U.S. DOE Zero Energy Ready Home & the Year Ahead

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Today’s Topics

1. The Year Ahead – 10,000’ View
2. DOE ZERH Program Updates
3. Getting Started with DOE ZERH
Poll

Who’s in the audience today?

a. Energy raters
b. Builders
c. Utilities
d. Others
U.S. DOE Zero Energy Ready Home

The Year Ahead - 10,000’ View
DOE Zero Energy Ready Home at a Glance

• Leading U.S. homebuilders are invested in DOE ZERH for market recognition and distinction

• 53% annual average growth

• National production builders starting to adopt

• Part of federal recognition system for high-performance, energy-efficient new homes

• Highest energy efficiency of federal labels, targeted performance benefits, and PV readiness
DOE Zero Energy Ready Home Staff

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DOE ZERH Program Participation is Growing

Federal Programs:
- ESSFNH;
- ESMFNC;
- Indoor airPLUS;
- HUD

Affordable Housing Programs (i.e., QAPs)

Green & sustainable building programs (i.e., EGC, LEED, NGBS, PHIUS)

Utility EE Programs

Innovative Pilot Programs (i.e., Connected Communities)
**DOE ZERH is Leveraged by Affordable Housing, Utility, State, & Green Financing Programs**

<table>
<thead>
<tr>
<th>Affordable Housing</th>
<th>State &amp; Utility Rebates</th>
<th>Codes</th>
<th>Green Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>CenterPoint (TX)</td>
<td>Boulder, CO</td>
<td>Fannie Mae</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Dominion Energy (UT)</td>
<td>Oregon 2023</td>
<td>Federal Home Loan Bank of NY</td>
</tr>
<tr>
<td>Delaware</td>
<td>Eversource (CT)</td>
<td>RI Stretch Code</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td>NJ (statewide)</td>
<td>Summit County, CO</td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td>Oncor (TX)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td>Rhode Island (statewide)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington D.C.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Plus Federal 45L Tax Credit for Energy Efficiency New Homes:**

DOE ZERH has been proposed as an upper tier, $5k tax credit for 45L starting in 2022.
Step One: Optimized Efficiency
- Enclosure
- Equipment
- Appliances / Lighting

Step Two: Optimized Performance
- Water Protection
- Ensured Comfort
- Indoor Air Quality

Step Three: Future Ready
- Solar Ready Construction
- Align with Latest Codes
Federal certification programs work together to provide a recognition system for residential new construction built to higher standards of performance and lead the way to zero emission homes.

- **EPA’s ENERGY STAR SFNH**: great starting point for builders on their journey to building above-code, high-performance, energy-efficient homes

- **DOE’s Zero Energy Ready Home V2**: step-up program for builders that brings higher levels of energy efficiency and additional specific provisions for improved building envelope performance

- **EPA’s new certification (TBD)**: program for builders that want to take the next step towards decarbonization / electrification, along with higher levels of energy efficiency

- Certify to **DOE’s Zero Energy Ready Home OR EPA’s new certification OR BOTH**
Federal certification programs work together to provide a recognition system for residential new construction built to higher standards of performance and lead the way to zero emission homes.

- **EPA's ENERGY STAR SFNH**: great starting point for builders on their journey to building above-code, high-performance, energy-efficient homes
  - 10% more energy efficient than adopted state code

- **DOE's Zero Energy Ready Home V2**: step-up program for builders that brings higher levels of energy efficiency and additional specific provisions for improved building envelope performance
  - 20% more energy efficiency than 2021 IECC (nationwide)
  - ENERGY STAR v3.2 and Indoor airPLUS certifications are prerequisites
  - Requires more efficient duct and hot water system designs, a complete package of IAQ protections, and PV readiness

- **EPA's new certification (TBD)**: program for builders that want to take the next step towards decarbonization / electrification, along with higher levels of energy efficiency
  - 10% more energy efficient than 2021 IECC (nationwide)
  - ENERGY STAR v3.2 certification is a prerequisite
  - Requires installation of connected heat pumps, connected HPWHs, induction cooking, and electric vehicle charging capabilities

- **Certify to DOE’s Zero Energy Ready Home or EPA’s new certification – or both**
  - Neither program is a prerequisite for the other
  - DOE and EPA are committed to continuing to work together to ensure that the Federal certification programs continue to evolve towards zero emission homes into the future
U.S. DOE Zero Energy Ready Home

Draft Program Updates
Why Zero Buildings

Buildings Share of Total U.S. Energy Use: **40%**

Buildings Share of Total U.S. Electricity Use: **75%**

Fossil Fuel Share of Total U.S. Electricity: **60%**

U.S. Share of Global Population: **4%**

U.S. Share of Global CO2 Emissions: **14% (3.5X)**
Eligible Building Types – Looking Ahead

- **Single-Family Detached**
  - Performance Compliance
  - ESSFNH Version 3.2 & IAP as prerequisites

- **Single-Family Attached**
  - ERI or Prescriptive Compliance
  - ESMFNC & IAP as prerequisites

- **Multifamily (Any Height)**
  - DOE ZERH – Version 2
  - DOE ZERH – Multifamily V1
DOE ZERH Requirements

### Optional Provisions

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Envelope</td>
<td>Ceiling, wall, floor, and gable insulation meet specified 2021 IECC levels.</td>
</tr>
<tr>
<td>3. Duct System</td>
<td>All ducts and heating and cooling in-place equipment are enclosed within the thermally natured envelope.</td>
</tr>
<tr>
<td>4. Water Heating Efficiency</td>
<td>Hot water delivery systems meet efficient design requirements.</td>
</tr>
<tr>
<td>5. Lighting &amp; Appliances</td>
<td>All lights in bathrooms, hallways, closets, and other areas are ENERGY STAR qualified.</td>
</tr>
<tr>
<td>6. Indoor Air Quality</td>
<td>Certified under: IEER Indoor AIRPLUS² or NERV 15 (minimum) filter installed in all ducted heating and cooling systems.</td>
</tr>
<tr>
<td>8. Neighborhood</td>
<td>Accessibility: Effective in future versions update of the DOE ZERH program, homes will integrate high efficiency systems, technologies, and measure for grid interactivity.</td>
</tr>
</tbody>
</table>

### Exhibit 2: DOE Zero Energy Ready Home Target Home

<table>
<thead>
<tr>
<th>HVAC Equipment</th>
<th>Very Hot &amp; Humid Climates (2021 IECC Climate Zones 1-12)</th>
<th>Warm &amp; Moderate Climates (2021 IECC Climate Zones 3-4 except North)</th>
<th>Cold &amp; Very Cold Climates (2021 IECC Climate Zones 5-8 and 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace AFUE</td>
<td>80%</td>
<td>80%</td>
<td>78%</td>
</tr>
<tr>
<td>CHP</td>
<td>16</td>
<td>15</td>
<td>16 (AHP)</td>
</tr>
<tr>
<td>Water pressure</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
</tr>
</tbody>
</table>

### ZERH System

<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
</tr>
</thead>
</table>
| Buffer 
APUC | 50% | 50% |
| Heat 
Recovery 
Mechanical Ventilation System Efficiency | 2.0 efficiency, no heat exchange | 2.0 efficiency, no heat exchange | 1.2 efficiency, balanced with heat exchange, 65% NOEE |

### DOE ZERH Targets

- **Target Home Sets the ERI**
# Building Envelope Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Envelope Insulation Levels</td>
<td>2015 IECC insulation levels for opaque areas</td>
<td><strong>2021 IECC insulation levels</strong> for opaque areas. Thermal breaks in walls in CZs 4-8.</td>
<td>Deliver most robust code-based building envelope with an additional, targeted provision for Above Grade Walls.</td>
</tr>
</tbody>
</table>
## 2021 IECC Insulation Values

<table>
<thead>
<tr>
<th>CZ</th>
<th>Ceiling</th>
<th>Wood-framed Wall</th>
<th>Mass Wall</th>
<th>Floor</th>
<th>Basement</th>
<th>Slab</th>
<th>Crawl Space Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>13 or 0+10</td>
<td>3/4</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>49</td>
<td>13 or 0+10</td>
<td>4/6</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>20 or 13+5 or 0+15</td>
<td>8/13</td>
<td>19</td>
<td>5/13</td>
<td>10, 2ft</td>
<td>5/13</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>20+5 or 13+10</td>
<td>8/13</td>
<td>19</td>
<td>10/13</td>
<td>10, 4ft</td>
<td>10/13</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>20+5 or 13+10</td>
<td>13/17</td>
<td>30</td>
<td>15/19 or 13+5</td>
<td>10, 4ft</td>
<td>15/19 or 13+5</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>30 or 20+5 or 13+10 or 0+20</td>
<td>15/20</td>
<td>30</td>
<td>15/19 or 13+5</td>
<td>10, 4ft</td>
<td>15/19 or 13+5</td>
</tr>
<tr>
<td>7/8</td>
<td>60</td>
<td>30 or 20+5 or 13+10 or 0+20</td>
<td>19/21</td>
<td>38</td>
<td>15/19 or 13+5</td>
<td>10, 4ft</td>
<td>15/19 or 13+5</td>
</tr>
</tbody>
</table>
## Envelope Efficiency Improvements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>2021 IECC UA Stringency Compared to DOE ZERH V1 UA Requirements A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ 0%</td>
</tr>
<tr>
<td>2</td>
<td>+ 5%</td>
</tr>
<tr>
<td>3</td>
<td>+16%</td>
</tr>
<tr>
<td>4</td>
<td>+8%</td>
</tr>
<tr>
<td>5</td>
<td>+8%</td>
</tr>
<tr>
<td>6</td>
<td>+1%</td>
</tr>
<tr>
<td>7</td>
<td>+1%</td>
</tr>
</tbody>
</table>

A. Based on 4 prototype models per Climate Zone: 1-story slab (CZ 1-3) or basement (CZ4+) foundation; 1-story crawlspace; 2-story slab or basement foundation (depending on CZ); 2-story interior TH unit on slab or basement foundation (depending on CZ)
## UA Tradeoffs Offer Flexibility

### Climate Zone 3
Two-Story, 2400 SF Home on Slab

<table>
<thead>
<tr>
<th></th>
<th>Slab Edge Insulation*</th>
<th>Above-Grade Walls</th>
<th>Window U / SHGC Factor</th>
<th>Ceilings</th>
<th>UA Tradeoff Complies?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021 IECC Prescriptive Requirement</td>
<td>R-10, 2’</td>
<td>R-20</td>
<td>0.30 / 0.25</td>
<td>R-49</td>
<td></td>
</tr>
<tr>
<td>UA Tradeoff Model</td>
<td>R-10, 2’</td>
<td>R-20</td>
<td><strong>0.28</strong> / 0.25</td>
<td><strong>R-38</strong></td>
<td><strong>YES</strong></td>
</tr>
</tbody>
</table>

* R-10 slab edge insulation is difficult to trade off
Thermal Breaks in Walls in CZs 4-8

- In Mixed & Cold Climates: provide thermal break for the studs in AGWs
### HVAC and Duct Location

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC and Duct Location</td>
<td>Requires ducts &amp; HVAC equipment to be located in an optimized location</td>
<td>Same as V1. Provision only applies to equipment &amp; ducts serving heating/cooling systems.</td>
<td>Improve HVAC efficiency and comfort.</td>
</tr>
<tr>
<td>Program Component</td>
<td>ZERH Version 1</td>
<td>ZERH Version 2.0 Proposed</td>
<td>Rationale</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------</td>
<td>---------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Window U/SHGC Values</td>
<td>Based on ENERGY STAR V5.0 or V6.0 specs</td>
<td>Based on ENERGY STAR V6.0 specs; Very Cold Climates (6-8) more rigorous at U 0.25</td>
<td>Updates minimum window requirements. Higher performance windows will likely be used as part of UA tradeoff strategies.</td>
</tr>
</tbody>
</table>
## DOE ZERH V2 Window Requirements

<table>
<thead>
<tr>
<th></th>
<th>IECC CZ 1-2</th>
<th>IECC CZ 3-4 except Marine</th>
<th>IECC CZ 5 and 4 Marine</th>
<th>IECC CZ 6-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-Value</td>
<td>0.40</td>
<td>[CZ 3] 0.30</td>
<td>[CZ 3] 0.25</td>
<td>≤ 0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[CZ 4] 0.30</td>
<td>[CZ 4] 0.25</td>
<td>Any</td>
</tr>
<tr>
<td>SHGC</td>
<td>0.25</td>
<td>0.30</td>
<td>0.40</td>
<td>Any</td>
</tr>
<tr>
<td>U-Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHGC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- CZ = Climate Zone
- U-Value: Heat Transfer Coefficient
- SHGC: Solar Heat Gain Coefficient
## Lighting Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Efficiency Lighting</td>
<td>80% requirement</td>
<td>95% requirement</td>
<td>Recognize cost-effectiveness of LEDs and increase ZERH efficiency, while providing a little flexibility. Note that the Target Home assumes 100% high efficiency lighting.</td>
</tr>
</tbody>
</table>
## Appliance Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Efficient Appliances</td>
<td>All builder-installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified</td>
<td>All builder-installed refrigerators, dishwashers, clothes washers, <strong>and clothes dryers</strong> are ENERGY STAR qualified</td>
<td>Recognize ENERGY STAR labeling of clothes dryers and increase ZERH efficiency</td>
</tr>
</tbody>
</table>
## Indoor Air Quality Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Air Quality</td>
<td>Certify under Indoor airPLUS (IAP) V1</td>
<td>Phase in certification under an updated IAP version over time. IAP Version 1 will be allowed through 2022. H/ERVs in Very Cold Climates (6-8) MERV 13 (minimum) filter installed on ducted heating and cooling systems</td>
<td>Maintain requirement to certify under the federal government’s residential IAQ label for new homes. Accelerate the MERV 13 filter requirement (likely to appear in the updated IAP specs)</td>
</tr>
</tbody>
</table>
H/ERVs in Cold Climates

- Required in Very Cold Climates Zones 6 – 8
- Provide whole-house ventilation while reducing impact on heating load
- Numerous technology options available

ERV or HRV
## PV Ready Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photovoltaic (PV) Readiness</td>
<td>Implement the ZERH PV-Ready Checklist</td>
<td>Same as V1, but eliminates the exception for sites with lower annual solar resources. Also updates provisions based on current technologies.</td>
<td>Increase PV Readiness in ZERH homes and recognize the steady increases in PV cost effectiveness.</td>
</tr>
</tbody>
</table>
Residential PV System Costs Down 64%

Average Daily Solar Radiation Per Month

ANNUAL

kWh/m²/day

- 10 to 14
- 8 to 10
- 7 to 8
- 6 to 7
- 5 to 6
- 4 to 5
- 3 to 4
- 2 to 3
- 0 to 2
- none

Required
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
**Update PV Ready Requirements**

**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

**Circuit Breaker** designated and/or installed for use by the PV system in the electric panel.
### Efficiency Target Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum Required Energy Efficiency Threshold</strong></td>
<td>Based on the Version 1 ZERH ERI Target Home specifications - circa 2013. <em>ERI scores in the 50s.</em></td>
<td>Updated ZERH Target Home achieves increased energy savings. <strong>Resulting ERI Targets in the 40s.</strong></td>
<td>Reflect recent innovations in the ZERH efficiency threshold.</td>
</tr>
</tbody>
</table>
Example ZERH V2 ERI Targets based on draft V2 specifications. Based on energy modeling of 2,400 SF home.
### Size Adjustment Factor Updates

<table>
<thead>
<tr>
<th>Program Component</th>
<th>ZERH Version 1</th>
<th>ZERH Version 2.0 Proposed</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Adjustment Factor (SAF)</td>
<td>SAF makes the ERI Target lower for homes larger than the benchmark.</td>
<td>SAF is sunset, consistent with ENERGY STAR Single Family New Homes program.</td>
<td>Homes under ZERH V2 will be very efficient regardless of SAF.</td>
</tr>
</tbody>
</table>
Poll

Which of the proposed DOE ZERH Version 2 updates looks the most challenging?

a. Increased envelope insulation levels
b. Lower ERI Values
c. Wider application of PV Ready measures
d. Increased lighting and appliance requirements
Implementation Timeframe

- 2021 Q4: ZERH V2 available for 30-day stakeholder comment period
- Early 2022: ZERH V2 finalized & integrated into rating software
- 2022 Q1: ZERH – Multifamily draft made available for stakeholder comment
U.S. DOE Zero Energy Ready Home

Getting Started with ZERH
• Same rater network
• Same modeling software (at least 3 different options)
• Same plan review & site inspection protocol
ZERH Partner Process

• Become a partner online (builder/developer or rater)
• Identify potential verifier partners at ZERH website
• No pre-registration of projects
• No program certification fees
• Recommend integrated design process (MEPs)
• Rater: plan review & site inspections
• Project Certification – generated by the Rater’s modeling report, once it is uploaded to the RESNET Registry
• Builder credited with certified home on DOE website
For More Information

www.buildings.energy.gov/zero/
• Review & Comment on Draft Version 2 Program Specs (soon)
• DOE Tour of Zero (~300 homes)
• 24+ Recorded Webinars
• Marketing Tool Kit

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