ENERGY RESEARCH AND DEVELOPMENT DIVISION

FINAL PROJECT REPORT

The Lancaster Advanced Energy Community Project

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PREFACE

The California Energy Commission's (CEC) 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; transportation; and energy transmission and distribution.

In 2011, 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 EPIC Program is funded by California utility customers under the auspices of the California Public Utilities Commission. The CEC and the state's three largest investor-owned electric 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 CEC is committed to ensuring public participation in its research and development programs to promote greater reliability, affordability, and safety for California electric ratepayers. EPIC investments advance these values by:

- 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 projects), and finally with a clean electricity supply.
- Supporting low-emission vehicles and transportation.
- Providing economic development.
- Using ratepayer funds efficiently.

The Lancaster Advanced Energy Community Project is the final report for EPC-18-011 conducted by Zero Net Energy Alliance and Community Energy and Equity Resources. The information from this project contributes to the CEC Energy Research and Development Division's EPIC Program.

For more information about the Energy Research and Development Division, please visit the CEC's research website (www.energy.ca.gov/research/) or contact the Energy Research and Development Division at ERDD@energy.ca.gov.

ABSTRACT

This report presents key findings from the Lancaster Advanced Energy Community Project, led by the Zero Net Energy Alliance (prime contractor) and Lancaster Energy, a community choice aggregation serving the City of Lancaster, which is approximately 70 miles north of downtown Los Angeles. Key challenges and solutions addressed in this implementation phase of the California Energy Commission's Advanced Energy Community Initiative included:

1. Development of an innovative virtual power plant and an enterprise-level distributed energy resource management system focused on the unique needs of community choice energy providers.
2. Strategies to scale deployment of customer-sited distributed energy resources via innovations in finance, incentives, and customer engagement.
3. Virtual power plant integration of three large-scale community microgrids, solar+storage, and flexible loads that enhance resilience and reduce customer bills and utility procurement costs.

The project also demonstrated effective strategies that optimize the value of distributed energy resources by leveraging the ability of community choice aggregators to act as registered demand response providers. Customers participating in the Lancaster Virtual Power Plant also received an innovative flat-rate value-sharing tariff, distributed as a monthly bill credit. To promote rapid adoption of virtual power plant software, the project created a low-cost perpetual user license that has been offered to all community choice energy agencies. This enables other community choice aggregations to take operational control of a custom-tailored virtual power plant platform that features open-source code stacks (supported by OpenADR and the Linux Foundation), which in turn enables ongoing collaborative refinement by customers and other development partners.

In summary, the virtual power plant platform and advanced energy community program framework demonstrated multiple co-benefits for Lancaster customers, the community choice aggregator, the electric grid, and the broader community. These include bill savings, peak load and greenhouse gas emission reductions, improved resilience, new revenue streams from demand response program participation, and a statewide scale-up pathway for broader virtual power plant deployment.

Keywords: community choice aggregation, virtual power plant, distributed energy resource, demand response provider, Distributed Energy Resource Management System, community microgrid, value-sharing tariff

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Background

The Lancaster Advanced Energy Community Project demonstrated that a virtual power plant owned, operated, and purpose-built for community choice aggregator applications can support California's clean energy and climate mandates while realizing the full economic potential forecasted for virtual power plants in California. Virtual power plants use software to link distributed energy resources — such as rooftop solar panels, home battery systems, smart thermostats, and commercial building controls — into a virtual network capable of collectively responding to energy demands at the source. Virtual power plants use digital control systems to shift or reduce overall demands on the grid at key times of day, allowing communities and individual ratepayers to consume electricity both more efficiently and cost-effectively.

This project is timely since it was specifically designed to support flexible load deployment targets and other key state policy goals for:

- **Grid Reliability:** The virtual power plant can be deployed to reduce energy imbalances on the grid.
- **Grid Decarbonization:** Increased battery energy storage and more efficient load management can increase the availability of carbon-free electrons.
- **Customer and Grid Upgrade Cost Reductions:** By increasing reliance on onsite energy generation, storage, and flexible load management, distribution and transmission upgrade costs can be avoided.
- **Local Resilience:** The project contributes to local resilience by demonstrating innovative financing and deployment approaches for microgrids and solar+storage assets at critical facilities.

Project Purpose and Approach

The Lancaster Advanced Energy Community pilot was designed to address a suite of challenges including the integration of renewable energy into the grid, temporal imbalances in power production and peak demand, the need for enhanced local resilience (considering growing climate impacts), and cost challenges for community choice aggregators, customers, and communities in developing zero-net-energy residential subdivisions.

This pilot addressed these challenges by funding the development of stand-alone and microgrid-integrated distributed energy resources deployable through a virtual power plant owned and operated by Lancaster Energy, a community choice aggregator. The project team sought to aggregate substantial solar photovoltaic, energy storage, and managed flexible load. Initial project development targets identified in the project's planning period (2016-2017) included a virtual power plant framework that would integrate:

- A residential microgrid consisting of 430 kilowatts of solar generation and 1,140 kilowatt-hours of storage, equipped with a new residential rate design.

- A Green District project comprising 2.5 megawatt-hours of flexible load, built with a novel public-private finance model to overcome upfront-cost barriers.
- A resilient community network comprised of multiple renewable microgrids within the city of Lancaster, with a total of 1.2 megawatts of solar power generation and 540 kilowatt-hours of storage.

In addition to ratepayer-focused benefits including resilience, decarbonization, and rate control, the project also demonstrated a new business model for community choice aggregators that leverages virtual power plants, public and private storage-ownership models, residential microgrids, and innovative rate designs to generate revenue and avoid cost. This pilot generated important learnings for state agencies, community choice aggregators, load-serving entities, customers, and industry partners.

Key Results and Conclusions

The project achieved the following key results.

- **Community Microgrids:** Constructed three major community microgrids and integrated them into the Lancaster Virtual Power Plant, providing resilience benefits at critical facilities.
- **Innovative Rate and Program Design:** Established a commercial Green District program that leveraged public and private financing to deploy substantial distributed energy resources at existing facilities. Customer benefits included enhanced resilience, energy savings, bill credits, incentives (ranging between $55,000 and $150,000 per year), and a value-sharing tariff.
- **Community-Focused Virtual Power Plant:** Deployed a community-focused virtual power plant (overseen by Lancaster Energy) that integrated distributed energy resources with grid services markets (including demand response programs), which provided:
    - Community choice ownership and operation that allowed Lancaster Energy to capture the full value of the virtual power plant for community benefit.
    - An enterprise-level distributed energy resource management system purpose-built to include a community choice aggregation-specific feature set, secured through a low-cost perpetual user license that encourages co-development among all users.
    - An open-source code and open communication protocols that streamlined vendor integration, limited licensing costs, enhanced interoperability, minimized business model conflicts, and mitigated privacy and security challenges.

Knowledge Transfer and Next Steps

The project team developed the following tools and strategies to support scale-up of advanced energy communities and virtual power plants.

- **Advanced Energy Community and Virtual Power Plant Roadmap:** This white paper shares lessons learned from the pilot that address distributed energy valuation, finance, and deployment strategies to promote scaled adoption of these innovations.
- **Community Microgrid Policy Recommendations:** Project partners convened an advisory group that included other advanced energy community project partners to collaboratively develop innovative policy recommendations that support the scaled deployment of community microgrids. Following publication of the white paper, aligned advocacy coalitions advanced work to implement the policy framework.
- **Community Microgrid Design Guide:** This document describes an innovative "nanogrid network" design created to overcome regulatory challenges faced by master-metered microgrids while enabling integrated site-wide microgrid management across multiple buildings and rights-of-way.
- **Market Development and Scaled Finance:** The project team presented project results and strategies at the California Climate Policy Summit, seminars co-hosted by the California Community Choice Association, and through direct outreach to leading community choice operators. The Zero Net Energy Alliance also supported scaled deployment strategies in Los Angeles County with The Energy Coalition and the multi-billion-dollar Vision 2026 Los Angeles County Clean Energy and Climate-Focused Bond Initiative, co-led by Move LA, to appear on the 2026 ballot (now targeting the 2028 ballot).

The Lancaster Advanced Energy Community demonstrated the technical and economic feasibility of a virtual power plant purpose-built for the community choice energy marketplace. When combined with customer-friendly tariffs, scaled finance, and community microgrid networks, this comprehensive advanced energy model will help California communities achieve greater resilience, reduce energy costs, and lower greenhouse gas emissions.

CHAPTER 1: Introduction

Advanced Energy Community Planning and Implementation

The California Energy Commission (CEC) launched its advanced energy community (AEC) solicitation to fund the planning and development of integrated clean-energy solutions designed to transform California communities into models of energy sustainability and resilience. A nearly 2-year planning period (Phase 1) was followed by the 6-year implementation project presented in this report (Phase 2). These AEC projects were envisioned as a comprehensive community-level strategic framework to address persistent barriers to realizing advanced energy solutions at local and regional scales, with a special focus on community choice aggregations (CCA) as key implementation partners. The challenges addressed by the AEC approach in Lancaster included lack of access to the meter-based data and software tools that optimally manage distributed energy resources (DER), ineffective financing and incentives, and limited community and customer engagement. In response, the CEC sought projects that would minimize new energy infrastructure needs, support grid reliability and resiliency, implement community-wide smart-grid technologies, and demonstrate financial viability.[1] To meet these needs, the Zero Net Energy (ZNE) Alliance, as prime contractor, partnered with the city of Lancaster and leading organizations in the clean energy industry to plan and implement the Lancaster project.

City of Lancaster and Utility Context

The city of Lancaster is a charter city in Northern Los Angeles County, located in the Antelope Valley region of California's high desert. The city's population is 170,013, with a diverse community that is 24 percent White, 45 percent Hispanic, and 21 percent Black. The city's median household income is $76,000, has a per capita income of $29,000, and a poverty rate of 15.5 percent. Under Mayor Rex Parris and a city council that strongly supports green initiatives, in 2011 Lancaster became the first city in the United States to commit to zero net energy, achieving this goal in 2019. In 2013, Lancaster was also the first city in the nation to require solar photovoltaics on all new homes. In 2014, the city opened the largest e-bus factory in North America in partnership with BYD Company Limited, a major electric-vehicle and clean-energy company. In 2015, the city launched Lancaster Energy, a CCA that provides clean power to 51,000 customer accounts, with a peak demand of 196 megawatts (MW), and soon joined with the neighboring city of San Jacinto to create the California Choice Energy Authority (CalChoice), which operates programs in collaboration with six other municipal CCAs. Given its statewide reach and impact, the city of Lancaster and Lancaster Energy are well-positioned to model and advance the scaled deployment of AEC solutions.

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[1] "The EPIC Challenge: Accelerating the Deployment of Advanced Energy Communities, Phase II." GFO-15-312. August 2018, page 4.

Project Purpose, Goals, and Metrics

The Lancaster project's purpose was to demonstrate effective AEC solutions that address key energy challenges facing both California communities and the electric grid. These include accelerating grid decarbonization, reducing energy costs, and enhancing grid reliability and resilience. To advance these goals, the project implemented the following initiatives and tasks.

- **Residential Microgrids for Affordable Housing (Task 2):** Develop one or more microgrids in a public housing development to serve as highly scalable examples of residential microgrids.
- **Resilient Community Network (Task 3):** Construct a network of community microgrids that demonstrate resilience benefits and technical innovations at critical facilities.
- **Green Energy District (Task 4):** Create a Green District program model featuring an innovative rate design and both public and private financing to accelerate DER and storage deployment at commercial and industrial facilities.
- **Community-Based Virtual Power Plant (Task 5):** Deploy a virtual power plant (VPP) designed to meet the unique needs of community choice energy providers, comprising: community microgrids, a resilient community DER network, and a Green District. Virtual power plants use "virtual wires" created by software control systems that rely on data systems — such as the internet, Wi-Fi, cellular networks, and the cloud — to virtually connect energy loads and assets.

These strategies are closely linked to California's policy mandates for clean energy, carbon and cost reductions, and grid resilience, and were designed to provide a range of corresponding ratepayer benefits. The Lancaster VPP utilizes state-of-the-art energy orchestration software that helps address energy imbalances on the grid, which also enhances reliability. Virtual power plants also reduce greenhouse gas emissions by increasing the availability of clean DERs at the grid edge, improving integration of renewable energy sources and reducing reliance on gas-fired peaker plants. Virtual power plants can also directly reduce energy costs for customers participating in AEC pilot initiatives. Meanwhile, costs are reduced for all ratepayers by avoiding distribution and transmission upgrade costs and optimizing flex-load management. The project supports local resilience and community safety by supporting solar+storage assets at critical facilities.

Key outcome metrics included the total capacity of storage, solar, and flex-load resources deployed, VPP operational integration with local DERs and the California Independent System Operator (California ISO), customer cost savings, and CCA procurement savings and revenue from VPP operations. Policy and program goals included developing recommendations to increase community microgrid deployment, innovate finance strategies to drive AEC scale-up, and best practices for the effective and efficient operation of platforms by CCAs. The market for these innovations is primarily the California CCA network and other load serving entities with aligned goals.

CHAPTER 2: Project Approach

Technology and Research Objectives

The overarching research objective of the Lancaster AEC was to refine and scale innovative technologies and business models to enhance grid reliability, community resilience, energy affordability, and accelerated decarbonization.

To address these challenges, the project pursued key strategies to:

- **Utilize innovative finance and tariff design** to accelerate energy storage and flex load deployment.
- **Develop community microgrids at critical facilities** to increase community and customer resilience.
- **Develop a CCA-operated virtual power plant** to mitigate the "duck curve" while providing community and customer benefits.
- **Demonstrate the integration of low-cost solar, storage, flex loads, and advanced VPP and DER controls** to build an equitable and resilient advanced energy community.

Project Partners

The Lancaster project engaged leading community and industry partners in key development roles. Community Energy & Equity Resources helped develop VPP and Green District strategies; Olivine developed an initial VPP operational framework; Energy Solutions, GridScape, and Mynt Systems assisted with microgrid design, engineering, and construction; Serious Controls developed and deployed the distributed energy management system (DERMS) to operate the VPP; TRC developed the measurement and verification (M&V) framework; and Tierra Resource Consultants, with The Climate Center and Outfront Solutions, assisted with knowledge transfer. NRG Energy, Inc. and its subsidiary, Direct Energy, provided scheduling coordination, and GPT Services (GPT) assisted in meter data management. ZNE Alliance provided project oversight in collaboration with the city of Lancaster.

Project Tasks

Community-Based Virtual Power Plant

The project team worked to establish a community-based VPP capable of providing additional value to Lancaster Energy and its customers by optimizing both behind-the-meter (BTM) customer savings and values from grid services market participation. This VPP provides the capability to integrate microgrids, flexible loads, and other DER assets in Lancaster Energy's service territory using a network of "virtual wires" so those assets can collectively respond to energy demands. The principal technology objective included creation of an enterprise DERMS (eDERMS) platform, developed by Serious Controls in collaboration with MCE, a CCA serving

Contra Costa, Marin, Napa, and Solano counties. Lancaster Energy and MCE were the first two CCAs to deploy an eDERMS platform purpose-built for that environment. The overarching purpose of both the Lancaster VPP and eDERMS was to maximize value for the CCA by continuously monitoring, optimizing, and enabling the dispatch of DERs into the wholesale market.[2] In this way, the project team has sought to unlock the full economic potential forecasted for VPPs in California.[3]

Lancaster's eDERMS platform marks an important departure from common aggregator-owned DERMS (aDERMS), which pose a range of potential problems. Aggregator-owned DERMS are hosted externally and therefore not fully visible to a CCA, making fundamental VPP processes opaque and causing coordination problems. When a CCA relies on a single aDERMS provider to deliver its VPP, it reduces customer choice and limits competition through vendor lock-in.[4] Ending an aDERMS contract can entail losing access to DERs that required significant investment to deploy, thus creating stranded assets.[5] Finally, maintaining high cybersecurity standards has required CCAs to restrict aDERMS access to sensitive elements (including customer information), which constrains CCA enterprise-wide data integration, customer support capacity, and overall VPP performance. By contrast, as shown in Figure 1, the eDERMS operates on Lancaster Energy's internal servers alongside other critical systems, ensuring full visibility, control, and strong cybersecurity protections that support regulatory compliance.

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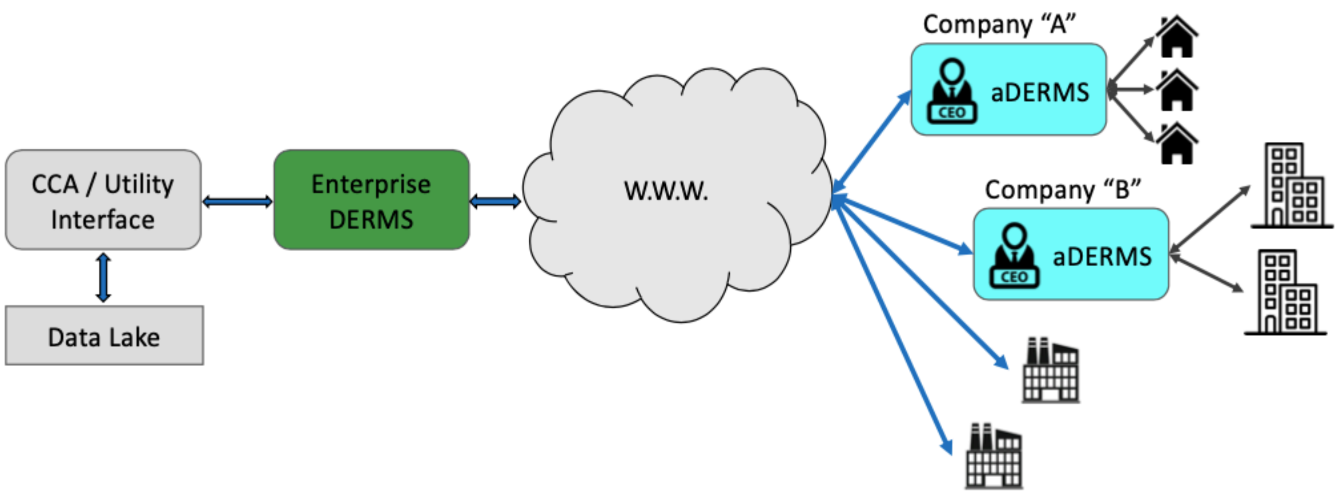
[2] The terms VPP and DERMS are typically used interchangeably, although DERMS often refers to software more narrowly, while VPPs may designate the larger ecosystem of a DERMS connected to individual DERs.

[3] This potential has been projected at $5 billion in annual savings per year according to recent studies by the Battle Group and others. Studies from the Brattle Group and the Rocky Mountain Institute have identified the environmental and load management potential of VPPs. See Hledik, R., et al. 2024. "California's Virtual Power Potential." Brattle Group. https://www.brattle.com/wp-content/uploads/2024/04/Californias-Virtual-Power-Potential-How-Five-Consumer-Technologies-Could-Improve-the-States-Energy-Affordability.pdf and Brehm, K., et al. 2023. "Virtual Power Plants, Real Benefits." Rocky Mountain Institute. https://rmi.org/insight/virtual-power-plants-real-benefits/

[4] Lock-in refers to instances wherein systems become so entrenched that they cannot easily be changed even when more favorable alternatives present themselves, including internal system upgrades or partnerships which may be difficult or impossible to integrate into proprietary systems.

[5] Stranded assets are investments that were made in the past but whose value cannot be recouped, and they typically arise when a critical component of the system that was required to make those investments function becomes non-operational. Proprietary systems commonly produce stranded assets when key vendors can no longer provide services, or critical software can no longer be updated.

Figure 1: Lancaster Energy Enterprise Distributed Energy Resource Management System (eDERMS)



Source: Serious Controls

Unlike typical third-party software-as-a-service solutions, Lancaster's eDERMS is purpose-built for CCA applications, focusing on data types and information systems already available to the CCA (for example, near real-time telemetry and meter data), purposely excluding features that are not relevant to CCAs. With access to these data, the eDERMS delivers the enhanced situational awareness needed for active load shaping and dynamic dispatch, which helps the CCA mitigate trading risks and enables real-time adjustments that improve VPP outcomes. These capabilities help unlock significant value and cost savings, reinforcing Lancaster Energy's value proposition while keeping retail rates low and stable for its customers.

The eDERMS is designed to support a more functional, diverse, and resilient network of DER assets while preserving long-term operational independence. Unlike aDERMS, which are generally limited to a narrow set of technologies and vendors, eDERMS is a vendor-agnostic technology that connects to a broad range of DER manufacturers and vendors, as well as any third-party aDERMS. This flexibility accelerates VPP growth by circumventing vendor lock-in and enabling an inclusive "bring your own device" model for VPP expansion, which gives customers more ways to participate with vendors and products they already trust. Based on outreach to other CCAs beyond Lancaster, the project team believes that these attributes of the new eDERMS platform can materially accelerate both future VPP and DER adoption and optimization.

The eDERMS is secured through a perpetual user license that allows a CCA to host the platform on its internal systems indefinitely, which in turn helps control licensing fees. Standard SaaS-based DERMS licenses can cost up to $1 million annually, often with hidden fees and escalators that erode cost-effectiveness in a CCA context. Where investor-owned utilities (IOUs) can recover these costs through rate increases, CCAs lack that cost-recovery mechanism, making high, recurring licensing fees unsustainable. The serious controls eDERMS will be offered to CCAs for a one-time fee scaled to service population, range from $20,000 to $200,000, a fraction of the current long-term cost for alternative systems.

Green District

The goal of the Green District program was to accelerate deployment of VPP-integrated storage and other DER assets with leading commercial, industrial, and public agency customers in Lancaster Energy's service territory. The Green District targeted facilities based on community and grid co-benefits and impact potential. Substantial private funding was leveraged by each site host which, in combination with CEC co-investment, enabled an attractive return on investment over the lifetime of the DER assets. These assets included solar+storage as well as microgrid and building-control elements specific to individual facility use cases. Implementing the Green District program involved both installing physical assets and virtually linking new and existing assets into the VPP.

The initial customer outreach process involved use of the Lancaster Recurve platform to identify customers with load curves that could benefit the most from storage and demand management opportunities created by the VPP/DERMS. Following an extensive vetting process explained in Chapter 3, the Lancaster team selected three locations that offered unique benefits as demonstration sites: the Lancaster Police Station, the Lancaster Baptist Church (including a K-12 school and college), and the Lancaster Toyota Dealership (which will have significant vehicle-to-grid assets coming online in the next several years). To serve these anchor sites, as well as future Green District commercial and industrial customers, the project team developed a novel value-sharing VPP tariff. In exchange for allowing Lancaster Energy to manage customer-sited DER assets, participating customers earn monthly bill credits through a third-party, validated pay-for-performance model. Green District sites and additional details on tariff design are described in more detail in Chapter 3.

Residential Microgrids for Affordable Housing

The project team sought to develop a financially viable and scalable community microgrid at a large affordable housing development known as the Housing Neighborhood Revitalization (HNR) project, referenced as HNR-1. This task was designed to help overcome cost challenges in developing zero-net-energy residential subdivisions, as well as to address policy goals and ratepayer benefits such as enhanced resilience and reliability, reduced carbon intensity, and lower energy costs. The project was developed on city land. The city sponsored an open competition for an experienced developer. After award of the project to Bridge Housing, a leading affordable housing developer, the team (led by Energy Solutions and GridScape) worked with the city and Bridge Housing for nearly two years on multiple comprehensive microgrid designs.

The original HNR-1 project was designed to function as a master-metered microgrid. A microgrid is defined by the United States Department of Energy as a group of interconnected loads and DERs within a clearly defined electrical boundary that can be controlled through a single connection point to the rest of the grid, which allows the microgrid to connect to the grid or disconnect ("island") during times of peak demand or during grid outages. This capability offers enhanced site resilience and a suite of environmental and economic benefits. Master-metered microgrids feature private internal distribution lines that enable electron-sharing across fenced lines. In this model, a community microgrid operator can operate the microgrid as a single controllable entity able to connect and disconnect from the grid to meet operational needs and simplify participation in wholesale markets. This original project plan could not be carried out due to a set of regulatory hurdles that effectively prohibited the proposed master-metered configuration (see Chapter 3).

As a potential workaround, the city devoted several months to exploring the creation of a site-specific "spot municipal utility." Ultimately this pathway proved too costly and uncertain. Next, the AEC team designed a "nanogrid network" approach. Nanogrids are hyper-local versions of microgrids that service a single building or unit but can be controlled from a single point of connection. Because they do not allow electron-sharing, they do not violate over-the-fence restrictions. Unfortunately, despite substantial investment in the design and engineering process, the Bridge team pulled out of the city contract due to exogeneous market factors, including substantial interest rate and construction cost increases following the COVID pandemic. The unexpected cancellation of the project prevented build-out of the nanogrid design. However, this innovation could still be a fruitful avenue for other community energy initiatives; the design is described in the project's microgrid-related guidance documents (see Project Deliverables section at the end of this report).

In place of the HNR-1 microgrids, the project team assessed many alternative sites including 4 candidate multi-unit residential buildings, several city facilities, and several commercial sites. The project team ultimately developed detailed pro formas for 8 alternative microgrid sites, including 5 multi-unit residential sites, as well as the Lancaster City Police Station, the Lancaster Baptist Church, and the Lancaster Toyota Dealership. Due to supply chain challenges and unfavorable tariffs, tax credits, and incentive policy shifts, the residential microgrids proved to be unfeasible within the project period. Therefore, the team elected to focus on the 3 community sites. These sites established the anchor facilities for the Lancaster Green District community microgrid network, which will progressively expand to include additional residential and commercial sites as economic and policy conditions stabilize.

Resilient Community Network Sites

In addition to the sites described, the project team initially proposed inclusion of a network of Lancaster School District sites where solar was already contracted through a leading power purchase agreement provider. During the planning phase of this project, it was understood that these school district contracts would enable VPP control of batteries and other DER assets at the sites. However, after a multi-month negotiation period, this prominent solar+storage company would not grant this anticipated flexibility.

Based on the school experience, Lancaster Energy and project team members resolved to integrate VPP-friendly terms wherever possible into future solar+storage deployments in Lancaster Energy's service territory. This is expected to yield significant benefits beginning in 2026 as multiple solar+storage projects are scheduled to come on line with the new agreement structure that will enable streamlined VPP integration.

Measurement and Verification Plan

An independent M&V team – composed of TRC and GPT – was assembled to establish a detailed methodology for evaluating the performance of the community-based VPP, comprising all DER and microgrid components. Because key VPP projects were pending completion in early 2026, the M&V goal of collecting one year of performance data after project completion could not be achieved. However, the M&V team was able to establish a VPP baseline based on predicted energy performance across the community, and these data can be used to evaluate the VPP's performance as assets are integrated into the VPP platform. Baseline meter data were collected by home area network devices installed at relevant sites, and advanced metering infrastructure data were provided by Lancaster Energy.

Most importantly, the M&V team was able to use data from the Lancaster AEC pilot to develop, test, and refine a novel performance evaluation metric that made it possible to accurately value daily load-shaping performance. This new methodology, referred to as FlexCalc, consists of two major components. First, a nonparametric modeling method developed by TRC adjusts ongoing baseline site demand counterfactual, and uses staggered, site-specific calibration periods to correct for drift. This approach eliminates the need for look-back windows of non-participation days, making it a good fit for daily load-shaping use cases. Second, comparison groups formed through a novel comparison group formation pipeline developed by GPT were used to adjust those baselines to account for exogenous impacts that cannot be seen in the historical data. GPT also developed mechanisms to enhance computational efficiency and support comparison site reuse, which together will enable Lancaster Energy and other load serving entities to operate larger programs with more participants.

Key Project Milestones

Following the identification of the new microgrid and DER deployment sites, key project milestones were adjusted to meet the revised schedule, shown in Table 1.

Table 1: Key Project Milestones

Activity	Duration	Milestone
Phase 1 AEC Project Planning Process	05/16 – 03/18	Plan completed: 03/18
Phase 2 AEC Implementation Project Proposal and Agreement	Proposal Submitted 10/18	Agreement executed: 06/19
Develop Green District Program Design, Tariff, & Marketing Materials	01/23 – 7/24	Program Design, Tariff, & Marketing package submitted to city: 07/24
Develop HNR-1 (multi-family development) Microgrid Design	01/21 – 12/22	Completed 12/22
Develop VPP Use Case and Technical Requirements Design & Report	01/25 – 09/25	Report completed 09/25
Develop VPP Infrastructure and Systems	09/19 – 12/25	Platform demo (in MCE territory): 08/24. Integration with Lancaster DERs: 11/25
Develop M&V Plan	09/19 – 01/23	M&V Plan v.1 complete 01/23

Activity	Duration	Milestone
Postponement & Cancellation of HNR-1 Multi-Family Project (and accompanying microgrid project)	N/A	Delay beyond grant period determined: May 2023
Cancellation: Q1 2024		
Vetting and Final Selection of Alternative Community Microgrid Sites	05/23 – 06/25	All three sites selected by 06/25
Construction of Toyota Microgrid	08/25 – 10/25	Est. completion 10/25
Construction of Police Microgrid	10/25 – 01/26	Est. completion 01/26
Construction of Lancaster Baptist Church Microgrid	10/25 – 02/26	Est. completion 02/26
Development of AEC / DER Program Design (focused on multi-family segment) for Clean Power Alliance	05/25 – 08/25	Completed 08/25
Development of AEC Program Design for Los Angeles Vision 2026 Bond Initiative (for 2026 ballot campaign)	09/25 – 01/26	Est. completion 01/26
Completion of Project M&V and Final Report	08/25 – 03/26	Est. completion 03/26

CHAPTER 3: Results

The Lancaster AEC project was successful in advancing the deployment of DERs, especially through community microgrid anchor sites, and creating a CCA-operated VPP that delivered: resilience, reliability, sustainability, revenue generation, cost-avoidance, and community value-sharing. Over the project period, the project encountered a diverse array of challenges including technological, market, and policy obstacles, which led to unavoidable project delays that required significant siting shifts. However, both innovations were piloted and challenges confronted, providing learnings that will streamline the process for other communities to deploy AEC solutions. The two most important innovations of the Lancaster AEC pilot were the Green District pilot and the creation of a purpose-built, enterprise-level distributed energy resource management (eDERMS) platform. This chapter describes those outcomes as well as the challenges overcome to advance these innovations.

Green District Pilot

Ultimately, the most successful initiative of the Lancaster pilot was the Green District project (including its constituent microgrids and DERs), which was designed to increase resilience and integrate diverse customer assets into the community-based VPP. This project involved both the installation of new energy assets and the creation of a VPP to link new and existing assets so that they could be orchestrated through the eDERMS. This pilot leveraged the novel use of Recurve data to identify commercial and industrial customer projects, which would deliver benefits to both site hosts and the broader community. The team reached out to those customers, created an innovative value-sharing tariff, and provided turnkey project management with support from third-party developers.

As noted, three community anchors were recruited for the Green District pilot. The Lancaster Baptist Church is a major community hub that serves over 5,000 area residents, operates a large K-12 school and college (including dormitories), and functions as one of the largest community resilience centers in the region. The new Lancaster Police Station functions as a critical emergency response, training, and dispatch hub. The Toyota of Lancaster dealership provides significant near-term dispatchable load to the VPP and has potential to host bi-directional vehicle-to-grid enabled vehicles as soon as the 2026 model year. With support from CEC mandates enshrined in Senate Bill (SB) 59, vehicle-to-grid functionality could potentially create a multi-MW energy storage resource capable of VPP integration. Sites are shown in Figure 2, and site attributes and co-benefits are described in Table 2.

Figure 2: Lancaster Community Microgrid Sites

Police Department | Lancaster Toyota Dealership | Lancaster Baptist Church

Source: Zero Net Energy Alliance

Table 2: Microgrid and Distributed Energy Resource Asset Deployment

Site	Assets	Current Annual Bills vs. Savings	Total vs. Net Cost[6]	Capital Cash Flow (CCF) - Savings Internal Rate of Return (IRR)/ Breakeven
Lancaster Police Station	• 141 kW rooftop solar + 141 kW carport solar (282 kW total) • 120 kWh Battery • CEC reimbursable share: $40,000	• To be determined based on VPP tariff longevity	• $1.4 million total • $625,000 net	• $1.3 million CCF/25 years • $431,000 IRR • 6.3 years breakeven
Lancaster Baptist Church	• 1.4 MW ground-mount solar + 250kW rooftop solar • 560 kWh Battery to augment existing 1MW Tesla megapack • Possible electric vehicle supply equipment & lighting to be determined • CEC reimbursable share: $400,000	• $1 million/year+ with current DERs • $746,000/year gross savings • $186,000+ net savings/year first 10 years (~$1.9 million over 10 years)	• $5.35 million total • ~$2.9 million net	• $8.52 million CCF/25 years • IRR to be determined depending on finance options • ~6 years breakeven
Lancaster Toyota Dealership	• 680 kW rooftop photovoltaic (PV) (after removing	• $313,000/year without	• $1.26 million total	• $5.3 million CCF/20 years

[6] Calculated after incentives, taxes, subsidies, rebates, and grants.

Site	Assets	Current Annual Bills vs. Savings	Total vs. Net Cost[6]	Capital Cash Flow (CCF) - Savings Internal Rate of Return (IRR)/ Breakeven
	2682 defective panels) • 636 kWh Battery • $450,000 AEC + $680,000 Toyota funds • Positioned for future vehicle-to-grid upgrades	PV/energy storage system • $113,000/year with PV/energy storage system	• $680,000 net	• 3.4 years breakeven

kW = kilowatt; kWh = kilowatt-hour

Considering energy cost savings, bill credits, and other incentives, participating customers are projected to save between $55,000 and $150,000 per year. Because of protracted work on both the school district and HNR-1 residential microgrids and the unexpected, late-stage cancellation of HNR-1, the alternative Green District sites were developed relatively late in the grant period so are projected to be interconnected after the end of the project period. It was therefore not possible to obtain significant VPP operational performance data. However, projections from the TRC evaluation (Table 3) illustrate projected performance data for each key customer site and the VPP in total.

Table 3: Projected VPP Performance Data

Site	Annual Import Reduction	Peak Demand Reduction	Annual Energy Cost Savings	Outage Hours Mitigated	Emissions Reductions
Lancaster Police Station	24.43 MWh	1.34 MW	$8,143	5 hours	12 MtCO2e
Lancaster Baptist Church	81.94 MWh	4.07 MW	$24,570	7.5 hours	25 MtCO2e
Lancaster Toyota Dealership	205.25 MWh	7.41 MW	$59,539	5 hours	60 MtCO2e
VPP Total	**311.62 MWh**	**12.82 MW**	**$92,252**	**17.5 hours**	**97 MtCO2e**

MWh = megawatt-hour; MtCO2e = metric tons of carbon dioxide equivalent

Market and Policy Challenges

The importance of the Green District project was further underscored by a series of market and policy obstacles, which Lancaster Energy confronted in pursuit of community resilience solutions both before and during the project planning and implementation periods. The challenges during the implementation phase necessitated a 1-year extension of the project completion date, from March 2025 to March 2026. The following subsections describe the most important challenges encountered and how they were overcome.

Customer Recruitment and Tariff

Initial attempts to identify customers for participation in the VPP focused on sites with the greatest potential to either provide cost-efficient storage resources to the VPP or provide meaningful community resilience benefits. While justified from both community cost and benefit perspectives, this focus constrained the number of sign-ups and potential sites by excluding smaller commercial-only sites and single-family residential customers.

To ensure robust savings and revenue forecasts, the project team adopted a relatively labor-intensive pro forma development process that included extensive use of energy tool-base software as well as custom Excel spreadsheet tools. These pro forma processes required frequent updates due to the unusually turbulent policy environment at both state and federal levels, as well as unprecedented supply-chain disarray and cost increases. This process in turn caused customer acquisition and project development delays. In response, the project team recruited Mynt Systems and Tierra Resource Consultants to help vet additional sites.

This customer recruitment pipeline helped the team identify 12 municipal, public, and commercial sites for in-depth analyses. While most of these sites proved infeasible given the challenges described here, casting a wider net ensured that selected sites would provide the greatest possible community benefits given the project's fiscal and timeline constraints. Once the sites at the Lancaster Police Department, Toyota dealership, and Baptist church were finalized, the project team reduced customer barriers to adoption by providing an integrated, turnkey package of engineering, procurement, and construction services, and coordinated financing, permitting, inspections, commissioning, and operations and maintenance on behalf of site hosts.

A key innovation of the Lancaster AEC pilot was the creation of a value-sharing tariff that would further strengthen the mutually beneficial relationship between the CCA and participating VPP customers. VPP program participation currently offers monthly bill credits at a rate of $0.11/kWh of verified load flexibility, delivered to the VPP annually along with a true-up payment at the end of the billing year. This value-sharing tariff helps establish VPP programs as bankable revenue streams, which will increase lender confidence over time and help customers access lower-cost capital to finance DER installations.

Microgrid Rules

A key initiative initiated in the project planning phase and the first part of the implementation phase was the construction of a residential master-metered microgrid at the multifamily HNR-1 development. Even if the overall housing project construction had proceeded as planned, the microgrid itself could not have been installed and interconnected as originally designed due to prohibitions against over-the-fence electron sharing (California Public Utilities Commission [CPUC] Code 218(b) and Southern California Edison [SCE] Rule 18). While initial dialogues with SCE staff suggested that the master-metered approach would be permissible, confidence was eroded as SCE staff support for the approval process and timeline became unclear.

Additionally, the CPUC administrative law judge decision in the "Track 4" microgrid proceeding barred regulatory flexibility sought by intervening stakeholders, relative to CPUC Code 218(b).

In response, the project team convened a Community Microgrid Working Group and wrote a white paper to develop policy solutions that address this and other barriers to master-metered microgrid deployment. The AEC team then redesigned the HNR-1 project as a network of nanogrids, which could realize some of the benefits of the master-metered microgrid without violating the CPUC code. While the HNR projects were ultimately not completed, the multifamily developer's interest in the project and its regulatory feasibility make a strong argument for implementing the nanogrid network solution in similar contexts.

Permitting

Permitting challenges posed a critical obstacle to timely microgrid construction and interconnection. New regulations and more intensive inspection procedures related to battery energy storage were introduced following the Palisades and Eaton fires of January 2025 and were adopted by Los Angeles County, which is the local agency with jurisdiction for Lancaster battery projects. These batteries must now pass burn tests to receive permits from the county, and few batteries have yet to undergo these tests, posing another gating issue for DER installations. To ensure these projects move forward in a timely fashion given permitting delays, the project team elected to redesign projects to include batteries assessed as most likely to pass the required tests (based on consultation with leading battery-fire experts at Pacific Northwest National Labs).

Integration

The project team also encountered barriers integrating assets at existing sites. As noted earlier, the team attempted to deploy a community microgrid network within the Lancaster School District; however, this partner chose to pursue a competing opportunity with Tesla that posed obstacles to VPP integration. While these assets could theoretically have been integrated into the VPP, efforts to coordinate controls with Tesla were unproductive. Legacy Tesla assets are also sited at the Lancaster Baptist Church, resulting in similar integration challenges relative to an existing Tesla megapack. In designing its eDERMS, Serious Controls embraced the use of open communication protocols (OpenADR). This approach enabled the integration of diverse DER technologies and vendors; if pursued on the policy level, the use of OpenADR may alleviate some integration issues associated with proprietary third-party assets.

Pursuing Multiple Use Cases

A relatively hidden barrier to VPP adoption is the difficulty that stakeholders encounter in M&V of the full spectrum of VPP revenues and avoided costs. To address this challenge, the project M&V team, led by TRC, clearly defined market-integrated use cases aimed at revenue generation and non-market integrated-use cases oriented toward cost avoidance.

To support Lancaster Energy's ability to generate revenue through market-integrated use cases, the team configured the VPP platform to aggregate and operate DER assets as proxy demand resources (PDR). Proxy demand resources are a type of demand resource (DR) that allows aggregators to assemble multiple smaller load-consuming resources as a single entity for California ISO market participation by using "proxy" energy forecasts. They can also schedule and bid these resources at custom aggregation points, making it easier for smaller DERs to participate in the market.

Non-market integrated use cases, collectively referred to as active load-shaping use cases, can be leveraged to reduce coincident peak load and take advantage of negative price events. These use cases include resource adequacy forecasting and mitigation, load-shifting for net energy metering customers, congestion price mitigation, and the ability to respond to day-of prices and sell day-ahead positions. Non-market integrated use cases also promote *soft cost avoidance*, where savings are embedded within broader operational benefits. These use cases include market informed demand automation server (MIDAS) dynamic rate participation,[7] the ability to report renewable energy credits, the potential to replace call options or use the VPP as a call option, and to implement new VPP hedging strategies. Taken together, delineating these use cases demonstrates a fuller spectrum of VPP values than previously available to CCAs.

VPP Measurement and Verification

Among these use cases, the Lancaster VPP was designed to enable daily load shaping. After researching existing and alternative proactive energy management systems, the M&V team, (comprising both TRC and GPT) concluded that these methodologies are now well-suited to valuing daily load shaping in CCA-operated VPPs for purposes of settlements with individual customers. Existing performance evaluation metrics impose restrictions on comparison site reuse that devalue DR programming and are impractical for use by CCAs; they furthermore require look-back windows of non-participation days that forestall proper valuation of daily load shaping. In response, the M&V team developed a new methodology, referred to as FlexCalc, that first uses a nonparametric modeling method to adjust an ongoing baseline site demand counterfactual using staggered, site-specific calibration periods, then using comparison groups to adjust those baselines. Tests using Lancaster Energy data showed that this method out-performed both time-of-week and temperature models and produced load-shift estimates, often within 2-percent of actual savings. Results have also shown tolerance for comparison group reuse, which will enable load serving entities to operate larger programs with more participants. This novel methodology will be essential in conducting comprehensive M&V analyses as VPP performance data become available.

VPP DERMS Platform

The principal technological breakthrough from the Lancaster AEC pilot was the development of a purpose-built, enterprise-level DERMS (eDERMS) platform capable of virtually integrating assets across device types including batteries, inverters, electric vehicle chargers, building-control systems, and aggregator-operated DERMS (aDERMS). This eDERMS software platform was created by Serious Controls after Lancaster Energy terminated its engagement with a third-party aggregator and elected to operate its own VPP as a demand response provider.

[7] The Market Informed Demand Automation Server (MIDAS) provides access to utilities' time-varying rates, greenhouse gas signals, and CAISO FlexAlerts. When connected to flexible loads, MIDAS informed energy management protocols can increase efficiency and reduce net carbon emissions. See https://www.energy.ca.gov/proceedings/market-informed-demand-automation-server-midas

Unlike more commonly implemented aDERMS, the eDERMS integrates with Lancaster Energy's internal systems and data, consolidating data streams — including DER telemetry, interval metered load data, real-time weather inputs, California ISO market signals and indicators, customers' personally identifiable information, and DER communications and controls — into a single "pane of glass." This strategy will help Lancaster Energy perform load forecasting, optimize its energy portfolio, refine its procurement strategy, and reduce both risk and costs. The eDERMS guarantees the CCA full visibility and control of its VPP, coupled with enhanced situational awareness through access to near-real time meter and telemetry data. The eDERMS is secured through a perpetual user license that reduces licensing fees and includes regular updates that ensure ongoing inter-operability, security, and reliability. The platform also integrates multiple open-source code packages, including OpenADR, to maximize interoperability and reduce risks of lock-in and stranded assets.

Technical and Technological Challenges

The eDERMS built by Serious Controls was designed as a solution to various technical and technological obstacles though developing the platform posed new challenges that had to be overcome. The most critical challenges follow.

Data Access for VPP Operations and California ISO Participation

Unlike traditional DRPs, CCAs lack direct access to customer meter data, and advanced metering infrastructure data can take up to seven days to be delivered, which is too slow for real-time VPP operations. Participation in California ISO markets also requires settlement-quality meter data for settlement, which CCAs do not inherently possess. To enable VPP operations and eventual California ISO participation, the team deployed devices that capture revenue-quality meter data directly from customer meters, then leveraged the purpose-built eDERMS to process this revenue-quality meter data to generate settlement-quality meter data (using California ISO-approved methodologies so that the data could be submitted for market settlement). The eDERMS can also integrate near real-time telemetry and meter data to support Lancaster Energy's use of PDR use cases for California ISO participation. This enables Lancaster Energy, as the demand response provider, to manage complex bidding, scheduling, and settlement procedures and interact directly with the California ISO. While Lancaster could not assemble the assets required for participation in California ISO markets within the project period, upon completion of VPP integration and registration of additional resources they will be able to do so.

Customer Privacy and Identifications

Because they are located within the CCA's firewall, enterprise systems can meet a higher standard of cybersecurity than aDERMS. However, operating an enterprise system requires strict protection of customers' personally identifiable information, while still enabling interoperability with third-party systems. Given the variety of identifiers tied to a customer account, the project team had to create additional reference types within the eDERMS with connection pathways to the CCA's internal data systems. This approach, which differs fundamentally from software-as-a-service-based aggregator models, provided the required data integrity and customer privacy protections.

Developing an Enterprise System

To construct an enterprise system, the team needed to integrate a greater number of third-party and internal systems than originally projected, slowing initial development. This challenge required fast-tracking with a "system in a room" approach that included the project M&V provider, Lancaster Energy IT staff (with supervision of the CCA's CRM platforms), data lakes, billing systems, and close collaboration with the California ISO in the development process. Each integration required custom development and training for stakeholders, which was provided.

DER Integrations

Integrating with a wide range of DERs exposed the lack of uniform communication standards across vendors. Many DER providers relied on proprietary protocols and were reluctant to invest in OpenADR support for a pilot project. This forced the development team to absorb the integration burden, slowing progress. To address this, the team decoupled the integration logic from the eDERMS core and created a standalone "BabbleFish" module designed for rapid third-party integration. This modular approach accelerated new integrations.

IT Environment Migration

Transitioning from Amazon Web Services to a Microsoft Azure production environment created challenges with data access and security. The first deployment in Lancaster was resolved over time through the collaboration of multiple IT teams.

In summary, while the Lancaster DERMS/VPP and microgrid project elements encountered several challenges throughout the project period, these challenges afforded the project team the opportunity to generate a broad set of learnings that will support future initiatives aimed at AEC goals.

CHAPTER 4: Knowledge Transfer

The project team pursued a diverse range of knowledge transfer opportunities including workshops, white papers, customer outreach and engagement, and industry and legislative meetings.

Workshops and White Papers

- **Master Community Design, Lancaster Advanced Energy Community:** This document presents an overview of the original Lancaster AEC project design elements including the affordable residential microgrid, flywheel technology, virtual power plant, Green District Program, and Resilient Schools Network.
- **Community Microgrid White Paper:** To communicate policy and regulatory recommendations that support community microgrid deployment, an extensive white paper was commissioned by ZNE Alliance and developed by a consortium of stakeholders including representatives from The Energy Coalition, EcoShift Consulting, the University of California, Berkeley, the Local Government Sustainable Energy Coalition, the city of Berkeley, the Climate Center, and GridScape. Re-Imagine Power team (led by Allie Detrio) members were primary authors, and the document was used by participating organizations for outreach purposes. (Recommendations are summarized in Chapter 5.)
- **Community Microgrid Design Guide:** This document describes an innovative nanogrid network design created to overcome regulatory challenges posed to master-metered microgrids while enabling integrated site-wide microgrid management across multiple buildings and rights-of-way. Other topics include integration challenges and lessons learned regarding microgrids and existing storage and solar assets, and design concepts for the microgrid integration of bi-directional, vehicle-to-grid-enabled electric vehicles (including emerging virtual synchronous machine technology).
- **Direct Outreach to CCAs:** Beginning in Q4 2025, the project team, led by ZNE Alliance, Community Energy & Equity Resources, and Tierra Resource Consultants, reached out to leading CCAs to present the results of the Lancaster and MCE pilot projects and listen to key concerns relative to VPP integration. These results are summarized in the final Knowledge Transfer Report. In addition, team members ZNE Alliance, Serious Controls, and Tierra Resource Consultants initiated an ongoing project development process with Community Power Alliance (the largest CCA in California), to deploy VPP and DER aggregation in CPA territory.
- **Advanced Energy Community Symposium:** The team developed and delivered a standalone conference on AECs in Oakland on February 19, 2026. The conference presented results from both the Lancaster and MCE projects, as well as AEC sister projects: Oakland EcoBlock and Avocado Heights initiatives in the cities of Oakland and Los Angeles, respectively. In addition, CEC staff, commissioners, and industry experts

presented state and CCA policy goals for affordability, resilience, and decarbonization. Attendance at the conference included leadership and staff from numerous CCAs and more than 100 aligned stakeholders from both industry and the community. The conference included opportunities for strategic dialogue, networking, and consultation with project leaders and policy makers.

- **Advanced Energy Community and Virtual Power Plant Roadmap:** This white paper broadly defines the potential contributions of CCA-owned and managed VPPs as a vehicle to advance state and local policy goals for resilience, affordability, and decarbonization. Specific strategies for optimally configuring and accelerating VPP deployment were discussed as a means to capture the more than $5 billion annual estimated VPP benefit potential in California, as defined by the Brattle Group and others. This paper has been distributed via the websites and direct outreach of all AEC project partners, with overall coordination by The Climate Center.
- **Market Development and Scaled Finance Strategy:** A scaled finance working group was convened by ZNE Alliance to advance AEC and VPP deployment within the regional climate and resilience bonds planned for the Los Angeles County Vision 2026 ballot initiative (led by Move LA and Community Partners, now targeting the 2028 ballot).[8] This effort is anticipated to raise over $800 million per year in comprehensive climate- and sustainability-related programs, including a strong emphasis on DER deployment. Additional regional bond initiatives are in development in the greater San Francisco Bay Area and in the San Joaquin Valley, where ZNE Alliance has co-convened leading stakeholders to develop ballot initiatives that will incorporate substantial funding for AECs and VPPs. These initiatives are also in development for the 2028 ballot.

Customer Outreach and Marketing

- **Websites:** Project webpages can be found on the Energize Innovation site (https://www.energizeinnovation.fund/projects/lancaster-advanced-energy-community-aec-project-0), the city website (https://www.cityoflancasterca.org/our-city/about-us/advanced-energy-community), and the Zero Net Energy Alliance site (https://www.znealliance.org/aec).
- **HNR-3 Design Workshops:** The project team conducted HNR-3 design workshops with GridScape. Through these workshops, the team refined its design to support microgrid deployment, developing the innovative nanogrid network model presented at the AEC symposium and in project reports and white papers.
- **School District Outreach:** The project team conducted a series of engagements with four campuses within the Lancaster School District to build microgrids that serve their facilities, ultimately securing a letter of support.
- **Downtown Microgrid Outreach:** The project team conducted outreach to 16 commercial and industrial customers in the downtown corridor, including 10 residential

[8] Move LA. (n.d.). *Vision 2026*. Move LA. https://www.movela.org/vision_2026_home.

facilities with an average of 121 units each, 5 retail sites with an average of 11 units each, and 1 mixed-use senior and retail site.

- **Outreach to Green District Customers:** To recruit Green District customers, the project team conducted outreach to 43 commercial, industrial, and public authority sites. The project team created customer outreach and marketing materials to recruit Green District customers.
- **Targeted Outreach Approach:** To support targeted recruitment for the Green District program, the project team created a customized analytic process using Recurve data to identify specific customers that could benefit the most from specific DER deployments and tariffs that go beyond a simple "largest customer" approach. The project team then conducted 2 workshops with 5 total Lancaster city staff to share this method with other program administrators.

Industry and Legislative Meetings and Contacts

- **Redwood Coast Microgrid Knowledge Exchange (March 12, 2020):** The project team, including TRC, met with the Redwood Coast Energy Authority to learn about RCEA's Blue Lake Rancheria community microgrid project and exchange knowledge on the CCA value proposition, FTM and islanding solar+storage, microgrid rate design, and business model evaluation.
- **CPUC Microgrid Advocacy (March 26, 2020):** The project team met with the CPUC R&M team, including Rosanne Ratkiewich and Forest Kaser, to discuss barriers to community microgrid deployment.
- **Community Microgrid Regulatory Engagement:** The project team worked with other community microgrid advocates to support legislative and regulatory advocacy efforts at the CPUC led by The Climate Center and involving more than 30 key advocacy organizations, as well as CCAs and allied industry associations. A key outcome of this advocacy was the establishment of a new small city, community-level membership base within the national Microgrid Resources Coalition, which previously represented mostly large developers. Lancaster was the first such entity to join.

CHAPTER 5: Conclusion

Project Importance

The Lancaster AEC project, along with the Richmond AEC project, has informed and inspired the accelerated deployment of VPPs statewide that will advance key California policy mandates for greenhouse gas reductions, renewable energy development, and flexible load shifts. The Lancaster VPP also demonstrates that resilience and reliability can be enhanced by using software as "virtual wires" to coordinate a fleet of customer-sited DERs; in this way, the VPP will allow Lancaster Energy to better align energy supply and demand and reduce distribution system congestion and stress. The project shows that CCA-operated VPPs can potentially become financially viable by realizing the new sources of revenue and savings identified in the Brattle Group study.

Benefits to California Ratepayers

The project team predicts that the pilot would result in 97 tons of total CO_2e emission reductions annually. Approximately 17.5 hours of outage mitigation are expected annually for the three microgrid-supported facilities. On average, participating customers are expected to realize direct-energy cost savings of $30,750 annually (based on 2026 rates), in addition to other program incentives; taken together, the three sites are estimated to receive $45,000 per year in monthly bill credits from Lancaster Energy. All told, customers are expected to receive between $55,000 and $150,000 per year in cost savings and credits for their participation in the VPP. Additionally, all ratepayers benefit from CCA cost savings, which reduce upward-trending rate pressures.

Lessons Learned and Future Market Development Opportunities

The Lancaster pilot demonstrated that large commercial customers and high-value community facilities are interested in siting DER assets and enrolling in CCA-operated VPPs. Lancaster's new flat-rate billing structure additionally demonstrates an innovative and attractive value proposition to customers. Finally, the project identified barriers to master-metered microgrids, identifying important regulatory reforms needed to reduce those barriers.

Future market development opportunities are substantial. Key industry associations and non-governmental organizations are working to accelerate VPP deployment through market transformation and legislative and regulatory advocacy. Direct outreach has confirmed that VPPs are of interest to virtually all CCAs, representing a total addressable market for CCA-operated VPPs of 25 CCAs, which collectively serve 14-million customers. Fully developing this market for CCA-operated VPPs will require sustained outreach and education by industry collaborators, NGOs, early adopters such as Lancaster Energy and MCE, and trusted industry associations. The planned AEC accelerator program — in development by ZNE Alliance and allied stakeholders — is a follow-on effort to the Lancaster and Richmond AEC projects and will be a key element in driving further market development in community-focused DER and VPP deployment.

Multi-stakeholder initiatives at the metro regional scale can also strengthen VPP market development. ZNE Alliance and The Energy Coalition are working with Los Angeles County stakeholders led by MOVE LA to integrate VPP, AEC, and DER infrastructure and strategies into its clean energy and climate bond ($1 billion per year, ongoing), planned for the 2028 ballot, along with a comparable initiative in the 9-county San Francisco Bay Area.

Recommendations

The project team has identified the following next steps for R&D and policy and regulatory changes, which would advance increased deployment of AECs and VPPs.

Research and Development Recommendations

- **Advanced Metering Applications:** Data from this and future pilots will be needed to research and develop new advanced metering configurations capable of accommodating VPP scale-up and customer and asset diversity.
- **Vehicle-to-Grid Functionality:** In response to supportive state legislation, manufacturers are expected to accelerate their transitions to vehicle-to-grid capabilities.[9] This and future pilots should be used to explore dynamic applications of vehicle-to-grid, vehicle-to-vehicle, vehicle-to-home, and vehicle-to-building, following the policy direction mandated in SB 59, which is the vehicle-to-grid legislation that gives CEC the authority to require bi-directional charging.
- **Price Signals:** Grid participants have explored diverse price signal types including real-time dynamic price signals, time-of-use rates, and app-based notification systems; future pilots can evaluate their effectiveness.
- **Use of AI Tools:** Future pilots should explore AI-enabled tools for optimizing DER selection, financing, and operations, especially to accelerate performance forecasts and pro forma development.
- **Microgrid Financing at Multifamily Developments:** The HNR-1 residential microgrid initiative showed how developers can overcome the split incentive problem associated with energy upgrades at multifamily developments. Bridge Housing, a national developer, increased rents but absorbed utility costs, allowing it to develop and sustain energy upgrade benefits. This strategy supports microgrid financing at multifamily developments.
- **Optimizing Multi-DER Coordination:** Serious Controls' eDERMS has greatly optimized multi-DER coordination; as the eDERMS is progressively co-developed by Lancaster Energy and MCE, further optimization is expected. Notably, MCE's VPP Flex

[9] Skinner, N. 2024. Senate Bill 59: Battery electric vehicles: bidirectional capability (2023–2024 Reg. Sess.). California Legislature. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB59.

pilot (a follow-on to the Richmond AEC initiative) is sharpening economic dispatch strategies for new VPP use cases.

- **Turnkey Solutions:** Increased state pilot funding could support the creation of turnkey solutions for customer outreach and engagement, DER selection, finance, installation, VPP integration, and operations and maintenance.
- **Replicability:** The HNR-1 effort with Bridge Housing and GridScape demonstrated nanogrid designs as a workable solution to electron-sharing prohibitions. The eDERMS VPP platform supports replicability by encouraging CCA adoption and co-development, which has demonstrated that CCAs can operate their own VPPs capable of California ISO market integration.

Policy and Regulatory Recommendations

Given the Lancaster AEC pilot outcomes summarized in Chapter 3, the project team recommends the following policy and regulatory changes:

- **Data Access:** While the project team was able to leverage new metering arrangements and the eDERMS to access near-real time meter and telemetry data, the team urges the CPUC to mandate sharing utility smart meter customer usage data with CCAs to enhance future VPP operations.
- **Flat Rate Design:** By enabling wholesale market participation, the VPP offers a new business model that is not reliant on retail energy sales. In response, the project team developed a novel flat rate design through HNR-1. Community choice aggregators should pursue these flat rates with VPP incentives to increase their value propositions to ratepayers.
- **Microgrid Enabling Regulations:** Given regulatory obstacles to master-metered community microgrid development at HNR-1, the CPUC should:
  - Amend its PUC Code 218 to exempt community microgrids from the definition of an electrical corporation.
  - Create a community microgrid operator designation, open to diverse operators (with the authority to develop master-metered microgrids), and adopt a supportive regulatory framework that ensures safety, reliability, and performance.
  - Enable the creation of new microgrid tariffs, rate schedules, and incentives.
  - Enable community microgrids to provide and be compensated for services to the distribution system operator as well as energy, capacity, and ancillary services.
  - Mandate reductions in interconnection costs and timelines for community microgrids.

Ultimately, the governance of the grid must evolve to realize the full promise of advanced energy communities, VPPs, and community microgrids. By adopting the recommendations outlined in this project, California can make significant progress on many of its highest-priority policy mandates and empower communities to optimally manage their own energy needs and achieve greater resilience. In tandem with these policy changes, the Lancaster AEC pilot demonstrates that CCA-owned and managed VPPs can capture new value streams with superior customer, community, CCA, and grid benefits.

List of Terms/Glossary

Term	Definition
aDERMS	aggregator-owned distributed energy resource management system
AEC	advanced energy community
Advanced Metering Infrastructure	Refers to the full measurement and collection system, which includes meters at the customer site, communication networks between the customer and a service provider, such as electric, gas, or water utility, and data reception and management systems that make the information available to the service provider (Source: Electric Power Research Institute [EPRI])
California ISO	California Independent Systems Operator – The neutral operator responsible for maintaining instantaneous balance of the grid system in California. California ISO performs its function by controlling the dispatch of flexible plants to ensure that loads match resources available to the system.
CCA	community choice aggregation
CCF	capital cash flow
CEC	California Energy Commission – The state's primary energy policy and planning agency. The agency was established by the California Legislature through the Warren-Alquist Act in 1974. It has seven core responsibilities: developing renewable energy, transforming transportation, increasing energy efficiency, investing in energy innovation, advancing state energy policy, certifying thermal power plants, and preparing for energy emergencies.
CPUC	California Public Utilities Commission – A state agency created by constitutional amendment in 1911 to regulate the rates and services of more than 1,500 privately owned utilities and 20,000 transportation companies. The CPUC is an administrative agency that exercises both legislative and judicial powers; its decisions and orders may be appealed only to the California Supreme Court. The major duties of the CPUC are to regulate privately owned utilities, securing adequate service to the public at rates that are just and reasonable both to customers and shareholders of the utilities, including rates, electricity transmission lines and natural gas pipelines. The CPUC also provides electricity and natural gas forecasting, and analysis and planning of energy supply and resources. Its headquarters is in San Francisco.

Term	Definition
Day-Ahead Market	The forward market for energy and ancillary services to be supplied during the settlement period of a particular trading day that is conducted by the California ISO, the PX, and other scheduling coordinators. This market closes with the California ISO's acceptance of the final day-ahead schedule.
Demand Response	Providing wholesale and retail electricity customers with the ability to choose to respond to time-based prices and other incentives by reducing or shifting electricity use, particularly during peak demand periods, so that changes in customer demand become a viable option for addressing pricing, system operations and reliability, infrastructure planning, operation and deferral, and other issues. (Source: Dan Delurey, U.S. Demand Response Coordinating Committee.)
DER	distributed energy resource – Small-scale power generation technologies (typically in the range of 3 to 10,000 kilowatts) located close to where electricity is used (for example, a home or business) to provide an alternative to or an enhancement of the traditional electric power system.
DERMS	distributed energy resource management system
Dispatch	The operating control of an integrated electric system to: Assign generation to specific generating plants and other sources of supply to effect the most reliable and economical supply as the total of the significant area loads rises or falls. Control operations and maintenance of high-voltage lines, substations and equipment, including administration of safety procedures. Operate the interconnection. Schedule energy transactions with other interconnected electric utilities.
Distribution	The delivery of electricity to the retail customer's home or business through low voltage distribution lines.
DRP	demand response provider
eDERMS	enterprise-level distributed energy resource management system
Enterprise Management	A term used for modern examples of enterprise resource planning that allow businesses to manage vital day-to-day processes such as inventory management, accounting, human resources and customer relationship management. Enterprise management supports how different business units work by sharing information through a shared database.
EPIC	Electric Program Investment Charge
HNR	housing neighborhood revitalization

Term	Definition
Interconnection	The linkage of transmission lines between two utilities, enabling power to be moved in either direction. Interconnections allow the utilities to help contain costs while enhancing system reliability.
IRR	internal rate of return
kW	kilowatt – One thousand (1,000) watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon a typical home, with central air conditioning and other equipment in use, might have a demand of 4 kW each hour.
kWh	kilowatt-hour – The most commonly-used unit of measure telling the amount of electricity consumed over time. It means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumes 534 kWh in an average month.
Load	The amount of electric power supplied to meet one or more end users' needs; an end-use device or an end-use customer that consumes power. Load should not be confused with demand, which is the measure of power that a load receives or requires.
Load Management	Steps taken to reduce power demand at peak load times or to shift some of it to off-peak times. This may be with reference to peak hours, peak days or peak seasons. The main thing affecting electric peaks is air-conditioning usage, which is therefore a prime target for load management efforts. Load management may be pursued by persuading consumers to modify behavior or by using equipment that regulates some electric consumption.
M&V	measurement and verification
MCE	Marin Clean Energy
Meter	A device for measuring levels and volumes of a customer's gas and electricity use.
Microgrid	A combination of localized electricity generation sources, energy storage devices, and multiple loads that acts as a small electric grid with respect to the main electric grid. The microgrid can operate interconnected or isolated from the main electric grid.
MIDAS	market informed demand automation server
Monitoring	The periodic or continuous sampling and analysis of air pollutants in ambient air or from individual pollution sources.
MtCO2e	metric tons of carbon dioxide equivalent
MW	Megawatt – One-thousand kilowatts (1,000 kW) or one million (1,000,000) watts. One megawatt is enough electrical capacity to power 1,000 average California homes. (Assuming a loading factor of 0.5 and an average California home having a 2-kilowatt peak capacity.)

Term	Definition
MWh	Megawatt-Hour – One-thousand kilowatt-hours, or an amount of electrical energy that would supply 1,370 typical homes in the Western U.S. for one month. (This is a rounding up to 8,760 kWh/year per home based on an average of 8,549 kWh used per household per year [U.S. DOE EIA, 1997 annual per capita electricity consumption figures]).
Net-Zero Energy	Producing as much energy on an annual basis as one consumes on site, usually with renewable energy sources such as photovoltaics or small-scale wind turbines.
PDR	proxy demand resource
Peak Load or Peak Demand	The electric load that corresponds to a maximum level of electric demand in a specified time period, the highest electrical demand within a particular period. Daily electric peaks on weekdays occur in late afternoon and early evening. Annual peaks occur on hot summer days.
Peak Load Power Plant	A power generating station that is normally used to produce extra electricity during peak load times.
Portfolio Management	The functions of resource planning and procurement under a traditional utility structure. Portfolio management can also be defined as the aggregation and management of a diverse portfolio of supply (and demand-reduction) resources which will act as a hedge against various risks that may affect specific resources (i.e., fuel price fluctuations and certainty of supply, common mode failures, operational reliability, changes in environmental regulations, and the risk of health, safety, and environmental damages that may occur as a result of operating some supply resources).
PV	photovoltaic cell – A semiconductor that converts light directly into electricity.
Reliability	Electric system reliability has two components: adequacy and security. Adequacy is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and unscheduled outages of system facilities. Security is the ability of the electric system to withstand sudden disturbances such as electric short circuits or unanticipated loss of system facilities.
SCE	Southern California Edison – One of California's largest investor-owned electric utilities, which delivers power to 15 million people in 50,000 square-miles across central, coastal and Southern California, excluding the city of Los Angeles and some other cities with municipal utilities.

Term	Definition
Tariff	A document, approved by the responsible regulatory agency, listing the terms and conditions, including a schedule of prices, under which utility services will be provided.
Time-of-Use Rates	Electricity prices that vary depending on the time periods in which the energy is consumed. In a time-of-use rate structure, higher prices are charged during utility peak-load times. Such rates can provide an incentive for consumers to curb power use during peak times.
VPP	virtual power plant – A network of decentralized, medium-scale power generating units and flexible loads, such as batteries, EVs, smart appliances, and flexible heating and cooling loads that can be effectively managed to the benefit of grid operators.[10]

[10] Assembly Committee on Utilities and Energy. March 12, 2025*. AB 740 (Harabedian) – Virtual power plants: load shifting: integrated energy policy report* (As amended March 12, 2025). California State Assembly.

Project Deliverables

Project deliverables, including interim project reports, are available upon request by emailing pubs@energy.ca.gov.

- Task 2: Residential Microgrids
  - Residential Microgrid Component Specification and System Engineering Report
  - Residential Microgrid Rate Schedule Report
  - Residential Microgrid Site Completion Report
  - Residential Microgrid Retail Billing Report
  - Staff training materials for microgrid operators
  - Residential microgrid data collection reports
  - Microgrid Operations Test Report
  - Operations and Maintenance Manual
  - Microgrid Toolkit for CCAs and local governments
- Task 3: Community Microgrids
  - Project Implementation Plan
  - Project Implementation Report
  - Facility Operations Plan
  - Annual Savings Report
  - System Engineering Report
  - Equipment and Services Procurement Report
  - Site completion reports
  - System Integration Test Report
  - Commissioning Report
  - Microgrid Operations and Maintenance Manual
  - Site data collection reports
  - Microgrid Operations Test Report
  - Lessons learned and best practices
  - API Interface Specification Report
  - Integration Test Report
- Task 4: Green District
  - Green District marketing materials
  - Green District Business Model and Cashflow tool
- Task 5: Community-Based Virtual Power Plant
  - VPP Use Case and Technical Requirements Report
  - VPP Participation Guide
- Task 6: Independent M&V
  - Measurement and Verification Plan
  - Microgrid performance reports
  - Community-Based Virtual Power Plant M&V Performance Report

- Task 7: Evaluation of Project Benefits
    - Benefits Questionnaire (kick-off, mid-term, and final)
- Task 8: Technology and Knowledge Transfer Activities
    - Initial fact sheet
    - Final project fact sheet
    - Presentation materials
    - Technology/Knowledge Transfer Plan
    - Technology/Knowledge Transfer Report
    - High-quality digital photographs