

Ultra-Low Energy School Case Study



Photos: PJHM Architecture

OVERVIEW

Building Size: 73,178 SF

Location: Irvine, CA

Construction Type: New Construction

Completion Date: 2015

Building Type: Education

CA Climate Zone: 8

Energy Use: Electric, Gas

Measured Energy Stats

29 - 12 = 17

BUILDING'S
TOTAL EUI

RENEWABLE
PRODUCTION RPI

BUILDING'S
NET EUI

Site Energy Use Index (EUI) kBtu/SF/year

The Energy Equation: **the building energy use minus the renewables production equals the net energy of the building.** Buildings may be 'Getting to Zero' and have a net EUI above zero. If renewable production exceeds energy use its net EUI is below zero (negative) and it is creating surplus energy.

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For more information:
newbuildings.org/zero-energy

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JEFFREY TRAIL MIDDLE SCHOOL

The Jeffrey Trail Middle School is a new school in the Irvine Unified School District (IUSD). The school was designed and constructed to meet the Collaborative for High Performance Schools (CHPS) performance standards for exemplary energy and water conservation. With the exception of a detached gymnasium, the school is designed as a single building which houses 18 regular classrooms, six science classrooms, three computer labs, and a variety of other specialty spaces including art and music facilities.

Planning & Design Approach

The Irvine Company proposed a land swap to make sure the school was built ahead of their new home development so they would be ready with an existing school. The emphasis on energy and water conservation, along with goals of implementing a successful education program, guided the design of the school. The school is divided into three wings centered around a large library media center. Each wing has two science labs and one computer lab. David Bell, an architect with PJHM Architects who helped design the building, noted "It is a design that is pretty unique to Irvine Unified. The architecture doesn't drive the education. The education drives the architecture."

Policy

The Irvine Unified School District has portfolio-wide goals of energy efficiency and solar energy generation. As part of their energy efficiency goals, the school district has issued an energy conservation and management policy to reduce energy consumption. The conservation policy covers systems such as: lighting, controls set-points, equipment and appliances as well as overall operations. These measures help contribute to the district's goal of reducing electricity consumption by 15%.

Team/Owner Details

Owner: Irvine Unified School District

Architect: PJHM Architects

Civil Engineer: RHA Engineering, Inc.

Structural Engineer: STB Structural Engineers

Plumbing and Mechanical Engineer: BP and Associates

Electrical Engineer: GLP Engineering



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Financing

To finance the solar system at Jeffrey Trail and throughout the district, the IUSD used a Power Purchase Agreement (PPA) from SunEdison. Prior to moving forward with the extensive solar plans, the district looked at rate increases over the length of operations—an average of 4.5%. After studying a variety of scenarios to see what increases they might face, the district concluded that under most scenarios, the solar investment would be cost effective, largely due to high energy costs and demand charges.

Energy Efficiency Strategies and Features

Envelope

Jeffrey Trail is a single building rather than a campus layout (only the gymnasium is separate). Having the school designed as a single structure, rather than a more spread out campus style layout, supports energy use reductions as well as improved security. The compact design with low surface area to volume ratios can reduce weather-driven heating and cooling loads.

Lighting and Daylighting

The Jeffrey Trail School reduces lighting loads with the use of natural daylighting and inverted pyramid skylights that fill classrooms with natural light. Lighting loads are further reduced with the integration of motion sensors in all spaces, which help prevent electricity wasted to light empty rooms.

HVAC

The design team debated packaged units versus a central plant. Although the efficiency in rooftop units are typically lower than that of a central plant configuration, the design team ultimately chose to proceed with rooftop units for their flexibility. Given the relatively regular schedule of school operations and low occupancy after hours, having multiple rooftop units avoids having to fire up the entire central plant to serve only two or three zones of the building. For the low occupancy after hours, running a single, smaller rooftop unit is more cost-effective.



Photos: PJHM Architecture

In addition to teachers working after hours, the school is often used for community events. These events tend to use the gym or another localized portion of the school, which again is better served locally by a rooftop unit rather than by an entire central plant.

Controls

The controls for the Jeffrey Trail School, and increasingly for other schools within the Irvine Unified School District, are remotely controlled by district maintenance staff. A wide range of MEP services including HVAC, lighting, and even plumbing are connected to an internal district network. This energy management system (EMS) allows technicians to respond to service calls off-site, which saves time and money for both maintenance and school staff. The externally controlled schedules for lighting and HVAC units allow for greater control and optimization to match the needs of each school's schedule. There is a growing trend towards EMS adoption in the district and new schools in the area, that are increasingly pursuing CHPS standards.

Plug Loads

Teachers and staff are not allowed to have personal refrigerators in order to cut down on additional plug loads. In some cases, teachers may need additional appliances as part of the curriculum, such as science teachers needing to keep laboratory materials refrigerated. For these special cases, teachers may appeal the district to get approval for their equipment.

Occupant Engagement and Training

The increased adoption of technological solutions to building controls require additional training for staff and building occupants. At the completion of a new school, the entire maintenance staff meets with the contractors onsite to receive training on the HVAC system and controls. These trainings are also videotaped to provide a resource to the school for future use. Given the extensive network connection of the equipment controls, onsite school staff do not need as much training. Teachers and staff are instead able to call in to the maintenance team to override set points and schedules. The drawback to the increased controls is the need for thorough training to get staff up to speed on the more complex systems. This creates an increased demand for trained staff and capable maintenance team members.

“We have developed our own fifth and sixth grade curriculum that lets students learn about a variety of types of renewable energy. We discuss the pros and cons of different types of renewable energy.

We are hearing that kids are more aware of things like conservation, recycling, and global warming.”

– Mark Sontag, IUSD Energy Consultant



Photos: PJHM Architecture

Renewable Energy Generation and Storage

Solar arrays are installed above the parking canopies. In addition to the energy saved from the use of natural light and the single-building design, these arrays are designed to provide enough capacity to not only power the school, but also 65-70 homes in the surrounding neighborhoods. The peak capacity is 423 kW. The photovoltaics (PV) distributed throughout the entire school district have 5.3 MW of capacity.

Although there is no energy storage currently in use at the school or the district as a whole, IUSD has long-term plans to implement storage for both solar and non-solar sites. There is a new incentive program offered by Southern California Edison (SCE) utility which will support efforts to reduce peak energy loads on the grid. By storing electricity generated in the morning from the solar system, expensive demand charges can be reduced during peak hours by tapping into the stored energy. Non-solar sites can viably use this same strategy by charging batteries at night when the energy grid demand is at its lowest. The savings from avoiding or reducing peak demand charges are further improving the financial case for solar.

Post Occupancy

Commissioning

The Jeffrey Trail School underwent an extensive commissioning process. The commissioned systems included: lighting controls, occupancy sensors, ductwork, zone damper terminal, building automation system, packaged gas/electric units, exhaust fans, make-up air units, fan coil/outdoor condensing units, domestic hot water heaters and associated circulating pumps and controls.

Monitoring

A consultant for the IUSD handles the monitoring of all solar sites for the district. The energy generation monitoring allows them to calculate the cumulative savings which have come from the avoided energy and peak demand changes. The entire IUSD PV system, to date, has saved the school district nearly \$1 million in avoided energy bills since the first installation in 2010.



Photo: P.J.H.M./Architects

At the utility level, a monitoring dashboard is available to staff. The same system is used as a teaching tool for students incorporated into the curriculum. Students can see the difference in generation on clear and cloudy days, and even see generation when there is a clear full moon.

Behavior

School staff have been trained to adjust behaviors to promote energy conservation. For instance, evening custodial staff were taught to turn on the lights for a single wing or particular area at a time rather than lighting up the whole building. Teachers and other staff working late can also contact the building manager to turn on the HVAC system.

Successes

The district's energy conservation protocol was issued first, which turned out to be an important contribution. This encouraged the school and district as a whole to take advantage of the "low hanging fruit." Examples include: motion-sensors, low-energy lights, handling 24-7 lights with emergency lighting, and working with utilities to update older equipment. Another school in the district was using older kilns that were 30 years old and refrigerators in staff lounges were sometimes 15-20 years old, leaving easy opportunities for replacing these loads with more efficient equipment.

The long-term savings from the upfront commitment to energy conservation, efficiency, and renewable energy help to fund additional programs for students, directly increasing the quality of the school's offerings. These savings are estimated to range between \$5 and \$11 million.

As part of the Science, Technology, Engineering and Math (STEM) curriculum, students are encouraged to learn about concepts of conservation, recycling, and renewable energy. The building itself therefore provides a great medium for exposing the students to direct experiential learning.



Photo: PJHM Architects

Lessons Learned

- Incentives can be challenging to understand and access. Accounting is difficult to provide at the level of detail that is required by the utilities in the process. The service representative from the individual utility can be an important source of help. SCE pro-actively offered recommendations for improved performance. IUSD representatives noted how valuable this annual input was in establishing a good relationship with the utility representatives.
- Computer loads are difficult to handle at the behest of the IT department districtwide. Large savings are available by shutting off monitors and computers automatically, especially when students aren't in school on the weekends and summer months. However, having computers online is necessary for the IT department to remotely access the machines for maintenance and updates.
- Education of occupants around the impacts of behavior is still a highly important strategy for ongoing energy management. Some occupants are less motivated to conserve energy when they see that the energy produced by PVs is "free" anyway.

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



Resources for More Information

- Video: SunEdison Solar for Schools powers Irvine Unified School District, <https://www.youtube.com/watch?v=HChbYaevOrU>
- IUSD Solar Technology Overview: http://www.iusd.org/district_services/facilities_planning_and_construction/solar_technology/
- Capital Engineering Project Profile: http://capital-engineering.com/expertise/build_opt_sustain/profiles/pp_comm_jeffreytrailms.pdf
- PJHM Architecture Project Description: <http://pjhm.com/project/jeffrey-trail-middle-school/>