



UNIVERSITY OF MINNESOTA | EXTENSION

MAKING A DIFFERENCE IN MINNESOTA: ENVIRONMENT + FOOD & AGRICULTURE + COMMUNITIES + FAMILIES + YOUTH

Zeroing In*: The Path to High-Performance

* with credit to Joe Lstiburek, Building Science Corporation

28th Energy Design Conference

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Duluth, MN

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CONTINUING EDUCATION CREDITS

- In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

“This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors** continuing education requirements.”

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ZEROING IN*: THE PATH TO HIGH-PERFORMANCE

- Part 1: The Why of Zero Energy Homes
 - Building Science + Systems Approach = High-Performance
 - Part 2: DOE Zero Energy Ready Home Program
 - Business Case
 - Technical Requirements
 - Part 3: Going to Net Zero Energy Today
 - Keys to Success
- A reflection on where we have been, where we are, and where we can go!

KEEPING OUR EYE ON THE BALL

- Is it possible that we have over-invested in products and under-invested in good design and proper execution?
- Are we not being realistic about the process?
 - Are we investing in risky designs, systems, and materials and hoping for perfect execution?
 - Are we counting on perfect homeowner operation and maintenance?

A GROWING EPIDEMIC: NOTMYJOBITIS



THE CONTEXT: FIVE THINGS*

- How did we get here?
- What is driving these changes?
- What does it mean for building design and construction practices?

* BSI:-039: The Five Things by Jospeh Lsitburek

FIVE FUNDAMENTAL CHANGES

- Increase thermal resistance
 - more insulation => less heat flow => less drying!
- Changes in permeability of linings
 - while this may mean less wetting,
 - it also can lead to very slow drying!
- Increased water/mold sensitivity of materials
- Moisture storage and redistribution
- Complex 3-D airflow networks in buildings

FIVE KEY DRIVERS FOR CHANGE

- Demand for Increased Comfort
- Drive for Improved Energy Efficiency
- Interest in Low-Maintenance Homes
- Concerns for Indoor Air Quality
- Rising Cost of Housing

FIVE INEVITABLE TRENDS

- Building Airtightness
 - getting tighter everyday; not certain where it will stop
- Mechanical Ventilation
 - must include air distribution; moving towards balanced
- Exterior Control Layers
 - especially insulation with vented cladding
- Ducts in Conditioned Space
 - will drive use of conditioned crawl spaces/attics
- Active Pressure Management
 - integrated make-up air



FIVE CHANGES WE MUST EMBRACE

- Step Back & Take a Broader Systems View
- Demand Performance Over Prescriptive
- Use Building Science, Engineered Approach
- Place a Premium on Robust
- Focus on Total Cost of Ownership

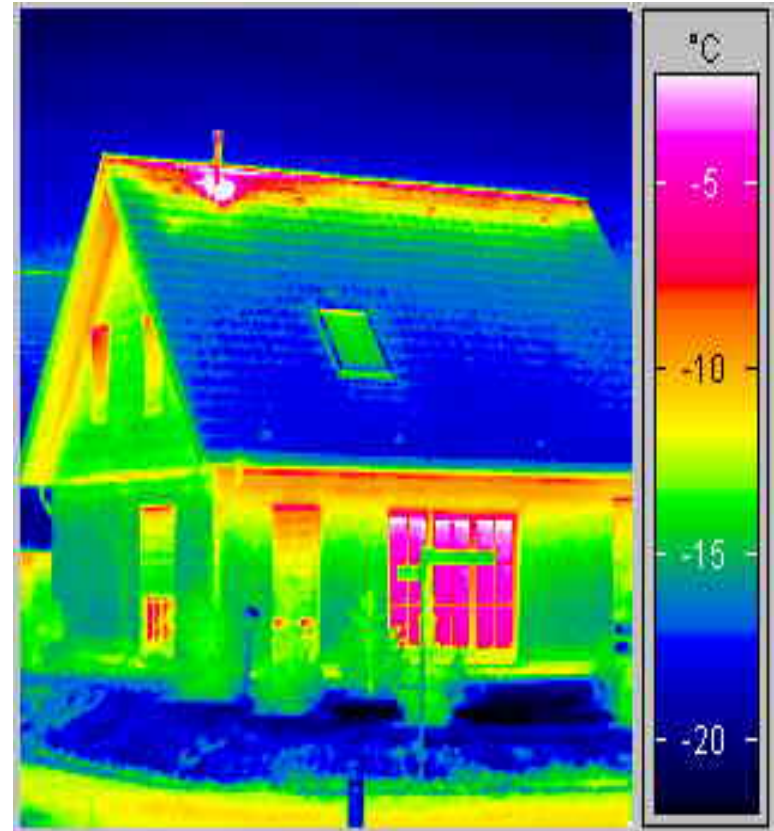
MAKING THE CASE FOR ROBUST

- We must ensure our high-performance houses meet our expectations today and in the future?
- High-performance houses will push our current approach. Therefore, we must ...
 - design and engineer (not just build) our homes.
 - build forgiveness/tolerance into all systems.
 - build redundancy into critical materials.
 - or make it easy to repair and/or replace key components
 - develop a more predictable delivery system.
 - provide continuous feedback to the occupant.



THE POWER OF ZERO ENERGY HOMES

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

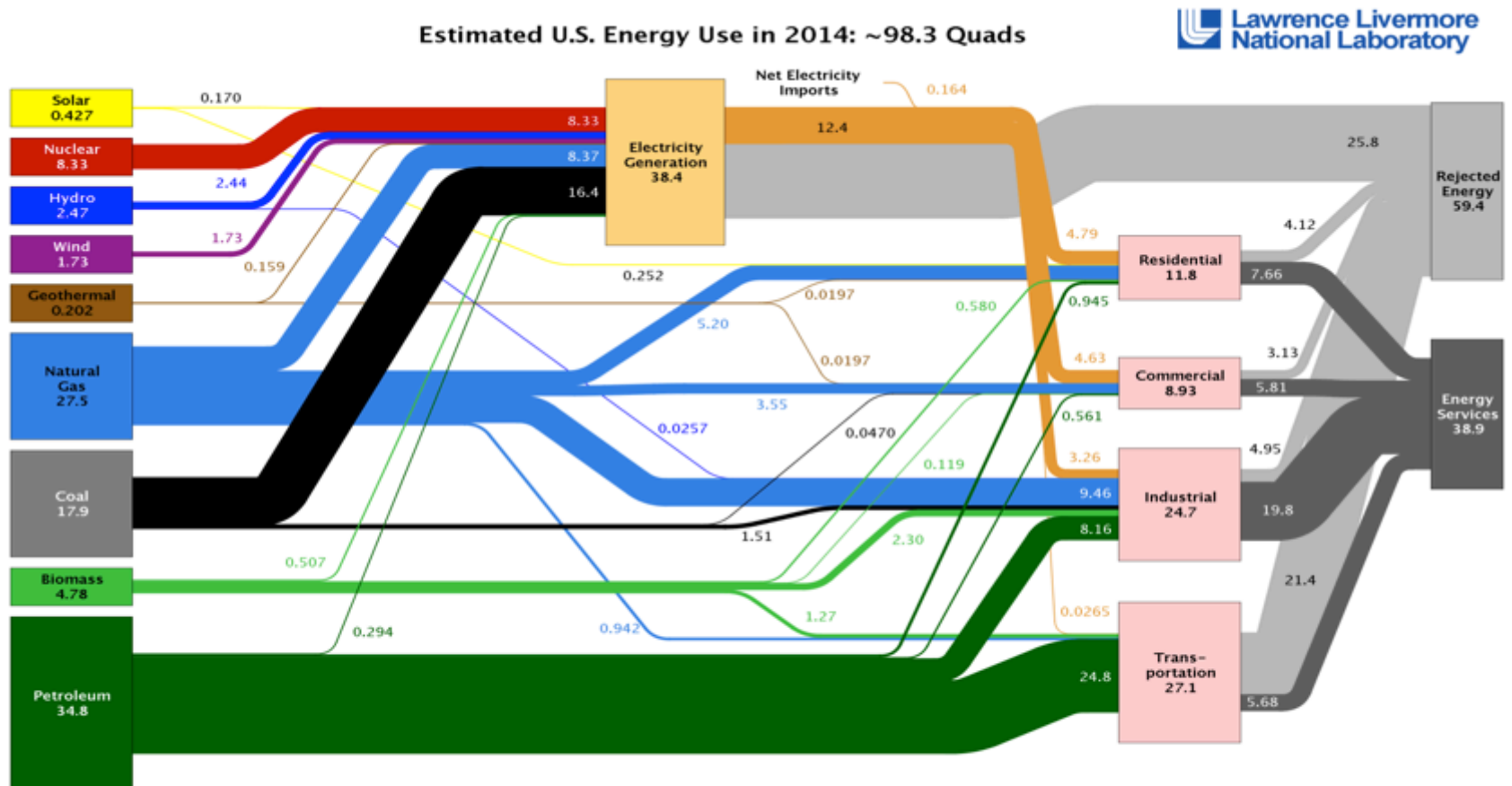


THE POWER OF ZERO ENERGY HOMES

- Absolutely – with a couple of caveats!
- Homes will always require energy.
- Can the home produce as much as it uses?
 - Is it site energy or source energy?
 - If dollars, don't forget the \$20 per month in fees.



THE ENERGY PICTURE IN THE U.S.

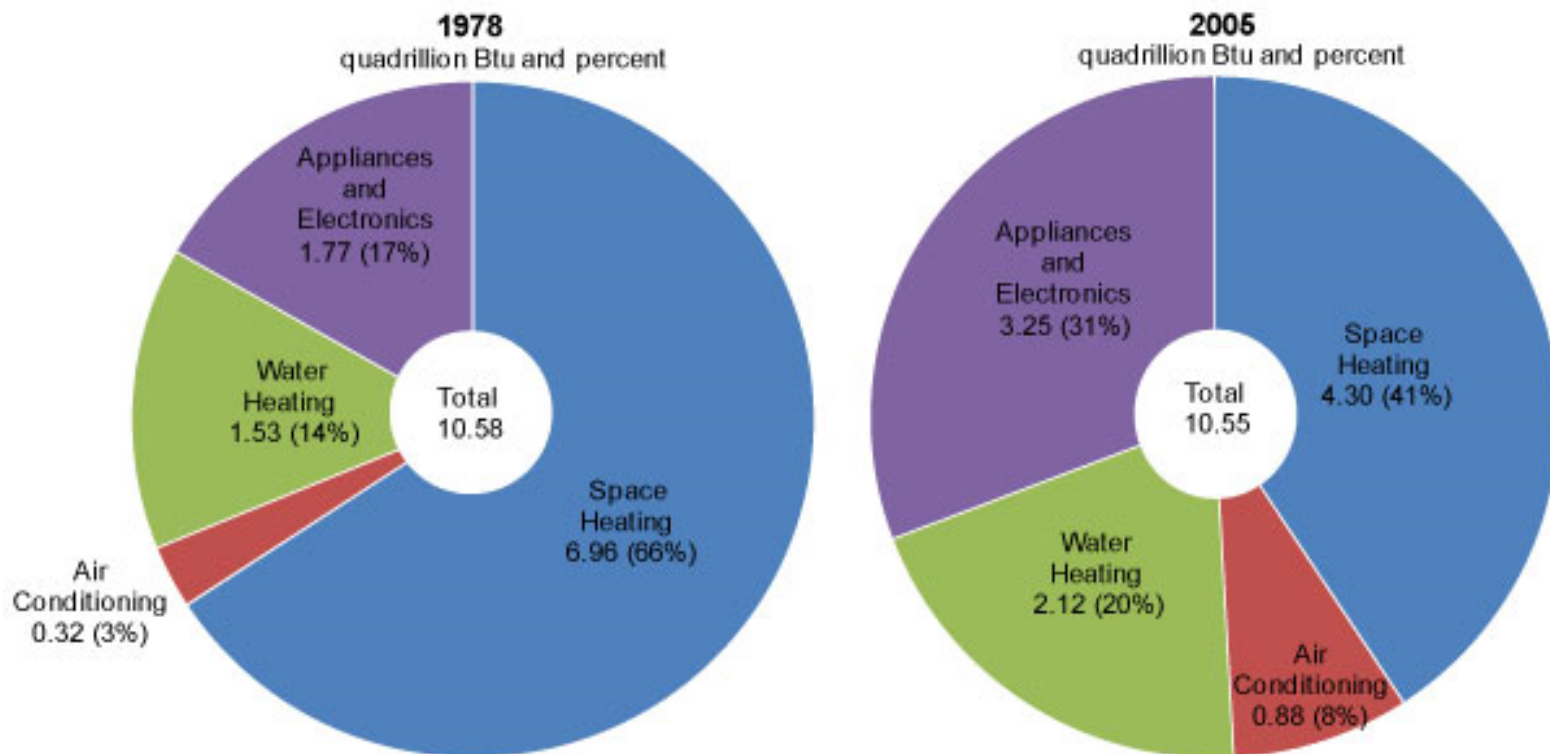


Source: LLNL 2015. Data is based on DOE/EIA-0035(2015-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents 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 USE IN OUR HOMES

Total energy use in homes



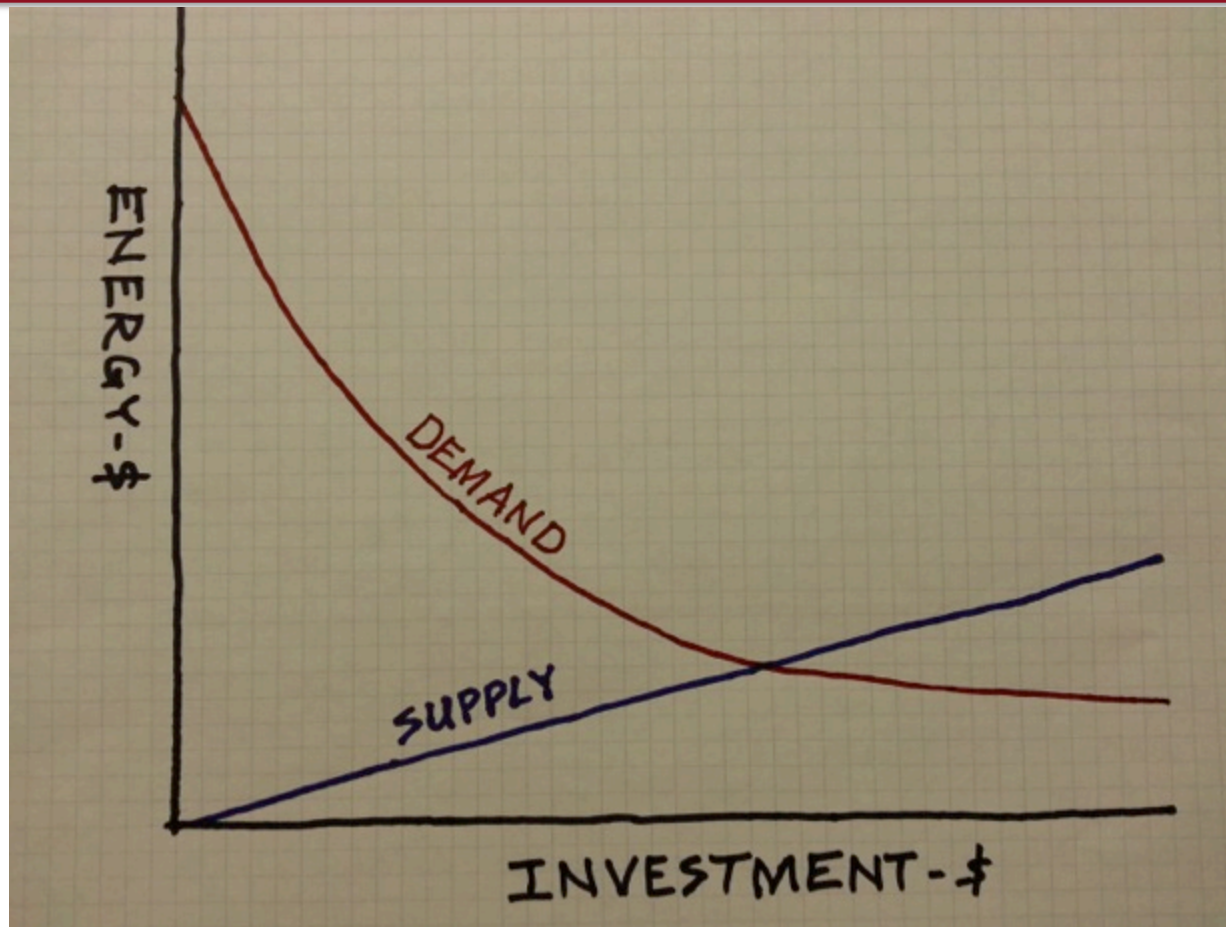
Source: U.S. Energy Information Administration, 1978 and 2005 Residential Energy Consumption Survey

FUNDAMENTAL ENERGY STRATEGIES

- Conservation
 - Lowest cost; best return
- Efficiency
 - Moderate expense; good return
- Alternatives
 - Most expensive; lowest return

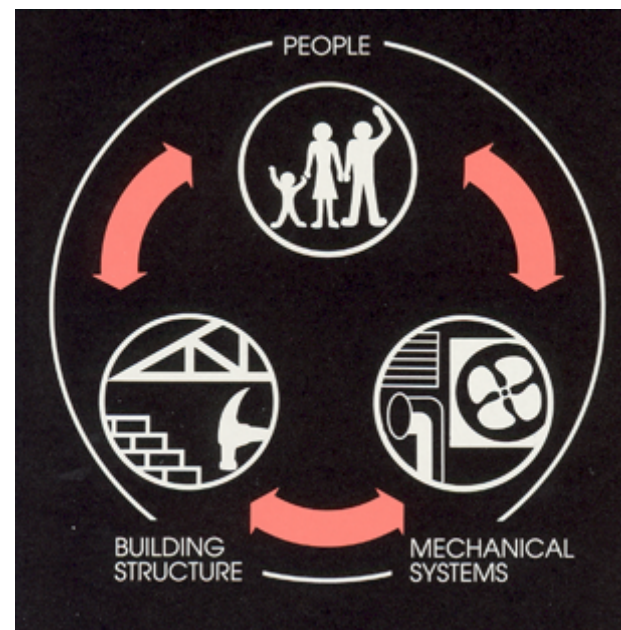


ENERGY SAVED VS. DOLLAR SPENT



ENERGY EFFICIENT HOME FORMULA

- 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.



THE BIGGER SYSTEMS VIEW

- We can and must do better!
 - Must balance efficiency with robust performance.
- Existing technology can get us there!
 - It's not about products; it's about execution.
- New technologies will be important
 - But we must be systematic in their evaluation & application.

THE PATHWAY TO NET ZERO ENERGY

- ENERGY STAR (ver 3.1)
 - gets the wheels moving in the right direction.
- DOE Zero Energy Ready Home (ver 6.0)
 - is a more comprehensive, holistic approach.
- Best Current Practices (according to me)
 - fills a couple of key gaps for our market/climate.
- Net Zero Today (by Joe Lstiburek)
 - provides a vision for the future.

PATH TO ZERO: METRICS

- Pathway Comparison
 - Enclosure
 - HVAC
 - Domestic Hot Water
 - Indoor Air Quality
 - Renewables

PATH TO ZERO: METRICS

Enclosure (R-values)	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Ceiling	50	50	50	50	60
Walls	20/21	25	25	30	40
Floors	30/38	30/38	30/38	40	NS
Foundation	15(10)	15	15	15	20
Slabs					
- Basement	0	0	0	10	10
- On-grade	10	10	10	15	20

PATH TO ZERO: METRICS

Enclosure (U-values)	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Windows	0.32	0.30	0.27	0.25	0.20
Doors	???	0.21	0.21	0.21	NS

Enclosure Airtightness	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
ACH@50Pa	3.0	3.0	2.0	1.0	1.5

PATH TO ZERO: METRICS

HVAC (Equipment)	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Heating					
- AFUE	80%	90%	94%	94%	95%
- HSPF	8.2	8.2	10.0	10.0	NS
Cooling (SEER)	13	13	13	15	18
Ventilation					
- Type	Balanced	NR*	Balanced	Balanced	Balanced
- HRV/ERV (Eff)	NR	NR	60%	70%	NS
- Distribute	All Rooms	NR*	NR*	All Rooms	All Rooms
Filtration(MERV)	8	8	8	11	NS

PATH TO ZERO: METRICS

HVAC (Ductwork)	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Ducts	Sealed S&R	Sealed S&R	Sealed S&R	Sealed S&R	Sealed S&R
Leakage	4cfm/100sf	4cfm/100sf	Condition	Condition	Condition
Insulation	R-8	R-8	NA	NA	NA

Make-Up Air	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Range	NA	NA	Vented	Vent/MUA	Vent/MUA
Dryer	???	Vented	Vented	Vent/MUA	Vent/MUA
Exhaust Fan	Allowed	Allowed	Allowed	Small/MUA	NS



PATH TO ZERO: METRICS

Domestic Hot Water	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Plant (EF)	???	0.67	0.67	CSC(combi)	NS
Insulation	R-3	R-3	R-5	R-5	NS
Distribution	NA	NA	WaterSense	WaterSense	NS

Appliances & Lighting	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Appliances	NA	E-STAR	E-STAR	E-STAR+	E-STAR+
Lighting	NA	80% E-STAR	80% E-STAR	90% LED	100% LED



PATH TO ZERO: METRICS

Indoor Air Quality	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
IndoorAir+	NA	Partial	Yes	Yes	NS
Garage Vent	NA	NA	Yes*	Yes*	NS
Radon	Rn Ready	Rn Ready	Rn Ready	ASD	NS

Renewable Ready	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Solar Thermal	NA	NA	Optional	Optional	NS
Solar PV	NA	NA	Yes*	Yes	Yes



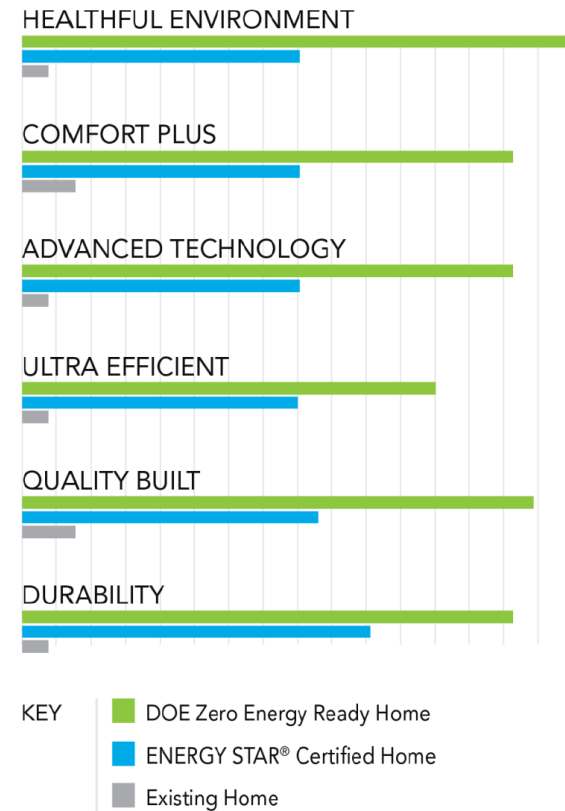
PATH TO ZERO: COST SUMMARY

	MN Code	ENERGY STAR	DOE ZERH	BCP (PH)	NZE (JL)*
Cost Premium	Base	\$5,000	\$10,000	\$15,000	\$20,000
Energy \$/yr	\$2,000	\$1,500	\$1,250	\$1,000	\$750
PV for NZE	20 kW	15 kW	12 kW	10 kW	8 kW
PV System \$	\$60,000	\$45,000	\$36,000	\$30,000	\$24,000
Total Cost	\$60,000	\$50,000	\$46,000	\$45,000	\$44,000

PART 2: ZERO ENERGY READY HOME



A Symbol of Excellence



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.

Ultra-High Efficiency + High-Performance

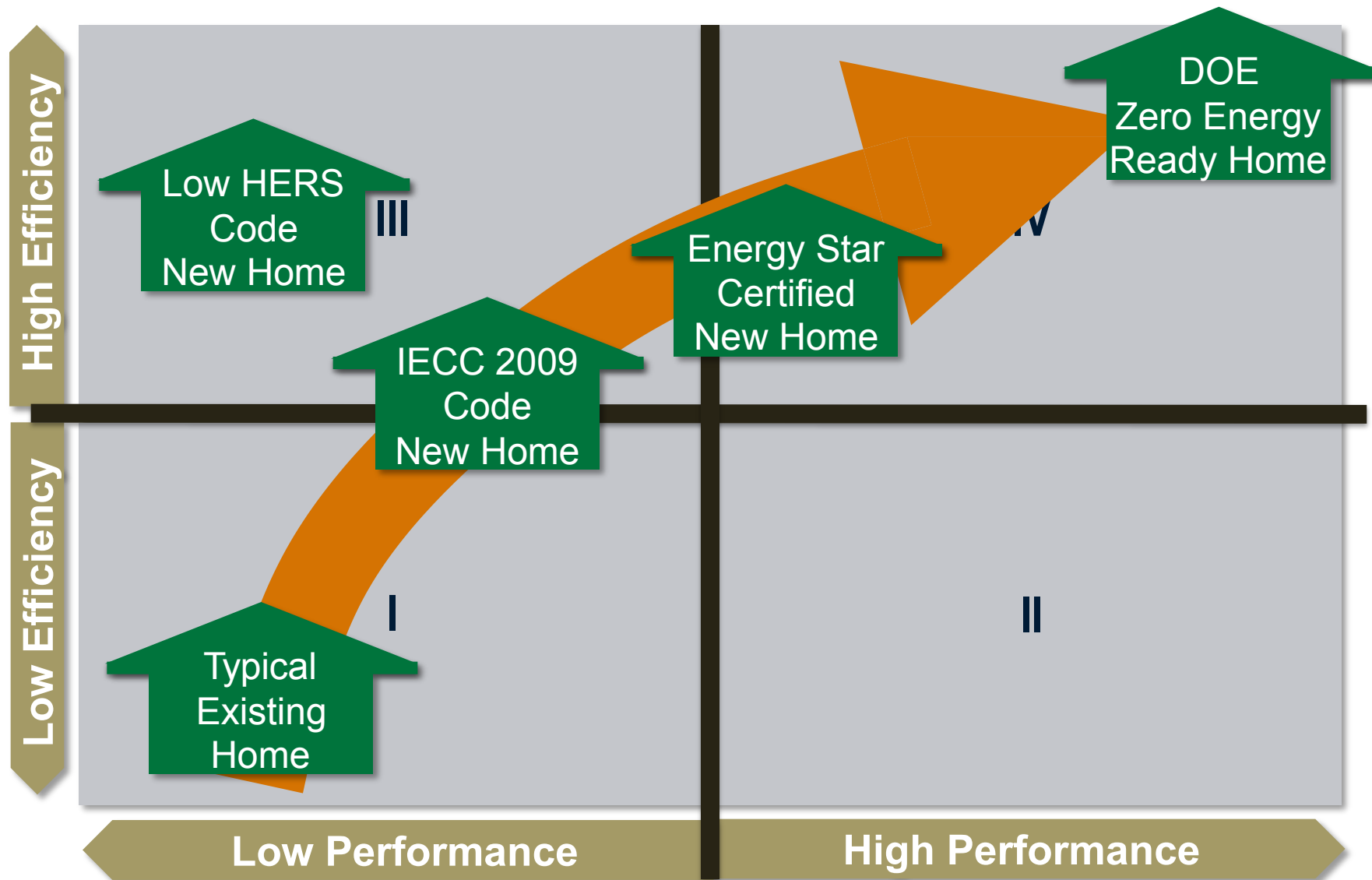
- Enclosure
- Low-Load HVAC
- Components

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

DOE Zero Energy Ready Home Path

U.S. DEPARTMENT OF
ENERGY

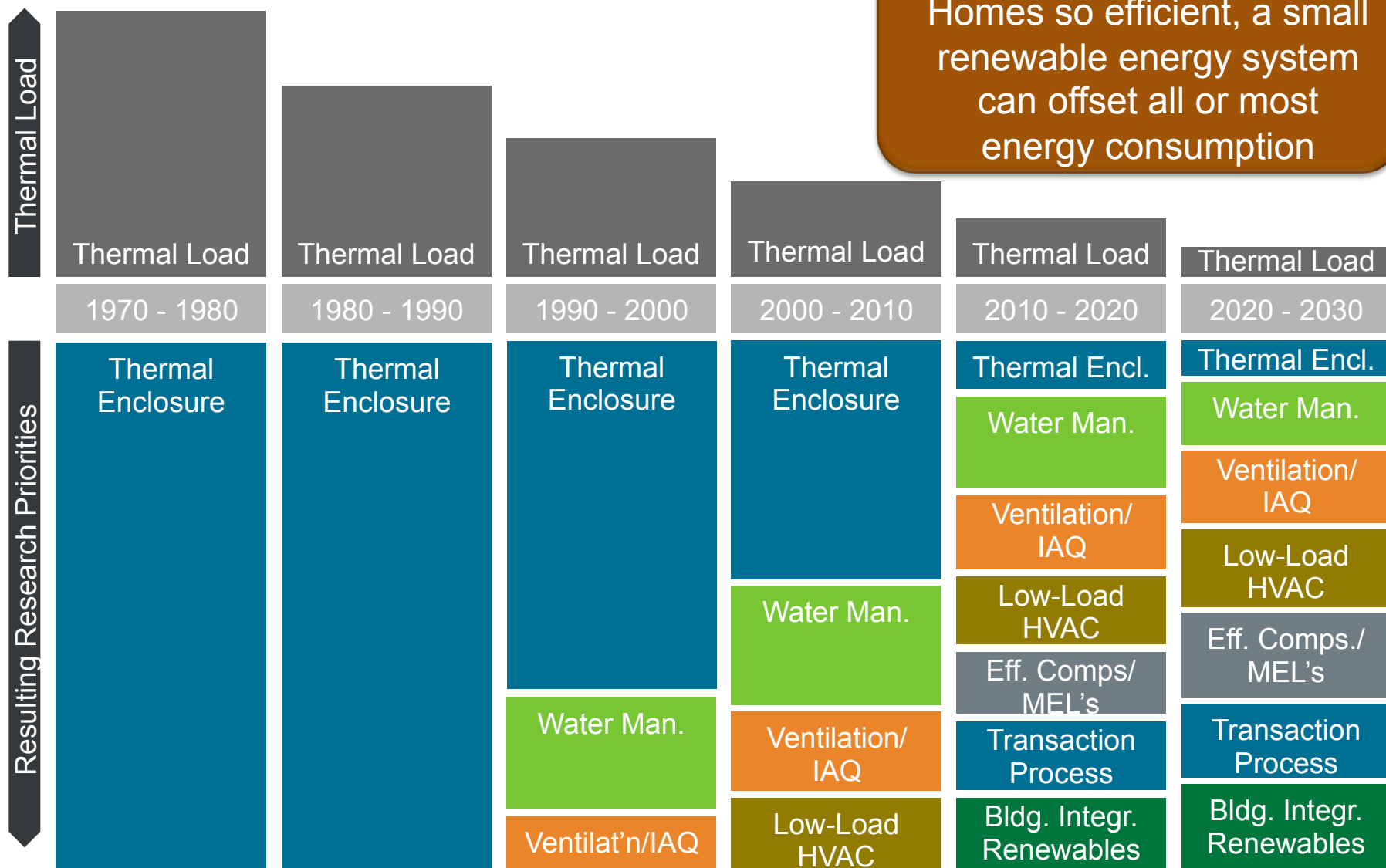
Energy Efficiency &
Renewable Energy



Building America Strategy

Goal:

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



Lots of Recognition Choices...

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



By constructing DOE Zero Energy Ready Homes, you will be:

- **in a select group of builders**
Only the top one percent of builders in the country meet the extraordinary energy efficiency, comfort, health, safety, durability, and quality levels associated with the DOE Zero Energy Ready Home.
- **providing unprecedented value**
Your customers will receive immediate energy savings of 40-50% and a home that can be easily adapted to net-zero performance with a small renewable energy system.
- **differentiated from the competition**
About 12 in 13 homes sales nationwide are 'used' homes. In addition, the majority of new homes are constructed to minimum code. Based on a foundation of comprehensive home performance, including ENERGY STAR Qualified Home v.3 and the latest proven innovations from DOE Building America, this program provides a path to constructing zero net-energy ready homes that none of your competition has.



Zero Energy Ready Home
Why Build:

The Business Case

Risk Management

Zero Differentiation

Exceed Expectations

Risk Management

Zero Differentiation

Exceed Expectations



More Rigorous Specs:

- Latest Energy Codes
- Low HERS Scores
- Voluntary Labels



Adv. Thermal Enclosure:

- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Risk 1: Ensured Comfort

Risk Management

Zero Differentiation

Exceed Expectations



Ultra Low HVAC Loads:

- Lower Air Flow/Mixing
- Longer Swing Seasons
- Less Humidity Control



Adv. Thermal Enclosure:

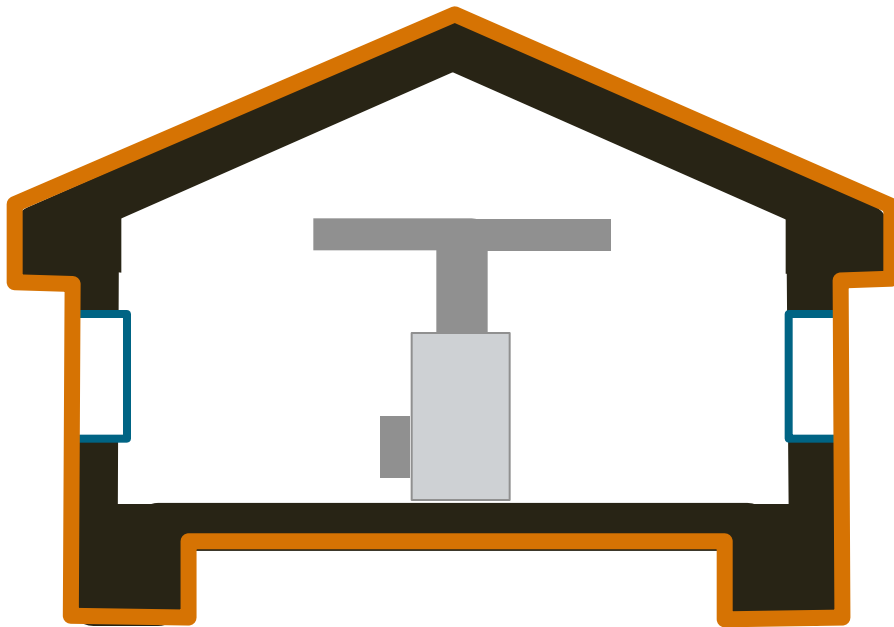
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Risk 1: Ensured Comfort Strategy

Risk Management

Zero Differentiation

Exceed Expectations



Ultra Low HVAC Loads:

- Lower Air Flow/Mixing
- Longer Swing Seasons
- Less Humidity Control



Optimized Low-Load Comfort System

- Right-Sized
- Properly Installed
- Complete (Htg., Clg. + RH)
- Tested

Risk 2: Moisture Man.

Risk Management

Zero Differentiation

Exceed Expectations



More Wetting Risk

- Colder Walls
- Less Drying Potential

Adv. Thermal Enclosure:

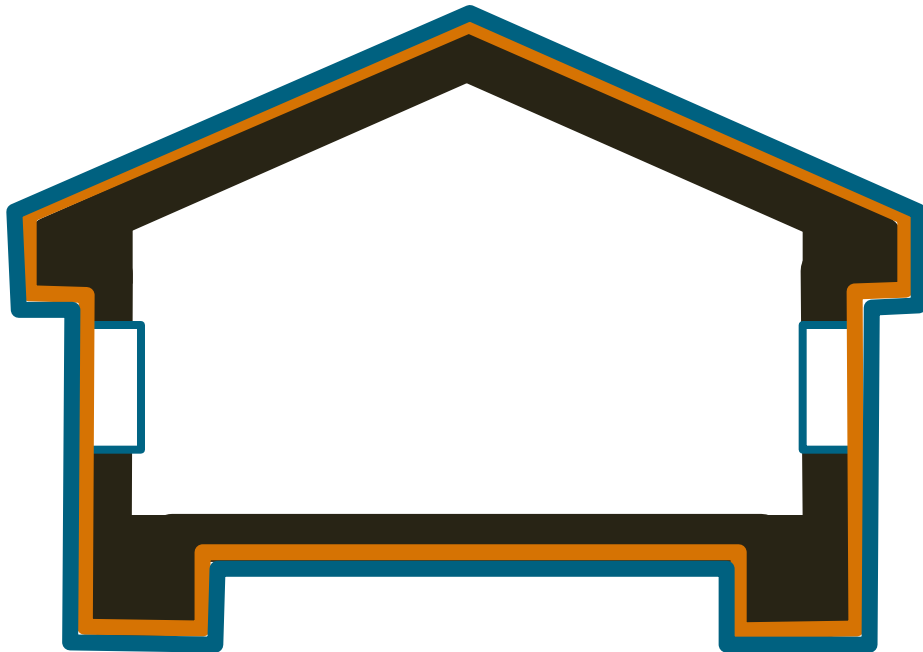
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 - Complete System
- Advanced Windows
- More Air Tightness

Risk 2: Moisture Man. Strategy

Risk Management

Zero Differentiation

Exceed Expectations



More Wetting Risk

- Colder Walls
- Less Drying Potential



Comprehensive Water Protection

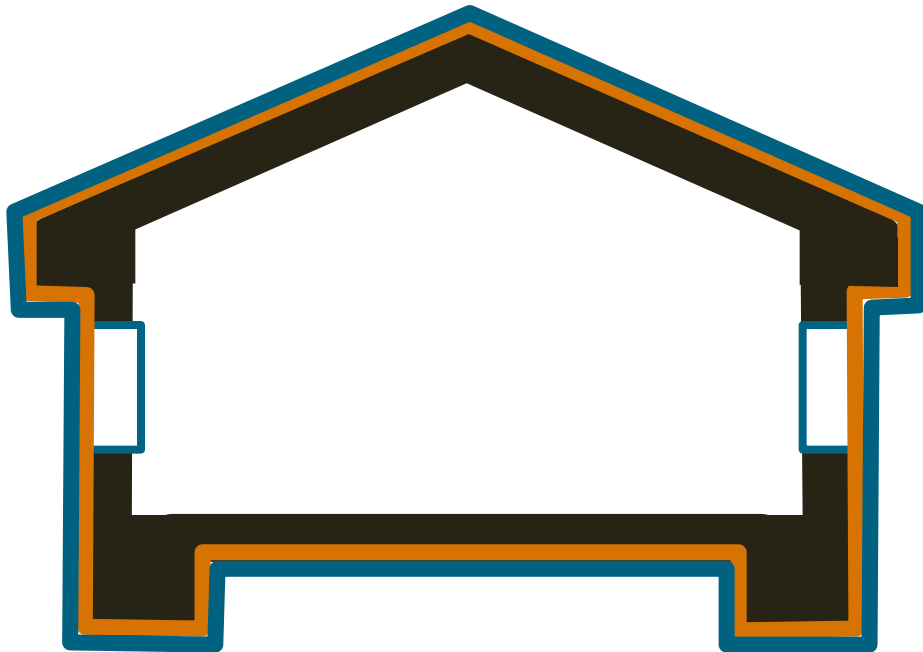
- Roofs
- Walls/Openings
- Site/Foundation
- Materials

Risk 3: Ensured IAQ

Risk Management

Zero Differentiation

Exceed Expectations



IAQ Risk:

- Less Dilution
- Less Filtration



Adv. Thermal Enclosure:

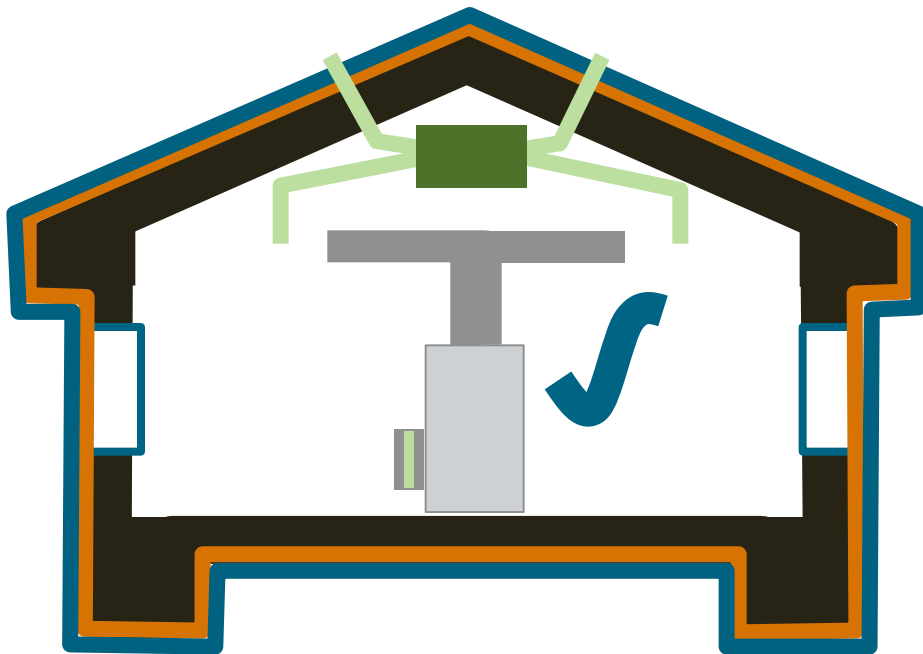
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Risk 3: Ensured IAQ Strategy

Risk Management

Zero Differentiation

Exceed Expectations



IAQ Risk:

- Less Dilution
- Less Filtration



Comprehensive IAQ System:

- Contaminant Control
- Fresh Air System
- High-Capture Filtration

Zero Strategy 1: Minimize Loads

Risk Management

Zero Differentiation

Exceed Expectations



Ultra Low HVAC Loads:

- Components and MELs 50+% of Energy Use



Adv. Thermal Enclosure:

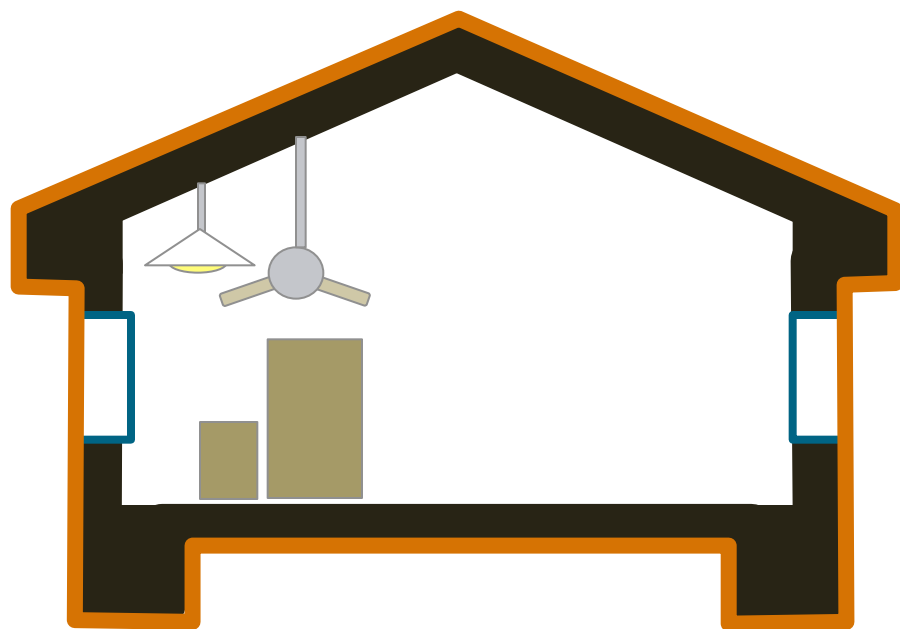
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 - Complete System
- Advanced Windows
- More Air Tightness

Zero Strategy 1: Minimize Loads

Risk Management

Zero Differentiation

Exceed Expectations



Ultra Low HVAC Loads:

- Components and MELs 50+% of Energy Use



Efficient Components:

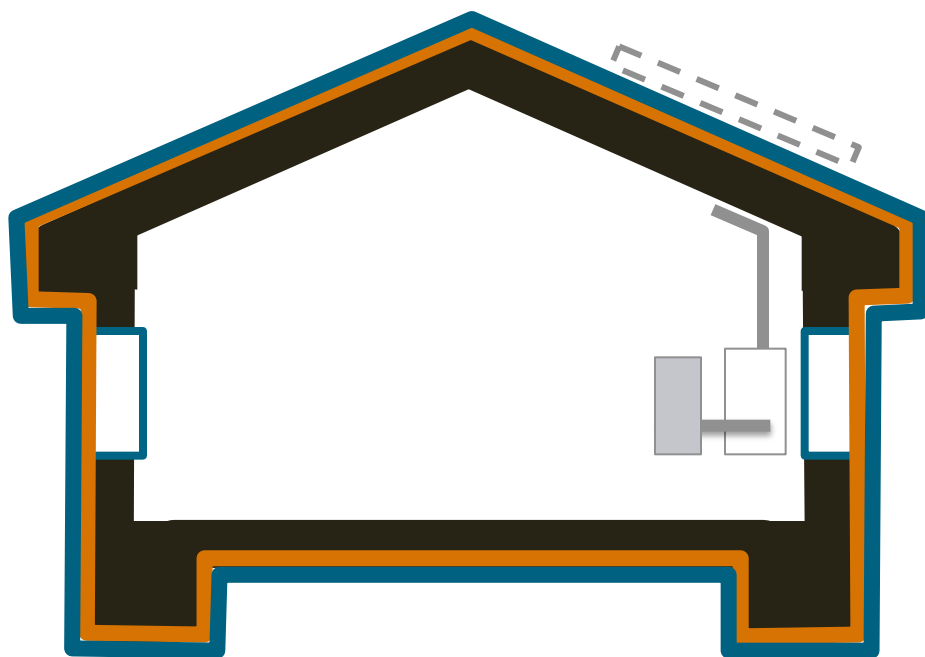
- Space Conditioning
- Water Heating
- Lighting
- Appliances
- Fans

Zero Strategy 2: Solar Ready

Risk Management

Zero Differentiation

Exceed Expectations



Solar Opportunity:

- Energy Loads So Low, All or Most Consumption Can be Offset with Renewable Energy
- Decreasing Solar Cost
- Rising Energy Costs



- **Solar Ready Home**

Zero Energy Ready Home Spec

Risk Management

Zero Differentiation

Exceed Expectations



Optimized Enclosure



Risk Management:

Optimized Comfort System
Complete Water Protection
Comprehensive IAQ System



Zero Differentiation:

Efficient Components
Solar Ready Construction

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.

'Green' vs. Zero Energy Ready

Risk Management

Zero Differentiation

Exceed Expectations

What's Missing in
Green Definition



Complete Systems that Ensure
Bankable **Value Propositions**



What's Included in
Zero Energy Ready Definition

Why Build: The Value

Risk Management

Zero Differentiation

Exceed Expectations

**Lives
Better**

Engineered
Comfort

Healthier
Living

Exclusivity

**Works
Better**

Ultra-Low
Utility Bills

Advanced
Technology

Visionary

**Lasts
Better**

Quality
Construction

More
Durability

Smart



Zero Energy Ready Homes **Made Simple**

Zero Energy Ready Home Systems





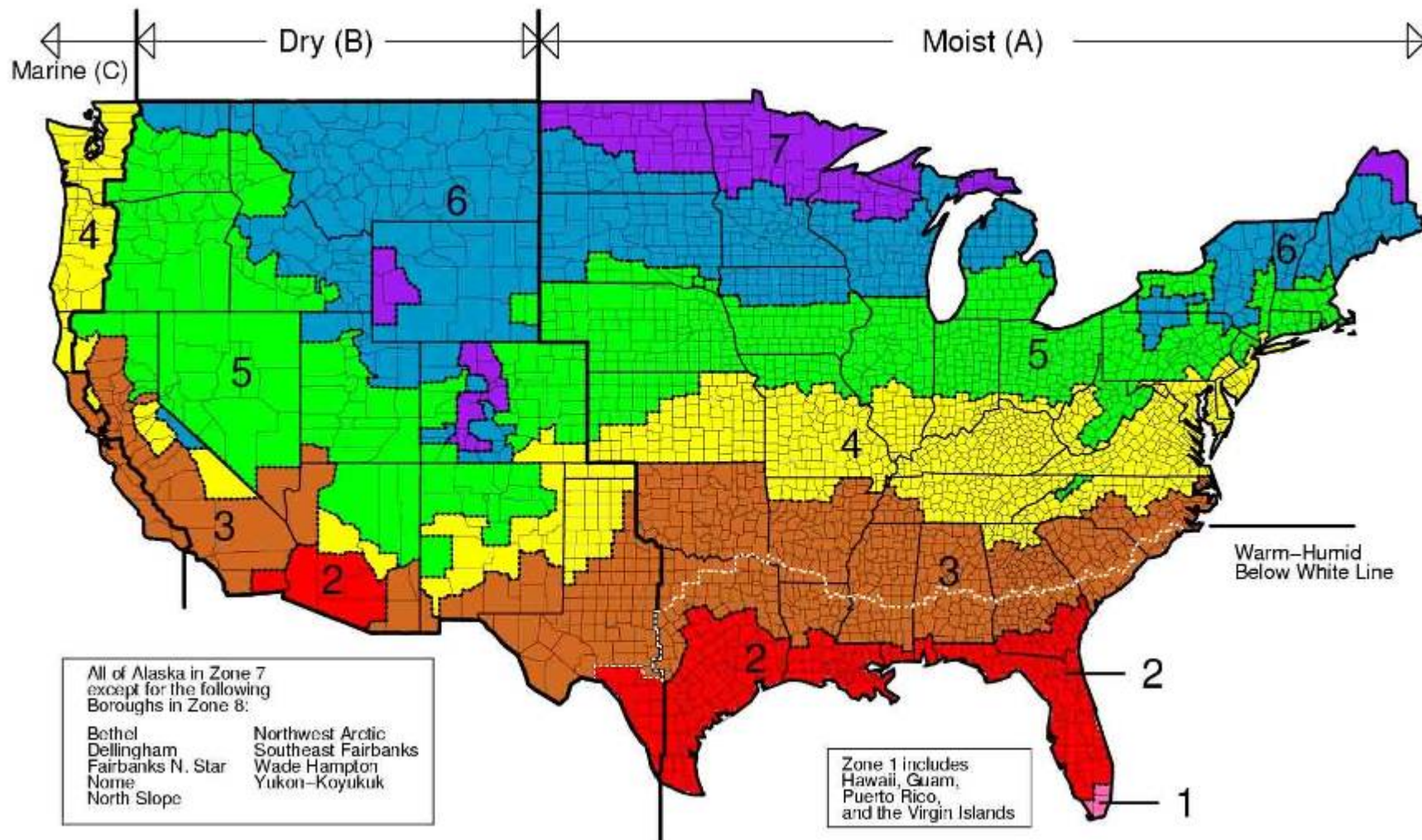
Zero Energy Ready Home

Technical Specifications: Putting It All Together

- 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



Align with ENERGY STAR for Homes v3:

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



DOE ZERH Framework

**Mandatory
Reqt.**

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

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	<input type="checkbox"/> Certified under ENERGY STAR Qualified Homes Version 3 ⁵
2. Envelope ⁶	<input type="checkbox"/> Fenestration shall meet or exceed latest ENERGY STAR requirements ^{7,8} <input type="checkbox"/> Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels ⁹
3. Duct System	<input type="checkbox"/> Ducts located within the home's thermal and air barrier boundary ¹⁰
4. Water Efficiency	<input type="checkbox"/> Hot water delivery systems shall meet efficient design requirements ¹¹
5. Lighting & Appliances ¹²	<input type="checkbox"/> All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified. <input type="checkbox"/> 80% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 80% of sockets <input type="checkbox"/> All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified
6. Indoor Air Quality	<input type="checkbox"/> EPA Indoor airPLUS Verification Checklist and Construction Specifications ¹³
7. Renewable Ready ¹⁴	<input type="checkbox"/> EPA Renewable Energy Ready Home Solar Electric Checklist and Specifications ¹⁵ <input type="checkbox"/> EPA Renewable Energy Ready Home Solar Thermal Checklist and Specifications ¹⁶

**Must
Comply**

**'Target
Home'
Specs**

Exhibit 2: DOE Challenge Home Target Home^{1,17}

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	16	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% SHG
Insulation and Infiltration			
<ul style="list-style-type: none"> Insulation levels shall meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards. Infiltration²¹ (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: Revised 07/01/2012 Page 2 of 8
Revised 07/01/2012

**Trade-Off
Flexibility**

**Size Adjust.
Factor**

Exhibit 3: Benchmark Home Size²⁶

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

**Identical to
Energy Star**



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

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

Climate Zone 6:

Walls: R-20+5 or R-13+10

Ceiling: R-49

Floor: R-30

Basement: R-15/19

Crawl Space: R-15/19

Slab: R-10 for 4 ft. depth



Zero Energy Ready Home **Performance Threshold**

'Target Home' vs. Energy Star Spec

Exhibit 2: DOE Challenge Home Target Home 3.17

Higher Eff.
HVAC
Equip.

2012 vs.
2009 IECC
Insul.

More Eff.
Windows

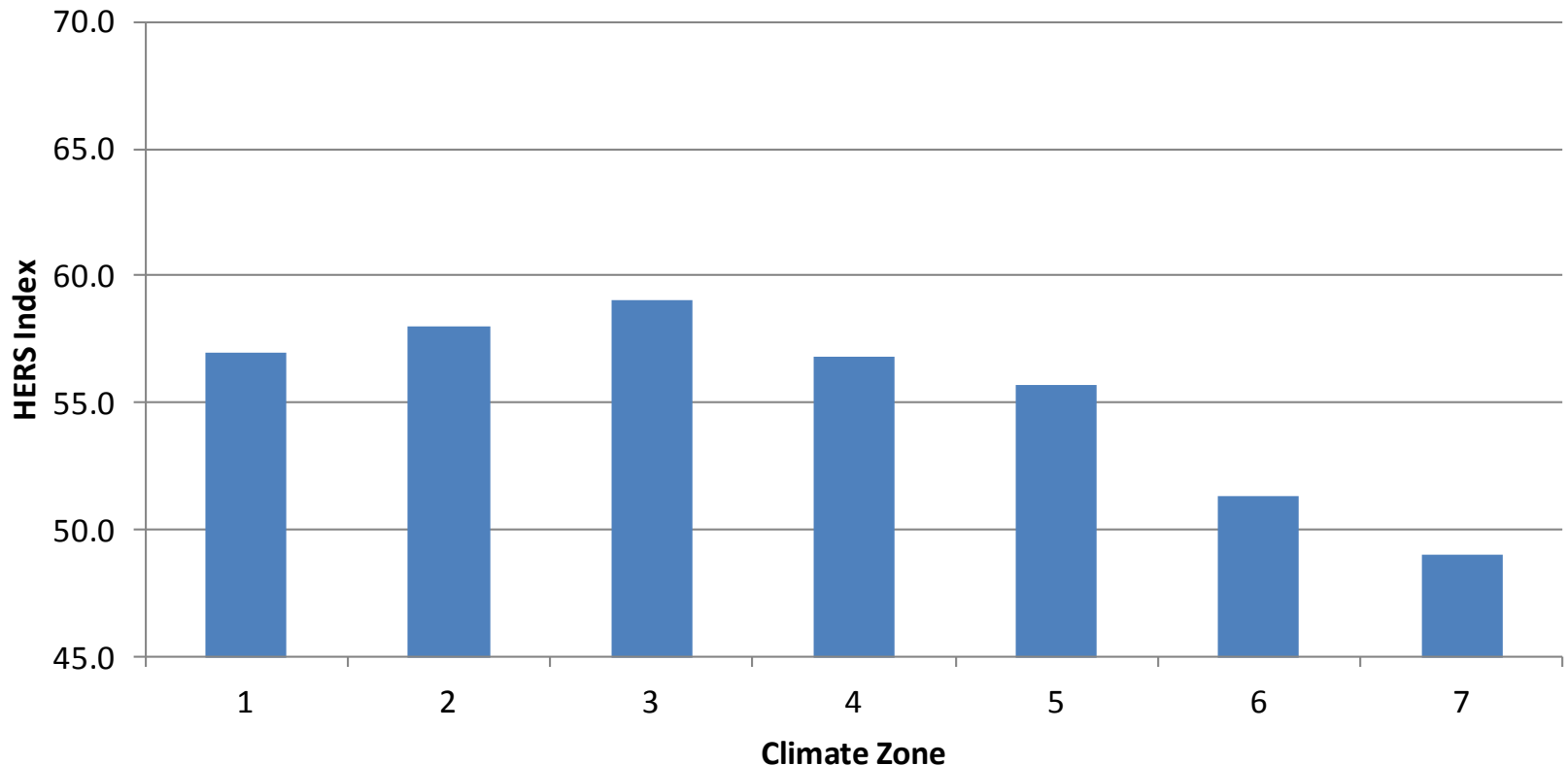
HVAC Equipment			
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ENERGY STAR minimum			
Thermostat ²⁵ & Ductwork			
<ul style="list-style-type: none"> Programmable thermostat (except for zones with radiant heat) 			
Lighting & Appliances			
<ul style="list-style-type: none"> For purposes of calculating 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. 			

Half ACH50

ENERGY
STAR Water
Htg.

Target Home Avg. HERS Scores

Average DOE Challenge Home HERS Index by Climate Zone
(Overall Average = 55.5)



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

**Size
Adjustment
Factor**

Exhibit 3: Benchmark Home Size²⁸

Bedrooms in Home to be Built	1	2	3	4	5	6	7	8
Conditioned Floor Area <small>Benchmark Home</small>	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.

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

Exhibit 3: Benchmark Home Size²⁸

Bedrooms in Home to be Built	1	2	3	4	5	6	7	8
Conditioned Floor Area <small>Benchmark Home</small>	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.

Size Mod. Factor = $\left[\frac{\text{CFA}_{\text{Benchmark Home}}}{\text{CFA}_{\text{Home to Be Built}}} \right]^{0.25}$
[Not to Exceed 1.0]



Recognition with **DOE Zero Energy Ready Home**

Process Overview

Registration and training – builders and raters register as partners and take orientation training to learn requirements.

Plan Evaluation – rater evaluates plans and pinpoints improvements to meet the DOE Zero Energy Ready Home requirements.

Construction – builder constructs home to meet all DOE Zero Energy Ready Home National Program Requirements

Field Verification – rater conducts independent inspections and testing required to earn the label.

Certification – rater submits verification information to HERS Provider; rater/provider submits rating to National Building Registry; and rater prints certificate and label for Builder

A critical element of partnering with DOE Zero Energy Ready Home as a builder is working with a Home Energy Rating System (HERS) Rater.

- **Review**
 - Technical Guidelines
 - Partnership Agreement Terms
- **Register**
 - Electronically Sign Agreement
- **Choose Optional Commitments:**



100% of homes meet DOE ZERH Guidelines



Homes meet EPA's WaterSense Guidelines



Homes meet IBHS's Fortified Home Guidelines



Meet DOE Home Quality Management Program

- **Resources**

- ☐ Customizable Homebuyer Brochures
- ☐ Case Studies
- ☐ Branding [Logos, Home Certificates and Labels]
- ☐ Electronic Newsletter [updates, policy changes, new innovations]

- **Technical Support**

- ☐ **Building America Solution Center**
- ☐ Building America Stakeholder Meetings
- ☐ Building America Research Studies

- **Recognition**

- ☐ DOE Housing Innovation Awards
- ☐ DOE Zero Energy Ready Home Web Site Locator Tool

- **Attract Buyers**

DOE maintains a Partner Locator tool that homebuyers can use to find DOE Challenge Home builders in their area.

- **Builder Listings**

All active partners are listed on the Partner Locator. Builder partners can differentiate their company listing on the Partner Locator through the optional commitments



DOE Challenge Home Partner Locator

Find out who is taking the challenge. Locate DOE Challenge Home partners near you! First choose a partner type and select a state. You can also enter a company name and find DOE Challenge Home partners that match your search.

Please note: Partners began registering for the new DOE CHALLENGE HOME on April 2, 2012. The locator will not produce large results of partners in the program for several weeks. Please check back to watch our progress.

Organization Type: Choose a State: [See Results](#)



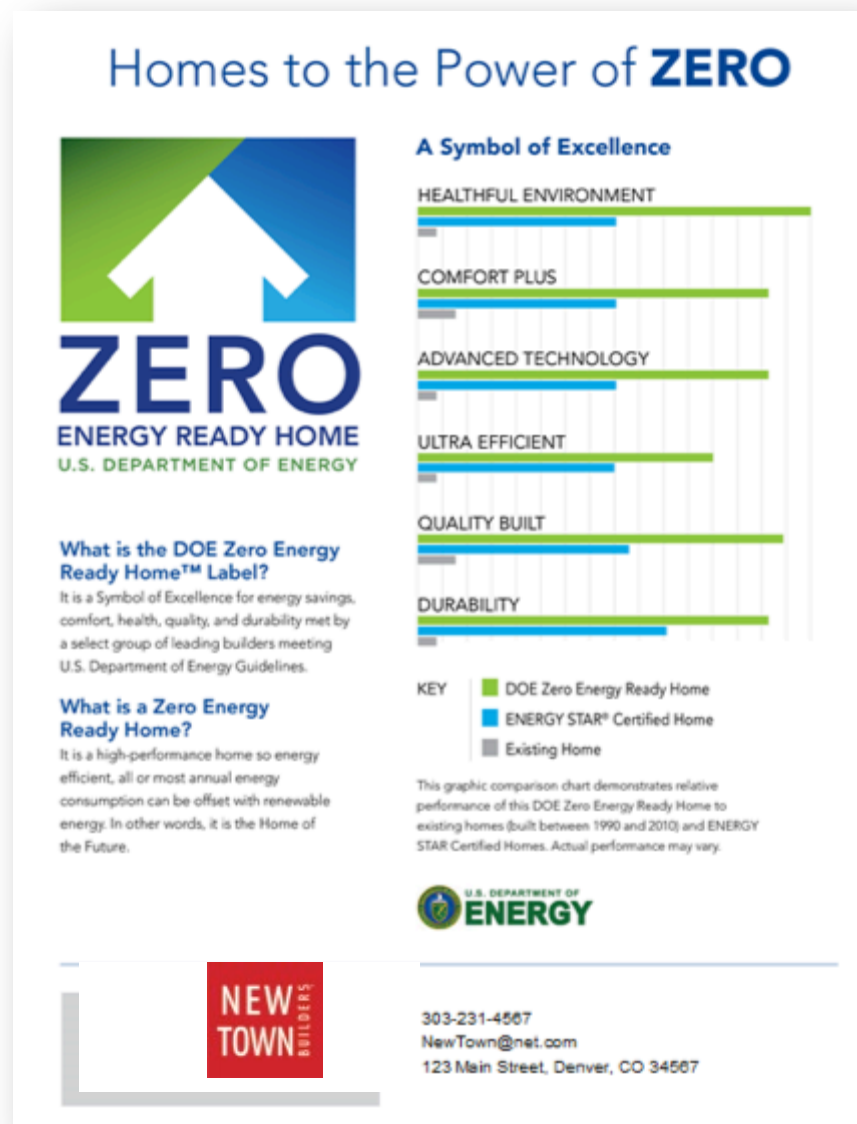
- **Number of Homes that Meet the Challenge**

The number of homes displayed on the Partner Locator come from the RESNET National Registry.

- **Website link**

A link to your website.

Translating the Value Proposition



Translating ZERH Value with Clarity

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Front Cover



Inside Spread



Flap

Back Cover

BA Top Innovations “Hall of Fame”

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

ADVANCED TECHNOLOGIES



**Building
Science Solutions**

**Energy Efficient
Components**

**Assured Health
and Safety**

HOUSE-AS-A-SYSTEM BUSINESS CASE



**New Homes
with Whole-House
Packages**

**Existing
Homes with Whole-
House Packages**

**Whole-House
Program Support**

EFFECTIVE GUIDANCE AND TOOLS



**High
Performance
Home Solutions**

**High
Performance
Home Metrics**

**Research
Tools**

INFRASTRUCTURE DEVELOPMENT



**Educating
Professionals**

**Recognizing
Value in
Transaction Process**

**Informing
Codes and
Standards**

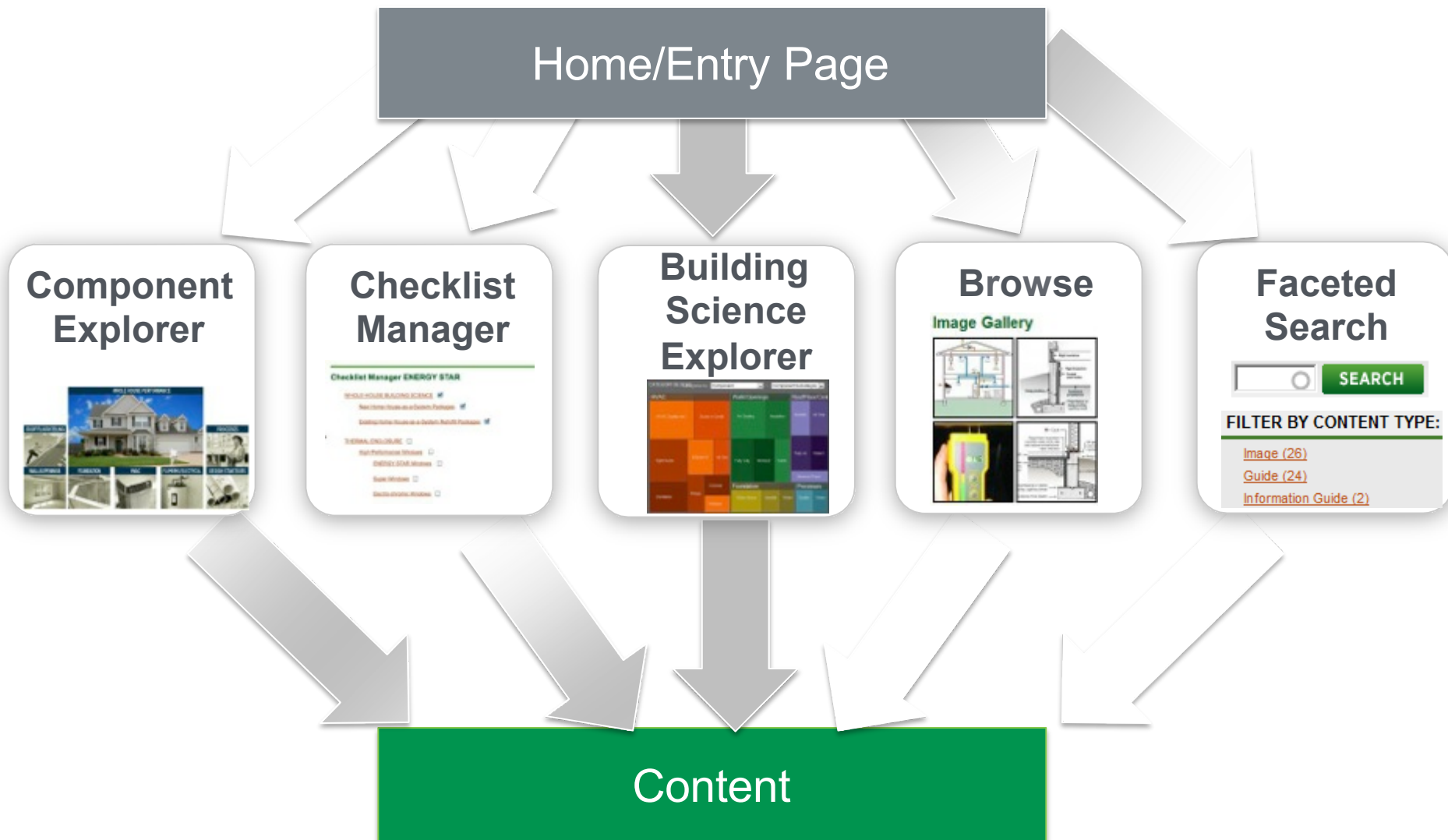
World-Class Research...

Building America Solution Center
BASC.energy.gov



...At Your
Fingertips

Multiple Interfaces



Quick Tour: Component Explorer

WHOLE HOUSE PERFORMANCE

ROOF/FLOOR/CEILING

WALLS/OPENINGS

FOUNDATION

HVAC

COMPONENTS

QA/QC

DESIGN

Walls/Opening Water
Managed Walls
Minimum Thermal Bridging
Insulation
Air Sealing
Fully Aligned Air Barriers

Fully Aligned Air Barriers
Behind Showers and Tubs
Behind Fireplaces
Attic Knee Walls
Skylight Shaft
Walls Adjoining Porch
Double Walls
Garage Rim/Band Joist

[Solution Center Home](#)

[Component Explorer](#)

[Checklist Manager](#)

[Building Science
Explorer](#)

[Browser](#)

[Guides](#)

[CAD Files](#)

[Case Studies](#)

[Image Gallery](#)

[References](#)

Attic Knee Walls

Please [Register](#) or [Login](#) to Provide Feedback.

Scope

Description

Ensuring Success

Climate

Training

CAD

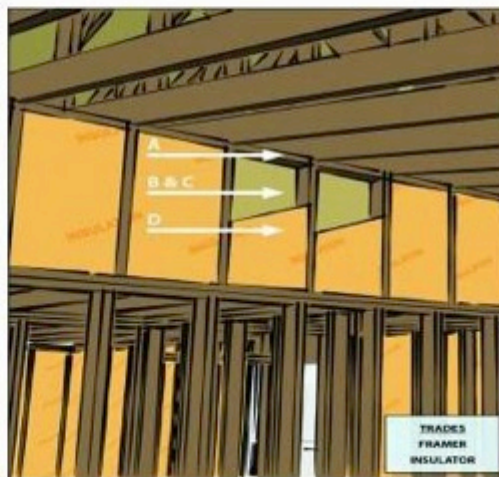
Compliance

More Info.

Scope

Fully Aligned Air Barrier

- A. Install a top and bottom plate or blocking at the top and bottom of all knee wall cavities.
- B. Back attic knee walls with a rigid air barrier or other supporting material to prevent insulation from sagging and create a continuous thermal barrier*
- C. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- D. Install insulation without misalignments, compressions, gaps, or voids in all knee wall cavities.



* ENERGY STAR recommends using a rigid air barrier, but it is not a requirement.

Notes:

An air barrier is defined as any durable solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams.



MOBILE FIELD KIT

The Building America Field Kit allows you to save items to your profile for review or use on-site.

[Sign Up](#)

or

[Log In](#)

Scope: Clearly defines and bounds the topic in a way builders and remodelers can contractually obligate their subcontractors.

diameter unless otherwise indicated by the manufacturer. Flexible air barriers shall not be made of kraft

For More Information



for more information:

www.buildings.energy.gov/zero/

e-mail contact:

zero@newportpartnersllc.com

THE FUTURE IS ALREADY 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 their energy bill to “zero”.




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: 2013

- 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: 2015

- 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)



PART 3: NET ZERO ENERGY TODAY

- Definition: the total amount of energy consumed is equal to the total amount of energy generated on-site.
- It can be done ...
 - But start by paying attention to the trade off between the cost of energy reduction and the cost of solar generation.

NET ZERO ENERGY TODAY

- Next be prepared – the whole building solution might look a bit different than you imagined.
 - There are a few other things that need your attention to as you move to Net Zero Energy.
 - From “BSI-081 Zeroing In” by Joseph Lstiburek

ZEROING IN*

- Don't get carried away with passive solar!
 - The heat gain in the winter is not needed.
 - The heat gain in the summer will hurt you.
 - But people want windows -- so pay attention and use good judgement on the window orientation, placement, and type.
- Ultra-efficiency crushes super-insulated.
- Collect the solar energy with PV.

ZEROING IN*

- Ultra-tight is critical, but it has consequences!
 - Large exhaust devices require a new approach and/or make-up air.
 - clothes dryer: consider a condensing unit
 - range hood: high capture rate with make-up air
 - Interior wood stoves/fireplaces ...
 - don't even think about it!

ZEROING IN*

- Ventilation system must be top-drawer!
 - Balance with heat/energy recovery is required.
 - Run the bathroom exhaust(s) through the HRV/ERV to avoid additional exhaust fans.
 - Be certain to provide fresh air to the bedrooms.

ZEROING IN*

- You must have internal air circulation!
 - Air isn't moving bottom to top or side to side.
 - You need mixing for thermal comfort.
 - You must distribute fresh/filtered air for IAQ.
- You can choose to do this with your space conditioning or ventilation system.

ZEROING IN*

- Perhaps the greatest challenge will be latent load management!
 - In the swing seasons and under part-load conditions moisture can float out of control.
- Do you think you can do this with your space conditioning or ventilation system?
 - It is tougher than it sounds.
 - Dehumidification may need to be an independent system.

FINAL NOTES & CAUTIONS

- High-performance houses will require new enclosure strategies and systems:
 - Higher insulation levels
 - Improved water, air, and vapor control layers
 - Better drying strategies
 - More robust delivery systems

FINAL NOTES & CAUTIONS

- High-performance enclosures will demand a new approach to the mechanical systems:
 - Integrated systems approach to low-load HVAC +DHW
 - Increased attention to indoor air quality
 - source control
 - ventilation
 - filtration
 - distribution
 - Improved make-up air solutions



RESOURCES

- Your New Partners
 - Home Energy Raters
 - Home Performance Consultants
 - Utility Providers & Programs
- Other Resources
 - ENERGY STAR
 - Building America

KEY RESOURCES

- DOE Building America Resources
 - General Energy Information (EERE)
 - DOE Zero Energy Ready Home (ZERH)
 - Tour of Zero
 - Top Innovations “Hall of Fame”
 - Building America Solution Center

KEY RESOURCES

- BSI-039: The Five Things
 - Joseph Lstiburek
- BSI-081: Zeroing In
 - Joseph Lstiburek
- High-Performance Enclosures
 - John Straube, 2012
- Getting Enclosures Right in ZERH
 - Joe Lsitburek, 2016
 - <http://energy.gov/eere/buildings/doe-zero-energy-ready-home-resources>
- EEBA Ventilation Guide
 - Armin Rudd, 2011



- Discussion & Questions

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