Meet the Home of the Future: U.S. DOE Zero Energy Ready Homes

Jamie Lyons, P.E
DOE Zero Energy Ready Home &
Robby Schwarz
EnergyLogic
I remind myself every morning: Nothing I say this day will teach me anything.... So if I’m going to learn, I must do it by listening.

Larry King
Good morning is a contradiction of terms.

Jim Davis
Outline

• Definition / Why Build
• DOE Zero Energy Ready Specs
  – National
  – CA Specific
• Rater Perspectives
• How to Move Forward

RELATED SESSIONS

Efficient Hot Water Distribution - 2/16 @ 3:30 pm

Ducts in Conditioned Space – 2/17 @ 10:30 am

IAQ & WaterSense - 2/17 @ 10:30 am

Ventilation – 2/17 @ 1:30 pm

Marketing & Sales Strategies for DOE Zero Energy Ready Homes – 2/17 @ 3:30 pm

High R Assemblies – 2/18 @ 8:30 am
Zero Energy Ready Homes

Defined
High-performance home so energy efficient, all or most annual energy consumption can be offset by renewable energy.
Translating Value Proposition

A Symbol of Excellence

- HEALTHFUL ENVIRONMENT
- COMFORT PLUS
- ADVANCED TECHNOLOGY
- ULTRA EFFICIENT
- QUALITY BUILT
- DURABILITY

KEY
- DOE Zero Energy Ready Home
- ENERGY STAR Home
- Existing Home

This label indicates relative performance of this DOE Challenge Home to existing homes (built between 1950 and 2010) and ENERGY STAR qualified homes. Actual performance may vary.
Ultra-High Efficiency Systems that optimizes cost-effectiveness

+ Assured Performance Systems that exceeds consumer expectations
Why Efficiency + Performance
ZERH Efficiency + Performance

Builder Risks:
- IAQ
- Moisture
- Comfort
- Combustion safety

Energy Star Certified New Home

Minimum Code New Home

Typical Existing Home

Low Efficiency

High Efficiency

Low Performance

High Performance

Zero Energy Ready Home
Risk Management

Zero Differentiation

Innovation Imperative
Zero Energy Ready Home
Technical Specifications
Technical Specifications…
How Heavy is the Lift?

- **ENERGY STAR Certified Homes v3**
  - Advanced Windows
  - Air-Tight Construction
  - 2012 IECC Insulation
  - Energy Efficient Components
- Efficient Hot Water Distribution
- Optimized Duct System
- Indoor Air Quality
  - Renewable Ready Construction
  - Efficiency Threshold (HERS Index)
DOE ZERH Framework

**Exhibit 1: DOE Challenge Home Mandatory Requirements for All Labeled Homes**

<table>
<thead>
<tr>
<th>Area of Improvement</th>
<th>Mandatory Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ENERGY STAR for Homes Baseline</td>
<td>Certified under ENERGY STAR Qualified Homes Version 3.0</td>
</tr>
<tr>
<td>2. Envelope</td>
<td>Fenestration shall meet or exceed latest ENERGY STAR requirements</td>
</tr>
<tr>
<td>3. Duct System</td>
<td>Ducts located within the home's thermal and air barrier boundary</td>
</tr>
<tr>
<td>4. Water Efficiency</td>
<td>Hot water delivery systems shall meet efficient design requirements</td>
</tr>
<tr>
<td>5. Lighting &amp; Appliances</td>
<td>All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified</td>
</tr>
<tr>
<td>6. Indoor Air Quality</td>
<td>All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified</td>
</tr>
</tbody>
</table>

**Exhibit 2: DOE Challenge Home Target Home**

<table>
<thead>
<tr>
<th>HVAC Equipment</th>
<th>Hot Climates (2012 IECC Zones 1.2)</th>
<th>Mixed Climates (2012 IECC Zones 3, 4 except Maine)</th>
<th>Cold Climates (2012 IECC Zones 4 Marine 5,6,7,8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFUE</td>
<td>80%</td>
<td>90%</td>
<td>92%</td>
</tr>
<tr>
<td>SEER</td>
<td>18</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>HSPF</td>
<td>0.2</td>
<td>0.3</td>
<td>1.0†</td>
</tr>
<tr>
<td>ENERGY STAR EER and COP Criteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASHRAE 62.1 Whole House Mechanical Ventilation System</td>
<td>1.4 cfm/W</td>
<td>1.4 cfm/W</td>
<td>1.2 cfm/W</td>
</tr>
</tbody>
</table>

**Insulation and Infiltration**
- Insulation levels shall meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards.
- Infiltration (ACH60): 3 in C2x1.2, 3.5 in C2x3.4, 2.5 in C2x6.7, 1.5 in C2x8

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SHGC</td>
<td>0.23</td>
<td>0.27</td>
<td>any</td>
</tr>
<tr>
<td>U-Wvalue</td>
<td>0.4</td>
<td>0.3</td>
<td>0.17</td>
</tr>
</tbody>
</table>
| Homes qualifying through the Prescriptive Path with a total window-to-floor area greater than 15% shall have adjusted U-values or SHGCs.

**Exhibit 3: Benchmark Home Size**

<table>
<thead>
<tr>
<th>Bedrooms in Home to be Built</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned Floor Area (Benchmark Home)</td>
<td>1,000</td>
<td>1,000</td>
<td>2,200</td>
<td>2,900</td>
<td>3,400</td>
<td>4,000</td>
<td>4,000</td>
<td>5,200</td>
</tr>
</tbody>
</table>

Mandatory Reqs. | Must Comply | ‘Target Home’ Specs | Trade-Off Flexibility | Identical to Energy Star | Size Adjust. Factor
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:
### Mandatory Requirements

#### Exhibit 1: DOE Challenge Home Mandatory Requirements for All Labeled Homes

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<td>□ Certified under ENERGY STAR Qualified Homes Version 3&lt;sup&gt;5&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
| 2. Envelope<sup>6</sup> | □ Fenestration shall meet or exceed latest ENERGY STAR requirements<sup>7 8</sup>  
□ Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels<sup>9</sup> |
| 3. Duct System | □ Ducts located within the home’s thermal and air barrier boundary<sup>10</sup> |
| 4. Water Efficiency | □ Hot water delivery systems shall meet efficient design requirements<sup>11</sup> |
| 5. Lighting & Appliances<sup>12</sup> | □ All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified.  
□ 80% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 80% of sockets  
□ All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified |
| 6. Indoor Air Quality | □ EPA Indoor airPLUS Verification Checklist and Construction Specifications<sup>13</sup> |
| 7. Renewable Ready<sup>14</sup> | □ EPA Renewable Energy Ready Home Solar Electric Checklist and Specifications<sup>15</sup>  
□ EPA Renewable Energy Ready Home Solar Thermal Checklist and Specifications<sup>16</sup> |

**Encouraged:**

- WaterSense Label (indoor and outdoor)
- Disaster Resistance (IBHS Fortified Home)
- Quality Management

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<sup>3</sup> See [Energy Star](https://www.energystar.gov) for details.

<sup>5</sup> [ENERGY STAR Version 3](https://www.energystar.gov).

<sup>7</sup> [ENERGY STAR](https://www.energystar.gov) level.

<sup>8</sup> [ENERGY STAR](https://www.energystar.gov) level.


<sup>10</sup> [American Society of Heating, Refrigerating and Air-Conditioning Engineers](https://www.ashrae.org).


<sup>12</sup> [International Code Council](https://www.iccsafe.org).

<sup>13</sup> [Environmental Protection Agency](https://www.epa.gov).

<sup>14</sup> [International Code Council](https://www.iccsafe.org).

<sup>15</sup> [Environmental Protection Agency](https://www.epa.gov).

<sup>16</sup> [International Code Council](https://www.iccsafe.org).
Zero Energy Ready Home

Technical Specifications
Mandatory Requirements:
ENERGY STAR for Homes
Version 3 Baseline
Align with ENERGY STAR for Homes v3:

- Comprehensive Building-Science System
- Variable vs. Fixed HERS Index Score
- House Size Adjustment to HERS Score
What is Building Science

Building Science:
- Air Flow
- Thermal Flow
- Moisture Flow

Thermal Enclosure System
Heating, Cooling, & Ventilation System
Water Management System
<table>
<thead>
<tr>
<th>Thermal Enclosure</th>
<th>Heating, Cooling &amp; Ventilation</th>
<th>Water Management</th>
</tr>
</thead>
</table>

**ENERGY STAR for Homes v3:**

- ✓ Thermal Enclosure Checklist
- ✓ HVAC QI Checklist - Contractor
- ✓ HVAC QI Checklist - Rater
- ✓ Water Management Checklist

*Note: Keep an eye on REV08 changes…*
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements

Envelope:

Advanced Windows
ENERGY STAR Windows

- Assures beyond-code window performance
- Fenestration used for passive solar design are exempt from the U-factor and SHGC requirements
- Area-weighted averages for U-factor, SHGC permitted
### ENERGY STAR Windows  
- **8-Month Phase-In for Updated Specs**

#### Window Specs to Apply to DOE Zero Energy Ready Home Projects

<table>
<thead>
<tr>
<th></th>
<th>Hot Climates IECC CZ 1-2</th>
<th>Mixed Climates IECC CZ 3-4 except Marine</th>
<th>Cold Climates IECC CZ 5-8 and 4 Marine*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U-Value</td>
<td>SHGC</td>
<td>U-value</td>
</tr>
<tr>
<td>ENERGY STAR Window Specs v5.0 - for projects permitted up to 8/31/2015**</td>
<td>0.60</td>
<td>0.27</td>
<td>[3] 0.35</td>
</tr>
<tr>
<td></td>
<td>0.30</td>
<td>0.31</td>
<td>0.32</td>
</tr>
<tr>
<td>ENERGY STAR Window Specs V6.0 - for projects permitted after 8/31/2015**</td>
<td>0.40</td>
<td>0.25</td>
<td>[3] 0.30</td>
</tr>
<tr>
<td></td>
<td>0.27*</td>
<td>0.28*</td>
<td>0.29*</td>
</tr>
</tbody>
</table>

*For Cold Climate Zones, the revised specs are applicable to DOE Zero Energy Ready Homes permitted after 8/31/2016*

**Note that DOE Zero Energy Ready Home offers multiple compliance paths. See the National Program Requirements, Exhibit 1 with footnotes, for details.
Zero Energy Ready Home

Technical Specifications: Best Practices

Air-Tight Construction
Why Air-Tight Construction

- 16 to 50% of HVAC Loads
- Moisture Problems
- Comfort Problems
- Indoor Air Quality
## Target Home Air-Tightness

<table>
<thead>
<tr>
<th>Climate Zones</th>
<th>Zero Energy Ready Home</th>
<th>ENERGY STAR V3</th>
<th>2012 IECC</th>
<th>Passive House</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>3.0</td>
<td>6.0</td>
<td>5.0</td>
<td>0.6</td>
</tr>
<tr>
<td>3-4</td>
<td>2.5</td>
<td>5.0</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>5-7</td>
<td>2.0</td>
<td>4.0</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>8</td>
<td>1.5</td>
<td>3.0</td>
<td>3.0</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Seal Usual Suspects

**Penetrations:**
- Plumbing
- Wiring
- Recessed Lights
- Vents
- HVAC Duct

**Shafts:**
- Flues
- Ducts
- Plumbing

**Cracks:**
- Sill Plates
- Windows & Doors
- Drywall at Top Plate
- Access Panels
- Sheathing Joints
- Foundation/Framing

**Odd Geometry:**
- Cantilevers
- Knee-walls
Air Leakage Distribution

Exterior air barrier
Cathedral ceiling

Sheathing / roof joint
1.1 cfm/ft @ 50 Pa

6% 1%
93%

- Sheathing / top plates
- Stud / top plates
- Top plates

2-Story house (Floor area = 2,000 ft²)
Sheathing / roof joint unsealed ≅ 0.5 ACH₅₀

<table>
<thead>
<tr>
<th>Zones</th>
<th>Requirement</th>
<th>Contribution to requirement (%)</th>
<th>Requirement</th>
<th>Contribution to requirement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2</td>
<td>3</td>
<td>17</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>3 – 4</td>
<td>2.5</td>
<td>20</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>5 – 7</td>
<td>2</td>
<td>25</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>1.5</td>
<td>33</td>
<td>3</td>
<td>17</td>
</tr>
</tbody>
</table>
Examples
Examples

Source: Building America Solution Center; [www.basc.pnnl.gov](http://www.basc.pnnl.gov)
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:

Envelope:

2012 IECC Insulation
2012 IECC Insulation

• Compliance with next generation code

• Three Options:
  ✓ Prescriptive
  ✓ Alternative equivalent U-factor
  ✓ Total UA calculation
    [allows window to be included]

• REM/Rate / EnergyGauge both calculate this
## Prescriptive Requirements

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Fenestration</th>
<th>Skylight U-Factor</th>
<th>Glazed Fenestration SHGC</th>
<th>Ceiling R-Value</th>
<th>Wood Frame Wall R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NR</td>
<td>0.75</td>
<td>0.25</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>0.40</td>
<td>0.65</td>
<td>0.25</td>
<td>38</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>0.35</td>
<td>0.55</td>
<td>0.25</td>
<td>38</td>
<td>20 or 13+5(^h)</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>0.35</td>
<td>0.55</td>
<td>0.40</td>
<td>49</td>
<td>20 or 13+5(^h)</td>
</tr>
<tr>
<td>5 &amp; Marine 4</td>
<td>0.32</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>20 or 13+5(^h)</td>
</tr>
<tr>
<td>6</td>
<td>0.32</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>20+5 or 13+10(^h)</td>
</tr>
<tr>
<td>7 &amp; 8</td>
<td>0.32</td>
<td>0.55</td>
<td>NR</td>
<td>49</td>
<td>20+5 or 13+10(^h)</td>
</tr>
</tbody>
</table>
### Prescriptive Requirements (cont.)

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Mass Wall R-Value</th>
<th>Floor R-Value</th>
<th>Basement Wall R-Value</th>
<th>Slab R-Value, Depth</th>
<th>Crawl Space Wall R-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/4</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>4/6</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>8/13</td>
<td>19</td>
<td>5/13(^f)</td>
<td>0</td>
<td>5/13</td>
</tr>
<tr>
<td>4 except Marine</td>
<td>8/13</td>
<td>19</td>
<td>10 /13</td>
<td>10, 2 ft</td>
<td>10/13</td>
</tr>
<tr>
<td>5 &amp; Marine 4</td>
<td>13/17</td>
<td>30(^g)</td>
<td>15/19</td>
<td>10, 2 ft</td>
<td>15/19</td>
</tr>
<tr>
<td>6</td>
<td>15/20</td>
<td>30(^g)</td>
<td>15/19</td>
<td>10, 4 ft</td>
<td>15/19</td>
</tr>
<tr>
<td>7 &amp; 8</td>
<td>19/21</td>
<td>38(^g)</td>
<td>15/19</td>
<td>10, 4 ft</td>
<td>15/19</td>
</tr>
</tbody>
</table>
High-R Wall Options

- Advanced Framing with Thicker Wall
- Rigid Insulation Exterior Sheathing
- Structural Insulated Panels (SIPs)
- Insulated Concrete Forms (ICFs)
- Double Wall
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:

Ducts in Conditioned Spaces
Why Ducts in Conditioned Space?

• **Significant Thermal Losses:**
  – Thermal losses triple for ducts in unconditioned vs. conditioned space
  – Total thermal losses can range from 10-45%
  – Extensive unconditioned space penetrations

• **Significant Performance Impacts:**
  – IAQ
  – Comfort
  – Durability
• **Short Duct Run**
  up to 10’ of total length is permitted to be outside of the home’s thermal and air barrier boundary.

• **Jump Ducts**
  may be located in attics if all joints, including boot-to-drywall, are fully air sealed with mastic

• **Ductless HVAC system**
  e.g. mini-splits can offer a non-ducted alternative
Ducts in Condit. Space Options

- **Conditioned Floor Space**
  - Dropped ceiling
  - Modified Attic Truss
  - Between floors

- **Unvented Crawl Space/Conditioned Basement**
  which is within the home’s thermal boundary

- **Unvented Attic**
  regardless of whether conditioned with a supply register

- **Vented Attic**
  equivalent option where other locations in conditioned space are impractical, expensive, don’t work well in specific climates, or increase envelope loads
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements: Efficient Hot Water Distribution
Water Efficiency as a System

- **Indoor Fixtures**
  - Plumbing Fixtures
  - Appliances and Other Equipment

- **Distribution**
  - Service Pressure
  - Metering (for Multi-Family Homes)
  - Leak Prevention
  - Hot Water Distribution

- **Outdoor**
  - Landscape Design
  - Irrigation (if installed)
Efficient Hot Water Distribution

• “Must Have” for Zero Energy Ready Homes
• Based on EPA WaterSense Specifications:
  – ≤ 0.5 gallons of water between the hot water source and any hot water fixture.
  – ≤ 0.6 gallons of water shall be collected from the hot water fixture before hot water (+ 10 °F) is delivered
  – Timer- and temperature-based recirculating systems shall not be used to meet the criteria.
Hot Water Distribution Options

- Core Plumbing Layout (wet wall)
- Manifold System
- Demand Pumping System
  - Pump Options
    - Integrated within tankless units
    - External pumps
  - Control Options
    - adaptive (smart) scheduling
    - occupant sensors trigger recirc.
    - Manual switches
  - Plumbing Options
    - Dedicated return line
    - Crossover valve
Zero Energy Ready Homes

Technical Specifications

Mandatory Requirements:

Efficient Components:
Lighting, Appliances, & Fans
Components and MEL’s are increasingly important in Low-Load Homes (~25 to 40%). Therefore, DOE ZERH requires:

- **ENERGY STAR Certified Appliances:**
  refrigerators, dishwashers, clothes washers

- **ENERGY STAR Certified Fans:**
  bathroom ventilation, ceiling fans

- **ENERGY STAR Certified Lighting:**
  Min. 80% of fixtures or lamps (CFL or LED)

*Only where installed by builder*
Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:

Indoor Air Quality
Increasing Health Concerns

$40 Billion

$20 Billion
Indoor vs. Outdoor Air Pollutants:
On average 2-5 times greater
Up to 100 times greater
While Americans Spend 90% of time indoors

Source: EPA
"If your child doesn’t use an inhaler, consider yourself a lucky parent because, 1 in 10 children in the U.S. suffers from asthma."

Source: Remarks for Administrator McCarthy, Announcement of Clean Power Plan, Washington, DC, June 2, 2014
Addressing Health Concerns

ENERGY STAR + Indoor airPLUS

- Radon
- Pests
- Materials
- CO
- HVAC
- Moisture

Comprehensive Indoor Air Quality Protection
In homes with exhaust-only whole-house ventilation:

- Garage exhaust fan, OR
- Pressure test
  - When house is +50 Pa wrt outdoors
  - House is ≥ +45 Pa wrt garage
Zero Energy Ready Home

Technical Specifications
Mandatory Requirements:
Renewable Ready
[Where Applicable]
Decreasing Renewable Cost
More than half of all U.S. homebuilders are expected to offer solar PV energy systems as an option in new single-family homes by 2016, up from just 12 percent in 2013.

Source:
RERH Applicability

Average Daily Solar Radiation Per Month

ANNUAL

PV Ready Encouraged

*Solar Hot Water Ready
Encouraged Nationally

PV Ready 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
Zero Energy Ready Home

Performance Threshold
Target Home HERS Scores to Qualify

Average DOE Zero Energy Ready Home HERS Index by Climate Zone
(Overall Average = 55.5)

Based on 1800, 2400, and 3600 ft² prototypes on climate-appropriate foundations.
Zero Energy Ready Home

California Compliance Options
California Compliance Options

**Prescriptive Path**
- California Mandatory Items (Exhibit 1)
- DOE ZERH National Program Requirements
- Prescriptive Path (Exhibit 2)

**Performance Path A**
- California Mandatory Items (Exhibit 1)
- Performance path using national software

**Performance Path B**
- California Mandatory Items (Exhibit 1)
- 25% better than 2013 Title 24

**Performance Path C**
- California Mandatory Items (Exhibit 1)
- Side by Side comparison in Title 24
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<td>☐ Certified under ENERGY STAR Qualified Homes Version 3 program requirements for the State of California(^\text{10}).</td>
</tr>
<tr>
<td>2. <strong>Envelope</strong> (^\text{11})</td>
<td>☐ Fenestration shall meet or exceed latest ENERGY STAR requirements or California 2013 Building Energy Efficiency Standards window requirements in table 150.1-A, <em>whichever is more stringent</em> (^\text{12, 13}).</td>
</tr>
<tr>
<td></td>
<td>☐ Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels or California 2013 Building Energy Efficiency Standards insulation requirements in table 150.1-A, <em>whichever is more stringent</em> (^\text{14}).</td>
</tr>
<tr>
<td>3. <strong>Duct System</strong></td>
<td>☐ Ducts located within the home’s thermal and air barrier boundary (^\text{15}).</td>
</tr>
<tr>
<td>4. <strong>Water Efficiency</strong></td>
<td>☐ Hot water delivery systems shall meet efficient design requirements (^\text{16}).</td>
</tr>
<tr>
<td>5. <strong>Lighting &amp; Appliances</strong> (^\text{17})</td>
<td>☐ All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified.</td>
</tr>
<tr>
<td></td>
<td>☐ 90% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 90% of sockets</td>
</tr>
<tr>
<td></td>
<td>☐ All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified</td>
</tr>
<tr>
<td>6. <strong>Indoor Air Quality</strong></td>
<td>☐ Certified under EPA Indoor airPLUS (^\text{18})</td>
</tr>
<tr>
<td>7. <strong>Renewable Ready</strong> (^\text{19})</td>
<td>☐ Consolidated Renewable Energy Ready Home (RERH) Checklist</td>
</tr>
<tr>
<td>8. <strong>Air Infiltration</strong></td>
<td>☐ For all CA Climate Zones 1-16, must be tested to achieve air infiltration levels at or below: 3 ACH50 for single family detached dwellings, or 4 ACH50 for attached single-family dwellings and dwellings in multifamily buildings (^\text{20}).</td>
</tr>
</tbody>
</table>
Meet the Home of the Future: Zero Energy Ready Homes

Robby Schwarz
RESNET 2015
Engaging Builders

- A Builder wants it
- Quest for differentiation
- Marketing
  - HERS Index, Code, Energy Star, IAP, WaterSense(?), DOE ZERH
- Better Performance
- Builder Risk Management
- The next step is small
# Boil it Down

## Exhibit 1: DOE Zero Energy Ready Home Mandatory Requirements for All Labeled Homes

<table>
<thead>
<tr>
<th>Area of Improvement</th>
<th>Mandatory Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>ENERGY STAR for Homes Baseline</strong></td>
<td>☐ Certified under ENERGY STAR Qualified Homes Version 3 (^3), (^10)</td>
</tr>
<tr>
<td>2. <strong>Envelope</strong></td>
<td>☐ Fenestration shall meet or exceed latest ENERGY STAR requirements (^12), (^13)</td>
</tr>
<tr>
<td></td>
<td>☐ Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels (^14), (^15)</td>
</tr>
<tr>
<td>3. <strong>Duct System</strong></td>
<td>☐ Ducts located within the home’s thermal and air barrier boundary (^16)</td>
</tr>
<tr>
<td>4. <strong>Water Efficiency</strong></td>
<td>☐ Hot water delivery systems shall meet efficient design requirements (^17)</td>
</tr>
<tr>
<td>5. <strong>Lighting &amp; Appliances</strong></td>
<td>☐ All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified.</td>
</tr>
<tr>
<td></td>
<td>☐ 80% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 80% of sockets</td>
</tr>
<tr>
<td></td>
<td>☐ All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified</td>
</tr>
<tr>
<td>6. <strong>Indoor Air Quality</strong></td>
<td>☐ Certified under EPA Indoor airPLUS (^10)</td>
</tr>
<tr>
<td>7. <strong>Renewable Ready</strong></td>
<td>☐ Consolidated Renewable Energy Ready Home (RERH) Checklist</td>
</tr>
</tbody>
</table>
In This Case

- Foundation R-11
- Slab R-0
- Floor Blown R-50
- Rim R-19
- Walls blown R-23
- Windows **U-30/SHGC.30**
- Doors R-5/ R-2.2
- Attic R-38
- Furnace 93.5 AFUE
- 100% Duct inside
- Water Heater 62 EF
- AC 13 Seer
- 3.5 ACH50
- Ventilation ASHRAE 62.2
- Energy Star Appliance 80% CFL
- HERS 59
Interesting Findings

- REM Modeling
  - Mandatory 2012 IECC insulation levels
    - you can pass DOE ZERH but not 2012 IECC
      - Air leakage rate Duct leakage Rate

- Mandatory
  - Windows
    - UA Trade offs allowed in REM but Window U-value is Mandatory
    - Rem models the UA trade off and .34 windows passed in the REM model
  - 100% Duct inside envelope
    - REM will demonstrate compliance with duct located outside

- You need to know this or you will be out of compliance
Marking any given checkbox certifies that the home complies with all mandatory requirements referenced by that checkbox. Needed for showing compliance on various reports.

### IECC - Mandatory Requirements

- [ ] 2004 IECC
- [ ] 2009 IECC
- [x] 2015 IECC
- [x] 2006 IECC
- [x] 2012 IECC
- [ ] NY-ECCC 2010

### ENERGY STAR Version 2.5, 3.0 and 3.1

- **Checklists Fully Enforced for 3.0 and 3.1**
  - [x] Thermal Enclosure Rater Checklist
  - [x] HVAC System Quality Installation Contractor
  - [x] HVAC System Quality Installation Rater
  - [x] Water Management System Builder

### ENERGY STAR Product Count

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerators</td>
<td>1</td>
</tr>
<tr>
<td>Ceiling Fans</td>
<td>1</td>
</tr>
<tr>
<td>Exhaust Fans</td>
<td>1</td>
</tr>
<tr>
<td>Dishwashers</td>
<td>1</td>
</tr>
</tbody>
</table>

### Conditioned Basement Exclusion

- **Basement Qualifies for SAF exclusion?**

| Basement Conditioned Floor Area: | 847 |

- [ ] Slab Insulation exemption from Thermal Enclosure Rater Checklist

- [x] Indoor airPLUS - can no longer substitute for Water Management Checklist
Marking any given checkbox certifies that the home complies with all mandatory requirements referenced by that checkbox, per the DOE Zero Energy Ready Home National Program Requirements.

### Mandatory Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenestration</td>
<td>✔️</td>
</tr>
<tr>
<td>Appliance</td>
<td>✔️</td>
</tr>
<tr>
<td>Insulation</td>
<td>✔️</td>
</tr>
<tr>
<td>Lighting</td>
<td>✔️</td>
</tr>
<tr>
<td>Renewable Energy Ready Solar Electric</td>
<td>✔️</td>
</tr>
<tr>
<td>Renewable Energy Ready Solar Hot Water</td>
<td>✔️</td>
</tr>
<tr>
<td>EPA Indoor airPLUS</td>
<td>✔️</td>
</tr>
<tr>
<td>Fan Efficiency</td>
<td>✔️</td>
</tr>
<tr>
<td>Duct Location</td>
<td>✔️</td>
</tr>
</tbody>
</table>

### Optional Home Builder Commitments for Recognition

<table>
<thead>
<tr>
<th>Commitment</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified under the EPA WaterSense for New Homes Program</td>
<td>No</td>
</tr>
<tr>
<td>Certified under the IBHS fortified for Safer Living Program</td>
<td>No</td>
</tr>
<tr>
<td>Followed the DOE Zero Energy Ready Home Quality Management Guidelines</td>
<td>No</td>
</tr>
<tr>
<td>The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year.</td>
<td>No</td>
</tr>
</tbody>
</table>
Interesting Findings

- Constructability
  - Mandatory items
    - Raised Heel Truss
      - Energy Star requires $\geq R-21$ over the top plate
      - DOE ZERH requires $\geq R-30$ over the top plate
    - 100% ducts inside the envelope
      - Inside, outside, or within?
    - All four Energy Star Checklists
    - IAP qualified
      - MERV 8
    - Renewable ready
ZERH Builder Sticking Points

- **IAP (Rev2)**
  - **Moisture control** – Aggregate under slabs
  - **Radon Systems**
  - **Duct system**
    - Protection / Cleaning
    - No HVAC Building cavities used per IAP
    - 100% in conditioned space
  - **Attached garages**
  - **Materials**
    - Dimensional woods, Particle boards, paints, carpets
Indoor Air Plus

- **Moisture control**
  - **Water Managed site & foundation**
    - Drainage, Capillary break, damp proofed, Etc.
  - **Water managed Wall assemblies**
    - Drainage plane, flashing details
  - **Water managed Roof assemblies**
    - Gutters and flashing
  - **Interior water management**
    - Moisture resistant materials

- **Radon control**
  - Radon resistant features including at least a passive radon system

- **Pest Barriers**
  - Minimize pathway for pests

- **HVAC Systems**
  - **Heating & Cooling equipment**
    - Sizing and design
  - **Ventilation**
    - ASHREA 62.2
  - **Air cleaning and filtration**
  - **Dehumidification**

- **Combustion pollutant control**
  - **Combustion source Controls**
    - Sealed or power vented equipment
  - Attached garages
    - Insolated

- **Low emission materials**
  - Engineered woods, Paints, Carpets

- **Home commissioning**
  - Duct testing, Pressure balancing, Flows, Etc.
ZERH Builder Sticking Points

Hot water circulation systems

- No more than 0.5 gallons of water can be stored within the pipe between the heater and any fixture.
- No more than 0.6 gallons of water can go down the drain before hot water is delivered.
- The water temperature must be 10° or more higher than when the water first came out of the faucet.
- Recirculation systems must have occupant control switch or adaptive learning technology.
Solar Electric Ready Checklist

- Install a 1” conduit
- Designate *proposed* array location and square footage
- Identify orientation (azimuth) *of proposed location*
- Blocking is permitted to be used as an alternative to the 4’ x 4’ or 3’x2’ wood panel
- 70 Amp double-pole breaker in electrical service panel or a labeled slot Solar Thermal Checklist
# DOE Zero Energy Ready Home

Projected Rating: Based on Plans - Field Confirmation Required.

<table>
<thead>
<tr>
<th>Energy Performance</th>
<th>DOE Zero Energy Ready Home Builder Partner ID#</th>
</tr>
</thead>
<tbody>
<tr>
<td>House Type</td>
<td>Single-family detached</td>
</tr>
<tr>
<td></td>
<td>210</td>
</tr>
<tr>
<td>Year built</td>
<td>2015</td>
</tr>
<tr>
<td></td>
<td>2800.0</td>
</tr>
<tr>
<td>Number of Bedrooms</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1953.0</td>
</tr>
<tr>
<td>Site address</td>
<td>Registered Builder</td>
</tr>
<tr>
<td></td>
<td>1887 Place to live</td>
</tr>
<tr>
<td></td>
<td>Denver</td>
</tr>
<tr>
<td></td>
<td>Registered Builder</td>
</tr>
<tr>
<td></td>
<td>CO. 80221</td>
</tr>
<tr>
<td>HERS Index without On-site Generation</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Date of Rating</td>
</tr>
<tr>
<td></td>
<td>2/10/2015</td>
</tr>
<tr>
<td>HERS Index with On-site Generation</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Rating Software</td>
</tr>
<tr>
<td></td>
<td>REM/Rate - v14.6</td>
</tr>
<tr>
<td>HERS Index of the Target Home using size adjustment factor</td>
<td>59</td>
</tr>
<tr>
<td>Estimated annual energy costs($)</td>
<td>1487</td>
</tr>
<tr>
<td>Estimated annual energy use</td>
<td>Electric: 6858 kWh \ Natural Gas: 723 Therms</td>
</tr>
<tr>
<td>Energy cost rates</td>
<td>Electric: 0.11 $/kWh \ Natural Gas: 0.98 $/Therms</td>
</tr>
<tr>
<td>Estimated annual emissions reductions</td>
<td>CO2: 6.1 tons / SO2: 7.8 lbs / NOx: 16.6 lbs</td>
</tr>
</tbody>
</table>
DOE Zero Energy Ready Home Certification

As the certified Rater for this house, I certify this house meets/complies with all mandatory requirements of the DOE Zero Energy Ready home guidelines, including the following:

- Compliance with all ENERGY STAR Qualified Homes Version 3 requirements and checklists
- Compliance with Mandatory Fenestration Requirements
- Compliance with Mandatory Insulation Requirements
- Compliance with Mandatory Duct Location Requirements
- Compliance with Mandatory Appliance Requirements
- Compliance with Mandatory Lighting Requirements
- Compliance with Mandatory Fan Efficiency Requirements
- Compliance with Mandatory EPA Indoor airPLUS
- Compliance with Mandatory Renewable Energy Ready Solar Electric Requirements
- Compliance with Mandatory Renewable Energy Ready Solar Hot Water Requirements

This home was qualified via sampling in lieu of testing, in accordance with allowable sampling provisions as stated in the DOE Zero Energy Ready Home National Program Requirements.

Optional Compliance for Builder Recognition

I further certify that the following also apply to this house:

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
<th>DON'T KNOW</th>
<th>Optional Home Builder Commitments for Recognition</th>
</tr>
</thead>
</table>

*Certification under the DOE Zero Energy Ready Home permits limited exceptions to full compliance with indoor airPLUS. Builders seeking the Indoor airPLUS label must achieve full compliance with the Indoor airPLUS Verification Checklist.

REM/Rate - Residential Energy Analysis and Rating Software v14.6
This information does not constitute any warranty of energy cost or savings.
DOE Zero Energy Ready Home
Projected Rating: Based on Plans - Field Confirmation Required.

Optional Compliance for Builder Recognition

I further certify that the following also apply to this house:

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</tr>
</tbody>
</table>

*Certification under the DOE Zero Energy Ready Home permits limited exceptions to full compliance with Indoor airPLUS. Builders seeking the Indoor airPLUS label must achieve full compliance with the Indoor airPLUS Verification Checklist.*
This home built at 1887 Place to live Denver, CO 80221 was verified by Robby Schwarz to meet Indoor airPLUS construction specifications as established by the U.S. Environmental Protection Agency.

Indoor airPLUS qualified homes are designed to contribute to improved indoor air quality.

Indoor airPLUS Features

- Moisture and Mold Control
- Radon Resistant Construction
- Pest Barriers
- Effective Heating, Ventilating, and Air-Conditioning Systems
- Safe Combustion
- Healthier Building Materials

2/10/2015

Not all features are required in all cases. To learn more about indoor air quality features in your home, ask your builder to review the Indoor airPLUS verification checklist with you, or visit www.epa.gov/indoorairplus.
Your home was designed, engineered, and constructed in conformance to U.S. Department of Energy (DOE) guidelines for extraordinary levels of excellence and quality. Projected Rating: Based on Plans - Field Confirmation Required.

HERS® Index

This home meets or exceeds the minimum criteria for the following:

- REM/Rate - Residential Energy Analysis and Rating Software v14.6

Sam Rashkin, Chief Architect
Building Technologies
U.S. Department of Energy
Robby Schwarz
Energylogic
robbynrglogic.com
720-838-0677
Zero Energy Ready Homes

Verifying & Labeling Homes
Verifying Homes

• Same: ENERGY STAR Homes framework

• New:
  1. Indoor airPLUS Checklist;
  2. Renewable Energy Ready Home Checklist (where applicable)
  3. Hot Water Distribution test

• Submissions:
  – Send “DOE Zero Energy Ready Verification Summary” electronically to zero@newportpartnersllc.com
  – Otherwise builders will not receive “credit” on DCH website
  – Considering RESNET National Homes Registry for future
Labeling & Certification

- Provide software-generated DOE Zero Energy Ready Home Certificate to builder/home buyer

- Submit software-generated DOE Zero Energy Ready Home Compliance Report to zero@newportpartnersllc.com
Becoming a Partner

• Partnership Categories
  – Builder
  – Verifier
  – Training Partner
  – Designer/Architect
  – Lender

• Review & Sign Online Agreement

• Be listed…be active!
Thank You

Questions?

To Become a Rater or Builder Partner:
www.buildings.energy.gov/zero

E-mail Contact:
zero@newportpartnersllc.com (Jamie)
robby@nrglogic.com

RELATED SESSIONS

Efficient Hot Water Distribution - 2/16 @ 3:30 pm

Ducts in Conditioned Space – 2/17 @ 10:30 am

IAQ & WaterSense - 2/17 @ 10:30 am

Ventilation – 2/17 @ 1:30 pm

Marketing & Sales Strategies for DOE Zero Energy Ready Homes – 2/17 @ 3:30 pm

High R Assemblies – 2/18 @ 8:30 am