

Emerging Zero Net Energy School Retrofit Case Study



Credit: Integral



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OVERVIEW

Location: Los Osos, CA

Size: 72,554 SF

Original Construction: 1977

Retrofit: 2017

School District: San Luis Coastal Unified School District

Number of Schools: 15

District Enrollment: 7,638 students

Los Osos Middle School Enrollment: 583

CA Climate Zone: 5

Team/Owner Details

Owner: San Luis Coastal Unified School District

Contractor: Thoma Electric, All Systems Heating & Air

ZNE Pilot Design Consultant: Integral Group

ZNE Pilot Monitoring Consultant: The Cadmus Group LLC

Energy Consultant: Avila Partners

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LOS OSOS MIDDLE SCHOOL

In 2012, the San Luis Coastal Unified School District (SLCUSD) began their process to achieve zero net energy (ZNE) by releasing an initial Request for Proposals (RFP) for consultants to assist with projects funded through the Proposition 39 program. SLCUSD selected Avila Partners to serve as an energy consultant on the projects. Avila Partners conducted early energy assessments that included walkthrough audits of all 15 facilities in the district with district staff and teachers to better understand the needs of each facility. Based on this information, the district submitted their first Energy Expenditure Plan (EEP) to the California Energy Commission (CEC), the first step in securing funding for the facility retrofits.

Prop 39 funds were already being used to upgrade the district's elementary schools and a \$170 million bond was underway for upgrades to the two high schools. Avila Partners proposed the Prop 39 ZNE Pilot, managed by the California Investor Owned Utilities and locally by Pacific Gas and Electric and Southern California Gas Company (SoCalGas), to the district as an additional source for further retrofit funding; the district agreed to apply.

Planning and Design Approach Stakeholder Engagement

The mild climate in coastal cities such as Los Osos makes ZNE performance a realistic target with minimal needs for heating and cooling. It should however be noted that in such mild climates payback on upgrades to heating systems can be limited with minimal use, making the financial case of energy efficiency upgrades tougher. The district's stated policy that layout of campus spaces should optimize energy conservation and provide a safe learning environment for students and staff helped promote the need for the ZNE target. Research that high performance, ZNE schools bolster student performance helped the community understand the benefits of the project. The district also valued the opportunity to take advantage of additional funding and expertise for the district through the Prop 39 ZNE Pilot.

“The district knew that everyone could relate to the concept of ZNE, which made it easy to say yes to the project at Los Osos Middle School.”

-Dave Houghton, Avila Partners



Project Goals

The existing rooftop PV system generation capacity of 15 kBtu/sf/yr established a solar energy budget for the project. The district's goal was to achieve ZNE without the need for additional on-site energy generation. This meant that the team had to significantly reduce their existing load to meet the capabilities of the PV system and achieve the Energy Use Intensity (EUI) range of 25 kBtu/sf/yr recommended by PG&E and SoCalGas for the ZNE School Retrofit Pilot Program. An analysis of measured energy performance showed the building was originally performing a 35 kBtu/sf/yr and that a deep energy retrofit could reduce this by 23% compared to existing conditions.

Building Assessment

The district is comprised of 15 school campuses, ten of which are elementary schools. Campuses often have more than one building, and many include multiple portable classrooms. The two middle schools were constructed in the 1970s, with facility upgrades in the 1990's, which still left room for improvements to the structures and a need for more modern equipment. The existing Facilities Master Plan included an analysis of these buildings and clearly prioritized the secondary schools for retrofits.

Additionally, four of the secondary schools had existing rooftop photovoltaic (PV) systems from a power purchase agreement. Choosing a school that already had solar meant that the Prop 39 ZNE Pilot Program funding could target energy conservation rather than generation. Among the secondary schools in the district, Los Osos Middle School was identified as the best candidate to target ZNE.

Due to limited funding, the district prioritizes those projects with the highest savings to investment ratio. Since lighting is often the most cost-effective measure, the majority of previously existing Prop 39 funding had been devoted to lighting retrofits. With projects in the elementary schools and high schools already under way—the ZNE pilot was the missing puzzle piece to complete district-wide energy upgrades.

Energy Modeling

The design team used an iterative modeling process to identify which efficiency measures offered the greatest value to the project. LOMS, like many school campuses with multiple buildings, had only one electric meter. So the team determined the breakout of consumption by end use (HVAC, lighting, etc.) for each of the buildings. The inefficient portables presented an opportunity for the replacement of the original temporary systems with high efficiency equipment.



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Next, the design team developed a list of energy efficiency measures which were tailored to the school's aesthetic and financial preferences. After initial simulation results, they shortened the list of efficiency measures to four packages that fit within the school's financial and energy budget. The team grouped the remaining measures (full interior and exterior lighting, heat pumps in portables, and automated building controls) into three design proposals, including associated first costs and expected ongoing costs and energy savings, to the district for selection.

Energy Efficiency Strategies and Features

Lighting and Daylighting

The original Prop 39 lighting retrofit projects in the district included replacing high pressure sodium and metal halide light to LEDs for all of the gym lighting in the SLCUSD schools. The schools immediately saw the operational benefits of these replacements. Building off this success, during the Prop 39 ZNE Pilot the district opted to upgrade the LOMS to LED lighting, despite a retrofit from T12 bulbs to T8 bulbs several years earlier. Hallways are now controlled by motion sensors to capture further savings when unoccupied. Additionally, with advancements in self-illuminated devices and projection screens, lighting needs in classrooms have changed so zoned lighting and dimming was deemed the most cost-effective approach. The programmable wireless lighting controls allowed the teachers to program classroom zones and set the lights to meet their specific educational needs.

While daylighting was considered in this project, the team opted not to modify the original envelope design with additional window or roof penetrations despite moderate availability of daylighting in the school. The team had concerns about opening the building envelope that could yield unexpected obstacles and potentially prohibitive costs.

HVAC

The HVAC equipment at LOMS was last renovated in 1998, so the current equipment was past its end-of-useful life as determined by the California Energy Commission to be 15 years. However, the HVAC system on the main building was performing well and was not needing replacement so the focus was turned to the systems on the portable classrooms. The replacement HVAC package installed in the portable classrooms included Bard heat pump units that condition with high efficiency heat pumps.

During planning and design, the team looked closely at how spaces were being used. They noticed that zoned HVAC systems were on a time clock, but sometimes they were heating and cooling empty rooms or rooms with doors open to the outside. The team chose to add interlock door controls to in the Bard units to minimize energy use while allowing for natural ventilation. These interlocks recognize when the door has been left open for a period of time and turns off equipment to avoid wasting heating, cooling and fan energy.

Domestic Hot Water

Originally, the campus had one boiler and five gas water heaters and one boiler sized to serve the kitchen, locker rooms, and bathrooms. The standard hot water heaters were installed in 1998 and had a 78% efficiency. When designed, the boiler was expected to serve the hot water demand for daily showering in the school locker rooms, however this was no longer the case. As a result, the system continuously

“It’s amazing to see all the momentum building around ZNE schools in SCLUSD and in California. Especially important is the intersection of existing building retrofits, school environments, and leveraging public funding. These are projects that save on energy bills and put money back into classrooms for the benefit of students, teachers, and staff.”

– Hillary Weitze, Integral Group

Brought to you by the California Investor Owned Utilities’ Proposition 39 Zero Net Energy (ZNE) Schools Pilot Program.



reheats a large volume of water that isn’t being used. A key part of this retrofit was to replace two of the water heaters with tankless, wall-mounted condensing water heaters with a thermal efficiency of 92%. The gym shower boiler was replaced with a smaller, more efficient condensing unit with a thermal efficiency of 95%.

Renewable Energy Generation

In 2012 the school received funding to add solar PV systems to help offset the district’s energy consumption. At LOMS, the ground-mounted 200 kW photovoltaic (PV) array generates 324,400 kWh/year. This was deemed to be sufficient to enable the school to meet their goal of ZNE after installing efficiency measures.

Occupant Engagement

Training teachers and students on how to use the daylighting system was critical to ensure optimal performance. Teachers bought in immediately to the new zoned lighting system, as it gave them more flexibility and adaptability to fit their curricular needs. The team also developed a controls and equipment manual for building operators, and trained facilities managers on efficient building operation and the proper use of controls.

Future Plans

Prop 39 and the Prop 39 ZNE Pilot Project has increased awareness of the importance of energy performance both in practice and in planning. Moving forward, the district plans to be more proactive about maintenance of and upgrades to the classroom environment.

The district is proud and excited about the progress this project has made technically, especially for the teachers, staff and students. A more comfortable and sustainable classroom environment creates a more positive environment for teacher retention and student wellbeing.

Lessons Learned

- During design it was important to understand how the spaces were being used in their ZNE retrofit design. They decided that choosing equipment with capacity to turn off lighting and HVAC equipment was very important to saving energy and streamlining system use during the design process.
- Submetering was installed pre-construction and will be used after construction to evaluate the actual energy savings of building retrofits.
- This project tackled a combination of electric and gas efficiency measures to achieve ZNE. Combining the increased options for reducing electric loads and the existing solar, the project team stayed within their initial solar budget. During this project, electricity-based energy efficiency measures were more targeted in the modeling process.
- Incorrect assumptions are a common risk of modeling, especially when the facility may only have one master meter. By putting in portable sub-meters early in the design process, the team was able to identify what controls and monitoring was needed for each end use type. For example, controls issues with the HVAC in portables meant they running more than expected, which significantly changed the initial modeling assumptions.