CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

ENERGY RESEARCH AND DEVELOPMENT DIVISION

FINAL PROJECT REPORT

Paseo Adelanto Supportive Housing and City Hall Net Zero Design Study

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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, energy transmission, and distribution and transportation.

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

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

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

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

Paseo Adelanto is a mixed-use complex featuring a new city hall and permanent supportive housing. This state-of-the-art complex combined cutting-edge renewable energy technologies, sustainable design and construction techniques and materials, green operational practices, and a highly innovative municipal partnership to create a unique mixed-use development. This project demonstrated how such multiple partnerships, innovative financing, and cutting-edge design, construction, and technology can create a scalable and replicable model that could be adopted by municipal jurisdictions and affordable housing developers across California.

The Jamboree Housing Corporation, a nonprofit housing developer and supportive services provider, in partnership with the City of San Juan Capistrano and others, designed a mixed-use development that incorporates permanent supportive housing and the local city hall, which benefits local vulnerable populations, city hall staff and visitors, and California ratepayers. The development includes a new city hall and 49 affordable units for households at very low- and low-income affordability levels, with one non-income restricted manager's unit. The development serves both individuals experiencing homelessness and individuals with mental illness. The 5.7-acre site formerly contained the city hall, which was demolished to complete a new construction project.

The design phase of the project incorporated the EPIC grant design challenge of a zero-emission design, which was achieved with integrated technology research, analysis, and community engagement. The team obtained all necessary permits and engaged with the local community, prospective occupants, and other building end users to evaluate both energy consumption and the impacts of the design and technology on the livability at the property. Construction is currently in process. The EPIC build phase grant funding was not awarded, so all referenced net-zero technologies were not fully implemented in construction.

Keywords: renewable energy, sustainable design, housing, mixed-use development, net zero, disadvantaged communities, distributed energy resources, energy efficiency

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Executive Summary

The Paseo Adelanto design is a mixed-use complex featuring a new city hall and permanent supportive housing. This state-of-the-art complex combines cutting-edge renewable energy technologies, sustainable design and construction techniques and materials, green operational practices, and a highly innovative municipal partnership to design a unique, energy-efficient mixed-use development. These sustainable technologies additionally benefit at-risk populations. This project demonstrates how multiple relationships, innovative financing, and cutting-edge design, construction, and technology elements can create a scalable and replicable model that may be applied to municipal jurisdictions and affordable housing developers. The Jamboree Housing Corporation (Jamboree), a nonprofit housing developer and provider of supportive services, worked in partnership with the city of San Juan Capistrano and consultant partners including the Cumming Group, Community Energy Labs, Inc., Architectural Nexus, Inc., and Gridscape Solutions to collaboratively build and manage a mixed-use development combining permanent supportive housing and replacement of the local city hall. This partnership benefits local vulnerable populations, city hall staff, visitors, and California's utility ratepayers. The development includes a new city hall and 49 affordable units for households at very low- and low-income affordability levels, and one non-income restricted manager's unit. The development further serves individuals experiencing homelessness and individuals with mental illness. The 5.7-acre site is home to the current city hall, which will be demolished to complete the new construction project. The design phase of the project incorporates the EPIC design challenge of zero-emission design, integrated with technology research, analysis, and community engagement. The team obtained all necessary construction permits and engaged with the local community, prospective occupants, and end users of the buildings to evaluate energy consumption and the impact of the design and technology on livability at the property. The EPIC build phase grant was not ultimately awarded, but many of the design concepts will nevertheless be incorporated during construction.

Project Background

This project supports California's clean energy and climate goals by cutting air pollution, including reducing greenhouse gas emissions and reducing fossil fuel consumption to less than one-tenth of 2022 levels. The project's design met the state's net-zero goal, but also incorporated innovative microgrid technology, real-time data analysis, and renewable energy sources. The research project's mission was to build a zero-emission, all-electric facility, without natural gas. The buildings' load during peak demand hours were met through a combination of on-site renewables, on-site storage, and load management. This specific project was especially timely given the enormous impact of climate-change-related extreme weather events and their direct impacts on communities, especially for those without reliable energy sources. The buildings would be able to "island," or separate and operate independently, from the main grid during outages and shed discretionary loads to provide power to critical loads. The microgrid is sized for indefinite renewable resource-driven Tier 1 backup power (critical loads using any combination of on-site renewables, on-site storage, and

load management). Planning for the future, 20 percent of all parking spaces at the development will have electric vehicle (EV) charging stations able to respond to grid and building signals; all remaining parking spaces will also be EV-ready (meaning they will have a dedicated electrical circuit with the capacity to support a charging station). Absent build phase funding, however, some elements were reduced, including a reduction in photovoltaic solar, EV chargers, and battery backup. Photovoltaic solar, EV chargers, and battery backup will still be included in the final development.

Project Purpose and Approach

The project's purpose was to apply an innovative and integrated approach to implementation of a sustainable design for net-zero, affordable housing through both a timely, efficient construction process and follow-up with both occupants and operators of the development. Jamboree designed this mid-rise, mixed-use development, which is affordable, equitable, climate-resilient, cost-competitive, emissions-free, and resilient to extreme weather events. Goals and objectives were achieved through implementation of five specific project tasks and critical milestones in the scope of work. The team quantified and measured energy and building performance goals and objectives using computer modeling. Jamboree assessed community engagement from quantitative and qualitative feedback from city hall staff, residents, and building operators through targeted engagement events.

The proposed objectives and key results for the project follow. These goals were tracked throughout the project. The design team researched innovative technologies and solutions to achieve each one. (Note that since EPIC build-phase funding was not awarded, not all technologies and solutions were implemented.)

Project objectives included:

- Consumption of only electric energy, no natural gas.
- Efficient residential energy use (Building A – Housing) with an energy use intensity (EUI) of between 15 and 18 thousand British thermal units (kBtu) per square foot per year (sf-yr).
- Efficient non-residential energy use (Building B – City Hall]), with an EUI of between 16 and 19 kBtu/sf-yr.
- Building energy performance between 5 percent and 25 percent better than the Title 24 2019 baseline.
- Reductions in operating and utility costs by between 5 percent and 10 percent.
- A minimum of 20 percent of the building’s peak load, which would be temporarily managed or curtailed in response to grid conditions. The buildings’ residential load during peak demand hours (4:00 p.m. to 9:00 p.m.) would be met through a combination of on-site renewables, on-site storage, and load management.
- All residential end uses, which would be controlled through a home energy management system.

- A home energy management system, which would respond to real-time pricing signals including the microgrid controller, would also be interoperable with distributed energy resource aggregation platforms such as virtual power plants.
- The building will be able to island from the main grid during outages and shed discretionary loads to provide power to Tier 1 critical loads (10 percent of peak load) and Tier 2 priority loads (25 percent of peak load).
    - The microgrid is sized for indefinite renewables-driven backup power of Tier 1 critical loads using any combination of on-site renewables, on-site storage, and load management.
- Planning for the future, 20 percent of all parking spaces associated with the development will have EV-charging stations that can respond to grid and building signals; all remaining parking spaces will be EV-ready, meaning they will have a dedicated electrical circuit with the capacity to eventually act as charging stations.

Key Results

The replication of this project could not be validated due to an imbalance in the return on investment for the technologies associated with net-zero construction and innovation. The team selected very specific technologies that showcase the highest level of zero-emissions in affordable housing, but considered the financial strain required to deliver a solid return on investment within the payback period.

Following are re-listed proposed objectives and key results under the Electric Program Investment Charge (EPIC) grant for this research project. Following those items are specific results from the modeling work, which supports the EPIC grant proposal.

- Consumption of only electricity, no natural gas.
- Efficient residential energy use (Building A – Housing) with an EUI between 15 and 18 kBtu/sf-yr.
    - Model results: Affordable housing building attained an EUI of 17.1 kBtu/sf-yr.
- Efficient non-residential energy use (Building B – City Hall) with an EUI between 16 and 19 kBtu/sf-yr.
    - Model results: The city hall building attained an EUI of 18.8 kBtu/sf-yr.
- Building energy performance was between 5 percent and 25 percent better than the Title 24 2019 baseline.
    - Model results: Achieved through energy-efficient building.
- Reduction in operating and utility costs by between 5 percent and 10 percent.
    - Model results: Achieved through reduced utility costs.
- A minimum of 20 percent of the building's peak load would be available to be temporarily managed or curtailed to respond to grid conditions while the building's

residential load during peak demand hours, 4:00 p.m. to 9:00 p.m., would be met through a combination of on-site renewables, on-site storage, and load management.

    - Model results: Community Energy Labs (CEL) model predictive control technology, solar panels, Gridscape battery storage of 240 kilowatt (kW)/600 kilowatt-hours (kWh) for Building A (residential) and 120 kW/300 kWh for Building B (commercial), totaling 360 kW/900 kWh.

- All residential end uses would be controlled through the home energy management system.
    - Model results: CEL model predictive control software controls with Ecobee thermostats.
- Home energy management system would respond to real-time pricing signals including microgrid controllers, which would not operate with distributed energy resource aggregation platforms such as virtual power plants.
    - Model results: Microgrid distributed energy resource management system software.
- Buildings will be able to island from the main grid during an outage and shed discretionary loads to provide power to Tier 1 critical loads (10 percent of peak load) and Tier 2 priority loads (25 percent of peak load).
    - Model results: Tier 1 included server rooms and emergency lighting. Tier 2 included Tier 1 plus the residential community room lighting, power, and fans for temporary sheltering.
- The microgrid was sized for indefinite renewables-driven backup power of Tier 1 critical loads using any combination of on-site renewables, on-site storage, and load management.
- Planning for the future, 20 percent of all parking spaces associated with the development will have EV-charging stations that can respond to grid and building signals; all remaining parking spaces will be EV-ready, meaning they will have a dedicated electrical circuit with the capacity to become charging stations.

Knowledge Transfer and Next Steps

Community Energy Labs led the team's proactive approach to gathering community input. An integral phase of this process involved arranging a hands-on design workshop, which took place on January 19th, 2023, at the Jamboree Heroes Landing permanent supportive housing apartments.

Engaging in the workshop were eight key community members including asset managers, maintenance directors, technicians, and program, property, and project managers from Jamboree. The members' diverse backgrounds and roles brought a wealth of perspectives to the three-hour session, which enriched their feedback.

Key takeaways from these workshops included a clear understanding of the community's energy consumption patterns within current buildings and preferences for interfacing with emerging technologies. Insights gained from this collaboration substantially influenced the design of CEL's user interface, ensuring that it effectively met the community's needs and expectations. This approach culminated in the creation of a flyer educational document. This document will be distributed to all residents at move-in to inform them of the benefits of the energy-saving technologies and how to use them.

The workshop also provided a platform for discussing the roles of non-residential common-area spaces. The concept of devoting these spaces to emergency cooling centers or communal gathering spots gathered enthusiastic support. This constructive discourse significantly contributed to the project's alignment with broader community needs. Notably, invaluable feedback from the community played an indispensable role in shaping the project's ultimate design.

The other community engagement part was sharing project design plans and intentions with local community newspapers including the *Capistrano Dispatch* and the *Orange County Register*. Articles included:

- "Jamboree Housing Kicks Off New City Hall, Housing Project Upcoming Groundbreaking Ceremony."
- "Affordable Housing Project Could Also Build San Juan Capistrano a New City Hall."
- "Plans Set for New San Juan Capistrano City Hall 50-unit Affordable Housing Project."

Takeaways

- Resident feedback determined both how the team would roll out the technologies and how users would be educated on the systems.
- The major energy load shifting and reduction technologies did not have a return on investment within the payback period. Battery incentives or utility-load management incentives could improve the unfavorable return on investment.

CHAPTER 1: Introduction

Project Overview

The Paseo Adelanto design features a mixed-use complex with a new city hall and permanent supportive housing. This state-of-the-art design combines cutting-edge renewable energy technologies, sustainable design and construction techniques and materials, green operational practices, and a highly innovative municipal partnership to ultimately create a unique mixed-use development. The development design includes a new city hall and 49 affordable units for households with very low- and low-income affordability levels and one non-income restricted manager's unit. The development design also serves individuals either experiencing homelessness or living with mental illness. The 5.7-acre site is home to the current city hall, which will be demolished as part of the new construction project.

Two of the proposed project's primary goals were to achieve a zero-emission mixed-used development and implement time-of-use energy controls. Both buildings were initially designed to comply with 2019 Title 24/20 standards for heating, ventilation, and air conditioning (HVAC), lighting, water heating, and lighting receptacles. Once design strategies were identified to reduce the building's energy consumption, the team increased equipment efficiencies beyond Title 24 requirements and added both renewable energy sources and energy storage elements.

Mixed-use development has emerged as both an integral component and a tool in smart growth strategies. Numerous reports have highlighted the environmental and socio-economic benefits of mixed-use development, and policy and market drivers are also trending in that direction. However, the pathway to zero-emission mixed-use development is currently uncertain and likely neither technically nor economically feasible using only available commercial technologies and standard building design and construction practices. Further complicating matters, recent studies have found that smart growth development can increase the gentrification and ultimate displacement of low-income households. This raises questions about whether mixed-use development can be planned, designed, and built that is affordable, equitable, and emission-free.

The project team began with traditional and off-the-shelf solutions before exploring other strategies and technologies. For this project to serve as a replicable prototype, it was important to start with best practices in design and with the highest efficiency in easily procurable systems. When the project could not meet certain goals with readily available systems, the team evaluated emerging and newer-to-market technologies and strategies to determine the best choices for this pilot project. Most solutions were easily retrofittable, making Paseo Adelanto a leading example of how best to perform this work with existing building stock.

The EPIC team partnered with Community Energy Labs (CEL), which is developing a modern building control solution that makes smart energy management and decarbonization more

accessible and affordable for building owners. This low-cost, grid-interactive building control platform uses model predictive control (MPC) to autonomously optimize energy, pricing, and comfort without placing undue burdens on building operators.

The design phase of the project included robust and integrated technology research, analysis, and a community engagement process that identified specific technologies for design. The Jamboree Housing Corporation (Jamboree) engaged with the local community, prospective occupants, and building users to evaluate options for design and technology that considered the preferences and requirements of these groups, while maximizing adoption of the most beneficial technologies available to achieve zero emission status and high resilience to climate hazards.

Project Goals

Project goals and metrics were developed through the lens of zero emissions. The team selected technology that met both California's standards and the highest carbon emissions reductions. The plan was to achieve those standards by identifying new research approaches and viable technologies. The team prioritized solutions that met the following criteria.

- **Affordability** – Includes low upfront costs that achieve operational savings.
- **Scalability** – Applicable to existing buildings that were not designed to be EPIC-ready.
- **Accessibility** – Readily available with easy procurement
- **Constructability** – Includes simple installations that require limited or no specialty subcontractors.
- **Maintainability** – No specialty expertise required; easy to repair or replace.

The team identified the following objectives and key results (OKRs) to ensure that the project fully met zero-emissions goals and technical innovations.

1. Efficient residential energy use (Building A – Housing) with an EUI between 15 and 18 thousand British thermal units (kBtu) per square foot per year (sf-yr).
2. Efficient non-residential energy use (Building B – City Hall) with an EUI between 16 and 19 kBtu/sf-yr.
3. Building energy performance of between 5 percent and 25 percent better than the Title 24 2019 baseline.
4. Reducing operating and utility costs by between 5 percent and 10 percent.
5. All electric (No natural gas consumption).
6. A minimum of 20 percent of the building peak load must be available for temporary management or curtailment in response to grid conditions.
7. The building's residential load during peak demand hours, from 4:00 p.m. and 9:00 p.m., must be met through a combination of on-site renewables, on-site storage, and load management.

8. All residential end uses must be controllable through the home energy management system and capable of responding to real-time pricing signals.
9. Buildings must be able to island from the main grid during an outage and to shed discretionary loads to provide power to Tier 1 critical loads (10 percent of peak load) and Tier 2 priority loads (25 percent of peak load).
10. Twenty percent of all parking spaces at the development must have electric vehicle (EV) charging stations that can respond to both grid and building signals. All remaining parking spaces must be EV-ready.

Once design strategies were identified to reduce building energy consumption, the team sought to increase equipment efficiencies beyond the Title 24 requirements. It was this combination of strategies that allowed for the design to meet the energy use intensity (EUI) target within the OKR without additional equipment or alternative systems. Several new technologies were reviewed against the research priorities, but it was determined that they were not needed to meet EUI targets.

Market Acceptance

The audiences most likely to use this market research include multifamily developers, affordable housing developers, and net-zero developments. Factors that could contribute to greater market use would be development of net-zero strategies with efficient technologies.

CHAPTER 2:
Project Approach

Overall Design Approach and Strategies

The standard of the proposed design was the California (Title 24) baseline. While this is a progressive building code compared with other states, net zero goes above and beyond the requirements of Title 24.

The team concentrated on significant emerging strategies to pursue the project goal of net zero by reducing unnecessary plug load in the commercial building. With approximately 25 percent annual occupancy, City Hall is unoccupied during evenings and weekends. This commercial office use allowed the team to investigate an effective control strategy to eliminate vampire power (also called phantom power or standby energy) consumption within the building. Vampire power encompasses energy consumed by electronics and appliances when they are turned off, idled, or unused but remain plugged in.

The team went beyond conventional approaches of Title-24-required motion sensors. Alongside local motion sensors, an electrical relay known as a vampire switch will be installed. This supplementary relay will connect to the security system. Its purpose is to connect to the electrical panels inside the building and, when the security system is activated, switch off all vampire power at designated receptacles.

Another technology provided by Gridscape was the EnergyScope™ microgrid system. This software is the acting site controller that will monitor and control all distributed energy resources (DERs) on-site. These include the photovoltaic (PV) solar system, the integrated battery energy storage system (BESS), local loads, and EV charging stations. The Gridscape EnergyScope™ online software will also create dashboards, essential visualizations and reports, and other controls required for the accessibility of various use cases.

The MPC created by CEL will also connect with the microgrid system and automatically reduce peak loads when grid demand is high.

Architectural Designs, Aesthetics, and Functionality

The functionality of Title 24's standard design was improved by incorporating efficient technologies that advanced the goal of net-zero emissions. The microgrid battery product offered both functional and aesthetic improvements. The microgrid battery required outside installation, but building codes prohibited its siting in the parking area. The team decided that it could serve as an educational display if sited in the courtyard for occupants and visitors. To increase its visual appeal, the team incorporated a mural to celebrate the uniqueness of Paseo Adelanto.

Another design component was incorporating building users' energy data to promote community engagement. The team planned to fully incorporate a user-friendly dashboard (see Figure 1) showcasing energy usage, thermostats, and time-of-use energy controls for the

education and understanding of real-time building operations. This dashboard was available to both the project team and end-users. If implemented fully, this data could be exported to a Microsoft Excel spreadsheet for deeper analysis.

Figure 1: Paseo Adelanto Dashboard Rendering

Source: Jamboree Housing Corporation

Less energy is required to heat, cool, and operate appliances and electronics in energy-efficient homes and buildings. Designing for energy efficiency is one of the greatest and most economical strategies to fight climate change and lower customer energy bills. The project team examined the site's climate and conditions to determine where efficiency improvements could be implemented.

The overall site plan of Paseo Adelanto capitalized on the temperate climate and oriented courtyards south and west to maximize natural daylight (see Figure 2, Figure 3, Figure 4, and Figure 5). Shading devices mitigated additional heat gain, enhancing the building’s overall energy performance. The inclusion of operable windows and an open corridor also enabled passive heating and cooling.

Figure 2: City Hall Rendering

Source: Jamboree Housing Corporation

Figure 3: Aerial View of Paseo Adelanto, Mixed-Use

Source: Jamboree Housing Corporation

Figure 4: Residential Courtyard

Source: Jamboree Housing Corporation

Figure 5: City Hall Interior Rendering

Source: Jamboree Housing Corporation

Design Strategies for Integrating Conventional and Emerging Energy Technologies

The Paseo Adelanto mixed-use development design aligned with 2019 Title 24/20 standards since the building was already under construction. The design team capitalized on the temperate climate of San Juan Capistrano, which allowed the residential building's corridors to remain open for natural ventilation. This eliminated the necessity of heating, cooling, and continuous mechanical ventilation. Windows were additionally equipped with protective shading elements, such as eyebrows, to reduce excessive heat gain.

Following identification of energy-reduction strategies within the design, the team focused on enhancing overall building efficiency to exceed Title 24 requirements.

The affordable housing building design achieved an EUI of 17.1 kBtu/sf-yr through implementation of:

- **Interior Lighting:** A 22 percent improvement in interior lighting efficiency in common areas, surpassing the Title 24 2019 baseline.
- **HVAC:** The majority of spaces equipped with Carrier's Mini Split Heat Pump delivered an efficiency of 12.5 energy efficiency ratio (EER)/10.3 heating seasonal performance factor (HSPF) compared with the Title 24 baseline efficiency of 11.2 EER/8.2 HSPF.
- **Domestic Hot Water Heater:** The Rheem® PRO H40 heat pump water heater with a uniform energy factor of 3.5, an enhancement over the 2.6 baseline.
- **Roof:** Incorporation of an attic with 5.5-inch R-19 cavity insulation beneath the roof deck, alongside R-30 ceiling insulation with a U-value, the sum of the thermal resistances of the layers that make up an entire building element, of 0.038.
- **Exterior Wall:** R-21 cavity insulation with a U-value of 0.065.
- **Plugs:** All residents receive a smart power strip along with a guide outlining compatible devices for effective plug load management within dwelling units.

The city hall building achieved an EUI of 18.8 kBtu/sf-yr through implementation of:

- **Interior Lighting:** 24 percent more efficient interior lighting than the Title 24 baseline.
- **HVAC:** HVAC Mini Split Heat pump with cooling EER 13 and heating HSPF 8.5, as compared with the Title 24 baseline cooling EER 10.8 and furnace efficiency of 78 percent.
- **DWH Water Heater:** Domestic hot water heater heat pump coefficient of performance 3.5, as compared with the Title 24 baseline natural gas hot water heater efficiency of 80 percent.
- **Roof:** Performance beyond code minimum, R-38 above deck continuous insulation.
- **Exterior Wall:** Performance beyond code minimum, R-21 cavity insulation.

End-Use Energy Efficiency

The team assumed the use of a vampire switch for the city hall building. This global switch will effectively halt the unnecessary consumption of electricity outside office hours by lighting, electronics, and appliances. It serves as a fail-safe measure, further advancing energy efficiency objectives set forth by Title 24 for commercial buildings. Importantly, this switch is cost-effective and straightforward to replace or repair in the event of malfunction.

Load Flexibility, Grid Interactions, and Resident Engagement

Community Energy Labs, Paseo Adelanto's technology partner, is developing a modern building control solution that ensures accessibility and affordability for building owners while enabling energy management and decarbonization. This cost-effective, grid-interactive building control platform employs MPC to autonomously optimize energy, pricing, and comfort without imposing excessive burdens on building operators.

Despite its potential, MPC remains confined to affluent corporate campuses, universities, or high-rise buildings due to its complexity, cost, and the expertise required for its configuration. However, mixed-use developments remain a unique opportunity to unlock MPC's full potential. These developments, housing multiple energy-intensive functions within a single structure, offer both a challenge and the chance to harness the advantages of MPC. The Paseo Adelanto project demonstrated how MPC control could be adopted at minimal cost, using readily available equipment and methods to scale across high-density, low-income housing developments. Community Energy Labs developed software to integrate with off-the-shelf thermostats, which would manage energy usage based on grid demand.

Currently, CEL's technology effectively governs management across 21 school campuses located in three separate climates zones, with 16 of those campuses located in California. This implementation has led to average reductions of 20 percent during peak loads while maintaining temperatures within a 2 percent to 5 percent range of desired comfort levels.

Community Energy Labs developed frequently asked questions documents for building management and supportive services staff to facilitate the installation process and keep occupants informed and engaged about the novel technology, increasing the likelihood of acceptance. There will also be information sheets for residents that explain the different controls features and how they impact energy consumption. Monthly utility data and savings will be available to residents on a display screen in the community lounge. This will create more transparency about the system and its features.

Microgrid Design Strategy

This project assessed various battery storage solutions, finally choosing the Gridscape Microgrid BESS system. This Gridscape BESS system contains all required hardware and software, which is pre-assembled in an outdoor enclosure for ease of installation and maintenance. Gridscape will provide, deploy, and configure a modular battery system with an integrated site controller to coordinate, manage, and control the proposed equipment and other energy resources. It will generate on-grid energy savings while also functioning in off-grid microgrid mode, which ensures that there is a supply of power for critical loads during

outages. It has a scalable architecture and provides real-time and historical monitoring and control, along with fault detection, alarm monitoring, performance management, and remote diagnostic capabilities.

EV Charging, Electric Mobility Strategy, V2B, and V2G Capability

The cloud-based platform for the battery, Gridscape EnergyScope™ DERMS, serves as a platform for managing DERs within a network. These individual resources encompass solar PV systems, battery systems, and EV charging systems (both direct current [DC] and alternating current [AC]). This platform also optimizes energy resource dispatch by meeting demand reduction goals and responding to market demand signals. This approach maximizes economic gains while minimizing greenhouse gas emissions. The optimization process considers factors including DER availability, production costs, utility rates, and load consumption patterns. The Gridscape EnergyScope™ Distributed Energy Resource Management System (DERMS) offers a consolidated dashboard for overseeing solar PV output, BESS performance, and EV charging systems managed through the open charge point protocol (OCPP), for both DC and AC chargers.

The research team examined the potential of integrating San Diego Gas and Electric (SDG&E) Company's "Power Your Drive [PYD] for Apartments and Condos EV Charging Infrastructure Program"[1] to develop a cost-effective EV solution. After a thorough analysis the team concluded that this program did not align with the specific timing needs and objectives of the current project.

This project's build timeline did not match SDG&E's PYD incentives timeline. Another significant challenge was managing ownership of the EV charging stations between the utility, residential entity, and city hall. Since the residential and city hall buildings are owned by separate entities, SDG&E clarified that they would not accommodate multiple owners for a single project.

The option for the EV chargers to be utility-owned could significantly lower operating and ownership costs while ensuring on-site charging availability. This option, however, did not meet EPIC's "on-site" requirement.

Considering these challenges, the team determined that the PYD incentive was not suitable for this stage of the current project.

Advanced Construction Planning and Practices

Jamboree's in-house general contractor, Quality Design and Construction, adopted a proactive approach for this conceptual design, offering cost-saving and sustainable building techniques. The team designed this project during the Schematic Design and Design Development phases to incorporate as many of the EPIC-ready features as possible. The contractor was involved early on in the process of the conceptual Schematic Design, Design Development, and Construction Drawings/Development Phase, providing cost analyses and constructability

[1] San Diego Gas & Electric. 2024. "Power Your Drive for Apartments and Condos." Online at: https://www.sdge.com/business/electric-vehicles/power-your-drive-apartments-and-condos#:~:text=To%20reduce%20greenhouse%20gas%20emissions%20(GHGs)

feedback and forecasted construction timing for all project components. Standard construction means and methods enabled achievement of project design goals.

Some advanced methods (such as thermostats) could become standard design practice for the developer. Integrating the battery and PV solar and designing and building these systems could both save time and reduce the cost of the overall development.

Solar and batteries can be prescriptive, meaning they are non-proprietary and non-specific. In a design/build model, which the team found was the best approach for battery and solar, contractors can both source the best products at the best prices and meet or exceed baseline design standards.

Market Transformation

The project team, including the City of San Juan Capistrano and Jamboree's marketing team, will highlight the project's design in all project communications. The case study will be shared through the Energize Innovation Forum, where other developers and jurisdictions can learn about Paseo Adelanto's design and benefits. Jamboree is interacting with jurisdictions that are interested in building affordable housing; like the joint city hall/affordable housing model, the project's design is an example of possible approaches to affordable housing development and sustainability.

Standardizing, Repeating, and Scaling Mixed-Use Development

This project also shows how mixed-use development can repurpose under-used public lands and renovate public facilities. The Paseo Adelanto model can apply to city halls, libraries, housing authorities, and other government offices. In addition, Paseo Adelanto built on Jamboree's mixed-use development and expertise while adding an advanced sustainability element. Jamboree often shares experience and lessons learned with its network of developers, cities, and elected government officials at both local and state levels.

Financing Strategies

The CEC EPIC program is the main funding source for the installation of the EPIC design. This grant funding opportunity does not recur on a yearly basis like most affordable housing financing sources, and financing is a major obstacle for affordable housing developers. Paseo Adelanto and other EPIC projects will add momentum to the conversation at the local and state levels for the importance of sustainability subsidies like EPIC and local rebate programs. The team explored a potential EV charger rebate program through SDG&E and obtained a list of potential subsidies from the emerging technologies team at SDG&E. Unfortunately, the project's design was ready for a potential application after EV charger program funds were exhausted. Moving forward, the team will track rebate programs and tax credit incentives as a backup to CEC funding for some of the technologies, like solar panels and microgrids. This includes the Self-Generation Incentive Program administered by the CEC and the 45L tax credits (26 USC § 45L) administered through the United States Department of Energy.

Standards and Protocols

Due to Paseo Adelanto's construction schedule, equipment research efforts largely focused on adaptable technologies that could either be affordably implemented in the code-compliant design or retrofitted as part of the project scope. Systems like the Pelican and Ecobee thermostats are both controllable and wireless and do not have incremental cost impacts on the current design. Other features such as the wiser control relay for domestic hot water and the smart plug power strips, had cost increases of less than $30,000, which would be more palatable for developers seeking to incorporate features with a large return of energy cost savings.

Despite offsetting energy costs, other proposed technologies come with significant up-front costs; their lifespan costs are high and outweigh any energy cost savings generated by the technologies. The team assumes this is partly due to the newness of the technologies and their limited availability. The hope is that with additional funding opportunities these technologies will become more common and ultimately contribute to a greater plug-and-play environment for developers.

Contingency Planning

The team included a $250,000 budget contingency for unforeseen costs. Project partners were accustomed to developing these new technologies with partners like Community Energy Labs and Gridscape, and relied upon their respective budget inputs to finalize cost estimates.

The team's approach to the build phase strove to prevent burdens to operation and supportive service budgets caused by the maintenance and replacement of the new technologies. At the same time, the team has been proactive in maintaining these new technologies to ensure the building is net-zero and optimally functioning. As a result, the team included four reserves as part of the build budget over the next 15 years:

1. Building management system lifespan costs.
2. BESS and solar maintenance reserves.
3. BESS and EV replacement reserves, projected to be used in year 13.
4. Knowledge transfer activities for the supportive services team to host on-site events for the future Sustainability Resident Committee as well as for new resident and staff education.

Community Engagement

To gather community input, CEL embraced a proactive approach. An integral phase of this process involved arranging a hands-on design workshop, which took place on January 19th, 2023, at Jamboree's Heroes Landing low-income apartments.

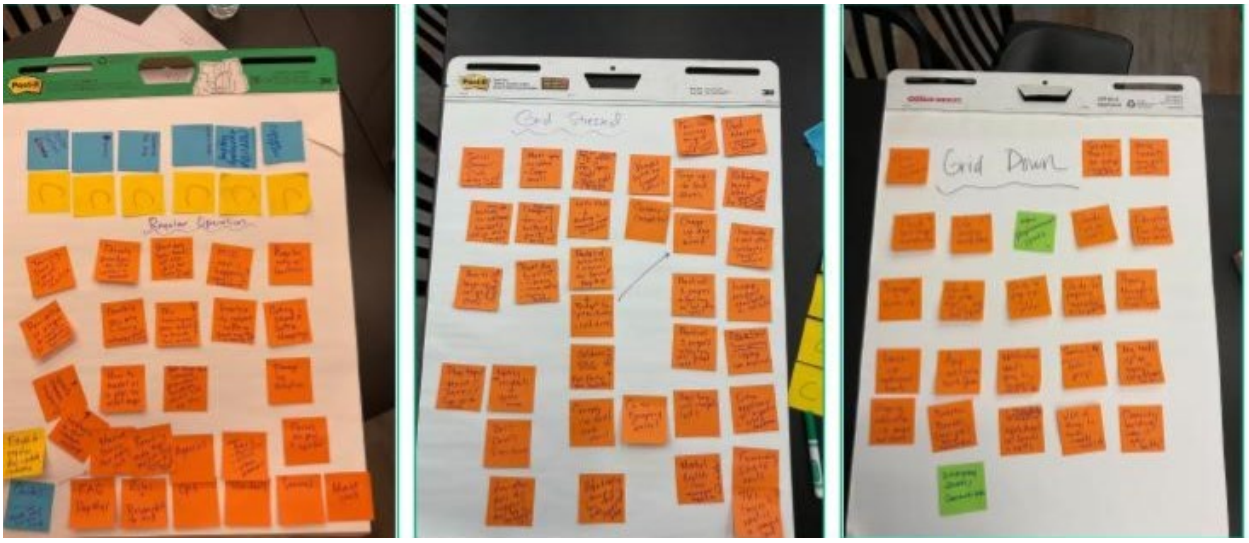
Engaging in the workshop were eight pivotal community members including asset managers, maintenance directors, technicians, and program, property, and project managers from Jamboree. Their diverse backgrounds and roles brought a wealth of perspectives into the three-hour session, enriching the feedback (see Figure 6).

Figure 6: Participants in the Design Workshop

Source: Jamboree Housing Corporation

Throughout the two-stage workshop, CEL sought to understand the community's energy consumption patterns within their buildings and their preferences for interfacing with emerging technologies (Figure 7). Insights gained from these discussions substantially influenced CEL's user interface design, ensuring that it effectively met the community's needs and expectations. This approach culminated in the creation of a flyer/education document format.

Figure 7: Typical, Grid Stressed, and Grid Down Community Priorities From the Workshop



Source: Jamboree Housing Corporation

The workshop also provided a platform for discussing the roles of non-residential common-area spaces. The concept of these spaces as emergency cooling centers or communal gathering spots gathered enthusiastic support. This two-way constructive discourse significantly contributed to the project's alignment with the broader community's needs. This

invaluable community feedback played an indispensable role in shaping the project's ultimate design.

Addressing Gentrification and Affordability

"Smart growth" refers to the compact development strategy that brings residential and commercial uses in proximity within urban and transit-centric areas. This approach is crucial for achieving Californian Governor Gavin Newsom's goal of constructing 3.5 million new housing units by 2025. As smart growth gains traction in California, it is imperative for both the State and developers to be mindful of these potential adverse effects when approving and pursuing new projects. Paseo Adelanto serves as a prime example of smart growth that not only avoids displace low-income households but also creates new opportunities for high-quality affordable housing.

Paseo Adelanto adopted a proactive approach to mitigate gentrification by reserving 49 out of 50 units for extremely low- and very low-income households. Among these units, 40 will serve households transitioning out of homelessness with incomes up to 30 percent of the area median income (AMI). These 40 units, falling under the 30 percent AMI bracket, will be equipped with project-based vouchers from the Orange County Housing Authority, guaranteeing that residents never pay more than 30 percent of their incomes on rent. Additionally, 9 units set at 50-percent AMI will have rents regulated by the California Tax Credit Allocation Committee.

Paseo Adelanto aligns seamlessly with local government priorities by contributing to the City of San Juan Capistrano's state-issued Regional Housing Needs Assessment goal of establishing 270 extremely low- and very low-income housing units. The inclusion of Paseo Adelanto in the city's 2021-2029 Housing Element reflects its status as a pending project that will deliver 50 units toward the Regional Housing Needs Assessment objective, please see Figure 8 of a residential community room.

Figure 8: Residential Community Room Rendering

Source: Jamboree Housing Corporation

Community Impacts

Paseo Adelanto's impact on the local community is profound, breathing new life into a local government building at the heart of the city, while creating 50 affordable Orange County rental units. This venture bolsters the area's housing options and emphasizes the county's commitment to sustainable, community-centric development.

The future rebuild of the City of San Juan Capistrano City Hall marks a significant upgrade from its decades-old, inadequate predecessor, promising a spacious, two-story, 16,000-square-foot facility that will be a source of pride for both staff members and the residents of San Juan Capistrano. Paseo Adelanto's residential segment fulfills a dual purpose: offering homes to 40 homeless individuals while creating jobs for on-site employees including case managers, a property manager, and maintenance personnel.

Paseo Adelanto represents the state's efforts to successful rejuvenate underused urban infill sites through strategic upzoning. The city's decision to transition the zoning from office and commercial uses to accommodate multi-family residential housing has set the stage for transformative change. This success story is a model for both other cities and affordable housing developers.

Workforce Development and Job Creation

During construction, approximately 50 jobs will be created for the labor and installation of the design systems. Once construction is completed, there will be four permanent jobs, including a case manager, a property manager, and maintenance personnel.

CEL will provide comprehensive training for the building's HVAC technicians and custodians, as well as for the operators reviewing new equipment, emerging technologies, and operational practices. In collaboration with Southern California Edison Company, CEL offers a free, two-day course entitled Grid-Interactive Efficient Buildings. Delivered in a virtual eight-hour format, this course qualifies for continuing education and certification credits for building, engineering, and HVAC trades.

Tenant Access to Electric Mobility, Solar Photovoltaics, and Demand Response

Paseo Adelanto will provide EV charging stations, PV solar, and smart buildings to city hall staff, residents of Paseo Adelanto, and the general public. Charging stations will be spread across both the city hall and residential parking areas. Drivers of EVs will have access to charging stations located at city hall, which is itself located within one block of the post office, office buildings, grocery stores, and a large mobile home park. The project will provide enough PV solar to offset 100 percent of building energy use, and building energy controls will ensure that the building consumes less energy in times of grid stress.

CHAPTER 3:
Results

The design phase of the project incorporated the challenge of zero-emissions in addition to integrated technology research, analysis, and community engagement. The team obtained all necessary permits and engaged with the local community, prospective occupants, and end users of the buildings to evaluate energy consumption and the impact of the design and the technology on the livability of the property. Because the build phase grant was not awarded, the net zero technologies were not fully installed after the buildings were constructed. Following are some of the specific results and solutions identified as part of the design process.

EV Charging Stations

For EV charging stations, Jamboree offered various options including ChargePoint EV charging stations and Gridscape integrated options such as BTC Power, Delta, Tritium, or Siemens. Both solutions could effectively respond to grid and building signals through the application of OCPP protocols 1.6-2.0.1. Gridscape is experienced in both deploying and integrating DC fast chargers and Level 2 AC EV chargers. These chargers would seamlessly function with Gridscape's EnergyScope™ DERMS system right out of the box.

Meanwhile, ChargePoint provides a comprehensive integration application programming interface (API) that forms the backbone of its interactive capacity. This API, featuring more than 40 integrations, employs the OCPP as a universal language for EV charging infrastructure. ChargePoint's EV stations can communicate directly with the grid and, when integrated with auxiliary control systems like CEL's MPC, they can also respond to instructions from these technologies.

This integration would allow Paseo Adelanto's team to intelligently manage EV charging by using data from the grid, building, and weather forecasts. The team examined the potential for integrating SDG&E's "Power Your Drive for Apartments and Condos EV Charging Infrastructure Program" to achieve a cost-effective EV solution. After a thorough analysis, the team concluded that this program did not align with the specific needs and objectives of the current project. Another significant challenge was managing ownership of the EV charging stations between the utility, a residential entity, and the city hall. Since the residential and city hall buildings are owned by separate entities, SDG&E clarified that they could not accommodate multiple owners for a single project. The option for the EV chargers to be utility-owned could significantly lower operating and ownership costs while ensuring on-site charging availability. This option, however, does not meet EPIC on-site requirements. Considering these challenges, the team determined that the PYD incentive was not suitable for the current project. The team, however, remains receptive to exploring similar opportunities that align with its mission to improve grid reliability and energy efficiency.

Load Flexibility, Grid Interactions, and Resident Engagement

Community Energy Labs is developing a modern building control solution that ensures accessibility and affordability for building owners while enabling energy management and decarbonization. This cost effective, grid-interactive building control platform employs MPC to autonomously optimize energy, pricing, and comfort without imposing excessive burdens on building operators.

CEL helped support the OKR 06 peak load management, which requires that a minimum of 20 percent of the building's peak load be available for temporary management or curtailed in response to grid conditions; MPC flexibly manages energy and shapes electricity demand, resulting in savings ranging from 5 percent to 25 percent and peak demand reductions of between 10 percent and 40 percent. These improvements considered various constraints such as air quality and comfort.

CEL's strategy used off-the-shelf wireless thermostats such as the Ecobee to communicate with the primary MPC software. This meant that no wires were needed to hook up the system, which reduced costs.

Microgrid Design Strategy

The Gridscape Microgrid BESS system contains necessary hardware and software that is pre-assembled in an outdoor-rated enclosure for ease of installation and maintenance. Gridscape will provide, deploy, and configure a modular battery system with an integrated site controller to coordinate, manage, and control the proposed on-site equipment and energy resources. It can generate on-grid energy savings while also functioning in off-grid microgrid mode, ensuring there is a supply of power for critical loads during outages. It has a scalable architecture and provides real-time and historical monitoring and control, along with fault detection, alarm monitoring, performance management, and remote diagnostic capabilities.

Specifically, the Microgrid BESS system proposed for Paseo Adelanto is 240 kW/600 kWh for Building A (residential) and 120 kW/300 kWh for Building B (commercial), totaling 360 kW/ 900 kWh. This system incorporates batteries from Samsung, LG Chem (Delta, Michigan), Energyport (lithium iron phosphate), and Spiers New Technologies (2nd life batteries). The system also houses PCS inverters capable of functioning in both grid-following and grid-forming modes to accommodate both on-grid and off-grid operations.

To ensure seamless communication and management, the Gridscape EnergyScope™ controller maintains a secure and encrypted cellular data connection that connects to the cloud. In the event of cellular data connectivity issues, the controller can also establish a connection via satellite, ensuring consistent functionality.

The Gridscape EnergyScope™ controller operates in real-time synchronization with the EnergyScope™ DERMS server. It continuously adapts energy flow control behaviors according to site conditions. Designed for effortless integration, the controller incorporates diverse DERs without requiring significant design modifications.

EV Charging, Electric Mobility Strategy, V2B, V2G Capability

The Gridscape EnergyScope™ DERMS is a cloud-based platform for managing DERs within a network. These resources include PV solar systems, BESS systems, and EV charging systems (both DC and AC). This platform optimizes energy resources dispatch by capitalizing on arbitrage opportunities, meeting demand reduction goals, and responding to market demand signals. This approach maximizes economic gains while minimizing greenhouse gas emissions. The optimization process considers factors like DER availability, production costs, utility rates, and load-consumption patterns. The Gridscape EnergyScope™ DERMS provides a consolidated dashboard for overseeing PV solar output, BESS performance, and EV charging systems managed through the OCPP protocol, for both DC and AC chargers. All EV charging stations can respond to signals from both the grid and the building.

Design Challenges

One barrier to efficiency was the requirement that the city hall and supportive housing be separately connected to the grid (SDG&E). This meant that the buildings could not share renewable energy resources such as solar or battery storage. The buildings are on opposite schedules, so it would have been beneficial for the city hall to use the residential solar (or vice versa). This was because both buildings required separate electric meters. Due to this, the utility could neither share renewable power nor be connected to one other. This is a significant barrier to renewable energy installations. With the high cost of battery storage, it would be more cost-effective if separate sites could share their capacities.

The design team also looked at installing solar power on the roofs, but the narrow residential floorplate and the mechanical equipment on the roof left very little space for a roof install to be cost-effective.

Energy and Emissions Performance

Energy Modeling Approach

Through the design phases, integrated environmental solutions was used to track proposed design and evaluated energy efficiency measures. Occupancy and building operating schedules in the model were based on actual conditions. Operating schedules are from the AHSRAE 90.1-2016 user manual, modified as needed to accommodate actual building operating hours and feedback from Jamboree. Lighting power density, HVAC, and envelope inputs were updated at 100 percent construction documents to reflect the actual design, and the dwelling unit lighting power density was boosted by 20 percent to account for plugged lights by residents; domestic hot water load was calculated using the United States Green Building Council’s Indoor Water Use Reduction Calculator. Based on feedback, the indoor temperature setpoint used for Building A was Heat: 70 degrees Fahrenheit [°F] (21 degrees Celsius [°C]), Cool: 74°F (23°C) to 79°F (26°C), and for Building B Heat: 70°F (21°C) to 60°F (16°C), and Cool: 75°F (24°C) to 80°F (27°C). City hall's hours are Monday through Thursday from 7:30 a.m. to 5:30 p.m., and Friday from 7:30 a.m. to 4:30 p.m. The annual 8,760-hour load profile is an hour-by-hour analysis that simulates a building's performance for all 8,760 hours in a given 12-month

period. These profiles were generated from this exercise and were used by Gridscape to evaluate battery sizing and the annual estimated kWh used to size PV for net-zero energy. Title 24 Part 6 code compliance energy models were created in the 2019 versions of California's Building Energy Code Compliance Software – Commercial and California's Building Energy Code Compliance Software – Residential software.

Load Management – Building A

Even in the baseline daily operations, it was assumed that between 4:00 p.m. and 9:00 p.m. the laundry room will not be used, which reduced the peak for the residential building by 8 percent. More relaxed set points [Heat: 68°F (20°C) to 60°F (16°C), Cool: 78°F (26°C) to 80°F (27°C)] could reduce peak demand by 6 percent. Limiting corridors and stairs to emergency lighting in common areas to 50 percent of design output levels could further reduce the peak by 4 percent. These strategies together can shave 10 percent off peak use. Awareness and education among the occupants will provide further opportunities to reduce peak loads.

Load Management – Building B

Relaxed set points [Heat: 68°F (20°C) to 60°F (16°C), Cool: 78°F (26°C) to 85°F (29°C)] could reduce the peak demand by 8 percent, turning off support spaces lighting except emergency lights and dimming open office lighting levels to 50 percent of the design output could reduce peak demand further for a combined peak reduction of 13 percent.

Battery Operation

A minimum state of charge of 20 percent for the batteries was determined based on the battery manufacturer's requirements, critical load supported during outages, and optimum battery size to satisfy the 4:00 p.m. to 9:00 p.m. load offset. The batteries will be at this level at any given time of the day and will not go below this threshold. Batteries will charge during the day when there is excess solar production and discharge up to the state of charge between 4:00 p.m. and 9:00 p.m. daily. The only times when the battery will need to be charged using grid power would be at off-peak or super-off-peak times during overcast and winter months when excess solar is either insufficient or unavailable.

Energy Use Intensity

The affordable housing building attained an EUI of 17.1 kBtu/sf-yr; whereas the City Hall building attained an EUI of 18.8 kBtu/sf-yr.

Costs and Benefits Performance

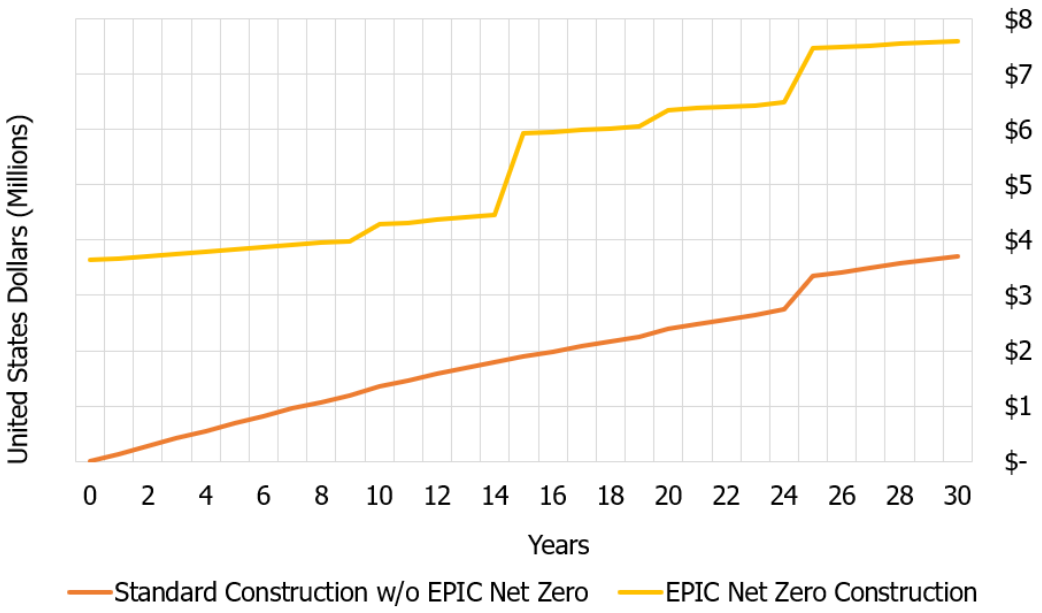
Due to high initial and replacement costs, the net zero design is more expensive (more than twice the cost) over the 30-year lifecycle than the baseline design. (See Table 1 and Figure 9).

Table 1: Capital Cost and Net Present Value With and Without Net-Zero Construction

Option	Description	Capital Cost Difference	30-year NPV
1	Standard Construction without EPIC Net Zero	$0	$3,712,194
2	EPIC Net Zero Construction	$3,645,391	$7,603,242

Source: Jamboree Housing Corporation

Figure 9: 30-Year Net Present Value of HVAC Options



Source: Jamboree Housing Corporation

Because construction began in 2023, the design team focused on features that could act as retrofit solutions. Wireless controls were both an aesthetic and economic solution to manage peak load since running wires through built walls would not be required. The other load management technologies, solar and battery, were sized appropriately for the project load and added to the site plan. The owner is providing smart-plug power strips for all units along with education materials so residents can plug equipment into the power strips. The battery is a costly investment but necessary to reach net zero and load-management goals.

The design team discussed passive ventilation for the city hall, but the control was too difficult for their team to manage its operation. Increasing the envelope performance beyond Title 24 is costly and did not make sense to discuss further due to the timeline of this project. The team therefore ended up with Title-24-compliant insulation able to achieve the target EUI levels in City Hall load reductions achieved with the vampire switch.

Technology Transfer Plan

CEL hosted a three-hour design workshop on January 19, 2023, at Jamboree's Heroes Landing low-income apartments. Eight participants including asset managers, maintenance directors and technicians, and program, property, and project managers from Jamboree participated in the two-stage workshop. This workshop allowed the team to gather community feedback and understand occupants' building energy usage and preferred interfaces with emerging technologies. The first part of the workshop allowed participants to reflect on their relationships to energy consumption and to learn the basics of how energy is changing and what new energy control options are emerging. It also allowed the team to learn how residents and building users spend their days and to gauge participant understanding and perceptions around what powers the appliances they use on a typical day. The team then asked participants to chart a typical day when a power outage occurs. The second part of the workshop allowed participants to provide input on the controls for Paseo Adelanto. It allowed the team to learn which interfaces and control priorities best fit the community. Initial findings indicated the desire for workforce training materials (tactical and instructional) and marketing handbooks (printed as opposed to digital).

CHAPTER 4:
Conclusion

The Paseo Adelanto net-zero design achieved the OKRs described in Chapter 1.

- Consumption of only electric energy, no natural gas.
- Efficient residential energy use (Building A – Housing) with an EUI between 15 and 18 kBtu/sf-yr.
    - Affordable housing building attained an EUI of 17.1 kBtu/sf-yr.
- Efficient non-residential energy use (Building B – City Hall) with an EUI between 16 and 19 kBtu/sf-yr.
    - City hall building attained an EUI of 18.8 kBtu/sf-yr.
- A minimum of 20 percent of the building's peak load will be available to be temporarily managed or curtailed to respond to grid conditions while the building's residential load during peak demand hours, 4;00 p.m. to 9:00 p.m., will be met through a combination of on-site renewables, on-site storage, and load management.
    - Solution: CEL MPC technology, solar panels, Gridscape battery storage of 240 kW/600 kWh for Building A (residential) and 120 kW/300 kWh for Building B (commercial), totaling 360 kW/900 kWh.
- All residential end uses would be controllable through the home energy management system.
    - CEL MPC software controls with Ecobee thermostats.
- Home energy management system will respond to real-time pricing signals including the microgrid controller, which will be interoperable with DER aggregation platforms such as virtual power plants.
    - Microgrid DERMs software.
- The building will be able to island from the main grid during outages and shed discretionary loads to provide power to Tier 1 critical loads (10 percent of peak load) and Tier 2 priority loads (25 percent of peak load).
    - Tier 1 included server rooms and emergency lighting.
    - Tier 2 included Tier 1 plus the residential community room lighting, power, and fans for temporary sheltering.
    - The microgrid was sized for indefinite renewables-driven backup power of Tier 1 critical loads using any combination of on-site renewables, on-site storage, and load management.

- Planning for the future, 20 percent of all parking spaces associated with the development will have EV-charging stations that can respond to grid and building signals; all remaining parking spaces will be EV-ready, with a dedicated electrical circuit with the capacity to eventually act as a charging station.

The net-zero energy usage design was achieved with a combination of technologies discussed in this report. The solar, battery storage, load reduction MPC software, increased insulation, and vampire switch load shut-off technologies together created very low building EUIs and net zero energy usage. The technologies selected such as the vampire switch and wireless thermostats connecting to the MPC software show how off-the-shelf technologies can reduce energy consumption. Off-the-shelf technology is also important because it enables later installations of renovation options.

The renewable energy and energy storage options have both high-cost barriers to entry and high maintenance costs. Solar panels have tax credits that shorten the payback, but the battery storage technology is still very expensive (along with high maintenance costs). This made the battery storage impossible to include in the budget of buildings with low operating incomes.

To help increase technology adoption, battery costs must come down or assistance such as tax credits must increase. Other projects similar to the city hall office schedule can immediately incorporate a vampire switch, however, to reduce usage at night when no one is using the building. The wireless thermostats were also one-to-one replacements in terms of cost from the standard design but included functionality for the MPC control. Other projects could consider using these thermostats or allowing demand-based control at time of installation or in the future. The PV solar system is well integrated into California Title 24 and did not require much additional space to achieve the full building offset. Other projects could look at maximizing solar PV space on-site to achieve similar results. The EV charger technology typically includes grid demand-based charging options and can be easily enabled with a DER management system like the Microgrid DERMs system used in this project.

Future areas of research would include adopting utility regulations that allow buildings to share excess energy. This regulation prevented these two buildings from benefiting from different building profiles. This likely would have also reduced the battery size needed on the whole site and its costs. Lastly, some ongoing software costs for the MPC controls and battery maintenance costs made the ongoing functionality of these technologies difficult to plan for. Future research should be done to discover alternative ways of financing ongoing costs.

The net-zero design for the Paseo Adelanto project shows how a mixed-use project can achieve aggressive energy goals. The project design fully offset the energy loads with PV solar and reduced peak demand. After much coordination and design, the team is pleased to present a design that achieves OKR net-zero goals and can be used as a guide for future projects.

GLOSSARY AND LIST OF ACRONYMS

Term	Definition
AC	alternating current
AMI	area median income
API	application programming interface
BESS	battery energy storage system
°C	degrees Celsius
CEL	Community Energy Labs
Critical Load	uninterruptible power supply that serves a vital function for a facility
DC	direct current
DER	distributed energy resources: renewable energy technologies, storage (such as batteries), and combined heat and power
DERMS	distributed energy resource management system: technology system that controls and optimizes the flow of electricity from distributed energy resources, such as solar panels
EER	energy efficiency ratio: a measure of how efficient a cooling system is. It is calculated by dividing the cooling capacity of a system by the power input it uses
EPIC	Electric Program Investment Charge
EUI	energy use intensity: refers to the amount of energy used per square foot annually. It is calculated by dividing the total energy consumed by the building in a year by the total gross floor area
EV	electric vehicle: a vehicle that runs fully or partially on electricity
°F	degrees Fahrenheit
greenhouse gas	gas that traps heat in the atmosphere
HSPF	heating seasonal performance factor: a heating efficiency rating for heat pumps. The higher the rating, the more efficient the heat pump
HVAC	heating, ventilation, and air conditioning
Jamboree	Jamboree Housing Corporation
kBtu	thousand British thermal units
kW	kilowatt
kWh	kilowatt-hour
microgrid	a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single

Term	Definition
	controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode
MPC	model predictive control: advanced method of process control that is used to control a process while satisfying a set of constraints
net zero emissions	A target of completely negating the amount of greenhouse gases produced by human activity, to be achieved by reducing emissions and implementing methods of absorbing carbon dioxide from the atmosphere
OCPP	open charge point protocol: an open-source communication standard that allows electric vehicle charging stations and management systems to communicate with each other.
OKRs	objectives and key results
PSH	permanent supportive housing: permanent housing in which housing assistance (e.g., long-term leasing or rental assistance) and supportive services are provided with at least one member (adult or child) with a disability in achieving housing stability
PV	photovoltaics: conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect
PYD	Power Your Drive: Power Your Drive for Apartments and Condos EV Charging Infrastructure Program
SDG&E	San Diego Gas & Electric Company
smart growth	the compact development strategy that brings residential and commercial uses in proximity within urban and transit-centric areas
SOC	state of charge: quantifies the remaining capacity available in a battery at a given time and to a given state of aging.
sq-yr	square foot per year
Tier 1 critical load	life-sustaining or crucial energy sources to keep operational during a grid outage
Tier 2 critical load	important but not crucial energy sources to keep operational during an outage
U-value	the sum of the thermal resistances of the layers that make up an entire building element
vampire switch	also called standby power, refers to the way electric power is consumed by electronic and electrical appliances while they are switched off but are designed to draw some power

Project Deliverables

- Equipment Research Plan
- Community Engagement Plan
- Summary of Outreach Activities
- Project Website
- User Interface Mockups and Interface Prototypes
- Concept Drawings and Sketches
- Schematic Designs
- Architectural Renderings
- Energy Model Findings
- Engineering Report
- Construction Documents
- Business and Operations Plan
- Concept Video