Perspectives on the Zero Energy Home

Energy Design Conference
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Duluth, MN

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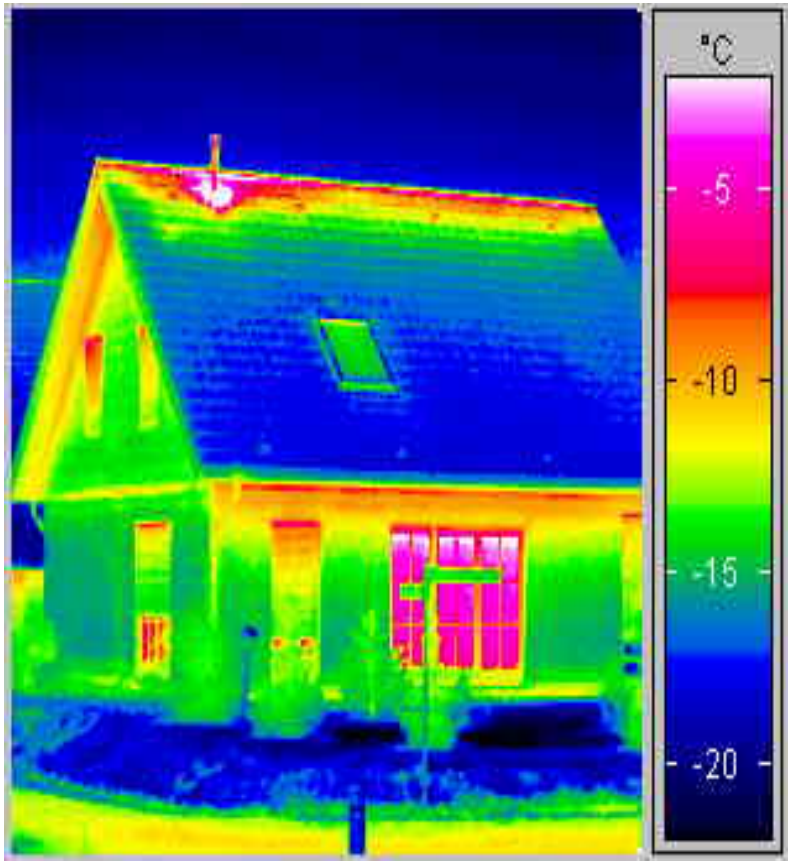
PERSPECTIVES ON THE ZERO ENERGY HOME

- Part 1: Overview of Zero Energy Ready Home
  - Pat Huelman, University of Minnesota
- Part 2: Custom Home Builder Perspective
  - Ray Pruban, Amaris Custom Homes
- Part 3: Team Opti-MN Impact Home
  - Laurel Johnston / Collin Coltman, University of Minnesota
- Part 4: Affordable Housing Perspective
  - Brian Wimmer, Rochester Area Habitat for Humanity

PERSPECTIVES ON THE ZERO ENERGY HOME

- Are there buyers who would like their utility bills to go away?
- How much is that worth to them?
- Can it be done?



PERSPECTIVES ON THE ZERO ENERGY HOME

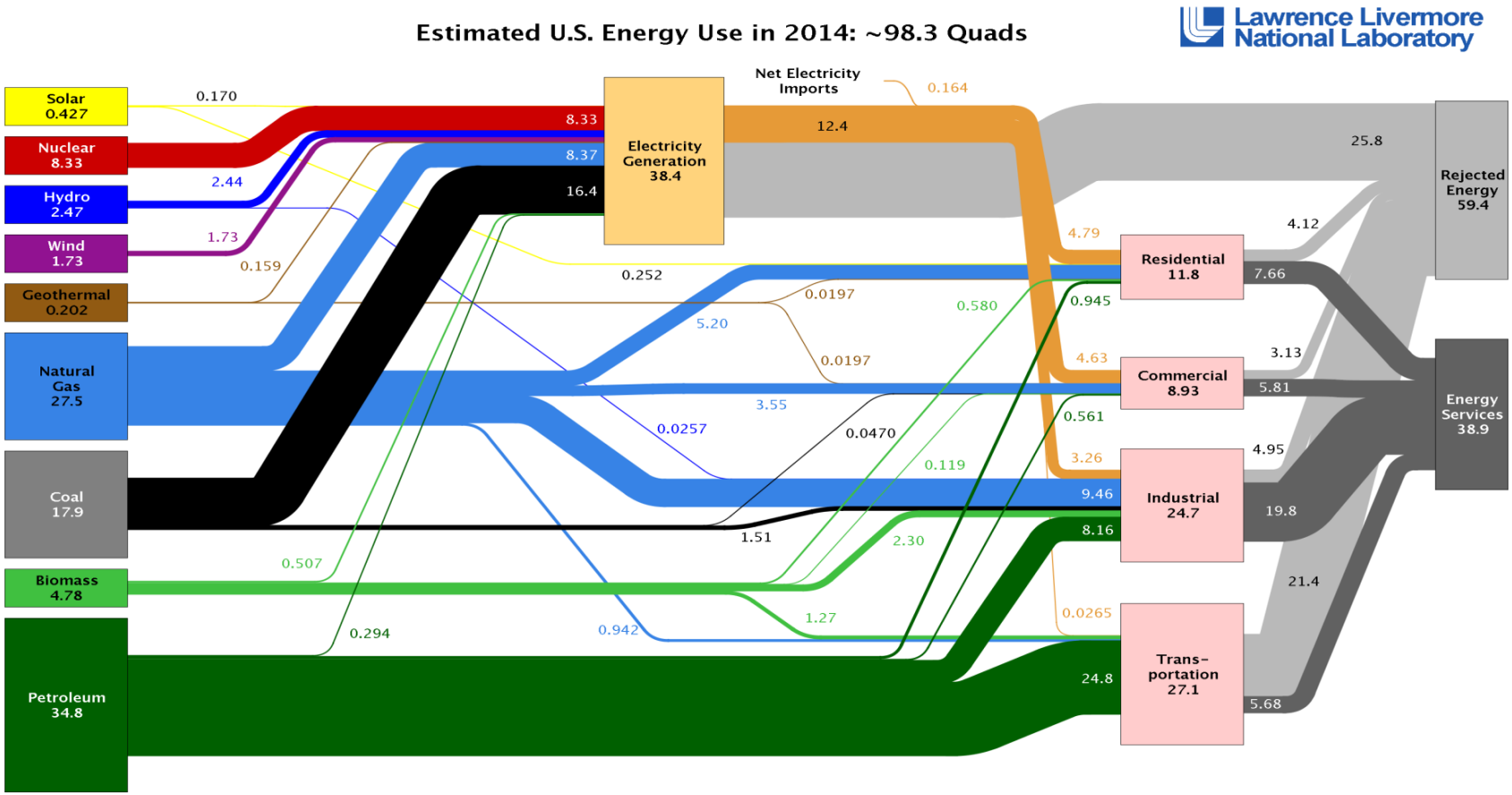
- Absolutely – with a couple of caveats!
- Homes will always require energy.

- Can the home produce as much as it uses?
  - and don't forget the $20 per month in fees.
- What does it cost?

ACT 1: THE SET-UP

- Seeing the Big Energy Picture
- Getting the Best Bang for Our $
- A Small Hiccup along the Way

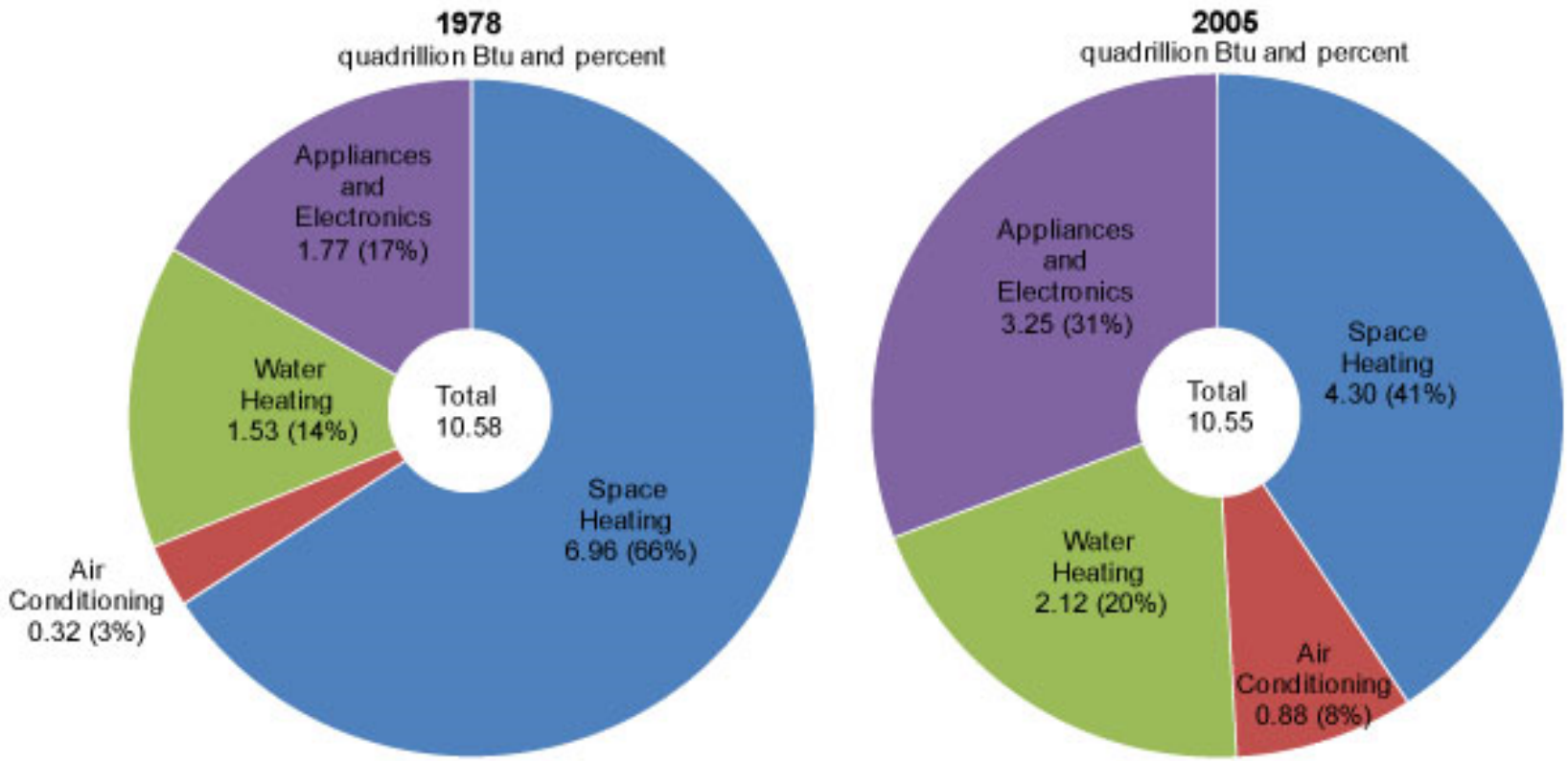
THE ENERGY PICTURE IN THE U.S.?



Source: LLNL 2015. Data is based on DOE/EIA-0035(2015-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential and commercial sectors 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

ENERGY IN OUR HOMES

Total energy use in homes



Source: U.S. Energy Information Administration, 1978 and 2005 Residential Energy Consumption Survey

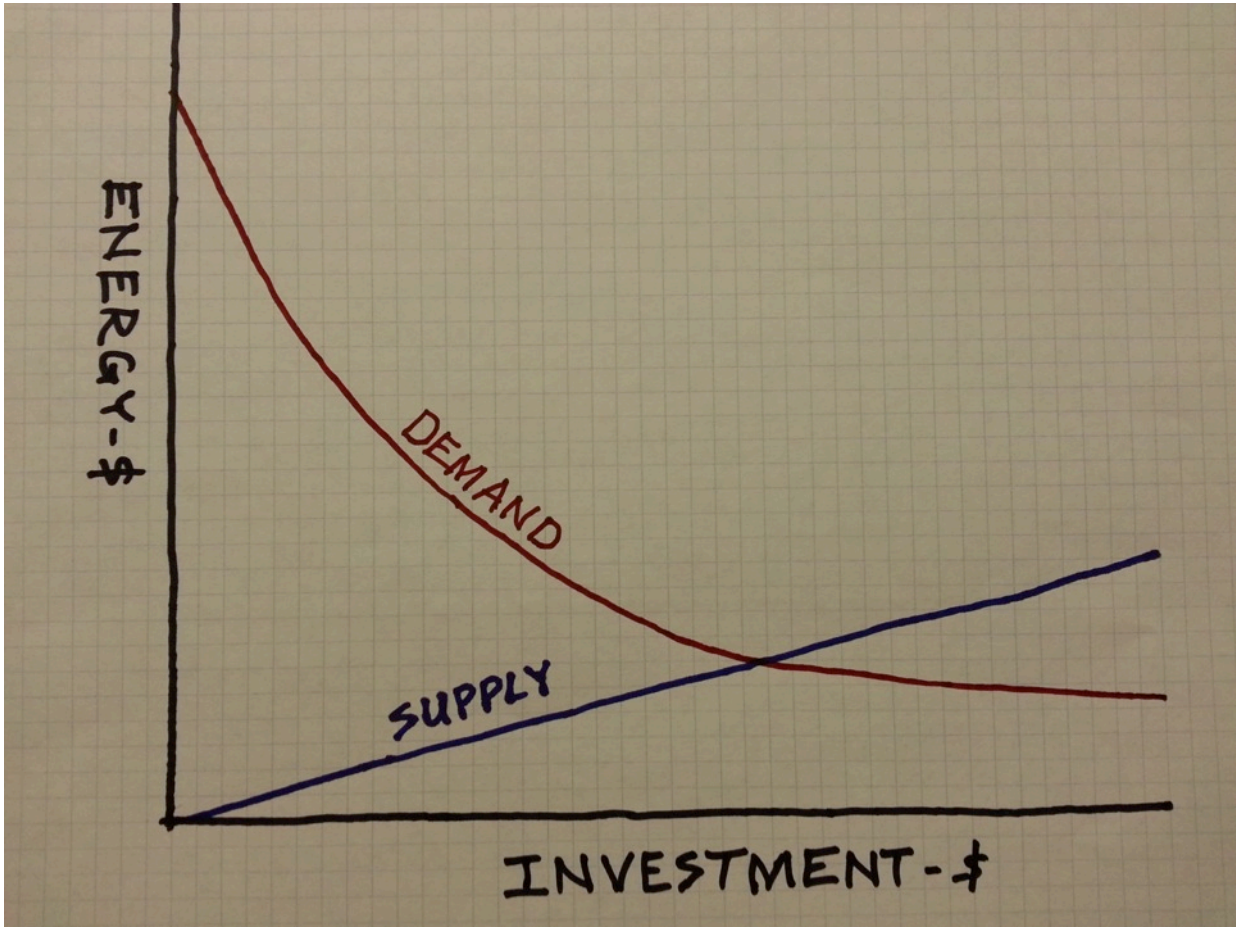
ENERGY STRATEGIES

- Conservation
  - Lowest cost; best return

- Efficiency
  - Moderate expense; good return

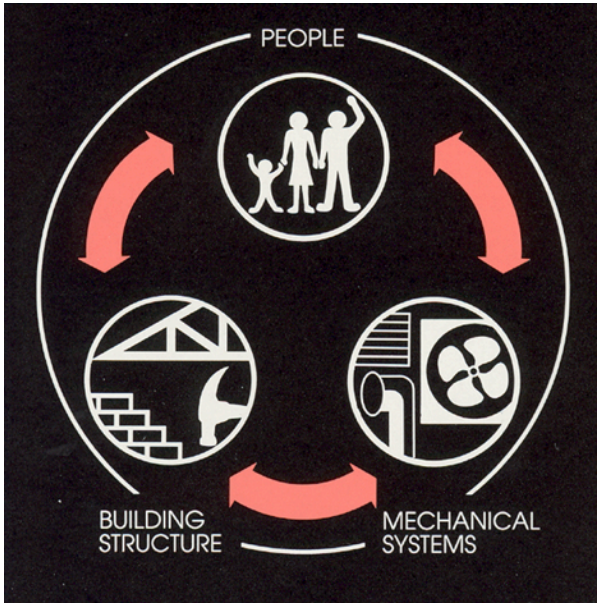
- Alternatives
  - Most expensive; lowest return

ENERGY SAVED VS. DOLLAR SPENT



FORMULA FOR ENERGY EFFICIENT HOMES

- Passive Design
  - Simple shapes, good orientation
- Building Enclosure
  - More insulation
  - Efficient windows & doors
  - Airtight construction
- Mechanical Systems
  - High-efficiency equipment
  - Efficient appliances & lighting
- Proper Operation & Maintenance



BUT THAT IS THE EASY PART

- The tougher part is how to save energy, without causing moisture and indoor air quality concerns?
  - When you remove heat flow you are also removing drying potential.
  - When you air seal (to retard moisture flows) you have less dilution of indoor pollutants.

CAN IT GET WORSE?

- The home building industry in the U.S. is incredibly diverse and fragmented.
- For a typical house, 25+ subcontractors will touch that home in some way.
- It is easy to see how things can get done improperly, undone by others, or simply missed.

A GROWING EPIDEMIC: NOTMYJOBITIS

ACT 2: A SYSTEMS-GUIDED APPROACH TO HIGH-PERFORMANCE HOME

- What if you could build a home with…
  - incredibly low energy bills,
  - superior thermal and acoustical comfort,
  - built-in long-term durability,
  - good healthy indoor air?
- And you can have it all within a reasonable budget!

Ultra-High Efficiency

- Enclosure
- Low-Load HVAC
- Efficient Components

+

High-Performance

- Affordable
- Comfort
- Health
- Durability
- Renewable Readiness
- Water Conservation
- Disaster Resistance

Efficiency + Performance Example

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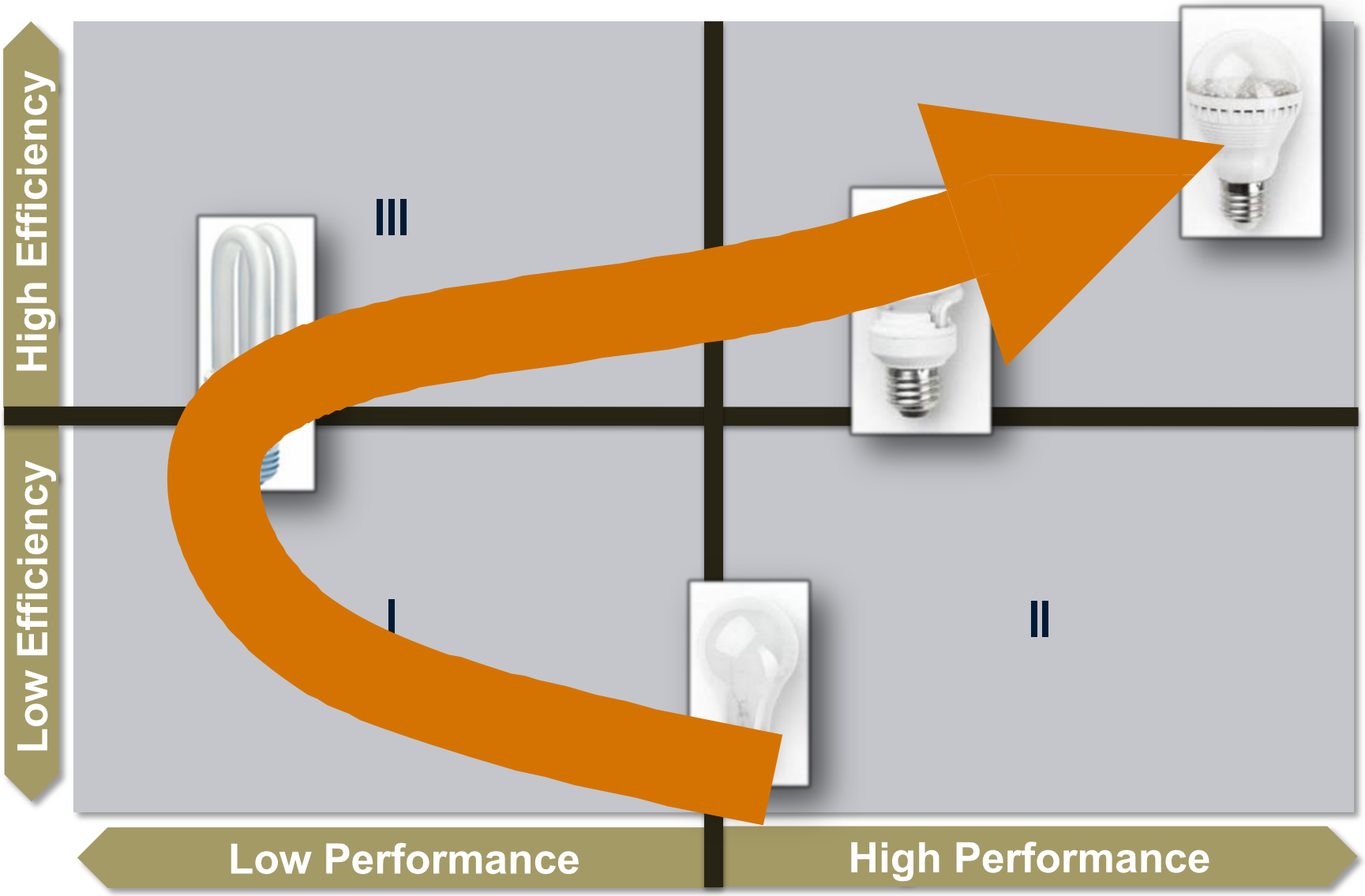

DOE Zero Energy Ready Home Path

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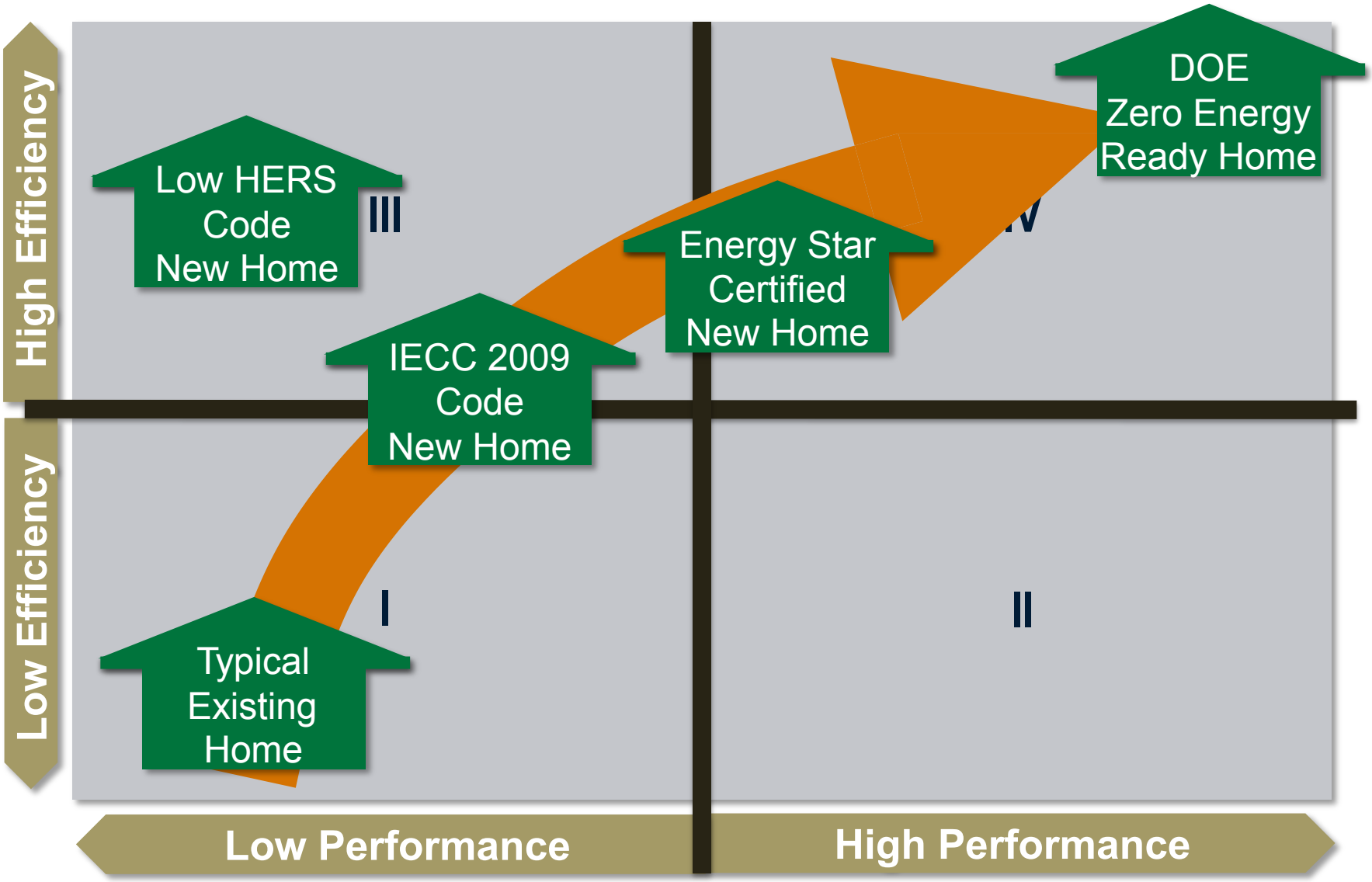

Building America Strategy

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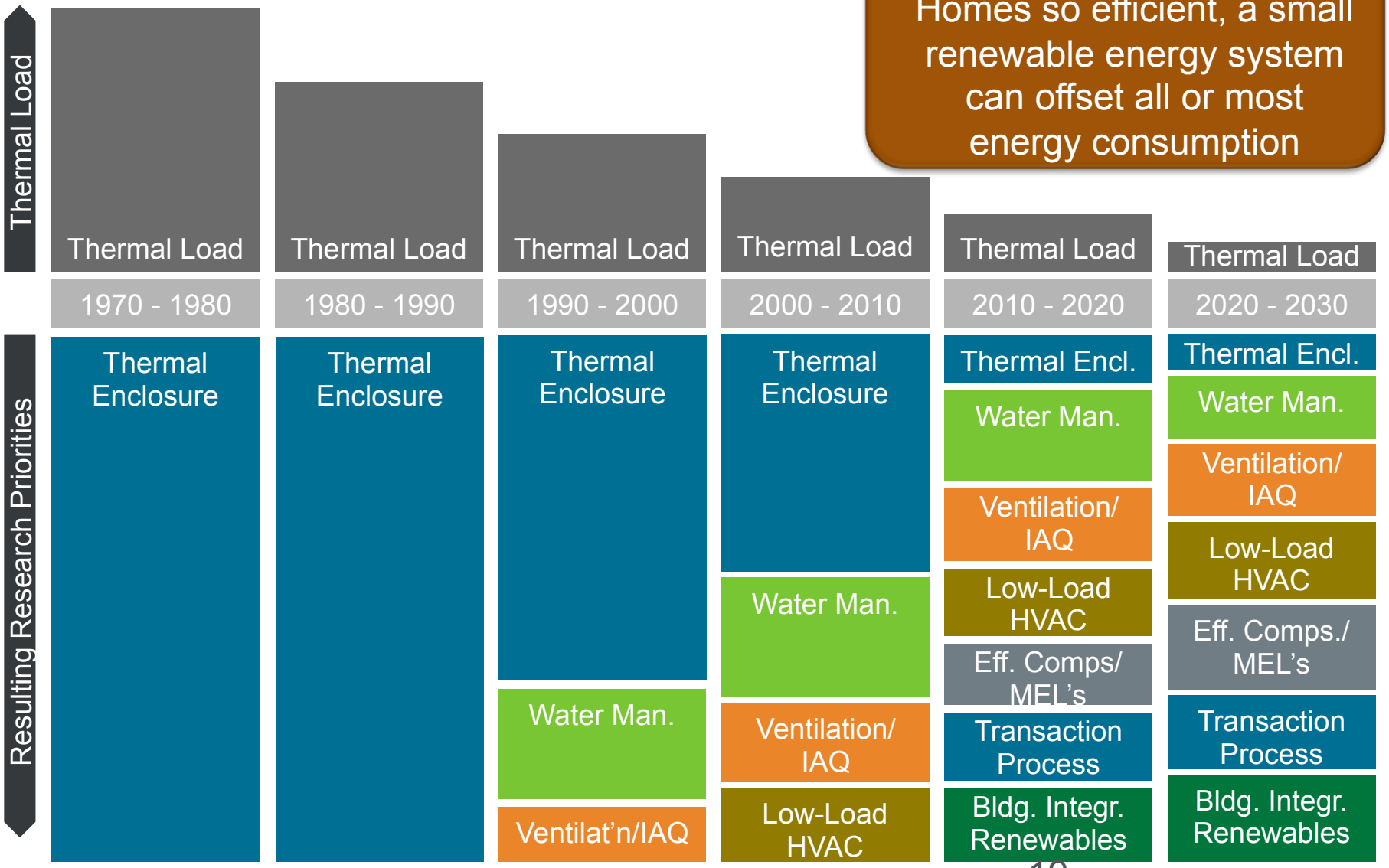
Goal:
Homes so efficient, a small renewable energy system can offset all or most energy consumption



Lots of Recognition Choices…

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Why Build: The Value

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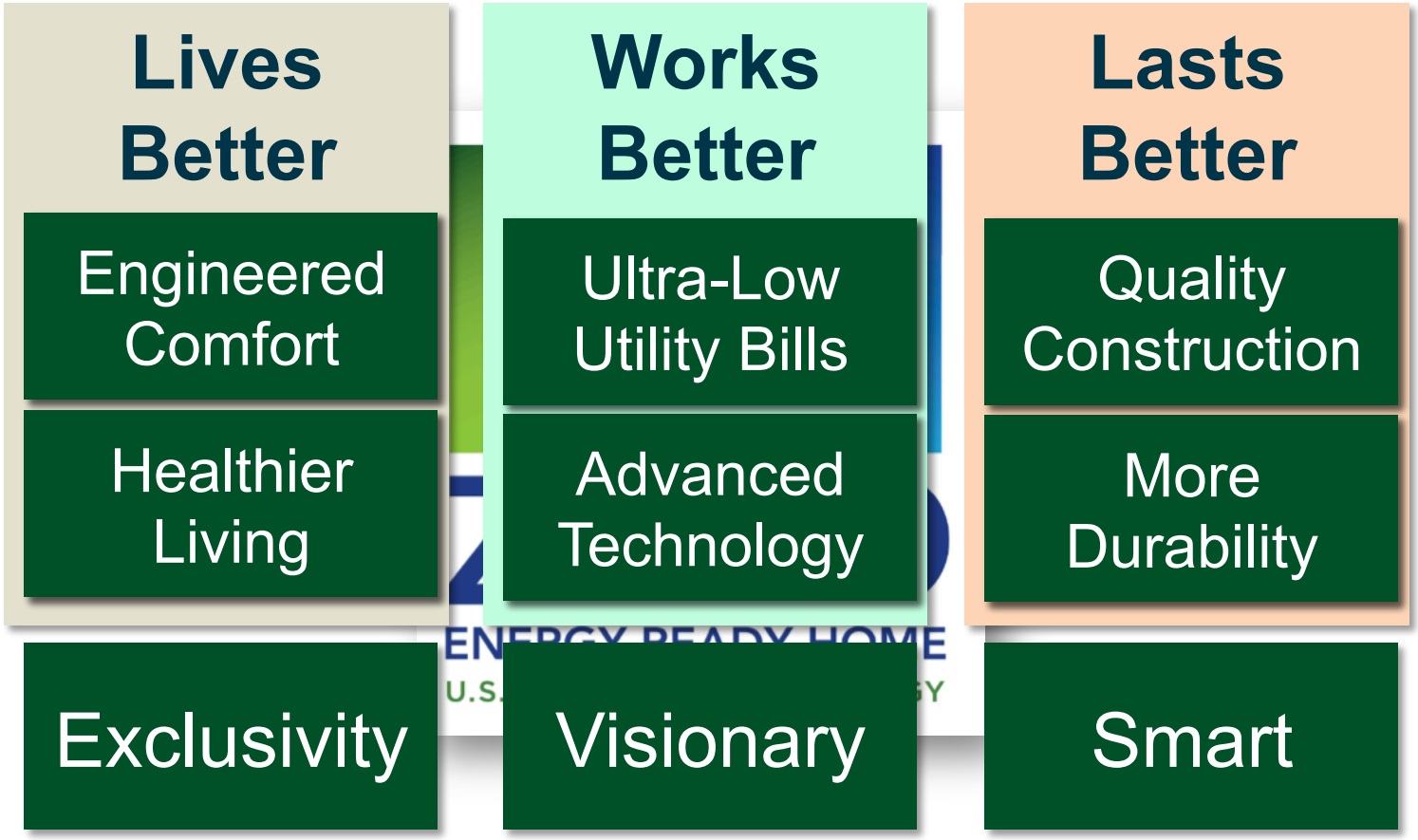
Risk Management | **Zero** Differentiation | **Exceed** Expectations



Zero Energy Ready Home Defined

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Risk Management | **Zero** Differentiation | **Exceed** Expectations

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

DOE ZERO ENERGY READY HOME

- Why build to DOE ZERH?
  - Consumer motivations
  - Builder motivations
- What does DOE ZERH require?
  - Overall a performance-based approach
  - With some prescriptive components
- How do you get there?
  - Strategic partners and resources

DOE ZERO ENERGY READY HOME

- Business Metrics
  - Competitive advantage
  - Reduced callbacks & warranty
  - Improved sales and referrals

- Harvesting the Value Innovation Premium
  - If you can successfully communicate,
  - the innovation and the value,
  - the market leader can command better margins.

DOE ZERO ENERGY READY HOME

- In my view, this program is …
  - Built on a technically solid platform
  - Focused on the right things (not just energy)
  - In the right way (performance-based)
  - At the right level (strategic differentiation)
  - With a delivery process that is credible, but not onerous.

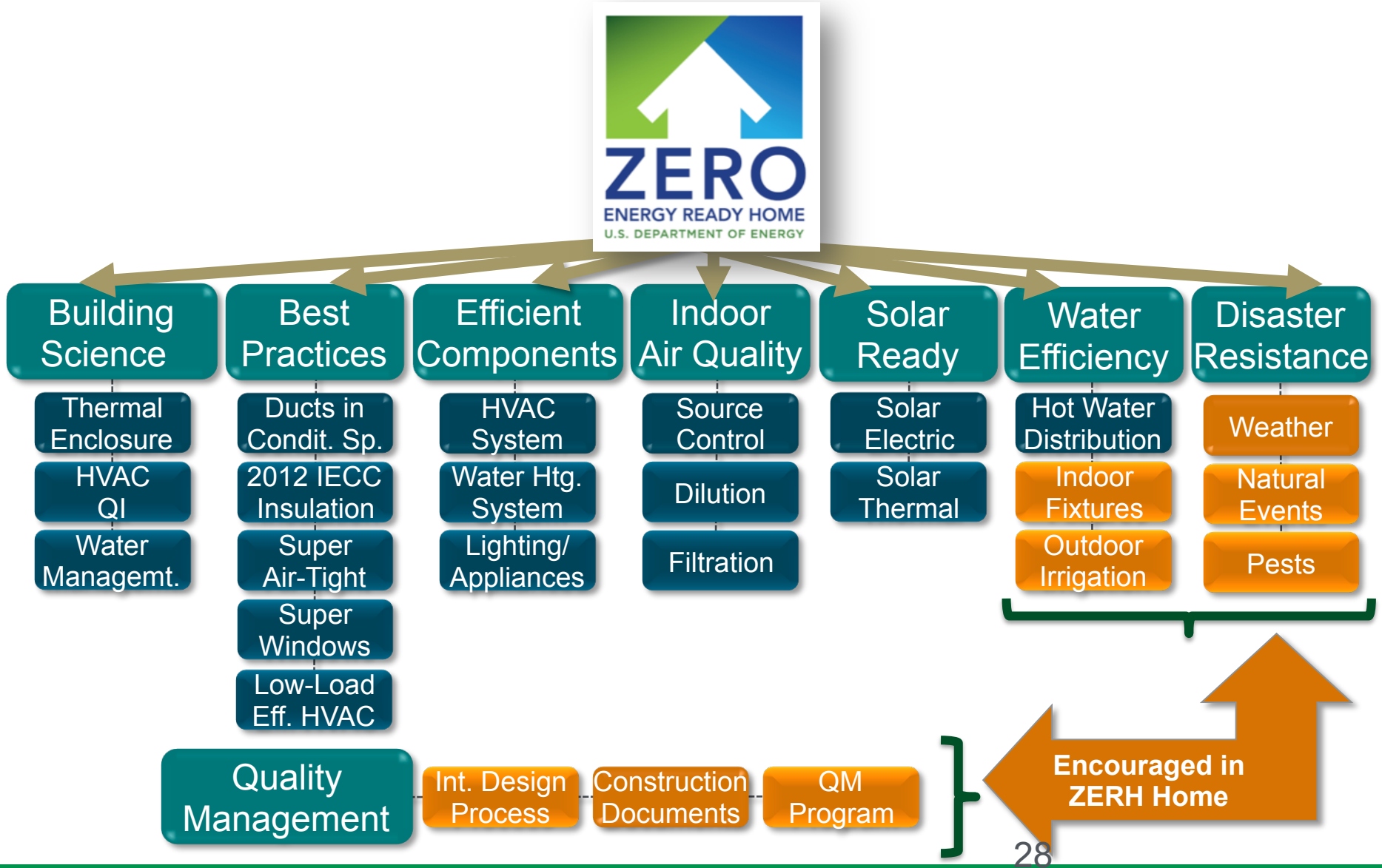
RALLY YOUR PARTNERS

- Energy Raters
- Home Performance Consultants
- Renew/Review/Revisit your Trade Allies
  - Design
  - Subs
  - Supply chain
- Other Resources
  - Link up with a Building America Team

GATHER YOUR RESOURCES

- Start by “Mining” the Building America Resources
  - General Energy Information (EERE Buildings)
    - http://energy.gov/eere/buildings/residential-buildings-integration
  - DOE Zero Energy Ready Home
    - http://energy.gov/eere/buildings/zero-energy-ready-home
  - Top Innovations “Hall of Fame”
    - http://energy.gov/eere/buildings/building-america-top-innovations
  - Building America Solutions Center
    - http://energy.gov/eere/buildings/building-america-solution-center

Zero Energy Ready Home



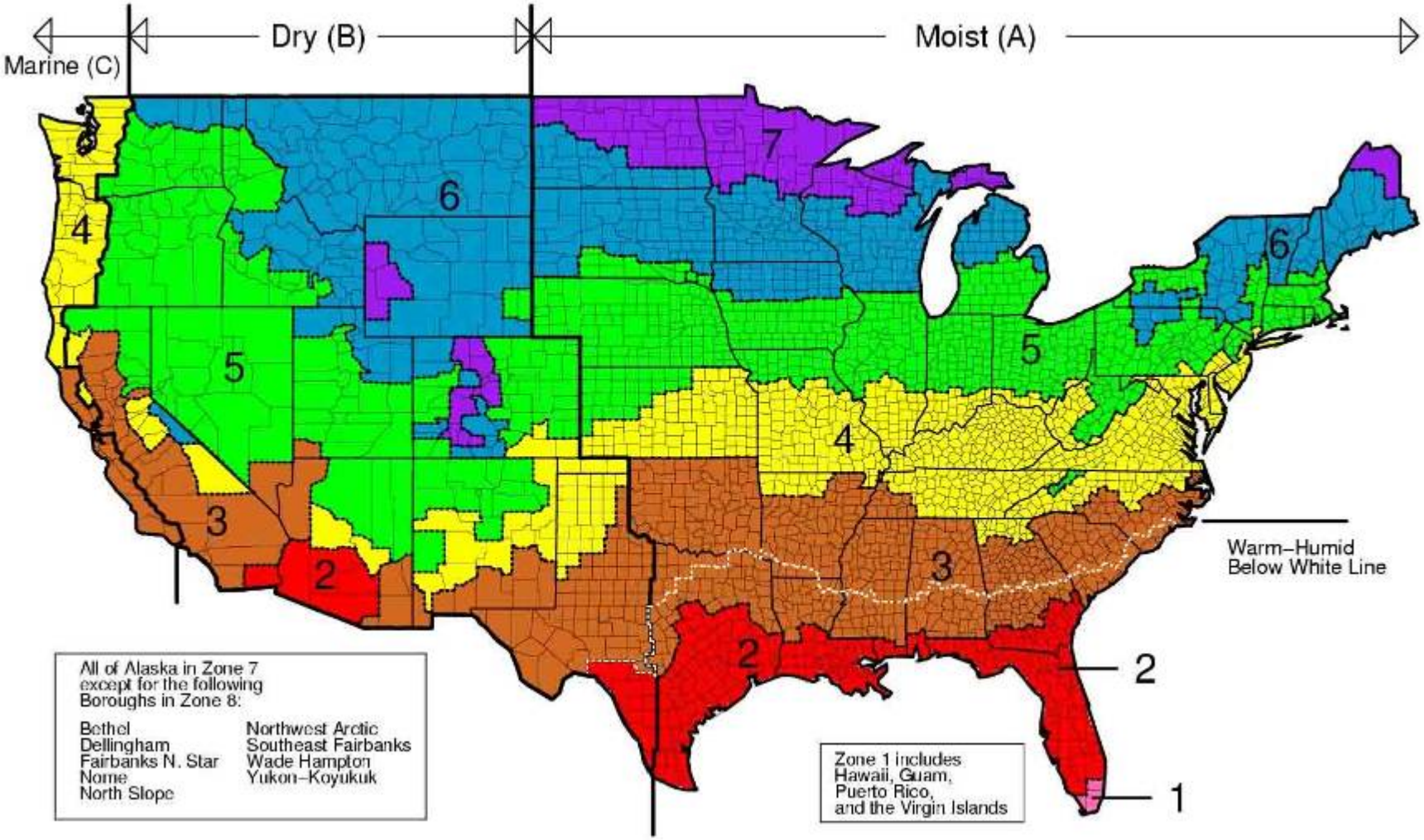
Zero Energy Ready Home

Technical Specifications: Putting It All Together

Technical Specifications

- ENERGY STAR Certified Homes v3
- Advanced Windows
- Air-Tight Construction
- 2012 IECC Insulation
- Energy Efficient Components
- Efficient Hot Water Distribution
- Indoor Air Quality
- Renewable Ready Construction

IECC Climate Zones



DOE ZERH Framework

Mandatory Reqts.

Must Comply

'Target Home' Specs

Trade-Off Flexibility

Size Adjust. Factor

Identical to Energy Star

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

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	☐ Certified under ENERGY STAR Qualified Homes Version 3[5]
2. Envelope[6]	☐ Fenestration shall meet or exceed latest ENERGY STAR requirements[7, 8] ☐ Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels[9]
3. Duct System	☐ Ducts located within the home's thermal and air barrier boundary[10]
4. Water Efficiency	☐ Hot water delivery systems shall meet efficient design requirements[11]
5. Lighting & Appliances[12]	☐ 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[13]
7. Renewable Ready[14]	☐ EPA Renewable Energy Ready Home Solar Electric Checklist and Specifications[15] ☐ EPA Renewable Energy Ready Home Solar Thermal Checklist and Specifications[16]

Exhibit 2: DOE Challenge Home Target Home [3, 17]

HVAC Equipment[18]			
	Hot Climates (2012 IECC Zones 1,2)[19]	Mixed Climates (2012 IECC Zones 3, 4 except Marine)	Cold Climates (2012 IECC Zones 4 Marine 5,6,7,8)
AFUE	80%	90%	94%
SEER	18	15	13
HSPF	8.2	9	10[20]
Geothermal Heat Pump	ENERGY STAR EER and COP Criteria		
ASHRAE 62.2 Whole-House Mechanical Ventilation System	1.4 cfm/W; no heat exchange	1.4 cfm/W; no heat exchange	1.2 cfm/W; heat exchange with 60% SRE
Insulation and Infiltration			
• Insulation levels shall meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards. • Infiltration[21] (ACH50): 3 in CZ's 1-2 | 2.5 in CZ's 3-4 | 2 in CZ's 5-7 | 1.5 in CZ 8			
Windows[22, 23, 24]			
	Hot Climates (2012 IECC Zones 1,2,)	Mixed Climates (2012 IECC Zones 3, 4 except Marine)	Cold Climates (2012 IECC Zones 4 Marine 5,6,7,8)
SHGC	0.25	0.27	any
U-Value	0.4	0.3	0.27
Homes qualifying through the Prescriptive Path with a total window-to-floor area greater than 15% shall have adjusted U-values or SHGCs.[25]			
Water Heater			
ENERGY STAR minimum; for heating oil water heaters use EF = 0.60			

Effective for Homes Permitted Starting 4/1/2012 | Revised 07/01/2012 | Page 2 of 8

Exhibit 3: Benchmark Home Size[26]

Bedrooms in Home to be Built	1	2	3	4	5	6	7	8
Conditioned Floor Area Benchmark Home	1,000	1,600	2,200	2,800	3,400	4,000	4,600	5,200

Zero Energy Ready Home

Technical Specifications Mandatory Requirements:

Mandatory Requirements

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Encouraged:

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

Zero Energy Ready Home

Performance Threshold

‘Target Home’ vs. Energy Star Spec

Higher Eff. HVAC Equip.

2012 vs. 2009 IECC Insul.

More Eff. Windows

Half ACH50

ENERGY STAR Water Htg.

Exhibit 2: DOE Challenge Home Target Home [3, 17]

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Windows [21, 22, 23]

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SHGC	0.25	0.27	any
U-Value	0.4	0.3	0.27

Homes qualifying through the Prescriptive Path with a total window-to-floor area greater than 15% shall have adjusted U-values or SHGCs. [24]

Water Heater

ENERGY STAR minimum

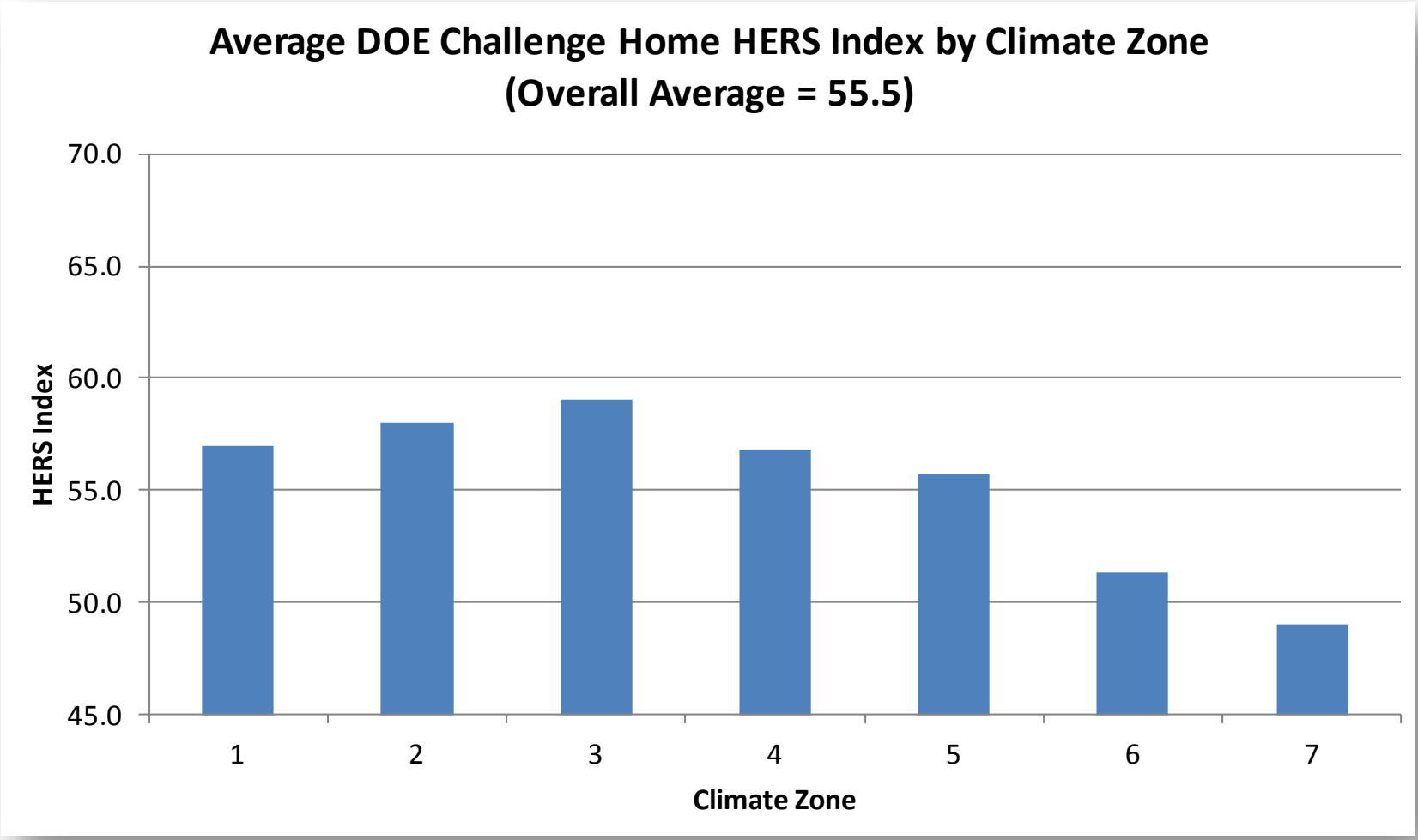
Thermostat [25] **& Ductwork**

- Programmable thermostat (except for zones with radiant heat)

Lighting & Appliances

- For purposes of calculating the DOE Challenge Home Target Home HERS Index, homes shall be modeled with an ENERGY STAR dishwasher, ENERGY STAR refrigerator, ENERGY STAR ceiling fans, and ENERGY STAR lamps (bulbs) in 80% of sockets or 80% of lighting fixtures are ENERGY STAR Qualified.

Target Home Avg. HERS Scores



Based on 1800, 2400, and 3600 ft ^{2} prototypes on climate-appropriate foundations.

Size Adjustment Factor

Homes larger than the benchmark home size must use the size adjustment factor to determine the target HERS index

Exhibit 3: Benchmark Home Size[26]

Bedrooms in Home to be Built	1	2	3	4	5	6	7	8
Conditioned Floor Area $_{\text{Benchmark Home}}$	1,000	1,600	2,200	2,800	3,400	4,000	4,600	5,200

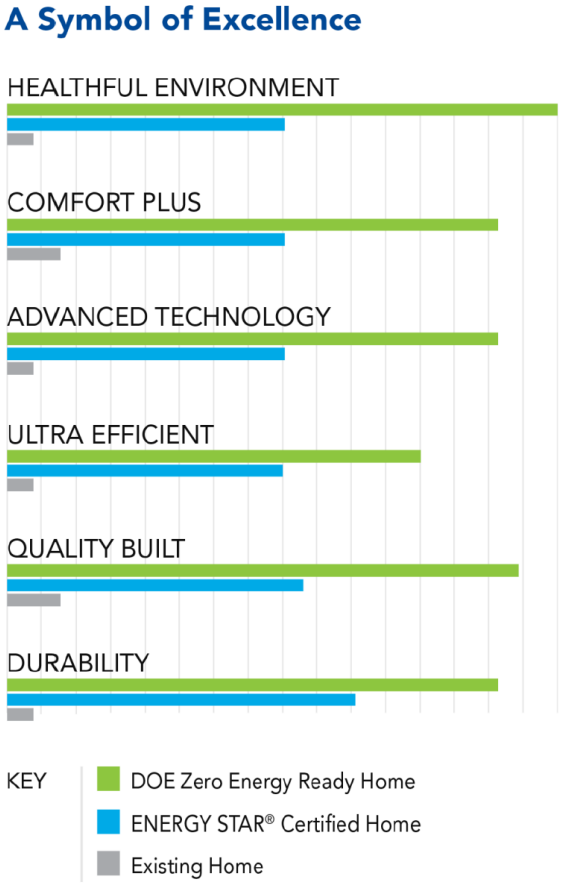
Note: Renewable energy systems may not be used to qualify for the Zero Energy Ready Home HERS Index Target Score, but may be used for the incremental HERS Index points needed for the Size Adjustment Factor.

$$\text{Size Mod. Factor} = [CFA_{\text{Benchmark Home}} / CFA_{\text{Home to Be Built}}]^{0.25}$$

[Not to Exceed 1.0]

A Verified Symbol of Excellence

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



ACT 3: THE FUTURE IS HERE!

- The technologies, systems, and best practices are in place for high-performance homes today.
- The “Zero Energy Ready Home” has been proven in the market.
- With solar PV prices falling, a small investment can take these homes to a “zero” energy bill.

MINNESOTA'S 1ST DOE ZERH HOME

- Amaris Custom Homes
  - Ray Pruban
- Debuted in 2013 BATC Fall Parade of Homes
  - Rambler with full walkout basement
  - 3,542 sq. ft. conditioned
  - 5 bedrooms, 4 baths
  - St. Paul, MN (CZ=6)

- HERS = 41 w/o PV
- HERS = 4 w/ 10 KW PV

AMARIS CUSTOM HOMES

- BASELINE certified ENERGY STAR for Homes v3.0
  - »
- ENVELOPE meets or exceeds 2012 IECC levels
  - »
- DUCT SYSTEM within home's thermal boundary
  - »
- WATER EFFICIENCY (WaterSense Section 3.3 specs)
  - »
- LIGHTING & APPLIANCES ENERGY STAR qualified
  - »
- INDOOR AIR QUALITY (EPA IndoorairPLUS Checklist)
  - »
- RENEWABLE READY chaseway built-in for PV array

AMARIS CUSTOM HOMES

- ICF foundation
- 2x6 w/ ccSPU + 1” XPS
- Raised heel truss w/ 2” ccSPU + R-48 fiberglass
- Windows: U = 0.25
- Airtightness = 465@50PA
- 95% AFUE furnace & boiler
- 16 SEER AC
- ERV & source exhausts
- ENERGY STAR Appliances
- 90% LED; 10% CFL

- Good shape & orientation
- Passive solar design
- In-floor heating w/ tile
- No/Low VOC materials

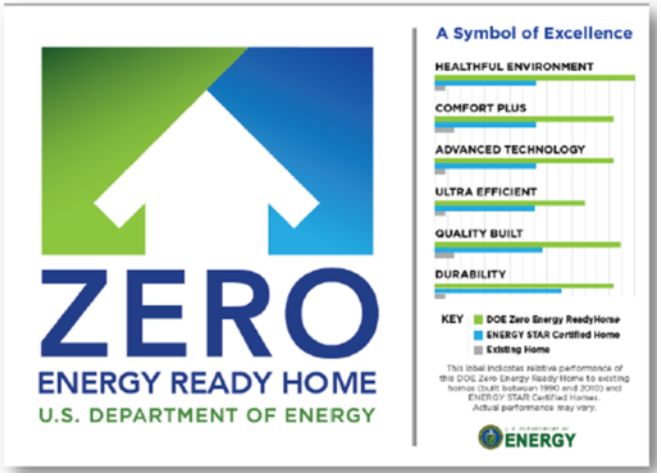
AMARIS CUSTOM HOMES

- Specific Home Certifications
  - DOE Challenge Home (now ZERH)
  - ENERGY STAR Version 3
  - MN GreenPath - Emerald
  - LEED for Homes v4 Beta – Silver

- Builders Association of the Twin Cities Reggie℠ Award of Excellence

AMARIS CUSTOM HOMES

- Challenges
  - Exterior foam
  - Mechanical systems
  - Water distribution
- Key Lessons
  - “Green” is challenging to sell because it is poorly defined
  - “Healthier living is built-in” resonates very well with his market
  - DOE ZERH label was his “best bang for the buck”
  - Has committed to 100% ZERH

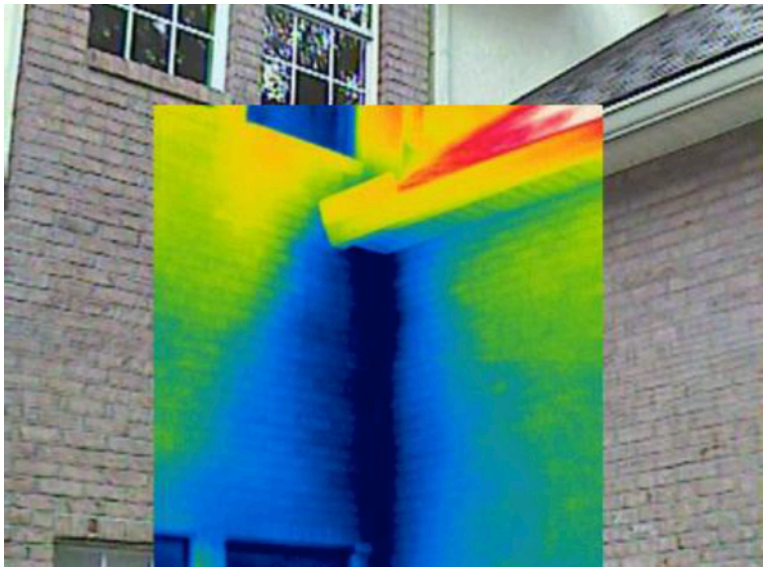


AMARIS CUSTOM HOMES

- Fall Parade of Homes
  - Afton, MN
  - Model #299
  - $899,000
- Custom Ranch
  - 3,800 sq. ft.
  - DOE ZERH w/ solar PV
  - “No utility bill guarantee” for 10 years (gas, elec, water)

BUILDING SCIENCE EDUCATION

- DOE recognizes a large building science void exists in post-secondary education;
  - They must increase the quantity/quality of building science education
  - To properly support high-performance buildings.



BUILDING SCIENCE EDUCATION

- The current “desired outcome” is to ensure all students in building design, engineering, construction, and operations will have:
  - a substantive “building science fundamentals” course early in their program,
  - solid “building science” concepts infused into their traditional courses, and
  - access to specialized, in-depth building science coursework

2015 DOE "RACE TO ZERO"

- National Renewable Energy Lab in Golden, CO
- 27 Universities; 33 Teams
- Competing to design cost-effective, zero energy ready homes for mainstream builders.

- Discussion & Questions

Contact Information

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