

Building Advanced Energy Communities, One Community at a Time

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ABSTRACT

This paper explores how an advanced energy community project funded by the California Energy Commission (CEC) Electric Program Investment Charge (EPIC) grant is developing models for affordable and accessible energy-producing communities.

Focusing on an advanced energy community project in Southern California, this paper highlights how these types of projects are addressing technical, financial, and social barriers to behavioral models that reduce greenhouse gas emissions.

The advanced energy community project aims to provide locally produced renewable energy to disadvantaged communities (DACs) in the San Gabriel Valley of Los Angeles County. The project takes a community-wide approach and will include a resiliency microgrid that offers safety during prolonged power outages, electric vehicle charging infrastructure, rooftop solar panels and battery systems, community solar for clean affordable electricity, and a mobile application for monitoring and managing energy use.

This paper details how advanced energy communities are bringing together diverse communities to help residents save on energy bills, reduce pollution, improve air quality, empower people, and decarbonize communities across California by producing local energy while ensuring DACs are not left behind in the transformation of our renewable energy future.

Introduction

In 2016, the CEC launched its Advanced Energy Communities (AEC) challenge with funding from the EPIC program (CEC EPIC). In late 2020, after receiving a phase 1 planning and design grant, the Bassett and Avocado Heights Advanced Energy Community (BAAEC) was one of only four phase II projects selected for construction. BAAEC's phase II kicked off in mid-2020 and will conclude in March 2025, with its construction phase expected to take place from late 2022 through early 2024.

With a focus on low-income and under-resourced communities, this paper discusses the challenges and opportunities of developing models for an equitable and just energy transition. It uses the BAAEC project experience, with people at the center of community-wide solutions, to take demonstrable steps towards successful and scalable solutions. The paper is not a detailed analysis of any one project feature. Instead, it reviews the intersection of advanced technologies, financial business models, regulatory considerations, and stakeholder partnerships for community-wide customer benefits that also accelerate the transition to a low carbon future.

The premise of BAAEC's design is the belief that we need collective action to address climate change. Studies show that community identity and engagement in community activities increases motivation for sustainable energy initiatives (Goedkoop, Sloot, and Jans 2022). Therefore, the BAAEC project has been designed to build community, achieve financial benefits, and create an uplifting experience for participants. BAAEC is creating cultural and societal change by providing resources and experiences that empower people to be environmental champions and lead their communities in the clean energy transition. This behavioral change can

only happen if we have the technology, business models, and policy to create an enriching experience for community participants.

Features of an Advanced Energy Community

The modern grid must integrate distributed energy resources (DERs) and build resilience and reliability. By supporting community acceptance and adoption of DERs, advanced energy communities can catalyze the creation of a decentralized, digital, and democratic electricity grid. Rather than a grid dominated by large, centralized utilities, a democratic grid is a network of smaller independently owned and widely dispersed renewable energy generators. BAAEC will focus on solutions for low-income and disadvantaged communities to demonstrate how the transition to local, clean, and affordable energy can be just and equitable. BAAEC's design takes a customer-focused approach and addresses resilience to climate change, access to local and affordable clean energy, innovation in managing and selling electricity, residential electrification, transportation electrification, and new modes of transportation. These benefits are the result of the seven individual project elements described in more detail in the sections below.

1. Energy Hub Community Resilience Center

BAAEC includes a solar + storage microgrid called the Energy Hub. BAAEC's Energy Hub will be a community center where people can take refuge during extreme heat or brownouts and blackouts. The facility will be located within the BAAEC community, will have space and amenities important for critical services, and will include solar energy and a 4-hour battery storage system that can power the facility when the grid is down. BAAEC surveyed the community and found overwhelming support for an existing Los Angeles County park as the site for the Energy Hub.

As noted by the Urban Sustainability Directors Network (USDN) in their description of resiliency hubs (another name for Community Resilience Centers), these projects provide important services during normal operations, during a climate change-related event, and in the recovery stage after an event. How a resiliency center serves the community is as unique as the community itself (Baja 2018).

The Bassett and Avocado Heights communities' most severe climate vulnerability is extreme heat, which is one of the deadliest consequences of climate change (Phillips, Barboza, and Vives 2021). Therefore, BAAEC's goal is to protect against extreme heat days (temperatures above 90 degrees) and heat waves (three or more days of extreme heat) (Phillips, Barboza, and Vives 2021). High density neighborhoods and little vegetation or tree canopy create a disproportionately higher risk of extreme heat in poor and minority communities (Benx and Burney 2021). The BAAEC project team, which includes two community-based organizations and the project's Community Advisory Committee (CAC), is involving the community in the design and implementation of the BAAEC Energy Hub. The BAAEC team has identified the best practices below through its early work creating an island-able microgrid resilience hub:

1. *Existing energy consumption:* confirm the amount of electrical load of the building can be offset by adding solar.

2. *Suitability for solar*: review the potential for rooftop solar considering shade, roof condition, potential for solar canopy. Size the solar system to offset as close to 100% of the historical annual consumption as economically feasible.
3. *Existing electrical infrastructure*: review the condition of the electrical switchgear and building wiring to ensure infrastructure is able to isolate loads that provide resilience through battery storage (critical loads).
4. *Critical load*: determine the critical load needed to power essential services in island operation, based on the facility's peak consumption period.
5. *Battery storage*: Size the battery storage so that there is both economic value from time-of-use arbitrage during normal, blue-sky conditions and resiliency value from a battery capacity that can power critical load, noting that it is possible for the battery to power through the night and be recharged with solar power the following day to provide a longer period of operation.

Across all project elements, the BAAEC team is engaging with the community to design around their needs and priorities. BAAEC's approach to its Energy Hub aligns with the principles presented by the Asian Pacific Environmental Network's Resilience Before Disaster Report (Lou, Raval, and Young 2020). However, BAAEC had to make some adjustments and compromises. Table 1 below identifies challenges and early recommendations for solutions that can support the infrastructure buildout of community resiliency centers at scale.

Table 1. Challenges and opportunities for community resilience centers

Challenge	Typical compromise	Opportunities for a solution
<i>Siting and utility interconnection.</i> Time-intensive and expensive studies and lacking transparency create a barrier in the resiliency center design process.	The community compromises with a location that can meet circuit hosting capacity and utility interconnection requirements.	The community receives transparent and streamlined interconnection analysis for sites of interest early in the process.
<i>Utility franchise rights.</i> Rules vary but, in general, franchise rights relate to how and whether entities other than the utility can provide electricity to customers.	A solar + storage microgrid behind a single customer utility meter is built when a campus-type approach could achieve better economies of scale and bring enhanced community services.	Establish policies, develop funding opportunities, and create processes for working with utilities to allow for multiple customer microgrids.
<i>Upfront financial investment.</i> Building infrastructure to protect against climate change events is capital intensive and unlikely to happen without government	Limited government funding is available to pilot projects that would otherwise not be built. Limited funding and programs prevent industry business model innovation to	Give local governments a leadership role as part of updating franchise rights and incentivize microgrids through rate reform and wholesale market

leadership.	accelerate project development.	participation.
<i>Operation during “blue sky” conditions.</i> Microgrids must have a business case under normal operations and must not only serve emergency events.	No funding or provisions are made to enhance current services. Under blue sky conditions, resilience centers have the potential to be hubs for enriching community activity.	The investment in solar, storage, and other energy systems in microgrids should be valued for their resilience benefits during emergencies <i>and</i> for grid services in non-emergency events.
<i>Operation during extreme heat events.</i> The consequences of extreme heat events (or other emergencies based on vulnerability to climate change) require proactive resilience center design that can meet the needs of the community.	Other than shelter and backup electricity, early microgrids do not include comprehensive support services that meet the needs of the community during climate change events.	Departments within the county can collaborate and bring multiple sources of funds to allow resilience centers to successfully support the community during extreme climate events. For example, centers can provide access to resources such as medical supplies, fresh water, ice, food, refrigeration, internet, and charging stations.

2. Community Solar

Community solar is growing across the United States, with a 121% year-over-year cumulative growth rate since 2010 (Heeter, Xu, and Chan 2021). Unfortunately, despite its many benefits, California has struggled to develop a community solar market and lags behind other states. As of the end of 2020, most of the community solar market (about 72%) was found in four states: Minnesota, Florida, Massachusetts, and New York (Heeter, J., Xu, K., Chan, G. 2021).

Community solar is driven by state-level programs where funding, policy and regulation create the market. Issues of equity can therefore be addressed through specific policy and program design. BAAEC will create project benefits in the Bassett and Avocado Heights communities by overcoming program design and implementation barriers. The project will then develop recommendations that influence state-level reform and support a successful community solar market in California.

BAAEC includes a community solar feature as part of its design. Community solar is a crucial component of the BAAEC project’s community-wide demonstration of a decentralized grid since it allows renters, homeowners without a roof suitable for solar, and households unable to finance their own project to access local and renewable energy. Unlike larger, remote utility-scale solar projects connected to the transmission grid, community solar projects can be adjacent to the communities they serve and connected to the distribution grid. Community solar can socialize development and soft costs, benefit from economies of scale, and solve local renewable energy accessibility and affordability issues. One study found that because of historical inequities in maintenance and investments in the distribution grid, less affluent

communities may have a harder time installing rooftop solar and other residential DERs (Brockway, Conde, and Callaway 2021).

BAAEC is developing a community solar project through a competitive solicitation process with Clean Power Alliance (CPA), the direct buyer of the project's electricity production, as further described below. As a Community Choice Aggregation (CCA) and state load-serving entity (LSE), CPA has an allocated community solar capacity to build through California Public Utility Commission (CPUC) programs created in June 2018 (CPUC 2018) and rolled out by utilities and CCAs in 2020.

BAAEC is developing a community solar project within the Community Solar Green Tariff (CSGT) program of the CPUC. The project will provide approximately 1 megawatt of power to supply local and renewable energy to a few hundred households. Funding from the CPUC allows the utility or CCA to buy community solar projects' electricity generation at a market-based retail rate, instead of paying wholesale rates from the traditional procurement of utility-scale solar. The CSGT program provides participating households with a 20% discount on their utility electricity bill. This consolidated billing and meaningful discount for subscribing customers is a valuable program design, but the program has its challenges.

Organizations like BAAEC that are pursuing community solar in California may struggle with project siting and interconnection uncertainties. Community solar project sites need to have suitable solar generation potential and adequate electrical infrastructure and cannot be paired with energy storage, as per current program policy (CPUC 2018). Moreover, the CSGT requires projects to be within 5 miles of the census tracts where subscribers reside.

3. Advanced Homes

BAAEC includes an Advanced Homes program, which provides rooftop solar, battery storage, a heat pump water heater (HPWH), and energy efficiency and weatherization measures for each participating home. Advanced Homes receive electric-ready assessments as a first step towards electrical infrastructure upgrades that prepare the home for an electric-only future. The project will optimize behind-the-meter end uses (appliances, etc.) and allow home battery storage and other smart devices to participate in the wholesale market via a virtual power plant. BAAEC's Advanced Homes program is identifying barriers to decarbonizing single-family homes, particularly those in low-income communities. Below are three key areas of focus: electrifying end uses, adding intelligent controls, and enabling homes to be grid-interactive efficient buildings.

Installation insights for residential electrification. BAAEC is developing best practices to systematize energy upgrades to existing single-family homes. The BAAEC team is working with low-income households using the CEC's Disadvantaged Communities – Single-Family Solar Homes program to partially pay for solar, the Self-Generation Incentive Program to partially pay for the battery storage, and the Technology and Equipment for Clean Heating statewide initiative to partially pay for the HPWH.

As of 2022, costs are still prohibitive for Advanced Home technologies, especially for low-income households. To support low-income families, BAAEC has to coordinate multiple funding sources, each with unique eligibility requirements, and must manage overwhelming installation logistics. As we build the roadmap for healthy, resilient, zero-carbon homes, the

following challenges identified through the BAAEC project may help influence program designs and the allocation of funding from state agencies.

1. *Roofs*: particularly in low-income communities, old roofs needing to be replaced are a leading barrier to installing rooftop solar.
2. *Unpermitted structures*: residential DER upgrades trigger complete building code inspections by the local Authority Having Jurisdiction. For households with unpermitted structures, this can lead to penalties, fees, or demands to rebuild that cause substantial negative economic impacts.
3. *Electrical wiring and panel upgrades*: most older homes must undergo circuit tracing, electrical rewiring, and upgrades to the main service panel (MSP) to support rooftop solar.
4. *Battery location*: communities in densely populated urban areas may not have adequate space for batteries inside garages.
5. *HPWH location*: Based on BAAEC’s community outreach experience, the recommended system upsizing (compared to traditional gas water heaters), drainage and ventilation requirements often prohibit the upgrade to clean and efficient HPWHs.

Intelligent controls in smart, Advanced Homes. In 2008, regulation from the CPUC (Rulemaking 08-12-009) required investor-owned utilities (IOUs) to submit smart grid deployment plans which included a Home Area Network (HAN). The CPUC concluded that a “smart grid” can decrease the need for other infrastructure investments and these benefits should be considered when planning infrastructure (CPUC 2010). The IOUs later filed Implementation Plans (per Decision 11-07-056) to initiate the HAN deployment, giving people access to real-time data from smart meters (advanced metering infrastructure, or AMI meters) so that customers can monitor their energy consumption.

Working with IOU-authorized access to smart meters is just one way that the smart devices industry has developed business models for Home Energy Management Systems (HEMS) that provide customers with transparent and actionable information. There are now systems-level approaches such as the ENERGY STAR® certification of Smart Home Energy Management Systems (SHEMS) and device- or appliance-specific demand management controls per Title 24 (Part 6, Sections 150.1(b)) performance standards (CEC 2019). One example is Appendix JA13 for HPWHs, which allows for daily load shifting “for the purpose of user bill reductions, maximized solar self-utilization, and grid harmonization” (CEC 2019).

BAAEC is demonstrating the potential role of whole-house load optimization as part of a modern grid. There are hardware and software elements of home energy management systems, and the BAAEC team recommends consideration of the following criteria as listed in Table 2 below.

Table 2. HEMS consideration for electric homes that participate in energy markets

Consideration	Parameters to consider and research objectives
Real-time monitoring and historical performance	Customers require energy consumption patterns data (collected at circuit breaker or main service panel, at plug-load and/or at the device/appliance level) and energy production performance data (from solar inverter).

tracking	
Forecasting	Machine-learning and artificial intelligence or otherwise sophisticated algorithms should provide forecasts of the energy bill, analyzing past usage and behavior patterns, weather data and energy systems (solar, electric and thermal battery systems) settings and programs.
DER integration and control	End-use load management requires the communication with and control of smart appliances as well as rooftop solar generation and storage DERs in the home.
User-friendly programming	HEMS must allow their optimization algorithms to be easily configured by users to optimize around comfort, economic value and/or GHG emissions reductions.
Grid connectivity	Value of home load optimizations and dispatching to the grid must be recognized through proper grid connectivity standards (OpenADR, 2030.5).
Interoperability	Communication and interoperability standards (e.g., ZigBee, Z-Wave, Wi-Fi, Modbus, Sunspec, DNP3) should allow homeowners to build HEMS across the home and with smart features (e.g., Alexa compatibility).
Hardware metering technology and installation	HEMS should balance customer value with cost-effective metering technology (bandwidth, latency, frequency) and installation options (e.g., plug load sensors, gateways, current transformer meters, utility meter collars, electromagnetic interference).

Energy market participation for residential grid-interactive efficient buildings. The BAAEC demonstration project is exploring business models for low-income households in DACs to participate in energy markets. Advanced Homes will use wholesale market participation to explore how monetizing behind-the-meter load can create revenue that can help pay back the DERs' initial investment. Building on the load optimization strategies described above, effective energy market participation may take any of the forms listed in Table 3. Though we acknowledge that each of these models is deserving of much more detail and discussion, they are introduced at a high level and generalized for comparative purposes only.

Table 3. Energy market participation strategies for residential buildings

Market participation model	Pros	Cons
<i>Demand response (DR) programs:</i> traditional DR programs provide bill credits or rewards for reducing electricity a few times a year during planned DR events with advanced customer notification.	Often a simple enrollment process. DR events are simple and transparent for customers and opting out of an event is often without penalty.	Credits or compensation is relatively small. Customers must decide among various IOU/CCA/third-party programs. There are un-enrollment requirements. Often, only a single device in the house is participating.
<i>Utility time-of-use and dynamic rates (also referred</i>	May offer utility savings for those that can change	Relatively new or in pilot stages. Requires more sophistication from

<i>to as real-time-pricing):</i> utilities use innovative rates to change customer behavior and align consumption with economic and grid conditions.	usage patterns. Can potentially capture the value of properly commissioned and programmed DERs and smart appliances.	customers to understand the value compared to other tariffs. Is a generalized rate design for a larger segment and may not be a fit for everyone.
<i>Utility virtual power plant programs:</i> a potential tool to defer infrastructure investments and/or a load modifying strategy to reduce resource adequacy obligations.	Can address constraints on specific segments of grid infrastructure. Potentially can provide higher incentives for participation. Has the potential to socialize cost and benefits across ratepayers.	Limited eligibility to targeted segments of grid infrastructure. Program offerings may differ across utilities and areas, creating customer confusion. There is no mechanism to guarantee that utility savings, whether from infrastructure deferral costs or from energy/capacity procurement savings from demand curtailment programs, are passed on to ratepayers.
<i>Third-party aggregators:</i> powered by sophisticated asset orchestration software, companies enroll participants and aggregate dispatchable load to meet existing resource adequacy (RA) contracts.	May offer program consistency over longer terms. Can benefit from non-utility program design and technology innovations.	May not benefit from higher incentives of utility pilot programs. Requires brand recognition as an alternative to the utility. Can include performance requirements as part of the participation agreement.

Developing policies to govern the models in Table 3 will be especially important for low-income households who may need grid service revenue to help pay for investments in clean energy, such as rooftop solar.

Industry groups are already envisioning a grid with high rates of residential DERs. For example, the Energy Systems Integration Group’s Distributed Energy Resources Task Force report (McDonnell, Gorman, and Kahrl 2022) discusses models for DER participation in energy markets and notes the role of a Distributed System Operator (DSO). This paper does not address more substantial reforms of the distribution grid, but notes that a high DER future—especially an equitable and just one—does require reexamining what energy markets should look like. One such transformational change may be the Federal Energy Regulatory Commission’s (FERC) Order No. 2222, which is FERC’s way to “usher in the electric grid of the future and promote competition in electric markets by removing the barriers preventing distributed energy resources (DERs) from competing on a level playing” (FERC Fact Sheet 2010, 01).

BAAEC considers the following principles critical to successfully scaling up solutions for low-income households:

1. Avoid utility bill increases by coupling DERs with technology and business models that ensure reliability and resilience.
2. Provide comprehensive services with consumer protection in mind. DER business models for low-income households should prioritize data privacy and consumer protection in equipment specifications, installation and commissioning practices.

3. Avoid repeating historical inequities as the energy industry goes through a clean energy transformation. Do not shy away from viable business models that have the potential to uplift those with fewer resources.

4. Prosumer Network

BAAEC will include a prosumer network field-based simulation. This project will simulate a transactive energy platform that measures, validates, and transfers carbon emission credits and dispatches energy within a network of homes. The platform will enable individual customers to choose when to be a consumer and when to be a producer of energy. We refer to these customers as prosumers. With rooftop solar production of electricity, battery storage, and behind-the-meter load management, prosumers can supply electricity to the grid. This is what a decentralized and democratized grid could look like, made possible by the internet of things (IoT) and blockchain technology to reduce the transactional costs of electricity bill settlement.

BAAEC's prosumer network simulation will test this technology with real-time tracking of Advanced Homes participants' energy consumption, production, and electricity carbon intensity. The information will be accessible to prosumers via a smartphone mobile application, fed by a sensor-to-satellite communication node at the home, and converted to a cryptocurrency as a proxy of the value generated by the prosumer's behavior. With the Prosumer Network, customers will no longer receive confusing utility bills that settle days after the end of the month and give customers little useful information. In the modern grid, where customer-owned DERs tap into the bidirectional flow of electricity in the distribution grid, prosumers can monetize their investment while building their own reliability and resiliency—keeping the lights on in the event of a grid outage.

BAAEC's Prosumer Network is a valuable field experiment because it incorporates real-world data by installing distributed assets in people's homes and communicating with customers via a mobile application. The simulated experiment uses a transactive energy model, a concept that addresses the bi-directional flow of energy in the grid of the future, where electricity generation is found at many points in the distribution grid. According to the GridWise Architecture Council (GWAC), the term "transactive" refers to the value that can be unlocked from economic or market-based constructs within the flow of electric power (GridWise Architecture Council 2015). DERs offer customers the means to control when and how much grid electricity they use, and transaction can help the utility offer new tariff options to best capture the demand flexibility on the customer's side of the meter. It could also allow aggregators of distributed assets to fulfill customer needs and the load management obligations of their capacity contracts. BAAEC is exploring the use of transactive energy as a means to include low-income customers in the clean energy future. Our simulation will test the hypothesis that a prosumer network can monetize dispatchable energy and allow low income residents to recoup investments in residential DER. BAAEC's Prosumer Network will help determine how much equity a prosumer network can bring to the energy transition.

As the electricity grid is decarbonized with renewable energy at scale and high DER adoption, the grid will need increased demand flexibility. A prosumer network can smooth out demand peaks by optimizing load within its participating group of prosumers. The prosumer network fits in Stage 3 of the transactive energy roadmap by the GridWise Alliance, as depicted in Figure 1 below, where there are high levels of DER adoptions and multi-party transactions and market operations (Gridwise Alliance 2019).

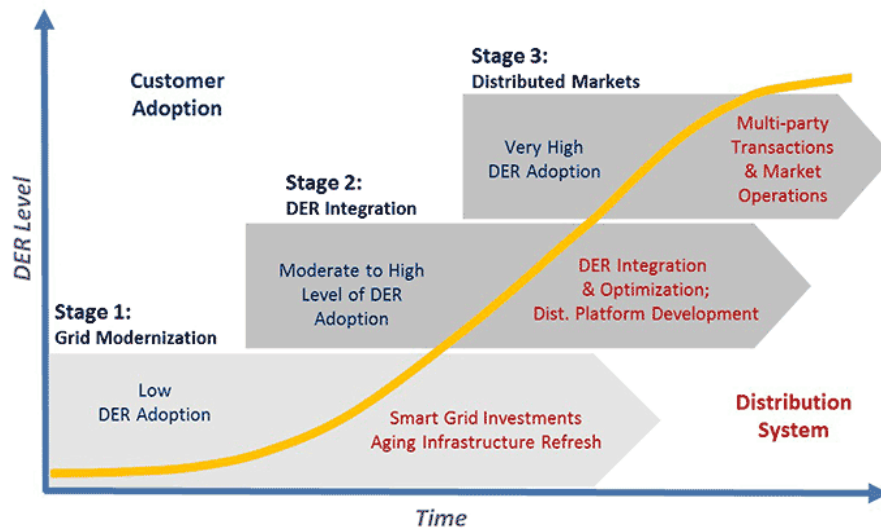


Figure 1. The GridWise® Architecture Council transactive energy roadmap outlines a vision to deploy transactive energy systems at scale as an operational element of the electric power system. [Illustration](#) courtesy of GridWise Alliance.

BAAEC is working through more than just cybersecurity and interoperability issues from emerging technologies. The project is focused on understanding the human element of a modern grid. BAAEC is focused on developing business models that allow for an equitable distribution of DERs. For price-sensitive low-income households spending a disproportionate amount of their income on utility bills (Borenstein, S., Fowlie, M., and Sallee J. 2021), a prosumer network with transactive energy contracts could potentially offer a revenue-creating and empowering tool.

Energy communities are an emerging business model across the world (Cuenca, Jamil, and Hayes 2021). For BAAEC, the energy community could take the form of peer-to-peer transactions, where prosumers sell excess energy to each other. Alternatively, the project can test regulatory reforms and new market designs with a peer-to-market approach, which would provide demand flexibility for the utility and/or the regional independent system operator (ISO). BAAEC's prosumer network will test customer-centric algorithms and optimization strategies that give customers more control over their utility rates. A prosumer network could offer new tools for low-income customers to earn revenue while reducing the need for gas peaker plants by reducing peak demand. The modern grid will bring wholesale and retail pricing closer together, with more stakeholders taking part in a balanced and reliable grid. BAAEC is working to ensure that as this new energy economy evolves, the interests of low-income households are prioritized.

5. EV Infrastructure and Zero-Emissions Mobility Options

BAAEC includes Clean Commuters, which features electric vehicle (EV) chargers, a community vanpool, and a zero emissions community shuttle for on-demand micro transit services. State and local policy are driving investment in a zero-emissions transportation system. California aims to have 1.5 million zero-emission vehicles on the road by 2025 (GIWGZV 2013) and Los Angeles County aims to have 60,000 EV chargers countywide by 2025 (SCO 2019). BAAEC will demonstrate strategies to drive customer acceptance for electric vehicles through

education and awareness campaigns, such as the energy leadership academy and field demonstrations of how to operate EV chargers. Cleaning the transportation sector without addressing our car-loving culture will keep us from healthy, walkable cities. BAAEC's Clean Commuters is designed to address this by reducing vehicle miles traveled while improving access to public transportation.

EV Chargers. The Bassett and Avocado Heights communities, like many under-resourced communities, is an EV charging station desert. BAAEC is installing up to 20 EV chargers at school sites and community parks throughout the community. By surveying community residents, BAAEC will study if electric vehicle purchasing behavior changes with increased availability of public vehicle charging.

Modal shift in transportation. BAAEC envisions an advanced energy community where cultural and social norms move us beyond cars. The demonstration project for zero emissions vanpool and on-demand micro transit shuttle service will reduce tailpipe emissions and may also provide insights into what might shift our car-loving culture towards low carbon shared mobility options.

6. Air Quality

BAAEC includes both hyperlocal ambient air quality monitoring and tailpipe emissions air quality monitoring. The project is focused on Bassett and Avocado Heights, two disadvantaged communities with high vulnerability to the impacts of climate change and communities that are overburdened by pollution. The California Communities Environmental Health Screening Tool (CalEnviroScreen) was used to identify and target the project location.

BAAEC connects activities with their negative environmental and health impacts by highlighting the type and source of pollutants in the air. One of the project's goals is to increase the adoption of clean and renewable energy solutions that reduce reliance on fossil fuels. The project will develop awareness around clean energy technologies by educating the community on its air quality, and identifying reduction strategies that can guide future advanced energy communities.

BAAEC's ambient air quality monitoring includes measured levels of carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), ozone (O₃), methane (CH₄), fine particulate matter (PM_{2.5}), and black carbon (BC) at 1-second intervals every ~100 meter segments. The project's first of three phases of mobile monitoring show improved data granularity relative to the area's fixed monitors provided by the Environmental Protection Agency (EPA). The community can compare BAAEC's hyperlocal measurements to the EPA's standards, California's standards, and World Health Organization guidelines, as demonstrated in Table 4 below (WHO 2021).

Table 4. Sample comparison of observed pollutant data to pollution standards/guidelines

	US Federal Standard	California Standard	WHO 2021 Guidelines	BAAEC Observed
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Pollutant / Exposure Time	3-year Annual Mean	3-year Annual Mean	Annual Mean	3-month Median
Fine Particulate Matter (PM2.5)	15 µg/m ³	12 µg/m ³	5 µg/m ³	Highest segment 18.6 µg/m ³

BAAEC's tailpipe air quality monitoring includes nitrogen oxides (NOx) emissions from a cross-section of vehicle types. This data will add to the community's environmental and air quality capacity and helps to identify high-polluting vehicles so they can be prioritized for replacement as we clean the transportation sector.

7. Community Outreach

BAAEC's advanced energy community design has people at the center. BAAEC will reach out to the community to educate community members and inspire them to take an active role in their advanced energy community. Our community-centric approach means that we are focused on creating tangible benefits for people across all aspects of the community. BAAEC's project features were developed based on a multi-year planning and design process that the community helped shape through surveys, workshops, and community events.

As BAAEC moves through implementation, the Technical Advisory Committee (TAC) and Community Advisory Committee (CAC) will provide guidance to ensure the project is meeting the community's needs. BAAEC's activities stem from a thoughtful outreach, engagement, and enrollment plan that was co-developed with the project's two community-based organizations

As the BAAEC team works to create an advanced energy community, we will conduct empowering outreach that uplifts people by providing information, access, ownership, and control over technologies, career options, and wealth-creating business models. BAAEC will create a youth advocacy program to get local students trained on BAAEC's projects and involved in local energy actions. BAAEC will also create an energy leadership academy to train adults in the community on environmental justice, local advocacy, and BAAEC's work. The following core values guide our work to create a participatory, collaborative community engagement.

Table 5: Community engagement core values

Authentic relationships	Equity, inclusion, and diversity	Transparency and trust-building	Community empowerment
Collaboration and shared purpose	Openness and learning	Collective impact and action	Sustained engagement and participatory culture

Conclusion

As part of modernizing our electricity grid, we must harness the value of distributed resources. A resilient, reliable, modern, and balanced grid is one where communities have agency and play an important role in meeting their own economic and resiliency needs.

This paper presents community-wide and customer-centric models to support an equitable and just energy transition. By sharing the design and early best practices from BAAEC, as well as the technical, financial, and social barriers being addressed, the paper makes the case for transformative projects that include local communities as part of the energy transition. In the coming years, BAAEC and similar projects will demonstrate that families can save on their utility bills while reducing pollution and improving air quality.

An advanced energy community like BAAEC can encourage and accelerate the adoption of advanced technologies, benefiting participants and inspiring others to think at community scale. By demonstrating economic feasibility, documenting performance, and vetting outreach strategies for customer acceptance, BAAEC is looking to identify behavioral and business models for scalable solutions that serve both customers and the grid.

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