 - Sixty percent of people surveyed knew how much their last energy bill was.
 - More than 75 percent of respondents indicated an interest in reducing their electricity bills.

The second half of the survey attempted to gauge participants' understanding of the impact of climate change on their local environment by presenting the following statement about high heat days:

In San Gabriel Valley, the number of days that are above 95° will rise from 32 days to 74 days by 2050. En el Valle de San Gabriel, el número de días que están por encima de 95°F aumentará de 32 días a 74 días en 2050.

Survey takers ranked the following statements according to a Likert Scale, which included the following choices: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree. Fewer survey takers filled out the second half of the survey (440), possibly because some people did not realize the survey was two-sided. Table 4 summarizes the results, broken down by renter/owner.

Table 4: Energy Efficiency Survey Results

	Renter – Strongly Agreed		Owner – Strongly Agreed	
I am aware of this trend	180	64%	92	58%
This information is believable	207	74%	130	76%
This information is relevant to me	201	72%	113	71%
This information encourages me to reduce my electricity usage	232	83%	132	83%
	Renter = 280 Owners = 160 Not Specified = 65			

Results of climate change opinions from survey administered by Day One at tabling events. Percentages were calculated based on the total respondents who answered the question.

Overall results are:

- Sixty percent of respondents strongly agreed that they were aware of that trend.
- Seventy-three percent strongly agreed that the statement believable.
- Seventy percent strongly agreed that the information was relevant to them.
- More than 80 percent strongly agreed that the increase in high heat days encourages them to save energy. A few respondents told survey administrators that they leave the house on hot days to reduce their energy use.

Focus Group Meeting Surveys

More than 80 people total attended the two focus group events, and completed 40 surveys. Complete results from the surveys are included in Appendix G. The following are highlights of the findings:

- More than 57 percent of people surveyed said that they had updated their home in some way to increase energy efficiency or reduce their electricity bill.
- Half of respondents said they would be interested in participating in the AEC, and most of those were open to being contacted in the future.
- The median apartment building resident had been at their current residence for 4.5 years, and nearly all expected to be living there still in two years. This focus group meeting took place in an apartment building designed for retirement living.
- The median respondent at the single-family focus group meeting had lived in their home an average of 22 years; a large majority, 87 percent, planned to continue living in their home for more than two years.
- The large majority of apartment residents (90 percent) and single-family residents (79 percent) pay their own electricity bills directly to the utility.
- The average monthly electricity bill ranged from a low of \$25 for winter months in the apartment residents to a high of \$86 in the summer for single-family residents. This is less than the average cost of \$101/month in L.A. County. However, more data and analysis is necessary to understand resident's average energy use per square foot and how that compares with corresponding countywide benchmarks.
- The average monthly natural gas bill for single-family residents ranged from a low of \$24 for summer months to a high of \$49 in the winter months. This is comparable to the average cost of \$33/month in L.A. County.²⁴
- The majority (71 percent) of apartment building residents rated the energy performance of their home as "okay," nearly 20 percent rated it as "good," and less than 5 percent chose "poor." The most frequently selected answer for single-family residents was also "okay" (42 percent); "good" was selected by 37 percent of respondents, and 16 percent chose "poor."
- A large majority of single-family residents (84 percent) had light-emitting diode (LED) lighting in their homes, while just 52 percent of apartment building residents said they had LED.
- Less than half of apartment building residents said they owned their own appliances, whereas 84 percent of single-family residents responded that they did.
- More than 60 percent of apartment building residents and 37 percent of single-family residents said they would sometimes leave their home to conserve energy.
- Sixteen percent of single-family residents would prefer to install energy efficiency upgrades themselves, whereas none of the apartment building residents were interested in installing the upgrades themselves.

In addition, Day One obtained data related to specific types and ages of appliances in residents' homes. This information, as well as the findings highlighted, provides a strong start for informing the implementation phase of the design, including selection of the final suite of energy efficiency upgrade options. The team anticipates that additional surveys will be

²⁴ Federico, F., Rauser, C. L., and Gold, M., 2017. *2017 Sustainable LA Environmental Report Card for Los Angeles County: Energy and Air Quality*. <https://grandchallenges.ucla.edu/sustainable-la/report-card/energy-2017/>.

conducted at the start of the implementation phase to increase the total number and representativeness of the survey responses.

The greatest challenge for the outreach was attempting to solicit interest in the project before having a commitment to fund the project. People wanted to know more about the financial impact, and the team was unable to satisfy their questions. Residents also needed additional information on how the grid worked and explanations for why this project would not result in a shortage of electricity to their home. This feedback will inform improved messaging in the implementation phase.

Despite these challenges, about half of all respondents indicated an interest in signing up for the AEC project after one presentation. This interest speaks to the importance of air quality, utility costs, home comfort, and the need for climate change adaptation in this community.

Relationship Between Community Outreach and AEC Design

Throughout the project, there was a continuous information exchange between the technical design and the outreach. Earlier sections of this report discussed how team members working on data analysis and modeling supported the development of outreach materials, survey questions, and focus meeting presentations.

At the same time, results from the outreach and survey results provided feedback to the design team. Survey results generally confirmed the modeling assumptions of the project but also added new ideas and options to the project approach. For example, through discussions with hundreds of people while tabling at local events and town hall meetings, Day One staff provided feedback to the team on several key issues. For example:

- Residents may be reluctant to allow people into their homes to conduct energy efficiency upgrades. Consequently, the team decided to include a self-install option for certain measures.
- Residents do not make a strong connection between rooftop solar photovoltaic (PV) and air quality. Part of the reason for this may be that the decades-old problem of lead and arsenic emissions from the nearby battery recycling plant is the dominant concern related to air quality. In addition, the partnership with the local clean air coalition group (who is organized around the recycling plant issue) to find interested community members may have caused the AEC message to become conflated with that of the Clean Air Coalition. The AEC will adjust messaging in the implementation phase to clarify the relationship between electricity generation and air quality.
- There may be aesthetic concerns with local installations of solar panels, canopies, or battery storage or a combination thereof. Such concerns on the part of residents recently derailed a solar project in the San Gabriel Valley. The BUSD superintendent raised a similar caution. It will be important to ensure community involvement and opportunity to comment on proposed installations, especially on school campuses. At the same time, stronger messaging is necessary to explain the link among current fossil fuel-based generation, air pollution, and health impacts, including asthma emergency room visits and hospitalizations among children.

Most importantly, this planning-phase outreach provided the on-the-ground time needed to develop a more informed and detailed understanding of what would be needed for success in the implementation phase. This will include conducting additional surveys to increase the total number of respondents, thereby improving the ability to infer from the results. The certainty of funding and the ability to develop clarity on project costs in the implementation phase will also improve the range of information and level of detail provided to prospective participants, which, should result in more accurate and actionable responses. Knowledge gained from the planning phase will also help refine messaging and education materials to improve effectiveness. An overview of the AEC team's vision for implementation outreach and support is provided in the next section.

Vision for Implementing Outreach and Support

If this AEC project is funded, current outreach efforts will be maintained, including frequently updated social media posts, a website with updated information, tabling at local events, presentations about the status of the project, and solicitation of input from the community. The project team will add components to ensure high participation of historically underserved groups. Implementation funding will allow the team to finalize recruitment of local community leaders to be energy ambassadors to the community. Community partnerships will be expanded to include the San Gabriel Valley Conservation Corps and the International Brotherhood of Electrical Workers to support the AEC goal of jobs training and increased economic opportunity within the community.

The following sections summarize the key components of the community outreach and support structure envisioned for the implementation phase.

Critical Community Partnerships

- Bassett Unified School District
- San Gabriel Valley Conservation Corps
- Clean Air Coalition of North Whittier and Avocado Heights
- International Brotherhood of Electrical Workers

Community Activities

- Energy ambassadors
- Ombudsman office and learning center
- Local workforce development (adult and youth)
- Smartphone application
- Website
- Ongoing energy education classes

The role of energy ambassadors would be to talk at community events, perhaps open their homes to small group meetings, and participate in other outreach activities for a stipend of \$150 per month. They would be the first to get an energy efficiency consultation in their home and to get upgrades installed. The process would be filmed, posted to the website, and used at presentations to show that it is acceptable for people to open their homes to the AEC project.

During the project planning phase, recognized community leaders were asked if they were interested in being energy ambassadors for the community. However, without implementation funding, it was not feasible to finalize selection of energy ambassadors, although the extensive work in this planning phase to lay the foundation has been done. Again, there must not be a delay in AEC development so the infrastructure does not require rebuilding.

An enrollment campaign will use the energy ambassadors to encourage people to sign up to the AEC. People who sign up and undergo energy efficiency upgrades will receive a lawn sign to show their neighbors they participated. Quarterly gatherings will take place to celebrate progress and answer participant questions.

Another innovation, also recommended in the California Energy Commission Low-Income Barriers Study,²⁵ will be to create an ombudsmen office and learning center for energy efficiency and the AEC. This office would be trusted and act as an information center providing residents with maintenance and operations questions after installing their energy efficiency upgrades. The office would also provide information on numerous energy issues.

Creating this office, potentially in conjunction with the local school district, will provide a one-stop-shop for education, assistance, and career development. There is already a solar panel installation classes at the Bassett Unified School District Adult School. This can be used as a launch pad for a homegrown green workforce to assist in energy efficiency upgrades and solar panel installation for the AEC project itself, giving people basic job experience to help them gain access to energy industry careers.

School-Based Activities

- Apprenticeships
- Job shadowing community solar and energy efficiency lesson plans
- Project service learning opportunities for students
- Panel demonstration for classroom use
- Summer learning institute
- Professional development for staff
- Marketing campaign
- Fund to allow for school projects

The school-based activities in Phase II of the project serve two purposes – outreach through education and career training to create local job opportunities in the local community. The opportunity to combine school-based activities with a community ombudsman to create a one-stop-shop for questions on the AEC, energy efficiency, and careers in the energy industry could be a breakthrough in community development.

²⁵ California Energy Commission. December 2016. *SB 350 Low-Income Barriers Study, Part A- Commission Final Report*. Publication Number: CEC-300-2016-009-CMF.

CHAPTER 5:

Technical Design Process

This chapter summarizes the most salient aspects of the project design process, including goals and approach, data analytics, selection of community-scale technologies, building and distributed energy resources modeling, and the relationship between the community outreach and the design process.

The research team conducted an extensive amount of analysis for this project. Details are contained in the project reports: <https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/>.

Goals and Approach

The proposed AEC design goals are to:

- Provide local energy generation to offset energy consumption and GHG emissions of a disadvantaged community.
- Generate more efficient, resilient, and affordable energy to community participants.
- Provide community access to cost-effective renewable generation and integrated demand side management (IDSM) retrofits.
- Reduce the cost for utility grid infrastructure and align with state goals.
- Improve system efficiency and cost-effectiveness.
- Reduce greenhouse gas (GHG) emissions.
- Promote social equity, environmental justice, and a more-livable community.
- Lead the way for replication of decentralized energy systems by other California communities.

The technical design process was composed of several tightly linked components and iterative processes. These components are summarized in the following subsections: Data Analytics, Selection of Community Scale Technologies, and Building and DER Modeling. Comprehensive descriptions are provided in separate reports, posted at:

<https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/>

Data Analytics

Performance Objectives

The following performance objectives guided the development of the data analytics method.

Data Driven

The overarching philosophy of this AEC design has been to embrace the comprehensive use of data to inform and guide each step in the decision-making process. The team collected and compiled an unprecedented diversity of data sources to pursue an integrated AEC design that is highly sensitive to the local context of the final selected project site, as well as the multiple objectives outlined by the GFO. Understanding the local context is the key to replicating an AEC, since it will vary across geographies. Methods can be generalized, but the design must reflect the local conditions.

Iterative

The project team worked through a large number of design iterations throughout this AEC design process. New designs necessitated developing and integrating new or disparate data sources that were overlooked or unknown to the team. These design iterations have been immensely educational, and the design has grown substantially stronger because of these various trials, errors, and innovations.

Flexible

To support this type of iterative planning workflow, a flexible and extensible data platform is required. Building off the foundational data integration efforts used to develop the UCLA Energy Atlas, the team rapidly executed numerous analyses of a depth and sophistication that would have otherwise been extremely time-consuming or impossible. Furthermore, in all aspects of the planning and design effort, the team sought to use cutting-edge, Web-based, interactive mapping and modeling tools, which are able to promote flexible decision-making.

Replicable

The fundamental goal of this project is to create a replicable planning framework that can be scaled out to different geographies throughout the state and beyond. This means that, wherever possible, publicly accessible datasets with statewide geographic coverage were used. In addition, transparency in documenting data processing procedures has been a priority. Reproducibility is the goal with the depth and specificity of this report. Further, it is developed to encourage potential improvement upon during future AEC planning projects.

Data Sources

The UCLA Energy Atlas

The fundamental basis for the project design is the UCLA Energy Atlas for Southern California, <http://www.energyatlas.ucla.edu/>. The atlas is the only meter-level energy consumption dataset in California. At the core of this atlas is a geospatial relational database that connects address-level energy consumption to building characteristics and census information. Customer privacy is maintained through data aggregation, whereby parcel-level consumption is summed to the neighborhood, city, or county scale, to meet nondisclosure guidelines.

Additional Datasets

A variety of other datasets were used for the design, including public and private. These include aerial imagery, census data, CalEnviroScreen, L.A. County Solar Rooftop database, L.A. County Assessor's parcel data, and Southern California Edison's (SCE) Distributed Energy Resource Integration Map (DERiM), among others.

Building Attribute Analysis

Building attributes for the parcels contained within the AEC project site are available from the Los Angeles County Assessor's Office parcel database. Within this database, each parcel contains aggregate information for the buildings that are within it. This information includes building construction vintage, total square footage, and building use type codes. As there can potentially be several buildings with separate use types on a land ownership parcel, some cleaning and standardization are necessary to organize and prepare the raw parcel data for integration with other analyses. Fortunately, in the context of this planning project, the team had the benefit of using parcel information that had already been cleaned and standardized as part of the initial effort to develop the UCLA Energy Atlas project and website.

The results of the building attribute analysis for the community of Avocado Heights/Bassett are in Chapter 3.

Sociodemographic Analysis

Sociodemographic for the AEC project site within Bassett and Avocado Heights was collected from the U.S. Census American Community Survey Database. This database is compiled from a statistically representative sample of households located within each census block group. The data year for the sociodemographic variables corresponds to the period ranging from 2010 to 2014. Although ACS statistics are available only at a relatively coarse spatial resolution (the census block group level), the attributes that it contains are extremely valuable for the types of decisions that must be made in the context of planning an AEC.

Key results of the sociodemographic attribute analysis are in Chapter 3 to describe the project target community of Avocado Heights/Bassett.

Energy Consumption Analysis

The quality the AEC design is in large part contingent upon the quality of the information contained within the historical consumption data contained in the UCLA Energy Atlas. This is because this dataset is used to calculate the magnitude and spatiotemporal distribution of energy consumption within the AEC project site, as well as to project changes in energy demand.

The close inspection of the dataset enabled the discovery that records for both the energy and the natural gas consumption appeared to have significant numbers of suspected illegitimate missing values. While it was not possible to determine source of this problem whether the collection, storage, or transmission of the underlying source consumption information, the geographic and temporal scope of the problem was such that researchers were forced to develop a sophisticated methodology for discerning and intelligently replacing missing values

with plausible estimates. A detailed analysis of this missing data problem, as well as the data filtering and imputation methods devised to resolve it, is provided in the *Data Methodology Report*.

Another major challenge associated with the use of account-level consumption data for energy analysis on such a relatively small geographic scale has to do with the ability to share consumption information for small numbers of account holders publicly due to privacy restrictions that govern this type of private information. To overcome this problem, information was shared only if it conformed to the masking constraints set forth for residential (>100 accounts) and nonresidential accounts (>15 accounts and no account having more than 15 percent of the total consumption share). For these reasons, in some of the reporting involving the use type-specific sectoral breakdowns of energy consumption for the site (Figures 9 and 10), some sectors will be missing (or masked) to accommodate these privacy requirements.

Figure 9: AEC Project Site Average Monthly Electricity Consumption by Parcel Use Type

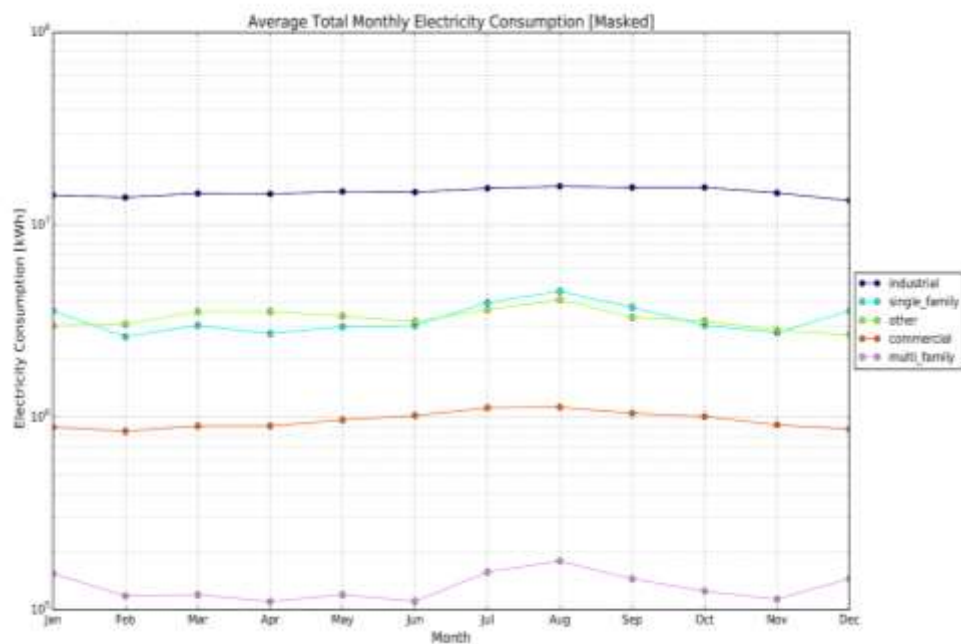
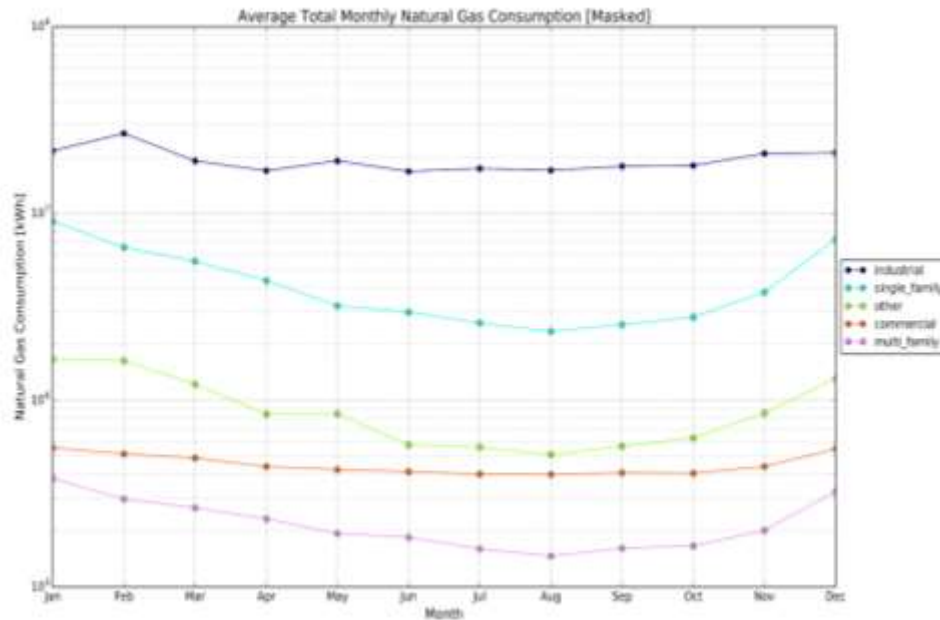


Figure 10: AEC Project Site Average Monthly Natural Gas Consumption by Parcel Use Type



Rooftop Solar Capacity Potential Analysis

Early in the design process, the team assessed the potential for rooftop solar to meet the energy demands of the target community (Table 5). This was accomplished by using the County of Los Angeles Solar Rooftop Database, which was made public in 2010. This database is a parcel-level estimate of available suitable rooftop area, potential panel nameplate capacity, and annual estimated output (watts) given 100 percent utilization of the estimated suitable rooftop area available at each parcel.

Table 5: Rooftop Solar Capacity Potential for AEC Project Site

Use-Type Category	Average Rooftop Capacity (kW)	Total Rooftop Capacity (kW)
Mixed Use	1.1	48
Single-Family	5.4	29,007
Multifamily	14.3	1,715
Condo	1.6	411
Institutional	75.9	1,290
Industrial	349.4	52,765
Commercial	22.4	2,661
Residential Other	129.0	387
Other	23.2	7,091

The analysis calculated the ratio of total combined annual onsite energy demand (combined natural gas and electric kWh) to the maximum potential rooftop solar annual output supply (annual total kWh output) for each of the single-family parcels within the project site for which complete energy supply and demand data were available. As Figure 11 shows, immediate ZNE potential is given by the green horizontal line, which depicts a supply-to-demand ratio of one. For this use-type category in this location, there are roughly 400 properties that would have sufficient on-site rooftop PV generation capacity to meet their combined energy demand without some sort of demand reduction or external energy generation support.

Figure 11: AEC Project Site Single-Family Residential Parcel Current Net-Zero-Energy Potential

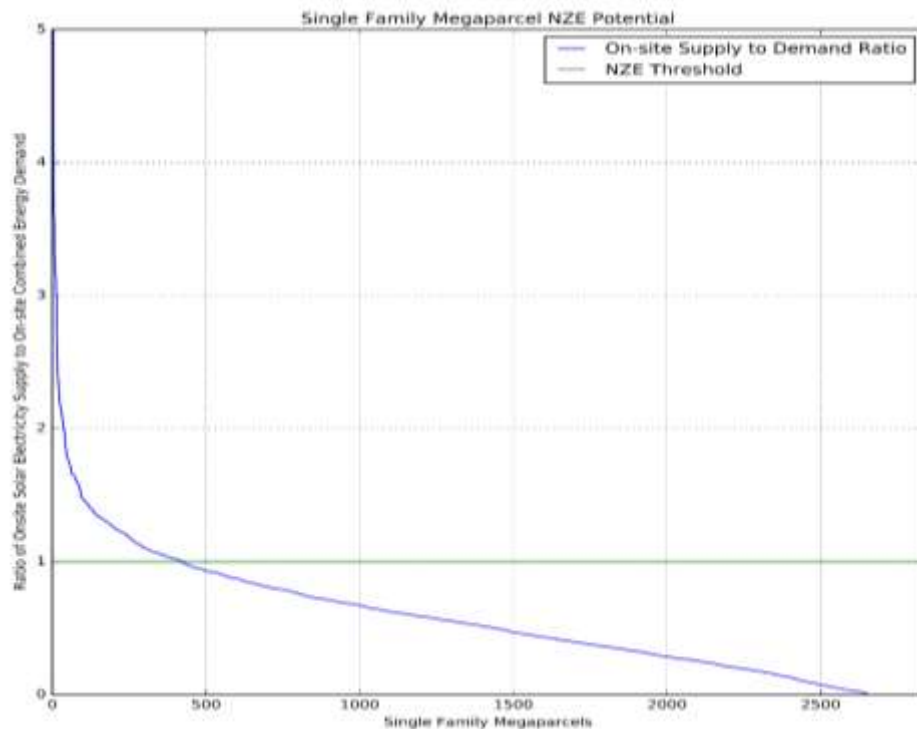
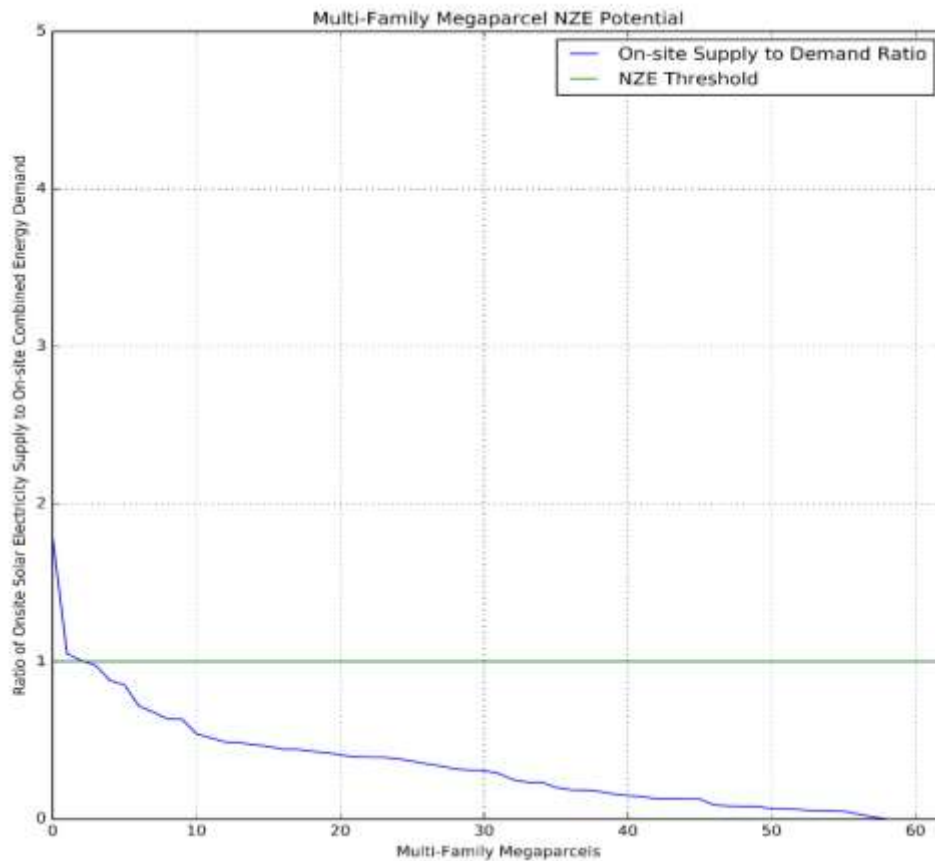


Figure 12 depicts the ratio of total combined annual onsite energy demand (combined natural gas and electric kWh) to the maximum potential rooftop solar annual output supply (annual total kWh output) for each of the multifamily parcels within the project site for which complete energy supply and demand data were available. As this figure shows, immediate ZNE potential is given by the green horizontal line, which depicts a supply-to-demand ratio of one. For this use-type category in this location, only three properties would be expected to have sufficient on-site rooftop PV generation capacity to meet their combined energy demand without some sort of demand reduction or external energy generation support.

Figure 12: AEC Project Site Multifamily Residential Parcel Current Net-Zero-Energy Potential



Canopy Structure Solar Capacity Potential Analysis

As part of the design of a community solar installation, the UCLA team investigated potential sites for the location of solar PV that go beyond rooftops, to include canopy structure solar installation on existing paved parking lots. These structures shade the parking spaces while producing significant quantities of electricity. For many sites, the amount of suitable parking lot area for canopy-mounted solar PV can exceed the total available rooftop area suitable for solar.

Because these parking lot canopy structures do not yet exist, however, the process of evaluating their capacity potential is more challenging than associated with evaluating rooftop capacity potential. Suitable parking lot areas must be manually delineated on a site-by-site basis. Due to the increased amount of effort required, the team developed canopy structure solar capacity potential estimates only for the set of large publicly owned properties within or adjacent to the proposed AEC site that are believed to be potential hosts to community solar installations. Some examples of sites in which this type of canopy structure capacity potential have already been evaluated include local public schools, airfields, and parks. In all cases, a standard assumption of a 10 watts/square foot (ft²) nameplate energy density was used for the solar PV panels.

An example of analysis results is shown in Figure 13.

Figure 13: AEC Project Site Potential Public School Solar Canopy Map



The map is a zoom inset focusing on three public school locations within the AEC project site. School land parcels are outlined in yellow, and the manually delineated canopy solar PV sites are shown as orange-shaded polygons. The design and location of these potential canopy structure sites required the UCLA team to study the detailed satellite imagery for each site and make case-by-case judgment calls about the suitability and extent of the parking lots available for this type of application.

Selection of Community-Scale Technologies

The following sections describe the selection process and major results of the community-scale technologies assessment. Details are contained in the project deliverable *Selection of Community-Scale Technologies Report*.²⁶

Selection Process

The process of selecting renewable energy generation and storage technologies for use in the AEC design proceeded according to the following steps. Although this process was used to select technologies for the AEC pilot site in Bassett and Avocado Heights, it has been described in a way that allows replication and application to other sites throughout the state.

First, in each case, the full suite of available technological options is summarized and compared. Following these summaries, specific high-level issues related to the technical feasibility associated with implementing each technology within the designated AEC project site are highlighted as a first-order filter. Next, the suite of services that can be separately provided

²⁶ Fournier, Eric, Felicia, Federico, Stephanie, Pincetl. 2017. *Using Data-Driven Approaches to Design Advanced Energy Communities: Selection of Community Scale Technologies Report* at: <https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/>

by generation and storage technologies is discussed with a view toward understanding how the services map to the specific needs of the target AEC members.

Once the technological options have been introduced and the related potential service benefits discussed, a case is made for the choice of a specific technological option. This argument includes details around the specific proposed implementation model of the project. Following this discussion, analyses of high-level cost and performance trends involving the selected technology are introduced. These analyses attempt to gauge the extent of market changes that are likely to take place throughout the implementation time horizon of the project.

The final components are discussions of leading component vendors and system integrators working within the designated technology space and with expertise completing projects of the requisite scale in same geographic region as that of the proposed AEC project site.

Selection Results

Renewable Energy Generation Assets

The generation technology selected for this AEC design is solar photovoltaics (PV). Solar PV technologies have matured significantly in terms of cost and performance efficiency over the past several years and have low life-cycle environmental impacts. Solar PV systems are well-suited to the project site area due to the high levels of incident solar radiation experienced throughout the year because of the latitude and local climactic conditions of the area. The system components also have excellent stability and durability characteristics, with no moving parts and minimal maintenance requirements, offering an excellent life-cycle value proposition with low risks of potential safety issues resulting from component failures. These stability characteristics combined with the associated ability for distributed, modular siting make them especially well-suited to implementing within the target AEC project site, a densely urbanized existing community.

Energy Storage Assets

The storage technology selected for this AEC design is chemical battery storage systems. The battery cell chemistries will be selected to optimize performance relative to the service needs of the target community. For long-duration, high depth of discharge storage applications, battery systems with traditionally lower-cost, sealed lead-acid battery chemistries will be deployed. Conversely, for shorter-duration, shallower depth of discharge storage applications, newer, higher-performance, but costlier lithium-ion battery chemistries will be deployed. Battery energy storage systems can be used in similarly modular ways as solar PV systems. While the colocation of storage and generation assets has several advantages that will be leveraged as part of the implementation model, there are also other interesting opportunities for the deployment of independent battery storage systems to provide specific target services to particularly vulnerable or high-value properties within the community. An example of such an application might be the development of a community emergency response center with dedicated battery energy storage systems capable of supplying several hours or days of uninterrupted power supply.

System Integration

Within the context of both generation and storage technologies, the team's research has indicated that the markets for solar PV and battery storage system components are becoming increasingly commodified, meaning that the price and performance differentiation among different component vendors' product offerings are negligible. As such, the team has identified the growing importance of the role of system integrators in bringing in the lowest-cost, highest-performance generation and storage system installations.

Building and DER Modeling

The following sections describe the selection process and major results of the building and distributed energy resources (DER) modeling. Details are contained in the project deliverable Master Community Design Report at this link: <https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/>.

Overview of Modeling Tools

EnergyPlus and Homer Energy software applications were used to generate a range of design configurations for evaluation.

EnergyPlus

EnergyPlus is an open-source and cross-platform software application that models the hourly energy consumption profiles of buildings. The software application is funded by the U.S. Department of Energy's Building Technologies Office and is based on key end uses such as heating, HVAC, lighting and plug-loads. Given that the monthly energy consumption data from the atlas were aggregated due to privacy constraints, the project team used EnergyPlus to generate hourly energy demand for each building in the Avocado Heights/Bassett project site.

As the project progresses to a more advanced implementation stage, the project team envisions that participating customers will authorize the project team to access their hourly Green Button data. Green Button is a utility option that allows customers to access their own energy data. At that point, the modeling will transition from EnergyPlus' modeled hour consumption profile to hourly Green Button data.

Homer Energy

Homer Energy is a microgrid design software application developed by the U.S. National Renewable Energy Laboratory. This software models various mixes of the grid and distributed energy resources to meet a community's energy needs. Homer Energy performs three principal functions: simulation, optimization, and sensitivity analysis.

The project team used Homer Energy to generate a range of design configurations based on varying project constraints and requirements. The simulated design configurations (mixes of energy resources, costing, GHG emission, autonomy hours, cash flow, resource dispatch schedule, inflation rate, energy escalation rate, and grid reliability levels) allowed the project team to evaluate various what-if scenarios.

Scope of AEC Community

Table 6 shows following target number of residential and institutional participants selected by the team to comprise the scope of the AEC community and served by the project design:

- 411 single-family homes
- 19 multifamily sites
- 6 primary schools
- 1 secondary school

Table 6: Size and Composition of Participating Buildings

Customer Class	# of buildings in Pilot Area	Sqft. area per site(ft ²)	Pilot participation %	# of pilot project buildings	Total Annual Energy per participating customer class
Residential multi family	94	2905	20%	19	964 GWhr
Residential single family	4110	1441	10%	410	9776 GWhr
Primary school	6	43718	100%	6	4250 GWhr
Secondary school	1	124222	100%	1	2488 GWhr

Modeling Scenarios

The project team modeled the following scenarios for the target community to assess design feasibility with respect to various levels of GHG emissions reduction.

Baseline

The baseline scenario refers to “business as usual” in which the community participants purchase electricity and gas from their serving utilities, Southern California Edison (SCE) and Southern California Gas (SoCalGas). In this scenario, energy consumption increases steadily over the 25-year planning period. The community faces continuing uncertainty about rising energy costs, does not reduce its GHG footprint, and is prone to reduced energy grid reliability and resiliency.

Zero Carbon

To evaluate the full spectrum of possible approaches to an AEC community, the team evaluated the feasibility of a zero-carbon approach, which would represent the ultimate goal of California’s GHG emissions reduction goals. The zero-carbon (ZC) approach would achieve zero GHG emissions through the construction of a microgrid and the electrification of all natural gas appliances and equipment in participating homes/buildings.

Some of the specific problems with the ZC approach include the following:

- Insufficient suitable space exists on currently identified participating sites to construct a community renewable energy and storage system large enough to satisfy the community's total energy demand. The required output of such a community system would almost certainly exceed SCE's 15 percent penetration limit under Rule 21.
- Electrification of natural gas appliances and systems is logistically and financially infeasible to achieve broad customer adoption.
- Installing a community microgrid is cost-prohibitive, as well as technically and legally infeasible.
- AEC participants would be affected by net utility bill increases to pay for the costs of the project.

Zero-Net Energy

The next scenario analyzed an approach focusing on offsetting energy use, both electric and natural gas, through renewable energy generation, without reducing all associated GHG emissions. The zero-net-energy (ZNE) approach does not require full electrification of all non-electricity end uses but does require a significant additional capacity of local renewable generation to offset all the electricity and natural gas consumption in the entire community.

Offsetting all of the electricity and natural gas consumption poses several significant challenges, such as the following:

- Insufficient suitable space exists on currently identified participating sites to construct a community renewable energy and storage system large enough to satisfy the community's total energy demand, and the required output of such a community system may exceed SCE's 15 percent penetration limit under Rule 21.
- Replacing cheaper natural gas with more expensive, locally generated renewable electricity is not as cost-effective as a market-based solution.
- VNEM across fuel types is infeasible based on current regulatory rules and policies.
- Participants in the AEC project area would be required to pay for natural gas offsets in the form of solar electric over-generation that they will not actually consume, while still paying for the natural gas they do consume.

Zero-Net Electricity (The Selected Approach)

Due to the current infeasibility of the ZC and ZNE approaches, the final modeling scenario, zero net electricity (ZNElec), focused on the most feasible approach to reduce energy and GHG emissions. In the ZNElec approach, 100 percent of electricity demand is offset through a community renewable energy system that is sized to equal participants' total annual electricity usage, along with comprehensive IDS retrofits at participating properties.

ZNElec Design Elements

- Implementation of a community renewable energy system that generates sufficient electricity to offset all participating community electricity demand
- Installation of IDSM retrofits at all participating customer sites
- Ensuring that the amount of renewable electricity produced by the project during a 25-year project life equals the total amount of electricity demand over the same period
- An on-bill repayment structure to repay the cost of IDSM retrofits
- Participants realizing shared economic benefits of the community renewable energy system as if those assets were on their own site, regardless of rental or ownership status of the building, through virtual net energy metering (VNEM)
- Participants receiving 100% renewable electricity
- Renewable generation allocated equitably to all participants by the load-serving entity (LSE)

ZNElec Design Assumptions

- Requires a comprehensive IDSM retrofit program
- Requires a sufficient number of community members and BUSD to enroll
- Assumes that the County of Los Angeles or BUSD or both provide sites for the construction/installation of community solar and storage
- Assumes Clean Power Alliance of Southern California (CPASC) is the LSE

ZNElec Design Impacts

- 100 percent renewable electricity provided
- 64 percent GHG offset
- 47 percent total energy offset
- Community renewable energy system size of 5.872 MW

Modeling Scenario Comparison

Tables 7, 8, and 9 show comparisons of the results for the modeling scenarios.

Table 7: Energy and Environmental Impact per Design Approach

Case	Electric Consumption Over 25 Years (TWh)	Electric Consumption Change from Baseline (%)	Natural Gas Consumption Over 25 Years (TWh)	Natural Gas Consumption Change from Baseline (%)	Community Renewable Energy Generated Over 25 Years (TWh)	Average GHG Emission Per Year (kg)	GHG Emissions Reduction from Baseline (%)
ZNE	212.68	-20%	144.67	-24%	357	198,665	-95%
ZNElec	212.68	-20%	144.67	-24%	213	1,532,109	-64%

Table 8: Design Approach Financial Impact per Design Approach

Case	Initial Capital Cost to Developer (NPC \$)	Total 25yr Revenue to Developer (NPV \$)	Net Value over 25 Years to Developer (NPV \$)	Total 25 yr Baseline Expenditures to Customer (NPC \$)	Total 25 yr Post AEC Expenditures to Customer (NPC \$)	Net Present Cost Red. to Customers %
ZNE	\$34.55M	\$38.00M	\$3.45M	\$73.22M	\$48.26M	34%
ZNElec	\$26.21M	\$32.93M	\$6.71M	\$73.22M	\$43.18M	41%

Table 9: System Specifications and Economic Benefits per Design Approach

Design Scenario	Total Solar (kW)	Total Storage (kWh)	Hours of Dispatchable Electricity	Initial Capital Cost NPC (\$Million)	NPV of Net Project Benefits to Developer NPV (\$Million)	NPV of Net Project Benefits to Customer NPV (\$Million)
Zero Net Energy (ZNE)	9,906	3,157	2.96	\$34.55	\$3.45	\$24.96
Zero Net Electricity (ZNElec)	5,872	4,676	5.73	\$26.21	\$6.71	\$30.03

CHAPTER 6:

Master Community Design

Design Overview

The selected design for the Avocado Heights/Bassett AEC provides locally generated, GHG-free electricity from community solar and storage to offset electricity consumption of participants who “opt in” to the AEC through an enrollment system. It also enables participants to benefit from savings resulting from various onsite integrated demand side management (IDSM) actions, including energy efficiency retrofits, demand response actions, and access to intuitive energy management system tools and resources.

The pilot community solar system is a 5.872 MW system designed to serve about 410 single-family homes, 19 multifamily properties, and 7 schools. AEC participants will benefit from deep energy efficiency retrofits to their occupied buildings, resulting in more comfortable living spaces, more productive working environments, increased building energy performance, and other shared community benefits.

In addition to the community solar and storage assets, the proposed project buildout will incorporate strategically located EV charging infrastructure that can be accessed by AEC project participants and be available to the entire Avocado Heights/Bassett community. The EV charging stations will be integrated into the solar and battery storage installations, as well as being sited at other strategic locations. The project also proposes to design and incorporate a community EV car share program in conjunction with the EV charging stations that will be made available to qualified AEC project participants and others in the community. The EV car share program will reduce the need for individual vehicle ownership, expand access to affordable zero-emission-vehicle services, and greatly enhance mobility resources/options within the project area.

The estimated total project cost is \$26 million. The AEC design assumes that the Clean Power Alliance of Southern California (CPASC) will sponsor the community solar and storage project and be responsible for the construction and operation. A third-party contractor, managed by either the CPASC or the County of Los Angeles, will implement the energy efficiency upgrade (IDSM) components of the project.

Combined with IDSM measures, the project will reduce electricity consumption by 21 percent and GHG emissions by 64 percent during a 25-year period.

Community Solar and Storage System

The AEC design will pilot implementing a community solar and storage system, and an advanced energy system, using a shared renewable energy power system integrating solar PV with battery storage and energy management systems provides electricity shared by many buildings. Through a process called *virtual net energy metering* (VNEM), members of the AEC

community are able to share the benefits of local renewable power even if they cannot or prefer not to install solar panels and/or an energy storage system on their own property. Participants who opt-in through an enrollment process share the benefits of 100 percent renewable electricity and lower energy costs with other AEC enrollees.

The community solar and storage system tracks the overall production and distribution of energy by using smart load management, optimizing customer load through demand response programs to help balance grid needs, and providing customer-site energy management resources through access to an intuitive energy management system (EMS).

IDER Technology Assumptions

Table 10 summarizes the AEC system design requirements at an estimated construction cost of \$26.2 million.

Table 10: AEC System Design

Design Scenario	Total Solar (kW)	Total Storage (kWh)	Hours of Dispatchable Electricity	Initial Capital Cost (\$)	NPV of Project Benefits (Baseline Energy Cost - Initial Capital)
AEC Design	5,872	4,676	5.73	\$26.21M	\$30.03M

The technology used in the system includes PV panels, inverters that connect the solar system to the SCE distribution system, batteries for storage and dispatch of electricity to the distribution grid. The system also includes intelligent energy management systems that can sell excess energy to the grid wholesale markets, and depending on the final design, electric vehicle charging stations combined with a community EV car-sharing program. Technology design assumptions are shown in Table 11.

Table 11: IDER Technology Assumptions for Community Solar and Storage

PV Panel	Efficiency = 20.3 percent or better Power Temperature Coefficient = -0.35 Annual Degradation = -0.4 percent per year Lifetime = 25 years Cost = \$2.14k per kW for rooftop and \$3.6K per kW for canopies
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Inverter	<p>Type = String smart inverter allowing islanding of customer premise in case of grid outage</p> <p>Lifetime = 15 years</p> <p>Efficiency = 98 percent</p> <p>Cost = \$300/kW</p>
Battery	<p>Depth of Discharge w/o degradation = 100 percent</p> <p>Lifetime = 3,000 cycle</p> <p>Cost = \$370 per kWh</p> <p>Round trip efficiency = 85 percent</p> <p>Smart charging where the charge rate depends on the available capacity of the local grid</p>
EV	<p>Community EV charging infrastructure incorporating smart charging</p> <p>Charge rate depends on the available capacity of the local grid</p> <p>Allow compatible EVs to supply energy to compatible buildings during grid outages</p>
Community Energy Management System	<p>Continuously balancing local energy production with energy demand of selected site; buy additional energy from grid if local supply insufficient</p> <p>Downloadable software application to track and manage energy use</p> <p>Sell excess energy to the grid in ancillary wholesale markets (if there are excess local supplies)</p> <p>Coordinate with SCE's local grid operation to maximize local distribution efficiency and reliability</p>

IDER Site Assumptions and Selection

The assumptions related to site selection are as follows:

- Located within SCE service area
- Located on County of Los Angeles (1st district) owned sites in unincorporated areas or BUSD campuses or both
- Within proximity of an electric grid substation

Figures 14 and 15 show examples of mapping conducted to assess the potential for various county-owned parcels to accommodate the required generation capacity and to interconnect to the grid.

Figure 14: AEC Community Solar Potential Focus



Figure 15: AEC Project Site Grid Capacity Focus



IDSM – Energy Efficiency Upgrades

The AEC design incorporates deep energy efficiency upgrades of participating buildings at no upfront cost to the participant. The baseline energy usage for participants' homes will be determined in accordance with Assembly Bill 802 (Williams, Chapter 590, Statutes of 2015) methodologies (expected to be adopted by the CPUC in 2018). Pre-and post-retrofit financial models will identify estimated costs and savings to potential participants.

Table 12 summarizes the presumed retrofit and energy management packages for each customer group. Each package includes the estimated cost of the retrofit, the estimated energy efficiency savings of the package, and a list of potential measure types per package. The actual measures installed will depend on the unique characteristics and conditions at each participating site.

Table 12: IDSM Retrofit Package per Building Type

IDSM Retrofit and Energy Management Package per Residential SF	Retrofit <ul style="list-style-type: none"> • Estimated Cost = \$12,764 per site • Estimated energy efficiency saving = 25 percent • Measures <ul style="list-style-type: none"> ○ Home energy management system ○ Smart programmable, connected, and DR-enabled thermostat ○ High efficiency water heater ○ Pool pump (if applicable) ○ Smart power strips
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	<ul style="list-style-type: none"> ○ Duct insulation & sealing or replacement with insulation ○ High efficiency and DR-enabled heat pump HVAC system ○ Low-flow shower heads and kitchen faucet ○ Smart Internet-connected sprinkler controller (if applicable) ○ Referrals to incentives for appliance replacement, windows, and other energy-saving opportunities <p>Energy Management</p> <ul style="list-style-type: none"> • Deploy in each participating household • Connecting customer home to a secured cloud-based AEC service portal • Connection between customer home and AEC service provider to enable tailored energy services for each customer • Cloud-based • Community connected • DR enabled • Home energy gateway • Engage customers on customer's smartphone or smartTV • Track customer responses with customer energy consumption
<p>IDS_M Retrofit Package per Residential MF</p>	<p>Retrofit</p> <ul style="list-style-type: none"> • Estimated Cost = \$27,417 per site • Estimated energy efficiency saving = 25 percent • Measures <ul style="list-style-type: none"> ○ Home energy management system ○ Smart programmable, connected, and DR-enabled thermostat ○ High efficiency water heater ○ Pool pumps (if applicable) ○ Smart power strips ○ Duct insulation & sealing or replacement with insulation ○ High efficiency and DR-enabled heat pump HVAC system ○ Low-flow shower heads and kitchen faucet ○ Smart Internet-connected sprinkler controller

	<ul style="list-style-type: none"> ○ Referrals to incentives for appliance replacement, windows, and other energy-saving opportunities
	<p>Energy Management</p> <ul style="list-style-type: none"> • Deploy in each participating household • Cloud-based • Personal information device connected • Community connected • Behavior driven • DR enabled • Home energy gateway • Engage customers on customer's smartphone or smartTV • Track customer responses with customer energy consumptions
IDSM Retrofit Package per Primary School	<p>Retrofit</p> <ul style="list-style-type: none"> • Estimated Cost = \$213,679 • Estimated energy efficiency saving = 15 percent • Measures <ul style="list-style-type: none"> ○ Campus energy management system ○ Lighting & occupancy sensors linked to HVAC and lighting ○ Interior LED lighting ○ Campus retrocommissioning including water audits
	<p>Energy Management</p> <ul style="list-style-type: none"> • Deploy in each participating school • Cloud-based • Personal information device connected • Community connected • Behavior driven • DR enabled • Building energy gateway
IDSM Retrofit Package per Secondary School	<p>Retrofit</p> <ul style="list-style-type: none"> • Estimated Cost = \$391,437 • Estimated energy efficiency saving = 15 percent • Measures <ul style="list-style-type: none"> ○ Campus energy management system ○ Lighting & occupancy sensors linked to HVAC and lighting

	<ul style="list-style-type: none"> ○ Interior LED lighting ○ Campus retrocommissioning including water audits
	<p>Energy Management</p> <ul style="list-style-type: none"> • Deploy in each participating school • Cloud-based • Personal information device connected • Community connected • Behavior driven • DR enabled • Building energy gateway

EV Infrastructure and Community Rideshare

Many disadvantaged communities in California are severely affected by air pollution, limited mobility, and the high costs of vehicle ownership. The Avocado Heights/Bassett community is no exception. Providing AEC participants with access to zero-emission transportation options is an important step toward addressing these challenges.

The AEC design proposes to install EV infrastructure as part of implementing the community solar and storage systems at designated public sites that will serve as the locations for EV charging sites. A detailed design of the EV charging infrastructure will be completed in conjunction with Phase II of the grant, however the current AEC design already assumes increased EV vehicle use by AEC participants as part of electricity demand estimates.

The design also includes a proposed community EV ridesharing (CEVR) program that would be available to AEC participants. It would be a new and convenient way for AEC participants to access zero-emission cars and electric bikes, as needed, to go to work, run errands, go to appointments, and attend meetings.

The CEVR concept being explored anticipates a partnership with rental car agencies and car dealers that would donate or greatly discount pricing for used EV vehicles that could be used in the program. The donated or discounted EV vehicles would be made available to CEVR drivers, working through established ridesharing companies, who would provide the service to AEC participants. The CEVR design would include a mobile app for AEC participants, linked to existing rideshare apps, to register for and access the zero-emission rideshare services. In addition to EV cars, an electric bike share or an electric bike rebate program or both would be made available to AEC participants.

The installed EV charging sites would be made available to the public in addition to supporting the CEVR program. The number of EV charging stations at each site will depend on the number of AEC participants, CEVR drivers, and expected energy consumption. Estimates on the need for EV chargers will account for community growth and increased use of the CEVR service. After

initial start-up and testing, the project team envisions that the CEVR program could be expanded to include other eligible community residents.

Since the AEC must maintain ZNElec status with the EV chargers, a fee structure should be developed to ensure that the CEVR is economically sustainable and the community solar and storage systems can still meet the needs of the AEC. The project team anticipates that the AEC participants and CEVR drivers could receive discounted or free charging while the public would pay for charging.

When combined with the other benefits for AEC participation, including community solar and storage, energy efficiency upgrades, and smart energy management systems, the EV charging sites and CEVR offer additional and significant other shared benefits in the form of reduced air emissions, greater mobility, reduced costs of vehicle ownership, and support for local green jobs and businesses.

The opportunity to incorporate an EV charging infrastructure and a car/bike sharing program was identified later in the AEC design process in conjunction with the county's efforts to construct additional EV charging stations. Detailed plans for the proposed design will be included in the Phase II proposal. As a result, the AEC team will conduct additional outreach on the community car/bike share project at the start of the implementation process to solicit feedback from the community on how to best structure such a program.

AEC Participants

Participants in the AEC include a targeted number of single-family and multifamily households and the Bassett Unified School District. Participants will opt-in to the AEC through an enrollment process to receive benefits from the various onsite integrated demand-side management (IDSMD) measures and community solar and storage measures. Successful implementation of the project will require a robust community education and engagement campaign to promote and acquire membership in the AEC. A comprehensive engagement strategy for the Avocado Heights/Bassett community has been designed and implemented as part of the project.

In exchange for no upfront costs for participating in the AEC, participants must:

- Enroll in the AEC.
- Be SCE/SoCalGas ratepayers in the pilot area.
- Install energy efficiency retrofits.
- Participate in evaluations/audits.
- Agree not to opt out of CPASC for the duration of the project period.

The projected type and number of participating buildings and participants per customer class are summarized in Table 13.

Table 13: Size and Composition of Participating Buildings

Customer Class	# of buildings in Pilot Area	Sqft. area per site(ft^2)	Pilot participation %	# of pilot project buildings	Total Annual Energy per participating customer class
Residential multi family	94	2905	20%	19	964 GWhr
Residential single family	4110	1441	10%	410	9776 GWhr
Primary school	6	43718	100%	6	4250 GWhr
Secondary school	1	124222	100%	1	2488 GWhr

Residential

Table 14 provides an overview of the type, cost, and impact of proposed single-family and multifamily retrofit packages.

Table 14: Single-Family and Multifamily Retrofit Package Overview

Typical residential/multi-family offering	Expenditure SF (\$)	Expenditure MF (\$)	Estimated EE gain
Home energy management	164	367	25%
DR enables smart programmable thermostat	400	1,200	
High eff. Water storage heater	1,800	3,600	
Smart power strips	500	1,500	
Wall & Attic insulation	3,700	5,750	
Duct insulation & sealing or replacement with insulation	2,500	6,000	
High eff. HVAC system	3,700	9,000	
Total Cost	\$12,764	\$27,417	

Institutional

Table 15 includes the type, cost, and effect of the retrofit package offerings proposed for BUSD.

Table 15: Bassett Unified School District Retrofit Package

Typical school district offering	Expenditure (\$) per Primary School Campus	Expenditure (\$) per Secondary School Campus	Estimated EE gain per campus
Campus & classroom energy management system	50,000	65,000	16%
Lighting & occupancy sensor linked to HVAC control	25,000	55,000	
Smart power strips	8,000	10,000	
LED lighting interior	55,000	90,000	
Retro-commissioning entire campus	75,679	171,437	
Total Cost	\$213,679	\$391,437	

Project Cost

The proposed AEC design initial construction costs are estimated at \$26.2 million, with a net present value (NPV) of total energy expenditures of \$43.1 million. The net present value of total energy expenditures in the baseline community is \$73.2 million. The NPV of the total expenditure reduction benefits by the AEC community is estimated at \$30 million. Table 16 summarizes the project costs and benefits.

Project implementation will include developing design and construction documents, permitting, interconnection requirements and fees, construction and installation costs of solar, and storage systems, program administration, financial incentives, and implementation costs for energy efficiency retrofits.

Table 16: AEC Design Project Cost

Design Scenario	Total Solar (kW)	Total Storage (kWh)	Hours of Autonomy	Initial Capital (\$)	NPV of Project Benefits (\$)
AEC Design	5,872	4,676	5.73	\$26,213,995	\$30,034,821

Energy/GHG Reduction Estimates

Tables 17, 18, and 19 summarize the energy and GHG emissions reductions associated with the AEC design, based on a zero-net-electricity approach. Results show a 64 percent reduction in GHG emissions over 25 years over current baseline. The capital cost of this design is \$26 million, with an NPV of total energy expenditures of \$43 million.

This design case has the lowest initial capital requirement and generates more than 60 percent reduction in GHG emissions. It is feasible from a regulatory and market perspective and represents the best current approach for the AEC design.

Table 17: Energy and GHG Emissions Data – Zero-Net Electricity

Zero Net Electricity (ZNElec)	25 Year Sector Electricity (MWh)	25 Year Sector Natural Gas (MWh)	% Energy Savings from Baseline (%)	25 Year Sector GHG Total Emissions (kg)	25 Year Emissions Reduction (%)
Single Family	83.62	112.49	25%	27,821,823	54%
Multifamily	6.86	11.23	25%	2,766,552	51%
Primary School	76.42	13.62	15%	4,894,847	80%
Secondary School	45.56	7.32	15%	(251,316)	102%
Total Community	212.68	144.67	21%	35,231,906	64%
Savings from Baseline	51,655	44,939	21%	70,026,364	n/a
Savings % from Baseline	20%	24%	21%	64%	n/a

Table 18: Environmental Impact – Zero-Net Electricity

Case	Electric Consumption Over 25 Years (TWh)	Electric Consumption Change from Baseline (%)	Natural Gas Consumption Over 25 Years (TWh)	Natural Gas Consumption Change from Baseline (%)	Renewable Energy Generated Over 25 Years (TWh)	Average GHG Emission Per Year (kg)	Emissions Reduction from Baseline (%)
ZNElec	212.68	-20%	144.67	-24%	213	1,532,109	-64%

Table 19: Financial Impact – Zero-Net Electricity

Case	Initial Capital Cost to Developer (NPC \$)	Total 25yr Revenue to Developer (NPV \$)	Net Value over 25 Years to Developer (NPV \$)	Total 25 yr Baseline Expenditures to Customer (NPC \$)	Total 25 yr Post AEC Expenditures to Customer (NPC \$)	Net Present Cost Red. to Customers %
ZNElec	\$26.21M	\$32.93M	\$6.71M	\$73.22M	\$43.18M	41%

Project Benefits

Based on the evaluation criteria that support the Energy Commission programmatic guidance and the goals of EPIC, the proposed AEC will offer numerous benefits to the community, participating residents, the school district, CPASC, and Los Angeles County. Benefits will be tracked and measured to evaluate the progress and positive effect of the AEC.

While many of the benefits listed below, such as reduced energy/GHG emissions and improved air quality, have obvious links to the proposed design, benefits related to reliability and resiliency may be less evident; therefore, additional discussion is provided here. The proposed AEC project design will support greater reliability and resiliency for AEC participants from numerous benefits that the project provides to the SCE distribution grid in the AEC project area. These benefits also include the new dispatchable energy storage resources available to California Independent System Operator (California ISO) from the project for increased statewide electricity grid stability. The final selected locations for the community solar and storage assets are determined as much as possible by identifying weak points or constrained areas within the SCE electricity distribution system.

The AEC project will improve the overall reliability and resiliency of SCE's distribution system. In addition, the AEC implementation design will evaluate the feasibility of installing satellite solar and energy storage systems at private sites within the participating community (including school sites) that can strengthen the reliability and resiliency of the electricity distribution services provided by SCE. Finally, a component of the final implementation design will be evaluating the feasibility of creating a powered emergency center(s) at school campus site(s) using solar and storage to benefit the community in the event of natural disasters and/or power outages.

The following are the specific benefits to each stakeholder group:

Community Benefits

- Provide more affordable energy in residential and public buildings
- Provide community with higher performing buildings and renewable energy
- Provide energy cost savings through implementing deep energy retrofits, including building weatherization and energy efficiency upgrades
- Expand the availability of EV charging stations in the community and create affordable and convenient access to EV vehicle usage through a community EV car sharing program
- Support local clean energy jobs and a green workforce

Participating Resident Benefits

- Realize more affordable energy
- Achieve higher-performing homes through IDSM upgrades, including weatherization and energy efficiency upgrades
- Achieve improved home comfort and indoor air quality
- Realize potential for increased resiliency in an emergency outage
- Offer prospective participants no upfront costs to participate
- Contribute to shared community benefits

School District Benefits

- Serve as a regional leader by demonstrating best practices for energy reduction
- Achieve significant energy cost savings
- Provide a more comfortable and productive learning environment
- Foster partnerships within the community
- Assist in leveraging Proposition 39 funds, which have been allocated to support schools with energy efficiency and energy generation projects
- Provide potential for increased resiliency and community refuge in the event of an emergency outage

County of Los Angeles Benefits

- Serve as a regional leader by demonstrating best practices for ZNE and disadvantaged community support
- Leverage the AEC as a catalyst for market innovation and local economic growth
- Alleviate local energy grid constraints
- Foster partnerships within the community
- Assist in meeting future climate action plan targets

Los Angeles Community Choice Energy Authority Benefits

- Fulfill its vision to create significantly more renewable local power resources
- Support access to clean power for members of disadvantaged communities within its service area
- Create a wide range of locally tailored customer programs, including energy efficiency and distributed energy resources
- Support local workforce training and development by building and operating a local renewable energy generation facility
- Create a new source for sustainable local jobs

Implementation Considerations

Several prerequisites must be satisfied for successful implementation of the AEC Design. These include:

1. **Approval of sites for the solar and storage systems.** The team is assessing feasible county owned properties located within the AEC project area for siting community solar. Upon final selection, Los Angeles County will need to secure approval for these sites.

Furthermore, the Bassett Unified School District will need to provide final approval for installing community solar on its properties. The team is working with BUSD on a feasibility assessment.

2. **CPASC approval to act as the load-serving entity.** The CPASC anticipates the delivery of retail electricity to begin in the first quarter of 2018. Discussions with the CPASC related to the AEC project proposal will occur over the next three months.
3. **CPASC approval of a virtual net energy metering (VNEM) tariff.** The AEC design assumes that CPASC will implement a VNEM tariff to enable shared economic benefits for participants from the community solar and storage facility. While there is no CPUC regulatory authority to implement the proposed virtual net energy metering rate by IOU's, the CPASC has the authority to create and administer its own VNEM tariff.

CHAPTER 7:

Project Financing and Business Plan

Overview

The financing plan encompasses funding strategies for the two major stakeholders in the participating Avocado Heights/Bassett AEC community, Clean Power Alliance of Southern California (CPASC), and the participating residents. Discussions with CPASC to clarify and finalize the details of their participation during AEC project implementation are underway. The local community participants and CPASC will retain the project financial benefits (Table 20).

The next sections provide a summary of the project financing. Details are included in the project deliverable *Financing Plan Report* at this link: <https://www.ioes.ucla.edu/project/the-epic-challenge-accelerating-the-deployment-of-advanced-energy-communities/>.

Table 20: Stakeholders and Financing Attributes

Asset	Financing Source	Amortization Strategy	Initial Owner	Final Owner	Seller of Retail Electricity	Consumer	Beneficiary
Community Solar and Storage	Public revenue bonds or PPA	Sales to AEC participants through VNEM	CPASC or PPA developer	CPASC	CPASC	Participant + CAISO	CPASC and participants
Individual Site Solar and/or Storage	Non-AEC financing	NA	NA	NA	NA	NA	NA
EE Retrofits	3 rd party private finance and/or PACE	On-bill repayment	AEC participant	AEC participant	NA	NA	AEC participants and private lender

Community Solar and Storage

In the proposed AEC design, CPASC acts as the project sponsor for the community solar and storage. The alliance will procure a specified amount of local solar photovoltaic and stationary electric storage to meet the needs of the AEC participants. A combination of unincorporated County of Los Angeles and Bassett Unified School District parcels located within or near the

AEC project area will be designated. All the output from community solar system will be measured and allocated to the AEC participants under the VNEM tariff.

The two most feasible financing strategies for CPASC to procure the community solar and storage assets are either a revenue bond or a power purchase agreement (PPA). In either case, the project will participate in the California ISO market.

Both the solar arrays and the battery storage systems (with more than a five-hour reserve of dispatchable storage) will be designed so CPASC can participate in the daily California ISO markets and pass through these net benefits to participants as a part of their VNEM tariff.

California ISO provides open and nondiscriminatory access to the transmission grid, supported by a competitive energy market for resources generating 1 megawatt or more. Depending on their resource capabilities, market participants can elect to bid into the electricity and ancillary services market or sell various other electricity products.²⁷ Distributed energy resource providers are market participants who own or operate an aggregation of distributed energy resources. Generating 1 megawatt or more enables their participation in the wholesale electricity market.

Electricity storage has the potential to provide significant flexibility in balancing the grid. The California ISO has two resource models that provide opportunities for storage technologies to participate in the wholesale electricity and ancillary services market: water pump storage and nongenerator resources (which include battery storage systems). The AEC design includes battery storage and is therefore eligible to participate in this wholesale market. Through robust design and effective real-time management of the AEC battery storage systems, CPASC will be able to generate additional revenues/incentive payments from California ISO beyond the value of the solar generation itself. These ancillary revenues will help reduce the charges that would otherwise be billed to AEC participants.

For a PPA, this step would add a new dimension to a typical agreement. With participation in the California ISO wholesale market, the solar and storage assets create additional revenue that offsets the generation charges to CPASC that would otherwise be collected by the developer. Therefore, the agreement between CPASC and the PPA developer would need to define the roles, responsibilities, and shared benefits from participating in the California ISO market. The result will be that the net payment to the PPA from CPASC, on behalf of the AEC participants, will be lower than it would otherwise be under a “solar generation without storage” project design.

²⁷ Ancillary services refer to operation beyond generation and transmission such as operating and spinning reserves to help balance the transmission system as it moves energy from generators to consumers.

Energy Efficiency Retrofits

Participant Enrollment in the AEC

To participate in the AEC, community residents must enroll in the AEC and agree to three requirements: 1) undertake energy efficiency retrofits in their house or apartment at no upfront cost, 2) receive 100 percent renewable energy from CPASC under a virtual net energy metering tariff, and 3) share ongoing data with CPASC about their energy consumption.

Single-family and multifamily participants will be offered an attractive funding strategy and streamlined implementation process as a motivation to retrofit their homes, whether rented or owned. Participants who wish to install their own on-site solar or energy storage systems will be provided with basic technical assistance and relevant information, but these systems will not be a part of the overall AEC project design or the AEC financing plan.

The AEC project build-out will require no upfront, out-of-pocket funding from participants. Participants will repay all energy efficiency retrofit work on their premises over time using their utility bill savings.

Energy efficiency retrofits will be funded through private, third-party financing that the contracted energy efficiency project implementer will secure, and the amortization of these energy efficiency retrofit costs will be recovered through an on-bill repayment (OBR) mechanism on participating customers' utility bills.

The AEC design anticipates that CPASC will contract with an implementer to manage and execute the IDSM energy efficiency retrofit components of the project. The implementer will install the appropriate energy efficiency retrofit package at participant sites and acquire and offer financing through a private third party. Alternatively, participants may opt to install the required energy efficiency measures themselves, in which case the IDSM implementer will conduct a verification inspection to confirm that the participant has in fact installed the efficiency measures. The participants will repay their energy efficiency investments from their energy bill savings through an on-bill repayment mechanism and described in the following section.

Third-Party Financing and On-Bill Repayment

The following is a summary of the steps for using private, third-party financing coupled with on-bill repayment (OBR) to finance the energy efficiency upgrades and retrofit packages. Participants may opt to use property-assessed clean energy (PACE) financing instead.

Step 1: Retrofits done at no upfront cost to participants

An energy efficiency program will be designed and launched for AEC participants to achieve a deep level of whole building retrofits that will include specified not-to-exceed costs for a package of energy efficiency measures customized for each unique participant case. The program approach includes a competitively prebid list of qualified specialty energy efficiency contractors, incorporation of innovative and effective energy management system technologies, participant education, and ongoing monitoring/tracking of AEC energy usage over time. A

third-party entity will implement this program under contract to either CPASC or the County of Los Angeles, one of whom will serve as the program administrator.

The energy efficiency retrofit program will be closely coordinated with CPASC to ensure that the AEC's projected energy efficiency savings are achieved and that an adequate amount of renewable community solar generation is deployed to obtain a zero-net-electricity result for the AEC participants.

The energy efficiency program implementer will identify and confirm the estimated total cost of AEC participant retrofits for all categories of structures: single-family, multifamily, and school district sites. The implementer will then solicit and obtain energy efficiency retrofit project funding from private financing sources that will be available to every AEC participant who undertakes energy efficiency retrofits and desires to borrow the required funds from the private lender.

Step 2: Retrofit costs paid back over time through savings on the SCE and SoCalGas utility bill

For the AEC-sponsored energy efficiency projects, the contractor will be paid from third-party lender funds (or from PACE funds) and the third-party financier will be repaid from an OBR mechanism placed on the utility bill. The OBR charge to recoup energy efficiency retrofit costs will be a separate line item on the utility bill that will be administered by CPASC. For PACE-funded retrofits, the repayment will occur according to the PACE program requirements that are administered separately by the County of Los Angeles and will not be a part of the AEC program implementer's responsibilities.

Step 3: CPASC recoups costs for community solar and storage via generation charges on bill

In addition to the energy efficiency retrofits, AEC participants will receive 100 percent renewable electricity supplied through CPASC. This component is described in the Community Solar and Storage section. Payments by participants to CPASC for renewable electricity will be embedded within the pricing of the CPASC's VNEM Generation Tariff.

Step 4: Energy efficiency retrofits owned by property owner or tenant

The property owners and tenants will own the energy efficiency improvements that are installed on the premises of AEC participants. It is also anticipated that the energy efficiency loans made by the third-party lender will be unsecured, which will be facilitated, in part, by the creation of a loan loss reserve (LLR)²⁸. Once the costs of the retrofit packages are paid back in their entirety, all financial benefits/savings from the measures will accrue to the property owner or tenant alone.

Step 5: The property owner will pay for "unsponsored" energy efficiency measures and private solar/storage installations separately

The AEC design will likely not include certain types of expensive and long-payback energy efficiency measures (new windows and doors for example) nor will it include private solar and

²⁸ A loan loss reserve is an expense set aside as an allowance for uncollected loan payments.

storage installations. However, AEC participants at their own discretion may choose to install such items on their own. In these instances, each property owner will be solely responsible for the financing and construction of such work. The AEC project will provide a basic level of technical assistance and information to participants in these cases and try to coordinate the work as best as possible with all the AEC-sponsored actions.

Financing Considerations

Each AEC participant's OBR costs are expected to be more than offset by the cost savings from reduced electricity and natural gas use on their SCE and SoCalGas bills. It must be acknowledged, however, that not all energy efficiency retrofits will realize the exact savings estimated, and that bill neutrality cannot be guaranteed for every energy efficiency retrofit, particularly when the number of occupants or the intensity of energy use by occupants, or both, in a particular home, apartment, or school building changes from the estimated baseline condition.

The retrofits are expected to result in additional benefits beyond energy savings for participants. These benefits will include improved indoor air quality and increased thermal comfort. Participants will be educated to use the required participant in-home energy monitoring effectively. The project implementer will conduct communitywide monitoring and tracking to ascertain that the projected EE savings goals are being met. It could also foster greater community connections around the built environment and the related quality.

In addition, to reduce lender risk and obtain more favorable interest rates for participants, it is anticipated that an LLR fund will also be established as a part of the AEC in the event that is necessary for the project to absorb loan defaults by AEC participants. The LLR will also make it possible for all the loans to be unsecured, expanding the potential pool of eligible AEC participants. The selected AEC project implementer will be required to follow an appropriately rigorous application and selection process for AEC participants to keep such defaults to a minimum.

CHAPTER 8:

Local Implementation Challenges and Recommendations

Overview

The Local Implementation Recommendation Report reviews applicable codes and standards and identifies opportunities and barriers for launching an advanced energy community. Three main categories of codes were identified for review based on the challenges encountered during the design process and anticipated for implementation:

1. Building energy codes
2. Distributed energy resource codes
3. Grid interconnection request standards

Building Energy Codes

Building energy codes set the minimum efficiency standards and guidelines for building retrofits, which are used in the AEC design to reduce building electricity demand. The applicable codes include the California Energy Code²⁹, CAL Green³⁰, and the Appliance Efficiency Regulations³¹. The California Energy Code dictates the energy efficiency requirements for new and renovated buildings, CAL Green lists additional sustainability requirements for buildings, and the Appliance Efficiency Regulations specify the energy efficiency for new appliances. However, since building retrofits for the AEC design will not include renovations to the building structure, these codes act more as guidelines for efficiency than requirements.

Distributed Energy Resource Codes

Distributed energy resources (DERs) include solar PV and battery storage systems. DER codes include efficiency guidelines, safety and operation requirements, and rules for installation on specific land types. The AEC design will need to comply with the requirements of the California Environmental Quality Act (CEQA), which ensures that installations mitigate potential environmental damage. However, there are existing exemptions for solar installations on buildings and parking lot canopies. In addition, solar installed on airfields will need to follow the Federal Aviation Administration's guidelines on reducing glint and glare from solar systems.

29 The California Energy Code, Title 24, Part 6

30 CAL Green, Title 24, Part 11

31 Appliance Efficiency Regulations, Title 20

Grid Interconnection Request Standards

Compliance with codes and standards surrounding the interconnection of DERs to the grid will be crucial to successfully implementing the AEC design. Regulations and procedures for grid interconnection requests are an evolving segment of energy codes. This degree of uncertainty reflects recent laws and policies to accelerate adoption and integration of DERs in California. The term *grid interconnect request* refers to the formal process of requesting the connection of an electricity generation source(s) to the electricity grid. Through this process, the utility provider or grid controller (California Independent System Operator) reviews and approves the proposed generation site and asset mix, ensuring that existing circuit lines and substations can handle any changes in the bidirectional flow of electricity. In California, the California Public Utility Commission (CPUC) regulates grid interconnection requests under Rule 21 for investor-owned utility providers (IOUs) but allows each IOU to establish its own request process and fee/tariff structure.

All solar generation systems installed for the AEC design will need to go through SCE's grid interconnection request process. This process has specific rules on the size of generation systems, where and how they are connected to the electricity grid, and how electricity will be sold. There are rules in place that limit the maximum amount of solar generation installed on a site, which present a challenge for the AEC design. This challenge includes a sizing limitation for sites that want to sell electricity under the net-energy-metering program and restrictions due to low capacity on the circuit line that the site will connect to.

Connecting distribution generation capacity to SCE's transmission system, including potentially selling electricity at SCE rates, requires interconnect request per SCE's Rule 21 process. Each applicant must complete an application that includes details of the project site, nameplate capacity, and other technical details. There are separate types of Rule 21 application forms for sites that are exporting, non-exporting, or participating in SCE's net energy metering (NEM) program.

Exporting sites are those that distribute all produced electricity onto the grid. Conversely, *non-exporting sites* consume all produced electricity on-site. Non-exporting sites also include generation sites used as backup systems in case of service blackouts from SCE. These generation sites still require a grid interconnection, as inadvertent exporting can occur when excess power is produced and cannot be consumed on site.

Net energy metering sites distribute all the electricity produced to the grid, but the owner or customers at the generation site are credited for the difference between electricity produced and consumed. SCE offers two NEM programs, NEM 1.0 and NEM 2.0. The NEM 1.0 program ended in July 2017. The primary difference between these two NEM programs is that NEM 2.0 accounts for time-of-use (TOU) electricity use when determining the net quantity of electricity consumption.

SCE also offers a virtual net-energy metering program that allows for electricity produced at a generation site credited to a specific account at a different location from the generation site. SCE offers two types of virtual net energy metering options, one for multitenant and

multimeter properties (referred to as schedule NEM-V-ST) and one for multifamily affordable solar housing (MASH-VNM). NEM-V-ST is available to owners/operators of properties with tenants or multiple meters behind the same service delivery point. This allows an owner/operator to generate electricity on site and distribute the benefits to tenants. The MASH-VNM program is available only for multifamily sites enrolled in the multifamily affordable solar housing program. This program is similar to the NEM-V structure but provides more incentives for solar installation. The MASH-VNM program is fully subscribed and not accepting applications. A newly authorized program eligible only to 100 percent deed-restricted affordable multifamily buildings (SOMAH) will also provide solar incentives and allow VNEM. SOMAH will be launched sometime in 2019.

Net energy metering programs also dictate a maximum amount of electricity generation for each site. Under the current NEM 1.0, solar must be sized to the historical energy use of the building and cannot exceed 1 MW. NEM 2.0 does not have a maximum cap on electricity generation but requires the generation capacity sized to the historical energy use of the generation sites. However, it is not clear what the maximum amount of electricity capacity is in relation to historical energy use of the sites. Government agencies have the ability to produce more electricity than the maximum allowable amount under the Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) program.³² This program allows government-owned buildings to produce electricity on-site and transfer the renewable energy credit to other government buildings.

Generation sites can submit a preapplication report to get information about surrounding substations and circuit lines. There are additional reports that SCE offers to get more information about the proposed circuit lines and point of interconnection. This preapplication report is optional, and SCE's Distributed Energy Resource Interconnection Map (DERiM) illustrates some of this information. This information is necessary to complete and approve the application forms for interconnecting the generation site. Information found in the DERiM includes the existing generation connected, the queued generation for resources that are requesting interconnection but not yet on-line, and the maximum remaining generation capacity on substations and circuit lines. The CPUC requires IOUs to make this grid capacity data available to help with public planning. Moreover, the DERiM shows the current penetration level for circuit lines, which represents that ratio of the total generation connected to the peak load.

Challenges

If implemented, this AEC project design will operate within the context of the Clean Power Alliance of Southern California program (CPASC),³³ a community choice aggregation (CCA) that is just coming on-line to serve Los Angeles County properties, county unincorporated areas, and dozens of member cities.

³² https://www.pge.com/en_US/for-our-business-partners/interconnection-renewables/export-power/distributed-generation-handbook/net-energy-metering/res-bct-program.page.

³³ <https://www.lacounty.gov/about-lacce/>.

However, for replication of this AEC design within IOU territories where there is not a CCA, questions remain about whether existing virtual net energy metering programs would adequately support such an approach. To produce enough electricity for this type of AEC program, solar will be installed on government buildings and schools within and around the project site. Each of these sites will need to submit an interconnection request under SCE's Rule 21 and pay the associated fees for interconnection and the study. Since solar production may need to offset the on-site electricity consumption and produce excess electricity for the other community sites, solar generation is maximized at the generation sites. However, if solar generation must be sized to the historical energy consumption of a site under SCE's net energy metering program, not enough electricity would likely be produced. This rule presents a potential barrier for producing enough excess electricity to supply all the participants in similar AEC projects not served through a community choice aggregator.

It is possible that community solar generation outside a CCA area could be developed under SCE's Enhanced Community Renewables program (one of SCE's offerings under its Green Tariff/Shared Renewables Program [GTSR]), but this would require the solar projects to be proposed, designed, and constructed by one of SCE's selected private solar developers. The Shared Renewables Program is still under development; therefore, it is not possible to assess whether any positive economic benefits will actually accrue to SCE customers who participate in the program after it is launched.

The Enhanced Community Renewables program does not include energy storage as an eligible project component and requires participants to pay a separate bill to the renewable power developer while receiving a credit on their monthly electricity bill from SCE. In addition, there is no mechanism to arrange for on-bill repayment of energy efficiency and energy management upgrades to participants' homes, likely requiring more paperwork. Such complexity would almost certainly create significant barriers to implementation.

While the AEC design proposed here only offsets electricity consumption, municipalities wishing to size their AEC to a ZNE standard would have even more hurdles due to separate billing for electricity and natural gas.

An additional consideration with respect to grid interconnection is the potential limit on the amount of renewable energy the AEC can produce – a single generation site cannot exceed 15 percent of the historical peak load for a given circuit. Restricting the allowable amount of renewable energy that can be added to a circuit line presents a problem for producing enough electricity for the AEC. This may require the AEC to focus on a number of sites for renewable energy generation that are less than the 15 percent threshold instead of maximizing the available solar potential of one or two sites. An analysis and mapping of local grid capacity for the project site are provided in the *AEC Design Report*, and the Solar Prioritization Tool addresses this issue for planning across Los Angeles County.

Recommendations

Based on the codes and standards reviewed, the following are the primary recommendations to streamline local use of AECs.

- The AEC design should focus on rooftop and parking canopies for solar generation systems instead of ground-mounted systems. Rooftop and parking canopies can bypass CEQA documentation and can better use space than ground-mounted systems, which require obstruction and brush-free area around the ground-mounted system.
- While the current grid interconnection process poses some constraints to the AEC design, there are ways to avoid issues during implementation. When selecting sites for solar generation systems, the SCE DERiM tool can identify potential line constraints and determine what the 15 percent penetration level limit is. This will help streamline the interconnection request process during implementation and avoid having to find additional sites for generation systems.
- The Enhanced Community Renewables program offers the closest match as a mechanism for implementing this AEC design in SCE areas without a CCA, but the many complexities, program gaps, uncertain economic benefits, and potential mismatches involved will likely create significant challenges and barriers for widespread customer participation in the program. Other IOUs' offerings under the GTSR program may have different attributes and limitations that make them more or less suitable, but it is much too early in the IOU implementation stage to draw any meaningful conclusions.

CHAPTER 9:

Energy Efficiency Program Effectiveness Assessment

Overview

California spends more than \$1 billion each year on energy efficiency (CPUC 2015).³⁴ Yet, limited evidence based on actual historical account-level energy use data exists for the effectiveness of such programs, and large-scale assessments evaluating building energy-efficiency improvements are rare. This report aims to understand the distribution of energy efficiency upgrades and participation across programs, as well as the effectiveness of various measures to achieve actual savings in electricity usage. State-of-the-art quantitative methods were applied to understand the effectiveness of energy efficiency programs using large-scale, high-frequency data for participation and outcomes at the account level. Monthly electricity use and energy-efficiency participation data was analyzed for 10 million accounts in SCE's service territory from 2010 to 2014. This scale of analysis ensures credible and generalizable results.³⁵

Unique Contribution

This study significantly improves on previous studies in four key ways:

1. It applies a rigorous econometric method to construct a comparable control group and address the self-selection issue in program participation.
2. It involves an assessment of all available end-user programs to prevent overlapping program effects—no study has ever simultaneously analyzed multiple programs
3. It includes a large sample of households (more than 10 million accounts) with actual monthly electricity use in 2010-2014.
4. It incorporates rich building-level information (such as vintage, square footage, user type) to improve statistical rigor and explore heterogeneous program impacts.

The new methods provide generalizable results and replicable recommendations. The contribution from this study is summarized in Table 21, comparing the sample size, timeframe, program coverage, and methods of this study with those from other existing studies.

34 Based on the CPUC *Energy Efficiency 2010-2012 Evaluation Report*, “the CPUC has authorized \$3.1 billion in ratepayer-funded energy efficiency programs for the 2010-2012 program cycle.” California Public Utilities Commission (2015). 2010 – 2012 Energy Efficiency Annual Progress Evaluation Report. San Francisco, CA: CPUC. <http://www.cpuc.ca.gov/General.aspx?id=6391>.

35 All the results are validated against different models and standard state-of-the-art statistical practice. Significant means that the p-value is smaller than 0.05.

Table 21: Comparison Across Current Studies

Study	EE Program	Study Sample	Time	Billing Data	With Control Group	Control for Multiple Programs	Building-level Info
This study	All available upgrades	10+ million households	2010-2014 (5 years, monthly)	Yes	Yes	Yes	Yes
PDDP evaluation	Palm Desert Demonstration Program	200+ telephone surveys	2012	No	No	No	No
Whole House Impact Study	Whole house retrofit	720-3,823 households	2011, 2012	Yes	Yes	No	No
HVAC Impact Study	Upstream equipment Incentives, quality maintenance, and quality installation	Around 100 households	2010-2012 (Not clear. Before and after)	Yes	Yes	No	No
Appliance Recycling Program report	Refrigerator and fridge recycling	52-60 households	Based on 10-14 days (1 year, 5-min)	Yes	No ³⁶	No	No
2015 Home Upgrade Program Impact Evaluation	Energy Upgrade California (Whole house retrofit)	4,351 households for electricity; 5,108 and 11,775 for natural gas	2011-2015 for kWh data, 2011-2016 for gas data	Yes	Yes	No	No

36 Surveying nonparticipants to gather information for extrapolation, but no real metering usage data were gathered and compared with the participants directly.

Davis et al. (2014)	Appliance replacement	1.9 million Mexican households	2009-2012 (2 years, monthly)	Yes	Yes	No	No
Fowlie et al. (2015)	Weatherization Assistance Program (WAP)	34,161 low-income households in Michigan	2011-2014 monthly	Yes	Yes	No	No
Allcott and Greenstone (2017)	Two Wisconsin residential energy efficiency programs (audit and then retrofit)	100,000 households	2006-2015 monthly	Yes	Yes	No	No
Boomhower and Davis (2017)³⁷	Quality installation program air-conditioner rebate	<6000 households in southern California	Jan 2012-April 2015 (hourly)	Yes	Yes	No	No
Zivin and Novan (2016)³⁸	Energy Savings Assistance Program	275 low-income households in San Diego	Nov 2011-Sep 2012 (monthly)	Yes	Yes	No	No
Liang et al. (2017)³⁹	Energy efficiency retrofits	201 residential, 636 commercial buildings	Jan 2008-April 2013 (monthly)	Yes	Yes	Yes	No

37 Boomhower, J. P., and L. W. Davis. 2017. "Do Energy Efficiency Investments Deliver at the Right Time?" Unpublished Manuscript.

38 Zivin, J. G., and K. Novan. 2016. "Upgrading Efficiency and Behavior: Electricity Savings From Residential Weatherization Programs." *The Energy Journal*, 37(4), 1-23.

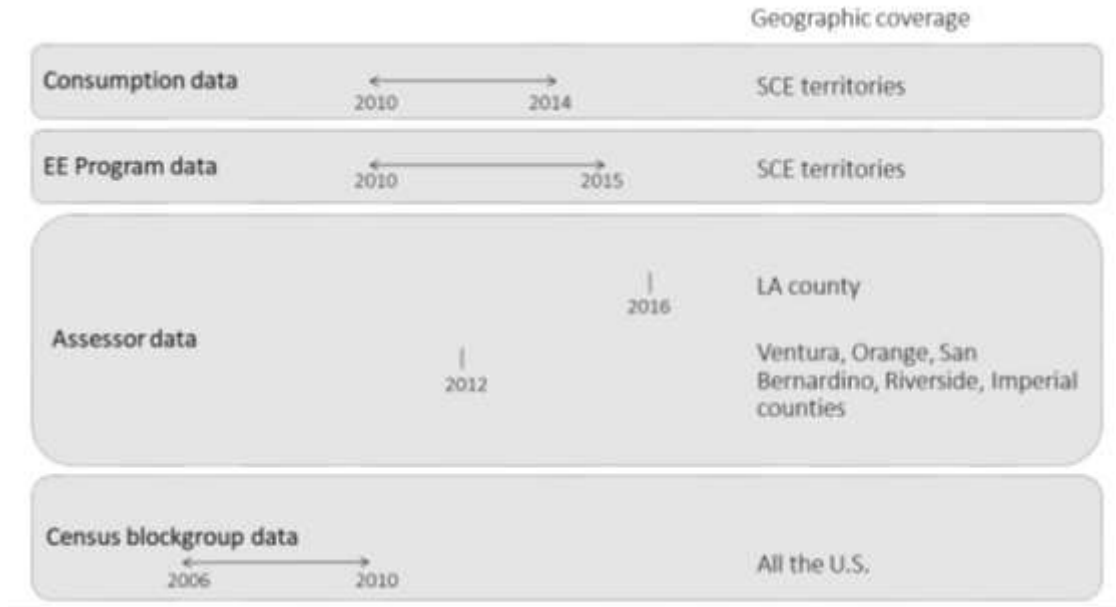
39 Liang, J., Y. Qiu, T. James, B.L. Ruddell, M. Dalrymple, S. Earl, and A. Castelazo. 2017. "Do Energy Retrofits Work? Evidence from commercial and residential buildings in *Phoenix*." *Journal of Environmental Economics and Management*.

Data Sources

The analysis used several sources of data (Figure 16). Electricity use and program participation data were from the *LA Energy Atlas*,⁴⁰ a relational database that enhances understanding of energy use across L.A. County. Key data for energy-efficiency program participation was from Southern California Edison, the regional electricity utility. Additional datasets, incorporated into the *LA Energy Atlas*, were included for parcels and building characteristic data from the Los Angeles County Assessor's property dataset, as well as sociodemographic information from the census database.

The Energy Atlas geocoding procedures connect the address information of each utility account to corresponding spatial (parcel) information, which provides building attributes (vintage, square footage, and use type) – essential elements to understanding energy use. This geocoding also links households' electricity use information to the census block in which they are located.

Figure 16: Data Scheme

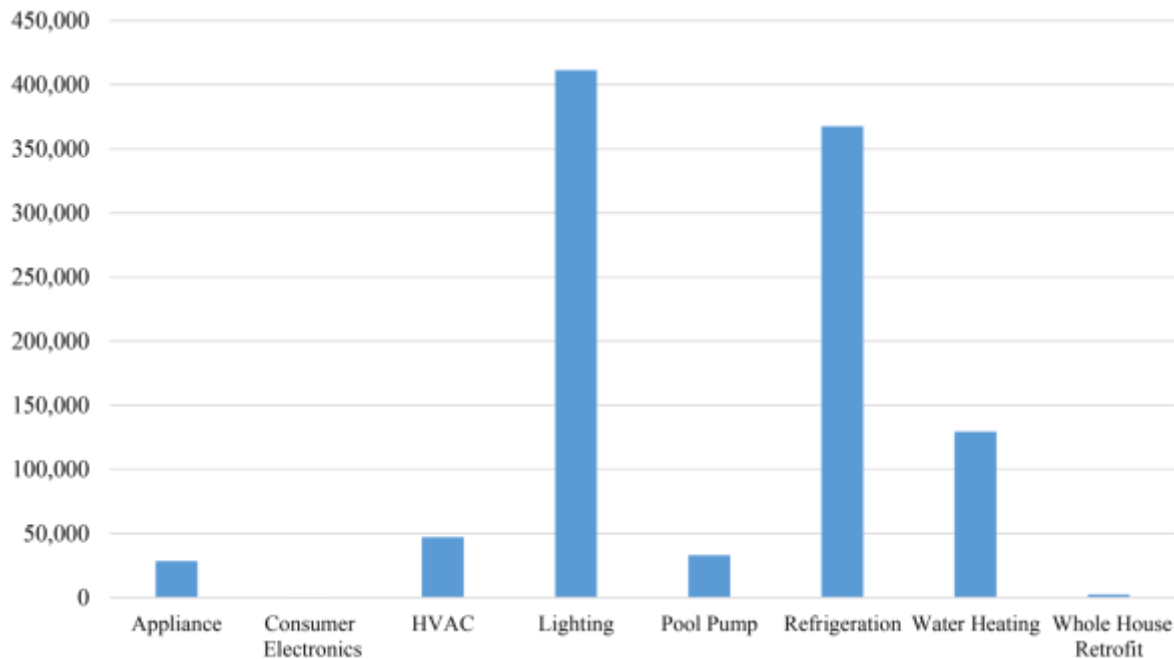


Program participation data identify residential energy efficiency programs implemented in SCE service territories during 2010-2015. The energy efficiency programs in this dataset are end-user-based programs that give households financial incentives (as rebates or free giveaways) to upgrade their household appliances or equipment to a more energy-efficient model. There were no electricity consumption data for 2015. For the summary statistics on energy efficiency participation, researchers used the whole sample from 2010 to 2015. For the program impacts on electricity savings, only 2010-2014 could be analyzed. Yet, the program information from 2015 was useful in preventing the selection of any future energy efficiency participants into the matched control group. In addition, most observations (more than 80 percent) have more than 12 months of data for the analysis.

⁴⁰ www.energyatlas.ucla.edu.

Whenever a household claimed rebates or direct financial support for an upgraded equipment/appliance, there was a record that documents related program information. Based on the installment date claimed on the form, researchers generated a program participation variable reflecting the claim month for each household. All subsequent monthly information for an energy efficiency participant was counted as a “treated period” for that certain program once a household has participated in a program. Figure 17 shows the number of SCE customers enrolled in different types of EE upgrade measures in the data.

Figure 17: Number of Accounts Participating in Incentives for Different EE Products



Program Data Scope and Limitations

This study focused on electricity savings associated with residential energy efficiency programs only. In addition, the model focused at the measure/product level, instead of evaluating more than 20 historical programs, to eliminate ad hoc characteristics of the specific program and to shed light on more generalizable policy recommendations and targets. However, researchers conducted additional modeling to look at how the effectiveness of certain upgrades might differ between programs.

Furthermore, program data included only those involving residential end users’ actions. Program types that were not part of the dataset include code/standard practice programs, subsidies for technology development, workforce training and marketing/outreach programs, and programs that provide energy efficiency information. It does not mean that those programs are not important. Simply, researchers were not able to analyze them directly using the data available.

A further limitation results from the categorization of some product types, which is poorly suited to support effectiveness evaluation. For example, HVAC upgrades do not distinguish

between AC units and heating systems. The inability to distinguish two energy delivery systems limits the ability to evaluate the effectiveness of HVAC measures. Secondary fields under this overall category contain more than 200 descriptors, making it infeasible to distinguish accurately whether the technologies are for heating or for cooling.

Methodology

The following describes a key element of the analysis methodology. A description of the entire methodology is contained in the project deliverable *Energy Efficiency Program Effectiveness Report*.

Overview of Econometrics Methodology

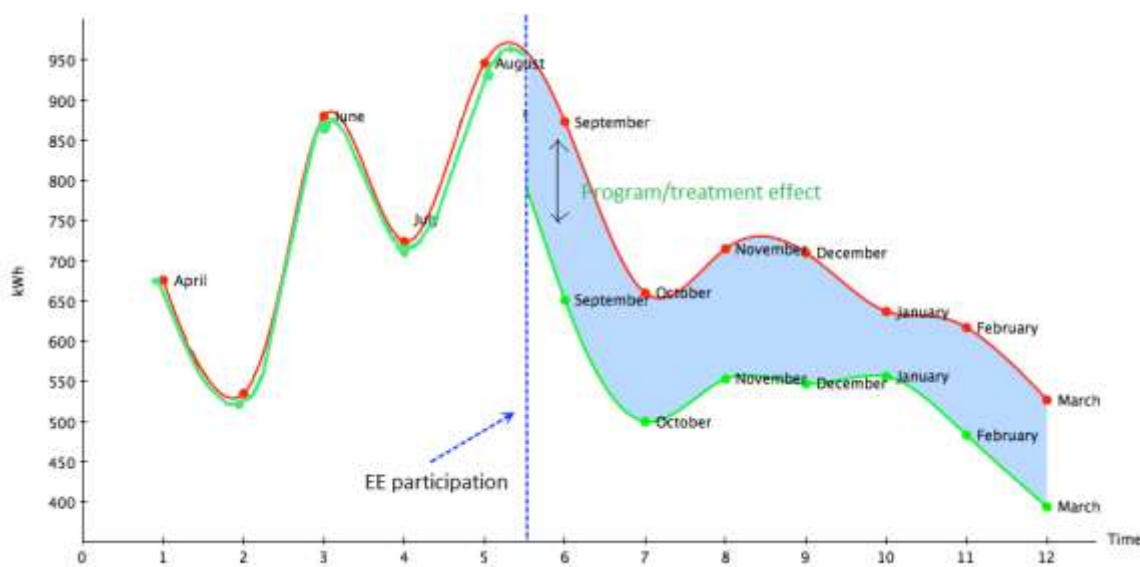
Estimating energy-efficiency program effectiveness for households requires multiple datasets. This analysis focused on all the residential energy efficiency upgrade incentive programs that were available to households from 2010 to 2015. The procedure deals with retroactive and time-dependent conditions that may confound with the program impacts the research intended to identify. These include factors such as economic and market conditions, weather, and resident behaviors. Thus, this study uses the power of ground-up big data to shed light on future implementation.

To evaluate the impact of these programs on electricity use, researchers used state-of-the-art statistical methods that address the issue of self-selection in any program evaluation in which participants represent small sets of self-selected groups with certain socioeconomic status. Using various statistical methods, unique access to the account-level data (with more than 10 million unique accounts), and computational expertise and capacity, the approach addresses the issue of self-selection and causation in assessing program impact.

The determination of program impacts uses a comparison of net change in electricity consumption over time between households that alternatively did or did not participate in energy efficiency programs. The challenge is capturing and controlling for all the factors that potentially affect energy use. For example, a more educated household may be more knowledgeable about energy efficiency programs and at the same time have better resources (such as well-insulated homes) to save energy. There are also household-level characteristics that can be important for this energy-efficiency program evaluation. For example, household size and composition can largely affect energy consumption at home. To address these confounding self-selection issues, the approach combined several statistical methods, including (1) a matching method using Mahalanobis Distance Matching (MDM), (2) fixed effects in panel-data estimation method, and (3) difference-in-difference (DID) techniques.⁴¹ (Figure 18.)

41 Angrist, J. D., and Pischke, J. S. 2008. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Figure 18: Difference-in-Difference Approach Illustration



Modeling and Hypothesis Testing

The statistical model aims to estimate the causal impacts of different programs in terms of electricity usage. The main hypothesis being testing is whether participating in energy efficiency programs leads to reducing actual electricity usage. To test this, researchers used matching, fixed effects and DID techniques discussed earlier. There are various versions of these statistical models. The broad idea of using those techniques in this evaluation context is standard in the current econometrics and statistical literature. The subversions of matching and fixed effects models, however, have pros and cons in the literature, and less consensus exists on which is the superior method among those subversions. To ensure the credibility of the results of this study, researchers estimated combinations of those subversions of matching and fixed effects. Twenty statistical models were used to pretest and estimate the effectiveness of energy efficiency programs. One reason to deploy various models is to test how sensitive the results are using different matching. Researchers choose different sets of variables for matching based on the literature. This task was time-consuming as each model took 7 to 14 days to set up and run. The high computational resource support at UCLA made this computation possible and enabled a timely deliverable.

Findings

The following are the key findings:

- Between 2010-2015, the overall adoption rate was about 8 percent, compared to 5.5 percent among the lowest income quartile.
- Compared to nonparticipants, energy efficiency program participants tend to live in newer houses, and they are more likely to be homeowners, rather than renters.
- Energy efficiency program participants live in neighborhoods with higher incomes, lower population densities, and larger rates of white, Asian, and highly educated populations.

Energy efficiency uptake among the highest income quartile is nearly twice of that among the lowest income quartile.

- Take-up is higher among households whose houses were built after 1990 than before 1950 (about 9 percent and 5 percent, respectively).
- In terms of electricity savings, the most effective programs were those providing incentives to upgrade pool pumps and refrigerators.
- Pool pump incentives led to, on average, 12 to 13 percent savings among participating households.
- Programs that promoted energy-efficient refrigeration also have statistically significant impacts, saving households on average 6 percent of electricity usage.
- Lighting programs, despite high participation by households, yielded only about 1 percent savings.
- There was almost no significant change in electricity consumption among participants who got incentives for HVAC or whole-building retrofit programs. No statistically significant difference in results was found for HVAC retrofits between direct install programs compared to non-direct-install programs.
- Program participants upgrading HVAC in older buildings use more electricity (statistically significant) after joining the program, compared to their nonparticipant counterparts. This rebound effect does not exist among HVAC program participants in newer buildings—they use less electricity (statistically significant) after joining the program, compared to their nonparticipant counterparts.
- The result for whole-building retrofit measures is the opposite from HVAC upgrades. Participants in older buildings after retrofitting consume roughly 2 percent less electricity, while participants in newer buildings use more electricity after participating in the program. This heterogeneous effect in whole-building retrofits indicates that older buildings may have larger savings potentials.

Relevance to AEC Design

This study showed that energy efficiency program adoption rates tend to be higher in areas with more educated and wealthier populations, and lower among Black and Hispanic populations compared to White populations. These trends confirm the need for an AEC design that addresses barriers to implementation in disadvantaged communities.

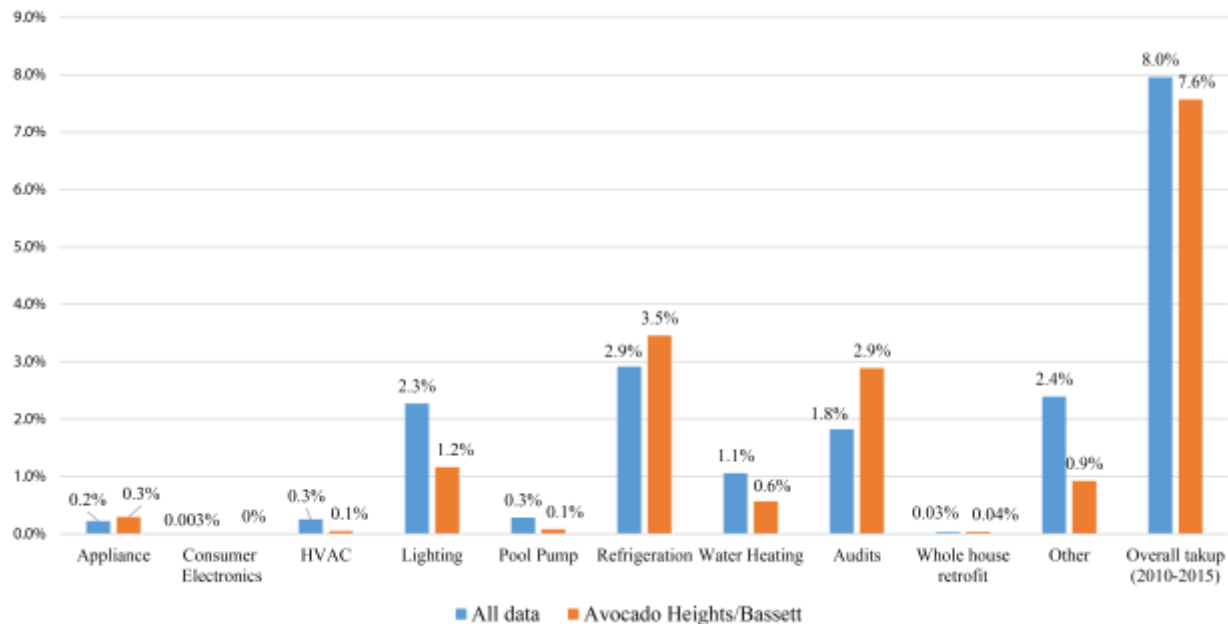
Findings were used as benchmarks for energy efficiency assumptions in the site design for the AEC project site in Avocado Heights/Bassett. They provide credibility to assumptions for parameters used in the community energy system model supporting the design process.

Figure 19 examines the energy efficiency take-up rate by products in the AEC project site compared to the overall Southern California study area. The overall adoption rate in the project site is 7.6 percent, slightly less than the overall adoption rate of 8 percent. Take-up rate for refrigeration measures is about 3.5 percent in the project site, compared to 2.9 percent overall.

Compared with the overall pool pump take-up rate, 0.3 percent, pool pump programs are less well adopted in the project site (0.1 percent) despite the high savings potentials. More than 700

above- and below-ground pools were identified within the study site; therefore, pool pump replacements may have a high potential for energy savings.

Figure 19: 2010-2015 EE Take-Up by Products (All Data vs. AEC Project Site)



Conclusions

This analysis reveals how there can be better allocations of resources to programs that yield larger impacts. The results also indicate that policy makers should reconsider the allocation of funds. As this analysis shows, engineering models are insufficient as the basis for funding allocation. Funding should be devoted to interventions that generate larger measured impacts, but this requires far more data-intensive research. For example, lighting programs, promoted as an effective energy efficiency upgrade worldwide, may have only minor effects on energy savings. Whole-building retrofits may generate more electricity savings when targeted at older houses. As some measures have the potential to generate rebound effects, better savings may be achieved by emphasizing conservation behavior, using individualized audits and consulting.

For future evaluations, the research team recommends that a more expressive classification field in the program tracking data be created. This classification could be similar to the “technology category” as defined in the Building Energy Data Exchange Specification, a dictionary of terms developed by the U.S. Department of Energy for stakeholders to make important energy investment decisions. The team recommends that within this classification scheme, categories such as HVAC, which represent a broad collection of energy services (such as heating, ventilation, cooling), should be broken down into separate categories. Each of these categories could be analyzed separately for performance and effectiveness.

Moreover, this work points to further research to determine unanticipated behaviors. There is a clear demand for programs to be evaluated using better statistical methods and much larger datasets.

CHAPTER 10:

Solar Prioritization Tool

Overview

The Solar Prioritization Tool is an interactive, Web-based platform for visualizing the best locations for installing distributed solar PV throughout Los Angeles County to meet the goals of local energy system resilience, community-scale zero-net electricity (ZNElec), grid reliability, and prioritized investments in disadvantaged communities. The online mapping platform uses cutting-edge data and methods to provide the most sophisticated ranking of priority sites for solar at high geographic resolution within the service territory of the regional investor-owned electric utility in L.A. County, Southern California Edison. This capability has been previously unavailable. The tool supports many energy planning activities, including identifying locations for distributed solar PV and electric vehicle charging stations installations, understanding geographic variations in congestion of local transmission and distribution grid infrastructure, and identifying high-detail areas best poised to achieve zero-net-energy and ZNElec goals.

Data

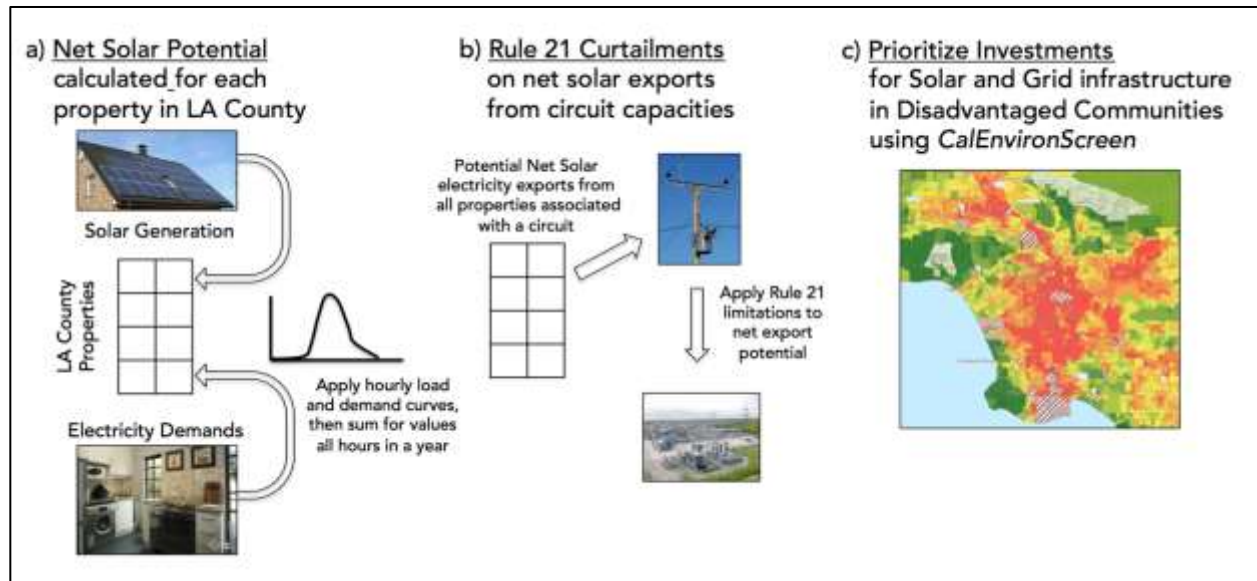
The prioritization tool builds on the knowledge generated as part of the AEC design process for integrating several data sources to support community-scale, zero-net-electricity planning. Specifically, the tool uses data for:

- Rooftop solar potential for all properties in L.A. County.
- Electricity consumption for all properties in LA County.
- Net-solar potential, considering historical on-site demand for potential installation sites.
- High-detail grid reliability data from the Distributed Energy Resources Integration Map (DERiM) based on data provided by Southern California Edison (SCE).
- Hourly profiles for load (demand) and solar electricity generation.
- Sociodemographic information from the CalEnviroScreen dataset and U.S. Census data.

Method

In developing the tool, researchers devised new methods for calculating net-solar potential within the constraints of grid capacity limitations and operations based on available data. These new methods included calculating hourly net-solar potential and attributing groups of parcels to local circuits across a vast metropolitan area that comprises nearly 16 percent of the population of California. An overview of the method is shown in Figure 20. Method details are included in the project deliverable *Solar Prioritization Tool Report*.

Figure 20: Data Integration Procedures for the Prioritization Tool



Using the Tool

The tool assembles multiple “big data” sets and makes the results accessible through a dynamic, high-resolution Web map interface (<http://solar.energyatlas.ucla.edu>). The tool supports multiple ways to view data, which include:

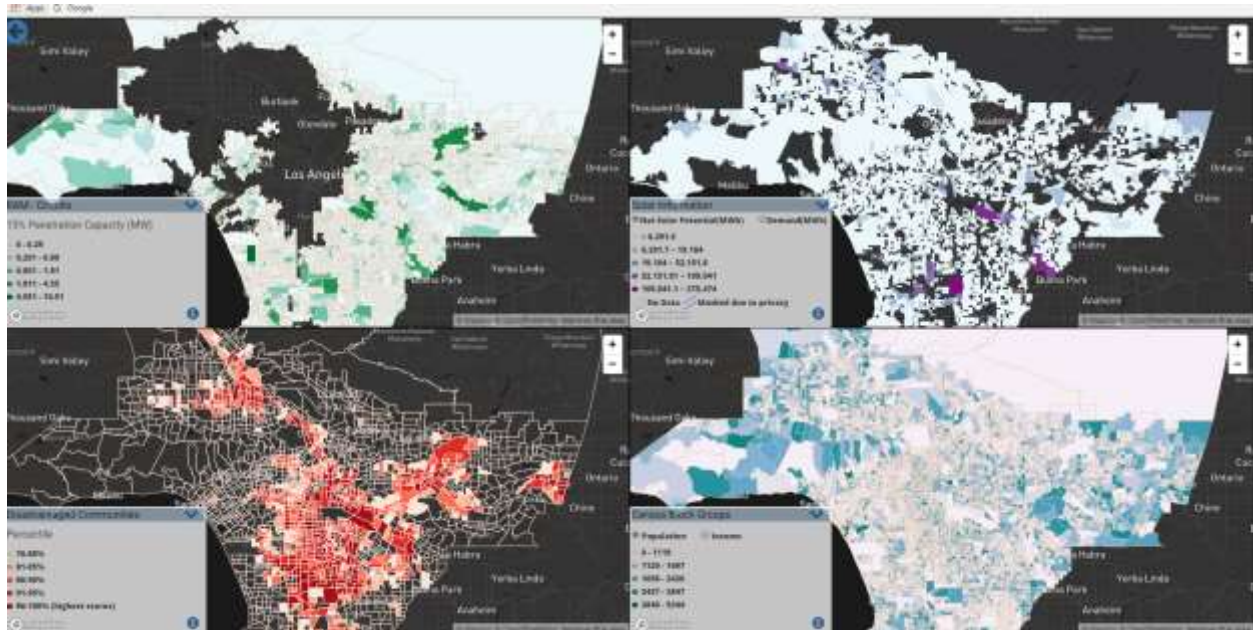
1. A *Summary Map* (Figure 21) showing a first-of-its-kind calculation for net-solar potential with color shading designating high priority locations for DERs.
2. A *Quadrant View* (Figure 22) with multiple screens showing the component maps that are used as inputs to the final composite net-solar potential value.

The tool is relevant to multiple types of users, including policy makers and regulators, utility planners, local government analysts, and researchers. User classes were devised, and the product was tailored based on feedback with regional stakeholders. The tool provides users opportunities to tailor the display results for the needs of diverse audiences. For instance, dynamic mapping allows for viewing results at multiple geographic scales. Furthermore, users can adjust the views through a custom interface that allows for selectable map layers and adjustable indices.

Figure 21: “Summary Map” Page of the Prioritization Tool



Figure 22: Snapshot of the “Quadrants” View of the Prioritization Tool



Results

Results from the analysis indicate that the potential net export of solar electricity to the grid from net-producing circuits in SCE's L.A. County territory is more than 3,700 GWh annually. *Net-producing circuits* refers to circuits with associated properties that, over an annual period,

could produce more electricity than they consume. This total includes buildings for an area with roughly one-sixth of the state's population.

This value requires nuance. The overall net solar generation potential for Los Angeles County is negative, meaning that over a year, buildings consume more than they could produce. However, many circuits in the L.A. County grid are associated with buildings that could be net producers. This figure is just as important for utility operations. Thus, the 3,700 GWh represents that generation potential that could be harvested if solar is installed in the correct locations.

By comparison, California's total 2016 electricity generation was 198,000 GWh.⁴² Thus, from the perspective of current utility regulations regarding grid capacity and operations, California can still significantly increase solar electricity generation to meet renewable energy production goals without affecting grid reliability.

Net-solar potential varies widely across the county. Of the 1,738 groups of parcels associated with circuits, this analysis indicated that CPUC privacy guidelines required 40 percent of them be masked to meet disclosure restrictions for consumption data. Of the reportable parcel groups, areas with positive net-solar export potential, including grid constraints, are throughout Los Angeles County (Figure 23). The area with diagonal shading is the City of Los Angeles, which is not included in this study. The highest totals are in northern Los Angeles County, with less population and more sunlight. Within the urban coastal plains, net-solar potential is evenly dispersed. Some areas could export more than 40,000 MWh annually to local grid circuits.

Mapping net-solar potential at the block-group level allows aligning infrastructure management policies with sociodemographic and economic indicators. Figure 24 shows the net-solar potential after accounting for hourly load and generation curves at the block group level. The map indicates similar areas of high net-solar export potential in northern Los Angeles County, along with a cluster of industrial and unincorporated areas in the center of L.A.'s metropolitan coastal plain.

42 http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html.

Figure 23: L.A. County Annual Solar Export Potential for Circuit Groups

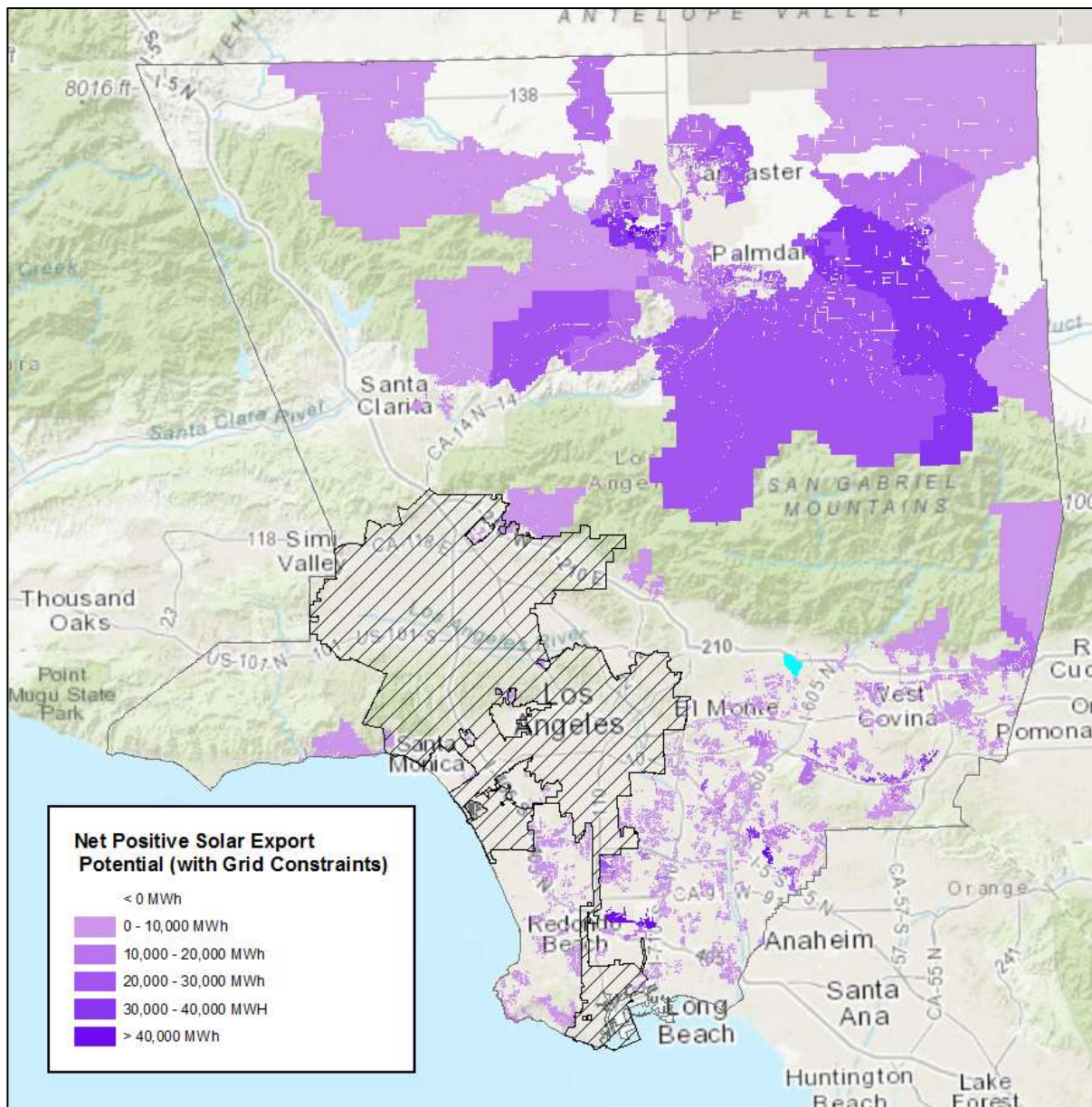
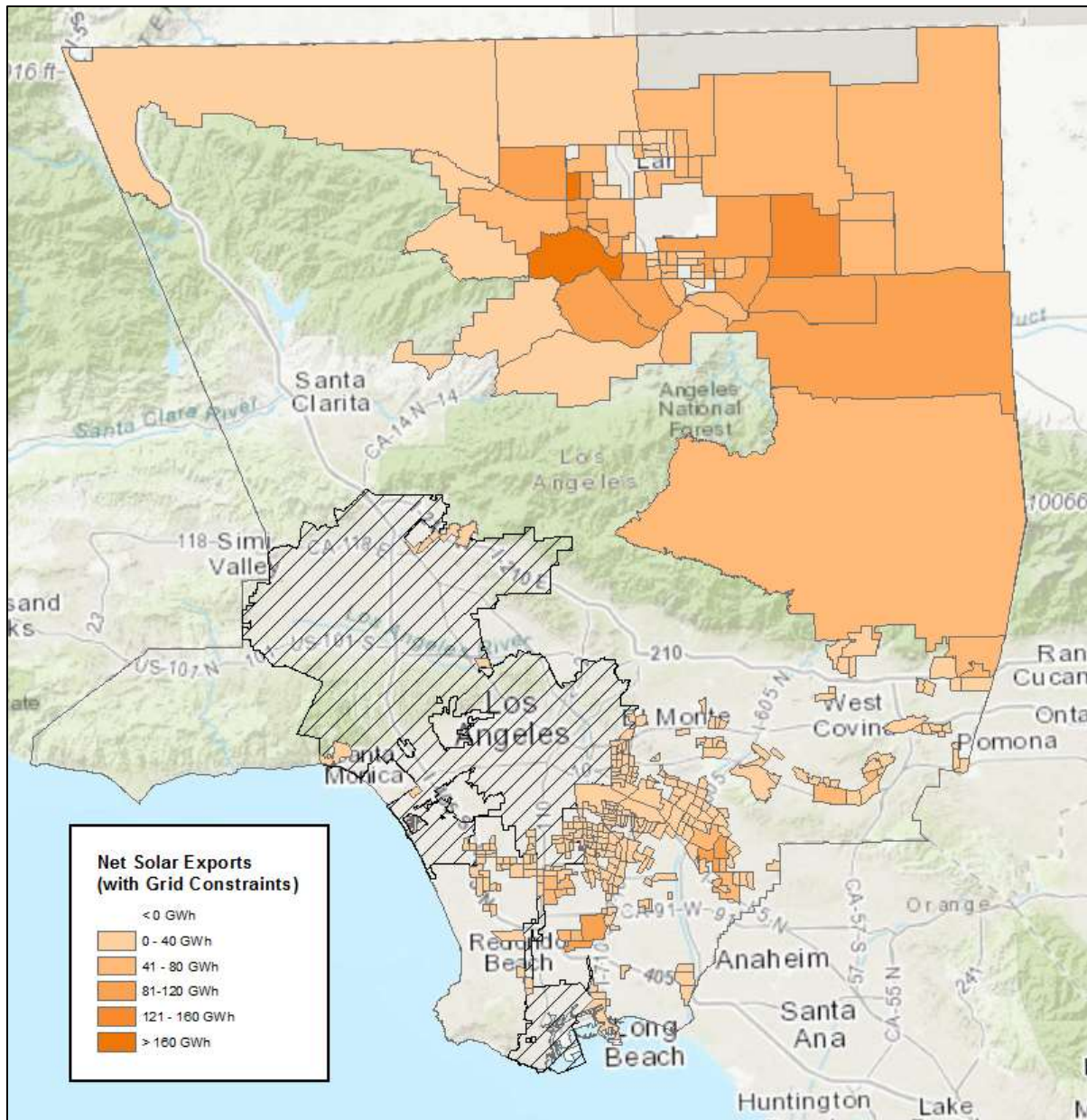


Figure 24: L.A. County Annual Net Solar Export Potential for Census Block Groups



Rule 21 Curtailments and Excess Capacity

Peak net-solar exports are closely related to the annual net-solar generation potential. The average peak net export for a circuit across the SCE L.A. County territory is 3.5 MW, while the average 15 percent penetration rate limit contained in SCE's DERiM dataset is 12.5 MW. Thus, on average, extra capacity exists on circuits.

However, the peak net solar export potential and the underlying Rule 21 export limits vary throughout the county. Areas with more solar interconnection capacity, based on Rule 21 penetration rate limits, include rural areas of northern Los Angeles County and dispersed communities within Los Angeles. These are indicated as darker regions in Figure 25. Masking

requirements do not apply to this map because the grid data are derived from publicly available SCE DERiM data. The 15 percent penetration rate limit for exports is shown in one of the dynamic map windows of the quadrants view in the online prioritization tool.

In some areas, the 15 percent penetration rate limit requires curtailing net generation potential (Figure 26). The total amount of curtailed power, calculated as the difference between the net potential and the 15 percent penetration rate value, was 1,507 MW. This amount represents unexploited solar potential for Los Angeles County imposed by the existing grid capacity regulations via Rule 21. As a comparison, this value is nearly equal to the generation capacity of the Hoover Dam, which is 2,000 MW. Infrastructure upgrades and more detailed assessments of net export potential based on actual conditions (integrated capacity analysis procedures) would likely reduce the curtailed amount, helping California meet its renewable energy goals.

In noncurtailed circuits, significant available capacity exists within the current Rule 21 guidelines. For these circuits, more than 17 GW of extra capacity exists, representing the difference between possible exports to the grid and on-site net generation capacity. Since solar potential is a fixed value given current technologies, a prime strategy for maximizing this capacity would be improving energy efficiency, which reduces consumption and allows more on-site generation to be exported

Figure 25: L.A. County Rule 21 Solar Export Limits

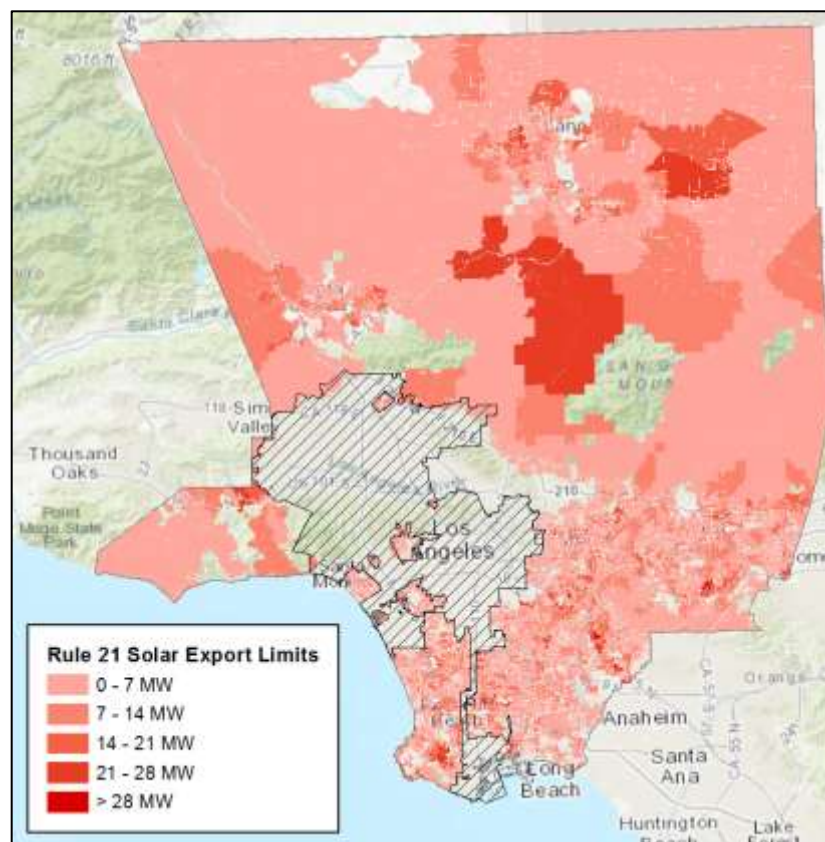
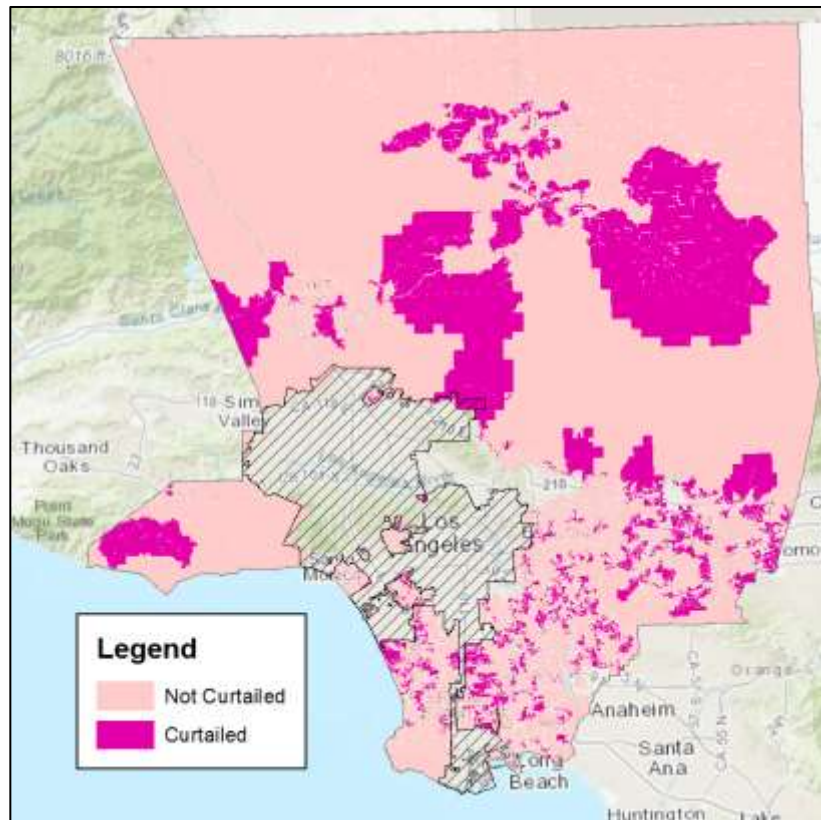


Figure 26: L.A. County Potential Rule 21 Curtailments



Solar Potential and Social Equity

The team analyzed data for grid operations, Rule 21 constraints, and net solar potential in comparison to sociodemographic characteristics within the CalEnviroScreen scores. This comparison allowed for analyzing data for grid and renewable generation capacity in the context of underserved communities. Researchers further investigated potential trends that would indicate structural inequalities in access to local grid resources, such as underserved communities having less excess grid capacity or lower net solar potential based on grid constraints. For each block group and the associated CalEnviroScreen statistics, the team aggregated the circuit groups contained within the block group and calculated various statistics associated with net potential solar generation, including grid capacity, net solar electricity generation potential, and others. Basic linear regression did not yield statistically significant results (assessed by high R^2 values) to describe relationships between CalEnviroScreen scores and net solar potential or DERiM data.

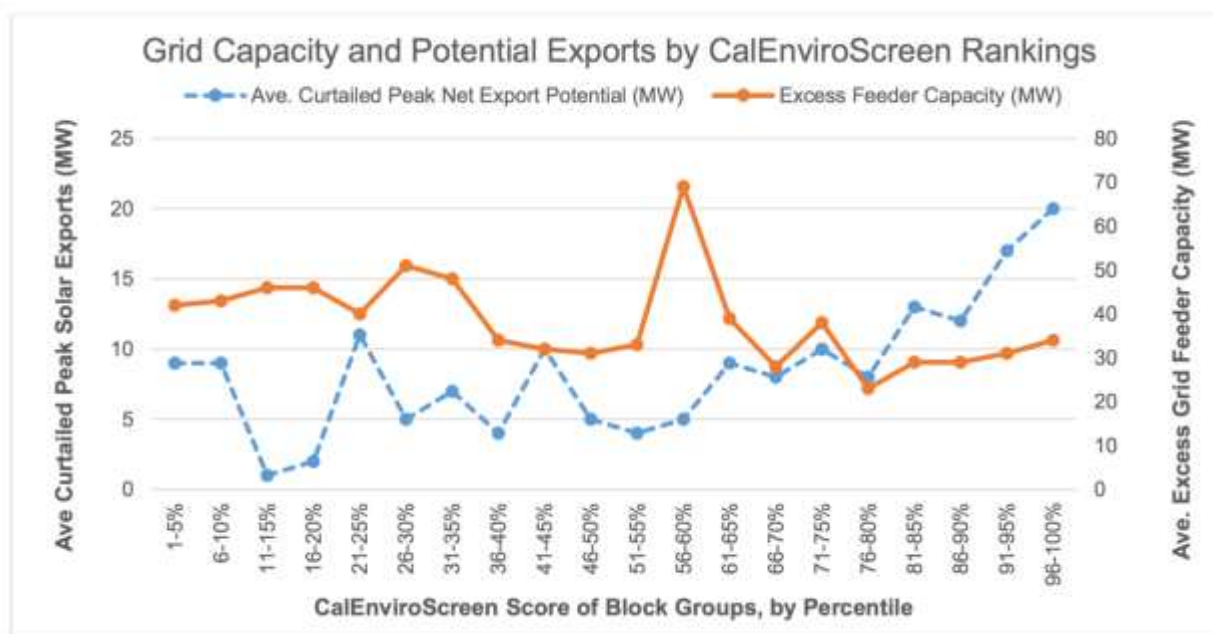
A more straightforward analysis of sociodemographic characteristics with net-solar potential and grid operations, however, did yield interesting trends. Net-solar potential was examined and grid operations data as a function of categorical bins (percentages) of CalEnviroScreen rankings. For each category (0 to 5 percent of all L.A. County block groups, 5 to 10 percent, and so forth.), the mean and standard deviation of net-solar potential and grid capacity were

calculated to investigate summary trends. This procedure yielded several results that hint at the complexity of spatial variability of net-solar potential distribution.

First, Los Angeles County has many census tracts deemed as high-risk in CalEnviroScreen. Large sections of Los Angeles are of low-to-moderate income and subject to environmental risks that range from flooding to industrialized wastes. The distribution of census tracts across Los Angeles is weighted toward high-risk categories.

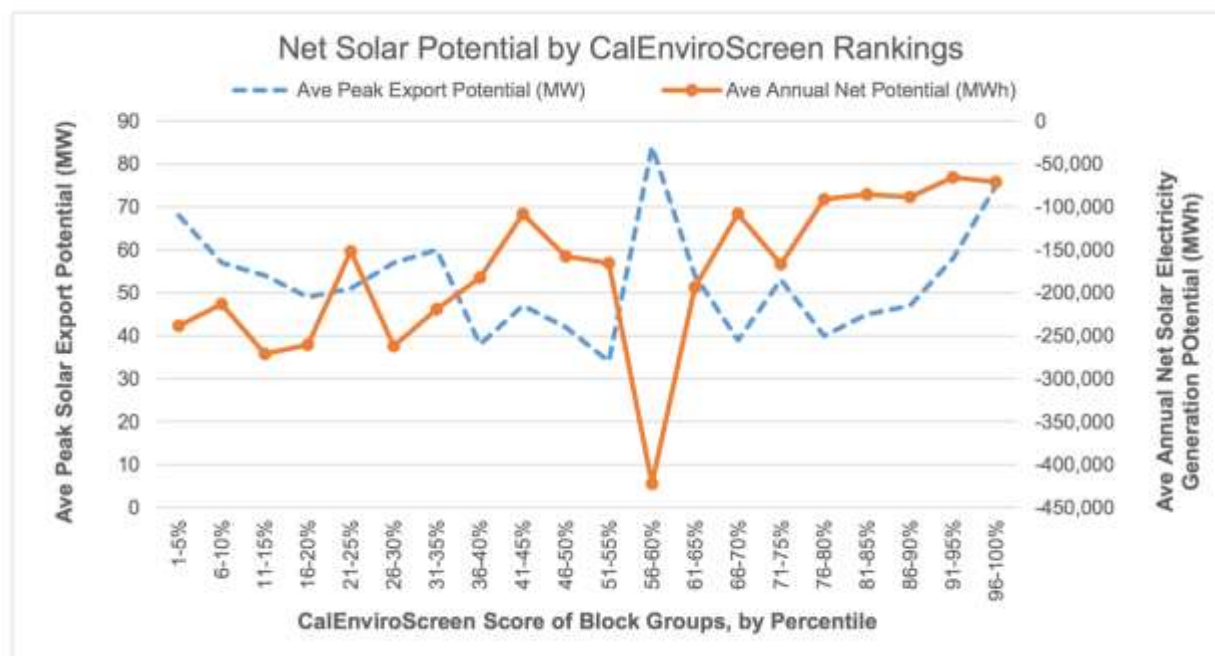
Second, average net solar potential after Rule 21 curtailments is consistently lower than average net potential when considering only on-site consumption and potential generation. This means that across the county, Rule 21 constraints measurably curtail solar generation. The largest curtailments occur in areas assessed as higher-risk by CalEnviroScreen (Figure 27).

Figure 27: Grid Capacity and Curtailments by CalEnviroScreen Percentile



Finally, while communities throughout Los Angeles County have negative net solar potential, meaning they consume more than they could potentially produce, the difference between on-site generation and consumption is lowest in at-risk communities. The average annual net solar electricity export potential (MWh) tends to decrease with higher (more at-risk) CalEnviroScreen scores (Figure 28). Peak net-solar potential is more consistent but still highest in at-risk communities. Furthermore, at-risk communities tend to have higher peak solar power export potential (MW), but they are subject to the most significant grid constraints. Moreover, the excess capacity in feeder lines for accepting additional solar exports is highest in communities deemed low risk from CalEnviroScreen, which are likely wealthier.

Figure 28: Net and Peak Solar Electricity Export Potential by CalEnviroScreen Percentile



The findings reveal complex trends in the spatial distribution of grid resources. Rule 21 limits do constrain potential net solar exports. Grid upgrades could allow for more solar generation exports to the grid. However, even within existing infrastructure and current Rule 21 constraints, the opportunities for increasing distributed solar generation are vast. Disadvantaged communities tend to have the smallest gap between annual solar generation potential and consumption, but they are subject to the greatest average curtailments of peak exports. Meanwhile, the excess capacity of grid feeder lines consistently decreases as CalEnviroScreen scores of at-risk communities increase. Thus, while installing solar in all parts of Los Angeles County can help meet statewide renewable energy goals, at-risk communities are subject to the most significant utility-imposed grid constraints, yet also closer to achieving ZNElec status based on current consumption, assessed solar potential, and time-dependent estimated net-solar potential.

This statistical analysis presented here summarizes global insights and provides direction for additional studies using the prioritization tool data. Future analysis can investigate relationships in more detail, as well as incorporate important factors that influence electricity consumption such as building size, age, and density of housing stock.

Policy Recommendations

Good data and effective policies are essential to local governments' plans for meeting statewide climate policy goals. This analysis and the publicly available tool are novel not only in scope and methods, but also in relevance for developing energy policy throughout California.

As part of developing the prioritization tool, researchers identified key recommendations that localities and policy makers can pursue to broaden access to quality data for planning

California's energy future and support its energy transition. These guide creating smarter statewide energy policies that look to a future of a transitioned energy grid. The recommendations can provide a framework for replicating the procedure in other California communities.

Develop Tools for Multiple Audiences

When creating energy planning tools such as a distributed solar prioritization tool, developers must consider the multiple potential users, each with slightly different information needs. This tool was developed for several classes of users:

- Local governments with interest in investing in local generation assets, participating in emerging community choice aggregation authorities and other activities to reduce local greenhouse gas emissions and fulfill climate action plans.
- Local government energy planners responsible for managing local government assets; for instance, local governments investing in electric utility fleets need to understand net export potential and grid capacity in identifying good sites to install charging stations.
- State energy planners within the California Energy Commission and the California Public Utilities Commission working with investor-owned utilities to increase renewable energy generation in urban areas throughout the state.
- Investor-owned and municipally owned utilities involved in operating and upgrading transmission and distribution grids, as well as interconnecting new generation assets.
- Nonprofits involved in promoting greater access to renewable energy, especially within underserved communities throughout California.

Open Access to Data

Discussions with stakeholders revealed that the datasets supporting the prioritization tool are in high demand but often inaccessible to the many users involved in energy planning. For instance, data for tax assessor rolls, parcel boundaries, and electricity consumption are important for developing spatial prioritization tools for distributed energy resources but are either unavailable or difficult to access.

Promote greater access to energy consumption data. The CPUC should continue to broaden access to high-detail energy consumption data. This is critical for many reasons. As shown through the analysis, the lack of consumption data creates big holes in the resulting maps due to masked consumption data. Local governments in California, which are the front lines of climate planning, are often on the front lines of using this highly disaggregated data for planning. High quality access is necessary and verifiable electricity and natural gas consumption data. Presently, many local governments have sporadic access to masked data, making comparisons and benchmarking across years difficult. Proceedings through the Energy Data Access Committee have been slow to produce results since the 2014 ruling.

Improve county tax assessor data. Property-level information is critical to understanding energy-use trends throughout California. However, it is also useful for many other resource management sectors in the public domain, such as water management and conservation. The Energy Commission and CPUC should work with state agencies and legislators to fund openly

available tax assessor and parcel data to ensure higher accuracy and consistency across the state. As part of developing the Energy Atlas, the team discovered and documented many inconsistencies with parcel data. Data quality and attributes vary widely by county. As energy and water utilities in California increase dependence on data for operations and planning, they should have access to improved datasets that are compatible statewide.

Promote better grid capacity data for circuits. The CPUC should continue working with IOUs to improve the quality of grid capacity data in support of increasing penetration of distributed generation resources. Further, state agencies should communicate with municipally owned utilities to promote similar access to data. The capacity constraints should be based on emerging procedures such as the Integrated Capacity Analysis feasibility studies conducted by the IOUs, which assess actual grid capacity, rather than a standardized assessment of the 15 percent peak-load penetration limit currently in place.

Compile and publish data for property-to-circuit relationships. California regulators should work with IOUs to improve published data for attributing properties to circuits. With this information accessible, large-scale energy systems planning would improve from more directly understanding on-site consumption and grid constraints. In this analysis, researchers assumed that properties were associated with local circuits based on a shortest proximity calculation. Improving this assumption with actual data that aligns properties and circuits would require compiling and perhaps digitizing multiple existing data sources, as well as integrating new sources such as imagery.

Prioritize solar installations to reduce climate change risks. Los Angeles County has diverse climate zones. Climate change, combined with urban heat island effects, will likely increase temperatures. High-detail climate modeling at UCLA has estimated the future effects of climate change on local surface temperatures.⁴³ Higher local temperatures result in increased electricity demands for indoor cooling. Investments in distributed solar generation and electricity grid capacity should be prioritized for estimated increases in electricity use for indoor cooling. Households in disadvantaged communities often have less access to funds for improving building energy efficiency, which results in higher energy bills that disproportionately affect family incomes.

Working With Communities

The electric grid represents hard infrastructure. Investments in capacity have long-lasting effects. For distributed renewable energy resources, grid investments shape where rooftop solar can be installed while retaining adequate grid reliability. However, electric grid resources are not evenly distributed. Utilities build grid infrastructure to meet demand. In the changing landscape of energy services, where the traditional centralized generation plant model is giving way to energy systems that use both centralized and distributed generation, the constraints of grid infrastructure can have unintended consequences for plans. These historical precedents

43 Berg, N., and Hall, A. 2017. *Anthropogenic Warming Impacts on California Snowpack During Drought*. *Geophysical Research Letters*, 44(5), 2511-2518.

may disproportionately affect underserved and disadvantaged communities without thoughtful planning driven by data.

Local communities looking to install distributed solar could be influenced by grid operations in numerous ways. For building owners, current regulations limit the size of on-site solar installations eligible for net energy metering based on historical consumption and limit interconnections overall based on the 15 percent penetration rate. Residents or local governments in areas with grid constraints could experience limits on the amount of distributed solar they can install, even if local planned needs or community preferences would seek more.

Alternatively, in areas with available grid capacity for distributed solar, utilities and local energy providers may see these as prime locations for new installations. However, for some communities, distributed solar arrays may be perceived as ugly or a nuisance when not thoughtfully installed. Limited information exists on how views of local solar installations vary across demographic groups. Local planners and state regulators must work to ensure that solar farms are not installed in underserved communities with excess grid capacity, simply because it avoids so-called “not-in-my-backyard” protests from more organized, affluent communities. Research into the geographic distribution of environmental hazards and risks often shows that underserved and disadvantaged communities experience greater exposure to pollution. Planners have the opportunity to ensure that poorly designed solar farms do not become another chapter in this tale.

To ensure thoughtful and equitable electric infrastructure management for the 21st century, researchers recommend that California statewide energy policies undertake analysis and engagement to ensure that California communities have access to desirable renewable energy resources. This can be accomplished through several strategies:

- Work with community groups to understand local preferences. Energy planners responsible for grid operations, upgrades, and solar installations should build connections with local community and nonprofit organizations. Such groups can help understand community preferences for implementing energy efficiency, installing rooftop solar, or building community solar assets.
- Understand renewable energy and grid infrastructure needs in underserved communities. California regulators, utilities, and local planners should support research that understands geographic distribution of electric grid infrastructure assets. How do grid assets vary among regions of varying sociodemographics? What grid constraints exist in promoting renewable energy installations in underserved communities?
- Promote equity in renewable energy installations. California policy makers should bolster new and existing incentive programs that promote renewable energy in underserved communities. This includes both installing generation capacity (such as distributed solar) and upgrading grid infrastructure. On the other hand, regulators should ensure that large-scale, industrial renewable energy installations such as a community solar farm are not installed in underserved areas simply because of available grid capacity.

GLOSSARY

Term	Definition
AEC (advanced energy community)	An advanced energy community is a community based on systems integration in which energy efficiency, renewable energy generation, and smart-grid technologies meet the energy supply and demand needs of its residents and supports local grid reliability and safety. Advanced energy communities can be a new, reconstruction, or retrofit development of a residential, commercial, or municipal development in new, unused or underused lands.
BUSD (Bassett Unified School District)	The school district within the AEC pilot site. Created in 1961, the district includes the following schools: Bassett Adult School, Bassett High School, BUSD Child Development, Don Julian Elementary School, Edgewood Academy, Nueva Vista Continuation School, Sunkist Elementary School, Torch Middle School, and Van Wig Elementary School
CCA (community choice aggregation)	Community choice aggregation is a program that allows cities, counties, and joint power authorities (JPAs) to procure electricity for individual customers within a defined jurisdiction. Customers may opt out if they do not want to participate. Electricity transmission and distribution are still the responsibility of the utility.
CEQA (California Environmental Quality Act)	The California Environmental Quality Act is a statute that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible.
CEVR (community electric vehicle ridesharing)	A CEVR is a program that enables participants to access zero-emission cars and electric bikes, as needed, to go to work, run errands, go to appointments, and attend meetings.
CPASC (Clean Power Alliance of Southern California)	The CPASC (formerly known as the LACCE) is a load-serving entity formed under community choice aggregation rules, operating within the Southern California Edison territory.
Disadvantaged Community	For this Energy Commission grant, a disadvantaged community is one located entirely within a 2010 census tract with the poorest environmental quality as defined by CalEnviroScreen 2.0 in the 75 or greater percentile range. Please refer to the following for more information: http://www.calepa.ca.gov/EnvJustice/GHGInvest/
DERiM (Distributed	Online platform for visualizing and downloading circuit-level data for electric grid capacity constraints. Southern California's electric investor-owned utility, Southern California Edison, publishes the DERiM to

Energy Resources Integration Map)	support distributed solar installations and has been continuously updating the database.
EMS (energy management system)	Energy management systems refer to any hardware or software systems that can monitor and provide feedback about a home's energy usage, and/or also enable advanced control of energy-using systems and devices in the home.
EPIC (Electric Program Investment Charge)	The Electric Program Investment Charge, created by the California Public Utilities Commission in December 2011, supports investments in clean energy technologies that benefit electricity ratepayers of Pacific Gas and Electric Company, Southern California Edison Company, and San Diego Gas & Electric Company.
GHG (greenhouse gas)	A greenhouse gas is a gas that contributes to the greenhouse effect by absorbing infrared radiation. Examples include carbon dioxide and chlorofluorocarbons.
GTSR (Green Tariff/Shared Renewables Program)	The GTSR is a program enacted by SB 43, which allows participating utility customers to meet up to 100 percent of their energy usage from eligible renewable resources.
IDER (Integrated Distributed Energy Resource)	IDER is a strategy that seeks to integrate distributed energy resources, which are defined as distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response technologies.
IDSM (integrated demand-side management)	IDSM refers to the integration of programs that reduce energy consumption or shift consumption to times when demand is lower. Programs include energy efficiency retrofits, demand response, and energy management systems.
IOU (investor-owned utility)	A private utility, regulated by public agencies, that provides utility services to residents. In California, the California Public Utilities Commission (CPUC) oversees IOU regulation and policy making.
LA Solar Map	Online map and database for property-level on-site solar electricity generation potential. Developed to provide building owners a resource for understanding solar investment options.
LACCE (Los Angeles Community Choice Energy)	LACCE is the former name of the Clean Power Alliance of Southern California, an entity formed under community choice aggregation rules.

LLR (loan loss reserve)	A loan loss reserve is a fund set aside as an allowance for uncollected loans and loan payments.
LSE (load-serving entity)	Load-serving entities are entities that have been granted authority by state or local law, regulation, or franchise to serve their own load directly through wholesale energy purchases.
MOU (municipally owned utility)	A public utility that provides utility services to residents. In California, MOUs are typically subject to local government supervisory boards and ratepayers.
NEM (net energy metering)	Net energy metering is a metering and billing arrangement designed to compensate distributed energy generation system owners for generation that is exported to the utility grid.
NPV (net present value)	Net present value is the difference between the present value of the future cash flows from an investment and the amount of investment.
NZE (net-zero-energy community)	A net-zero-energy community is a collection of properties whose local onsite energy production is at least equal to the associated local onsite energy demand over a designated period.
OBR (on-bill repayment)	A mechanism to allow customers to pay back energy efficiency upgrades over time through a line item added to their monthly utility bill.
PERC (powered emergency refuge center)	A community facility that serves as a shelter in the event of a natural disaster or power outage and that can provide emergency power for heating/cooling, recharging communications, medical equipment, and other essential needs.
PPA (power purchase agreement)	A power purchase agreement is a financial arrangement in which a third-party developer owns, operates, and maintains the energy generations system. A host customer agrees to site the system on its property and purchases the electric output of the system from the provider for a predetermined period. This financial arrangement allows the host customer to receive stable and often low-cost electricity, while the provider or another party acquires valuable financial benefits, such as tax credits and income generated from the sale of electricity.
SCE (Southern California Edison)	Investor-owned electric utility company with service territory covering much of Southern California
SoCalGas (Southern California Gas Company)	Investor-owned natural gas utility company with service territory covering most of Southern California

smart grid	Smart grid is the thoughtful integration of intelligent technologies and innovative services that produce a more efficient, sustainable, economic, and secure electrical supply for California communities.
TOU (time of use)	Time-of-use is a rate plan in which rates vary according to the time of day, season, and day type (weekday or weekend/holiday). Higher rates are charged during the peak demand hours and lower rates during off-peak (low) demand hours. Rates are also typically higher in summer months than in winter months. This rate structure provides price signals to energy users to shift energy use from peak hours to off-peak hours.
UCLA Energy Atlas	The UCLA Energy Atlas for Southern California, http://www.energyatlas.ucla.edu/ , is the only meter-level energy consumption dataset in California. At the core is a geospatial relational database that connects address level energy consumption to building characteristics and census information. Customer privacy is maintained through data aggregation to meet nondisclosure guidelines.
VNEM (virtual net energy metering)	Virtual net energy metering is a tariff arrangement that enables a property owner to allocate the property's solar system's energy credits to residents outside of that property. This allows community members to share the benefits of renewable energy even if they cannot install solar generation on their own property.
ZC (zero carbon)	A zero-carbon community is a collection of properties that obtains 100 percent of its energy from renewable resources. Such a community would not have any natural gas appliances and would be served by a microgrid connected to the renewable generation assets.
ZNE (Zero Net Energy)	A zero net energy community is a collection of properties whose local onsite energy production is at least equal to its local onsite energy demand over some designated period.
ZNElec (Zero Net Electricity)	A zero-net-electricity community is a collection of properties whose local onsite, or community, electricity production is at least equal to its local onsite energy demand over some designated period.