Understanding the Costs and Benefits of Net Zero Design
background
background

Packard Sustainability Report and Matrix 2001, 2002


Living Building Study 2009
Packard Sustainability Report and Matrix
2001, 2002

Authors:
David & Lucile Packard Foundation
BNIM Architects
Hawley Peterson Snyder Architects
Keen Engineering
Oppenheim Lewis
Holland Design
Examining the Cost of Green 2004

Cost of Green Revisited 2007

Author: Davis Langdon
background

Living Building Financial Study 2009

Authors:
- Cascadia Region Green Building Council
- Sera Architects
- Skanska USA Building
- Gerding Edlen
- Interface Engineering
- New Buildings Institute
statistical analysis
data gathered

- Project details (program, rating, location, etc)
- Construction cost
- Construction costs detail
- Projected operating costs (energy and water)
- Actual operating costs
- Anecdotal evidence
building types

- community centers (learning/visitor)
- K-12 schools
- office buildings – low-rise
- wet labs
- libraries
- office buildings – T.I.
- Healthcare
- High rise mixed use/residential
normalize data

- common location
- common time

establish comparison baseline

- the project’s original budget
- the project itself, without the green elements
- similar projects
community centers
statistical analysis

Cost/SF

- Control Buildings
- LEED Gold/Platinum
- Net Zero/Living Buildings

early data
office buildings – low-rise

statistical analysis

early data
The Power of Zero: Optimizing Value for Next Generation Green

BNIM   |   Integral Group   |   Davis Langdon/AECOM

wet lab
statistical analysis
early data

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<th>Cost/SF</th>
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<th>Net Zero/Living Buildings</th>
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energy use intensity: energy star rating by city

statistical analysis
kBtu/SF/Year (EUI) Actual

- K-12 Schools
- Community Centers
- Offices (Low Rise)
- Wet Labs
value discovery
statistical analysis
value discovery

statistical analysis
design thinking at the building scale
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GOALS & ASPIRATIONS

PROGRAM

• Flexible laboratories for molecular and cutting edge computational biology
• Support for cutting-edge computational biology

SUSTAINABILITY GOALS

• “The most sustainable lab building in the world”
• Minimum 50% less energy use and on-site power generation
• Carbon neutral – without "buying” carbon offsets
• Capture 100% rainwater on site
• Reduce domestic water demand 50%
• Net-zero waste water
• Natural ventilation and light in all occupied spaces
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DESIGN PROCESS

1. Identify unique opportunities of location

2. Organize Program (Occupancy Use and Time)

3. Analyze Actual Loads (Right-size everything)

4. High Performance Architecture (Envelope, Sunshading, Daylighting)

5. Decouple Thermal & Ventilation (Utilize the most efficient systems and equipment available / heat recovery)

6. Select Renewable Sources of Energy

Images courtesy of JCVI
PV Output Required = 4x Roof Area Available

Area Available = “Energy Budget”

- Heating
- Cooling
- Pumps
- Fans
- DHW
- Lighting
- Exterior Lighting
- Vehicles
- Office Plug Loads
- Lab Plug Loads
- Freezers
- PV Output

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ACHIEVING NET ZERO
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ON-SITE PHOTOVOLTAICS

"Energy Budget"

- Heating
- Cooling
- Pumps
- Fans
- DHW
- Lighting
- Exterior Lighting
- Vehicles
- Office Plug Loads
- Lab Plug Loads
- Freezers
- PV Output
IDEAs Z Squared Design Facility  

Architects: EHDD  
ILFI Net Zero Energy  
60% over ASHRAE 90.1  

EUI = 22.6
Sunnyvale, CA
Sharp Development
RMW Architecture
30,000 gsf
Net Zero within standard budget

predicted EUI = 22.5
concepts: mechanical/architectural

- Automatically controlled passive night cooling
- Upgraded exterior insulation allows precooling of thermal mass walls
- Ceiling fans extend comfort temperature range
- Custom operable skylights use prevailing breezes to induce internal airflow
- High efficiency/low cost rooftop package units used only as needed (rarely)
- High performance glazing – no need for external shades
concepts: financial

• Performance based lease provides carrot (and stick) for good occupant behaviour
• Added construction cost = $44/sf including 32,000 sf PV array
• Drastically reduced reserve requirements for maintenance and HVAC
• Reduced operating expenses – utilities, landscape, etc
• Demisability to reduce churn costs
• Unanticipated cost reductions (e.g. no mechanical screen)

• IF actual energy use meets predicted, than the financial model is more profitable than standard practice (build to code)

• Future projects – higher rents and lease rates
DOE GOAL: PROOF OF CONCEPT

Large Scale Net Zero Energy At Market Rate

$260/sf
EUI = 25 kBTU/sf

NREL Research Support Facility
“World's Largest Net Zero”
LEED Platinum Certified: AIA COTE Top 10
RNL Design
NET ZERO ENERGY
285 kW PV array provides 100% of net annual energy.

GREEN STREETS
Rain gardens filter street runoff.

PARKING REDUCTION
67 parking spaces meet demand, instead of 160 required by code.

SOLAR CONTROL
Layered sunshading, including dynamic blinds, protects southwest exposure.

“CALIFORNIA LIVING”
Collaborative central courtyard is focal point and heart of the building.

NARROW BUILDING
40’ width maximizes daylighting and natural ventilation.

EFFICIENT SYSTEMS
Chilled beams allow 75% reduction in fan energy with 100% outside air delivery.

BIOPHILIA
Green roof provides habitat and enhances views from interior.

CLIMATE-RESPONSIVE COOLING
Compressor-free cooling tower feeds 50,000 gallon chilled water storage.

OPTIMIZED ENVELOPE
Triple-glazed windows and reduced thermal bridging shrinks heating demand.

TOWARDS ZERO WATER
Rainwater is captured in a 20,000 gallon cistern, reducing potable water demand by 69%.
Glazing Energy Impacts

+ $75,000  Premium for installed glazing
- $150,000  Simplify heating system

= $75,000 first cost *savings*

Plus $300,000 savings in fewer PVs
Packard Foundation NZE BIM Model

Super-low Pressure Drop

Chiller

HX’s
cost drivers and tools

Location
Program
Site conditions
Climate
Delivery
Team
Client values

Team
Client values
BIM
Modeling
Targets

GREEN IS NOT A PRIMARY COST DRIVER!