

Verified Zero Net Energy Building Case Study



Photos: Bruce Damonte



OVERVIEW

Location: Sunnyvale, CA
Project Size: 31,759 SF
Construction Type: Retrofit
Completion Date: 2013
Occupied: May 2014
Building Type: Office
Climate Zone: 4
Total Building Cost: \$5,136,015
Cost per SF: \$162
Hard costs: \$4,042,458

Measured Energy Stats

13.5 - 28.7 = -15.2

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.

nbi new buildings
institute

For more information:
newbuildings.org/zero-energy

435 INDIO WAY

435 Indio Way in Sunnyvale, California, was built in 1973 as a research and development laboratory and office for Hewlett Packard. Like many buildings in the Silicon Valley, it is a simple one-story, tilt-up that since 2006 had been left vacant. Building owners Huettig & Schromm, Inc. were particularly interested in renovating and reviving the building so that it would be zero net energy (ZNE). The owners brought in the SHARP Development Company to complete and realize the goal of ZNE, keeping cost in mind.

The renovation had to fit one main criteria—the design had to be a better financial investment than a typical code-minimum building by the standard metrics of real estate development. The financial parameters were strict but easily translatable to the developer and those involved in the project.

Both owner and developer wanted this design to be created as a prototype for a common building type in the real estate market. As one of the first of its kind, the building puts forward a test of the feasibility and success of cost-effective ZNE office buildings.

Planning & Design Approach

The objectives for this design-build were very clearly set and agreed upon from the initial project kickoff. The building was to perform at ZNE while also being a more profitable investment than a code-minimum renovation of the same building type. The owner and developer recognized early on that many ZNE building features provide both benefits for the occupants, as well as financial benefits that may not be easily quantifiable. With these objectives and previous experiences leading the approach, the design team applied a mix of ZNE design features while examining profitability as compared to a code-minimum building.

Team/Owner Details

Owner: Huettig & Schromm, Inc.

Architect: RMW Architecture & Interiors

Structural Engineer: SEI (Structural Engineers Inc.)

MEP Engineering: Integral Group

Landscape: Taniguchi Landscape Architects

Developer: SHARP Development

General Contractor: Hillhouse Construction

Master System Integrator: Intertie Automation

Awards

Technology Award from the Golden Gate Chapter of ASHRAE in the existing commercial buildings category

2015 Acterra Business Environmental Award for Best Sustainable Built Environment

"Best Reuse/Rehab Project" by the Silicon Valley Business Journal in 2014.

SHARP Development first engaged the engineering team and general contractor, followed by the design architect. The key to the success was strong contractor involvement from the beginning in both engineering and architectural design choices. The initial project design choice was to complete 435 Indio with a passive design approach, including passive ventilation and thermal mass for pre-cooling. The team knew that in order for this building to be constructed and operate successfully, the system and controls had to perform faultlessly. Because of this need for a high functioning and integrated control system, a Master System Integrator was also added to the team in the design phase to assist the engineers in coordinating all the building's systems.

Policy

California has the nation's most stringent energy policy for new buildings as per Title 24 Energy Code requirements. All commercial buildings will have to be net zero by 2030, producing as much energy onsite as they consume over a year.

In addition, the city of Sunnyvale is now requiring the use of solar thermal technology for water heating. This is done to cut electricity and natural gas consumption while harnessing the ample amounts of sunlight California receives.

A noteworthy feature of the 435 Indio design was that the decisions made regarding building to ZNE were not based on a mandated policy, but rather on fundamental business principles. SHARP Development envisions net zero cost and net positive operation. With previous design successes operating at net positive, they have turned their focus to the health and wellness of the building and its occupants, while maintaining project profitability.

Integrated Design Process

As mentioned above, the design team, owner, and engineers were involved in the process early to ensure that the design was highly responsive to the climate and well-being of the occupants, as well as thoughtful of financial considerations. To accomplish this, the team modeled and evaluated the effect of every energy-related design decision. They considered the overall performance and longevity of the equipment or design piece and compared it against the financial cost and performance. Cost analysis of both the ZNE design features and the code-minimum alternative were obtained to examine the profitability of both alternatives. This ultimately confirmed that the ZNE design achieved the better bottom line overall.

Financing Costs & Benefits

Construction & Design Costs

The owner and developer realized this ZNE renovation was a smart financial investment. They suspected that the ZNE design approach would be more profitable and included the ZNE design features and business-as-usual design features in the pro forma financial analysis.

For 435 Indio, the hard costs of ZNE design were about 30% more than that of a code-minimum building, while the softs costs were approximately the same. Specifically, the hard cost of the ZNE design ended up being approximately \$4 million, versus a code-minimum building with comparable features with hard costs

Photo: Bruce Damonte



“We wanted to prove that this type of sustainable renovation is not only cost-effective, but actually more profitable than the old way of doing things.”

- Kevin Bates, President of SHARP Development

of approximately \$2.9 million. The total costs of this ZNE project including Architect & Engineer costs, hard costs, soft costs, and a solar photovoltaic system were \$5.1 million, compared to a code-minimum building, with no PV system, with a project cost of \$3.5 million.

Operating Costs & Income

435 Indio leased up 15 months faster than the market average, which means the owners received 15 months worth of rent during time that would typically have been idle. Factor in the competitive market rent rates due to high demand and the property was immediately making more money than a conventional building.

Operating expenses, including negligible utilities, landscaping, and maintenance are expected to cost 34% less than the comparable code-minimum building, according to the pro forma financial analysis. With increased revenue, decreased use of reserves, and decreased operating costs, the ZNE design choices add to the property exponentially as the initially higher hard and soft costs payoff.

Financing

PG&E and governmental rebates totaled \$298,764, or approximately one fifth of the cost differential between a code-minimum building and the renovation that was done at 435 Indio. It is important to note that the PG&E rebates would not apply to a code-minimum building, so building to ZNE affords you the ability to take advantage of rebates such as these.

Appraisals & Asset Value

The difference of \$49.84 per square foot for a ZNE building may seem prohibitive, but the real bottom line impact lies beyond first cost considerations. According to the financial analysis, this type of build is profitable from two standpoints. If, for example, the owner was going to sell the property immediately after construction, the high market demand for this type of building increases the sale price to a factor high enough to cover the higher construction costs. The owners assumed a 6.5% cap rate¹ after operating expenses for the building. The cap rate is an assumption based on market data to determine whether the revenue is going to offset costs. Dividing the asset revenue by the cap rate gives you the value of the investment. A typical cap rate for this type of real estate in this market is between 5.5%-6.0%, so setting a more conservative cap rate allows the owners to insure stability against any market volatility prior to lease-up.

However, this type of building is significantly more profitable if held for a longer period because of higher cash flow and reduced operating and maintenance costs, allowing the building to be paid off in a few short years. Some ways the cash flow is increased include:

- Lower operating and maintenance costs due to simpler and smaller systems.
- Faster and earlier lease-up rates due to high demand for healthier, more comfortable ZNE buildings.

¹ Cap Rate: The capitalization rate (often called the cap rate) is the ratio of Net Operating Income (NOI) to property asset value. So, for example, if a property was listed for \$1,000,000 and generated an NOI of \$100,000, then the cap rate would be \$100,000/\$1,000,000, or 10%. The cap rate is an important metric for the understanding of the risk of an investment and how it compares to other property types in the geographic region.

Photo: Bruce Damonte



- Lower financial reserves were required because of the lower cost of more efficient and smaller HVAC systems, and less tenant improvement needs upon turnover.
- Increased rental income due to higher market demand with competitive rents, and higher tenant retention with lower “down time” due to designing with occupant comfort in mind.
- Triple net leases² are more attractive to tenants.

According to SHARP Development, assuming a 5.83 year time frame to fully amortize, an additional \$49.84 per square-foot of value is recovered due to the additional premium rent and faster lease up rates. Upon completion, the building has an additional \$100.83 square-foot of value over a typical code-minimum building. The building value if then sold becomes approximately \$150 more than a typical code-minimum building.

Energy Efficiency Strategies and Features

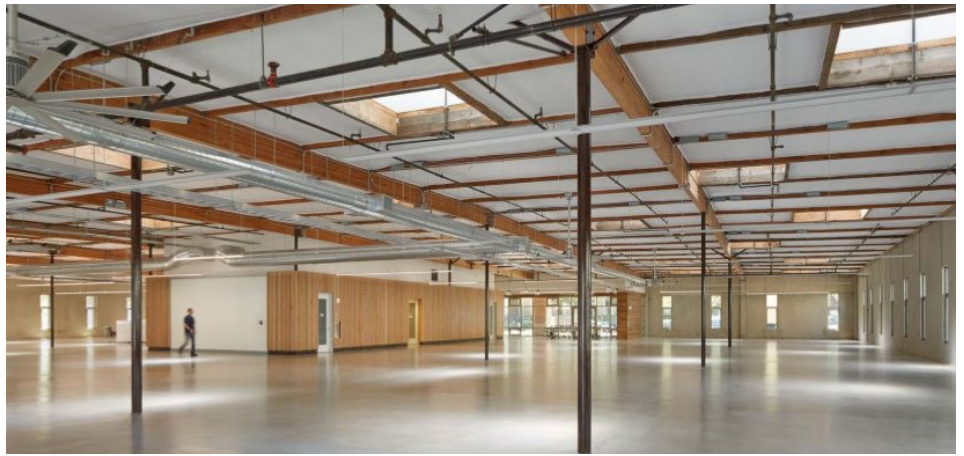
Lighting and Daylighting

Since daylighting is known to enhance occupant comfort and well being, as well as drive the Energy Use Intensity (EUI) and power needs down, the team prioritized access to natural light through skylights, windows, and doors during the renovation. Forty-three daylight cupolas are carved out of the roof to minimize heat loss and heat gain, while allowing more direct daylight as south facing cupolas than a traditional north-facing skylight. Studies determined the size, spacing, direction, and degree of tilt to achieve the highest intensity of daylight while minimizing heat gain. As a result, natural light illuminates the building from an hour after sunrise until an hour before sunset.

Windows were given special attention in the design. Almost 2,000-square-feet of View electrochromic (self-tinting) windows from Dynamic Glass are installed in both

² Triple Net Leases: <http://www.propertymetrics.com/blog/2015/02/19/nnn-triple-net-lease/>

Photo: Bruce Damonte



“The airy open space is beautiful, with a persistent soft light coming from rows of tall operable windows on every side, indirect light from skylights, polished concrete floors, slowly spinning ceiling fans, a white fabric ceiling and exposed ductwork.”

– Integral Group

fixed and operable windows, and doors. Operable windows are motorized and automated to permit natural ventilation.

Outside, an awning covering the front doors provides shade and passive cooling. The existing trees surrounding the building provide additional shade to other windows and add value to the natural outdoor gathering spaces.

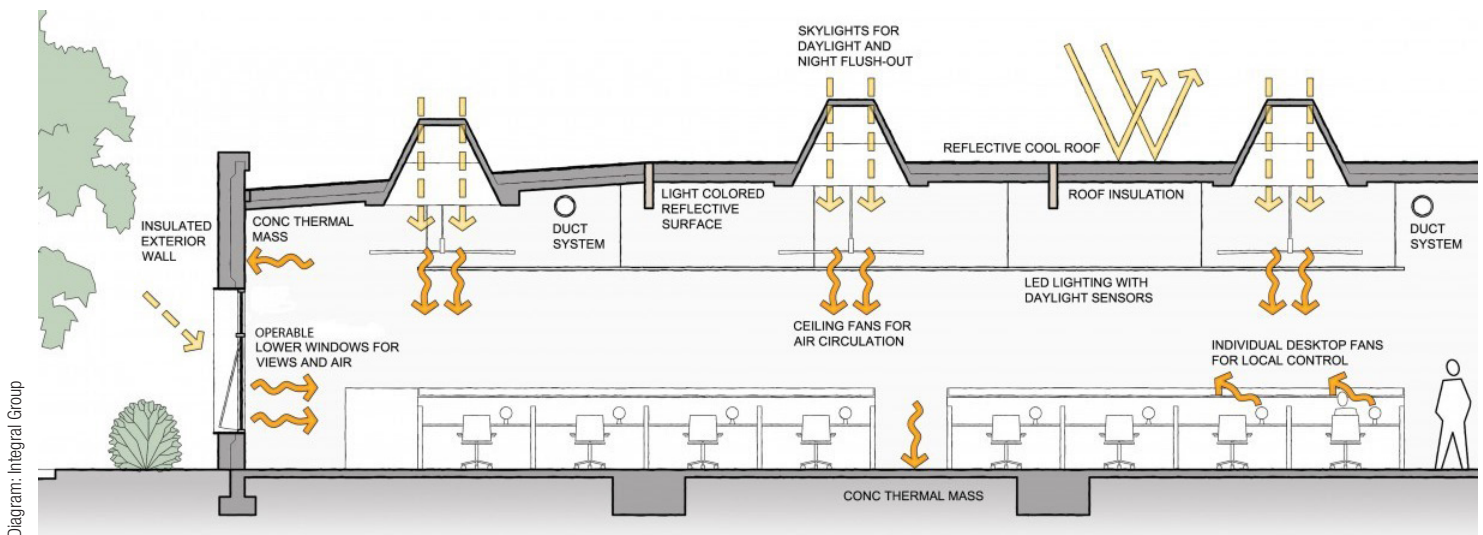
To compliment daylight, suspended LED fixtures placed further apart than normal supplement typical daylight levels when necessary. The fixtures are wired to both occupancy motion sensors and infrared sensors, allowing tenants full control of the lighting while still responding to daylight availability. At 25%, lighting is still the second biggest energy consumer in the building despite the daylight responsive techniques used.

Envelope

Night ventilation of thermal mass is a primary strategy at 435 Indio. The building’s interior concrete walls and slab serve as an outstanding heat sink, however insulation had to be added on the exterior walls so the thermal mass was exposed on the interior and available to exchange with cool air in the evenings. Using a ceramic-based coating, 5-5/8” thick polystyrene was adhered to the outside of the building all the way down to the concrete slab. The concrete floor also acts as thermal storage so carpet was excluded from the design and is discouraged in tenant renovations. The addition of the insulation to the outside rather than interior walls also added 326-square-feet of leasable space, adding 6” all the way around the building. After completion, the walls now have a R-20 insulatory value.

The original lightweight roof had to be improved with insulated foam roofing to provide better insulation and additional support for the new solar photovoltaic system and daylighting design. A cool roof coating was applied over the foam roofing and 10” batt insulation was added to keep the building cool during summer months. After renovation, the roof has a R-factor of 40.

Acoustic fabric combats noise and contributes to driving down lighting loads. The acoustic fabric used is cost effective at \$4 per square foot, compared to a typical T-bar drop ceiling which costs between \$4.50-\$5 per square foot, extremely durable, and has visual reflective properties for even distribution of light across the space.



HVAC & Natural Ventilation

Actuators open the skylights and ground-level windows and rising hot air is moved by eight-foot steel fans as part of a night flushing program for pre-cooling of the thermal mass in the warmer months. Other perimeter windows are also operable for tenant adjustment. As part of the passive flow for the space, conference rooms and other larger spaces are located at the perimeter so they can be passively heated and cooled.

The HVAC system consists of two air-source heat pumps that serve as the backup heating and cooling for the passive systems of the building. The HVAC system is 22% of a traditionally sized system.

Plug Loads

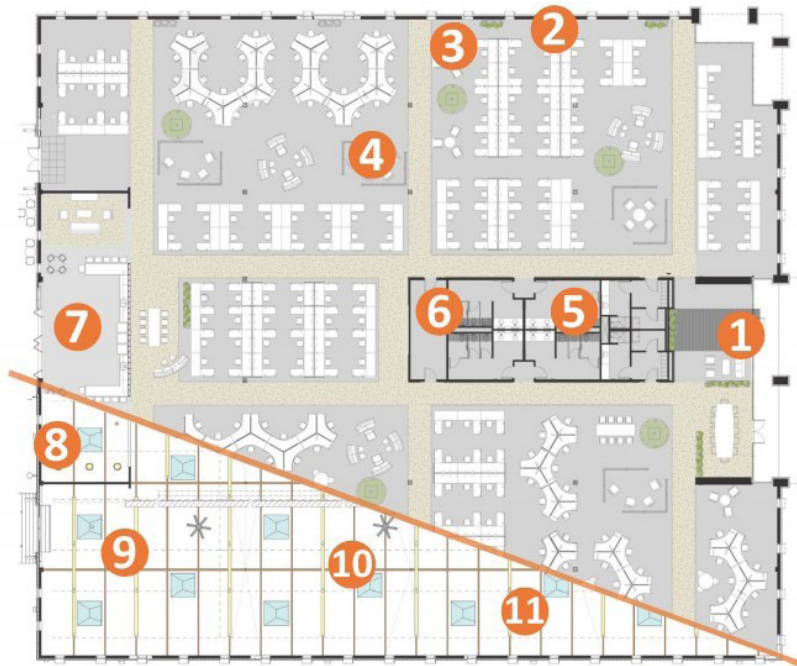
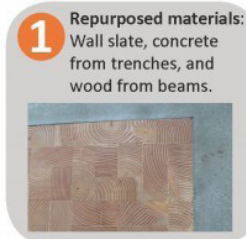
Due to the nature of the occupancy—an open space with tech firms—the plug loads are by far the biggest energy end use of the project, at 58%. However, information given to tenants at the time of leasing includes recommendations for plug load management and energy reduction. Installed circuit metering in these tenant-occupied spaces also provides real-time information to tenants about their plug use.

Controls

SHARP Development's expertise in ZNE design contributed to the understanding of the importance of master system integration for the controls used in ZNE buildings. Starting early in the design process, a Master System Integrator and building controls company advised on the controls system. The integrator developed an "omni-controller" to monitor how all passive systems worked in tandem. Building controls can be operated manually, automatically, and remotely turning fans on and off, opening/closing windows, and performing other control related tasks.

The lighting controls are a stand-alone system built into the light fixtures as part of a standard manufactured system. The lighting is connected to the same omni-controller as the other controls so that the integrator can have access to the data as an integrated part of the building's system.

435 Indio Way: Net Zero Energy Strategies



Occupant Engagement & Training

Occupants are given a “driver’s manual” when first moving into the space that advises them on plug load reduction techniques, Energy Star-approved appliances that they may supplement, and additional information about the space. In an effort to control occupant behavior, the lease restricts the use of appliances such as floor heaters and provides suggestions for Energy Star approved task lighting and desk fans with the right for approval by the building owners. For most tenants there is a fairly steep adaptation curve as they begin to understand why the building is doing certain things at specific times of day. Some tenants commented about how the opening and closing of windows was initially disconcerting. Tenants benefit from a real-time dashboard in the lobby or on their smart devices that show their energy use and power generation.

Renewable Energy Generation & Storage

435 Indio has a 113.2-kW flat-panel solar photovoltaic system across the entire roof site along with two solar thermal panels for hot water. The roof-top photovoltaic system generates 266,000 kWh per year and the solar thermal system generates 500 kWh per year. This system is generating 113% of what the building uses on an annual basis.

“Economically, you’ll really make your money on a ZNE building on the market down cycle. In that time frame tenants try and drive your rent down or leave. Whoever is most desperate and has the lowest rent gets a tenant. However, tenants won’t leave a ZNE building in the down cycle because of the connectivity to nature, acoustics, and natural dynamics. People will not want to leave.”

— Kevin Bates, President of
SHARP Development

Post Occupancy

Commissioning

Multiple members of the original design team carried out commissioning. The general contractor, master system integrator, and the rest of the design team continued to manage and adjust the omni-controlled system and monitor the building operations post occupancy.

Monitoring

Once the initial commissioning and post occupancy monitoring period was complete, the owner engaged the master integrator to continue monitoring the omni-controller and integrated building systems. Post operation, the integrator implemented a BACnet 8³ communications protocol with the omni-controller so that it could communicate with the HVAC system. Tenants also monitor their own plug loads and continually improve their own practices and equipment to reduce demand.

Behavior

The behavior of the tenants has arguably the largest effect on whether a building can achieve ZNE. Post occupancy, 435 Indio had a very active adjustment period. Occupants learned to acclimate to the new features as the “smart building” functioned autonomously throughout all hours of the day. Once tenant needs were taken into account, the design team was able to address them—most of which seemed to be overcoming the psychological interpretation of the occupants’ surroundings. For example, occupants interpret grey walls as making them feel colder than they actually are, so by painting the walls white, tenants are less likely to feel that they need to heat a space. To address the issue of late night tenants, the team identified where the occupants were and adjusted where and when windows were opened to efficiently flush the air without causing discomfort.

Successes

435 Indio proves that a ZNE renovation can make financial sense for developers thanks to accelerated lease-up, increased rent, and lower operational costs. This project met both of its objectives to be better than a code-minimum design and to be a smart financial investment. As observed, the ZNE design, especially when held and operated, rather than sold immediately, is more profitable than code-minimum for this building type. Due to this success, SHARP Development has gone on to complete three other projects that leased up either during or before construction started.

³ BACnet is a communications protocol for building automation and control networks. It is an ASHRAE, ANSI, and ISO 16484-5 standard protocol that was designed to allow communication of building automation and control systems for applications such as HVAC, lighting control, access control, etc.



Lessons Learned

Overall this project was a stunning example of profitability for ZNE design. However, as with any building, it did not come without its struggles. One such issue was that much of the technology used in this project was new to the market and may not have performed the way they were intended. In this case, the lighting sensor technology did not perform as expected and it took tuning time to work as part of the omni-control system. Other lessons learned include taking into account the effect occupant education has on energy consumption and the adjustment period for tenants.

Resources For More Information

- A Real Estate Developers Case for Net Zero: <http://www.integralgroup.com/blog/a-real-estate-developers-business-case-for-net-zero/>
- 435 Indio Way: <http://hillhouseconstruction.com/project/435-indio-way-sunnyvale/>
- 435 Indio Way Net Zero Energy Offices: <http://rmw.com/projects/435-indio-way/>
- PG&E Case Study: <http://bit.ly/29VOVwx>