What’s Next in Zero Energy: Multifamily, Residential, and Other Trends

Wednesday, July 10
3:30 PM – 5:00 PM
Speakers

- Jamie Lyons, Newport Partners
- Martha Campbell, Rocky Mountain Institute (RMI)
- Moderator: Eric Werling, DOE
Introduction:
A Growing Movement to Zero Energy

ZER0
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Climate Mobilization Act

Study Finds Green Home Building Continues to Gain Traction
Introduction: Single & Multifamily; New & Existing
Resources: Building America Solution Center

... at Your Finger Tips

2,700,000 Served!
>350,000 users

- Best Practices
- Case Studies
- Program Checklists
- Research Reports
- Building Science Advisor
- Home Improvement Expert
- Sales Tool
- Mobile Field Kit
Jamie Lyons
Newport Partners
What’s Next for Zero Energy
Better Buildings 2019 Summit
1. All Signs Point to Zero
2. What is Zero
3. Why Zero
4. How to Build Zero
5. Resources
Zero Energy Ready Home

All Signs Point to Zero
ZERH Certifications

- **2013 to 2018**
- **Annual**
- **Cumulative**

- **3,000+ Homes**
- **2X, Past 3 Years**

- **2013**: 0
- **2014**: 0
- **2015**: 0
- **2016**: 0
- **2017**: 0
- **2018**: 3,000+
Zero Residential Units

2015
2016
2017

100% Growth

Zero Builder Commitment

Built or Plan to Build a Net Zero, Near Net Zero, or Net Zero Ready Home

Source: Dodge Data & Analytics, October 2017
Mayors from 19 cities around the world signed a pledge to enact regulations and/or planning policy to ensure new buildings operate at net zero carbon by 2030 and all buildings by 2050.

Source: Smart Energy Decisions
States Implementing/Planning Zero Codes:

• California
• Oregon
• Puerto Rico
• Washington
• New York
Zero for Affordable Housing

States Leveraging DOE Zero Energy Ready Home in Low Income Housing Tax Credit Plans:

- Delaware
- Georgia
- New Jersey
- Pennsylvania
- Washington DC
Zero Energy Ready Home

What is Zero
Energy Efficiency Related Risks

1. Moisture Damage
2. Ensured Comfort
3. Ensured Indoor Air Quality
Risk #1: Moisture Damage

Colder Surface →

More Efficient Enclosure

Cold Side

Less Efficient Enclosure

Warm Side

Thermal/Air Flow

More Wetting, Less Drying

Less Wetting, More Drying
Risk #2: Ensured Comfort

More Efficient Enclosure

Less Efficient Enclosure

Thermal/Air Flow

Cold Side

Warm Side

Less Air Flow, Longer Swing Seasons

More Air Flow, Shorter Swing Seasons
Risk #3: Ensured IAQ

More Efficient Enclosure

Cold Side

Thermal/Air Flow

Less Efficient Enclosure

Warm Side

Thermal/Air Flow

More Accumulated Contaminants

Less Accumulated Contaminants
Zero = Comprehensive Strategy

<table>
<thead>
<tr>
<th>Step One: Optimize Efficiency</th>
<th>Step Two: Do No Harm</th>
<th>Step Three: Ensure Zero Ready</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Efficient Enclosure</td>
<td>Comprehensive Water Protection</td>
<td>Solar Ready Construction</td>
</tr>
<tr>
<td>Energy Efficient Components</td>
<td>Ensured Comfort System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comprehensive Indoor Air Quality</td>
<td></td>
</tr>
</tbody>
</table>
Zero Energy Ready Home Orientation

Why Zero
Why Zero: Better Experience

Zero Lives Better

$10,000’s Savings
Cozy Indoors
Total Comfort
Healthy Living
Peace-of-Mind
Quality Assurance
Future Ready
Why ZERH: Cost Effective

<table>
<thead>
<tr>
<th>ZER Incremental Cost</th>
<th>Houston (C22)</th>
<th>Atlanta (C23)</th>
<th>Baltimore (C24)</th>
<th>Chicago (C25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortgage Threshold (30 Years)</td>
<td>$10,900</td>
<td>$15,384</td>
<td>$22,905</td>
<td>$26,919</td>
</tr>
<tr>
<td>Resale Threshold (12 Years)</td>
<td>$5,576</td>
<td>$7,903</td>
<td>$11,835</td>
<td>$10,472</td>
</tr>
<tr>
<td>Consumer WTP (4%)</td>
<td>$9,139</td>
<td>$9,690</td>
<td>$10,130</td>
<td>$13,874</td>
</tr>
<tr>
<td>First Cost Threshold (0%)</td>
<td>$0</td>
<td>$0</td>
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</tr>
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<tr>
<td>Mortgage Threshold (30 Years)</td>
<td>$26,715</td>
<td>$35,927</td>
<td>$49,118</td>
<td>$49,144</td>
</tr>
<tr>
<td>Resale Threshold (12 Years)</td>
<td>$13,367</td>
<td>$18,245</td>
<td>$24,945</td>
<td>$23,063</td>
</tr>
<tr>
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<td>$9,139</td>
<td>$9,690</td>
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Source: ‘The Economics of Zero Energy Homes: Single Family Insights,’ Rocky Mountain Institute, 10/18
Why ZERH: Builder Business Case

• **Less Liability**
  – Customer Satisfaction
  – Customer Service Costs
  – Risk Management (3rd-party verification)

• **Market Differentiation**
  – Key Competition (Existing, Code, ENERGY STAR)
  – New Sales Force (Homebuyers)
2030 Projected Impacts:*

• ~$150 Billion Utility Bill Savings
• ~1 Million Job-Years of Work
• ~1,100 MMTCe <Carbon Emissions

* Impacts based on internal DOE analysis assuming 30% high-performance new homes by 2030
Zero Energy Ready Home

How to Build Zero
The East Lift from ENERGY STAR to Zero
The Easy Lift to ZERH…

<table>
<thead>
<tr>
<th>IECC 2012 Enclosure</th>
<th>HERS 70-80</th>
<th>IECC 2012</th>
<th>ENERGY STAR v3</th>
<th>IECC 2012 Enclosure</th>
<th>HERS 65-75</th>
<th>HERS 55-65</th>
<th>ENERGY STAR v3.1</th>
<th>ZERH</th>
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<td>HVAC QI with WHV</td>
<td>Water Management</td>
<td>Independent Verification</td>
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<tr>
<td>Eff. Comps.&amp; H₂O Distrib.</td>
<td>EPA Indoor Air Package</td>
<td>Optimized Duct Location</td>
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</table>
Typical DOE ZERH-Compliant HERS Index by Climate Zone

Based on 1800, 2400, and 3600 ft² prototypes on climate-appropriate foundations.
ZERH Threshold Pervasive

• 236,000+ HERS Ratings
• 61 Avg. HERS Index
• ~85,000 Homes Ready for ZERH

Source: “Demand for HERS Continues to Grow: Over 236,000 Homes HERS Rated in 2018,” RESNET blog, January 17, 2019
The Easy Lift to ZERH…

<table>
<thead>
<tr>
<th>IECC 2012</th>
<th>IECC 2009</th>
<th>IECC 2012</th>
<th>IECC 2015</th>
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<td>Enclosure</td>
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- Solar Ready
- Eff. Comps. & H₂O Distrib.
- EPA Indoor Air Package
- Optimized Duct Location
- Independent Verification

- IECC 2012
- ENERGY STAR v3
- ZERH
### 2015 IECC Prescriptive Requirements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Fenestration</th>
<th>Slab R-Value &amp; Depth</th>
<th>Basemt Wall R-Value</th>
<th>Floor R-Value</th>
<th>Ceiling R-Value</th>
<th>Wood Frame Wall R-Value</th>
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<tbody>
<tr>
<td></td>
<td>U-factor</td>
<td>SHGC</td>
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<td>30</td>
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<td>20 or 13+5</td>
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The Easy Lift to ZERH…

**Solar Ready**
- Eff. Comps. & H₂O Distrib.
- EPA Indoor Air Package
- Optimized Duct Location

**Water Management**
- HVAC QI with WHV
- Water Management
- Independent Verification

**Independent Verification**
- IECC 2012 Enclosure
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- HERS 65-75
- HERS 55-65
- HERS 48-55

**Energy Star**
- ENERGY STAR v3
- ENERGY STAR v3.1
- ZERH

Pre-requisite for DOE ZERH
### The Easy Lift to ZERH...

#### IECC 2012
- **Enclosure**: HVAC QI with WHV
- **Water Management**: Independent Verification
- **HERS 70-80**

#### IECC 2009
- **Enclosure**: HVAC QI with WHV
- **Water Management**: Independent Verification
- **HERS 65-75**

#### ENERGY STAR v3
- **HERS 55-65**

#### ENERGY STAR v3.1
- **HERS 48-55**

#### ZERH
- **Solar Ready**
- **Eff. Comps. & H₂O Distrib.**
- **EPA Indoor Air Package**
- **Optimized Duct Location**

Each category is marked with a checkmark. **35** | **INNOVATION & INTEGRATION: Transforming the Energy Efficiency Market**
Options for Optimized Duct Location

- Ducts in Dropped Ceiling
- Ducts Between Floors
- Crawl Space/Basement
- Ducts in Conditioned Space
- Buried Ducts
  - Buried & SPF encapsulated (Humid Climates)
  - Buried (Dry Climates)
  - Buried (2018 IECC)
The Easy Lift to ZERH...

<table>
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<th>Pre-requisite for DOE ZERH</th>
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A Complete Efficiency Package covering IAQ

ENERGY STAR + Indoor airPLUS

Envelopes
HVAC
Moisture
CO

Radon
Pests
Materials
CO +
HVAC +
Moisture +

Comprehensive Indoor Air Quality Protection
The Easy Lift to ZERH...

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</table>
Components and MEL’s are increasingly larger part of total energy use in low-load homes (~50%).

Key:
- MEL’s
- Lighting & Appliances
- Heating & Cooling
- Hot Water
The Easy Lift to ZERH…

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Energy Efficiency & Renewable Energy

Buildings.Energy.gov

41 | INNOVATION & INTEGRATION: Transforming the Energy Efficiency Market
**Documentation** of the maximum allowable dead load and live load ratings of the existing roof (Rec DL.: +6 lbs./sq. ft.)

- **Conduit** to run DC wire from roof to inverter
- **Dedicated Area** for installing inverter and balance of system
- **Conduit** to run AC wire from inverter location to electric panel
- **Circuit Breaker** designated and/or installed for use by the PV system in the electric panel
Zero Energy Ready Home

Multifamily Provisions
Process for determining where a Multifamily project fits within ENERGY STAR...

Then...

Now....
## Integration with ENERGY STAR Multifamily New Construction

<table>
<thead>
<tr>
<th>Program</th>
<th>Eligible Building Types</th>
<th>Performance Basis</th>
<th>Addresses Common Spaces</th>
<th>Implementation Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY STAR Multifamily New Construction (V1, 1.1, 1.2)</td>
<td>Dwellings in any size MF building&lt;br&gt; In mixed use buildings, dwellings + common space must be &gt; 50% of total square footage</td>
<td>ERI Prescriptive ASHRAE</td>
<td>Yes</td>
<td>Available for use currently&lt;br&gt;Required for permit dates on/after 1/1/2021</td>
</tr>
<tr>
<td>DOE Zero Energy Ready Home – Multifamily</td>
<td>Same as ESMFNC, with a limit of 5 stories or less</td>
<td>ERI Prescriptive</td>
<td>Yes</td>
<td>Will be available for use Spring 2020</td>
</tr>
</tbody>
</table>
Zero Energy Ready Home

Resources
Technical Resources

• DOE Zero Energy Ready Home Program Requirements
• 20+ Tech Training Webinars
  – Getting Enclosures Right, Joe Lstiburek, BSC
  – Low Load HVAC, Greg Cobb, Energy Inspectors
• Fact Sheets
  – How to Find Low Emission Products
  – ZERH Savings & Cost Estimate
• Building America Solution Center
• 100+ ZERH Project Case Studies
Recognition Resources

- Zero Energy Ready Home Logo
- Customizable Resources
  - Dare to Compare Brochure
  - Dare to Compare Fact Sheet
  - Superior Experience Fact Sheets
  - Homeowner Manual
  - Drop-in Messaging
  - Drop-in Homebuyer Testimonials
- Housing Innovation Awards
- Tour of Zero
- Partner Locator

"No more trips to the hospital!!!"

Homeowner
For More Information

Web Site:
www.buildings.energy.gov/zero/

e-mail Contact:
zero@newportpartnersllc.com
REALIZE
Industrialized Retrofits for Multifamily Buildings
Martha Campbell | Better Buildings Summit
2019

Transforming global energy use to create a clean, prosperous, and secure low carbon future.
AGENDA

• REALIZE OVERVIEW
• RETROFIT MODEL
  – ENVELOPE SYSTEMS
  – MECHANICAL SYSTEMS
  – BUSINESS MODEL
• DOE PILOT
AGENDA

• REALIZE OVERVIEW
• RETROFIT MODEL
  – ENVELOPE SYSTEMS
  – MECHANICAL SYSTEMS
  – BUSINESS MODEL
• DOE PILOT
THE PROBLEM
A “MODERN” DAY RENOVATION
A SERVICE ANALOGY
THE SOLUTION
ENERGIESPRONG
ENERGIESPRONG: A MODEL OF INSPIRATION

Core offering: A net zero carbon retrofit bundle that is 1) affordable, 2) attractive, 3) ensures energy performance, and 4) can be delivered in less than two weeks.

- **Quality**: Net-zero energy homes with long performance warranties
- **Non-Intrusive**: Refurbishment within a week to 10 days
- **Affordable**: Financeable through energy cost savings
- **Look & Feel**: Attractive and comfortable homes
REALIZE: GOAL AND MISSION

REALIZE seeks to create a business model inspired by Energiesprong to catalyze industry to develop readily available, cost-effective, deep energy retrofits for the US residential market.
SOME OF OUR PARTNERS
AGENDA

• REALIZE OVERVIEW
• RETROFIT MODEL
  – ENVELOPE SYSTEMS
  – MECHANICAL SYSTEMS
  – BUSINESS MODEL
• DOE PILOT
ENVELOPE SYSTEMS
FACADE PANELS: A VARIETY OF SOLUTIONS
Panel Description:
- SIP panels made with fiberglass, OSB, graphite-infused foam, and waterproofing sealant material.
- Cut to meet 3D imaging model specifications by CNC machine
- Windows and doors installed into panel
- Exterior claddings applied to panel: stucco and STO brick veneer
FACADE INSTALLATION SITE PRE-WORK
RENOLUTION PROJECT
AGENDA

• REALIZE OVERVIEW
• RETROFIT MODEL
  – ENVELOPE SYSTEMS
  – MECHANICAL SYSTEMS
  – BUSINESS MODEL
• DOE PILOT
ENERGIESPRONG MECHANICAL SYSTEMS

• Retrofits are always all-electric

• The mechanical systems typically consists of:
  – heat pump (space heating and DHW)
  – ERV
  – solar panels & inverter
  – printed circuit board controls

• Systems are either distributed or centralized into one closet/unit

• The market was late to innovate on the mechanical side and more progress has been made on the facade systems
FACTORY ZERO INTEGRATED CLIMATE ENERGY MODULE (iCEM)

- PV Inverter
- Heat Pump (for DHW and space heating)
- Control Board and Thermostat
- Plumbing (behind control board and ducting)
- DHW Tank
- ERV

- Parts sourced from various OEMs and assembled on site
- Approximately 8 units assembled per week
- Working with Denzo to get standardized parts for next model
FACTORY ZERO PROJECT EXAMPLES
AGENDA

- REALIZE OVERVIEW
- NETHERLANDS FIELD TRIP
  - ENVELOPE SYSTEMS
  - MECHANICAL SYSTEMS
  - BUSINESS MODEL
- DOE PILOT
FINANCING
## COMPONENTS OF THE FINANCING CHALLENGE

<table>
<thead>
<tr>
<th>#1 Revenue Challenges (Source)</th>
<th>#2 Transaction Complexity (Source)</th>
<th>#3 Cost Issues (Uses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Project economics for deeper performance improvements don’t pencil out due to an inability for owners to capture more rent through adjustments in the utility allowance</td>
<td>• Affordable housing capital stack is complex with many conflicting strings and interests attached</td>
<td>• Suppliers need sight to a pipeline to commit R&amp;D investment</td>
</tr>
<tr>
<td>• A handful of lenders underwrite to 75%-80% of the savings, none underwrite up to 100%</td>
<td>• Poor policy alignment or coordination amongst government agencies disincentive stated government carbon reduction goals</td>
<td>• Large volumes of organized demand needed to negotiate and drive down costs</td>
</tr>
<tr>
<td></td>
<td>• Utility incentive programs are disaggregated and can have limiting cost-effectiveness requirements</td>
<td>• Greater organization along the value chain, helps reduce cost and mark-ups</td>
</tr>
</tbody>
</table>
DUTCH SOLUTION FOR CHALLENGE #1: REVENUE

CONVERT UTILITY BILLS INTO A REVENUE STREAM FOR BUILDING OWNERS
DUTCH SOLUTION FOR CHALLENGE #2: COMPLEXITY

THREE LAYER CAPITAL STACK WITH A 40 YEAR INVESTMENT HORIZON

<table>
<thead>
<tr>
<th>CAPITAL STACK</th>
<th>Description</th>
</tr>
</thead>
</table>
| 15% Subsidy   | - National Step Subsidy ~ 6,000 Euro per unit  
                - Heat Pump Subsidy ~ 1,700 Euro |
| 40% Housing Association Debt | - Housing associations were privatized as non-profits in 1995 by the Dutch government and absolved of debt  
                                   - Housing associations then created a pool of funds all members can borrow from at an extremely low cost of capital, some loans as low as 1% over 40 years |
| 45% Additional Debt | - 40 year performance warranty from contractor ensures savings  
                        - Housing Association Fund guarantees the borrowing of all their members  
                        - Government serves as an additional backstop should the Housing Association Fund become insolvent  
                        - Average ROI sought is ~5.25% |
DUTCH SOLUTION FOR CHALLENGE #3: COSTS

AGGREGATE LARGE VOLUMES OF DEMAND TO NEGOTIATE PRICES
DUTCH SOLUTION FOR CHALLENGE #3: COSTS

GCs ORGANIZE A COMPLEX VALUE CHAIN TO PRODUCTIZE THEIR OFFERING

UPSTREAM

Product Supplier
Component Supplier
1st Tier Supplier/Co-developer
2nd Tier Supplier

INDUSTRY

2nd Tier Supplier
1st Tier Supplier/Co-developer
Interior Systems Supplier
MEP System Supplier
Roof System Supplier
Facade Supplier

Concept Owner
Service
Sales Channel
Customer

DOWNSTREAM

Original Equipment Manufacturer (General Contractor)
Assembly
Service after installation

Energiesprong
Local Government
Local Installation Company
Developer

RAW MATERIALS

Customer
AGENDA

• REALIZE OVERVIEW
• RETROFIT MODEL
  – ENVELOPE SYSTEMS
  – MECHANICAL SYSTEMS
  – BUSINESS MODEL
• DOE PILOT
DOE PROJECT OVERVIEW

US DEPARTMENT OF ENERGY BUILDING AMERICA PROGRAM FOA-0001630


Desired Project Outcome:
Develop a standardizable, transferable, climate zone specific net zero energy ready retrofit system, designed with at least a 50% lower energy use intensity relative to the measured baseline energy performance
DOE TEAM SELECTION PROCESS

https://www.rmi.org/our-work/buildings/realize/rfps/
PILOT BUILDING SELECTED

440 TREMONT STREET, BOSTON, MA - WINN COMPANIES
PILOT BUILDING NEXT STEPS

• Develop panel and mechanical system designs

• Conduct costing exercise including energy savings

• Finalize pilot building designs to include panel and mechanical system products

• Kick off construction in Q1 2022

Centria panel examples
THANK YOU

FOR MORE INFORMATION VISIT
WWW.RMI.ORG/REALIZE OR EMAIL US AT
REALIZE@RMI.ORG
Thank You

Provide feedback on this session in the Summit App!

Download the app to your mobile device or go to event.crowdcompass.com/bbsummit19