Operating at Zero and Delivering Value
The Bullitt Center Three Years Later

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NBI Getting to Zero National Forum
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Justin Stenkamp, PE, LEED AP, PAE
Bullitt Center | Sections
Net Zero (+)

United States Photovoltaic Solar Resource:
Flat plate tilted at latitude
Net Zero Energy

determining the CARRYING CAPACITY of the site:

- solar harvest 230,000 kWh/year
- gross building area 52,000 gsf
- Energy Use Index (EUI)16
Bullitt Center | Energy Systems

Project Performance Timeline

Bullitt Center Energy Data since Completion - 12 month running total

1-year LEED performance period

Production (RPI)

Consumption (EUI)

RPI 16

EUI 10

RPI 16

EUI 12

Metered End Use data available
### Financial Considerations

#### Project Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>$3,380,000</td>
</tr>
<tr>
<td><strong>Hard Costs</strong></td>
<td>$23,360,000</td>
</tr>
<tr>
<td>Pre-Construction</td>
<td>$450,000</td>
</tr>
<tr>
<td>Construction</td>
<td>$18,160,000(350/sf)</td>
</tr>
<tr>
<td>Owners Direct</td>
<td>$2,940,000</td>
</tr>
<tr>
<td>Sales Tax</td>
<td>$1,810,000</td>
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<tr>
<td><strong>Soft Costs</strong></td>
<td>$5,290,000</td>
</tr>
<tr>
<td>Architecture &amp; Engineering</td>
<td>$2,550,000</td>
</tr>
<tr>
<td>Permits &amp; Municipal Fees</td>
<td>$320,000</td>
</tr>
<tr>
<td>Utility Expenses</td>
<td>$600,000</td>
</tr>
<tr>
<td>Other</td>
<td>$1,680,000</td>
</tr>
<tr>
<td><strong>Finance Costs</strong></td>
<td>$470,000</td>
</tr>
<tr>
<td><strong>TOTAL COST</strong></td>
<td><strong>$32,500,000</strong></td>
</tr>
</tbody>
</table>

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**Window Systems**
Window Operations - Annual

Blue: Closed
Yellow: Open

Temperature Ranges:
- 80 F
- 55 F

Diagram: Dylan Davis/UW IDL

Window Operations - Summer

Diagram: Dylan Davis/UW IDL
Window Operations – Swing Season

LBC Beauty and Spirit Survey Results
Building Systems + Performance
Bullitt Center

HVAC System Overview

[Diagram of HVAC system]

[Images of posters with 'The Good, The Bad, The Ugly']
Bullitt Center Performance

Predicted vs. Actual

Electric Consumption, kWh

SCL Power Used
PV Exported to SCL
PV Used by Bullitt
Savings over Baseline
Bullitt Center Energy

PV Array

Energy Consumption (kWh)

ACTUAL Energy Production
PREDICTED Energy Production

Thermal Comfort Theory

- Humidity
- Clothing Insulation
- Air Speed
- Metabolic Rate
- Air Temperature
- Radiant Temperature
South Zone Summer Temperature Profile

Performance

Thermal Comfort

North Zone Shoulder Temperature Profile

Performance

Thermal Comfort
Post Occupancy Adjustments
Living in a Living Building

Issues

Living in a Living Building

Solutions
Monitoring
Tenant Perspective
Plug Loads Consume Approx. 29%* of Seattle Energy Code Office Building Site Energy (SEC, 2009)

Plug Load Energy in NW Buildings

EUI ~42 kBtu/ft²-yr
Plug loads alone = ~12.8 kBtu/ft²-yr

*This is based on modeling done in 2009 – The wattage appears to be dropping somewhat due to adoption of more laptop computers and cloud computing.

Bullitt Center Modeled (Operating 2015)

EUI ~16 kBtu/ft²-yr *(Now operating ~10 kBtu/ft²-yr)*
Plugs alone = ~7.6 (3.1) kBtu/ft²-yr- with controls

*If plug load reduction performance is not persistent over time the project will not meet net-zero operation.
Green Lease at Bullitt Center

Many provisions...
Includes tenant energy budget apportioned by square footage of leased area.

UW Leased Area: 7950 ft²
Annual Energy budget: 5452 kWh

Plug Load Energy Allocation Density: 0.69 kWh/ft²-yr
Plug Load "Density" @ 1300* hrs: 0.53 W/ft² (whole building)

@ 150 ft²/person: ~80 W/workstation (average operating W)

* 1300 hours of estimated operation time per year per workstation
### Work Station Efficiencies

<table>
<thead>
<tr>
<th>Monitors</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – 20” CCFL-LCD @ 75 Watts each</td>
<td>1 - Desktop @ 100 Watts</td>
</tr>
<tr>
<td>2 – 22” LED-LCD @ 40 Watts each</td>
<td>1 - Desktop @ 80 Watts</td>
</tr>
<tr>
<td>2 – 22” LED-LCD @ 14 Watts each</td>
<td>1 - Laptop @ 35-62 Watts</td>
</tr>
</tbody>
</table>

Typical: 250 watts  
Good (2009): 160 watts  
Better: ~75 watts

Graphic: PAE Engineering

### Comprehensive Plug Load/Task Lighting Management

- Web-based Real Time Plug Load Data Collection, Scheduling, and Reporting at Each Receptacle.

Image: Enmetric Plug Load Manager/UW IDL
Plug Load Energy 2015

Approx. 120 FTE
January 2015

Approx. 170 FTE
December 2015

Plug Loads by Occupancy

Hourly Data Occupied/Unoccupied
Communicating a Culture of Conservation

Physical and situational cues activate + support values

Tenant Engagement

Encouraging Pro-environmental Actions:
Cue: Solar Array
Action: Energy Conservation

http://www.bullittcenter.org/
Tenant Engagement

Encouraging Pro-environmental Actions:
Cue: Bike parking, showers, lockers
Action: Transportation + Healthy Exercise

http://www.bullittcenter.org/

Tenant Engagement

Encouraging Pro-environmental Actions:
Value: Biospheric
Cue: Light Filled Stair at Main Entry (no elevator lobby to be seen)
Action: Energy Use + Healthy Exercise + Views of the Sound
MEETS Concept

Metered Energy Efficiency Transaction Structure

1. Tenants pay for Baseline
2. Measure the saved energy with a meter
3. Buy and sell it through PPA just like generation

“Negawatts”
MEETS Benefits

**Owner**
- New $ flow
- Receive ECM savings
- Tenants pay normal rates

**Investor**
- ~30 yr return
- Increased $ for performance
- Like a PPA

**Utility**
- ~30 yr fixed revenue
- Helps meet regulatory requirements

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Financial Considerations

Challenges – Net Present Cost

<table>
<thead>
<tr>
<th>Time (Years)</th>
<th>Average Building</th>
<th>Net Zero Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$10</td>
<td>$13</td>
</tr>
<tr>
<td>30</td>
<td>$23</td>
<td>$19</td>
</tr>
<tr>
<td>60</td>
<td>$63</td>
<td>$20</td>
</tr>
<tr>
<td>100</td>
<td>$350</td>
<td>$21</td>
</tr>
</tbody>
</table>

Authorized for use by MEETS AC licensees by EnergyRM 05-09-2014
Bullitt Center Performance

Predicted vs. Actual

Electric Consumption, kWh

SCL Power Used
PV Exported to SCL
PV Used by Bullitt
Savings over Baseline

2013 2014 2015 2016

THANK YOU!

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