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
West Berkeley 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)
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.
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- 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.)*
Determine existing energy load, using the historic building energy use data.

(Track your buildings’ energy use!)

<table>
<thead>
<tr>
<th>Mental Health Clinic/2640 MLK WAY</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014 kWh</th>
<th>Avg kWh</th>
<th>Existing sq ft</th>
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<tbody>
<tr>
<td>Average</td>
<td>126,778</td>
<td>107,218</td>
<td>111,797</td>
<td>106,113</td>
<td>90,431</td>
<td><strong>98,272</strong></td>
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<td>kWh</td>
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<td>49,811</td>
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<td>therms</td>
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<td>62,778</td>
<td>61,986</td>
<td>57,710</td>
<td>35,169</td>
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</tbody>
</table>

**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 kWh)
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.*
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• Managing Daylighting in interior spaces

From point A to point B
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- Final Panel Layout, with Sky Lighting and Mechanical equipment
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- Floorplan showing 6 zoned spaces for lighting and mechanical
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- Four Efficiency Scenarios, showing total amount of energy to be offset by solar

![Energy End Use Breakdown and Cost Chart](chart.png)
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Design Elements – *beyond Title 24 part 6*

- Tubular Skylights
Berkeley Mental Health Clinic

Design Elements – *beyond Title 24 part 6*

- Tubular Skylights
- R20 into exterior walls (dense-packed cellulose)
Berkeley Mental Health Clinic

Design Elements – *beyond Title 24 part 6*

- Tubular Skylights
- R20 into exterior walls (dense-packed cellulose)
- R30+ attic insulation
Berkeley Mental Health Clinic

Design Elements – beyond Title 24 part 6

- Tubular Skylights
- R20 into exterior walls (dense-packed cellulose)
- R30+ attic insulation
- Double-paned Low-E, U-factor 0.34, SHGC of 0.28
Design Elements – *beyond Title 24 part 6*

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- LED lighting 0.8w/sf/average
Berkeley Mental Health Clinic

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- 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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