April 13, 2017
Call Slides and Discussion Summary
Agenda

- Agenda Review and Ground Rules
- Opening Polls
- Brief Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - Danny Parker, Principal Research Scientist, Florida Solar Energy Center
  - Ian Hammon-Hogan, Research Manager, BIRAenergy
- Discussion
  - How has your organization incorporated deep retrofits or considered near-zero energy use in home retrofits?
  - What challenges have you encountered? What strategies have helped your program overcome challenges?
  - What advice or recommendations can you offer for how residential energy efficiency programs can move into the deep energy retrofit space and increase demand for zero energy ready homes?
  - Other questions/issues related to zero energy ready homes?
- Closing Poll
Better Buildings Residential Network: Connects energy efficiency programs and partners to share best practices and learn from one another to increase the number of homes that are energy efficient.

Membership: Open to organizations committed to accelerating the pace of home energy upgrades.

Benefits:
- Peer Exchange Calls 4x/month
- Tools, templates, & resources
- Recognition in media, materials
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- Residential Program Solution Center guided tours

Commitment: Provide DOE with annual number of residential upgrades, and information about associated benefits.

For more information or to join, email bbresidentialnetwork@ee.doe.gov, or go to energy.gov/eere/bbrn and click Join
Peer Exchange Call Series

We hold one Peer Exchange call the first four Thursdays of each month from 1:00-2:30 pm ET

Calls cover a range of topics, including financing & revenue, data & evaluation, business partners, multifamily housing, and marketing & outreach for all stages of program development and implementation

Upcoming calls:

- April 27: Just What the Doctor Ordered: Integrating Health Benefits into Energy-Efficiency Programs
- May 4: Multifamily-Focused Network Collaborations
- May 18: Innovation Station: The Latest Advances in Energy Efficiency Technology

Send call topic ideas to peerexchange@rossstrategic.com
See the Better Buildings Residential Network Program website to register
Program Experience: Florida Solar Energy Center
RETROFIT TOWARDS ZERO: Results in Monitored Florida Homes

Danny Parker
Karen Sutherland, Dave Chasar and Eric Martin

Ultimate Retrofit: Zero Energy Ready Homes
Better Buildings Network Peer Exchange
April 13, 2017

A Research Institute of the University of Central Florida
FSEC and Building America

- Goal: Near Zero Energy w/large reductions in existing homes
- BA: detailed monitoring of energy reduction opportunities
- Appeal to utilities: real world evaluation of performance measures and technologies both energy & peak
- Phased Deep Retrofit (PDR) Project: partnership with FPL targeting retrofit packages – shallow & deep, and advanced technology
  - Shallow: Largely lighting & water heating measures; low cost; pass thru
  - Deep: Major equipment (HPs & HPWH), envelope measures, appliances
- Evaluate and measure consumer acceptance and interactions (e.g. what are realistic savings of connected thermostats)
- Enthusiastic homeowners used retrofits as springboard to zero
It’s Complicated: Mix & Size of End-Uses at Each Site Unique
Cooling Largest Energy End-Use

- Average Home Total = 44.1 kWh/day; 16,080 kWh/year

No single end-use dominates; Conventional loads (space heat/cool & water heat) only 45% of total; lighting & plug loads large difficult to address category
What Makes Up the Peak Load?

Peak Load: 5:00pm

Electricity by End Use, Daily Demand Profile
All Houses, Jan 1, 2013 to Dec 31, 2013
<table>
<thead>
<tr>
<th>Component</th>
<th>Original</th>
<th>Shallow Retrofit</th>
<th>Deep Retrofit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy</td>
<td>3 adults (2 permanent, 1 periodic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>CMU walls, average 10.6 ft ceilings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td>Slab-on-grade / 2,554 ft²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attic/roof</td>
<td>Vented / light colored asphalt shingle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows</td>
<td>Double glazed mix of clear/tint pane, metal/vinyl frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attic Insulation</td>
<td>R-19</td>
<td>R-38</td>
<td></td>
</tr>
<tr>
<td>Space conditioning</td>
<td>SEER 10</td>
<td>SEER 16</td>
<td>2-speed, heat pump</td>
</tr>
<tr>
<td></td>
<td>5-ton heat pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermostat</td>
<td>Manual</td>
<td>Nest thermostat</td>
<td></td>
</tr>
<tr>
<td>Water heater</td>
<td>50-gal Electric resistance</td>
<td>Tank/pipes insulated (R3), 2 new showerheads</td>
<td>80-gal, Heat pump water heater</td>
</tr>
<tr>
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<tr>
<td>Appliances</td>
<td>Refrigerator, dishwasher, washer/dryer</td>
<td>Energy efficient washer</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>89 Lamps, 3.39kW</td>
<td>89 Lamps, 1.53kW</td>
<td></td>
</tr>
<tr>
<td>Envelope Leakage</td>
<td></td>
<td>6.51 ACH @50Pa</td>
<td></td>
</tr>
<tr>
<td>Duct leakage</td>
<td>0.09 Qn, out</td>
<td>0.05 Qn, out</td>
<td></td>
</tr>
</tbody>
</table>
Site 19 – Shallow Retrofit Savings: Water Heating and Lighting Energy

Daily Energy (kWh/day)

- Water Heater
- Other Power

Shallow Retrofit (4/17/13)

Water Heater Savings – 11%
(1.5kWh/day)

Lighting Savings 0.65kWh/day

FLORIDA SOLAR ENERGY CENTER — A Research Institute of the University of Central Florida
Site 19 – Deep Retrofit Savings: Cooling Energy Use

51% Savings (week pre/post) (from 77 to 38 kWh/day)
Site 19 – Deep Retrofit Savings:
Water Heating Energy

80% Overall Savings
(from 14 to 3 kWh/day)
Site 19 – Retrofit Effects on Whole House Power

Whole House Power at Site 19

- Shallow retrofit
- HVAC
- HPWH
- Insulation
- Washer/Dryer

Electric Energy kWh/day

September 2012 - July 2014

FLORIDA SOLAR ENERGY CENTER — A Research Institute of the University of Central Florida
Site 19 – Measured Savings & Simulated PV Output (Beopt)

Whole House Power at Site 19

- 2013
- 2014
- 10kW PV output (south-facing)
- 10kW PV output (west-facing)

Electric Energy kWh/day

January - July

Deep Retrofit Aug-Nov, 2013
Shallow Retrofit 4/17/2013

FLORIDA SOLAR ENERGY CENTER — A Research Institute of the University of Central Florida
Site 19 – Whole House Power (including PV) Sep-2012 to Aug-2016

Whole House Power

Electric Energy kWh/day

Shallow Retrofit

Deep Retrofit

Whole House Power


PDR019BLDPWR  PDR019BLDPWC
Site 19 – Average Daily Load Profiles

Pre retrofit: 2012-2013, 72kWh
Post retrofit: 44kWh
Post+PV: Net 13kWh
PV Output: 31 kWh/day
Retrofit to Zero: Site #19 Example

- **Site 19** – Measured annual consumption reduced by 47%
  - From 24,483 to 12,862 kWh/year

- Summertime consumption from April – August, 2013 vs. 2014 dropped from 87 to 46 kWh/day

- Retrofit measures include:
  - Efficient lighting
  - Added attic insulation
  - Heat pump water heater
  - Duct sealing
  - High-efficiency heat pump
  - Smart thermostat
  - Heat pump clothes dryer

- **10 kW PV system installed April 2015:**
  - Avg net electricity use of 13 kWh/day w/ PV system output (31 kWh/day) — an **82% reduction towards zero energy**
Phased Deep Retrofit: Conclusions

• Findings from a detailed field metering FL pilot study point to home energy savings retrofit packages:
  – Shallow (9% savings; 1356 kWh/yr)
  – Deeper retrofits (38% savings; 7067 kWh/yr)
  – Hi performance Technologies that enable Zero Energy Home

• Planning Stages for Large-scale study in California
  – How will existing CA homes to reach Net Zero Energy?
  – Realistic assessment of smart metering load disaggregation
  – Evaluation of PV across geography & electrical storage
  – Legacy sample for long-term tracking of consumption trend
    • What are emerging loads?
Thank you

Danny Parker, Karen Sutherland

FOR MORE INFORMATION: LINKS:

Papers:
Presentation Highlights: Florida Solar Energy Center (1 of 2)

- **There's not one single magic bullet:** an integrated package with multiple energy efficiency measures is needed to achieve zero energy homes.
  - At one of the sites, Florida Solar Energy Center (FSEC)’s Phased Deep Retrofit (PDR) study achieved an average of 82% reduction of energy use through both shallow and deep upgrades (solar photovoltaic included).

- **Home energy technologies are fast evolving** (e.g. mini split heat pumps, smart thermostats), thus creating an opportunity for even greater savings and expansion of zero energy homes.

- **Solar PV systems are often the next step in the process:**
  - In some cases, the high energy savings encouraged PDR participants to go even further and add a solar PV system.
Key project features and results:

- **FSEC’s PDR** study was funded by the U.S. Department of Energy (DOE). **Average costs were:**
  - **Shallow retrofits:** ~$375 per home.
  - **Deep retrofits:** ~ $14,300 per home.

- **Payback period:** Shallow retrofits had a short payback period of ~2 – 2.5 years, while deeper retrofits of ~10.5 years.
  - The homeowner had to be in the market to replace their HVAC system to qualify for the study, which reduced the payback period.

- **Not all measures proved to be cost-effective.**
  - FSEC found that the change of refrigerator, for example, didn’t yield significant energy savings.
  - The biggest expenses involved upgrading the heat pump, pool pump, and/or water heater.
Program Experience: BIRAenergy
THE VERY EFFICIENT RETROFIT PACKAGE AT BEECHWOOD, IN LANCASTER, CALIFORNIA

A Replicable & Scalable Method to Design Energy Efficient Retrofit Packages for Low-Income Multifamily Buildings

Ian Hammon-Hogan
Research Manager
Project Partners

CEC PIER program
Dustin Davis, Project Manager

EPRI
ELECTRIC POWER RESEARCH INSTITUTE
Ram Narayananurthy
Peng Zhao

Southern California Gas Company
Ahmed Abdullah
Jeff Horn
Joe Shiau
Jack Chen

LINC Housing
Samara Larson
Mandy Wang

EDISON
J erine Ahmed
Ron Kliwer

biraenergy
Rob Hammon
Ian H. Hammon
The Beechwood Community

4: 10-Plex’s
2: 8-Plex’s
22: Duplex’s
1: Community Center
Baseline Features

• Site Visit
Calibrated BEopt Models
## Calibrated BEopt Models

- **MELs Survey**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ELECTRIC USE</th>
<th>QUANTITY</th>
<th>FREQUENCY OF USE</th>
<th>ADDITIONAL INFORMATION</th>
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<tr>
<td>APLIANCES</td>
<td>OVEN</td>
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<td>REFRIGERATOR</td>
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<td>MICROWAVE</td>
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<td>COFFEE MAKER</td>
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<td>TOASTER OVEN</td>
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<td>WAFFLE IRON</td>
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<td>BLENDER</td>
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<td>ELECTRICAL GRILL/GRIDDLE</td>
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<td>DEEP FRYER</td>
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<td>SLOW COOKER/CROCK POT</td>
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<td>HAIR DRYER</td>
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<td>CURLING IRON</td>
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<td>ELECTRIC SHAVER</td>
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<td>ELECTRONICS/ENTERTAINMENT</td>
<td>TELEVISION</td>
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<td>DVD PLAYER/VCR</td>
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<td>VIDEO GAMING SYSTEM</td>
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<td>CLOCK RADIO</td>
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<td>HOME STEREO/PORTABLE STEREO</td>
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<td>SUBWOOFER</td>
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<td>CABLE BOX</td>
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<td>CABLE/DSL MODEM</td>
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<td>COMPUTER - LAPTOP</td>
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<td>COMPUTER - DESKTOP</td>
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<td>PRINTER</td>
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<td>CHARGER - CELL PHONE</td>
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<td>CHARGER - DIGITAL CAMERA</td>
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<td>CHARGER - MP3 PLAYER</td>
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<td>MISCELLANEOUS</td>
<td>MEDICAL EQUIPMENT</td>
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<td>FISH TANK</td>
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<td>CEILING FAN</td>
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<td>THERMOSTAT</td>
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<td>BATHROOM HEATER</td>
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<td>ELECTRIC SPACE HEATER</td>
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<td>FAN (PORTABLE)</td>
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<td>AIR CLEANER</td>
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<td>HEATING PADS</td>
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<td>CLOTHES IRON</td>
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<td></td>
<td>BABY MONITOR</td>
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Baseline Features

- Site Visit

<table>
<thead>
<tr>
<th>Modeling Parameter</th>
<th>Beechwood Base Case Package</th>
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<tbody>
<tr>
<td>Miscellaneous Electric Load</td>
<td>1273 kWh/year per unit</td>
</tr>
<tr>
<td>Attic Insulation</td>
<td>Ceiling Assembly U-Factor = 0.1220</td>
</tr>
<tr>
<td>Roof Material</td>
<td>Light colored gravel (Absorptivity = 0.75, Emissivity = 0.91)</td>
</tr>
<tr>
<td>Window Types</td>
<td>Double pane, metal frame (E Factor = 0.76, SGHC = 0.67)</td>
</tr>
<tr>
<td>Air Leakage</td>
<td>14.1 ACH50</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>Top-mounted freezer, 480 kWh/year</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>318 kWh/year</td>
</tr>
<tr>
<td>Lighting</td>
<td>100% Incandescent Lighting</td>
</tr>
<tr>
<td>Air Conditioner</td>
<td>12 SEER</td>
</tr>
<tr>
<td>Furnace</td>
<td>80% AFUE</td>
</tr>
<tr>
<td>Ducts</td>
<td>32% Leakage, Uninsulated</td>
</tr>
<tr>
<td>Water Heater</td>
<td>Multiplex: Shared portion of 100gal Boiler (0.80 EF)</td>
</tr>
<tr>
<td></td>
<td>Duplex: 40gal Storage (0.62 EF)</td>
</tr>
</tbody>
</table>
Calibrated Models: Pre-Retrofit

Average Consumption for 2 Bed 8-Plex vs. Simulated Consumption of Units in Building

- **Actual Use** (Bill Data)
- **Simulated Use**

Month of Year

Kilowatt-hours (kWh)

Avg Consumption for 2Bed in 8-Plex, Monitored

Building 1, Avg kWh per unit, Base, Simulated
Calibrated Models: Pre-Retrofit

Beechwood Units & Common Area Natural Gas Use, As-Built, Measured vs Simulated

- **Simulated Use**
- **Actual Use (Bill Data)**

Therms Used

Month of Year

- **Simulated**
- **Monitored**
Development of EE Package

• Sensitivity Analysis
## Development of EE Package

### Impacts of Individual Features

<table>
<thead>
<tr>
<th>Single Feature Replacement #</th>
<th>Base Case Single Feature Replacement Package</th>
<th>Source Energy Use (s-Mbtu/yr)</th>
<th>% Source Energy Savings</th>
<th>Cost of Feature</th>
<th>Cost : Benefit ($/kBtu)</th>
<th>Annual Estimated Change in Utility Bill</th>
<th>Simple Payoff (Years)</th>
<th>Used in Initial VER Packages?</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>R-20 XPS Roof</td>
<td>179.2</td>
<td>22%</td>
<td>$ 4,871</td>
<td>$ 0.10</td>
<td>$ 453</td>
<td>11</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>Ducts in Conditioned Space</td>
<td>180.0</td>
<td>21%</td>
<td>$ 4,871</td>
<td>$ 0.10</td>
<td>$ 448</td>
<td>11</td>
<td>Y</td>
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<tr>
<td>3</td>
<td>R8 Ducts, 7.5% Leakage</td>
<td>187.6</td>
<td>18%</td>
<td>$ 1,949</td>
<td>$ 0.05</td>
<td>$ 378</td>
<td>5</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>3.0 ACH50</td>
<td>203.7</td>
<td>11%</td>
<td>$ 2,214</td>
<td>$ 0.09</td>
<td>$ 210</td>
<td>11</td>
<td>Y</td>
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<tr>
<td>5</td>
<td>56 sqft SHW</td>
<td>214.5</td>
<td>6%</td>
<td>$ 2,885</td>
<td>$ 0.20</td>
<td>$ 102</td>
<td>28</td>
<td>Y</td>
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<tr>
<td>6</td>
<td>8.4 ACH50</td>
<td>215.6</td>
<td>6%</td>
<td>$ 1,476</td>
<td>$ 0.11</td>
<td>$ 111</td>
<td>13</td>
<td>Y</td>
</tr>
<tr>
<td>7</td>
<td>0.29 / 0.31 Windows</td>
<td>216.2</td>
<td>5%</td>
<td>$ 5,140</td>
<td>$ 0.41</td>
<td>$ 104</td>
<td>49</td>
<td>N</td>
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<tr>
<td>8</td>
<td>Duct Sealing</td>
<td>216.8</td>
<td>5%</td>
<td>$ 2,406</td>
<td>$ 0.20</td>
<td>$ 108</td>
<td>22</td>
<td>Y</td>
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<tr>
<td>9</td>
<td>R-13, Gr. 1, Cellulose Walls</td>
<td>217.8</td>
<td>5%</td>
<td>$ 4,826</td>
<td>$ 0.44</td>
<td>$ 98</td>
<td>49</td>
<td>N</td>
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<tr>
<td>10</td>
<td>Radiant Barrier</td>
<td>218.8</td>
<td>4%</td>
<td>$ 494</td>
<td>$ 0.05</td>
<td>$ 98</td>
<td>5</td>
<td>N</td>
</tr>
<tr>
<td>11</td>
<td>R13, Gr. 3, Cellulose Walls</td>
<td>218.5</td>
<td>5%</td>
<td>$ 4,826</td>
<td>$ 0.47</td>
<td>$ 92</td>
<td>53</td>
<td>N</td>
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<tr>
<td>12</td>
<td>100% LED</td>
<td>219.7</td>
<td>4%</td>
<td>$ 1,045</td>
<td>$ 0.11</td>
<td>$ 113</td>
<td>9</td>
<td>Y</td>
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<tr>
<td>13</td>
<td>16 SEER AC (2-Stage)</td>
<td>222.5</td>
<td>3%</td>
<td>$ 1,200</td>
<td>$ 0.19</td>
<td>$ 86</td>
<td>14</td>
<td>N</td>
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<tr>
<td>14</td>
<td>0.95 EF Tankless Condensing DHW</td>
<td>223.5</td>
<td>2%</td>
<td>$ 910</td>
<td>$ 0.17</td>
<td>$ 48</td>
<td>19</td>
<td>Y</td>
</tr>
<tr>
<td>15</td>
<td>0.21 / 0.21 Windows</td>
<td>224.4</td>
<td>2%</td>
<td>$ 5,188</td>
<td>$ 1.18</td>
<td>$ 36</td>
<td>143</td>
<td>N</td>
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<tr>
<td>16</td>
<td>Cool Roof</td>
<td>224.7</td>
<td>2%</td>
<td>$ 1,476</td>
<td>$ 0.36</td>
<td>$ 56</td>
<td>27</td>
<td>N</td>
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<tr>
<td>17</td>
<td>EnergySTAR Frig &amp; DW</td>
<td>226.8</td>
<td>1%</td>
<td>$ 1,934</td>
<td>$ 0.97</td>
<td>$ 23</td>
<td>86</td>
<td>Y</td>
</tr>
<tr>
<td>18</td>
<td>2013-T24 Low Slope Roof</td>
<td>227.7</td>
<td>1%</td>
<td>$ 4,871</td>
<td>$ 2.77</td>
<td>$ 29</td>
<td>169</td>
<td>N</td>
</tr>
<tr>
<td>19</td>
<td>Home Energy Management Syste</td>
<td>227.6</td>
<td>1%</td>
<td>$ 600</td>
<td>$ 0.50</td>
<td>$ 15</td>
<td>41</td>
<td>Y</td>
</tr>
<tr>
<td>20</td>
<td>2 Smart, Premium Ceiling Fans</td>
<td>229.6</td>
<td>0%</td>
<td>$ 800</td>
<td>$(0.99)</td>
<td>$(9)</td>
<td>96</td>
<td>N</td>
</tr>
<tr>
<td>21</td>
<td>Induction Cooktop</td>
<td>230.7</td>
<td>-1%</td>
<td>$ 1,879</td>
<td>$(1.07)</td>
<td>$(32)</td>
<td>58</td>
<td>N</td>
</tr>
<tr>
<td>22</td>
<td>6 Smart, Premium Ceiling Fans</td>
<td>231.1</td>
<td>-1%</td>
<td>$ 2,400</td>
<td>$(1.08)</td>
<td>$(28)</td>
<td>86</td>
<td>N</td>
</tr>
</tbody>
</table>
VERs Package Installation

• Final Package Recommendations

<table>
<thead>
<tr>
<th>Feature</th>
<th>Beechwood VER Case Model Package Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Miscellaneous Electric Load</strong></td>
<td>Home Energy Management System and Communicating Tstats (est 12% MELS savings)</td>
</tr>
<tr>
<td><strong>Attic Insulation</strong></td>
<td>Additional 7&quot; blown fiberglass in est. 1/4 of ceiling area</td>
</tr>
<tr>
<td></td>
<td>R-15 (ballasted) or R-20 XPS (on Building 3 only)</td>
</tr>
<tr>
<td><strong>Air Leakage</strong></td>
<td>3.0 ACH50 (1.5 SLA)</td>
</tr>
<tr>
<td><strong>Refrigerator</strong></td>
<td>Top-mounted freezer, EnergySTAR, 348 kWh/year</td>
</tr>
<tr>
<td><strong>Dishwasher</strong></td>
<td>EnergySTAR, 290 kWh/year</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>100% LED</td>
</tr>
<tr>
<td><strong>Ducts</strong></td>
<td>Ducts in Conditioned Space, 6% leakage</td>
</tr>
<tr>
<td><strong>Water Heating</strong></td>
<td>Multiplex: SHW with first 100gal Boiler backup 0.94 EF</td>
</tr>
<tr>
<td></td>
<td>Duplex: 0.96 EF tankless condensing DHW</td>
</tr>
</tbody>
</table>
VERs Package Installation
Estimating the Savings Against Control Group

- Behavior Changes with the weather
Calibrated Models: Post-Retrofit
VERS: Very Efficient Retrofit

~25% Electrical Savings

~50% Gas Savings

<table>
<thead>
<tr>
<th></th>
<th>$ Saved Per Year</th>
<th>Rate</th>
<th>Cost</th>
<th>Simple Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>$4,280</td>
<td>$0.92</td>
<td>$368,281</td>
<td>86</td>
</tr>
<tr>
<td>Electric</td>
<td>$7,194</td>
<td>$0.165</td>
<td>$368,281</td>
<td>N/A</td>
</tr>
<tr>
<td>Total EE</td>
<td>$11,474</td>
<td>N/A</td>
<td>$368,281</td>
<td>32</td>
</tr>
<tr>
<td>PV</td>
<td>$19,390</td>
<td>$0.165</td>
<td>$331,800</td>
<td>N/A</td>
</tr>
<tr>
<td>Gas + PV</td>
<td>$23,671</td>
<td>N/A</td>
<td>$700,081</td>
<td>30</td>
</tr>
<tr>
<td>EE + PV</td>
<td>$30,864</td>
<td>N/A</td>
<td>$700,081</td>
<td>23</td>
</tr>
</tbody>
</table>
Capture All the Savings

• Ideally, Financial Incentives should be Equally Available to all Fuel Types

• With Combined Gas & Electrical Savings, the VERs can be cost-effective in 23 years or less
## Additional Details

### The Community Center Retrofit

<table>
<thead>
<tr>
<th>Feature Category</th>
<th>Base Case (Unimproved Features)</th>
<th>Very Efficient Retrofit (VER) Package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wall Insulation and Framing</strong></td>
<td>R-8 Fiberglass Batt, 2x4, 16 in o.c.</td>
<td>R-8 Fiberglass Batt, 2x4, 16 in o.c.</td>
</tr>
<tr>
<td><strong>Wall Sheathing</strong></td>
<td>OSB</td>
<td>OSB</td>
</tr>
<tr>
<td><strong>Exterior Finish</strong></td>
<td>Stucco, Light</td>
<td>Stucco, Light</td>
</tr>
<tr>
<td><strong>Attic Insulation &amp; Type</strong></td>
<td>Ceiling R-19 Fiberglass, Vented</td>
<td>Ceiling R-19 Fiberglass, 3” SPF (R18), Vented</td>
</tr>
<tr>
<td><strong>Roof Type &amp; Material</strong></td>
<td>Flat roof, gravelled</td>
<td>Flat roof, gravelled</td>
</tr>
<tr>
<td><strong>Radiant Barrier</strong></td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Window Type</strong></td>
<td>Double-Pane, Clear, Metal Frame</td>
<td>Double-Pane, Clear, Metal Frame</td>
</tr>
<tr>
<td><strong>Air Leakage</strong></td>
<td>10 ACH50</td>
<td>7 ACH50 (Aeroseal)</td>
</tr>
<tr>
<td><strong>Mechanical Ventilation</strong></td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Central Air Conditioner</strong></td>
<td>SEER 14</td>
<td>SEER 14, with economizer</td>
</tr>
<tr>
<td><strong>Furnace</strong></td>
<td>Gas, 80% AFUE</td>
<td>Gas, 80% AFUE</td>
</tr>
<tr>
<td><strong>Ducts</strong></td>
<td>30% Leakage, Uninsulated</td>
<td>7.5% Leakage, R-4</td>
</tr>
<tr>
<td><strong>Smart Thermostat?</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Water Heater</strong></td>
<td>Gas, 100gal tank, 0.62 EF</td>
<td>Gas, 100gal tank, 0.62 EF</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Uninsulated, TrunkBranch, Copper</td>
<td>Uninsulated, TrunkBranch, Copper</td>
</tr>
<tr>
<td><strong>Lighting</strong></td>
<td>100% CFL</td>
<td>100% LED</td>
</tr>
<tr>
<td><strong>Refrigerator</strong></td>
<td>Standard Efficiency, 19 cu ft</td>
<td>Standard Efficiency, 19 cu ft</td>
</tr>
<tr>
<td><strong>Cooking Range</strong></td>
<td>Gas, Conventional</td>
<td>Gas, Conventional</td>
</tr>
<tr>
<td><strong>Dishwasher</strong></td>
<td>318 Annual kWh</td>
<td>318 Annual kWh</td>
</tr>
<tr>
<td><strong>Clothes Washer</strong></td>
<td>In Laundry Room</td>
<td>In Laundry Room</td>
</tr>
<tr>
<td><strong>Clothes Dryer</strong></td>
<td>Gas. In Laundry Room</td>
<td>Gas. In Laundry Room</td>
</tr>
</tbody>
</table>
Additional Details

• The Community Center Retrofit
Additional Details

• The Community Center Retrofit
Additional Details

- Asbestos Abatement was costly
BIRAenergy used a building energy simulation program to identify a customized package of cost-effective zero energy measures for properties participating in the study.

- This also allowed BIRAenergy to provide a cost estimate for retrofits, since the project targeted low-income families.
- To calibrate the building simulation model, BIRAenergy administered resident energy use surveys and used utility bill data provided by the electrical companies.
- The building model was similar to the real energy savings, with only about ~7% error.
- BIRAenergy’s modeling was done using the Building Energy Optimization (BEopt) software.
Presentation Highlights: BIRAenergy (2 of 2)

- **One at a time:** Energy upgrade measures were implemented gradually, which allowed BIRAenergy to evaluate the impact of each intervention on energy savings.
  - Able to meet 99% of electrical needs by installing an 80kWH solar PV system.
  - Duct replacement contributed to natural gas savings.

- **Controlling for behavior change:** Because the pilot occurred at a multi-family property, applying deep retrofits to a limited number of units created a natural control group of units that did not receive retrofits. Comparing the energy use differences allowed the researchers to confirm that the reductions were not a result of changes in resident behavior.

- **Payback:** For both electrical and gas savings, the payback period is estimated to be ~ 23 years.
Explore resources related to best practices on upgrades for zero energy ready homes:

- View this [webinar](https://rpsc.energy.gov) providing an overview of the Zero Energy Ready Home program, including the business case and how to be recognized by DOE.
- Read this [case study](https://rpsc.energy.gov) of a DOE Zero Energy Ready Home: Mantell-Hecathorn Builders, Durango, CO.
- Learn about how Enhabit used performance-based incentives to encourage deeper savings in this [case study](https://rpsc.energy.gov).

- Check out the latest [Proven Practices](https://rpsc.energy.gov) post on [Keeping the Program Simple](https://rpsc.energy.gov).
- The Solution Center is continually updated to support residential energy efficiency programs—[member ideas are wanted](https://rpsc.energy.gov)!
Additional resources

- **Building Energy Optimization (BEopt) software**
  - This software was used by BIRAenergy in their building energy simulation. BEopt has been developed by the National Renewable Energy Laboratory in support of the U. S. Department of Energy’s (DOE) Building America program. It provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero net energy. BEopt uses EnergyPlus, DOE’s simulation engine.

- **Vermont’s Zero Energy Now Program**
  - This program delivered 22 single-family home deep energy retrofit projects in 2016 as part of Green Mountain Power’s (GMP) Community Energy & Efficiency Development (CEED) Program. The program was implemented by the Building Performance Professionals Association of Vermont (BPPA) and Energy Futures Group (EFG).
2017 Better Buildings Summit is one month away!

Be sure to register today for the 2017 Better Buildings Summit!

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#BBSummit17 registration is right around the corner. Get ready to learn about expert #EnergyEfficiency enhancements http://bit.ly/2iZCMsB
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**Better Buildings LinkedIn**

We can't wait to hear from you!
Oct 5-15, 2017  DENVER

- 13 Collegiate teams compete in 10 contests
  - New for 2017: Innovation and Water
- Winning team best blends technology, market potential, design excellence with smart energy solar production and maximum energy and water efficiency.
- Large free public event – showcases best of clean energy technology
- Denver location: new, mixed use smart community on transit line near Denver International Airport
- Sponsorship Opportunities

Credit: Thomas Kelsey/U.S. Department of Energy Solar Decathlon
Addenda: Attendee Information and Poll Results
Call Attendee Locations
Call Attendees: Network Members

- Alaska Housing Finance Corporation
- AppleBlossom Energy Inc.
- Build It Green
- Center for Sustainable Energy
- City of Berkeley
- City of Fort Collins
- City of Kansas City
- CLEAResult
- Earth Advantage Institute
- Efficiency Nova Scotia
- Efficiency Vermont
- Energy Efficiency Specialists
- Enhabit
- Katsujinken Foundation

- FMC Facility Management Consultores
- Fort Collins Utilities
- LEDVANCE
- La Plata Electric Association
- Mitsubishi Electric Cooling and Heating
- New York State Energy Research & Development Authority (NYSERDA)
- Ryan Taylor Architects, LLC
- Seventhwave
- South Burlington Energy Committee
- Stewards of Affordable Housing for the Future
- TRC Energy Services
Call Attendees: Non-Members (1 of 3)

- AEMEP Group
- Arizona State University
- BIRAenergy
- Brooklyn Green Home Solutions Inc
- BSHM Architects, Inc.
- Canadian Home Builders' Association (CHBA)
- Carlisle Companies
- CASE - RPI
- California Institute of Environmental Design and Management (CIEDM)
- City of Vancouver
- Clallam County
- Construction Services Group of Educational Service District 112
- Coolearth Architecture Inc.
- County of San Diego
- CSRA
- Dimensions-Energétiques
- Eden Housing
- Efficiency Maine Trust
- Enbridge Gas Distribution
- Energy Futures Group Inc.
Call Attendees: Non-Members (2 of 3)

- Energy Management Services
- Energy Solutions
- Environmental Design / Build
- Florida Solar Energy Center
- Franklin Energy
- Frontier Energy, Inc.
- Greater Minnesota Housing Fund
- Green Compass Consulting
- Greenbanc
- Greenergy Realty
- HILCO Electric Cooperative Inc.
- Homecrete Homes
- Honeywell
- ID3A, LLC
- Intelligent Technology Services
- Local Government Commission
- Low Energy Edge Node Analytic Laboratories
- Lutron Electronics
- Madison Gas & Electric Company
- Madison Lakeview LLC
- Massachusetts Department of Energy Resources
Call Attendees: Non-Members (3 of 3)

- NANA Regional Corporation, Inc.
- Nexant
- U.S. National Park Service
- Natural Resources Canada
- National Renewable Energy Laboratory
- Office of Energy Resources (Rhode Island)
- Oregon Institute of Technology
- People's Self Help Housing
- Philip Neumann Energy Design
- Power Integrations, Inc.
- PV Blue
- RE/MAX Alliance
- San Francisco Department of the Environment
- Sierra Business Council
- Sim2
- Simkus Development LLC
- Solar Habitats, LLC
- Sustainable Buildings Canada
- The Energy Experts
- Transition Living
- University of Kansas
- University of Minnesota
Opening Poll #1

Which of the following best describes your organization’s experience with zero energy ready homes?

- Some experience/familiarity – 59%
- Limited experience/familiarity – 24%
- Very experienced/familiar – 11%
- No experience/familiarity – 3%
- Not applicable – 3%
Closing Poll

- After today's call, what will you do?
  - Seek out additional information on one or more of the ideas – 66%
  - Consider implementing one or more of the ideas discussed – 26%
  - Make no changes to your current approach – 8%
  - Other (please explain) – 0%