How to Build ZNE Buildings
(Without Anyone Noticing)

Alice La Pierre,
Energy Efficiency Coordinator
City of Berkeley Office of Energy & Sustainable Development

New Construction ZNE (everyone notices…)

- West Berkeley Library, Berkeley's first ZNE building, 9,300 ft2
- Produces excess electricity
- New EV charging station in the planning stages to make better use of excess energy



New Construction ZNE
West Berkeley Library

- Financing
  - Measure FF – Berkeley Public Library Bond for $26 million authorized in 2008 by voters to provide improvements at all 4 branch libraries
  - PG&E "ZNE Pilot Program" covered $60,000 in incremental costs through rebates (no longer available from PG&E)

New Construction ZNE
West Berkeley Library

- Energy Systems
  - Solar Thermal, for DHW and space heating (radiant floor heating system)

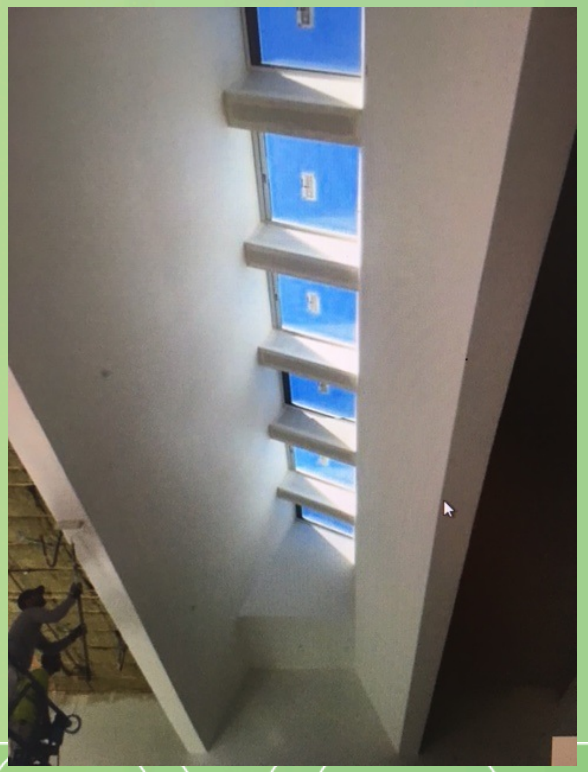




New Construction ZNE
West Berkeley Library

- Energy Systems
  - Daylighting: operable and fixed windows

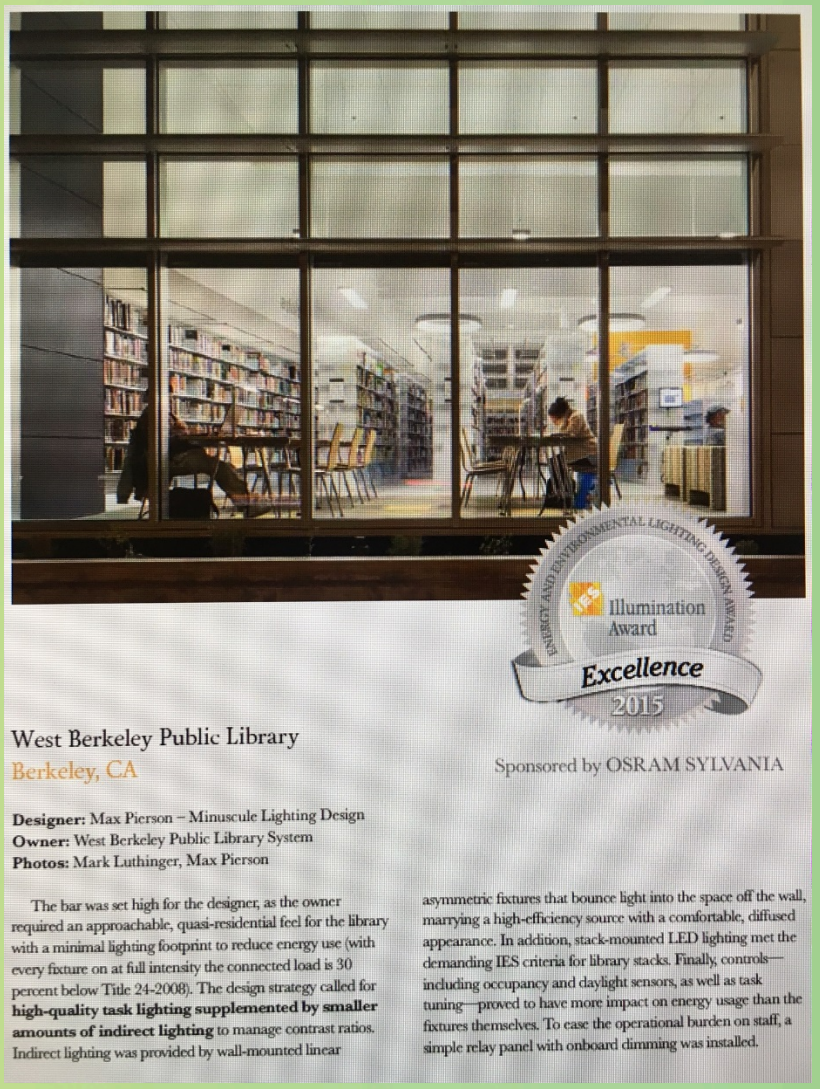




New Construction ZNE

West Berkeley Library

- Energy Systems
  - High Efficiency lighting (for 2008 code)
  - Lighting controls automatically adjust to the amount of natural daylight



Illumination Award
Excellence
2015

West Berkeley Public Library
Berkeley, CA

Sponsored by OSRAM SYLVANIA

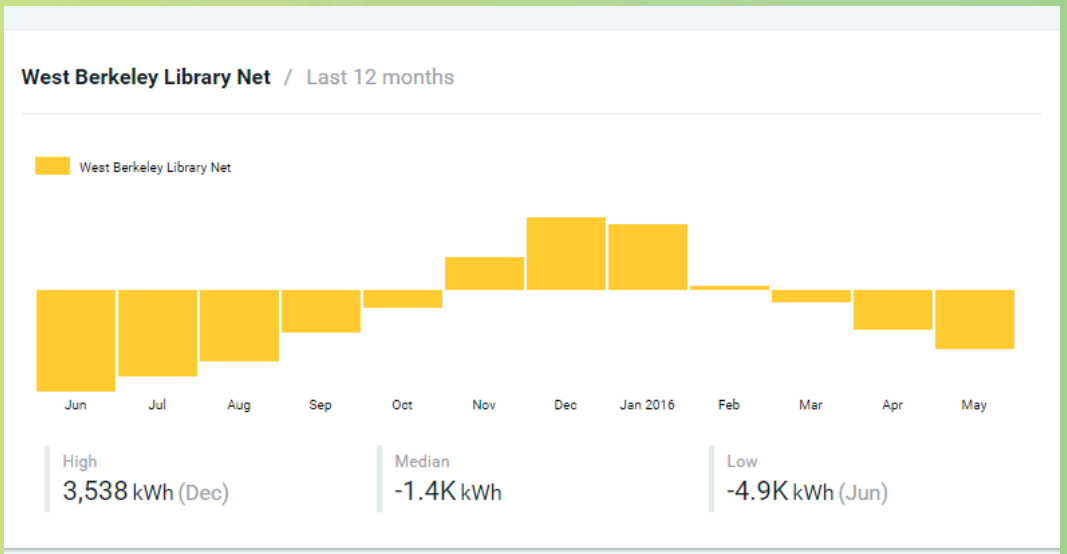
Designer: Max Pierson – Minuscule Lighting Design
Owner: West Berkeley Public Library System
Photos: Mark Luthinger, Max Pierson

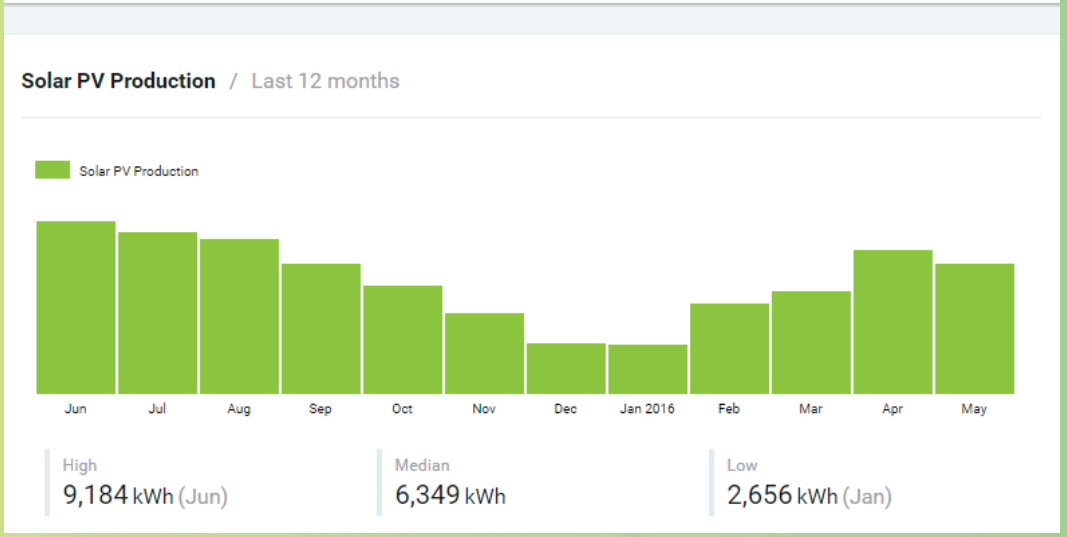
The bar was set high for the designer, as the owner required an approachable, quasi-residential feel for the library with a minimal lighting footprint to reduce energy use (with every fixture on at full intensity the connected load is 30 percent below Title 24-2008). The design strategy called for **high-quality task lighting supplemented by smaller amounts of indirect lighting** to manage contrast ratios. Indirect lighting was provided by wall-mounted linear asymmetric fixtures that bounce light into the space off the wall, marrying a high-efficiency source with a comfortable, diffused appearance. In addition, stack-mounted LED lighting met the demanding IES criteria for library stacks. Finally, controls—including occupancy and daylight sensors, as well as task tuning—proved to have more impact on energy usage than the fixtures themselves. To ease the operational burden on staff, a simple relay panel with onboard dimming was installed.

West Berkley Library Solar

- Last 12 months
  - *Solar PV Production*: 73,235 kWh
  - *Solar Thermal Production*: 39,578 kBtu

- Space heating and cooling is supplemented by Heat Pumps during extreme weather (winter and summer)





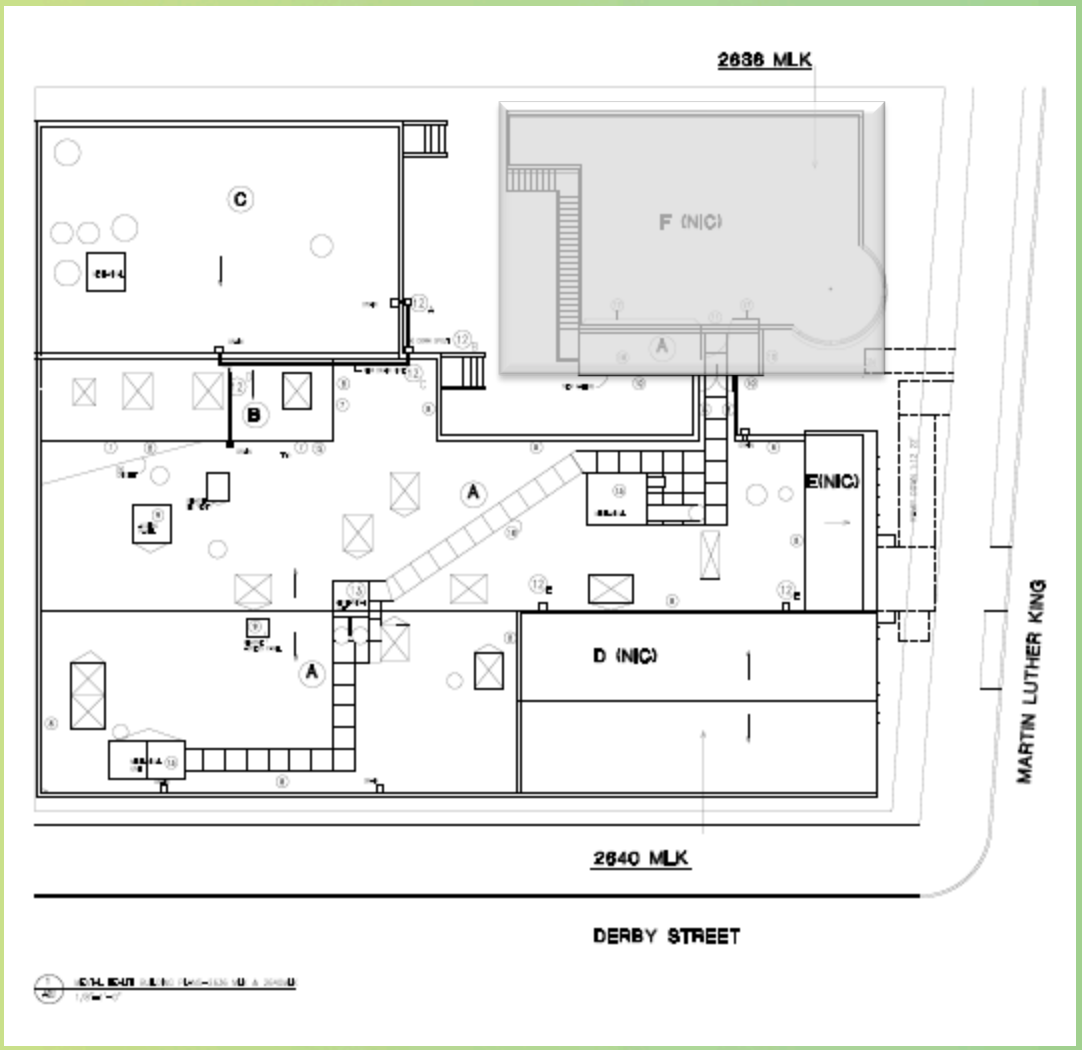
West Berkley Library Solar

Commissioning is mandatory, and necessary to ensure your ZNE building is performing as expected.

What about Existing Buildings?

Berkeley Mental Health Clinic

- Single Story (5,260 ft2)
- Multiple Skylights and HVAC units in inconvenient locations
- Historic tile roof recently replaced
- Not ADA compliant
- Standing water in crawlspace, mold & ventilation issues
- Lots of staff complaints for drafts, smells, over heating in summer, etc.



Berkeley Mental Health Clinic

- Existing conditions – ~70 year old woodframed structure, a former mortuary made into offices
- Crawlspace floor damp year round; Derby Creek runs under the building.
- Ductwork lying in mud; missing insulation, exposed to moisture. Air in office and clinic spaces smells of damp earth.
- Three furnaces from the 1980s, two AC units, of unknown age, one water heater installed in 1995.
- Crawlspace sealed off to prevent mice from entering building prevents ventilation and drying of space.
- No insulation, single-paned glass





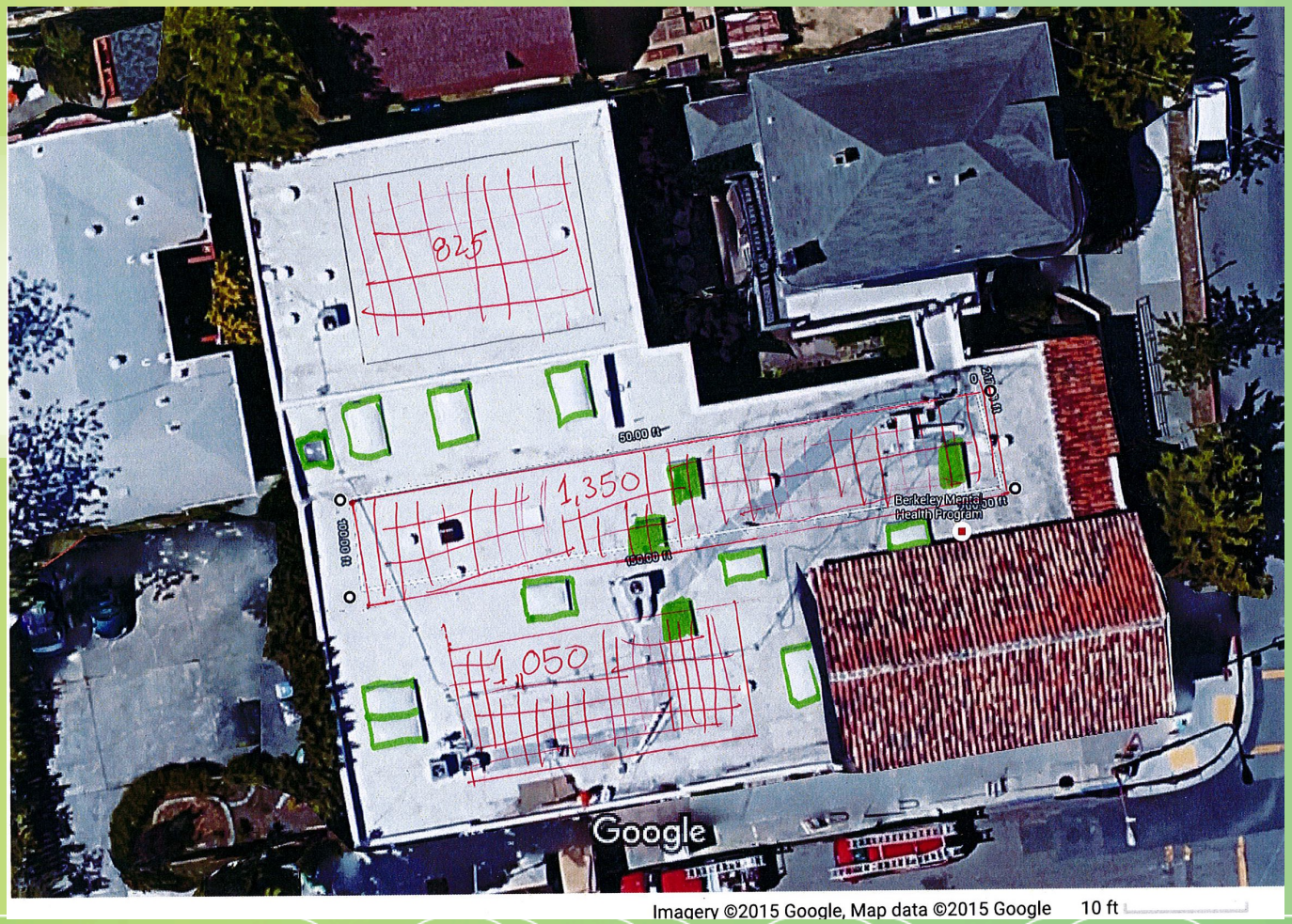
Critical: Ratio of Load to Roof Area

Berkeley Mental Health Clinic

Initial Process:
Check Roof Area for maximum allowance for solar production.

Identify type of solar PV panels that will provide maximum kw/ft2

This will tell you your maximum solar production on site. *(Remember pathways for Fire Code.)*



Berkeley Mental Health Clinic

Determine existing energy load, using the historic building energy use data.

(Track your buildings' energy use!)

Mental Health Clinic/2640 MLK WAY	2010	2011	2012	2013	2014 kWhe	Avg kWhe	Existing sq ft
Average	126,778	107,218	111,797	106,113	90,431	**98,272**	5,260
kWh	39,408	44,440	49,811	48,403	55,262	51,833	
therms	87,370	62,778	61,986	57,710	35,169	46,440	

Presumed 20 watts/ft2 average for panel production (high efficiency)
Usable space: ~3,500 ft2
Allowable system size: 70 kW based on roof space
Expected production: (70 kW * 1,540 hours of daylight, average = 107,800 kWhe

Berkeley Mental Health Clinic

- Confirm "back of envelope" estimates for production and consumption by hiring an engineering firm to do a ZNE Feasibility Study

Net Zero Feasibility Study Fee Summary:

Net Zero Feasibility fees:

ELS 3 weeks x .5 FTE ($110/hr) $**6,600**
(ELS credit back design fee for envelope/daylighting design) **(-$2,000)**
Bernheim and Dean, Inc, - Net Zero Cost Consulting/Systems Integration **$5,940**
F.W. Associates (NTE budget for Electrical consult) **$ 500**
*Capital Engineering (Energy model -- **$6,500**)
*SOHA (evaluate structural capacity for PV on roof) **$3,000**

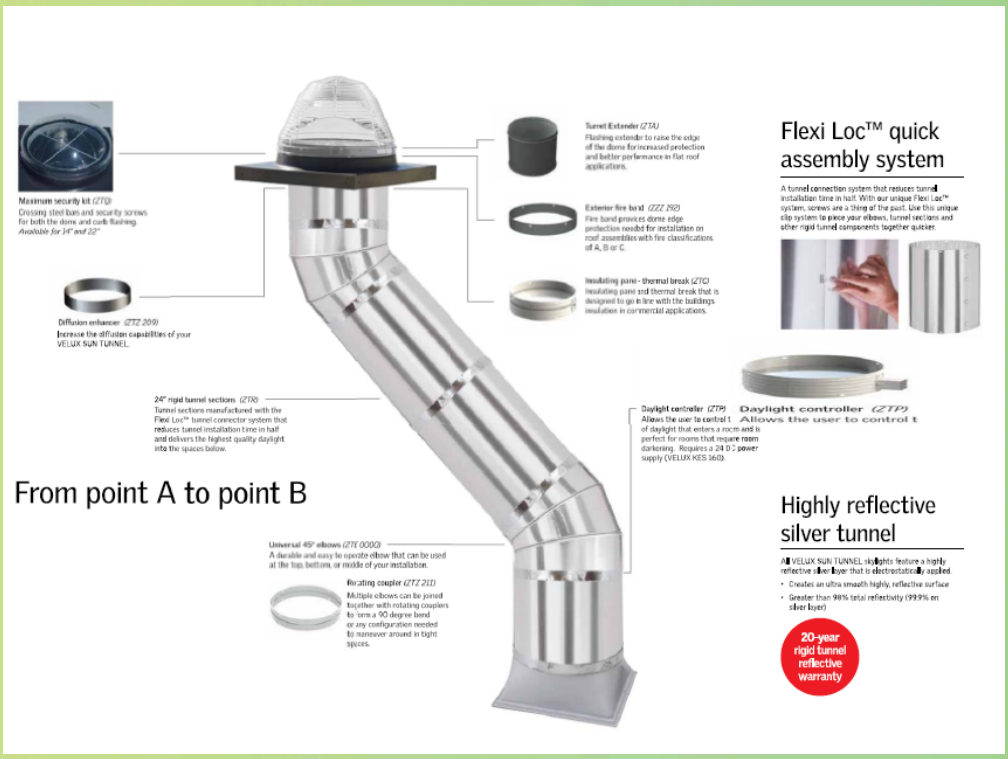
Total Fee Net Zero Study: $20,540

**Note that structural evaluation and Net Zero Cost estimating are not required if net zero are found not feasible.*

Berkeley Mental Health Clinic

- Managing Daylighting in interior spaces





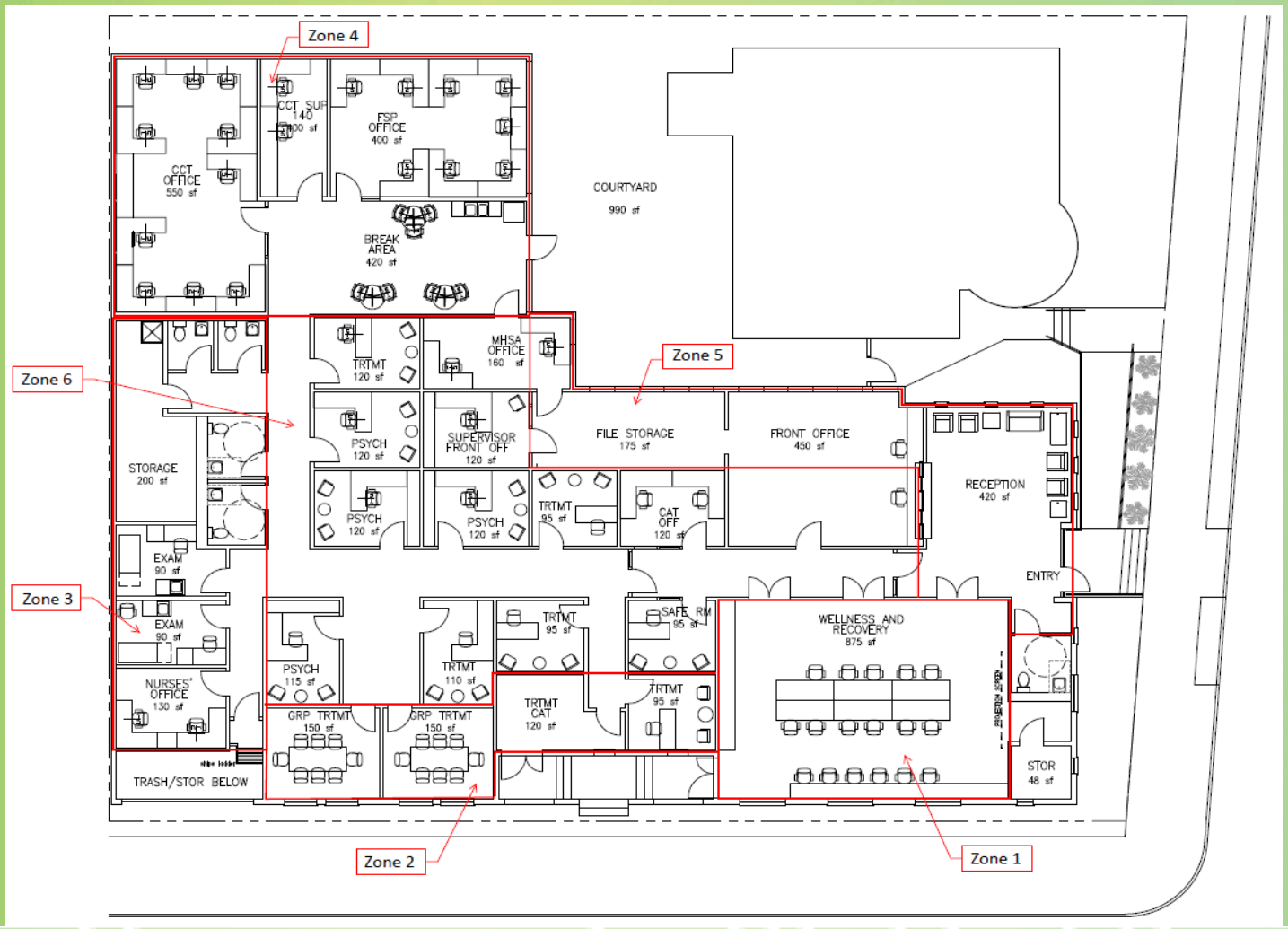
Berkeley Mental Health Clinic

- Final Panel Layout, with Sky Lighting and Mechanical equipment



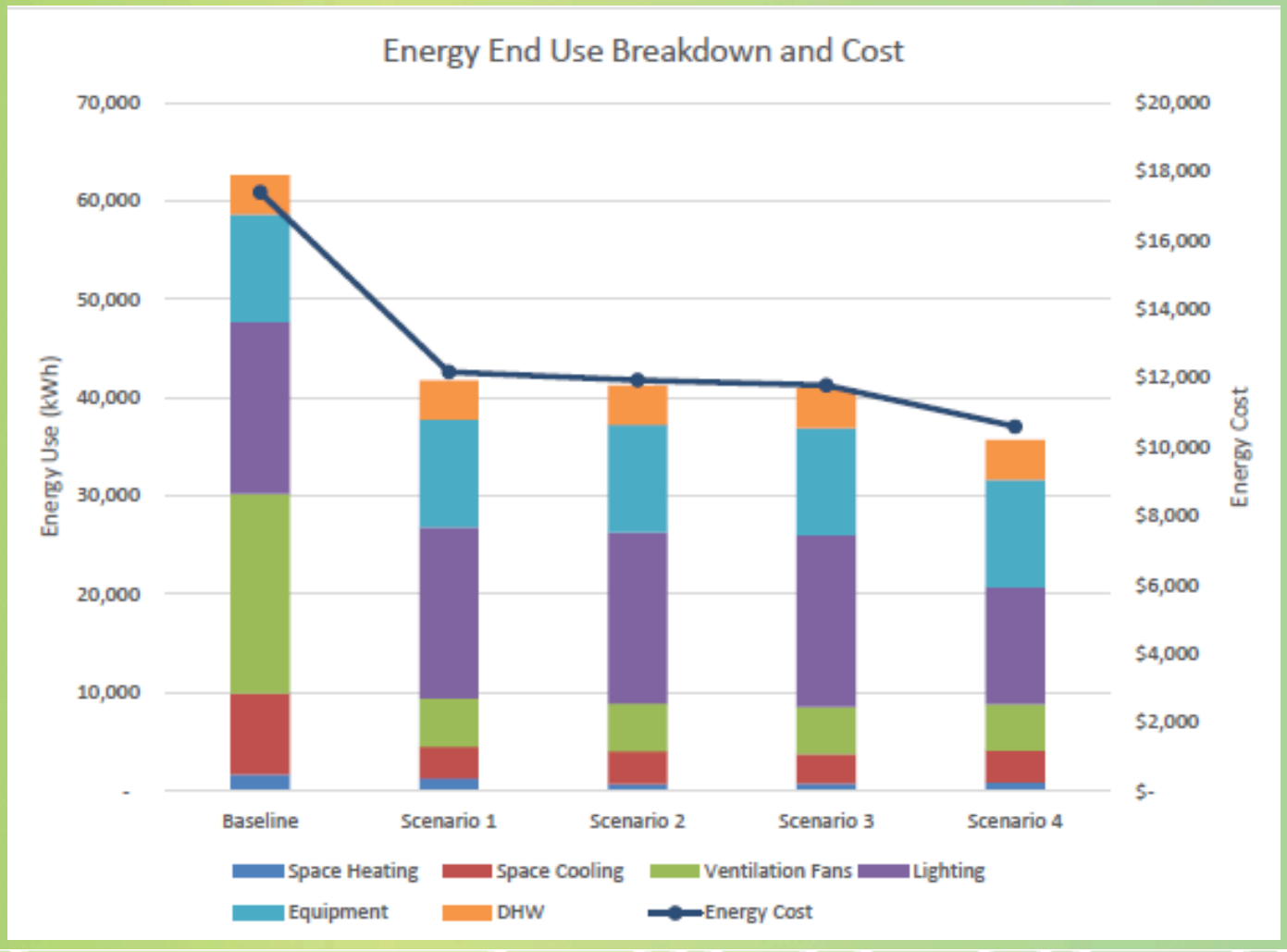
Berkeley Mental Health Clinic

- Floorplan showing 6 zoned spaces for lighting and mechanical



Berkeley Mental Health Clinic

- Four Efficiency Scenarios, showing total amount of energy to be offset by solar



Berkeley Mental Health Clinic

- Design Elements – *beyond Title 24 part 6*
  - Tubular Skylights

Berkeley Mental Health Clinic

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  - Double-paned Low-E, U-factor 0.34, SHGC of 0.28

Berkeley Mental Health Clinic

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  - LED lighting 0.8w/sf/average

Berkeley Mental Health Clinic

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Berkeley Mental Health Clinic

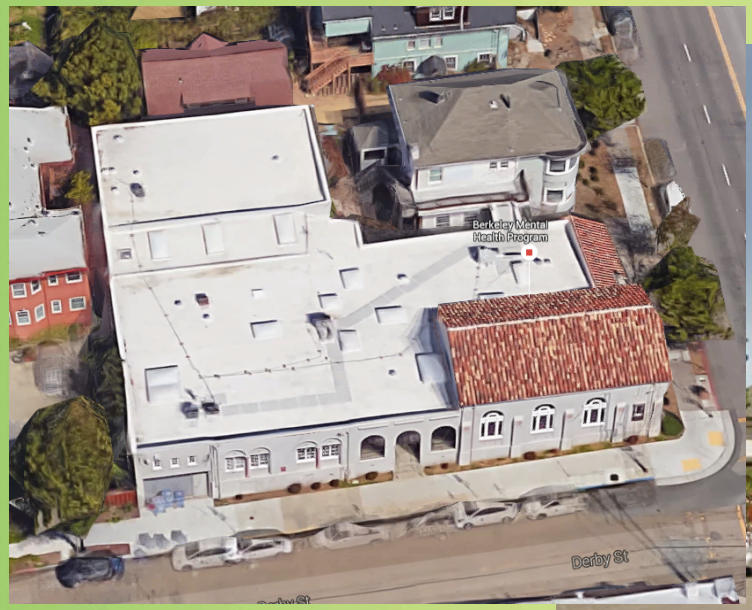
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  - DHW – 120 Btu/hr tankless

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  - LED lighting 0.8w/sf/average
  - Mechanical- high efficiency DX cooling, heat pump heating, VAV fans
  - DHW – 120 Btu/hr tankless
  - Building energy management system for scheduling and controls (sensors, software, wiring and wireless)

Berkeley Mental Health Clinic

- Existing site – remodeled site will look similar from the street
- Total expected cost, incl. ADA improvements, ZNE measures, LEED admin and commissioning, and Savings By Design admin services: **$499,000 -- $525,000**
- Does not include staff relocation and rental of temporary spaces.





Keys to creating ZNE through Remodeling:

1. Choose sites with good roof space to floor area; single or two-storey sites are generally best. Know your building's LOADS!

2. REQUIRE that the initial design be as efficient as possible – no "standard" HVAC solutions (package units, gas furnaces, or gas DHW.)

3. Incorporate passive systems -- daylighting, low E windows, draft sealing, insulation, and passive ventilation where possible to reduce operating costs and increase comfort.

4. Choose an experienced Architect who wants to take on this kind of project, and can communicate well with the rest of the Design Team. Ensure your Design Team includes ZNE experts.

5. Funding – look at CEC low-interest loans, municipal bonds, and utility rebates where available.

Creating ZNE through Remodeling

It's not as hard as you think it might be, as long as your buildings aren't too big.

Questions?

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