

Emerging Zero Net Energy Building Case Study



Photos: Courtesy City of San José

OVERVIEW

Location: San José, CA
Project Size: 46,000 SF
Construction Type: Retrofit and new construction
Completion Date: 2014, additional renewables added 2016
Building Type: Office, Warehouse/ Retail, Laboratory
CA Climate Zone: 4
Total Building Cost: \$27,100,000 (excluding land)
Cost/SF: \$589
Hard costs: \$25,100,000
Soft costs: \$2,000,000

Measured Energy Stats

17.50 - 17.44 = 0.06

BUILDING'S TOTAL EUI	RENEWABLE PRODUCTION RPI	BUILDING'S NET EUI
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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

Project Profile developed by New Buildings Institute ©2016

ENVIRONMENTAL INNOVATION CENTER

Completed in 2014, the Environmental Innovation Center (EIC) in San José, CA, is a local government-owned education and environmental resources center that is targeting zero net energy (ZNE) performance. The project contains a 10,000-square-foot new building and a retrofit of a 46,000-square-foot, 1950s warehouse on over four acres. The multi-tenant space is divided between retail, demonstration facilities, laboratories, and warehouse. Energy reducing features include solar tracking skylights, solar tubes, LED lighting, and a cool roof. Solar panels on the building and parking canopies, in addition to wind turbines, are designed to generate enough electricity to offset the building's use. The installation of solar panels was added in 2016, so while the project does not have a full year of utility data, performance over past six months indicates that the building is performing at zero net energy.

The EIC is an important demonstration of the City's leadership and commitment to achieving this Green Vision. As part of this campaign, the city encourages its residents to incorporate energy saving lighting, energy monitoring systems, smart cooling systems, and green roofs. Pacific Gas and Electric is helping to measure the city's energy consumption as well to verify their goal progress.

Planning & Design Approach

The City initially teamed up with San José State University urban planning students to determine the best use for the site given its location and status as a brownfield. Anderson Brulé Architects then helped to create a master plan for Las Plumas Eco Park Industrial Park where the EIC is located. The original factory structure was included in the California Register of Historic Resources and was listed as a Historic Landmark. Therefore, the project architect, Group 4 Architecture, chose to leave two elevations of the mid-century modern building untouched, and relocated the entrance.

Team/Owner Details

Architect: Group 4 Architecture

Structural Engineer: Rutherford & Chekene

PV Engineering: Emcor

Mechanical & Plumbing: Integral Group

Civil Engineering: BKF Engineers

Electrical Engineering: O'Mahony & Myer Electrical

Landscape Architect: SWA

Commissioning Agent: GRD Energy

Solar Contractor: Sun Light and Power

Awards

LEED Gold certification

Santa Clara Valley Urban Runoff Pollution Prevention Program Site Design Award

Several multi-day design charrettes involved the EIC's three tenants and teams from the City's Public Works and Environmental Services Departments. The architect integrated many of the ideas introduced in the charrettes into a design that accommodates all parties. A ZNE project goal was considered but the project had a limited budget, so the team instead aimed to be as efficient as possible in the design until they could find the resources to add on-site renewables later to the project.

The Clean Technology Development Center is one of the tenants of the EIC and occupies 22,500 square feet of the building, primarily comprised of laboratory, demonstration, development, and testing facilities. This posed a unique challenge in the design of the ventilation system, technology, security, and other mechanical, electrical, and plumbing components. Digital modeling helped select the most efficient approach to these systems. The model also tested daylighting to reduce the electrical lighting load, as well as solar shading to properly orient solar panels.

Policy

The City of San José built the EIC as part of their local government efforts to achieve their "Green Vision" policy goals including growing San José into a global, clean-energy technology hub. Adopted in 2007 by the San José City Council, the Green Vision¹ comprises ten ambitious goals, including jobs, energy, water, waste, trees, and transportation. Energy goals include achieving the following by 2022:

- Create 25,000 clean technology jobs
- Reduce per capita energy use by 50%
- Use 100% clean energy sources
- Build or retrofit 50 million square feet of green buildings
- Adopt a General Plan with measurable standards for sustainable development

Financing Costs & Benefits

Construction & Design Costs

The City invested \$4.3 million in the land and existing structure. The construction itself cost \$25.1 million, and an additional \$2 million was allocated to design. To stay as close to budget as possible, the City also turned to value engineering. A common solution for over-budget projects, value engineering in many cases focuses on cost reduction at the expense of quality. However, the EIC project team was careful to prioritize green features ahead of all other potential cuts. The landscaping plan was scaled back and ceilings were left unpainted to ensure the team could follow through on energy-saving components.

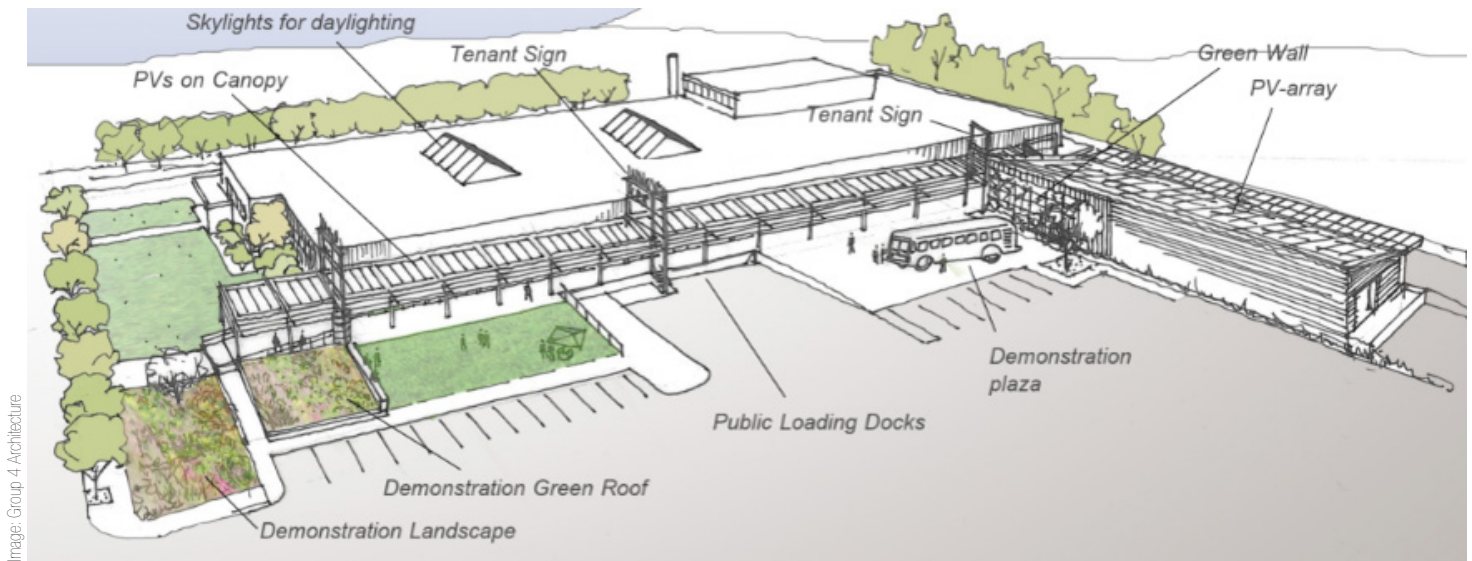
Operating Costs

Estimated operating costs from the City are approximately \$130,000 each year. This figure accounts for utilities, landscaping, insurance, and maintenance.



Photo: Group 4 Architecture

¹ City of San José Green Vision Goals website. <http://www.sanjoseca.gov/index.aspx?nid=2737>.



Financing & Incentives

The federal New Markets Tax Credit (NMTC) provided \$4.3 million in funding and allowed the City to complete the project debt-free. The project was eligible for this financing option because the site was in an economically depressed area of San José. The City established a nonprofit to own the EIC which allowed them to sell the NMTC to investors in exchange for project funding at the end of the seven-year tax credit, at which time the nonprofit will transfer ownership to the City. This process also offered unusually low interest rates of 0.5%.

Funding from the City came from San José's Integrated Waste Management Fund, unclaimed deposits in the Construction Demolition Deposit Program, and other city funds. Additionally, the California State Recycling Department awarded a grant to the project. A grant from the Economic Development Administration (EDA) funded the installation of the solar array.

Return on Investment

Transforming the rundown warehouse to a green technology hub and center for the community helped to increase the property value of the neighborhood. The improvement spurred two additional developments in the neighborhood, as well as new housing. Most importantly, the site now has a purpose in the community. The retrofit significantly increased the property value, and the green features further increased its worth. Business Cluster was a consultant that helped create a Strategic Plan for the Environmental Business Center and served as a funding advisor. Implementing the plan helped to increase the return on investment. The NMTC helped the project achieve a full payback period of only seven years.

“Simpler designs are good, the more passive the better. If we can create an amazing envelope, then we don’t need to worry about more complex systems.”

– John Hartman, Principal,
Group 4 Architecture

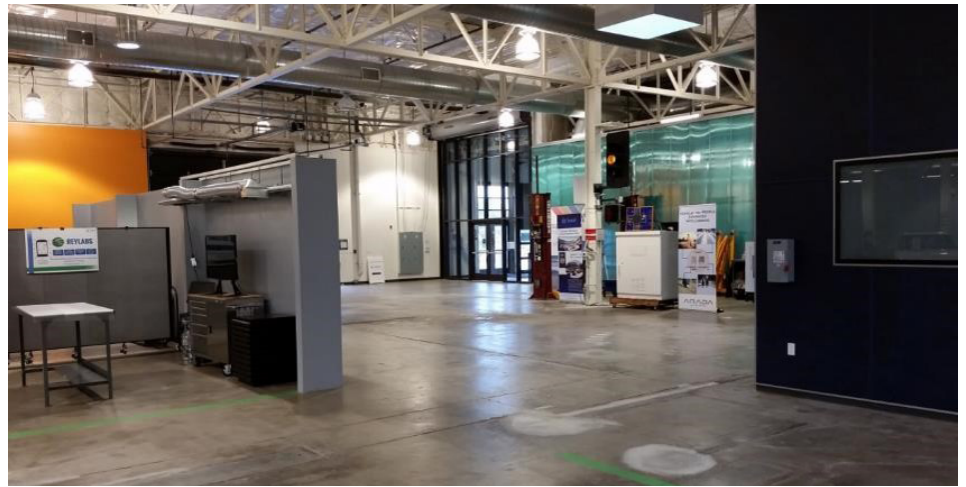


Photo: Courtesy City of San José

Energy Efficiency Strategies & Features

Lighting & Daylighting

Aligning with the city’s goals, the project replaced existing low-pressure sodium streetlights in the parking lot and street right of way with high-efficiency LEDs. These lights use 60 percent less electricity than the old fixtures. Inside the building, sixteen solar tracking skylights and eleven solar tubes efficiently bring daylight into the space. The skylights offer reliable daylighting from 9 a.m. to 3 p.m. Windows also help to bring natural light into the building. Tinting helps reduce glare and solar heat gain from some windows, while operable shades prevent glare from others. Daylighting allows the electrical lighting to remain off during most daytime hours. Occupancy sensors control a portion of this electrical lighting system. The City is slowly working to replace the fluorescent lights in the shared office space with efficient LED lights.

Envelope

The existing exterior skin on the warehouse contributed to the building’s historic character, and had to be retained as much as possible. Added insulation included R-19 structural insulated panels (SIPs) in the building interior at the user level, with batt insulation at the walls above and R-30 rigid insulation in the warehouse ceiling (which energy modeling suggested would have the greatest impact on envelope performance). Existing operable windows on the west side of the warehouse are considered historic so they were maintained. New roll-up doors installed on the east side offer outside air opportunities during pleasant weather and also provide a welcoming entry to the building for the public.

The building features a cool roof with a high solar reflectance index to prevent excessive heat absorption during the day. The design team initially digitally modeled a night sky cooling system for the project, though it determined the necessary roof area would be better used for the photovoltaic system.

HVAC

The HVAC system was a major challenge for the design team because the various zones need unique heating, cooling, and ventilation requirements. The research and development spaces required specific design requirements resulting in a natural gas rooftop (RTU) heating and cooling unit with economizers. The economizers recognize when outdoor air is within the design temperature set



Photos: Courtesy City of San José



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points and can be used in place of mechanically cooled air. The larger ducted work reduces static pressure and does not require as much energy to ventilate the space as a conventional RTU would. To offset the high energy demand of similar zones, the hazardous waste facility relies exclusively on natural ventilation.

In other zones, the mechanical system uses a water-cooled chiller with a variable air volume (VAV) air handling unit (AHU) and thermal storage. A cooling tower uses night-time evaporation to pre-chill the water, which is stored in a tank for use the next day to reduce the cooling load on the chiller.

Controls

Occupancy sensors ensure that lights are off when rooms are not in use. The HVAC system also relies on demand control ventilation tied to sensors monitoring the zone CO₂ levels. This connects to a night flush function to passively cool the building.

Plug Loads

Two tenant spaces were not leased early in the design so the design team didn't have time to engage tenants. However, the three primary occupants share a common interest in sustainability and each play a role in managing energy consumption through equipment selection and occupant behavior. Plug loads from the first year of occupancy helped accurately size the PV system installed in 2016.

Occupant Engagement & Training

The County's household hazardous waste program staff participated in meetings during the design phase. Although the remaining two rentable spaces were leased late in the design process, these additional occupants were also invited to design meetings. This enabled occupants to discuss their individual requirements of the building with the design team.

Building commissioners offered tours to the City staff to provide in-depth explanations of the building's systems. The site is now used in part as an educational facility, offering tours to schools, government agencies, and other community groups interested in learning about its sustainable features.

Photo: Courtesy City of San José



Renewable Energy Generation & Storage

Two years after completion of the building, in 2016, the City was able to secure the funding to add a photovoltaic (PV) system to the roof and parking canopies. Digital models allowed the solar contractor to design a PV system of 1,164 panels that are anticipated to generate an estimated 599 kWh annually. Approximately 45% of the system is on the building itself, while three parking canopies account for the remaining PV panels.

The EIC Tower, shown to the left, also includes demonstration technologies for renewable energy including four 5 kW wind turbines which operate best in low winds and supplement the PV panels on cloudy days. Although the tower generates only a small amount compared to the larger on-site solar arrays, the tower has become a landmark in the community and an important visual highlighting innovative energy approaches and leadership efforts of the City.

Post Occupancy

Monitoring & Commissioning

A building monitoring system makes it easy for the City to track lighting and HVAC performance for the building. An online dashboard allows users to track generation from the PV system. The City of San José has all of their buildings feedback into a central Building Management System (BMS) so it was necessary to select systems that would comply with City specifications. This can be a challenge when a system is much older or doesn't have the modules in place. This can complicate commissioning if the City needs to grant the agent access to the BMS.

Commissioning began in June 2014 and revealed several issues involving the air cooling tower, pumps, and chiller sequencing. Resolution of these problems decreased the energy load necessary to operate the HVAC system.

Successes

The EIC provides many benefits for the community, serving as an educational center, drawing people in and showcasing its green features. The space also offers conference and training rooms that local organizations use frequently and it is a hub for environmental events and tours.

An important success was the phasing of the project design and grant funding. The City segmented the project into three different funding packages, with early phase tied to a grant related to site work and street trees; Phase 2 work with design team; Phase 3 solar added as design build. If done all at the same time, it would not have been as possible nor as fundable. The City was creative in the process to secure a mix of local and national funding which made many of the various environmental features of the project possible.

“Not having the right people engaged as stakeholders and operators can derail a project. However, the EIC project had really strong collaboration and got the right people onboard to make the right informed decisions which was a strong success.”

- John Hartman, Principal,
Group 4 Architecture



Lessons Learned

- With many stakeholders in the project, it was helpful to have as many people as possible at the table early on in the process. It was also important to be flexible in the design phase, as well as to be open to a variety of funding sources with different grants and opportunities for possible green building components.
- Operators and maintenance staff may not always have the facilities staff to operate the buildings to the degree necessary and may need to tie into larger city control systems that may not have all the criteria that are needed so these are challenges.
- The architecture team did extensive work in the design phase to incorporate the roof stanchions to support the sub-grid for the PV array, with conduit to parking, roof and inverters later, all of these were coordinated with skylights and a preliminary PV array design for later buildout.

Resources For More Information

- San José Environmental Innovation Center webpage: <http://www.sanjoseca.gov/index.aspx?NID=4022>
- San José Environmental Innovation Center Sustainability Features: <https://www.sanjoseca.gov/DocumentCenter/View/31539>
- San José Environmental Innovation Center Fact Sheet: <https://www.sanjoseca.gov/DocumentCenter/View/28291>