COMPARING 3 CERTIFICATION METRICS THAT DRIVE SUSTAINABILITY IN AFFORDABLE MULTI-FAMILY HOUSING

NESEA BUILDING ENERGY 2018
MARCH 8, 2018

Moderator: Betsy Harper, Sustainability Program Developer at MA Department of Housing and Community Development (DHCD)

Enterprise Green Communities: Darien Crimmin, VP Energy and Sustainability at Winn Development

Zero Net Energy: Julie Klump, VP Design and Building Performance at POAH

Passive House: Michael Hindle, Principal of Passive to Positive
## Metric Comparisons

<table>
<thead>
<tr>
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<td></td>
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<tr>
<td>ACH @ 50 Pascals</td>
<td>Unit types range 8 – 15; No Req.</td>
<td>Not Available</td>
<td>Buildings range 1.3 - 1.7; No Req.</td>
</tr>
<tr>
<td>Renewable Energy?</td>
<td>Not required</td>
<td>Not required</td>
<td>Necessary to get to Net Zero</td>
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**HERS Rating**
- Typically = 85; Historic bldg. exception = 100
- No specific #; based on Energy Star reference home
- HERS Score = 0

**ACH @ 50 Pascals**
- Unit types range 8 – 15; No Req.
- Not Available
- Buildings range 1.3 - 1.7; No Req.

**Renewable Energy?**
- Not required
- Not required
- Necessary to get to Net Zero

**Durability & Health Benefits**
- Comprehensive prescriptive point system, e.g. storm water management; low VOC products; water efficiency
- Non-prescriptive, Living Building Petals
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<td>No specific #; based on Energy Star reference home</td>
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<td>Not applicable; modeled differently (would be 30 or less)</td>
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<td>Unit types range 8 – 15; No Req.</td>
<td>Not Available</td>
<td>Buildings range 1.3 - 1.7; No Req.</td>
<td>0.05 CFM50 / sf (variable)</td>
</tr>
<tr>
<td><strong>Renewable Energy?</strong></td>
<td>Not required</td>
<td>Not required</td>
<td>Necessary to get to Net Zero</td>
<td>Frequently included, but not required</td>
</tr>
<tr>
<td><strong>Durability &amp; Health Benefits</strong></td>
<td>Comprehensive prescriptive point system, e.g. storm water management; low VOC products; water efficiency</td>
<td>Non-prescriptive, Living Building Petals</td>
<td>Non-prescriptive, but best practices result in high IAQ</td>
<td></td>
</tr>
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</table>
Comparing Certification Metrics in Affordable Multifamily Housing

Enterprise Green Communities
WinnCompanies – At A Glance

- We are the 5th largest multifamily management company in the nation with 121 million square feet under management.

- WinnCompanies is the largest privately held management company; owning and managing real estate holdings valued at approximately $14 Billion.

- We operate multifamily housing in urban, suburban and metro markets nation-wide. Our assets include luxury high rise, mid-rise, historic re-use and garden style residences totaling more than 100,000 units in more than 580 apartment communities.

- We operate in 22 states and have 3,000 employees, including 318 veterans.
Sustainability Initiatives

• **Green Building Certification:** All acquisitions, rehabs, and new developments embrace sustainability.

• **Deep Energy Retrofits:** Completed the nation's largest deep energy retrofit at Castle Square, saving more than 50 percent of energy usage.

• **Better Buildings Challenge:** U.S. Department of Energy Better Buildings Challenge partner, committed to saving 20% energy usage across portfolio within the next decade.

• **Green Financing:** Developing effective models to finance energy improvements in affordable multifamily housing.

• **Solar Power:** Leading the multifamily industry in solar power development, transforming rooftops into power plants with more than 2 megawatt of PV installed.

WinnGreen Case Study: Castle Square | Boston, MA

Our $125mm+ reconstruction of the 500 unit property won multiple industry awards, including Best Urban Tower and Best Urban Low Rise.

Former U.S. Secretary of HUD remarked the development “made history” as “the largest ‘deep’ green retrofit ever undertaken in the United States”.

WinnCompanies
Development / Residential / Military
Enterprise Green Communities: What and Why?

Enterprise Green Communities Certification Categories

- Integrative Design
- Operations, Maintenance + Resident Engagement
- Healthy Living Environment
- Materials
- Energy Efficiency
- Location + Neighborhood Fabric
- Site Improvements
- Water Conservation

A holistic approach to building a green community

meet mandatory criteria

35
optional points
NEW CONSTRUCTION

30
optional points
SUBSTANTIAL & MODERATE REHABILITATIONS
Enterprise Green Communities: What and Why?
EGC Impact

Standard Mod Rehab:
- Capital Needs
- Deferred Maintenance
- Compliance w/ Code & QAP

With EGC:
- Capital Needs
- Integrated approach
- Comprehensive green specs
- Resident and O&M manuals
- Performance and Data Driven
- Energy Modeling (HERS Index or ASHRAE 90.1)
Performance Drivers:
- Blower doors → air sealing
- Duct blasters → aeroseal

Prescriptive:
- LED, WaterSense, FloorScore, low-VOC
- Resident Manuals and Orientations
- Utility Monitoring: owner and tenant
- Resiliency and health
Applicable for low-rise multifamily with individual HVAC. EGC requires ASHRAE modeling for mid-rise/high-rise

Model Factors: insulation, fenestration, air leakage, unit area, fuel efficiency, etc

New construction vs existing building vs historic carve out?

HERS of 85 is approximately equivalent to 2009 IECC and 100 is approximately equal to 2006 IECC

A HERS Index of zero indicates zero net energy (ZNE).
The Atlantics

Atlantic Terrace – 195 units

Atlantic Terrace – 108 units
The Atlantics - Scope

Atlantic Terrace – 195 units
- Kitchens, baths, flooring
- High Efficiency Lighting
- Energy Star Appliances
- Air Sealing to <10 ACH50
- Duct sealing to <10%
- DHW: Energy Star Direct Vent

Atlantic Terrace – 108 units
- Kitchens, baths, flooring
- High Efficiency Lighting
- Energy Star Appliances
- Air Sealing to <15 ACH50
- A/C: 15 SEER
- Furnace: 95 AFUE
- DHW: Energy Star Direct Vent
- Window Upgrade: Energy Star Performance
Driving down HERS

<table>
<thead>
<tr>
<th>Energy Efficiency Opportunity</th>
<th>Electricity Savings (kWh)</th>
<th>Natural Gas Savings (therm)</th>
<th>Annual Cost Savings ($)</th>
<th>HERS Index Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanical Opportunities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 10 EER A/C (available in Magic Pak)</td>
<td>110-214</td>
<td>0</td>
<td>$10-17</td>
<td>2-4</td>
</tr>
<tr>
<td>2 13 SEER A/C (split system)</td>
<td>412-655</td>
<td>0</td>
<td>$34-52</td>
<td>7-11</td>
</tr>
<tr>
<td>3 15 SEER A/C (split system)</td>
<td>543-848</td>
<td>0</td>
<td>$44-67</td>
<td>10-14</td>
</tr>
<tr>
<td>4 90 AFUE Gas Furnace (split system)</td>
<td>25-131</td>
<td>15-24</td>
<td>$11-22</td>
<td>3-5</td>
</tr>
<tr>
<td>5 95 AFUE Gas Furnace (split system)</td>
<td>56-153</td>
<td>21-34</td>
<td>$16-33</td>
<td>4-7</td>
</tr>
<tr>
<td><strong>Hot Water Opportunities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Direct Vent Water Heater (Energy Star)</td>
<td>2.905-3.050 (140-145)</td>
<td>$163-164</td>
<td>4-5</td>
<td></td>
</tr>
<tr>
<td>7 On Demand Gas Water Heater (Energy Star)</td>
<td>2.905-3.050 (112)</td>
<td>$177-178</td>
<td>8-9</td>
<td></td>
</tr>
<tr>
<td><strong>Lighting Opportunities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 100% Fluorescent Lighting</td>
<td>882 (17)</td>
<td></td>
<td>$62</td>
<td>7</td>
</tr>
<tr>
<td><strong>Appliance Opportunities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Refrigerator (Energy Star)</td>
<td>406 (8)</td>
<td></td>
<td>$29</td>
<td>3</td>
</tr>
<tr>
<td>10 Dishwasher (Energy Star)</td>
<td>138 (1)</td>
<td></td>
<td>$11</td>
<td>1</td>
</tr>
<tr>
<td><strong>Diagnostic items (must be measured and based on actual performance)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Air sealing to 15 ACH (from 20 ACH)</td>
<td>1.440-2.125</td>
<td>$126-191</td>
<td>Up to 13</td>
<td></td>
</tr>
<tr>
<td>12 Duct Sealing to 10%</td>
<td>2.125-2.139</td>
<td>45-87</td>
<td>$191-213</td>
<td>Up To 13</td>
</tr>
</tbody>
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**EEO Description**

<table>
<thead>
<tr>
<th>EEO Description</th>
<th>HERS Impact</th>
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<tr>
<td>Blower Door (Infiltration)</td>
<td></td>
</tr>
<tr>
<td>10 ACH 50</td>
<td>13</td>
</tr>
<tr>
<td>12 ACH 50</td>
<td>11</td>
</tr>
<tr>
<td>14 ACH 50</td>
<td>8</td>
</tr>
<tr>
<td>16 ACH 50</td>
<td>6</td>
</tr>
<tr>
<td>18 ACH 50</td>
<td>3</td>
</tr>
<tr>
<td>Existing - 20 ACH 50</td>
<td>--</td>
</tr>
<tr>
<td><strong>Duct Blaster (duct leakage)</strong></td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>17</td>
</tr>
<tr>
<td>10%</td>
<td>14</td>
</tr>
<tr>
<td>20%</td>
<td>9</td>
</tr>
<tr>
<td>30%</td>
<td>4</td>
</tr>
<tr>
<td>Existing - 40%</td>
<td>--</td>
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</table>
Multiple pathways to achieve performance requirement

Assessment allows for flexibility based on costs comparison and other factors
Added costs due to:

AeroSealing to reduce duct leakage @ $1200/unit

Air Sealing runs $500-1000/unit depending on extent

New tankless DHW
Pre vs. Post Rehab: Energy Performance

- Pre-rehab HERS Index 120-135
- Final post rehab HERS Index 76-85

- 20 ACH\textsubscript{50} Air Infiltration
- 8-15 ACH\textsubscript{50} Air Infiltration

- 40% Duct Leakage
- <10% Duct Leakage
# Pre vs. Post Rehab: Utility Allowances

<table>
<thead>
<tr>
<th>Atlantic Terrace Utility Allowances</th>
<th>1-BR Electric</th>
<th>1-BR Gas</th>
<th>2-BR Electric</th>
<th>2-BR Gas</th>
<th>3-BR Electric</th>
<th>3-BR Gas</th>
</tr>
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<tr>
<td><strong>Pre-Rehab Actual</strong></td>
<td>$ 44.27</td>
<td>$ 29.58</td>
<td>$ 71.57</td>
<td>$ 31.56</td>
<td>$ 89.61</td>
<td>$ 39.19</td>
</tr>
<tr>
<td><strong>Post-Rehab Modeled</strong></td>
<td>$ 33.86</td>
<td>$ 20.47</td>
<td>$ 40.41</td>
<td>$ 25.25</td>
<td>$ 45.53</td>
<td>$ 32.30</td>
</tr>
<tr>
<td><strong>Savings</strong></td>
<td>24%</td>
<td>31%</td>
<td>44%</td>
<td>20%</td>
<td>49%</td>
<td>18%</td>
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## Pre vs. Post Rehab: Portfolio Manager

### Atlantic Terrace vs. Atlantic Gardens

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<tr>
<td>ENERGY STAR Score (1-100)</td>
<td>72</td>
<td>93</td>
<td>21.00 (29.20%)</td>
<td>53</td>
<td>89</td>
<td>36.00 (67.90%)</td>
</tr>
<tr>
<td>Source EUI (kBtu/ft²)</td>
<td>110.6</td>
<td>84.9</td>
<td>-25.70 (-23.20%)</td>
<td>127.8</td>
<td>90.8</td>
<td>-37.00 (-29.00%)</td>
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EGC drives quality and comprehensive approach to moderate and substantial renovations;

- Applicable to rehabs and new construction;
- Replicable owner driven process;
- Occupied rehab with existing hazards (ACM in walls);
- Budget restrictions always apply;
- Missed air sealing opportunities in occupied units.
Solar at Atlantic Terrace

How Community Solar Works for You

Solar Savings!

Community Solar
Solar facilities located across the District produce electricity.

Credit on Your Bill
Eligible residents sign up to have portion of the solar value automatically transferred to their monthly Pepco bill.

Clean Electricity
Solar electricity feeds into the grid, and Pepco calculates its dollar value each month.
Thank You

Darien Crimmin
dcgrimmin@winnco.com
Non-Profit Developer and Owner
Non-Profit Developer and Owner
**POAH’s Foray into Green Building Certifications**

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<th>Certification</th>
<th>Motivation</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>LEED Certifications: Platinum and Gold level</td>
<td>Grant Funds and City of Boston Requirement</td>
<td>Not our best performing buildings</td>
</tr>
<tr>
<td>Enterprise GC Rehab</td>
<td>Piloting for Company Wide Adoption</td>
<td>Tenants heating use down by 34%</td>
</tr>
<tr>
<td>Enterprise GC New Construction</td>
<td>QAP Points</td>
<td>Still Under Construction</td>
</tr>
<tr>
<td>Passive House</td>
<td>QAP Points (CT)</td>
<td>Under review for tax-credit funding</td>
</tr>
<tr>
<td>Net Zero Ready</td>
<td>Proof of concept for funders and in-house team</td>
<td>Still collecting data</td>
</tr>
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Net Zero Certifications

International Living Future Institute: Zero Energy Building Certification Standard:

100% of the Building’s Energy Needs Met on an Annual Basis by on-site renewable energy. No combustion is allowed.

- Created in 1917 as a partnership of ILFI and New Buildings Institute (NBI)
- Simple
- Metric has to be Verified, Certification not granted until a year of Net Zero has been achieved.

DOE Zero Energy Ready Home

- Similar to EGC uses a Provider and a Verifier to confirm construction is completed per the HERS model
- Program designed to allow builders and architects to certify their projects
- Energy Ready, renewable system not required for certification but building has to be solar ready.
Near Net Zero? Melpet Farm, Dennis, MA

27 Units in 8 buildings
Affordable Housing
Construction Cost Per Unit ~ $350,000
Solar PV: $500,000 (paid loan with SRECs and tax credits)
Near Net Zero: Initial Parameters

Base Case: Code Compliant
12 variations on the base case

- Final Case “Sweet Spot”
  - R-25 Walls, R-18 Basement Walls
  - .05 cfm/50/ssf
  - HRV per unit
  - Mini Split Heating and Cooling with One Cassette and supplemental heating in Bedrooms
  - R-5 Windows, SHGC .56
  - Unit electric loads 14,400 kWh
  - Total kBtu per building 67,710
  - Solar Production 17 kW sized to offset total kBtu

* Heating and DHW as modeled would be half the plug loads modeled
**Near Net Zero: What Changed**

**Base Case: Code Compliant**

12 variations on the base case

- Final Case “Sweet Spot”
  - R-25 Walls, R-18 Basement Walls
  - Removed Basements in all but One Building
  - Changed HPWHs to standard electric DHW
  - .05 cfm/50/ssf
  - Lunos with Bath Exhaust (minimal recovery)
  - VRF per Building with Heads in each room and resistance heater in bathrooms
  - R-5 Windows, SHGC .56
  - Unit electric loads 14,400 KWH
  - 17 kw solar per building
  - Building Average total 130,000 kBTU without solar according to HERS model
Air Tightness: results were “not bad”

Target was .05 cfm50/cf
Results ranged from .06 to .08
Annual kBtu Consumption per Building:

- Results varied by building, but overall, actual has been lower than targeted.
- Actual is about half way between the NZ target and HERS target.
Solar Production: Meeting Targets

Targeted annual renewable energy production in kWh

Actual Solar Production in KWh Jan - Dec 2017

No big surprise on building 7 given orientation
Solar Production Per Month: Only Hitting Half of the Total Load

TOTAL MELPET ELECTRIC CONSUMPTION SUPPLIED BY SOLAR
OVERALL: 55%
Who is living in Building 9?
Water usage was on target.....
Projected and Actual Data: Per Unit Per Heat Pump Cassette

TOTAL ENERGY USED 3/1/18 THRU 3/5/18 (KWH)

A weeks worth of data, what can this level of data tell us?
1. Are plug loads the culprit?
2. Are the cassettes set to maximize efficiency?
3. Do we need cassettes in each room?
Lessons Learned

Lessons learned:

1. The three Cs:
   a. **Cost**, balance cost with what you can achieve getting to Net Zero or PH and
   b. **Contractors**, Don’t stop with integrative design, do integrative construction, involve
      subs in preconstruction meetings, diagnostic testing, and understanding goals
      of the project
   c. **Customers**, educate residents on the goals of the project and how to use equipment.
      This education has to be ongoing. What are the residents in Building 9 doing?

2. It takes some time to get things right including data collection

3. Maybe the 4th C is **Collect data**: the systems may not be working correctly including
   renewable systems or settings by residents so it is important to have access to data and
   take the time to look at it.

4. Use certifications that verify performance. Deemed savings without verification doesn’t
   move the market.
Thank you!

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617.449.1017
PH TEAM

ZA+D, LLC
MATT FINE, CPHC®, LEED AP®
• DIRECTOR, ZA+Dpassiv
• SENIOR PROJECT MANAGER, ZA+D, LLC

PASSIVE TO POSITIVE
MICHAEL HINDLE, CPHC®,
• PASSIVE HOUSE CONSULTANT
FORMER PRESIDENT, BOARD OF MANAGERS
PASSIVE HOUSE ALLIANCE – UNITED STATES

HAMEL BUILDERS
TERESA HAMM, CPHC®,
• PROJECT MANAGER
CPHB®, HERS

THC, AFFORDABLE HOUSING
BLAISE RASTELLO
• DIRECTOR OF AFFORDABLE HOUSING

Passive to POSITIVE
PASSIVE HOUSE AND LOW IMPACT DESIGN

THC, Housing Families, Transforming Lives
WEINBERG COMMONS
A PASSIVE HOUSE RETROFIT TALE OF EPIC PROPORTIONS
A LONG, LONG TIME AGO IN SE, D.C.
NEIGHBORHOOD & HOMELESSNESS

Washington, D.C. Metro Area Homelessness, 2011
Point-In-Time Count Estimates of the Homeless Population

Rate of Homelessness
- 5 - 11
- 12 - 21
- 22 - 109

Source: HOMELESSNESS RESEARCH INSTITUTE
DEVELOPER ETHICS

- **TRUE AFFORDABILITY:** health, comfort and economic stability

- **HEALTH:** Good IAQ assured

- **COMFORT:** Comfortable by design, naturally and easily

- **FINANCIAL STABILITY:** Low and reliable cost through efficiency – no spikes – very predictable
PROJECT BACKGROUND

- (3) BLDGS. / 36 (2) BR UNITS
- 675 NRSF EA.
- PARTIAL BASEMENT / CRAWL SPACE
- (3) STORIES

NON-DESCRIPT SENSE OF PLACE

WASTEFUL, INAPPROPRIATE, AND OUT-DATED SYSTEMS
PROJECT BACKGROUND

UNHEALTHY INTERIOR ENVIRONMENT

LOW-TECH, UN-INSULATED BUILDING ENCLOSURE
AN ORDINARY RENOVATION?

REPAIR- UPGRADE FINISHES, MINIMAL IF ANY INSULATION

NO MANAGEMENT OF CONDENSATION PLANE TEMPERATURES -

MOLD GROWTH STILL ASSURED!!

Dew point of interior air = @ 52.5°F

The entire furred out cavity is below dew point of interior air! @ 53°F
UNINSULATED MAISONRY?

COMFORT FACTORS?
Air temp
RH
Air velocity
Mean radiant surface temps
ENTER: THE PH RETROFIT
ELIMINATE LOSS:
(almost!)

CONTINUOUS INSULATION DEFINING THE THERMAL ENVELOPE
ENVELOPE
DESIGN +
OCCUPANT
HEALTH

RETROFIT-
MANAGE
CONDENSATION PLANE
TEMPERATURES –

THIS WALL WILL NOT
GROW MOLD

Dew point of interior air = @ 52.5°F

The entire masonry structure is above the dew-point of interior air. Layers outside masonry wall are vapor open.
CASE STUDY:
CONSTRUCTION PROCESS
ESTIMATING – HOW DO YOU PRICE SOMETHING NONE OF “YOUR GUYS” EVER HEARD OF??

“PUT IN IN THE DRAWINGS AND I’LL PRICE IT”

“We’re gonna put this out on the street.”

“Well it is not as robust, but if you are sure it will save us real money we can go with . . .”

“My guys have never done this- they way under-bid it”

PRE-CONSTRUCTION MODEL/PROCESS

“Hey, could you give us some cost feedback on assemblies options?”

“Get all your “A-Team” subs in here and we will explain it all before they price it.”

“That mineral wool and Prosoco are un-godly expensive - you gotta get that outta there”

“Why is this an add? I thought you said the mineral wool and Prosoco were ungodly expensive”
PRE-CONSTRUCTION
CHALLENGES

SUBCONTRACTOR
BUY-IN
• EXIST. PLASTER OVER GYPSUM BD. SUBSTRATE & VERTICAL 1X FURRING

• BRICK & CMU BACK-UP

• 9 ½” WD. ‘I’-JOISTS @ 24” O.C., MECHANICAL ATTACH. @ 36” O.C., STAGGERED

• FLUID-APPLIED AIR AND WATER RESISTIVE BARRIER

• 8” MINERAL WOOL INSULATION @ 6 LB./CU. FT. DENSITY

• HORIZONTAL 5/4 WD. FURRING @ 18” O.C., STAGGERED

• 5/8” FIBER CEMENT CLADDING ON PROPRIETARY CLIPS
• 5/8" FIBER CEMENT CLADDING ON PROPRIETARY CLIPS
• EXIST. PLASTER OVER GYP. BD. SUBSTRATE & VERT. 1X FURRING
• BRICK & C MU BACK-UP
• 9 1/2" WD. ‘I’-JOISTS @ 24" O.C., MEC H. ATTACH. @ 36" O.C., STAGGERED
• 2.2 LBS./C U. FT. DENSITY SPRAY-APPLIED FIBERGLASS
• REINF. WRB SERVES AS AIR-TIGHT LAYER
• VERT. 2 3/8" W. AIR SEALING TAPE
• HORIZ. 5/4 WD. FURRING @ 18" O.C., STAGGERED
• 5/8" FIBER CEMENT CLADDING ON PROPRIETARY CLIPS

LESS ROBUST AND HARDER TO BUILD

POST “VE” ENCLOSURE
THE ROOF RETROFIT: AN AIR SEALING AND SEQUENCING CHALLENGE
THE ROOF RETROFIT: AN AIR SEALING AND SEQUENCING CHALLENGE
CREATING THE INSULATION CAVITY
AIR-TIGHTNESS:
NOW TO THE EXTERIOR

DEFINING THE AIR-TIGHTNESS LAYER:
NO DRAFTS REDUCES LOW HUMIDITY IN WINTER
REDUCES EXCESS HUMIDITY IN SUMMER
DETAILS AS A RESULT OF “VALUE-ENGINEERING”
CHALLENGES WITH BUILDING...CAPILLARY...
CHALLENGES WITH BUILDING ...AND HYDROSTATIC MOISTURE...
UTILIZE HARDY CONTROL LAYERS
CRAWLSPACE INSULATION AND VAPOR CONTROL SEQUENCE
CRAWLSPACE INSULATION AND VAPOR CONTROL SEQUENCE
CONSTRUCTION CHALLENGES

COORDINATION INTENSITY

WHININGBERG LIST

- Typical Bath layouts
- Kitchen Layouts (ELEVATIONS)
- HVAC Submittals Approved
- ELEC Submittals Due
- Tub Surround Submittal
- Foam Block R Value + Thickness BRC
- EXT Block Hollow Needs to be filled for orders
- Foam Block Type + Thickness Bold C Sheet
- EDC Bain Ref
- GAS LINES ARE HOT + NEED TO BE REMOVED
- DELTA Accessories Submittals Issued
- 3/4 vs 1" Window Framing
- Stool Dimensions
- 2 hr Shaft Division
CONSTRUCTION CHALLENGES

SUBSTITUTION REQUESTS
CONSTRUCTION CHALLENGES

TEMPORARY MATERIAL PROTECTION AND SEQUENCE
CONSTRUCTION CHALLENGES

LACK OF SUBCONTRACTOR CONTROL
CONSTRUCTION CHALLENGES

INSTALLATION QUALITY

"TRUST, BUT VERIFY" - EVERYTHING
FIELD CONDITION

CHALLENGES

MOCK-UP
FIELD CONDITION

CHALLENGES

MOCK-UP
AHH....
ASSIMILATION

CONSTRUCTION
CHALLENGES
RESULTS:

SMALL SYSTEMS, LOW LOADS
IMPROVED COMFORT
AFFORDABILITY
REDUCED CARBON LOAD
PASSIVE MEASURES MATTER!

ASYMMETRICAL LOADS AND COMFORT RISKS
SOLAR GAIN
WHEN YOU WANT IT
SHADING WHEN YOU DON’T
SHOULDER SEASON - warm

Solar Gain / cooling August

Heating / Cooling [kWh/m²]
IT WORKS
ONE WEEK POWER OUT IN DECEMBER:
HIGH PERFORMANCE ENVIRONMENT MAINTAINS COMFORT AND SAFETY
ONE WEEK POWER OUTAGE IN JULY:
INTERNAL HEAT GAINS AND SOLAR GAIN DRIVE INCREASE IN TEMPERATURES
ONE WEEK POWER OUTAGE IN JULY:

BUT . . .

THAT IS WHEN WE HAVE SOLAR AVAILABLE
RESULTS:
DEEP ENERGY REDUCTIONS

ENERGY
- 6KBTU/SF.YR EUI
- 2988 KW/OCUPANT PER YEAR PRIMARY ENERGY
- ___% REDUCED ENERGY DEMAND FROM BENCHMARK MODEL

THE FIRST PASSIVE HOUSE, RETROFIT APARTMENT BUILDING IN THE US
PROJECTED SAVINGS OF CASES:
EXISTING, MINIMAL, MODERATE, AS BUILT

percent of total cost ($7,003,330.00)

- design 5.71%
- construction 84.41%
- Energy+Water Green premiums 7.91%
- other green premiums 1.41%
- certification .07%
- permits 1.78%

bar chart showing site and source energy kWhr for baseline pre-retrofit, Case 1 minimal retrofit, Case 2 moderate retrofit, Case 3a as built retrofit no PV, Case 3b as built.
COST OF GREEN MEASURES:
PASSIVE MEASURES vs. RENEWABLES - - $ / kWh SAVED

- design premium 4.22%
- renewable energy 27.36%
- Passive and design related energy and water measures 50.68%
- other green measures 16.8%

green measures related cost
$592,000.00
QUESTIONS?

THANK YOU

QUESTIONS?
## Characteristics of Metrics in 3 Case Studies

<table>
<thead>
<tr>
<th></th>
<th>Enterprise Green Communities</th>
<th>Zero Net Energy Ready</th>
<th>Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROJECT TYPE</strong></td>
<td>2 Properties, Major Rehab</td>
<td>1 Property w/ 8 buildings, New Construction</td>
<td>1 Property w/ 3 buildings, Major Rehab</td>
</tr>
<tr>
<td><strong>Achieved HERS rating</strong></td>
<td>Range 78 - 85</td>
<td>Buildings range 0 - 32</td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Achieved ACH @ 50 Pascals</strong></td>
<td>Unit types range 8 - 15</td>
<td>Buildings range 1.3 - 1.7</td>
<td>Average 0.6, ranging from 0.5 – 0.7</td>
</tr>
<tr>
<td><strong>Renewable Energy?</strong></td>
<td>Solar added on 1 property afterwards</td>
<td>Yes, was included</td>
<td>Yes, was included</td>
</tr>
<tr>
<td><strong>Durability &amp; Health Benefits</strong></td>
<td>Reduced toxins; added on-site rainwater retention with bio-swales</td>
<td>Envelope retained heat during 4-day winter power failure; design drove high IAQ</td>
<td>Removed moisture problems with ERV and added moisture barrier within building envelope</td>
</tr>
</tbody>
</table>