Net Zero Multifamily Cost and Energy Optimization

NESEA BuildingEnergy Boston
March 14th, 2019

Jesse Schwartzberg, RA: Black Mountain Architecture
Dave Bruns: Bruns Realty Group, LLC
The Market

U.S. Energy Consumption by Sector

The Market

A Nation Of Renters

- Renter Occupied Housing as % of Total Housing Units
- SA Home Ownership Rate

Q2-2000 to Q2-2014
The Goals

- Profitable
- Bankable
- Marketable
- Reproducible
The Net Zero Concept

- Solar Photovoltaic
- Passive Solar Heating
- Solar Water Heating

Inverter/Panel

Net Meter

Utility System
Project #1: NetZero Village
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The Results: Cost

Conventional Wood Frame

• $80,000 per unit
• $85+/- per SF

Net Zero Village

• $100,000 per unit
• $100+/- per SF
The Results: Energy

### 2016-2017: Buildings 1-6 (72 units)

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Predicted</th>
<th>Deviation</th>
<th>kWh/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumed:</td>
<td>371,386 kWh</td>
<td>338,364 kWh</td>
<td>10%</td>
<td>5,158 kWh</td>
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<tr>
<td>Produced:</td>
<td>430,617 kWh</td>
<td>475,200 kWh</td>
<td>-9%</td>
<td>5,981 kWh</td>
</tr>
<tr>
<td>Net:</td>
<td>59,231 kWh (+16%)</td>
<td>-</td>
<td>-</td>
<td>823 kWh</td>
</tr>
</tbody>
</table>

### 2018-2019: Buildings 1-11 (132 units)

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Predicted</th>
<th>Deviation</th>
<th>kWh/Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumed:</td>
<td>821,621 kWh</td>
<td>620,334 kWh</td>
<td>32%</td>
<td>6,224 kWh</td>
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<tr>
<td>Produced:</td>
<td>754,010 kWh</td>
<td>871,200 kWh</td>
<td>-13%</td>
<td>5,712 kWh</td>
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<tr>
<td>Net:</td>
<td>-67,611 kWh (-8%)</td>
<td>-</td>
<td>-</td>
<td>-512 kWh</td>
</tr>
</tbody>
</table>
INVITATION TO ATTEND

BUILDING ENERGY 2002

The conference and trade show for renewable energy and green building professionals

Tufts University
Medford, MA
March 20–23, 2002

Organized by NESEA

Title Sponsor

Hosted by

BLACK MOUNTAIN ARCHITECTURE

netZero Village

SOLARA ECO/LUXURY LIVING
Next 30 Minutes:

• Integrated Design Process

• Team Members/ Roles

• Key Building Systems, Specifications, and Details

• Modeling Tools Used to Inform Decisions

• Window Specification Example

• Heat Pump Specification Example
Dave’s Question:

Is it less expensive to reach our net zero goal by installing 3” of Closed Cell Spray Foam instead of 2” or by purchasing additional PV?

-David Bruns
Team’s Goals in Response to Dave’s Question:

- Make Informed Decisions
- Spend construction $ in areas of highest value to Net Zero Goal
- Stop spending with diminishing returns
- Analyze every building component through the lens on $ and kWh
The Integrated Design Process: Weekly Meetings
The Developer

Dave Bruns
Bruns Realty Group, LLC

- Vision
- Rental Property Experience
- Integrity
- Compassion
- Trust
The Builder

Ballston-Mourningkill Associates

Rob Hofmann

• Multifamily Experience
• Eager to Learn
• Lean and Efficient
• Laser focus on costs

Eric Carlson
The Architects

Harris Sanders Architects

Owen Neitzel

• Multifamily Experience
• Code Knowledge
• Market Knowledge
• Open to Integrated Design Process

Daniel Sanders
Black Mountain Architecture: Jesse Schwartzberg

- Energy Architect
- Integrated Design Process Leader
- Building Science Knowledge
The HERS Rater

• Energy Star Rater
• Problem Solver
• Multifamily Experience
• Building Science Knowledge

Tom Vitale
En-Tech Associates, Inc.
The DHW Designer and Contractor

Peter Skinner
E2G Solar

- Solar Thermal Guru
- Understands how to best capture the sun’s energy
- Passion for Solar DHW
Key Building Specifications

- Designed for local Albany tradespeople
- Easy to Build
- Easy to Bid
Key Building Specifications: Roof

- TPO
- 4" Polyiso
- OSB
- 2 ½" Closed Cell Spray Foam
- R-38 Assembly
Key Building Specifications: Walls

- ½” Polyiso ZIP-R Sheathing
- 2x6 Wood Stud
- 3 ½” Closed Cell Spray Foam
- GWB
- R-25 Assembly
Key Building Specifications: Walls
Key Building Specifications: Windows

- Single Hung Vinyl
- Double Pane
- 180/i89 Glass
- SHGC = .52
- Condensation Resistance = .46
- U-value = .24
- R-value = 4
Key Building Specifications: Exterior Sun Shades

- PVC
- Off-the-Shelf Fence Parts
- Custom Fabricated
- $250 per shade
Key Building Specifications: Foundation/Slab

- 4" Concrete
- 6-mil poly
- 8" Compacted Earth
- 2" XPS Foam
- Undisturbed Earth
Key Building Specifications: Foundation/Slab
Key Building Specifications: Mechanicals

- Air Source Heat Pumps
- Low temperature
- 1-Ton units
- One indoor unit per apartment
- One outdoor unit per apartment
- One unit per common area
Key Building Specifications: Mechanicals

- 70% Assumed Sensible Recovery Efficiency (HVI)
Key Building Specifications: Active Solar

- 66 KW system per building
- Located on carports
- 79,200 kwh predicted annual generation
- Predicted EUI: 15.2
Key Building Specifications: Passive Solar

- E-W Orientation
- South-facing Windows
- Solar Pathfinder Study
Key Building Specifications: Passive Solar

- Sun’s heat + Tight envelope = Minimal heating required during construction
Key Building Specifications: Solar Thermal/DHW

- 78% of DHW Need
- NYSERDA Incentives
- Critical to Net Zero
Key Building Specifications: Airtightness

- Initial Fog Test
- Pre GWB Test
- Pre Occupation Test
- .6 ACH50 (Actual)
Key Building Specifications: Monitoring

- Utility Meters
- PV Meters
- E-Guage Meters
- Analysis Takes Time
How Did We Answer Dave’s Question?: Energy Modeling

• Good
• Better
• Best

Passive House Planning Package

# Energy & Cost Value Engineering: Windows

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Good</th>
<th>Better</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base</strong></td>
<td>Guardian 63/31, 2-pane, Lo-e</td>
<td>Windows: Cardinal 180, 2-pane, Lo-e, Argon</td>
<td>Guardian 75/68, 3-pane, Lo-e, Air</td>
<td>Trosch, 3-pane, Lo-e, Argon</td>
</tr>
<tr>
<td></td>
<td>U-cog = 0.29, SHGC = 0.31</td>
<td>U-cog = 0.26, SHGC = 0.65</td>
<td>U-cog = 0.18, SHGC = 0.54</td>
<td>U-cog = 0.09, SHGC = 0.50</td>
</tr>
<tr>
<td><strong>Saved</strong></td>
<td>10,573 kwh</td>
<td>1,307 kwh AdditionalSaved</td>
<td>3,239 kwh AdditionalSaved</td>
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</tbody>
</table>

$\rightarrow$$\rightarrow$$\rightarrow$ $\rightarrow$ $\rightarrow$ $\rightarrow$

$10,573 \text{ kwh Saved}$

$1,307 \text{ kwh Additional Saved}$

$3,239 \text{ kwh Additional Saved}$
# Energy & Cost Value Engineering: Windows

## Paradigm Window and Glazing Options

<table>
<thead>
<tr>
<th>Plan/Design</th>
<th>U-value</th>
<th>SHGC</th>
<th>CR</th>
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<tbody>
<tr>
<td><strong>SINGLE HUNG DOUBLE GLAZING 3/4&quot; IGU w/ Argon</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>180</td>
<td>0.28</td>
<td>0.52</td>
<td>0.61</td>
</tr>
<tr>
<td>180/ i89</td>
<td>0.24</td>
<td>0.52</td>
<td>0.46</td>
</tr>
<tr>
<td>270</td>
<td>0.27</td>
<td>0.28</td>
<td>0.62</td>
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<tr>
<td><strong>SINGLE HUNG TRIPLE GLAZING 3/4&quot; IGU w/ Argon</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>180/CLR/ 180</td>
<td>0.25</td>
<td>0.47</td>
<td>0.63</td>
</tr>
<tr>
<td>180/CLR/ i89</td>
<td>0.25</td>
<td>0.48</td>
<td>0.47</td>
</tr>
<tr>
<td>270/CLR/ 270</td>
<td>0.24</td>
<td>0.26</td>
<td>0.66</td>
</tr>
<tr>
<td><strong>CASEMENT TRIPLE GLAZED W/ 1&quot; IGU w/ Argon</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>180/CLR/ 180</td>
<td>0.21</td>
<td>0.38</td>
<td>0.68</td>
</tr>
<tr>
<td>270/CLR/ 270</td>
<td>0.21</td>
<td>0.22</td>
<td>0.68</td>
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<tr>
<td>270</td>
<td>0.26</td>
<td>0.23</td>
<td>0.61</td>
</tr>
<tr>
<td>180</td>
<td>0.26</td>
<td>0.42</td>
<td>0.63</td>
</tr>
</tbody>
</table>
Energy & Cost Value Engineering: Heat Pumps
Energy Modeling/Value Engineering: Heat Pumps
Lessons Learned: NetZero Village

- Shared Responsibility
- Personal Dedication
Project#2: Solara
Project #2: Solara
Project #2: Solara
Project #2: Solara

- Elevators
- Double-loaded corridor
- Switch from HRV to ERV
- Switch from ½” polyiso to 1” (ZIP-R)
- Heat pump hot water
- Heat pump dryers
- “Smart and Holistic” master building controls
- Hot water recirculation loop
- Dehumidification plan
- Eave detail
Project #2: Solara
Project #2: Solara
Project #2: Solara
Project #2: Solara
Reproducible Goal Achieved!
Who’s Watching the Project?
You can do this too!
QUESTIONS

Dave Bruns
Bruns Realty Group, LLC
brunsrealty@yahoo.com

Jesse Schwartzberg
Black Mountain Architecture
jesse@blackmountainarchitecture.com