Moving To High Performance Homes: Will They be Robust or Fragile?

Energy Design Conference

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MOVING TO HIGH PERFORMANCE HOMES: WILL THEY BE ROBUST OR FRAGILE?

- Prologue: Introduction to Building America
- Act 1: Making a Case for Robust
- Act 2: A Search for Contenders
- Act 3: A Path Forward

- It is intended to be a reflective and thought-provoking session on where we have been, where we are, and where we need to go!

Building Technologies Program

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

Building America

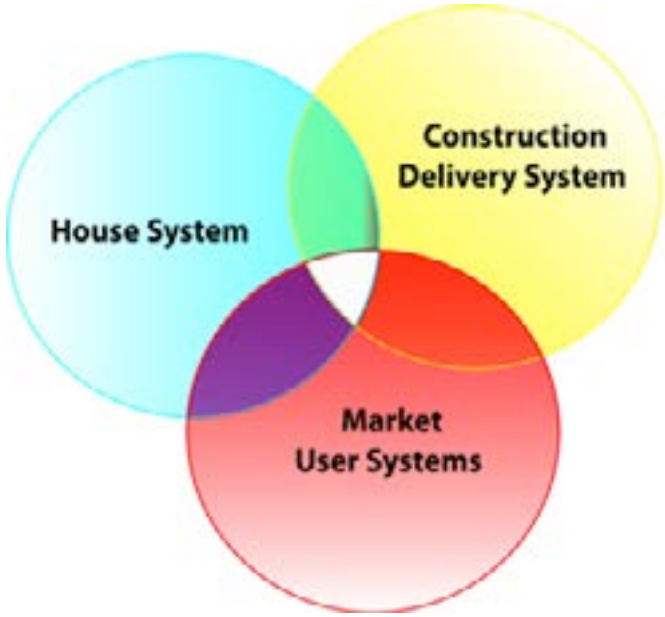
National Renewable Energy Lab

INTRODUCTION TO BUILDING AMERICA

- Focus is to reduce energy use by 50% in new houses and 30% in existing residential buildings.
- Promote building science solutions using a systems engineering and integrated design approach.
- “Do no harm” => we must ensure that safety, health, and durability are maintained or improved.
- Accelerate the adoption of high-performance technology.

Industry Research Teams

- Exploring the next generation of high performance homes for cold climates, using
  - building science as our compass
  - research as our guide
- Taking a total systems approach
  - House (physical) system
  - Construction delivery system
  - Market (consumer-user) system



NorthernSTAR
A Building America partner in research, innovation, and real home solutions.

- Research and deployment of a whole-house, systems engineered, integrated design approach to select the least cost and highest value features including:
  - Climate-specific designs
  - Highly-efficient walls, foundations, roofs
  - Super-efficient windows & doors
  - Passive solar space & water heating
  - State-of-the-art heating & cooling systems
  - Advanced hot water, appliances, lighting
  - Solar thermal and solar electric systems
  - Moisture resistant construction
  - Healthy indoor air

- Research Team Lead: University of Minnesota
  - Cold Climate Housing Program – Pat Huelman
  - Center for Sustainable Building Research – John Carmody

- Research Team Partners
  - Center for Energy and Environment – David Bohac
  - Building Knowledge, Inc. – Ed VonThoma
  - Energy Center of Wisconsin – Dan Cautley

- University Research Partners
  - Advanced Building Systems Group (BBE)
  - Initiative for Sustainable Enterprise (IonE/IREE)
  - Energy Systems Design Program (BBE)
  - Mechanical Engineering (CSE)
  - Clean Energy Resource Teams (CFANS)
  - Natural Resource Research Institute (UM-D)

- University Support
  - College of Food, Agricultural & Natural Resource Sciences
  - Initiative for Renewable Energy and Environment
  - University of Minnesota Extension

- External Research Partners
  - Building Green
  - Conservation Technologies
  - Hunt Utilities Group
  - McGregor Pearce
  - Verified Green
  - Wagner Zaun Architecture

- Building Enclosure
  - CertainTeed
  - DuPont - Building Innovations
  - Johns Manville
  - BASF
  - Dow
- Windows and Fenestration
  - Andersen Corporation
  - Cardinal Corporation
  - Marvin Windows and Doors
- Mechanical Systems
  - AIM
  - A.O. Smith
  - Panasonic
  - Venmar Ventilation
  - RenewAire
- Builders/Remodelers/Suppliers
  - Christian Builders
  - JET Construction & Remodeling
  - Lumber Dealers Supply
  - Nor-Son Construction
  - Northway Construction
  - TDS Custom Construction
  - Thompson Homes
  - Wausau Supply Company
  - Cobblestone Homes
  - Amaris Custom Homes
  - Lampert Lumber
  - Cocoon Home Performance Solutions
- Professional/Community
  - MN Office of Energy Security
  - NARI

- Current Research Portfolio
  - Foundation Insulation Systems
    - Full-scale testing of interior systems at the CRRF
    - Exploring innovative retrofit options for masonry

  - Project Overcoat
    - Exterior insulation systems focused on airtightness of 1-1/2 story roof applications
  - Integrated Space & Water Heating Systems
    - In-situ monitoring in WX homes

- Future Research Plans
  - Integrated Space & Water Heating
    - Laboratory optimization
  - Project Overcoat
    - Cost reduction (materials & labor)
  - Foundation Insulation for Existing Homes
    - Testing insulation system performance at the CRRF
    - Demonstrate “excavationless” method for exterior retrofit
  - Simplified Test Method for Combustion Safety

OVERARCHING THEMES

- We can and must do better!
  - Challenge ourselves towards better performance
- Existing technology can get us there, but …
  - We need to reduce the focus on products.
  - We must embrace more robust systems.
  - We need improvement in design & execution.
- Together we must find more robust designs, technologies, and processes for the future.

A SYSTEMS-GUIDED, PERFORMANCE-BASED APPROACH

- A house is a dynamic system of interconnected parts and components.
- It is driven by the climate, site, indoor conditions, and the laws of physics.
- And depending on how it is designed, constructed, and operated, it may perform …
  - very well,
  - very poorly, or
  - anywhere in between!

TOTAL BUILDING PERFORMANCE DEMANDS A "SYSTEMS APPROACH"

- Building a home today is …
  - not just parts, but practices,
  - not just materials, but methods, and
  - not just products, but process.
- If properly designed, constructed, and operated the whole should be more than the sum of the parts.
  - We must move from simple assembly to component integration to system synergy.

CAN WE GET MORE FOR LESS?

		Performance		
		Poorer	Same	Better
Costs	More	very bad	bad	likely
	Same	bad	*	good
	Less	likely	good	possible

KEEPING OUR EYE ON THE BALL

- So where does performance – especially health and safety, long-term energy efficiency, and building durability – fit into our current game plan?

- Reminder: In the past, excessive energy consumption provided forgiveness at many different levels of building performance.

KEEPING OUR EYE ON THE BALL

- Is it possible that we are putting our eggs into a very fragile basket?
  - It appears that some of the designs, systems, materials, and operations are falling short of our performance expectations.

- Are we not standing back far enough to see the whole picture?

KEEPING OUR EYE ON THE BALL

- Is it possible that we have over-invested in things and under-invested in design and execution?
  - How many times have you heard that we no longer have a quality, skilled labor force in construction?

- If that is true and we don't think we can change it.
  - It is even more important that we find designs, systems, materials, and methods that are not as installation sensitive.

KEEPING OUR EYE ON THE BALL

- Are we not being realistic about the process?
  - Are we using materials/methods that we don't fully understand or that might be beyond our abilities?
  - Are we investing in risky designs, systems, and materials and hoping for perfect execution?
  - Are we using execution sensitive approaches in an world of poorly trained and supervised execution?
  - Are we counting on perfect homeowner operation and maintenance?

A GROWING EPIDEMIC: NOTMYJOBITIS

HIGH-PERFORMANCE HOUSING: 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 the envelope (mechanical systems, occupants, etc).
  - This will require more robust designs
  - It will demand systems with forgiveness/tolerance
  - We must have a more predictable delivery system
  - The owners/occupants will need to be in the loop

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Robust
  - Strong, healthy, and hardy in constitution
  - Built, constructed, or designed to be sturdy, durable, or hard-wearing
  - A system that is able to recover from unexpected conditions during operation
- Things that seem to work regardless what your subs, nature, or client throw at them!

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Fragile
  - Easily broken; not having a strong structure
  - Unlikely to withstand severe stresses and strains

- Things that make perfect sense on paper, but seem to be “too fickle” to handle the real life situations they encounter.

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Designs
  - House
  - Mechanicals
- Systems
  - Envelope
  - Equipment
- Materials/Products
  - Components
  - Assemblies
- Methods (Execution)
  - Techniques
  - Process/Sequence
  - Delivery system
- Operation & Maintenance
  - Normal operation
  - Preventative maintenance
  - Emergency response
  - Repair & replacement

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- When push comes to shove; will your home's response be one of robustness or fragility?
  - Climate extremes
  - Abnormal interior conditions
  - Execution errors
  - Unusual operations
  - Neglected maintenance

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Foundation A.
  - Exterior waterproofing
  - Capillary break
  - Exterior XPS insulation
  - Interior frame wall
    - paperless drywall
    - latex paint
- Foundation B.
  - Dampproofing
  - No capillary break
  - Interior frame wall
    - poly
    - fiberglass
    - poly
    - drywall

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Cold Climate Wall A.
  - Good overhang
  - Wall construction
    - vinyl siding
    - house wrap
    - fiberboard sheathing
    - fiberglass batt
    - airtight poly
    - drywall
  - No air-conditioning
- Cold Climate Wall B.
  - No overhang
  - Wall construction
    - stucco
    - house wrap
    - OSB sheathing
    - fiberglass batt
    - non-airtight poly
    - drywall
  - Heavy air-conditioning

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- House A.
  - Sealed combustion furnace
  - Atmospherically-vented water heater
  - Fireplace
  - Large downdraft range vent
- House B.
  - Sealed combustion furnace
  - Power-vented water heater
  - Airtight wood stove
  - Modest range hood

HIGH-PERFORMANCE HOUSING: MAKING THE CASE FOR ROBUST

- Ductwork A.

- Ductwork B.

LET'S START WITH FRAGILE

- Fragile Designs
  - Tuck-under garages
    - bonus rooms over garages
  - Challenging roofs and roof/ wall connections
  - Tall window walls
  - Upper level laundry rooms

LET'S START WITH FRAGILE

- Fragile Systems
  - Interior foundation insulation
    - especially air & vapor permeable insulation
  - Ductwork outside the thermal envelope
    - especially below slab and attic ductwork
  - Vented crawl spaces
  - Cantilevered floors

LET'S START WITH FRAGILE

- Fragile Products/Materials
  - Natural draft water heater
    - especially in tighter homes
  - Flex duct
  - Cultured stone exteriors
    - w/o air space & drainage
  - Low-density attic insulation
  - Carpet on slabs
    - especially below grade

LET'S START WITH FRAGILE

- Fragile Execution
  - Tuck-under garages & bonus rooms over garages
  - Flanged windows
  - Air sealing complex ceiling designs
    - especially chases and recessed can lights

LET'S START WITH FRAGILE

- Fragile Operation
  - Air intakes
    - ventilation, make-up, or combustion air
  - Carpets
  - Large range vents
  - Washing machines draining into laundry tubs

LET'S START WITH FRAGILE

- Things you've tried that absolutely made sense in theory, but turned out to be far too difficult to pull off in the field.
  -
  -
  -

NOW LET'S THINK ABOUT ROBUST

- Robust Designs
  - Simple house geometry
  - Simple roof geometry
  - Detached garage

NOW LET'S THINK ABOUT ROBUST

- Robust Systems
  - Exterior insulation
    - foundation (with possible exception of above grade)
    - walls
  - Comprehensive & tested air sealing (0.1 cfm/sf)
  - Vented attics in cold climates
  - Active subslab depressurization systems
  - Exterior insulation

NOW LET'S THINK ABOUT ROBUST

- Robust Products/Materials
  - Sealed combustion equipment
  - Low-sone spot ventilation with sensors/controls
  - Low-e, warm-edge, NFRC-rated glazing systems
  - Vinyl siding
  - Integral foundation insulation

NOW LET'S THINK ABOUT ROBUST

- Robust Execution
  - Vented-rain screen
  - Open web floor trusses
  - Foundation waterproofing with drainage
  - Spray foam rims and bands

NOW LET'S THINK ABOUT ROBUST

- Robust Operation
  - Central exhaust systems
  - Well-drained foundation
  - Warm-edge windows
  - Basement (lowest level) laundry w/ pan and drain

NOW LET'S THINK ABOUT ROBUST

- Things that you have tried that you can take to the bank, even if it wasn't done perfectly.
  -
  -
  -

ROBUST OR FRAGILE?

- Robust or Fragile?
  - Conditioned crawl space
  - Unvented (hot) roofs
  - Wood foundations
  - Passive solar design
  - Ground source heat pumps
  - Heat (or Energy) Recovery Ventilation

ROBUST OR FRAGILE?

- Robust or Fragile?
  - Spray foam for walls
    - closed-cell medium density
    - open-cell low density
  - Housewraps (weather resistive barriers)
  - Insulated Concrete Forms (ICFs)
  - Structural Insulated Panels (SIPs)
  - Setback thermostats

MAKING THE CASE FOR ROBUST

- Robust: Don't think of it as a thing, but more of a conceptual way of evaluating new designs, systems, materials, execution, and operation.

- There are a number of ways to think of robust.
  - It is idiot proof, bullet proof, and unlikely to fail.
  - If it fails, it won't hurt anything else.
  - If it fails, it will be easy to repair or replace.
  - If it fails, there is a planned back-up or redundancy.

CHALLENGING QUESTION

- Did the move to …
  - bigger and more complex designs, with newer (perhaps, untested) materials
  - along with poor systems design and integration
  - and changes in the industry structure, trades, codes and standards
  - with clueless homeowners
- push us towards fragile and unacceptable performance?

CHALLENGING QUESTION

- What must we do to move away from the fragile edge and move towards more robust
  - Designs,
  - Systems,
  - Materials,
  - Methods, and
  - Operation?

CHALLENGING QUESTION

- Can it be evolution or must it be revolution?
  - It seems that small incremental steps (evolution) got us in this predicament
  - And bigger, bolder steps (revolution) might be needed to get us back out!

APPLICATIONS AND TECHNOLOGIES FOR BUILDING ROBUST HOMES

- A Call to Move Towards Simple Elegance
  - Smaller homes; simpler designs
  - Embrace an integrated design philosophy
  - Better approaches to construction sequencing
  - More appropriate, user-friendly controls
  - Always building on the basics and what we know to be true – not just the latest fad.

APPLICATIONS AND TECHNOLOGIES FOR BUILDING ROBUST HOMES

- A Call for Systems Engineering
  - Better systems design and evaluation
  - More robust materials and components
  - Consideration to accessibility, repair, replacement
  - Enhanced QA/QC, continuous monitoring & improvement, final commissioning

APPLICATIONS AND TECHNOLOGIES FOR BUILDING ROBUST HOMES

- A Call for More Robust Design, Systems, Products, Execution, and Operation
  - Ideally the houses is robust at all levels.
  - However, if a design, system, or product is less than robust,
    - it may require more attention in execution and operation.
  - Likewise, if the execution or operation are not particularly robust,
    - it would dictate a more robust design, system or

APPLICATIONS AND TECHNOLOGIES FOR BUILDING ROBUST HOMES

- A Call for High-Performance Homes

- But it will demand a new approach. 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.

PAT'S PICKS

- Dry and Warm Slab w/ RRNC
  - 4" of ¾" and up aggregate; no fines
  - 1 to 3" of extruded polystyrene
  - Poly vapor retarder (optional)
  - 4" high quality slab; all joints and edges sealed
  - Sealed sump basket
  - 3 or 4" passive vent from below slab to the roof
    - with electrical box nearby in attic for fan activation

PAT'S PICKS

- Windows Designed for Integration
  - High-quality low U-value, warm-edge window
  - Comes with a custom fit sill pan and head flashing with end dams
  - Flanges are air/water tight with tabs to integrate with flashing and weather resistive barrier

PAT'S PICKS

- Combo Space and Water Heating
  - ECM driven air handler on an efficiently planned, airtight duct system.
  - Properly sized hot water and AC coils
  - Sealed combustion water heater (or small boiler)
  - Both airflow and water temperature can be modulated to meet loads and comfort
  - Can be used for circulation and/or ventilation air distribution
  - Water storage could be handy for excess energy

PAT'S PICKS

- Ventilation Integrated with Forced Air
  - Use the forced air system for supply air to all habitable rooms
    - could tie in exhaust air in some situations.
  - Provides an opportunity for both conditioning and MERV 10+ filtration of outside air
  - Can be used for both continuous and boost ventilation

PAT'S PICKS

- Whole House Dehumidification
  - Since ventilation does not equal humidity control, it is critical to provide systematic dehumidification.
  - Independent control for indoor humidity for condensation, mold, and dust mites
  - Aid in summer comfort
  - Might be able to use a smart AC with combo space heating.

PAT'S PICKS

- Exterior Thermal & Moisture Mgmt. System
  - Build the entire structure; foundation, floor systems, walls, and roof
  - Wrap the entire envelope with a "peel & stick" membrane integrated with openings/penetrations
  - Add rigid foam insulation 2 to 3" on foundation, 3 to 4" on walls and 6 to 8" on the roof.
  - Add furring strips, overhangs, etc.
  - Install siding; roof sheathing and roofing.

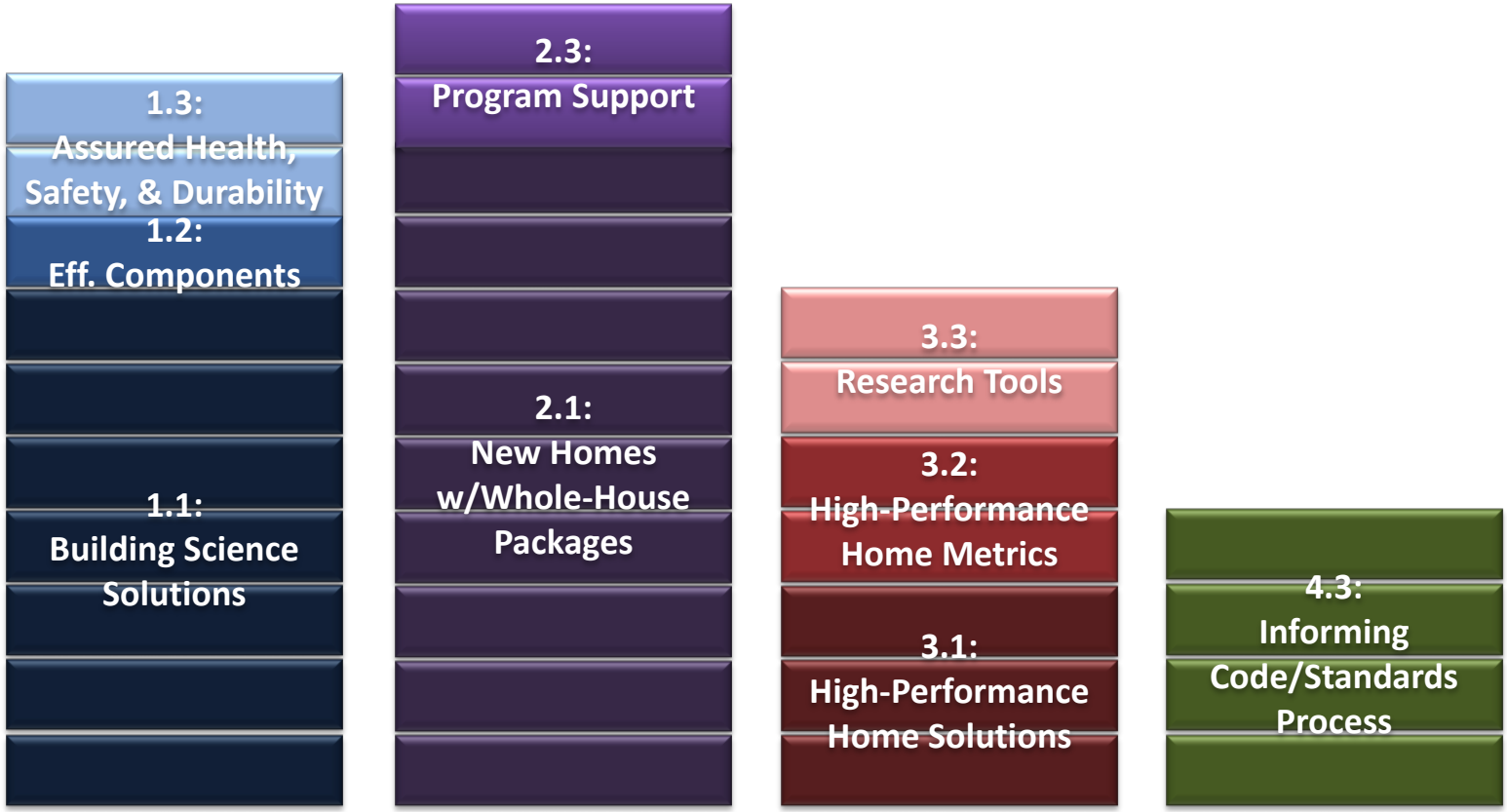
A PATH FORWARD

- Partners
  - Energy Rater
  - Home Performance Consultant
  - Other Resources
    - Building America

A PATH FORWARD

- Building America Resources
  - General Energy Information
  - Top Innovations “Hall of Fame”
  - Building America Solutions Center

BA TOP INNOVATIONS 'HALL OF FAME'



World-Class Research…

Building America Solution Center

BASC.energy.gov

…At Your Fingertips

A PATH FORWARD

- Programs
  - Triple E Homes
  - Energy Star for Homes (v.3)
  - DOE Challenge Home

DOE Challenge Home

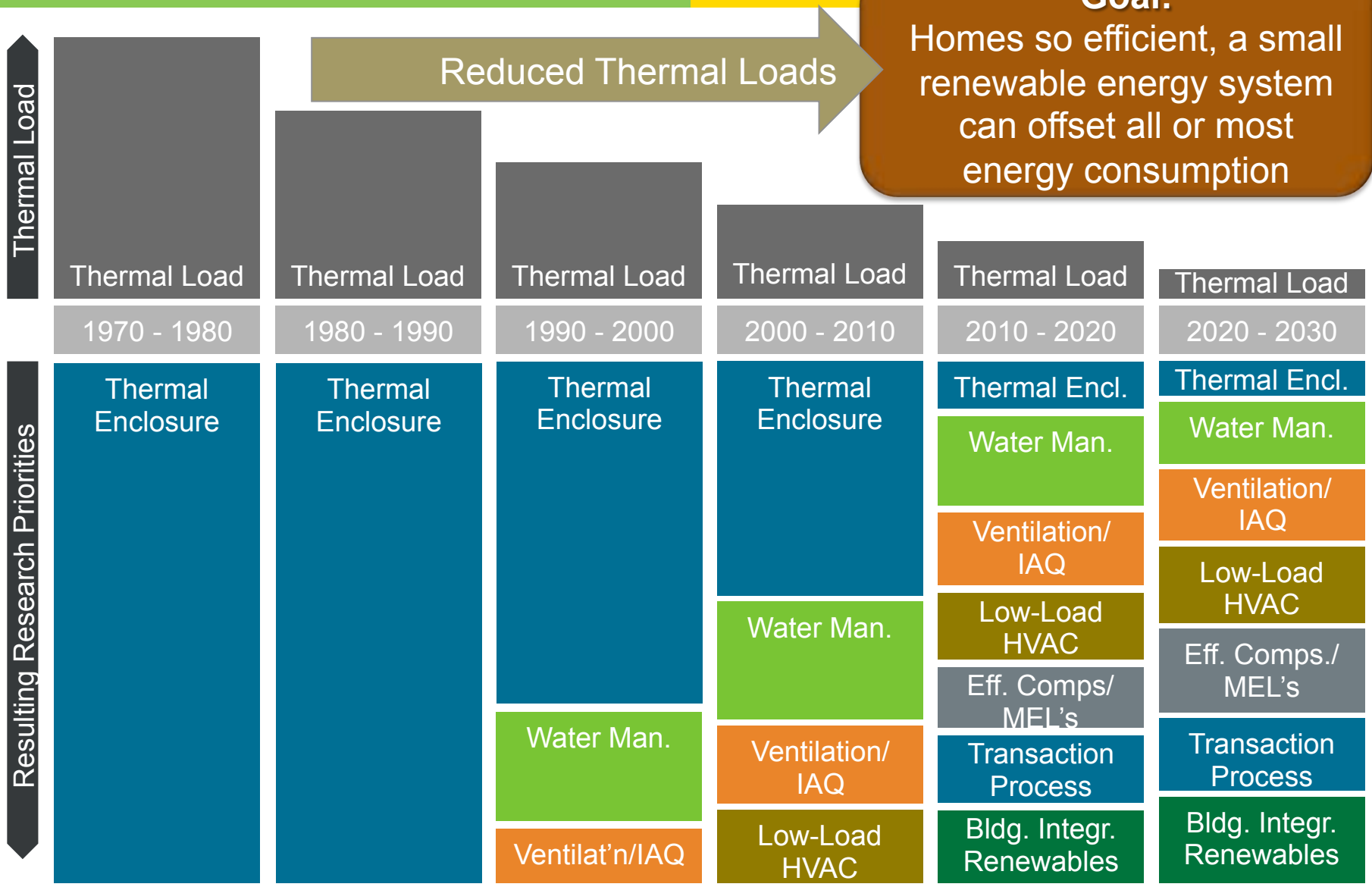
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Building America
DOE Challenge Home

Building America Strategy

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

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



Why Building America Innovations

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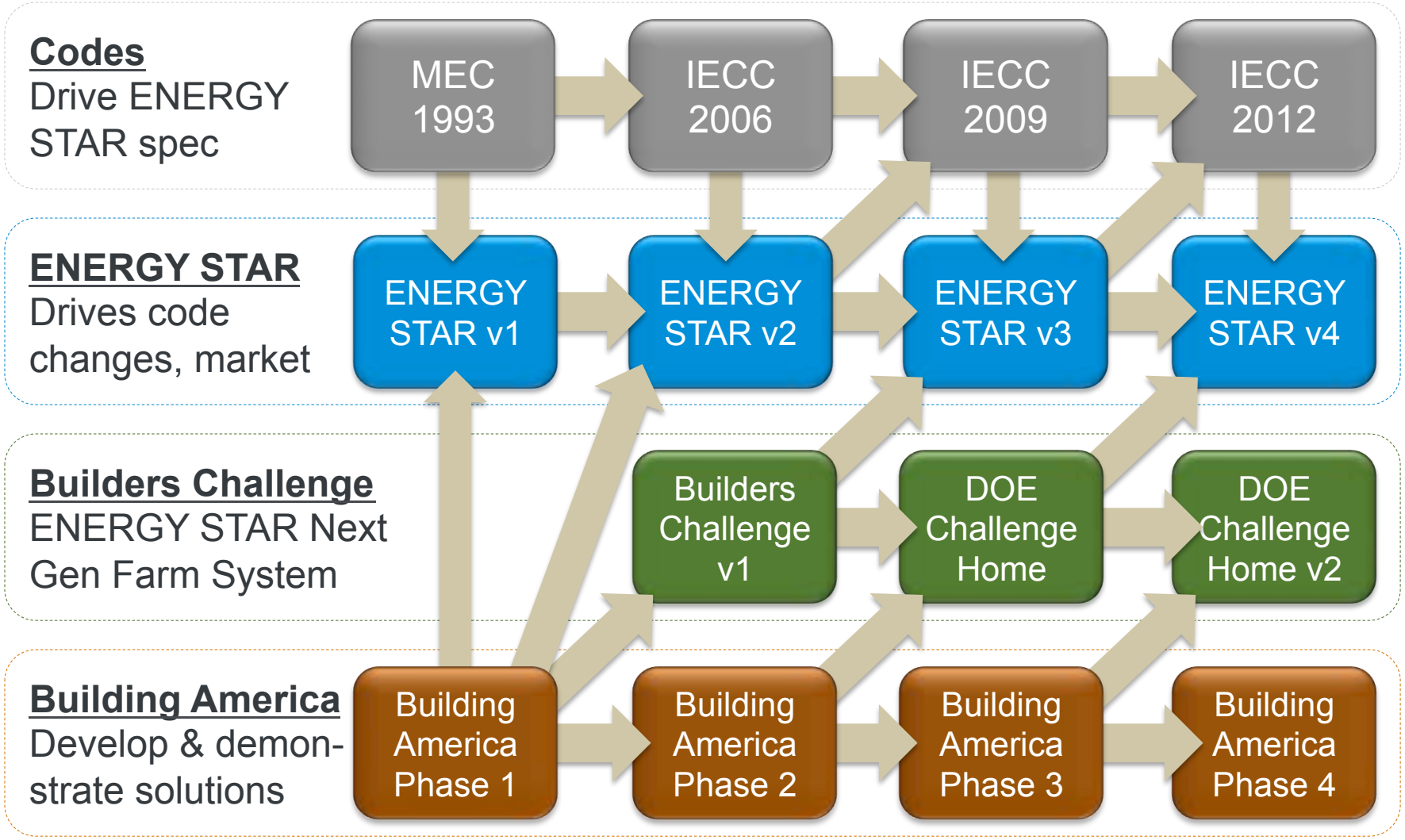

Building America

DOE Challenge Home

The Pitch

By constructing DOE Challenge 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 Challenge 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 net-zero energy ready homes that none of your competition has.

The DOE Challenge Home Business Case

Old Business Solution:

Minimize Cost

to attract and convince buyers
to choose your product over your competition
and the existing housing market.

New Business Solution:

Maximize Value

so homebuyers are compelled
to want new housing again
and choose your home
over competitor's products.

Business Case: Innovation Premium

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Price Based on 'Value', NOT Cost

Innovation/Value Premium

Profit

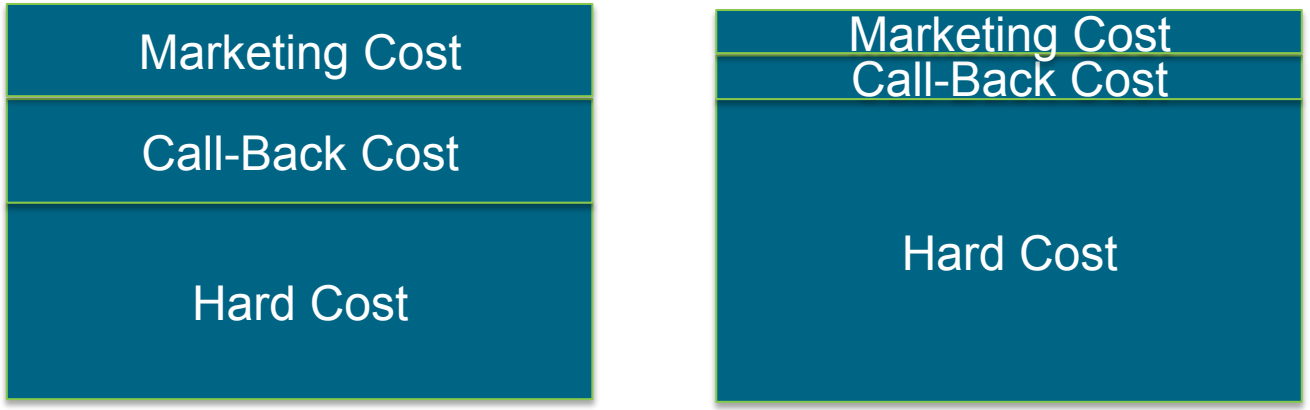
i-Phone Cost

Profit

Old Cell Phone Cost

VS.

Business Case: Real Cost

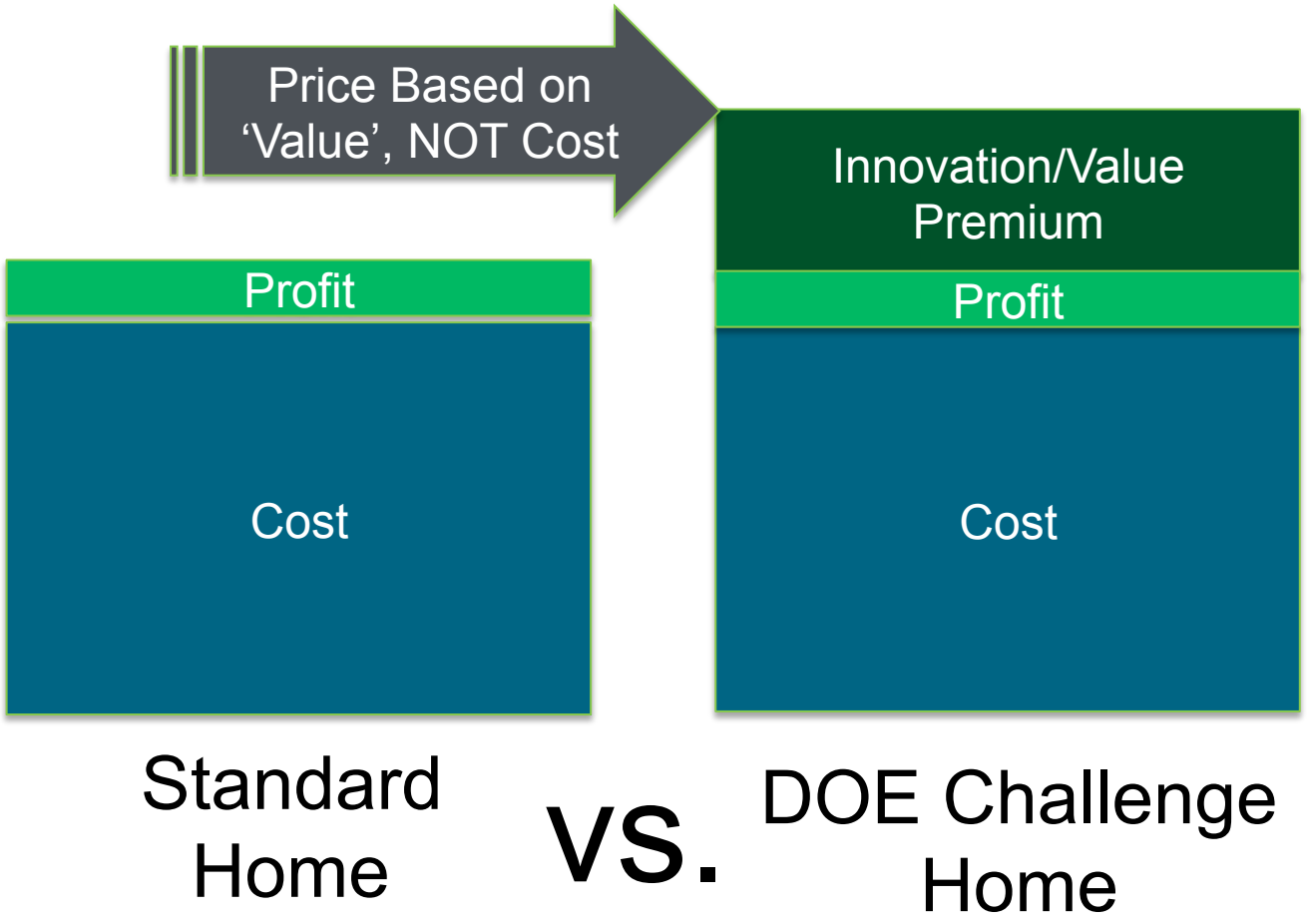


Standard Home

VS.

DOE Challenge Home

Business Case: Innovation Premium



Business Case: Home of the Future

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Ultra-Low/No Utility Bills

Advanced Home Management

Built-in Black-out Power Supply

Luxurious Comfort & Quiet

Much Lower Insurance Cost

Healthier Living

Lower Mortgage Rate

Quality Components

Long-Term Warranty

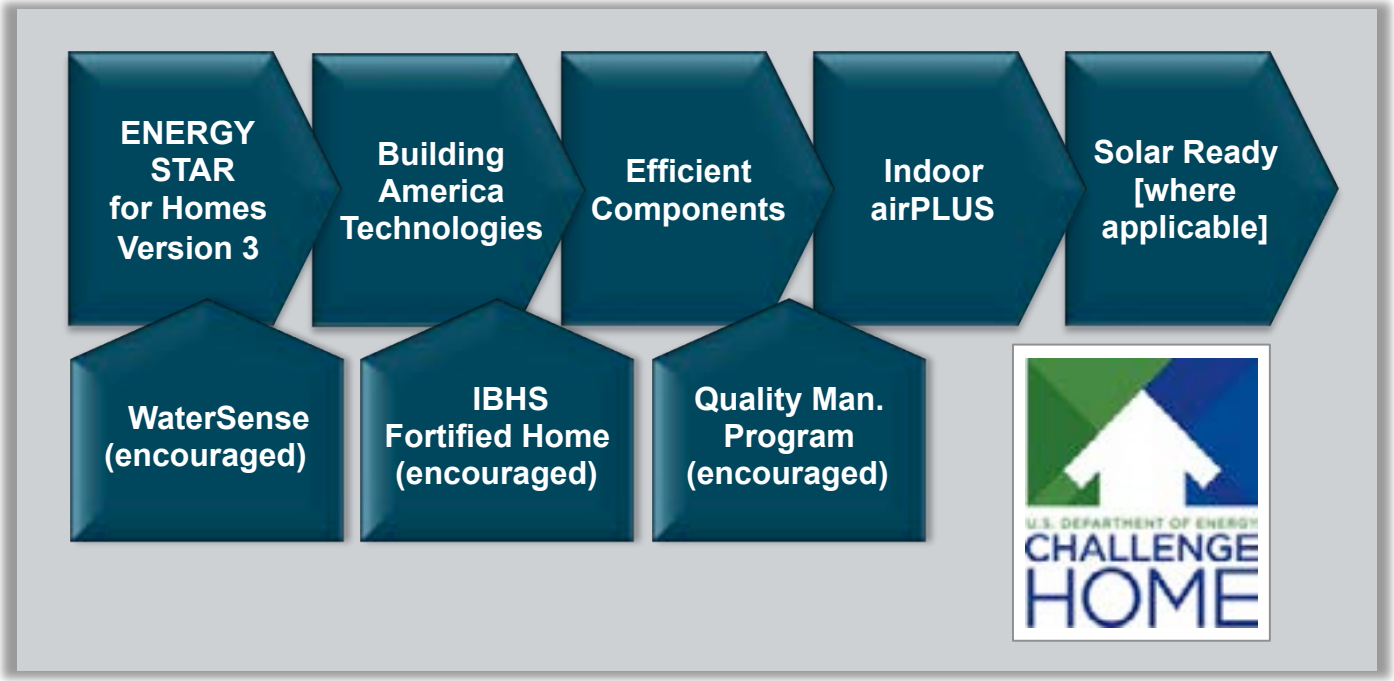
Low Maintenance

Minimal Wasted Water

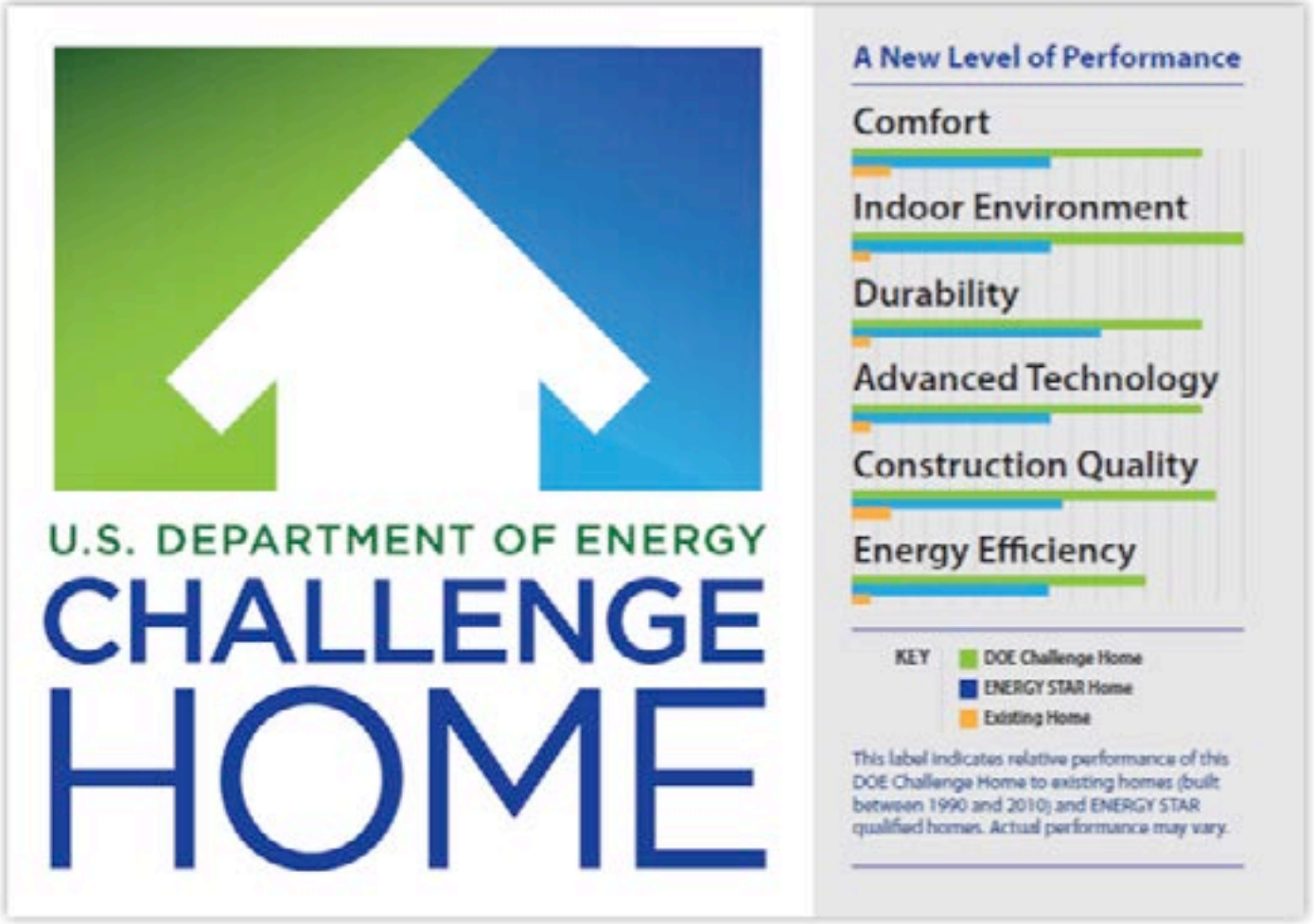
Disaster Resistance

The Foundation

Specifications flow from the program strategy….



Strong Marketing Message



Strong Marketing Message

Front Cover

Inside Spread

Back Cover

Path to Zero Net-Energy Ready

Zero Net-Energy Ready:

- The New Reality
- Home of the Future
- Builders in Action
- Made Simple
- Business Case
- Value Proposition
- **Technical Specifications**
- Recognition w/Challenge Home
- Local Solution

Technical Specifications:

- Building Science
- Best Practices
- Ducts in Conditioned Space
- Super Air-Tight Construction
- 2012 IECC Insulation
- Efficient Low-Load HVAC
- Efficient Components
- Indoor Air Quality
- Solar Ready
- Water Conservation
- Disaster Resistance
- Quality Management

Process Overview

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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 Challenge Home requirements.

Construction – builder constructs home to meet all DOE Challenge 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 Challenge Home as a builder is working with a Home Energy Rating System (HERS) Rater.

Partner 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

- **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.

DOE Challenge Home Framework

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

DOE Challenge Home Mandatory Reqmnts.

"Target Home" Design Specs

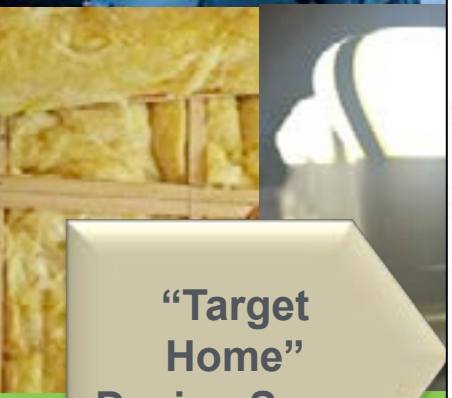
DOE Challenge Home
National Program Requirements
April 1, 2012

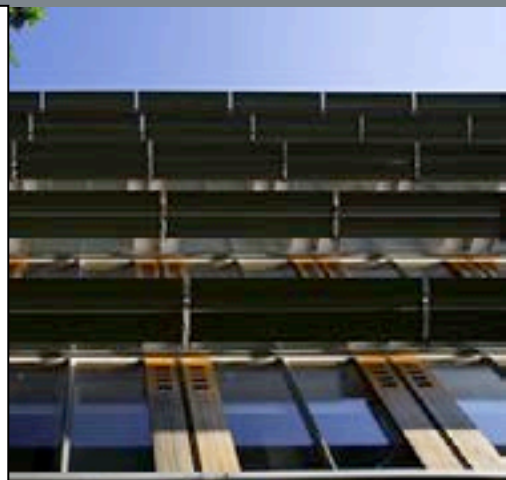
Exhibit 1: DOE Challenge Home Mandatory Requirements for All Labeled Homes

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	☐ Certified under ENERGY STAR Qualified Homes Version 3[9]
2. Envelope[9]	☐ 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[5, 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 Climates** (2012 IECC Zones 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.[24]			
Water Heater			
ENERGY STAR minimum			
Thermostat[25] & Ductwork			
• Programmable thermostat (except for zones with radiant heat)			





DOE Challenge Home Framework

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Size Adjustment Factor

Exhibit 3: Benchmark Home Size[28]

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

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

DOE Challenge Home Mandatory Requirements

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]

Encouraged:

- EPA WaterSense
- EPA Indoor airPLUS (full compliance)
- Quality Management
- Disaster Resistance (IBHS Fortified Home)

DOE Challenge Home Target Home Design

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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 Climates** (2012 IECC Zones 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. [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.

Half ACH50

More Eff. Windows

ENERGY STAR Water Htg.

For More Information

Visit the Challenge Home web site to learn more and find approved builder partners:

http://www1.eere.energy.gov/buildings/challenge/

NorthernSTAR BA Project Concept

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- **Introducing DOE Challenge Home Project**
  - Find 4-6 Builder Partners
  - Cluster of 5-10 high performance DOE Challenge Homes
  - To be featured in the 2013 BATC Fall Parade of Homes

- **Potential Partners**
  - Lampert Lumber
  - Builders Association of the Twin Cities
  - Builders
  - Home Performance Raters
  - Utilities

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- Questions

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