MUTLFAMILY ZNE CASE STUDY

Edwina Benner Plaza | Sunnyvale, CA

PROJECT PROFILE

- 100% affordable all-electric building GreenPoint Rated Platinum
- Built in 2018 under 2016 Code
- 104,727 square feet
- 66 units- 120 bedrooms (1,2,3 bedrooms)
- Located in: Sunnyvale, CA
- Climate Zone: 4
- Units direct metered for electricity

Photo credit: Keith Baker

Owner: Midpen Housing; Architect: David Baker Architects; Energy Consultant: Association for Energy Affordability

Project Goals and Achievements.

The design team did not start with the goal to build an all-electric project but was convinced to pursue this approach given the health, environmental, and operational cost benefits, as well as the design review, field verification, and commissioning resources made available by the CEC EPIC grant. The team settled on a goal to deliver a highly efficient all-electric building with solar PV to entirely offset owner-paid electricity. The greatest design challenge was shifting the domestic hot water system from a traditional gas boiler with solar thermal offset to a central heat pump water heating (CHPWH) system with solar PV offset. While moving the design away from fossil fuels, the project team looked to balance upfront and operational costs, all while operating within the tight budget of a tax credit-funded affordable housing development.

Edwina Benner Plaza is a podium-style building with three double-loaded sections connected by outdoor walkways, with 3 stories of residential units over the ground floor with common area spaces, offices, an outdoor playground, and an open-air parking garage. The building's hot water needs are fulfilled by two Sanden (now Eco2 Systems) SANCO2-based heat pump water heating plants. The base water heating system consists of four SANCO2 heat pumps connected to one 500-gallon storage tank. The rear section of the building is served by one of these systems, while the front and middle sections of the building are served by three of these systems in parallel. Both plants have a residential-sized Rheem heat pump water heater piped in parallel for recirculation heat maintenance. Recirculation pumps are Grundfos Magna 1 variable-speed units, and recirculationrisers are balanced with Caleffi thermal balancing valves.

Results

The research team played a significant role on both the design and commissioning to realize the CHPWH system performance that was ultimately achieved, with an annual average COP of 4.

ANNUAL KWH CONSUMPTION

242,687	192,604
Net Consumption	PV Production *Common Area Only*
20%	**9.7%**
% from ZNE	% Above 2019 Code

EFFICIENCY MEASURES

- Envelope: R-21 and R-38 Roof, Cool Roof, R-19 walls
- DHW: Central Modular Sanden System – 16 Sanden heat pumps, 2,000 gal of HW storage with Rheem HPWH recirc heaters
- HVAC: Individual ductless minisplit heat pumps HSPF 8.2 and SEER 14
- LED lighting
- Low flow fixtures

The success of Edwina Benner Plaza demonstratesto other developers the feasibility of all-electric affordable housing projects.It also is influencing MidPenHousing's ongoing and planned projects. -Matt Lewis, Project Manager, Midpen

https://norcalapa.org/2020/08/affordable-housing-in-silicon-valley-puts-focus-on- sustainability/

Research Team: Association for Energy Affordability, Franklin Energy, Redwood Energy and Stone Energy Associates. For more information about EPIC grant, please visit www.aea.us.org/research. DRAFT Final Report: Getting to All-Electric Multifamily ZNE Construction Publication Number: CEC-500-202X-XXX.

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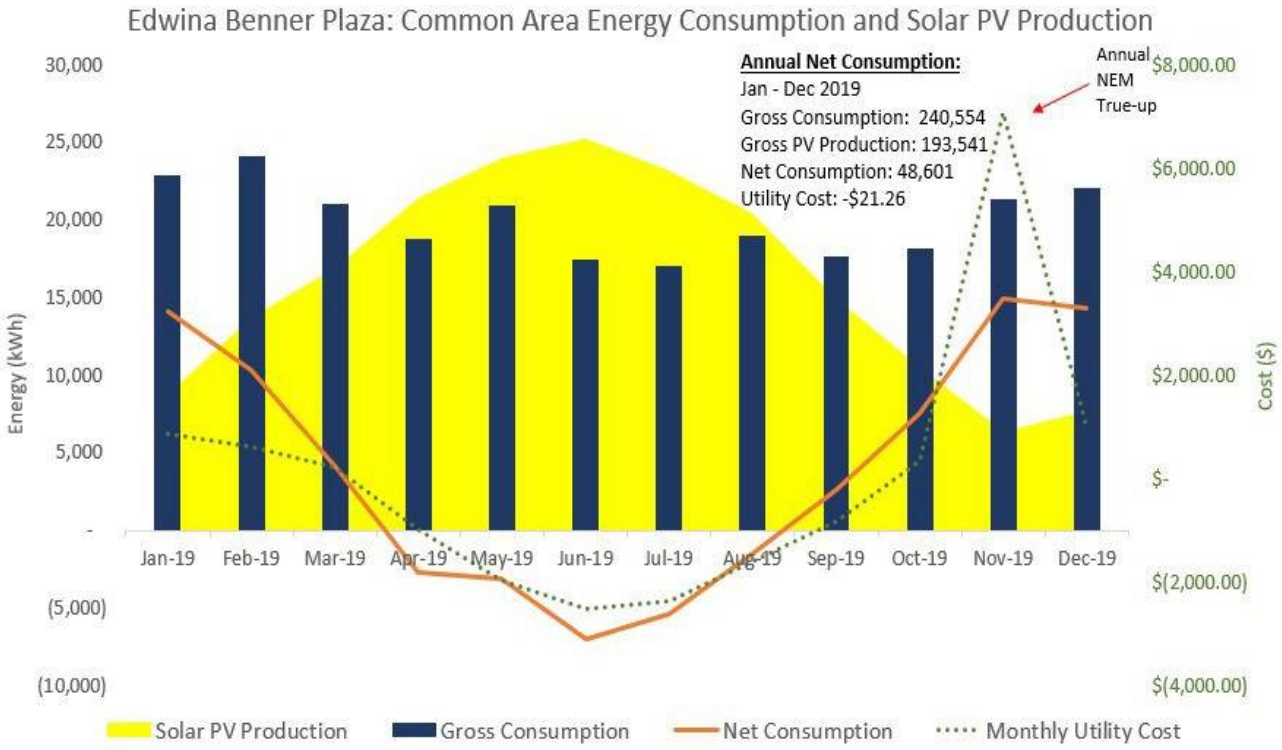
Design: Central heat pump water heating was a new system type for the developer, plumbing engineer, and architect. With this all-electric goal, AEA helped the teamwork through a redesign process. Initially the redesign resulted in a grossly oversized heat pump system, but after additional review and assistance, the team was able to optimize the design with large storage tanks and fewer heat pumps. This large-storage slow-recovery approach to heat pump water heating is the opposite of the standard practice for gas water heating and took considerable discussion to agree upon.

Verification and Monitoring: During construction, the research team identified and helped to correct issues relating to nearly every component of the system, including heat pump install location, system controls, piping configuration, recirculation components, and balanced distribution. These construction issues occurred (and were corrected) for both material procurement and installation. Construction verification, commissioning, and performance monitoring enabled by the research study resulted in the identification and correction of many issues, and ultimately yielded an optimized, high-performing system.

Holistic Performance: Over the 2019 calendar year, the electricity consumption of the optimized CHPHW system and other efficient common area loads was not 100% offset by the solar PV system. However, the project did see 100% electricity cost offset, yielding zero net cost over the year. The solar PV system produced energy as expected, but the cumulative common area loads (including the CHPHW system) consumed more energy than the models predicted. Despite this higher-than-expected electricity consumption, the common area meter achieved net zero cost in 2019 in part due to favorable electric rates for solar PV offset from Silicon Valley Clean Energy, the community choice energy provider from which the building purchases electricity. The all-electric design paired with renewables for energy offset proved successful in eliminating operational energy cost for the owner.

GHG SAVINGS
Above 2019
Code
161 $MTCO_2$

34.5 Passenger Vehicles Removed for One Year



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The research team conducted a comparative analysis between Benner Plaza, an all-electric building with solar PV, and Onizuka Crossing, a mixed-fuel building with both solar PV and solar thermal of similar size (58 units) and vintage, in the same area, and designed and developed by the same team. This analysis clearly showed:

1. All-electric design works and is cost-competitive with mixed-fuel design
2. All-electric design makes 100% energy and cost offset by renewables achievable, which is not possible with gas systems.

Despite two different renewable energy systems, the mixed-fuel building was not able to achieve net zero energy usage or cost as gas fuel consumption can never be fully offset like electricity can. In addition to energy offset, the availability of high-efficiency heat pump equipment makes all-electric design advantageous from an energy consumption standpoint. The central heat pump water heating system at Benner Plaza is more than 3x more efficient than the high-efficiency gas boiler system at Onizuka Crossing. Despite the difference in gas and electric utility rates, the mixed-fuel building ended the same calendar year with a multi-thousand-dollar common area utility bill, while the all-electric building ended the year with a negative common area utility net cost. With good design support and optimized, efficient design, all-electric buildings are better for building occupants, owners, and the planet.

Conclusions

Attentive support from design through installation and commissioning is key when executing an all-electric design, particularly if it is the first of its kind for a project team or in a building portfolio. Some form of system monitoring, for both CHPWH and PV, is critical to the performance and success of any highly customized system. As these systems become more standardized, with more off-the-shelf and turnkey solutions available to designers, the need for meticulous design review and commissioning will diminish. All-electric systems paired with solar PV in new construction is cost-effective in construction and operational costs and has the ability to achieve full annual net zero energy offset.