Building the High Performance House

Beyond Code Programs That Give You and Your Customer The Edge

- 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."

- For additional continuing education approvals, please see your credit tracking card.

Learning Objectives

1. Using experience from presenters and the audience, define what constitutes a standard code house compared with a house that goes beyond code.
2. Attendees will gain a good understanding of the content of programs presented.
3. Understand how the programs differ.
4. Enhance critical thinking skills to allow builders to determine which programs will further their goals.
5. Understand what overall components are necessary to achieve a high performance home.
6. Understand the overall importance of building high performance and low energy use homes.
7. Attendees will be able to define for themselves the five most important items that must be done to build a very efficient house.
8. Attendees will be able to identify upgrades that are consistent with building science principles.

Part Two

Paths and Programs To Achieving a High-Performance House

Presenters

- Mike Resech
  - Residential Science Resources
- Rachel Wagner
  - Wagner Zaun Architecture
- Pat Huelman
  - University of Minnesota Cold Climate Housing

Utility-Sponsored New Home Programs

- There are several performance-based programs in MN
- Program availability varies based on Service Provider
- Most require third party performance testing
- Pay rebates based on tested performance and/or equuipment

Home Energy Excellence Program

- Rebate and participation updates for 2017
- Cost of HERS Rating is sponsored
  - No out of pocket cost for builders
- Rater must perform an insulation inspection along with HERS Rating
- Rebates are paid based on natural gas savings over baseline

Rebate Structure

Rebate Eligibility Level	
Positive gas savings with less than 20% gas savings over code	$0
20% - 24.99% energy savings better than code	$500
25% - 29.99% energy savings better than code	$750
30% - 34.99% energy savings better than code	$1,000
35% - 39.99% energy savings better than code	$1,500
Over 40% energy savings better than code	$2,000

High-Efficiency Homes Program

- New Program design for 2017
- Builder must contract directly with a certified HERS Rater and is responsible for the cost of the rating
- Rater must perform an insulation inspection along with HERS Rating
- Rebates are paid based on natural gas savings over baseline

Rebate Structure

Percent gas savings above code	Rebate Abount
10 - 14% gas savings	$500
15 - 19% gas savings	$750
20 - 24% gas savings	$1,000
25 - 29% gas savings	$1,500
30 - 34% gas savings	$2,000
35 - 39% gas savings	$2,500
40 - 44% gas savings	$3,000
45 - 49% gas savings	$3,500
50% and above gas savings	$4,000

Homes without natural gas water heater will be capped at this rebate level.

Homes with gas savings above 50% will be capped at this rebate level.

Efficient New Home Construction Program

- New Program design for 2017
- Builder must contract directly with a certified HERS Rater and is responsible for the cost of the rating

Rebate Structure

Xcel Energy Gas-only or Gas/Electric combo customers	
Total energy savings less than 10% better than code and/or negative therm savings	Not Eligible
Positive gas savings with at least 10% but less than 14.9% total energy savings better than code	$250
15-19.9% total energy savings better than code	$500
20-24.9% total energy savings better than code	$1,000
25-29.9% total energy savings better than code	$1,200
30-34.9% total energy savings better than code	$1,500
35% and above total energy savings better than code	$2,000
Appliance Rebates	
ENERGY STAR® rated Clothes washer	$50
ENERGY STAR rated Refrigerator	$15

- Rater must perform an insulation inspection along with HERS Rating
- Rebates are paid based on total energy savings over baseline
- Additional rebates for certain electric appliances may be available

Triple E New Construction

- Offers prescriptive and performance incentives to houses with electric heat
  - Prescriptive requires a plan review and two inspections
  - Performance is based on air tightness
- Rebate incentives are relative to the amount of electric savings and include
  - Appliance rebates
  - Qualified LED lighting fixtures
  - Central air conditioning
  - Drain water heat recovery
  - Air source heat pumps / ground source heat pumps
  - Window upgrades
  - Solar
  - Building orientation

focus on energy
Partnering with Wisconsin utilities

New Homes Program

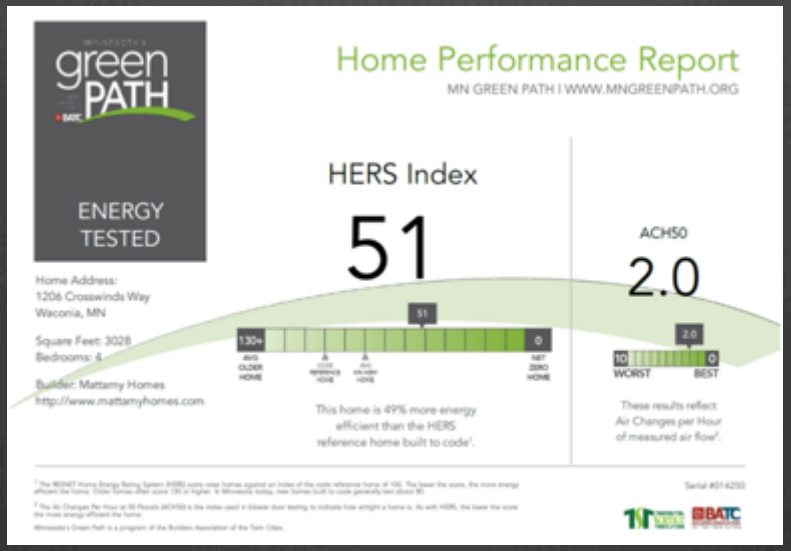
- Partners with Wisconsin Energy utilities and Home Builders
- Offers incentive rewards for percentage of energy reduction over base code
- Prescriptive path available for
  - Heating and cooling – requires an assessment
  - Renewables

Sponsored by the Builders Association of the Twin Cities (BATC)

- Market based program
  - Targeted at new home buyers
- Provides marketing materials and trainings for builders
- Three levels of participation
  - Tested
  - Advanced
  - Master

Green Path Tested Requirements

- Builder must be a member of a builders association
- All homes must receive a RESNET HERS Rating



Green Path Tested Benefits

- Home Performance Report – HPR
- Eligible for the Green Path Energy Tour in BATC's Parade of Homes

Green Path Certified: Advanced Master

Advanced Requirements

- Builder must be a member of a builders association
- All homes must receive a RESNET HERS Rating
- Final HERS must be 55 or lower
- Must receive 20 total checklist points

Advanced Benefits

- Special Home Performance Report (HPR)
- Eligible for the Green Path Energy Tour in BATC's Parade of Homes
- Qualifies as a Green Certification on the MLS

Master Requirements

- Builder must be a member of a builders association
- All homes must receive a RESNET HERS Rating
- Final HERS must be 50 or lower
- Must receive 50 total checklist points

Master Benefits

- Special Home Performance Report (HPR)
- Eligible for the Green Path Energy Tour in BATC's Parade of Homes
- Qualifies as a Green Certification on the MLS

Green Path Checklists

Five Categories:

- Energy Efficiency
- Indoor Environment Quality
- Resource Management
- Water Management
- Land Use

Minnesota Green Path Indoor Environment Quality

1) Patio slabs, walks, and driveway are sloped a minimum from house
2) Garage floors are sloped a minimum of 1/8" per foot doorway, or integrated floor drains are installed
3) Active soil gas (radon) mitigation system is installed in
4) 4" min perforated foundation drain with 3/4" of grave installed at OUTSIDE perimeter of footings
5) 4" min perforated foundation drain with 3/4" of grave installed at INSIDE perimeter of footings
6) Water-based waterproofing system used on below-gr
7) A drainage plane and air/drainage space exists behin
8) Recessed light fixtures are sealed to drywall with gask (see manual for unconditioned space requirements)
9) Spray-foam insulation (R-14 minimum) is applied for a entire attic floor
10) ENERGYSTAR® rated garage exhaust fans are installe (25CFM continuous, or 100CFM intermittent)
11) Heat Recovery Ventilator (HRV) or Energy Recovery Ve
12) Air filters are HEPA or better performing, with MERV
13) Ductwork is sealed with water-based, low-VOC (<30 g
14) HVAC contractor verified that rooms and zones have b (upload report)
15) Carpet covers 50% or less of floor space, not counting kitchens, entryways, or utility rooms
16) No carpet is installed; home has all hard-surface floori
17) Building materials stored on-site are protected from w
18) Exterior envelope is sealed using gasket or acoustical wall-to-wall, or floor-to-wall intersections
19) Basement has a foundation drainage system inside an pump, or tied to a drainage outlet
20) Certified low-VOC or no-VOC interior paints and finis
21) Carpet, adhesives, and cushion qualify for CRI Green testing program
22) Local exhaust ventilation to outdoors is installed for b clothes dryers, central vacuum system, etc.
23) Central forced-air HVAC systems have minimum MER and no ozone generators

©MN Green Path

Check List

Minnesota Green Path Energy Efficiency

1) Enter the R-value of the under-slab (subslab) foam insulation 1
2) A thermal mass has been installed (see manual for specifics) 1
3) A passive solar heating or cooling design package was used 1
4) A systems approach to home design was used (upload plan) 1
5) A vestibule with two gasketed self-closing doors and walk-off mat was installed 1
6) Bottom plates of exterior walls are sealed to subfloor 1
7) Foundation and mudsill are sealed 1
8) Cantilevered floors are sealed above supporting walls 1
9) Air conditioning unit is properly installed 1
10) A geothermal system is installed with a high-efficiency furnace (95+) with an ECM Motor 2
11) No polyethylene is present in walls or ceilings 1
12) No wood burning fireplace are present inside the thermal envelope 1
13) An induction cook top is installed 1
14) A solar-electric photovoltaic system is installed 1
15) A drain-water heat recovery unit (DHR / Combi-core) is installed 1
16) Home is ready for solar-electric photovoltaic retrofitting 1
17) All windows are triple-pane glass 1
18) A Desuper Heater is installed 1
19) No recessed lights are installed recessed into unconditioned space 1
20) High-Efficiency Furnace (95+) 2
21) Air Source Heat Pump Installed 2
22) Install High Efficiency Boiler (85+) 2
23) Install Electronically Commutated (ECM) Motor 1
24) Special Feature 2

MORE >>

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www.mngreenpath.org (1/12)

Advanced

- 5 Points in Energy Efficiency
- 5 Points in Indoor Environment Quality
- 5 Points from the remaining 3 categories
- 5 Bonus Points – can come from any category

Master

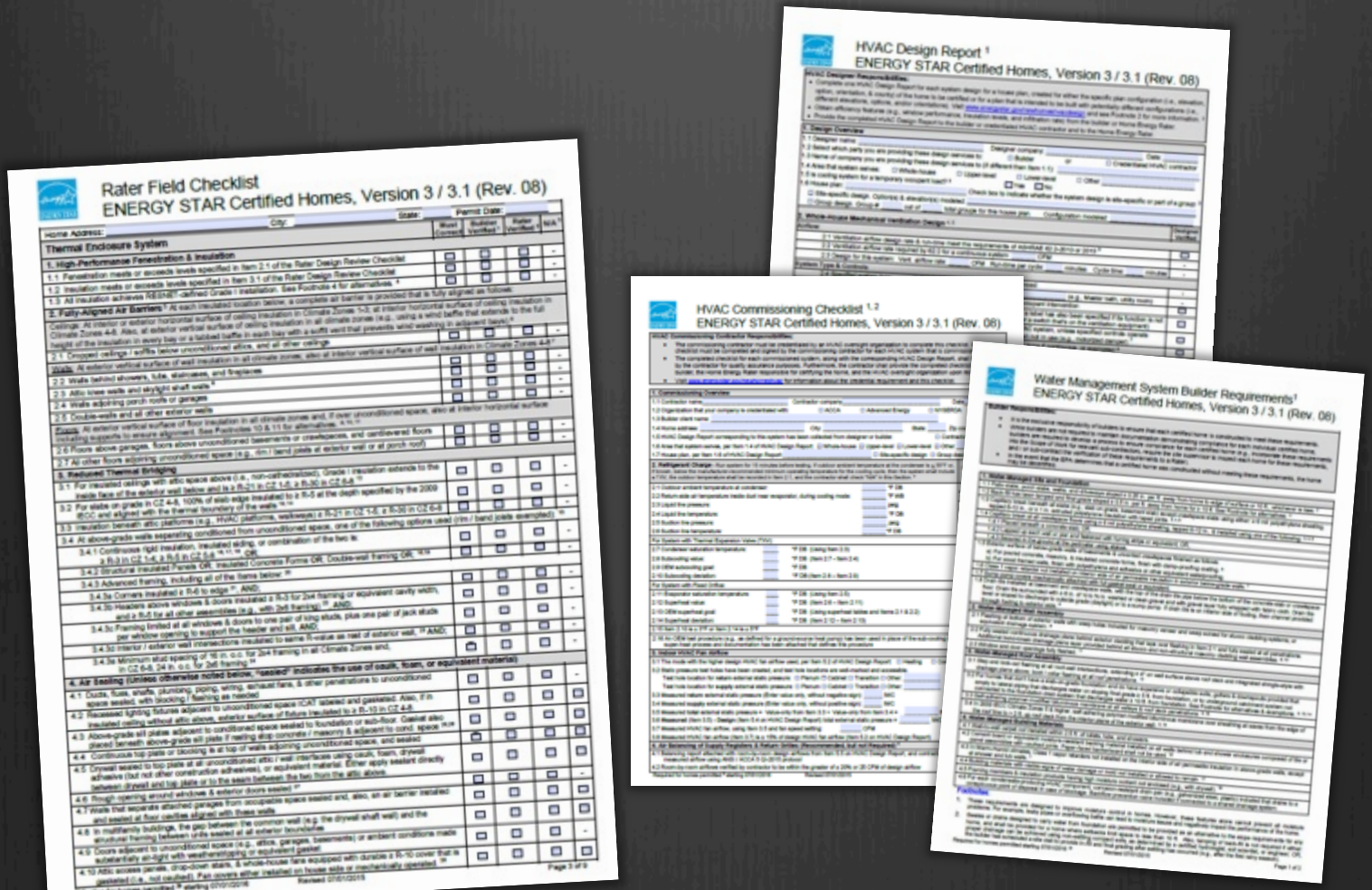
- 10 Points in each of the 5 categories

- 1995 - Certified New Homes Program launched
- Target of 30% more energy efficient than baseline code
- Provides marketing materials and trainings for sales associates
- Overall brand awareness reached 89% in 2016

ENERGY STAR
Certification Requirements

- Requires Builder Partnership Agreement
- Must partner with an approved HERS Rater
- HVAC installer must be accredited
- HERS performance requirement based on home size
- Version 3 checklists must be completed by Rater and HVAC contactor

Revision 8 Checklists



ENERGY STAR® CERTIFIED NEW HOMES

BETTER IS BETTER

When rigorous ENERGY STAR requirements are applied to new home construction, the result is a home built better from the ground up, delivering better durability, better comfort, and reduced utility and maintenance costs. This makes an ENERGY STAR certified home the simple choice for energy efficiency.

ENERGY STAR® CERTIFIED NEW HOME

Builder Name: Gamble Builders
Permit Date/Number: 4 April 2011
Home Address: 1310 L Street,
Washington DC 20005

Rating Company: G Force Testing
Rater Identification Number: 2345678
Rating Date: 6 July 2011
Version: 3.0

Standard Features of an ENERGY STAR Certified New Home

Your ENERGY STAR certified new home has been designed, constructed, and independently verified to meet rigorous requirements for energy efficiency set by the U.S. Environmental Protection Agency (EPA), including:

Thermal Enclosure System

A complete thermal enclosure system that includes comprehensive air sealing, quality-installed insulation and high-performing windows to deliver improved comfort and lower utility bills.

Air Infiltration Test: **4 ACH50**

Primary Insulation Levels:
Ceiling: R30 **Floor: R-10**
Wall: R19 **Slab: R-6**

Primary Window Efficiency:
U-Value: 0.60 **SHGC: 0.27**

Water Management System

A comprehensive water management system to protect roofs, walls, and foundations.

Flashing, a drainage plane, and site grading to move water from the roof to the ground and then away from the home.

Water-resistant materials on below-grade walls and underneath slabs to reduce the potential for water entering into the home.

Management of moisture levels in building materials during construction.

Heating, Cooling, and Ventilation System

A high-efficiency heating, cooling system, and ventilation system that is designed and installed for optimal performance.

Total Duct Leakage:
6 CFM25 per 100 sq. ft.

Duct Leakage to Outdoors:
4 CFM25 per 100 sq. ft.

Primary Heating (System Type • Fuel Type • Efficiency):
Fuel-fired Hydronic Distribution • Natural Gas • 90 AFUE

Primary Cooling (System Type • Fuel Type • Efficiency):
Ground-source Heat Pump • Electric • 14.5 SEER

Energy Efficient Lighting and Appliances

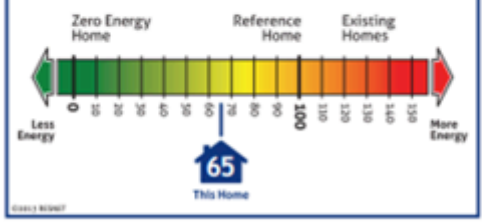
Energy efficient products to help reduce utility bills, while providing high-quality performance.

ENERGY STAR Qualified Lighting: **75%**

ENERGY STAR Qualified Appliances and Fans:
Refrigerators: 1 **Dishwashers: 1**
Ceiling Fans: 4 **Exhaust Fans: 3**

Primary Water Heater (System Type • Fuel Type • Efficiency):
Electric Resistance Heater • Electric • 0.94 EF

HERS® Index



This certificate provides a summary of the major energy efficiency and other construction features that contribute to this home earning the ENERGY STAR, including its Home Energy Rating System (HERS) score, as determined through independent inspection and verification performed by a trained professional. The Home Energy Rating System is a nationally-recognized uniform measurement of the energy efficiency of homes.

Note that when a home contains multiple performance levels for a particular feature (e.g., window efficiency or insulation levels), the predominant value is shown. Also, homes may be certified to earn the ENERGY STAR using a sampling protocol, whereby one home is randomly selected from a set of homes for representative inspections and testing. In such cases, the features found in each home within the set are intended to meet or exceed the values presented on this certificate. The actual values for your home may differ, but offer equivalent or better performance. This certificate was printed using REMRate™ (Version XX.XX).

Learn more at www.energystar.gov/homefeatures

Peace of Mind

An integrated approach to design combined with tried-and-true best building practices adds up to a home with better durability, better comfort and reduced utility and maintenance costs.

Enduring Quality

Purchasing a new home is a big investment, so it's important to know that it's built to last

Features include:

- Complete Thermal Enclosure System
- High-efficiency Heating, Ventilation, and Cooling System
- Comprehensive Water Management System
- Energy-efficient Lighting and Appliances

Wall-to-Wall Comfort

Features include efficient delivery of comfort, a constant supply of fresh, filtered air, and consistent temperatures felt across every room, making the entire home comfortable year-round.

Proven Value

ENERGY STAR certified new homes offer better energy efficiency and performance compared to other homes, making them a better value.

LEED for Homes

- Program of the USBGC = U.S. Green Building Council
  - Began in 1993 – the brainchild of 3 real estate developers
  - Non-profit Membership organization
- LEED = Leadership in Energy and Environmental Design
  - Began in 2000
  - Rating/Certification Program
- 5 categories for buildings and communities, including LEED for Homes v.4
- 4 Certification “Levels:”
  - Certified
  - Silver
  - Gold
  - Platinum

LEED for Homes
Technical Aspects

Points-based system

- Both mandatory and optional points
- Checklist and detailed guides aid process
- Choices in “optional points” to get to certification level

9 Categories

Integrative Process

LT = Location and Transportation

SS = Sustainable Sites

WE = Water Efficiency

EA = Energy and Atmosphere

MR = Materials and Resources

EO = Indoor Environmental Quality

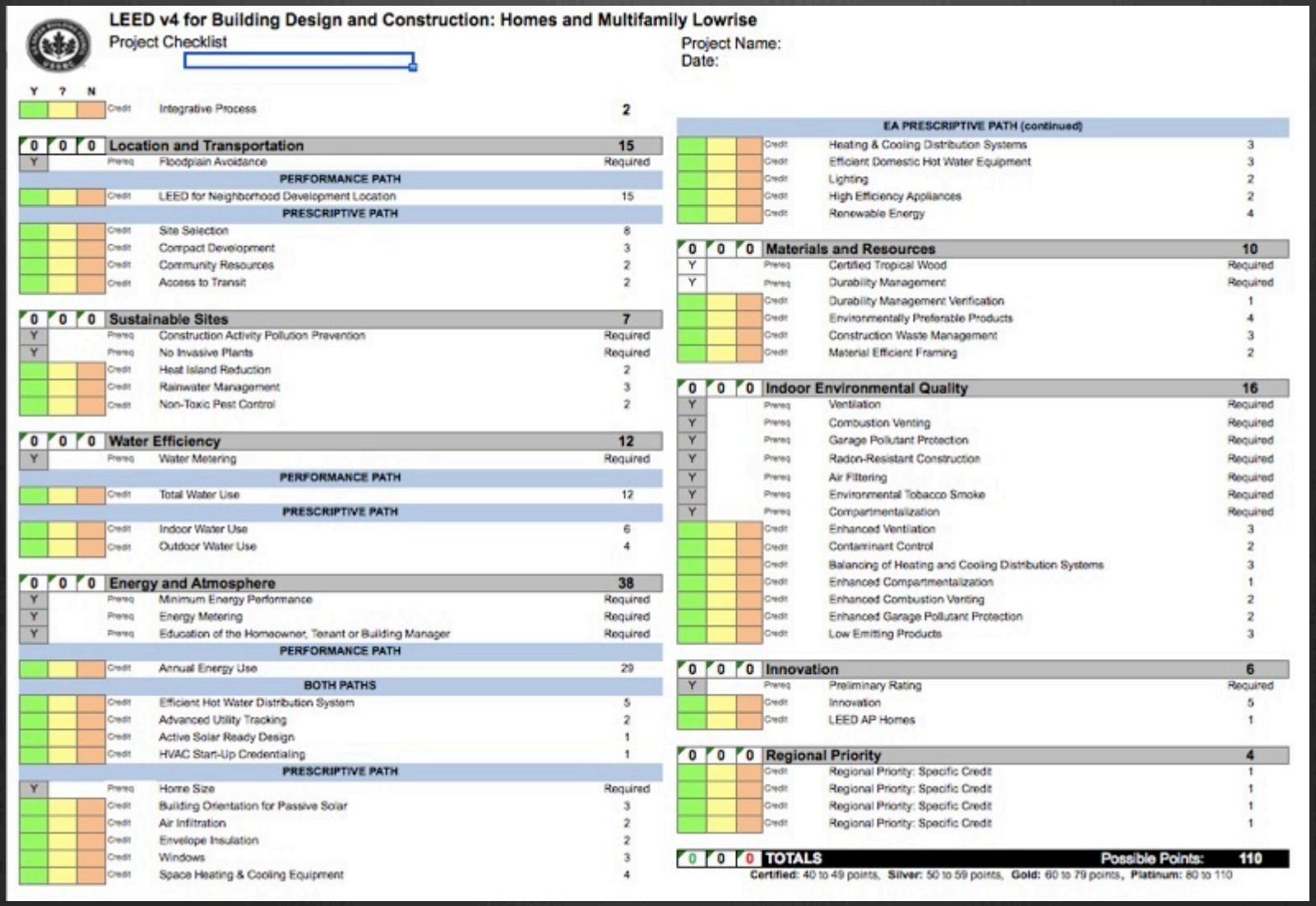
IN = Innovation

RP = Regional Priority

LEED for Homes
Compliance Protocol

- 4 “steps”: register, verify, review certify.
- Two verifying assisters:
  - LEED for Homes Provider Organization
  - LEED for Homes Certifying Body Detailed (long) guide for technical criteria
- Third party “energy rater” oversees inspections & testing
  - 2 site visits
  - A lot of required supplemental documentation
- Fees are complicated, based upon submittals and fees of the selected rater (estimate $3,000 – 7,000 per home)

LEED for Homes Project Checklist



LEED v4 for Building Design and Construction: Homes and Multifamily Lowrise

Project Checklist

Project Name:
Date:

Y	?	N			
			Credit	Integrative Process	2
0	0	0		**Location and Transportation**	**15**
Y			Prereq	Floodplain Avoidance	Required
				PERFORMANCE PATH	
			Credit	LEED for Neighborhood Development Location	15
				PRESCRIPTIVE PATH	
			Credit	Site Selection	6
			Credit	Compact Development	3
			Credit	Community Resources	2
			Credit	Access to Transit	2
0	0	0		**Sustainable Sites**	**7**
Y			Prereq	Construction Activity Pollution Prevention	Required
Y			Prereq	No Invasive Plants	Required
			Credit	Heat Island Reduction	2
			Credit	Rainwater Management	3
			Credit	Non-Toxic Pest Control	2
0	0	0		**Water Efficiency**	**12**
Y			Prereq	Water Metering	Required
				PERFORMANCE PATH	
			Credit	Total Water Use	12
				PRESCRIPTIVE PATH	
			Credit	Indoor Water Use	6
			Credit	Outdoor Water Use	4
0	0	0		**Energy and Atmosphere**	**38**
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Energy Metering	Required
Y			Prereq	Education of the Homeowner, Tenant or Building Manager	Required
				PERFORMANCE PATH	
			Credit	Annual Energy Use	29
				BOTH PATHS	
			Credit	Efficient Hot Water Distribution System	5
			Credit	Advanced Utility Tracking	2
			Credit	Active Solar Ready Design	1
			Credit	HVAC Start-Up Credentialing	1
				PRESCRIPTIVE PATH	
Y			Prereq	Home Size	Required
			Credit	Building Orientation for Passive Solar	3
			Credit	Air Infiltration	2
			Credit	Envelope Insulation	2
			Credit	Windows	3
			Credit	Space Heating & Cooling Equipment	4
				EA PRESCRIPTIVE PATH (continued)	
			Credit	Heating & Cooling Distribution Systems	3
			Credit	Efficient Domestic Hot Water Equipment	3
			Credit	Lighting	2
			Credit	High Efficiency Appliances	2
			Credit	Renewable Energy	4
0	0	0		**Materials and Resources**	**10**
Y			Prereq	Certified Tropical Wood	Required
Y			Prereq	Durability Management	Required
			Credit	Durability Management Verification	1
			Credit	Environmentally Preferable Products	4
			Credit	Construction Waste Management	3
			Credit	Material Efficient Framing	2
0	0	0		**Indoor Environmental Quality**	**16**
Y			Prereq	Ventilation	Required
Y			Prereq	Combustion Venting	Required
Y			Prereq	Garage Pollutant Protection	Required
Y			Prereq	Radon-Resistant Construction	Required
Y			Prereq	Air Filtering	Required
Y			Prereq	Environmental Tobacco Smoke	Required
Y			Prereq	Compartmentalization	Required
			Credit	Enhanced Ventilation	3
			Credit	Contaminant Control	2
			Credit	Balancing of Heating and Cooling Distribution Systems	3
			Credit	Enhanced Compartmentalization	1
			Credit	Enhanced Combustion Venting	2
			Credit	Enhanced Garage Pollutant Protection	2
			Credit	Low Emitting Products	3
0	0	0		**Innovation**	**6**
Y			Prereq	Preliminary Rating	Required
			Credit	Innovation	5
			Credit	LEED AP Homes	1
0	0	0		**Regional Priority**	**4**
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
0	0	0		**TOTALS**	**Possible Points: 110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Passive House/Passivhaus

A stringent building energy standard based upon a goal of dramatically decreasing building energy use and global environmental impact.

The targets are clearly defined and immutable.

- Maximum building annual primary energy load (modeled).
- Maximum space conditioning loads (modeled).
- Maximum building air tightness (tested).

Passive House/Passivhaus

PHIUS: the U.S. Standard

- Katrin Klingenberg, Urbana, Illinois in 2003
- Stephan Tanner, BioHaus @ Concordia Language Village, 2006
- PHIUS founded 2007
- New U.S. PH standard 2015

PHI: the International Standard

- Dr. Wolfgang Feist
- Early 1990s
- 60-70% total energy savings
- 80-90% total heating savings
- Passive House Institute (**PHI**) established 1996

Thank you to Josh VandeBerg of Western Technical College for stats.

Technical Criteria

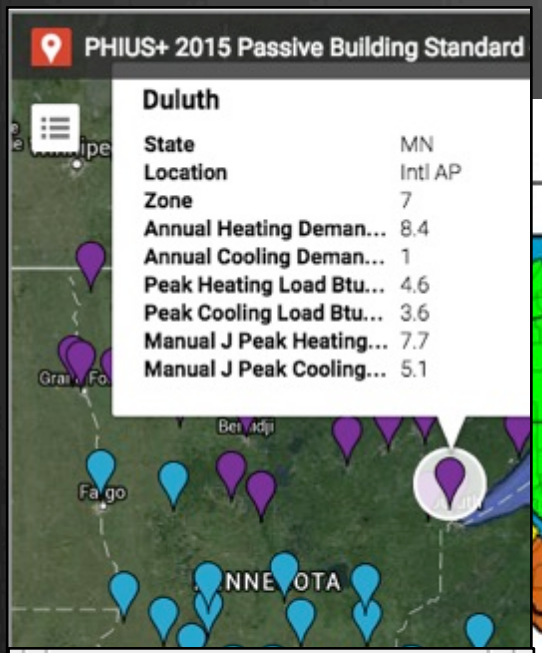
PHIUS: the U.S. Standard

- Climate based heating and cooling loads
  - Heating/ft2 annual
  - Cooling/ft2 annual
  - Peak heating load
  - Peak cooling load
- Air tightness .05cfm50/ft2 shell
- Primary energy
  - 6400 kWh/person/year
- Some credit/offset for PV
- PHIUS+ option

PHI: the International Standard

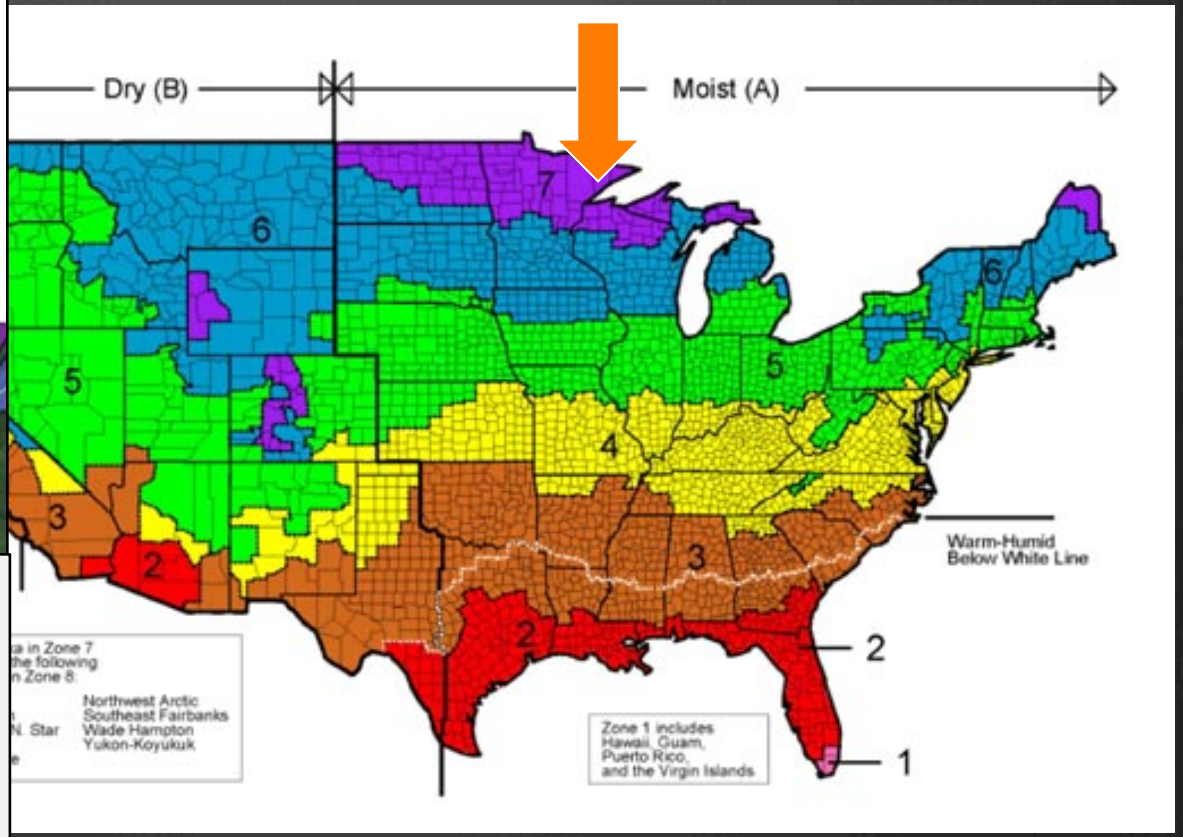
- Space heat/space cool:
  - 4.75 Btu/ft2 annual OR
  - 3.17 Btu/hr/ft2 peak load
- Air tightness .6ACH50
- Primary energy
  - 38 kBtu/ft2/yr
- Thermal comfort criteria for 90% of the time
- Thermal bridges addressed

PHIUS Passive House Standard in Duluth



HDD, Base 65F:	9906
CDH, Base 74F:	849
IECC Climate Zone:	7A
ASHRAE W Factor:	1.00
Design Heating Temp:	-15
Design Cooling Temp:	81

Where I live and work

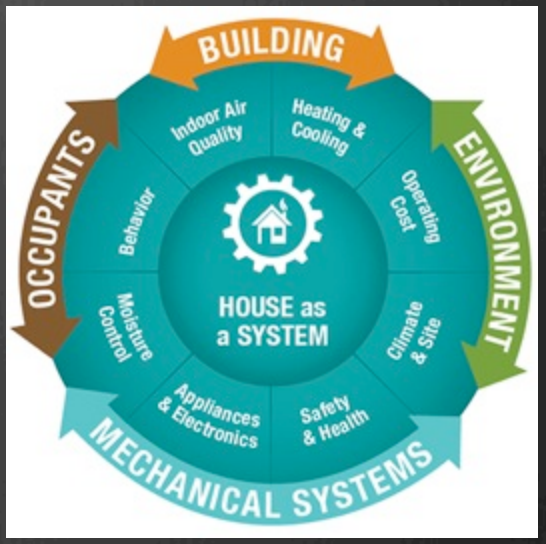


Compliance Protocol/Certification Path

- Typically requires a certified PH consultant, but a “do-it-yourselfer” may submit a project for certification.
- Building must be modeled in certifying organization’s approved method.
- Many submittals are required:
  - Energy model
  - THERM analysis or psi calculations for identified thermal bridges
  - Detailed building design documentation
  - PH “approved” windows and HVAC components and/or documentation that components meet PH criteria
  - Building construction documentation and blower door test results
- Cost for certification ranges, estimate $2,000 - $3,000
- Cost for submittals, modeling, design guidance varies.
- PHIUS is the certifying organization for U.S. standard.
- PHI has numerous certifiers in North America.

DIY: the “un-program” path

- Know Your Building Science
- Identify Your Goals
- Set Your Targets
- Define Your Path
- Establish Protocols with Your Team
- Communicate Effectively
- Test, Verify, and Evaluate



DIY: Use (y)Our Community

- Who Are Your Allies?
  - A HERS Rater and/or building performance specialist
  - Key subcontractors
  - A designer or architect (no, really)
  - Others Doing Similar Work
- What Are Your Resources?
  - Organizations (PHIUS, BPI, NAPHN, MBPA, NESEA, etc)
  - Online tools (buildingscience.com, greenbuildingadvisor.com)
  - Good books and magazines
  - Energy modeling software (REMRate, REMDesign, PHPP)
  - Attend Conferences, Join a Group

A DIY High-Performance Approach

1. Invest in the envelope: enough to manage IEQ, occupant comfort, building durability, annual loads and resiliency.
2. Get heating and cooling loads compatible with simpler space conditioning systems.
3. Be ready for solar PV.
4. Don’t overinvest in initial MEP systems.
   - Efficient technologies (HPWH, ASHP, lighting/electrical systems) are getting better (and different) faster.
5. Build so that equipment and systems can be upgraded.

DIY: The “Pretty Good House”

An “un-program” created by consensus

- Builders, designers, energy raters
- Learn more about it on greenbuildingadvisor.com
- 2 short graphic handbooks available for $1-2 apiece! Authored by Helen Watts, PE and available on Etsy

Basic Principles:

Support the local/regional economy.

Healthy for occupants and healthier for the planet.

Not So Big! Minimal or reasonable operating costs.

Robustly-insulated: climate specific

Excellent air tightness (<1 ACH50).

Ready for renewables.

Tested/commissioned building operation.

Monitored energy use.

DOE Zero Energy Ready Home

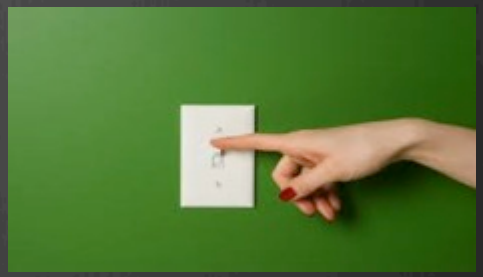
- Why build to DOE ZERH?
  - Consumer motivations
  - Builder motivations
- What does DOE ZERH require?
  - Overall it is a performance-based approach
  - With some prescriptive components
- How do you get there?
  - Strategic partners and resources

Lots of Recognition Choices…

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

Energy Strategies

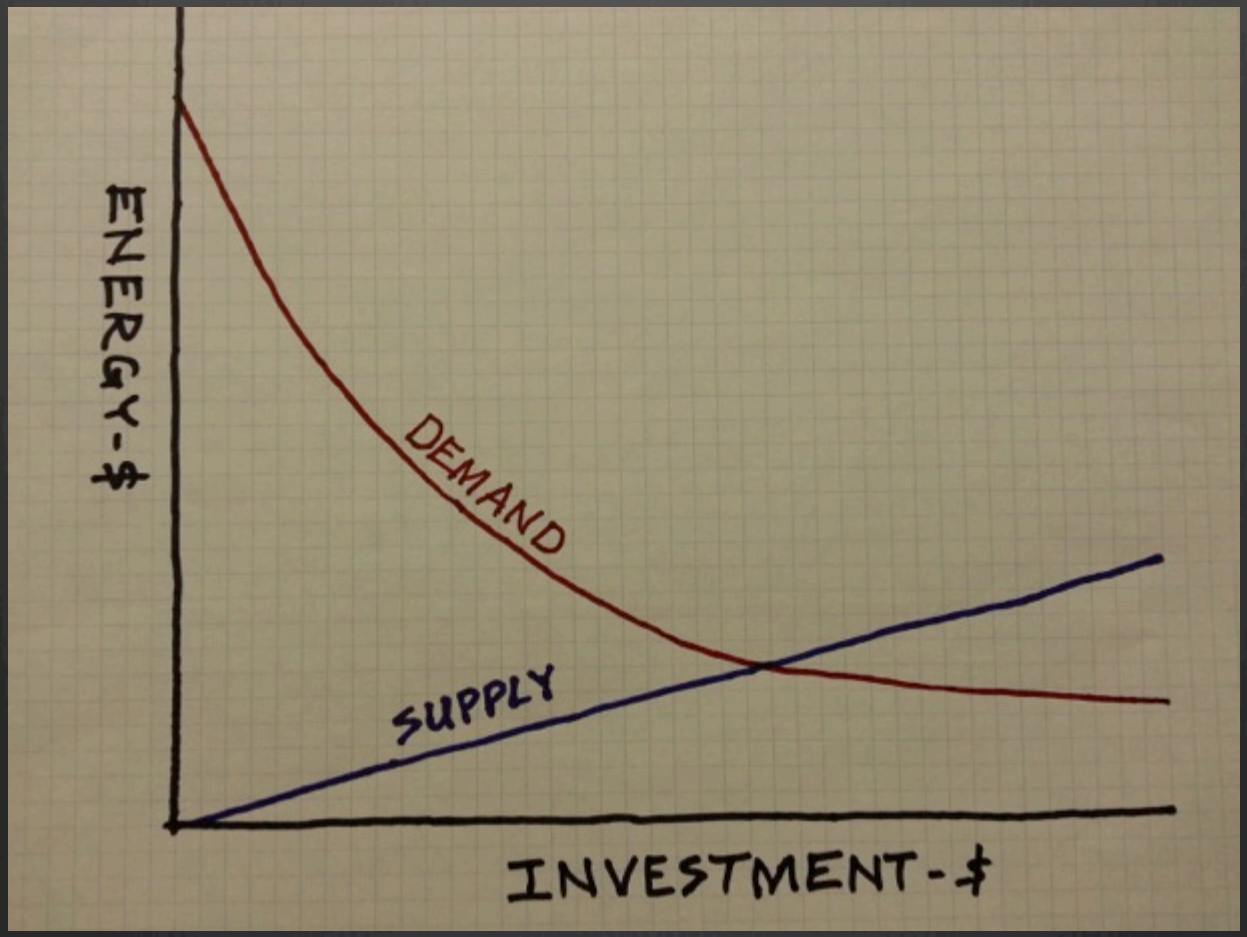
- Conservation
  - Lowest cost - best return



- Efficiency
  - Moderate expense - good return

- Alternatives
  - Most expensive - lowest return

Energy Saved vs. Dollar Spent



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 Builder's Challenge

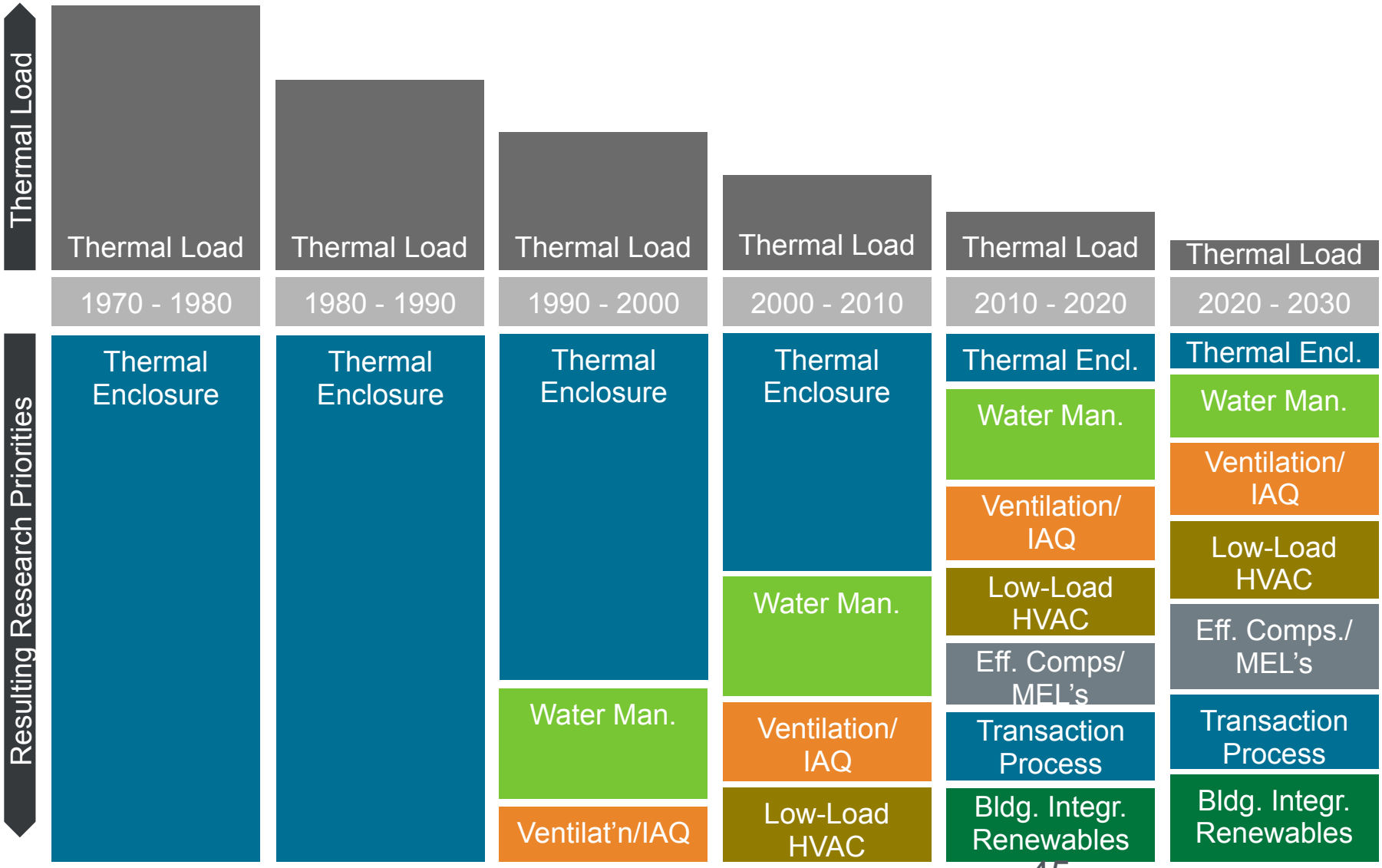
- The home building industry in the U.S. is incredibly diverse and fragmented.
- For a typical house, 25+ subcontractors will touch that home in some way.
- It is easy to see how things can get done improperly, undone by others, or simply missed.

A Systems-Guided Approach to a 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!

Building America Strategy

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



Ultra-High Efficiency

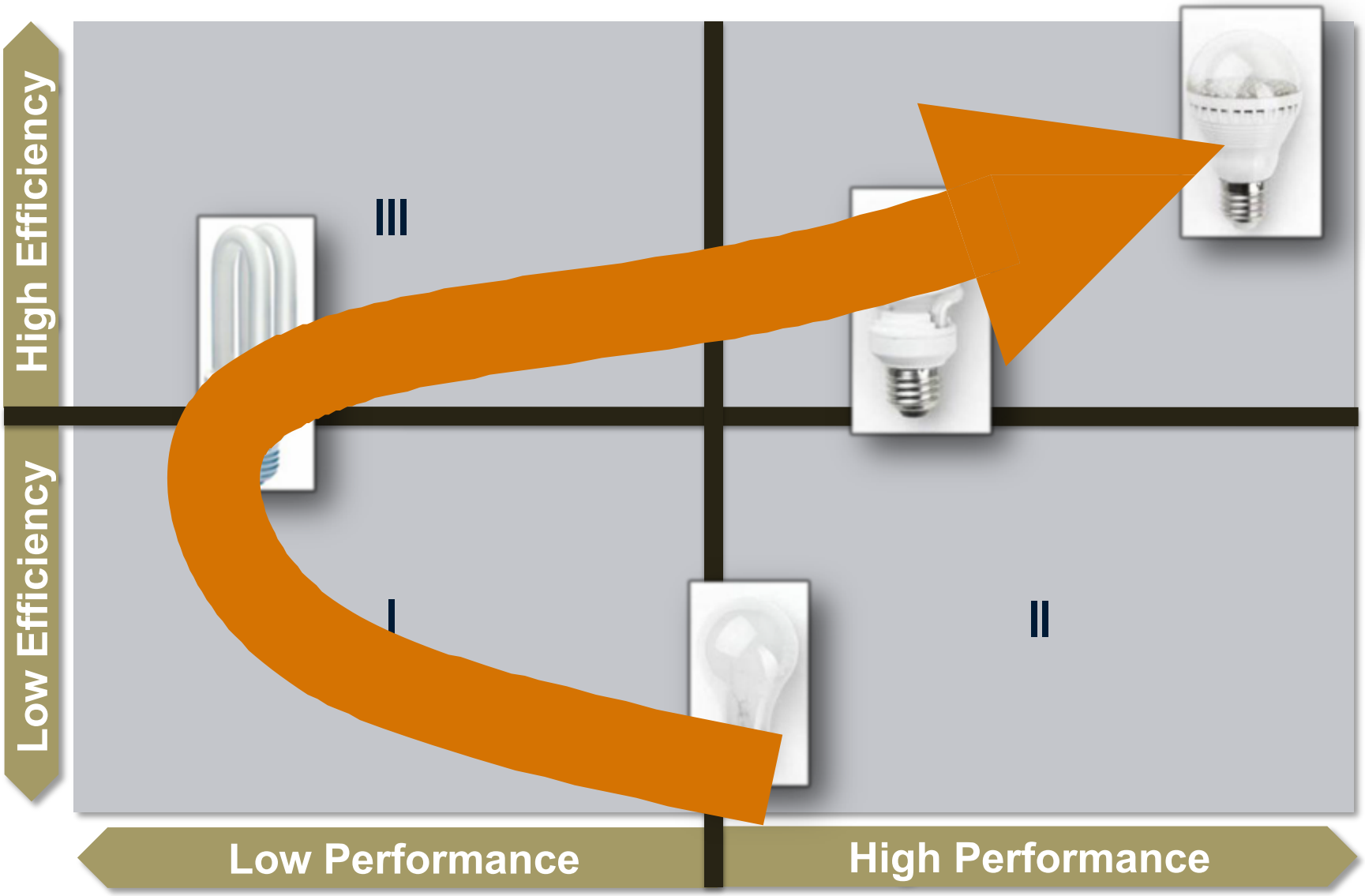
- Enclosure
- Low-Load HVAC
- Efficient Components

+

High-Performance

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

Efficiency + Performance Example



DOE Zero Energy Ready Home Path

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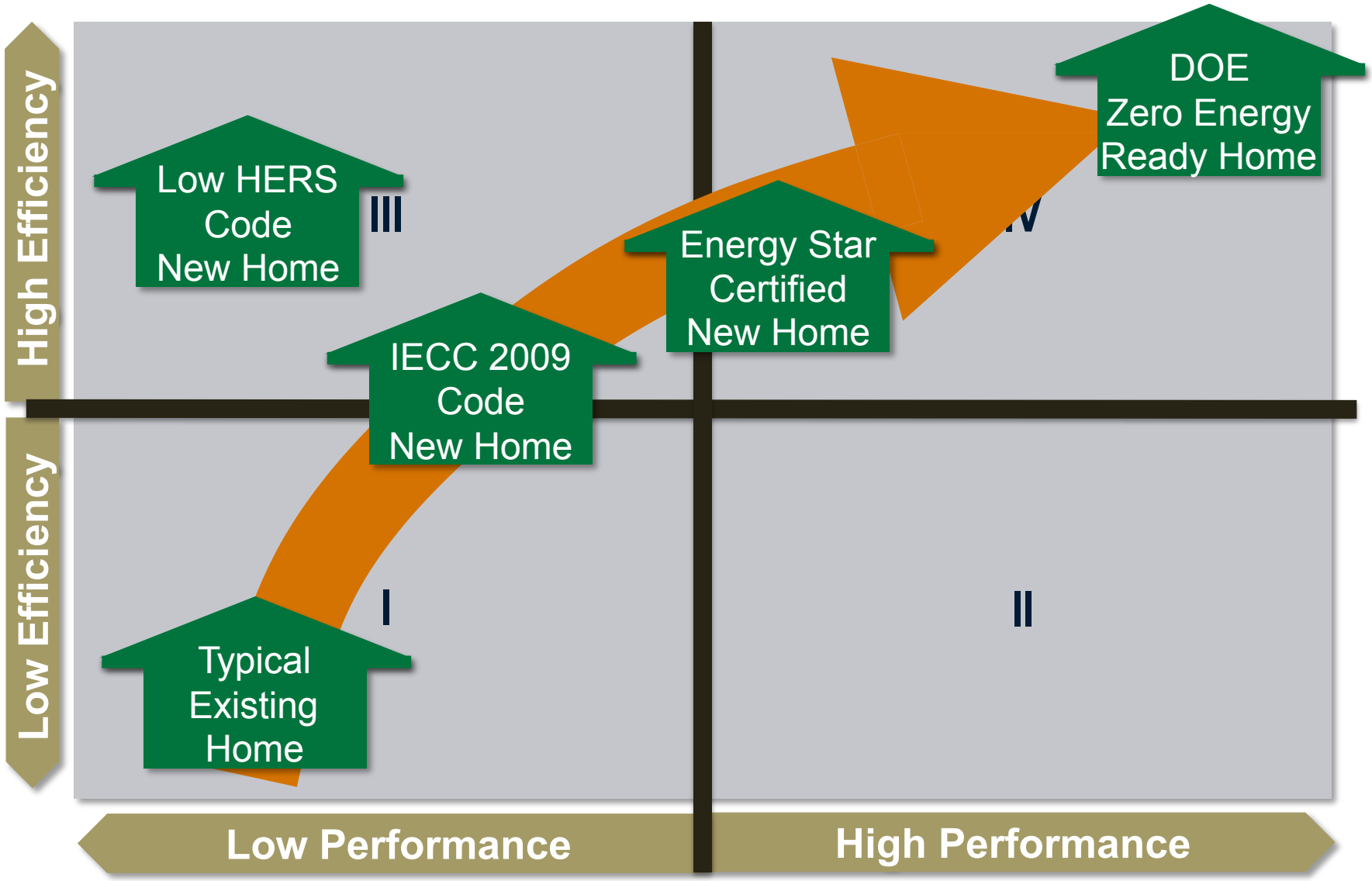

Why Build: The Value

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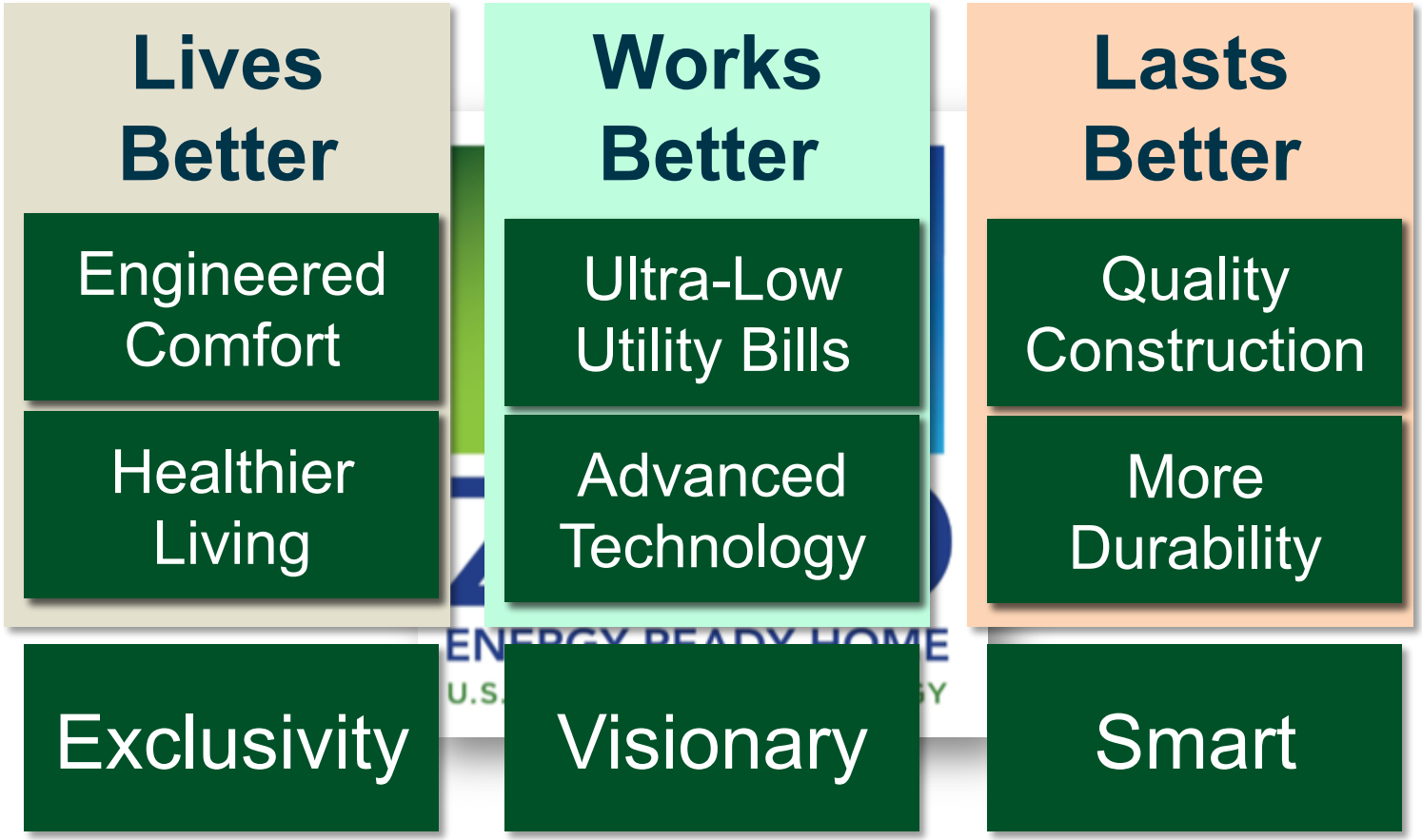
Risk Management | **Zero** Differentiation | **Exceed** Expectations



Zero Energy Ready Home Defined

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

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

High-Performance home, that is so **Energy Efficient**, all or most of its annual energy consumption can be offset by renewable energy

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 a better margin.

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

Zero Energy Ready Home

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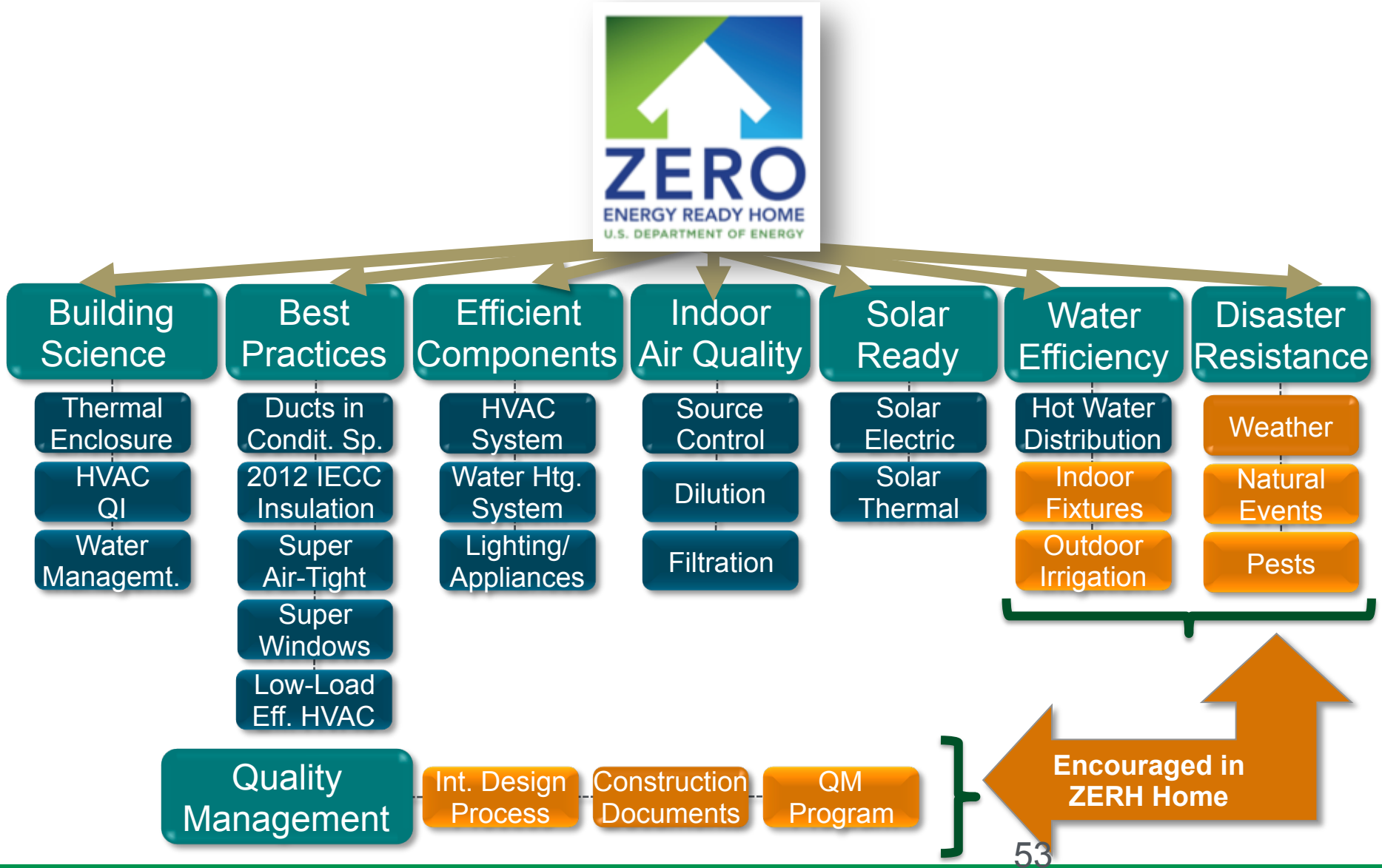


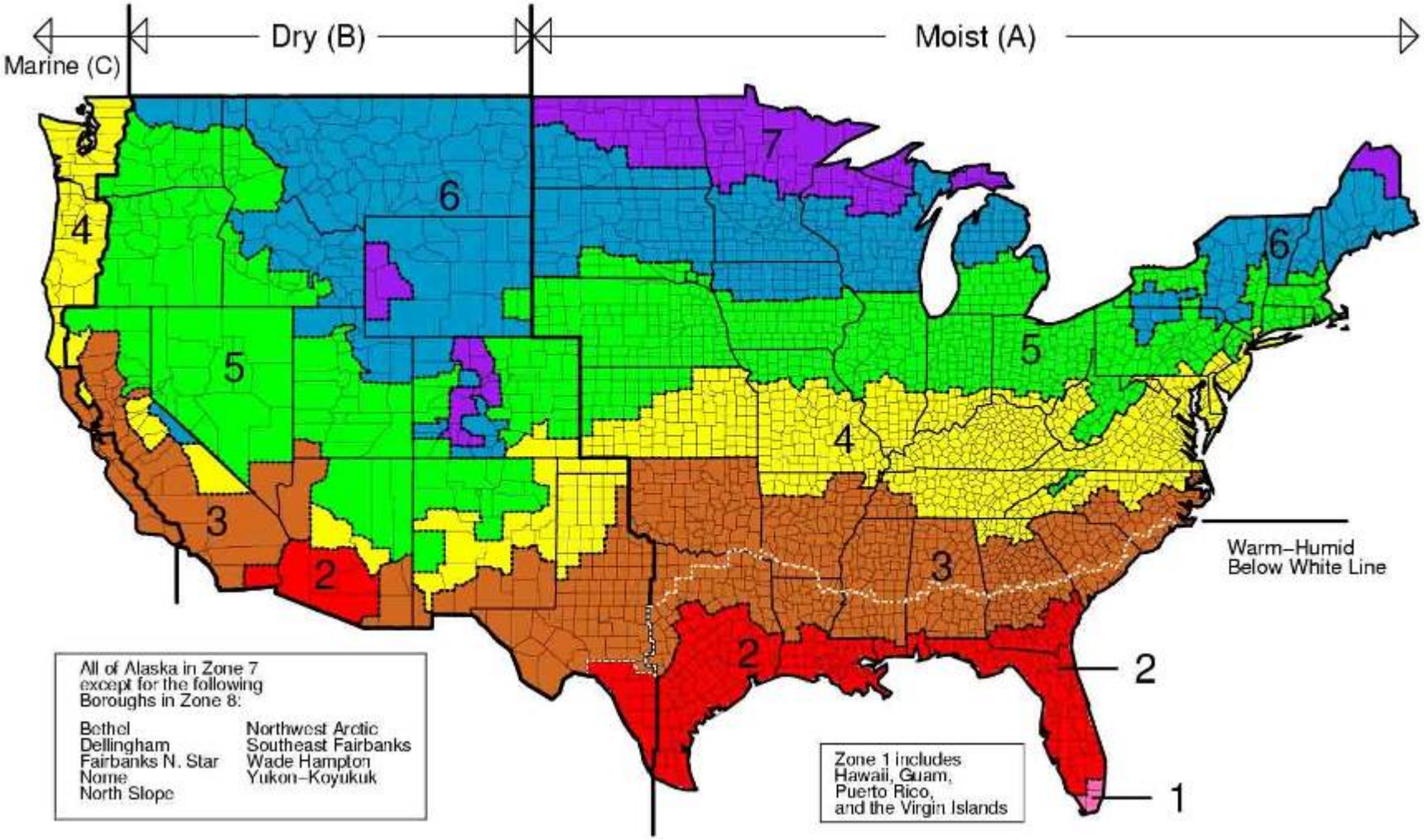
Zero Energy Ready Home

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 6/1/2012 | 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

Mandatory Requirements

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Encouraged:

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

‘Target Home’ vs. Energy Star Spec

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

HVAC Equipment			
	Hot Climates (2012 IECC Zones 1,2) [18]	**Mixed Climates** (2012 IECC Zones 3,4)	**Cold Climates** (2012 IECC Zones 5,6,7,8)
AFUE	80%	90%	94%
SEER	18	15	13
HSPF	8.2	9	10 [19]
Geothermal Heat Pump	ENERGY STAR EER and COP Criteria		
ASHRAE 62.2 Whole-House MV System Performance	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 [20] (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 [21, 22, 23]			
	Hot Climates (2012 IECC Zones 1,2,)	**Mixed Climates** (2012 IECC Zones 3,4)	**Cold Clim** (2012 IECC Zones
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.			

Higher Eff. HVAC Equip.

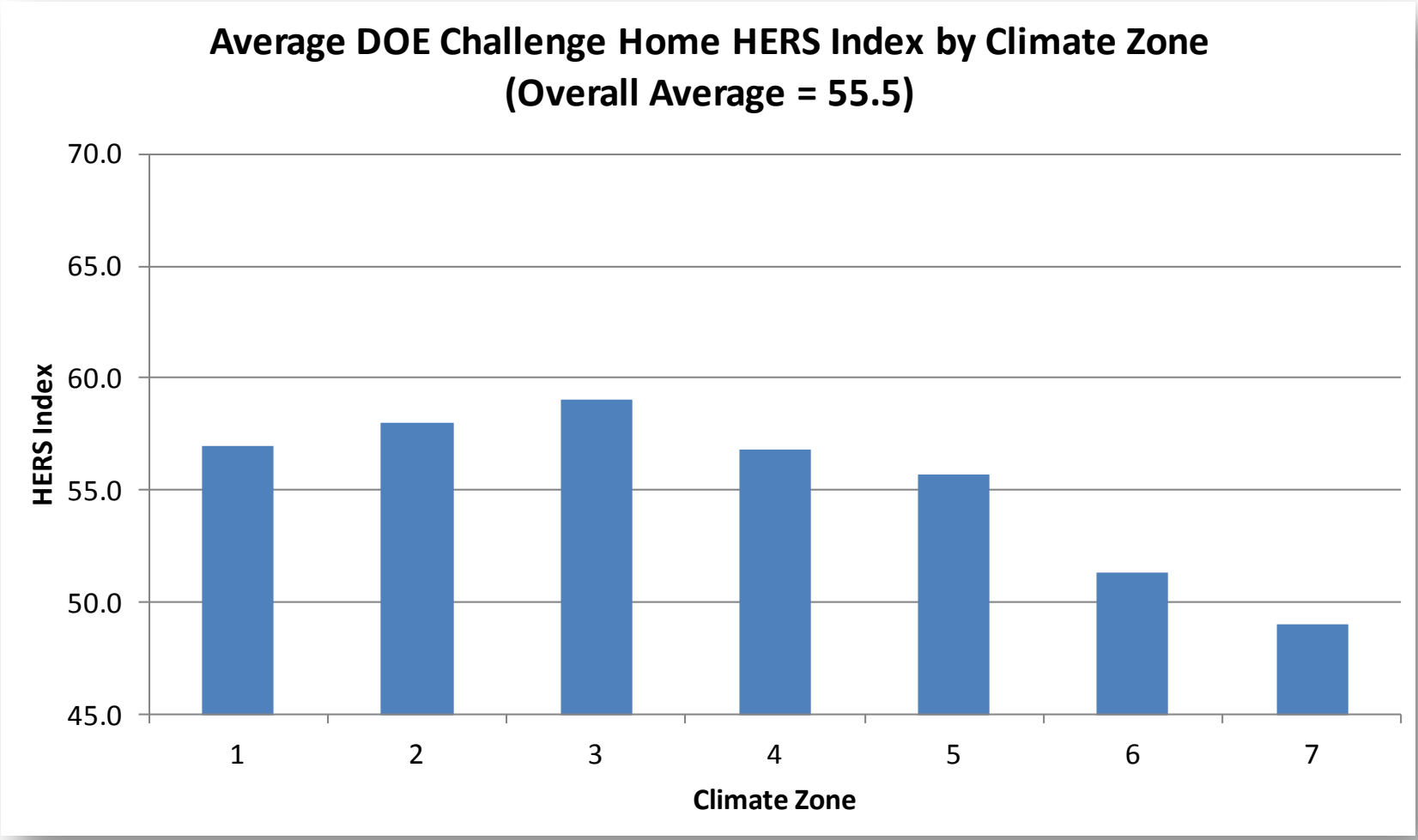
2012 vs. 2009 IECC Insul.

More Eff. Windows

Half ACH50

ENERGY STAR Water Htg.

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

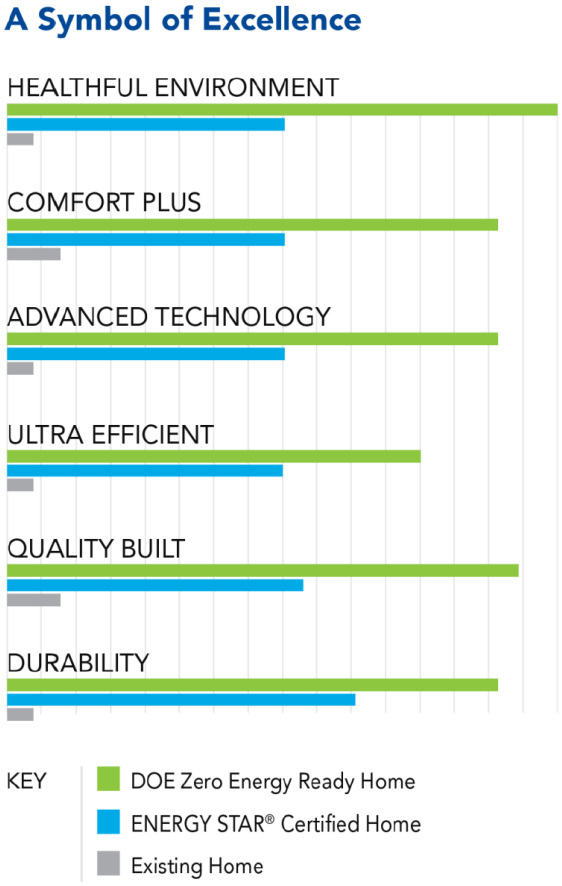
Note: Renewable energy systems may not be used to qualify for the Zero Energy Ready Home HERS Index Target Score, but may be used for the incremental HERS Index points needed for the Size Adjustment Factor.

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

[Not to Exceed 1.0]

A Verified Symbol of Excellence

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY



ZERH Process Requirements

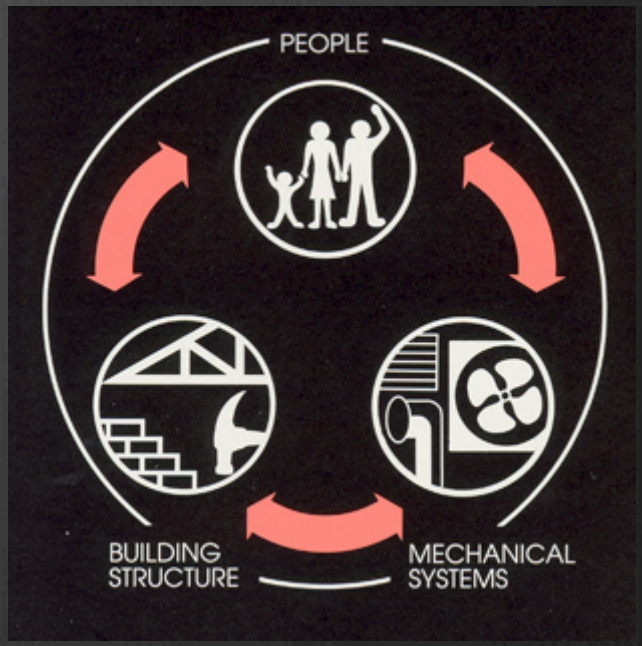
- Make a commitment to the program
  - required online training session
  - Must build at least 1 ZERH per year
  - optional certifications
- Engage an EnergyStar qualified rater
  - Initial rating
  - Site verification
  - Final rating
- Provide online house certification

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

Formula for H-P Homes

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



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 and other DOE 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