

DOE Zero Energy Ready Home

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



Zero Energy Ready Home Training

SAM RASHKIN
Chief Architect
Building Technologies Office

For More Information

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



For More Information:

www.buildings.energy.gov/zero/

e-mail Contact:

zero@newportpartnersllc.com

Zero Energy Ready Home:

- Why Build
- Technical Specifications
- Recognition





Zero Energy Ready Home

Why Build

Why Build

- The Visible Future
- The Business Case
- Translating Value





Zero Energy Ready Home
Why Build:
The Visible Future

“You can predict the future accurately.

*All you have to do is leave out the parts
you could be wrong about.”*

*“The key... is knowing how to distinguish a
soft trend from a **hard trend**...*

It’s knowing how to recognize certainty.”

Daniel Burrus, *“Flash Foresight”*

Three Hard Business Trends

**Accelerating
Change**

**Increasing
Information**

**Innovation
Imperative**

Change

Information

Innovation

“Accelerating rate of change is as certain as the sun rising in the east...

It’s going to sweep across our landscape like the technological tsunami it is....

It will disrupt catastrophically every aspect of every industry...

—*except for those who see it coming.*”

Daniel Burrus, ***“Flash Foresight”***

Despite the importance of the housing industry to the national economy,

there is very little investment in residential technologies.

This is especially true of the single-family homes that make up most of America's housing stock;

it can take 10 to 25 years for a new housing technology to achieve full market penetration.

Source: 'The Diffusion of Innovation in the Residential Building Industry,' Center for Housing Research Virginia Tech and NAHB Research Center. January 2004

Change

Information

Innovation

BY JANN SWANSON

Real Estate Web Searches Climb 253% in Four Years as 90% of Homebuyers Use Internet as Primary Research

Jan 7 2013, 3:50PM

Text 

Home-shopping consumers are not only exponentially increasing their **reliance on the Internet** but are also developing distinct patterns for using it in their housing searches. **Google** and the **National Association of**

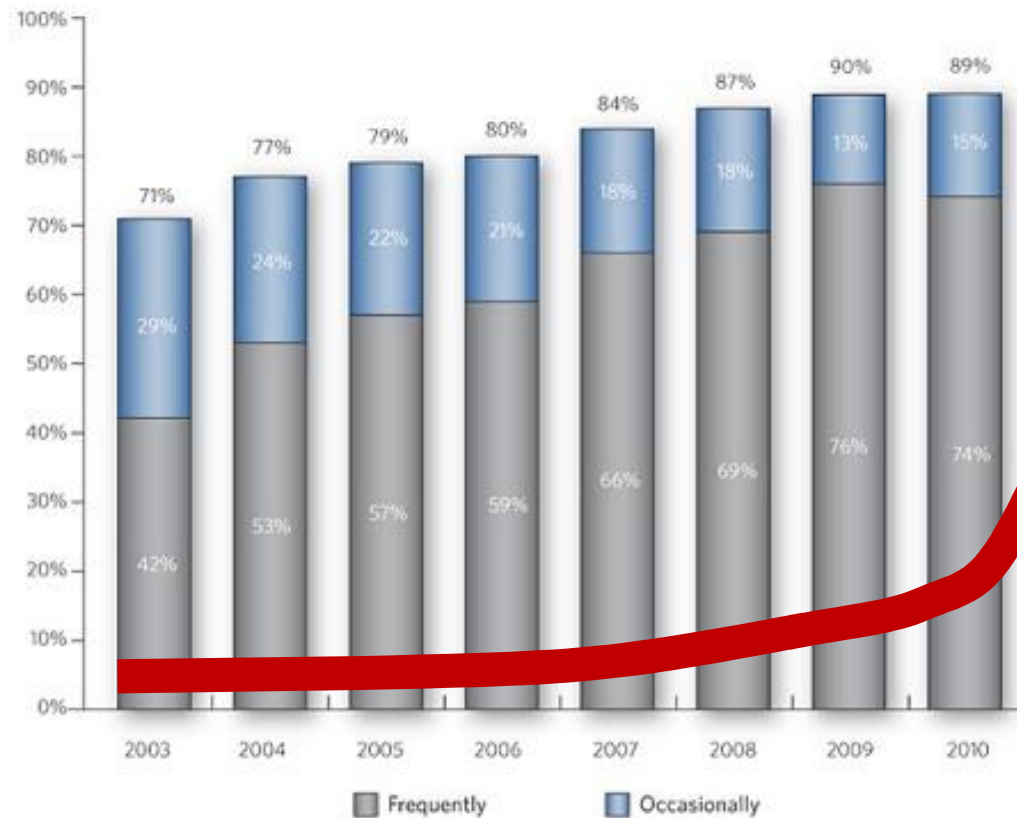
More Informed Consumers

Change

Information

Innovation

Exhibit 3-13 USE OF INTERNET TO SEARCH FOR HOMES, 2003-2010



Internet Content Available

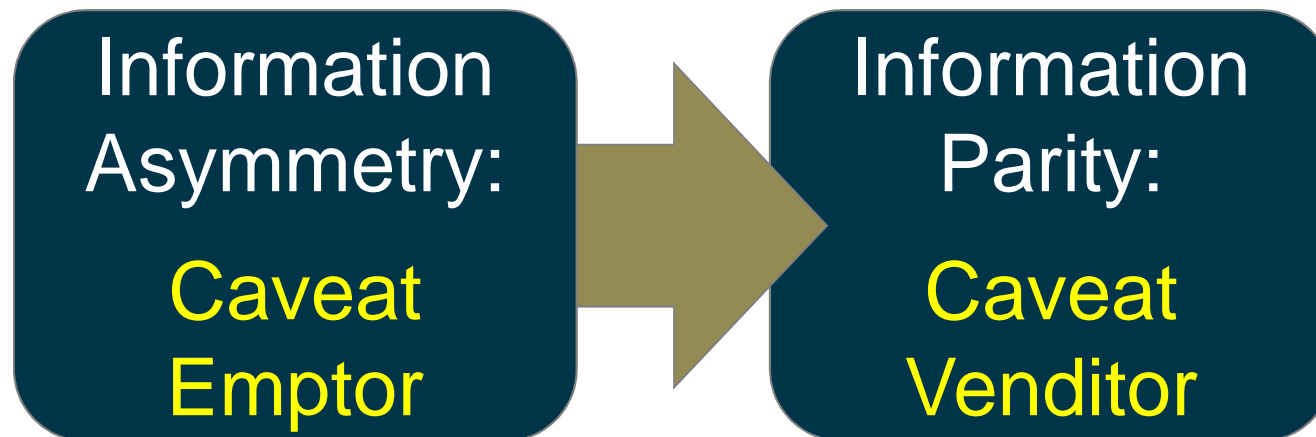
SOURCE: National Association of Realtors® - Profile of Home Buyers and sellers 2010

More Informed Consumers

Change

Information

Innovation



What Car Buyers Know

Change

Information

Innovation

- **Design**

- Appearance
- Size
- Function

- **Performance**

- Energy Efficiency (MPG)
- Acceleration/Handling
- Safety/Crash Test Ratings

- **Cost**

- Invoice Price
- 'Great/Good/Fair' Price
- Resale Value
- Maintenance Cost

- **Durability**

- Repair Record
- Recalls
- Warranty

- **Value**

- Awards/Special Recognition
- Professional Reviews
- Owner Reviews

What Home Buyers Will Know

Change

Information

Innovation

- **Design**

- Appearance
- Size
- Function

- **Performance**

- Energy Efficiency (HERS)
- Comfort
- Health

- **Cost**

- Sticker Price
- Ownership Cost (PITI + E)
- Resale Value
- Maintenance Cost

- **Durability**

- Repair Record
- Disaster Resistance
- Warranty

- **Value**

- Awards/Special Recognition
- Professional Reviews
- Owner Reviews

Innovation Drivers

Change

Information

Innovation

- Next Generation of Buyers
- The Competition

Next Generation Homebuyers

Change

Information

Innovation



78 Million Gen-Y'ers

What We Know About Gen-Y

Change

Information

Innovation

- Debt
- Sharing Economy
- Delayed Commitment
- Crash Experience
- Innovation Junkies



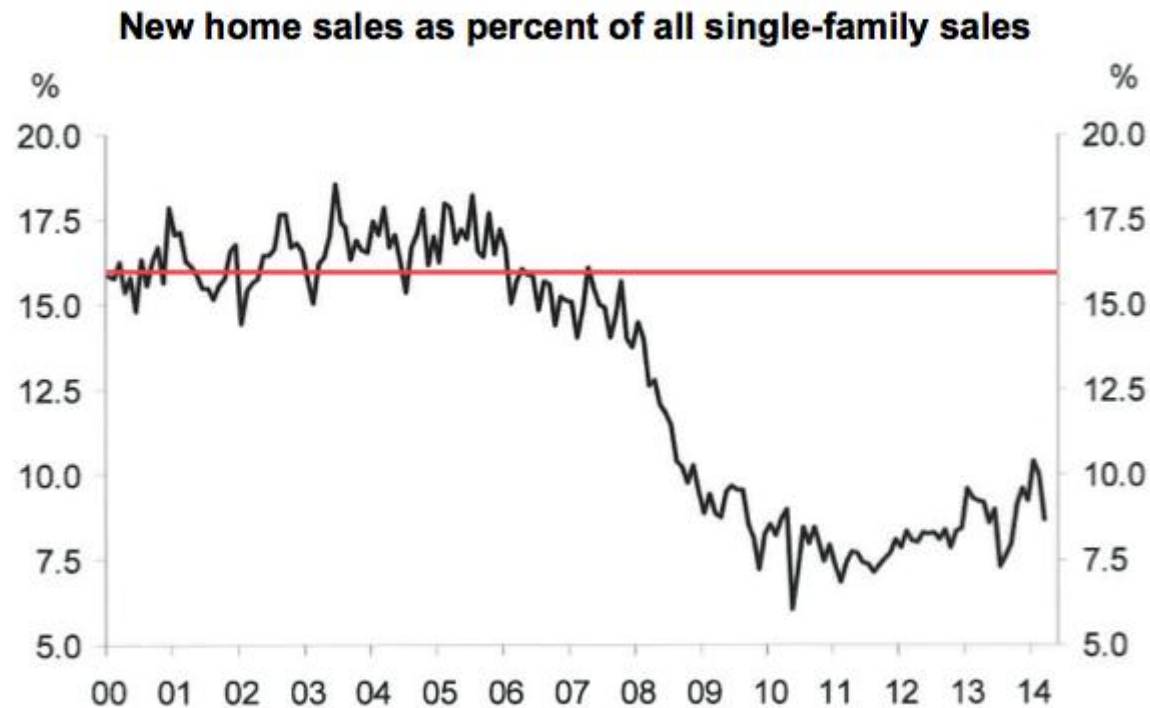
The Competition

Change

Information

Innovation

New home sales still hurting



Source: Census, NAR, DB Global Markets Research

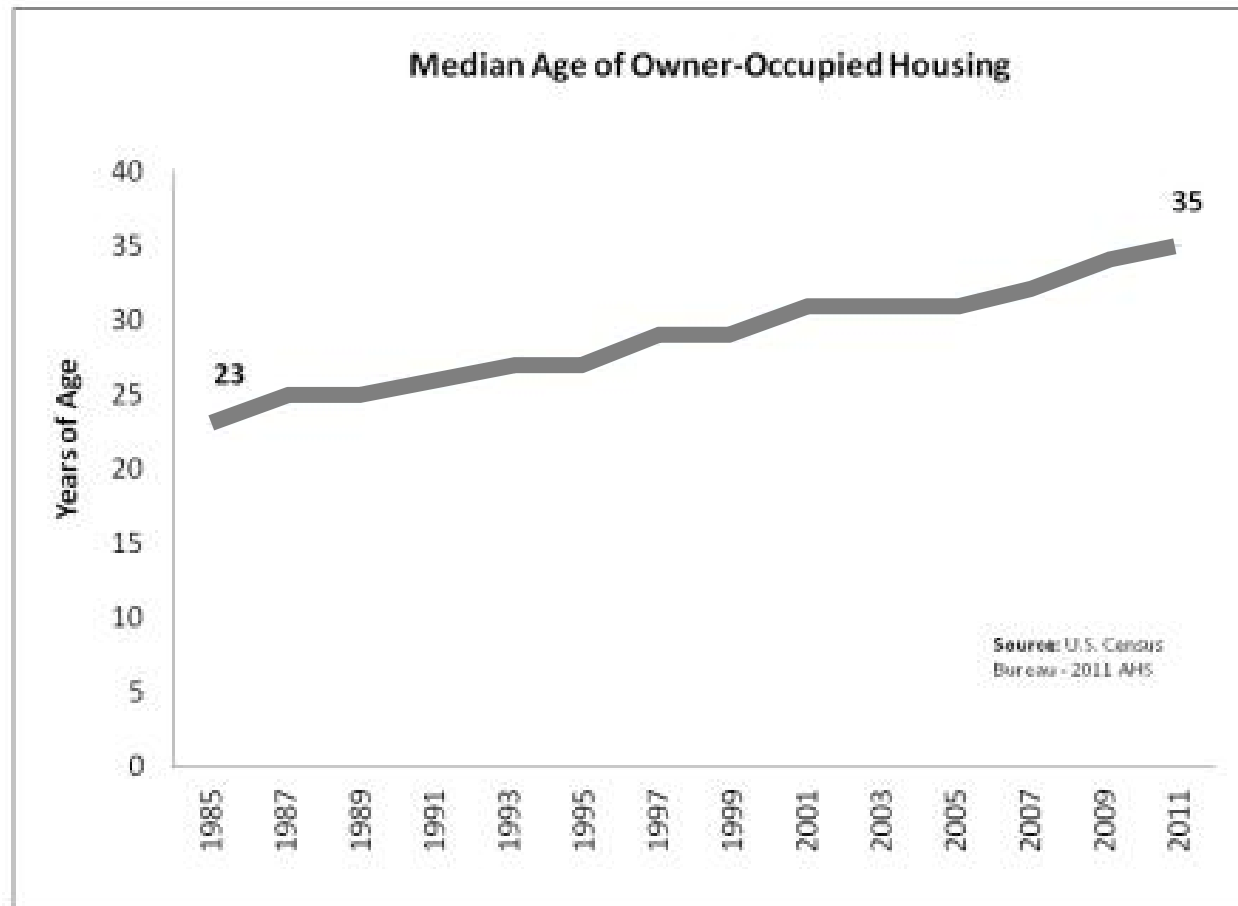


Aging Housing Stock

Change

Information

Innovation



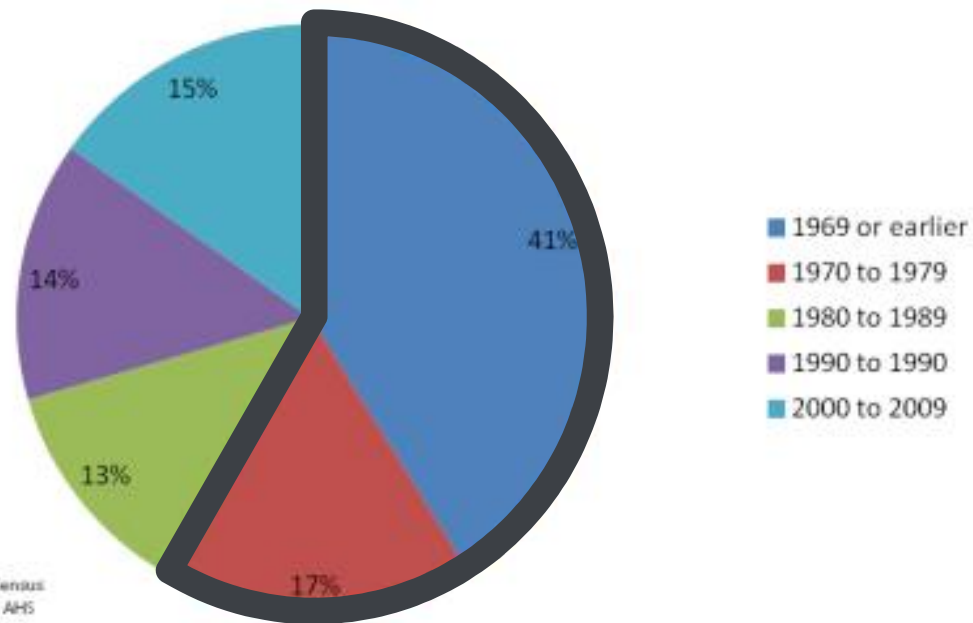
Aging Housing Stock

Change

Information

Innovation

Share of Owner-Occupied Housing
Years Structure Built - 2011



Source: U.S. Census Bureau - 2011 AHS

Change

Information

Innovation

Existing Homes:

- High Utility Bills
- Poor Comfort
- Health Risks
- Moisture Problem Risks
- Excessive Bugs/Pests
- Durability Issues
- Obsolete Technology



Meet
85+%
of Your
Competition

Change

Information

Innovation

Exceed Customer Expectations

Rules*:

1. If it can be done, it **will** be done.
2. If you don't do it,
someone else will.

* Daniel Burrus, "*Flash Foresight*"

Change

Information

Innovation

Disruption with Someone Else Doing It:

- **Kodak**
- **Polaroid**
- **Motorola**
- **Palm**
- **American Car Manufacturers**
- **TWA and other Legacy Airlines**
- **Converse Sneakers**
- **and the list goes on...**

Visible Future in the Media

Change

An air conditioner
that anticipates
your needs
PAGE 59

Solar panels that
eliminate your
energy bills
PAGE 76

A door that can
sense your approach
PAGE 59

A sprinkler that
tracks the weather
PAGE 80

Information



Innovation

Walls that
can weather a
hurricane
PAGE 66

A car that can
power your house
PAGE 79

A garden that
filters your air
PAGE 87



Zero Energy Ready Home
Why Build:
The Business Case

Risk Management

Zero Differentiation

Exceed Expectations



- Latest Energy Codes
- Low HERS Scores
- Voluntary Labels



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

Risk 1: Ensured Comfort

Risk Management

Zero Differentiation

Exceed Expectations



- Lower Htg./Clg. Loads
- Lower Air Flow/Mixing
- Longer Swing Seasons
- Less Humidity Control

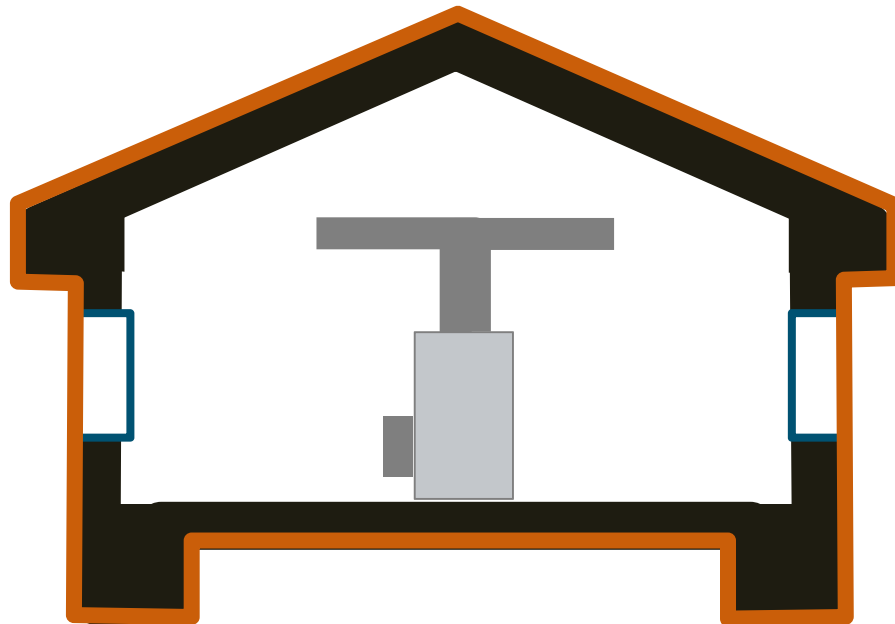
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Risk 1: Ensured Comfort Strategy

Risk Management

Zero Differentiation

Exceed Expectations



- Lower Htg./Clg. Loads
- Lower Air Flow/Mixing
- Longer Swing Seasons
- Less Humidity Control



Optimized Low-Load Comfort System

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

Risk 2: Moisture Man.

Risk Management

Zero Differentiation

Exceed Expectations



- Colder Walls
- More Wetting Potential
- Less Drying Potential



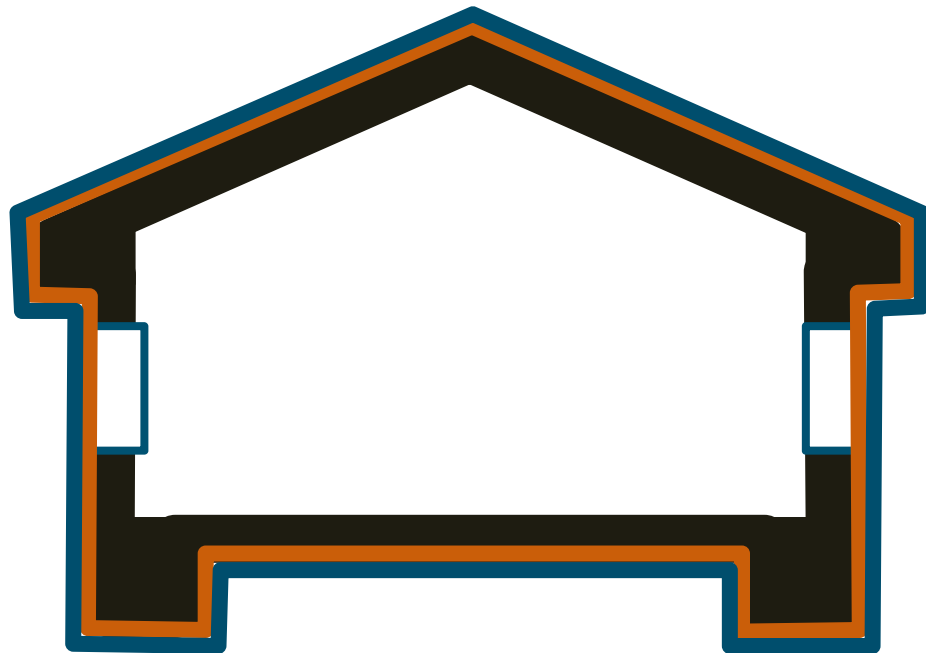
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Risk 2: Moisture Man. Strategy

Risk Management

Zero Differentiation

Exceed Expectations



- Colder Walls
- More Wetting Potential
- Less Drying Potential



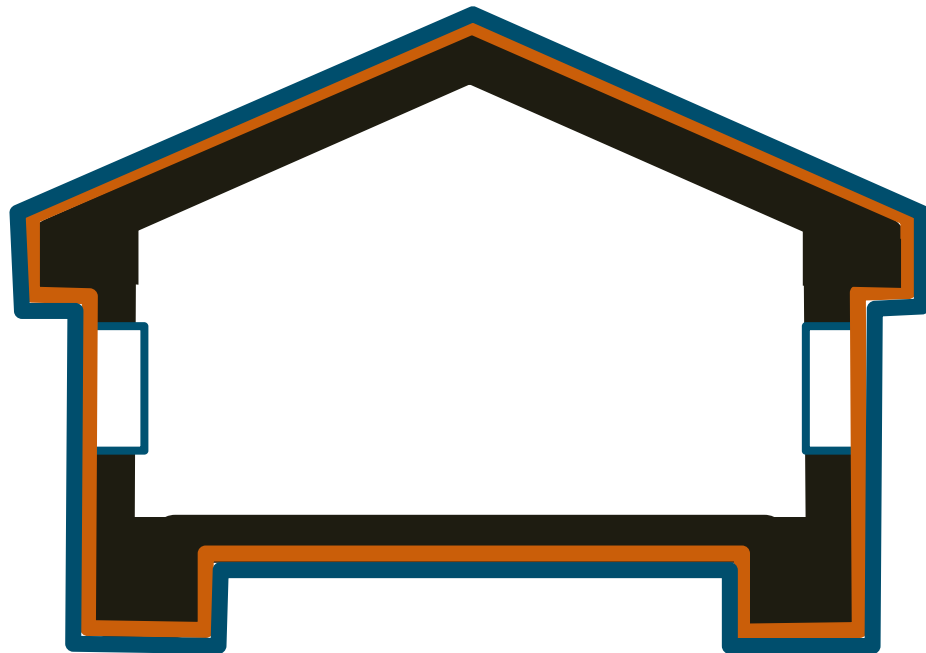
- Complete Water Protection System
 - Water Man. Roofs
 - Water Man. Walls/Openings
 - Water Man. Site/ Foundation
 - Water Man. Materials

Risk 3: Ensured IAQ

Risk Management

Zero Differentiation

Exceed Expectations



- Less Dilution
- Less Filtration



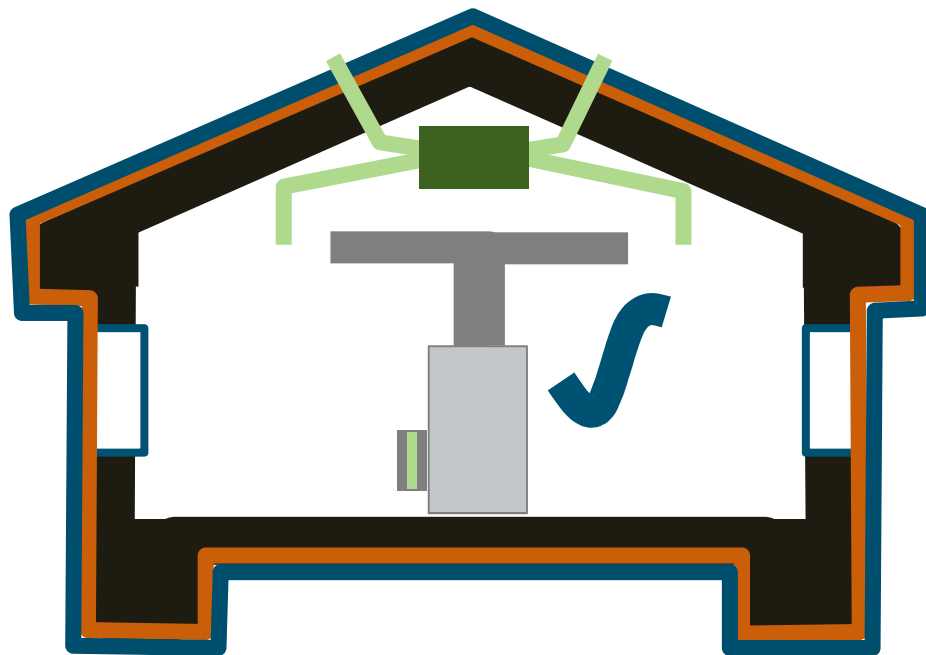
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Risk 3: Ensured IAQ Strategy

Risk Management

Zero Differentiation

Exceed Expectations



- Less Dilution
- Less Filtration



- Complete IAQ System:
- Contaminant Control
 - Fresh Air System
 - High-Capture Filtration

Zero Strategy 1: Minimize Loads

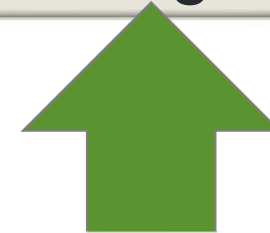
Risk Management

Zero Differentiation

Exceed Expectations



- Ultra-Low Space Conditioning Loads



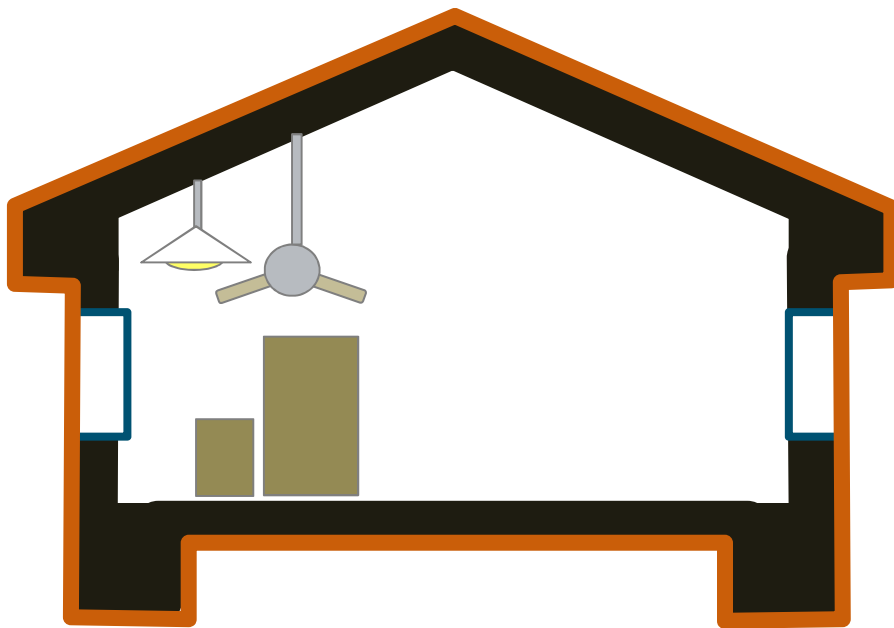
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness

Zero Strategy 1: Minimize Loads

Risk Management

Zero Differentiation

Exceed Expectations



- Ultra-Low Space Conditioning Loads



- Energy Components and MEL's More Than 50% Energy Use



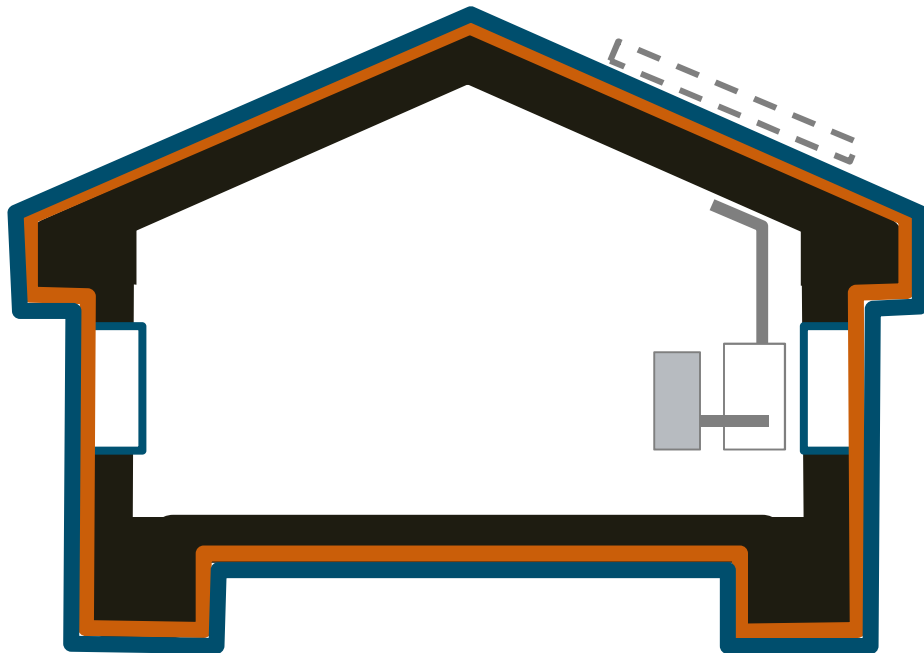
- Energy Efficient Water Htg., Lighting, Appliances, and Fans

Zero Strategy 2: Solar Ready

Risk Management

Zero Differentiation

Exceed Expectations



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



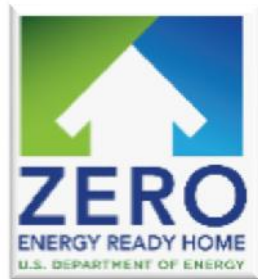
- Solar Ready Home

Risk/Zero Summary

Risk Management

Zero Differentiation

Exceed Expectations



Optimized Thermal Enclosure



Risk Management Strategy:
Optimized Comfort System
Complete Water Protection
Comprehensive IAQ



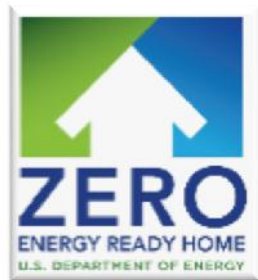
Zero Strategy:
Energy Efficient Components
Solar Ready Construction

ZERH Definition

Risk Management

Zero Differentiation

Exceed Expectations



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

Risk Management

Zero Differentiation

Exceed Expectations

A 'Green' Home is...

A Home with a Package of Measures
Earning a Bunch of Points
Needed to Achieve
One of Four Levels of Greenness.

'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

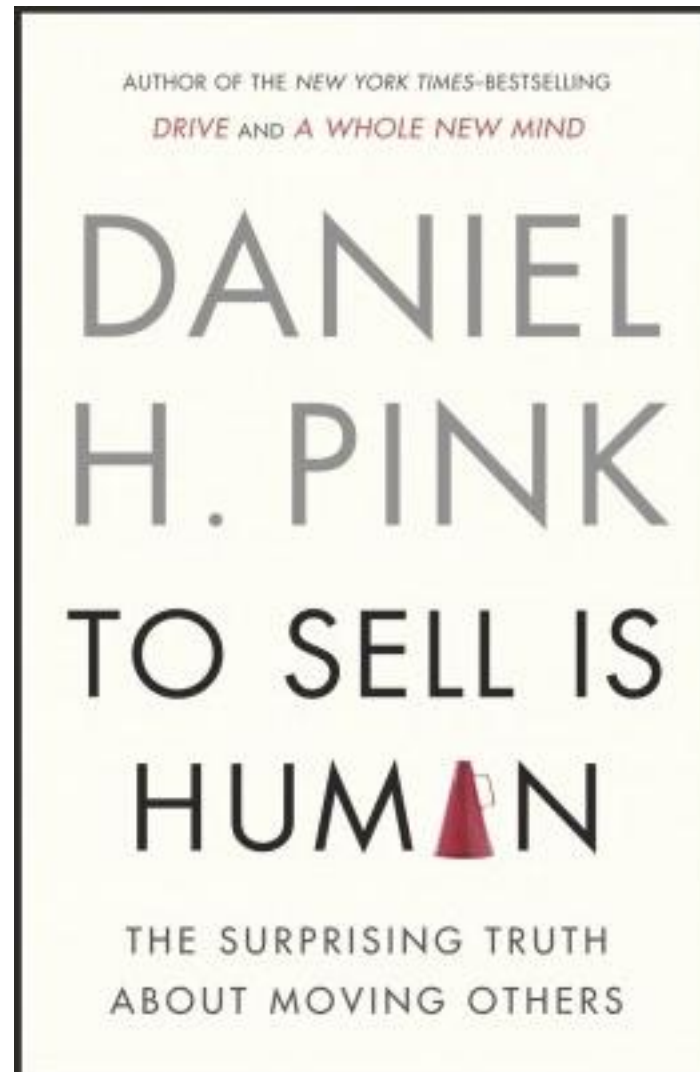
More
Durability

Smart



Zero Energy Ready Home
Why Build:
Translating Value

Reading Assignment



Clarity depends on contrast.

We often understand something better
when we see it in comparison
with something else
than when we see it in isolation.

Homes to the Power of **ZERO**



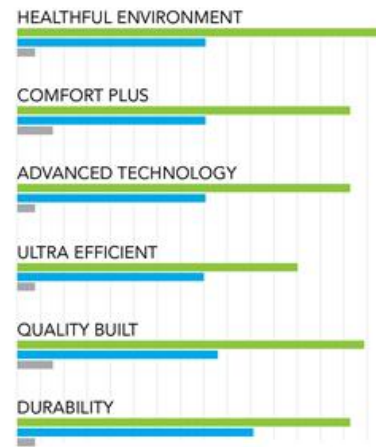
What is the DOE Zero Energy Ready Home™ Label?

It is a Symbol of Excellence for energy savings, comfort, health, quality, and durability met by a select group of leading builders meeting U.S. Department of Energy Guidelines.

What is a Zero Energy Ready Home?

It is a high-performance home so energy efficient, all or most annual energy consumption can be offset with renewable energy. In other words, it is the Home of the Future.

A Symbol of Excellence



KEY

- DOE Zero Energy Ready Home
- ENERGY STAR® Certified Home
- Existing Home

This graphic comparison chart demonstrates relative performance of this DOE Zero Energy Ready Home to existing homes (built between 1990 and 2010) and ENERGY STAR Certified Homes. Actual performance may vary.



303-231-4567
NewTown@net.com
123 Main Street, Denver, CO 34567

DOE Challenge Home Label Methodology

October 2012



DOE Challenge Home
Label Methodology

October 2012

1

Homes to the Power of **ZERO**



What is the DOE Zero Energy Ready Home™ Label?

It is a Symbol of Excellence for energy savings, comfort, health, quality, and durability met by a select group of leading builders meeting U.S. Department of Energy Guidelines.

What is a Zero Energy Ready Home?

It is a high-performance home so energy efficient, all or most annual energy consumption can be offset with renewable energy. In other words, it is the Home of the Future.

A Symbol of Excellence

HEALTHFUL ENVIRONMENT



COMFORT PLUS



ADVANCED TECHNOLOGY



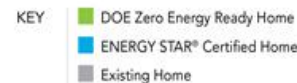
ULTRA EFFICIENT



QUALITY BUILT



DURABILITY

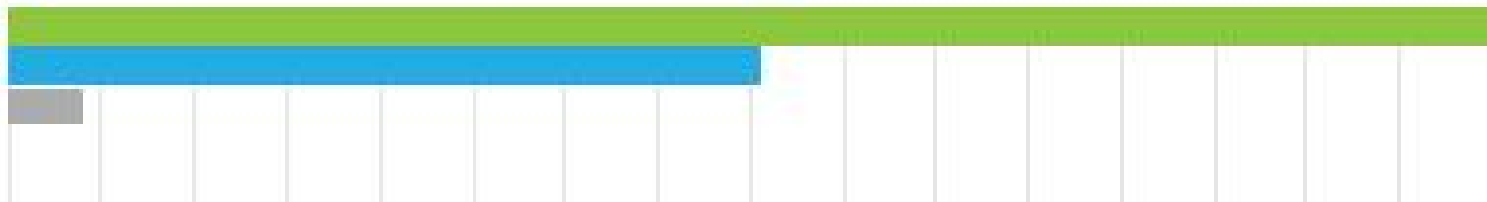


This graphic comparison chart demonstrates relative performance of this DOE Zero Energy Ready Home to existing homes (built between 1990 and 2010) and ENERGY STAR Certified Homes. Actual performance may vary.



303-231-4567
NewTown@net.com
123 Main Street, Denver, CO 34567

HEALTHFUL ENVIRONMENT



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

This label indicates relative performance of this DOE Zero Energy Ready Home to existing homes (built between 1990 and 2010) and ENERGY STAR qualified homes. Actual performance may vary.



Translating ZERH Value with Clarity



Front Cover

Lives Better

HEALTHFUL ENVIRONMENT

Every DOE Zero Energy Ready Home has a comprehensive package of measures to minimize dangerous pollutants, provide continuous fresh air, and effectively filter the air you breathe.

COMFORT PLUS

Superior insulation, windows, air sealing and space conditioning systems included in every DOE Zero Energy Ready Home surround you with even temperatures, low humidity, and quiet in every room on every floor.

KEY

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

Works Better

ADVANCED TECHNOLOGY

Every DOE Zero Energy Ready Home begins with solid building science specified by ENERGY STAR for Homes, and then adds advanced technologies and practices from DOE's world-class research program, Building America.

ULTRA EFFICIENT

Compared to a typical home, an ultra efficient Zero Energy Ready Home is inexpensive to own. In fact, every DOE Zero Energy Ready Home is so energy efficient, a small solar electric system can easily offset most, or all, of your annual energy consumption. We call this Zero Net-Energy Ready.

Lasts Better

QUALITY BUILT

Advanced construction practices and technologies are specified for every DOE Zero Energy Ready Home. Then they are enforced by independent verifiers with detailed checklists and prescribed diagnostics.

DURABILITY

The advanced levels of energy savings, comfort, health, durability, quality and future performance in every DOE Zero Energy Ready Home provide value that will stand the test of time, and will meet and exceed forthcoming code requirements.

LEARN MORE AT: buildings.energy.gov/zero

Inside Spread

The Future of Housing—Today

Only a select group of the top builders in the country meet the extraordinary levels of excellence and quality specified by U.S. Department of Energy guidelines.



LEARN MORE AT:
buildings.energy.gov/zero

Flap



Back Cover

New Town Builders Lives Better: Healthful Environment



- Fresh Air:
 - Supply Fresh Air System
 - Odor and Moisture Control Fans
 - High-Capture Filtration Technology
- Quiet:
 - Quiet Window Technology
 - Quiet Wall Technology
- Moisture Control:
 - Dry-by-Design Construction
 - Moisture Control System – Whole House
 - Moisture Controlled Comfort System
 - Moisture Controlled Windows
 - Moisture Controlled Lower Level
- Pest Control:
 - Bug Control Barrier
 - Pest Screened Home
- Outdoor Contaminant Control:
 - Contaminant Sealed Construction
 - Contaminant Sealed Comfort Delivery
 - Dust and Pollen Barrier
 - Radon Controlled Home
- Chemical Control:
 - Formaldehyde Controlled Home
 - VOC Controlled Home
- Fume Control:
 - Carbon Monoxide Controlled Equipment
 - Carbon Monoxide Controlled Fireplace
 - Fume Controlled Garage

Translating ZERH Value with Clarity



Energy Efficiency & Renewable Energy



A Symbol of Excellence

Every Zero Energy Ready Home offers a cost-effective, high performance package of energy savings, comfort, health, and durability unparalleled in today's market place.



Lives Better

HEALTHFUL ENVIRONMENT

Every DOE Zero Energy Ready Home has a comprehensive package of measures to minimize dangerous pollutants, provide continuous fresh air, and effectively filter the air you breathe.

COMFORT PLUS

Superior insulation, windows, air sealing and space conditioning systems included in every DOE Zero Energy Ready Home surround you with even temperatures, low humidity and quiet in every room on every floor.

KEY

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



Works Better

ADVANCED TECHNOLOGY

Every DOE Zero Energy Ready Home begins with solid building science specified by ENERGY STAR for Homes, and then adds advanced technologies and practices from DOE's world-class research program, Building America.

ULTRA EFFICIENT

Compared to a typical home, an ultra efficient Zero Energy Ready Home is inexpensive to own. In fact, every DOE Zero Energy Ready Home is so energy efficient, a small solar electric system can easily offset most, or all, of your annual energy consumption. We call this Zero Net-Energy Ready.



Lasts Better

QUALITY BUILT

Advanced construction practices and technologies are specified for every DOE Zero Energy Ready Home. Then they are enforced by independent verifiers with detailed checklists and prescribed diagnostics.

DURABILITY

The advanced levels of energy savings, comfort, health, durability, quality and future performance in every DOE Zero Energy Ready Home provide value that will stand the test of time, and will meet and exceed forthcoming code requirements.

LEARN MORE AT: buildings.energy.gov/zero

The Future of Housing—Today

Only a select group of the top builders in the country meet the extraordinary levels of excellence and quality specified by U.S. Department of Energy guidelines.



LEARN MORE AT:
buildings.energy.gov/zero



Call us at:
303-231-4567

NewTown@net.com



A Symbol of Excellence

HEALTHFUL ENVIRONMENT

COMFORT PLUS

ADVANCED TECHNOLOGY

ULTRA EFFICIENT

QUALITY BUILT

DURABILITY

KEY

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

This label indicates relative performance of this DOE Zero Energy Ready Home to existing homes built between 1990 and 2009 and ENERGY STAR Certified Homes. Actual performance may vary.



Front Cover

Inside Spread

Flap

Back Cover

Contrast Matters

**My power bill is \$5.
What's yours?**

- Heather Robbins, Garbett Homeowner

garbettHOMES.com
Now you're living.



Contrast Matters

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

de young properties®

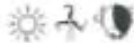


“My Cool Mom’s August Electric Bill Was **\$-57.97!**
What Was Yours?”

- **Ali Domino**
Resident of a De Young
Net Zero **EnergySmart™** Home



PACIFIC GAS AND ELECTRIC COMPANY
NET ENERGY MEASURING ELECTRIC STATEMENT
Service Dates July 14, 2013 to August 13, 2013
*Energy period from Jan. 2013 to Mar. 2013



Ali and her mother Leah are enjoying the savings and comfort of their De Young Net Zero **EnergySmart™** home. De Young homes,

de young properties®

YOU DON'T NEED TO

Imagine

A HOME IN THE YEAR 2020...

IT'S ALREADY HERE!



Contrast Matters



Technology Displays



Deconstructed Homes

Outdoor Comfort System



Indoor Comfort System



Compare and Contrast

: Contrast Matters



“Our daughter couldn’t breathe without discomfort for years. Within two months of moving into our new RTHI Home

**we threw
away the
inhaler.
That was
priceless!”**

Charly and Mary Jones,
RTHI homeowner



Contrast Matters



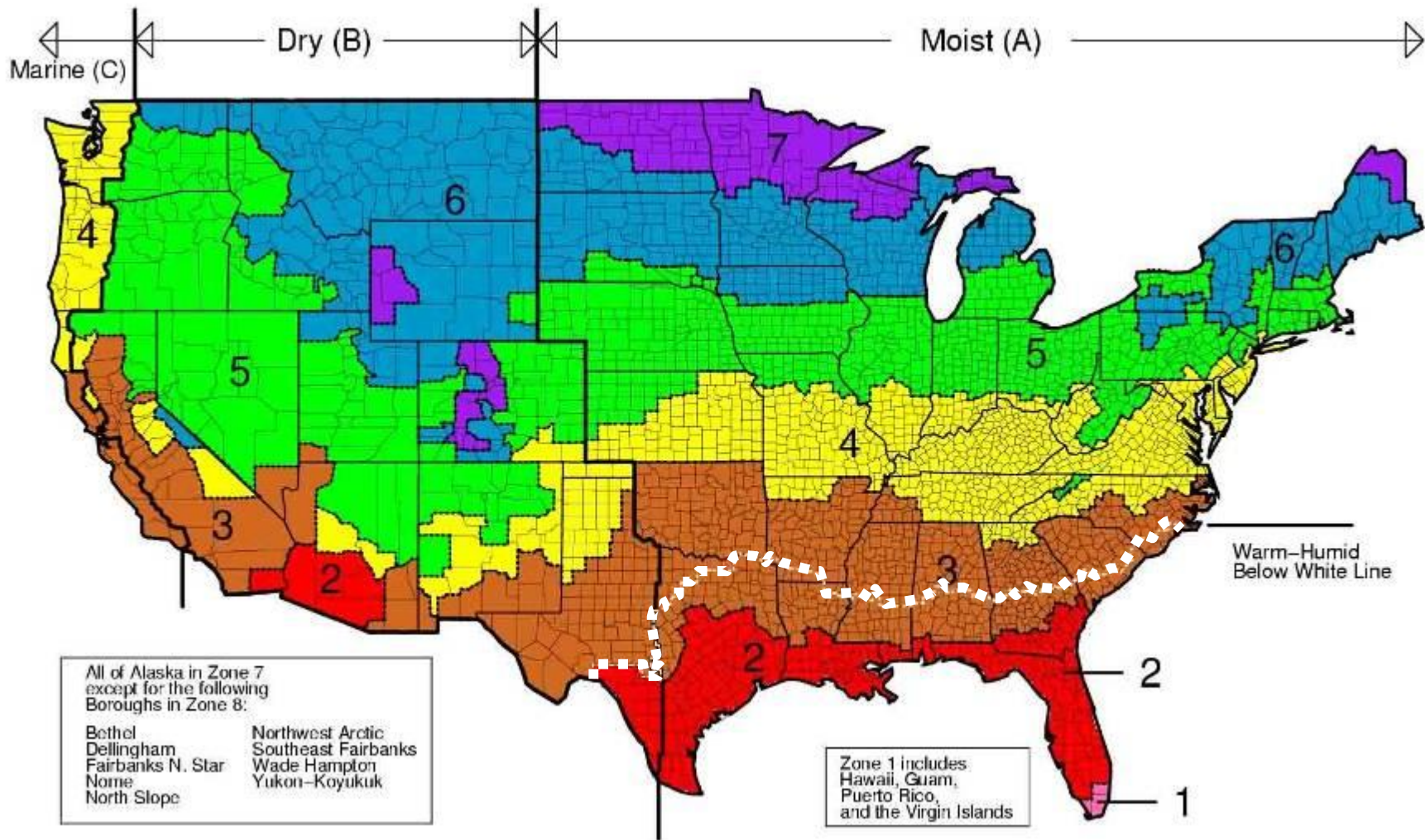


Zero Energy Ready Home **Technical Specifications**

- 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



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

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

Mandatory Reqts.

Must Comply

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% SRP
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			

'Target Home' Specs

Trade-Off Flexibility

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

Exhibit 3: Benchmark Home Size²⁶

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

Size Adjust. Factor

Identical to Energy Star



Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:

Mandatory Requirements

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 <u>airPLUS</u> 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

Encouraged:

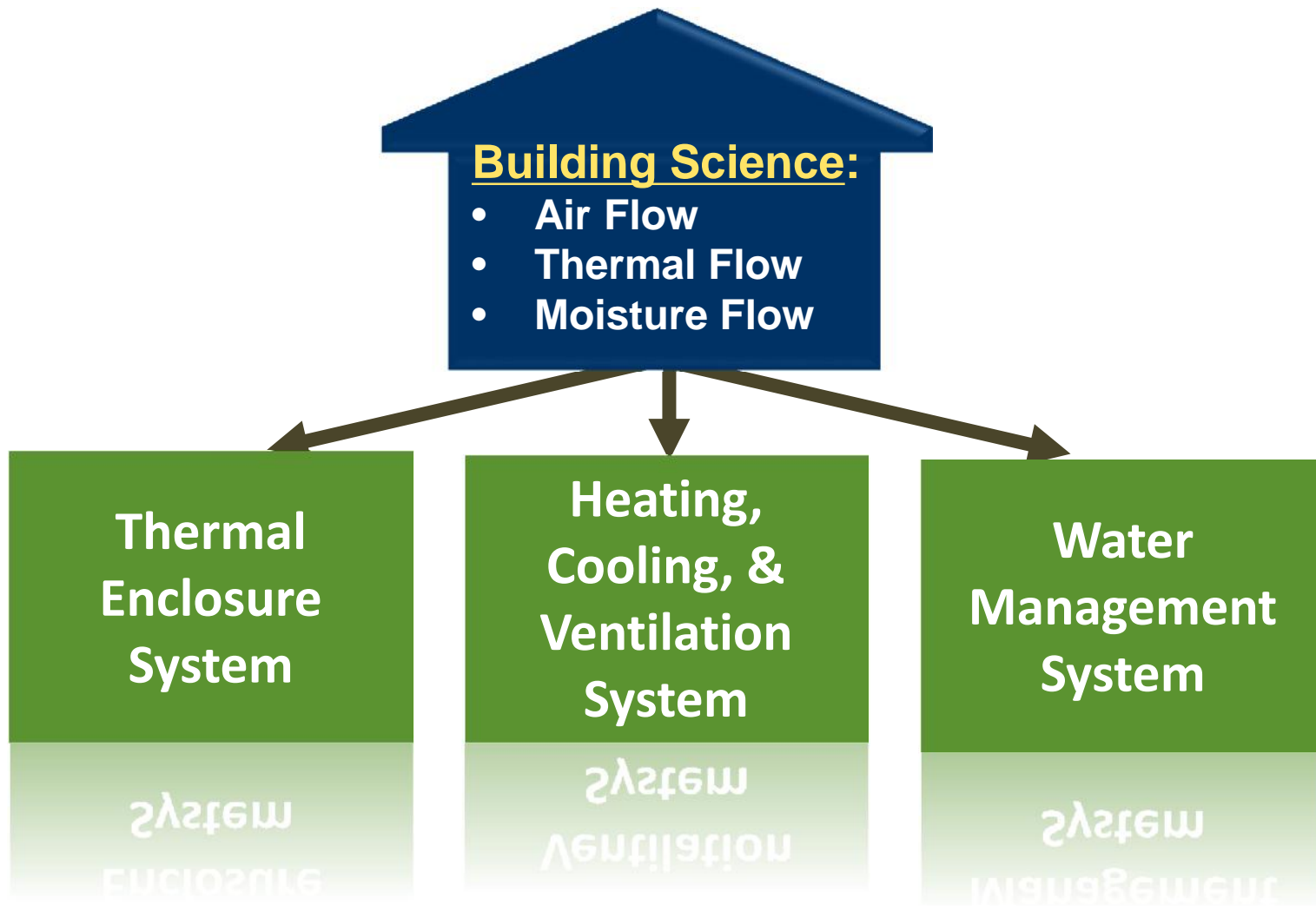
- WaterSense Label (indoor and outdoor)
- Disaster Resistance (IBHS Fortified Home)
- Quality Management



Zero Energy Ready Home

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

What is Building Science



System 1:
Thermal enclosure system

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

A well-insulated and air-sealed home,
with good windows and doors,
reduces the amount of energy needed
to keep the home comfortable.

System 1: Thermal Enclosure System Basic Concepts

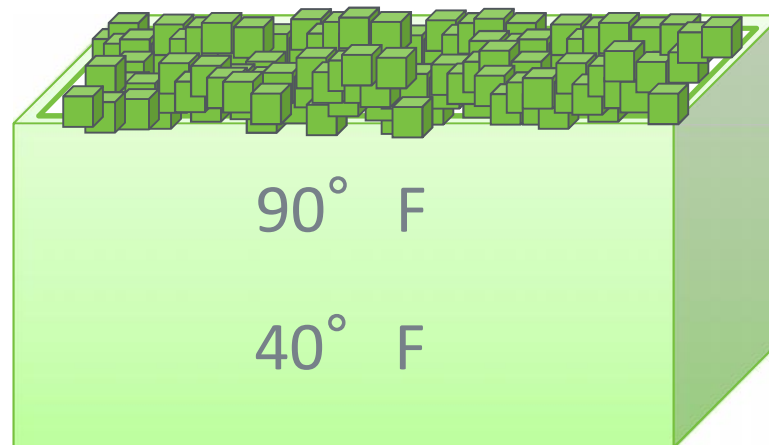
**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

1. Energy moves from more to less.

90° F - Outside



Cooler with Ice

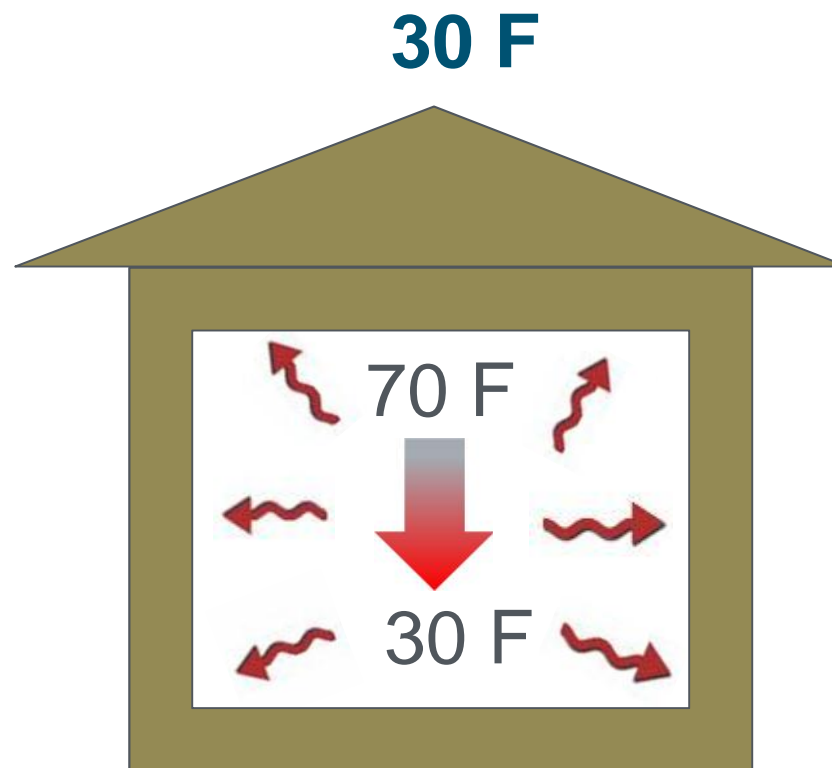
System 1: Thermal Enclosure System Basic Concepts

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

1. Energy moves from more to less.



**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

2. Heat Transfer is quantified in British Thermal Units (BTU's)



1 Btu is approximately equal to the energy in a single match.

System 1: Thermal Enclosure System What We're Trying to Avoid

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**



Attic air infiltration into the wall

System 1: Thermal Enclosure System Drywall Sealed at Top Plates

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

**Default:
Foam**



**Alternative:
Sill sealer**



**Alternative:
Constr. Adhesive**



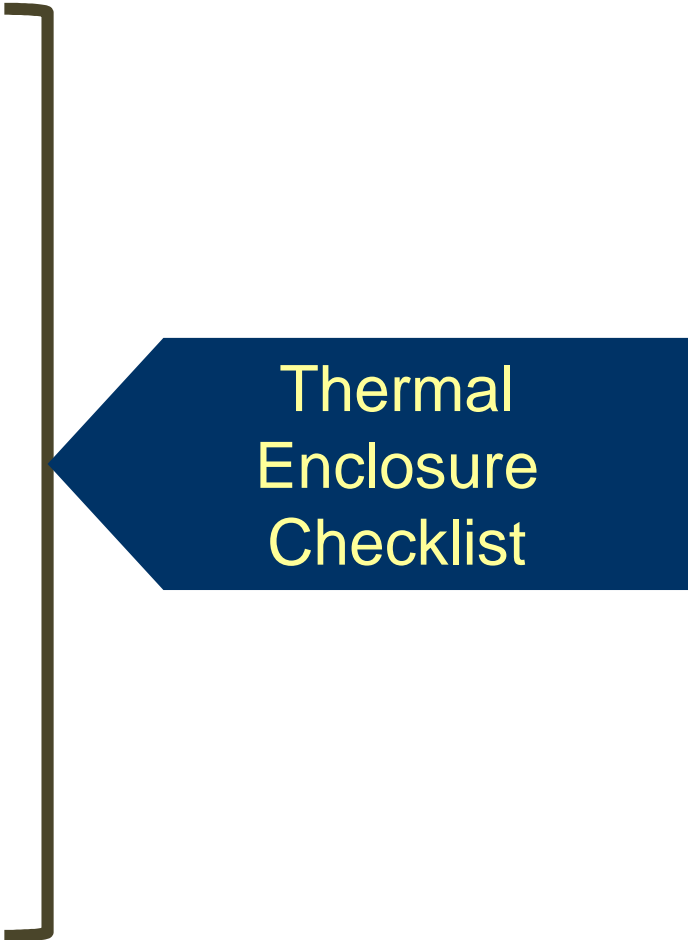
System 1: Thermal Enclosure System Air and Thermal Flow Control

Thermal Enclosure

Heating, Cooling & Ventilation

Water Management

- **Air Sealing**
- **Air Barriers**
 - Thermal Bypass
 - Wind Intrusion
- **Insulation**
 - Adequate Quantity
 - Proper Installation
 - Minimum Thermal Bridging
- **Adv. Windows**



Thermal
Enclosure
Checklist

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

- **Heating and Cooling Equipment:**

- High efficiency
- Properly designed and installed
- Combined with a duct system that's insulated, sealed, and balanced

... Maintain comfort with less energy.

- **Ventilation System:**

- Remove low-quality air
- Provide outdoor air
- Filter contaminants to improve IAQ

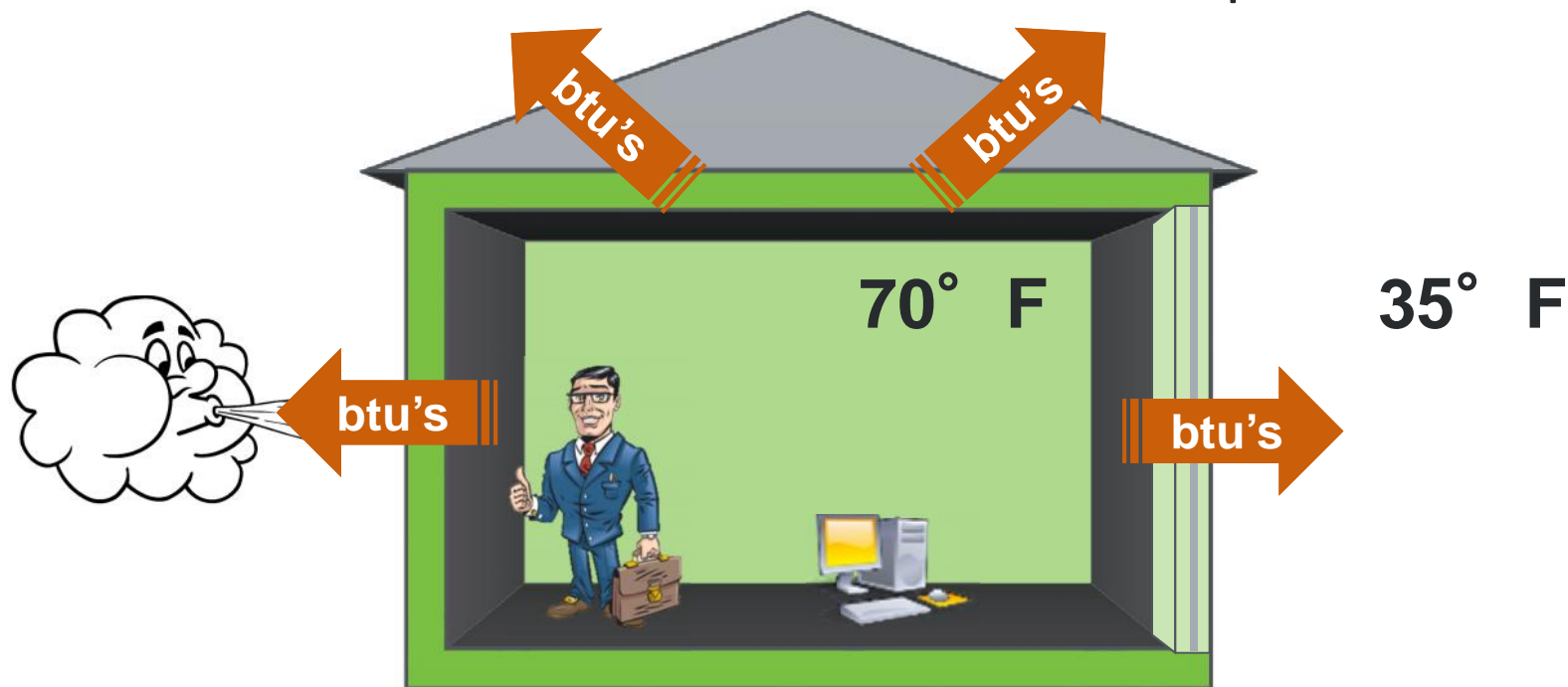
System 2: HVAC System Calculating Heating & Cooling Load

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

- Heating Load varies for each hour of the year.
- Heating Peak Load: Maximum energy lost in a single hour, which must be added back to maintain temperature.

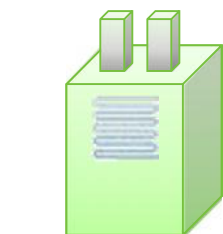
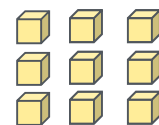
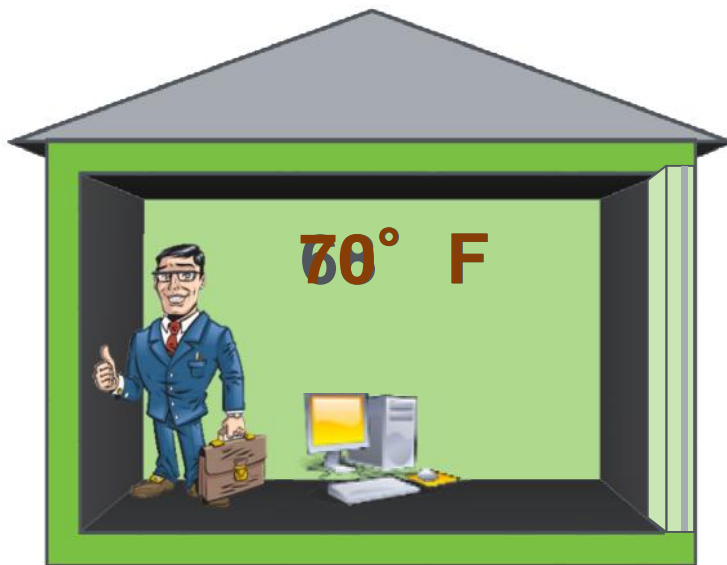


Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

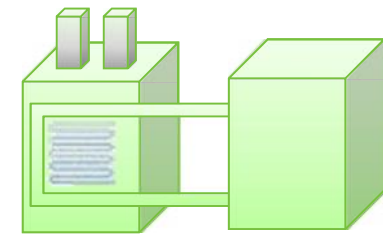
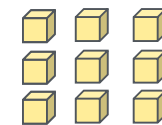
- Cooling & heating equipment are “btu machines” that add or remove btu’s to offset the load
- Load = number of btu’s equipment has to remove or add
- Load independent of type of equipment used



Furnace



Boiler



HP

System 2: HVAC System

What We're Trying to Avoid

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Random Acts of Sizing



System 2: HVAC System

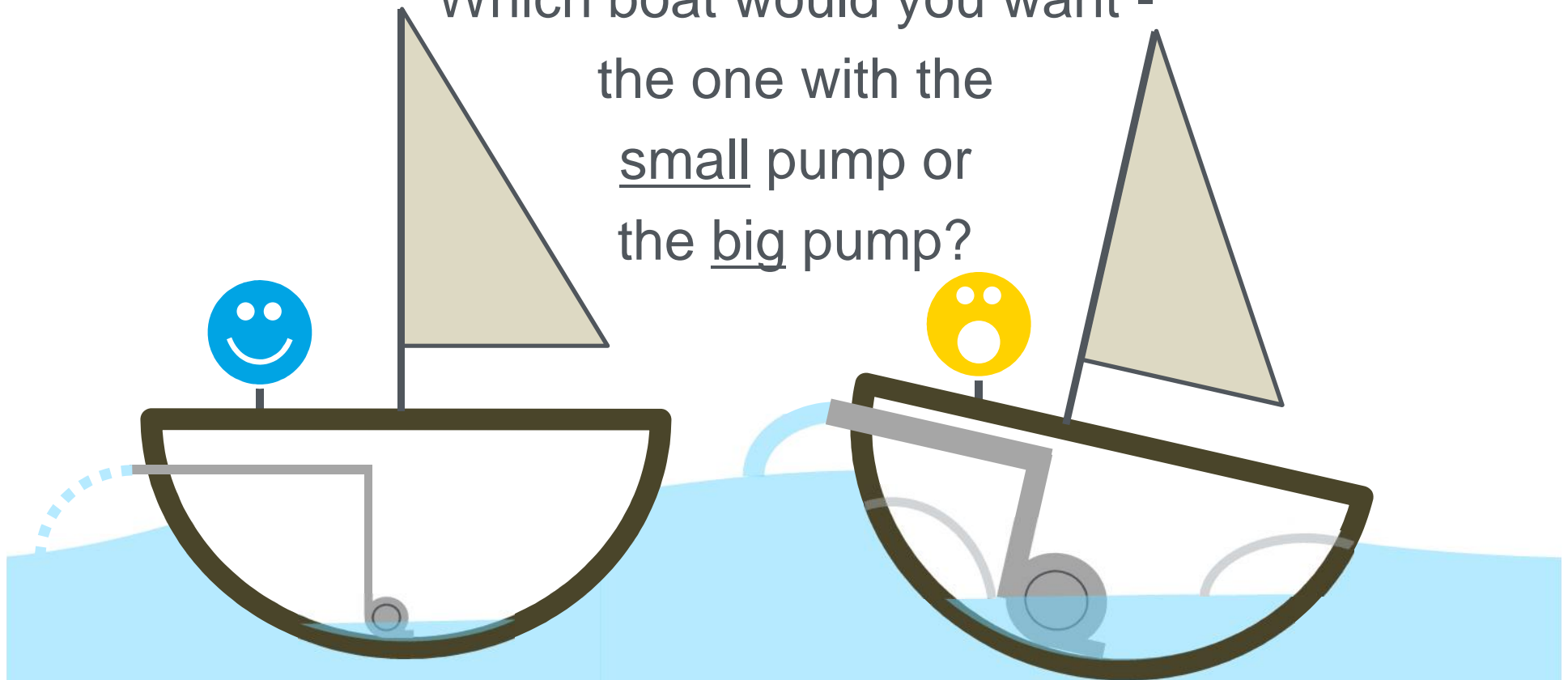
What We're Trying to Avoid

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Which boat would you want -
the one with the
small pump or
the big pump?



System 2: HVAC System
HVAC-C (3.12); HVAC-R (1.2.9)

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Verify that the equipment capacity
is right-sized relative to
the heating and cooling load.

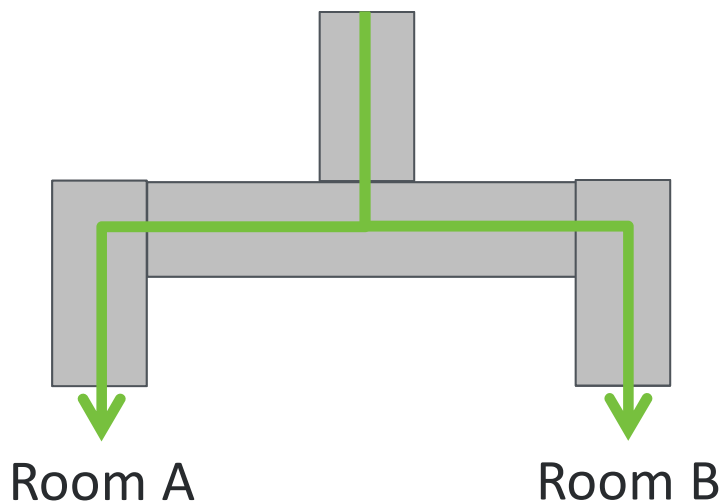
System 2: HVAC System Duct System Design

Thermal
Enclosure

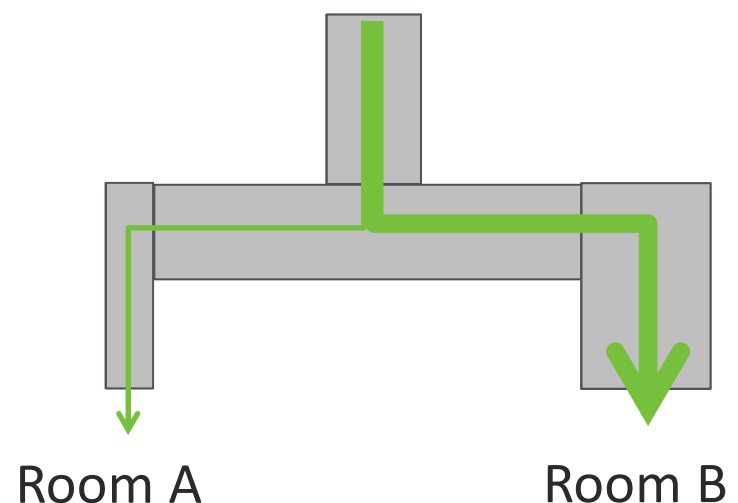
Heating, Cooling
& Ventilation

Water
Management

1. Air follows the path of least resistance.



Equal resistance,
equal flow



Higher resistance,
less flow

System 2: HVAC System Duct System Design

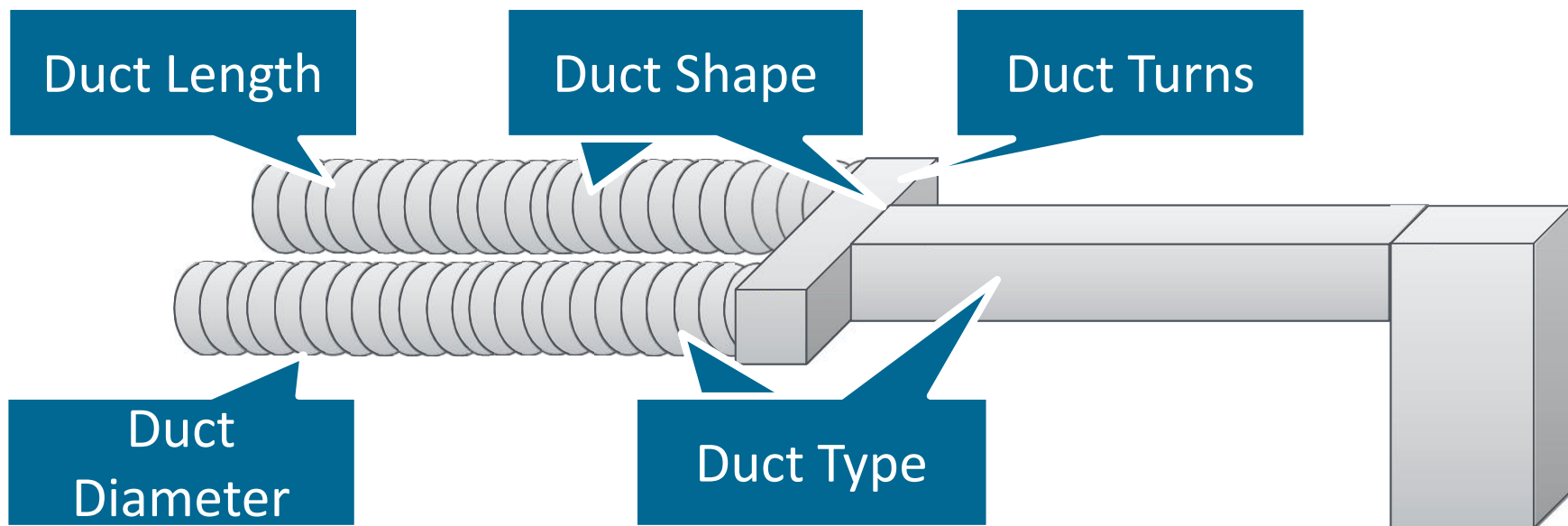
Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Factors that influence the airflow of the ducts:

- Duct Length
- Duct Size
- Duct Shape
- Duct Type
- Duct Turns
- Other Components (e.g., Filters)



System 2: HVAC System

What We Are Trying to Avoid

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**



Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Verify that the ducts are balanced, insulated, tight, and installed without major defects.

System 2: HVAC System Basic Concepts

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Design:

1. Calculate Heating/Cooling Loads
2. Select Equipment that Meets Loads
3. Design Duct System that Gets Air from Equipment to Rooms and Back

Commission:

- A. Check Airflow at Air Handler
- B. Check Refrigerant Charge
- C. Measure Airflow at Registers/Exhaust

HVAC QI
Contractor
Checklist

HVAC QI
Rater
Checklist

System 3: Water Management

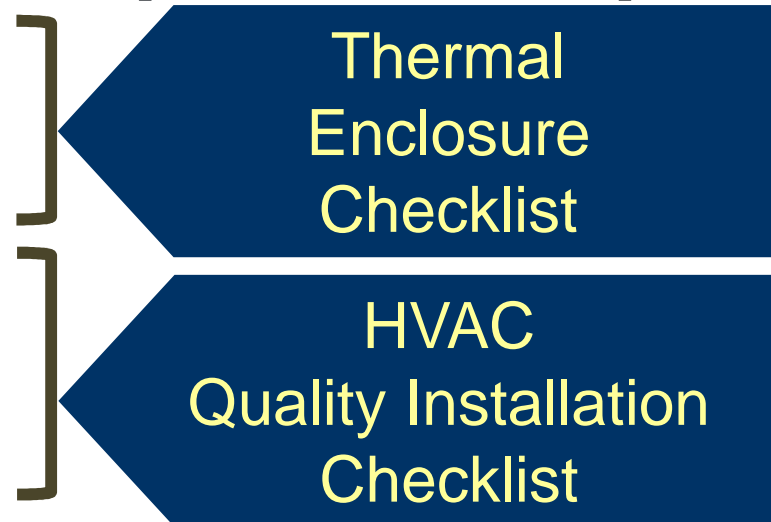
Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Moisture Vapor (Air Flow)

- Air Sealing
- Air Barriers
- Vapor Barriers/Retarders
- HVAC Quality Installation
- Whole-House Ventilation
- Spot Ventilation

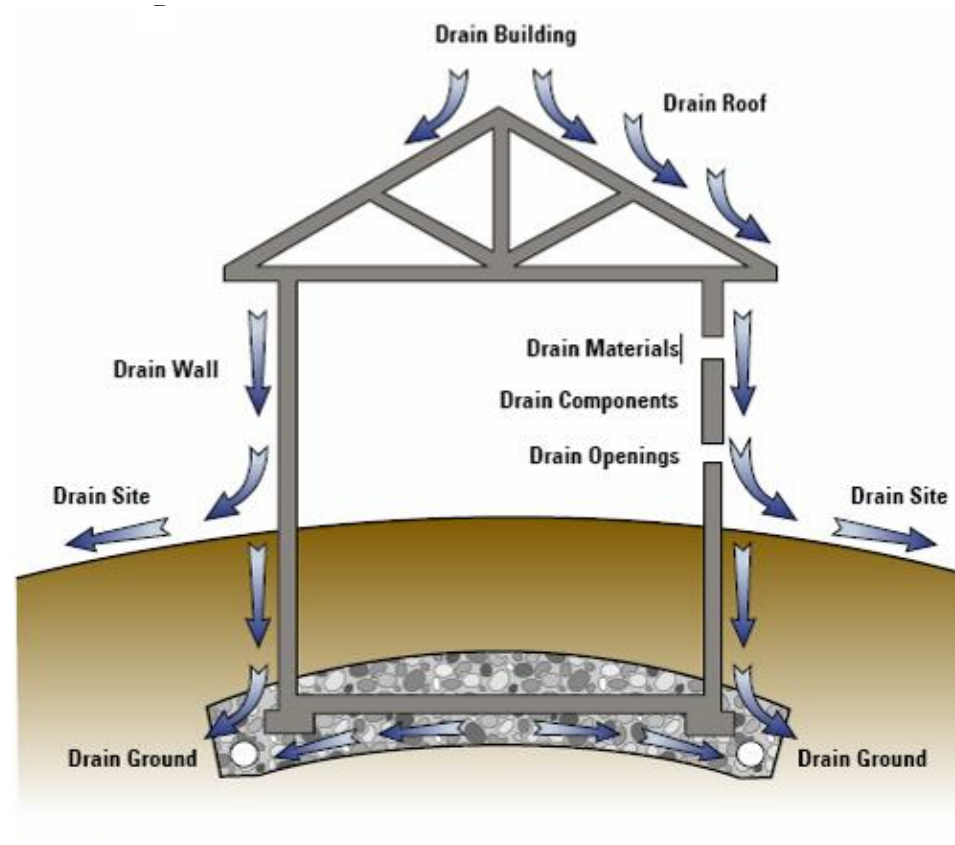


System 3: Water Management Basic Concept

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management



System 3: Water Management Basic Concept

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

- Many materials used in building homes are not durable when wet.
- Especially important in high performance homes, regardless of whether ENERGY STAR certified.

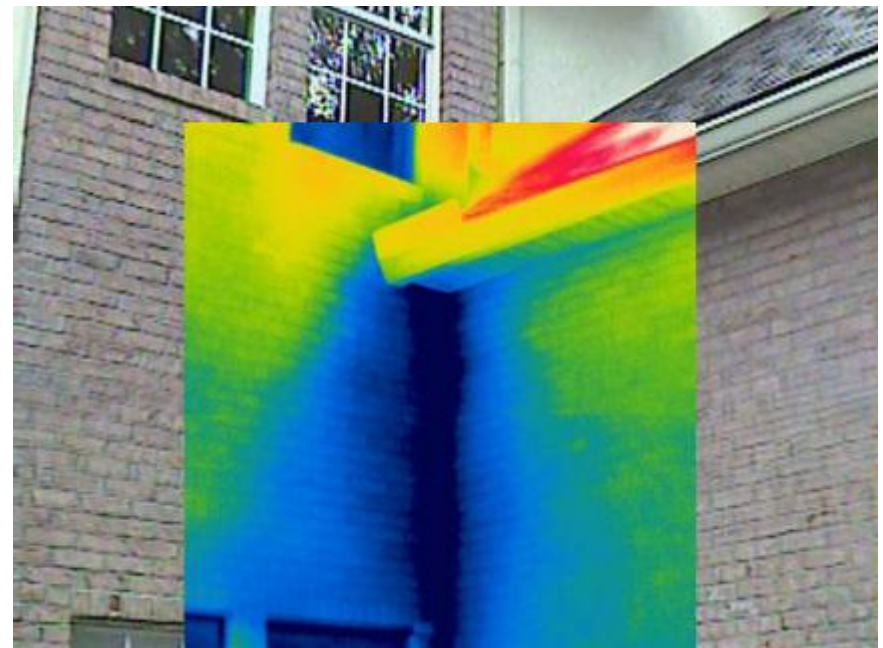


System 3: Water Management What We're Trying to Avoid

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management



Missing step & kick-out flashing

System 3: Water Management

Step and Kick-Out Flashing (3.1)

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

- Step and kick-out flashing at all roof-wall intersections, extending 4" on wall surface about roof deck and integrated with drainage plane above.
- Step flashing goes behind water barrier on wall and under shingles on the roof.



System 3: Water Management Bulk Moisture Control

Thermal
Enclosure

Heating, Cooling
& Ventilation

Water
Management

Bulk Moisture

- weather resistant barriers
- flashing
- capillary breaks

Water
Management
Checklist

**Thermal
Enclosure**

**Heating, Cooling
& Ventilation**

**Water
Management**

ENERGY STAR for Homes v3:

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



Zero Energy Ready Home

Technical Specifications Mandatory Requirements Envelope: Advanced Windows

ENERGY STAR Windows

- Assures beyond-code window performance
- Fenestration used for passive solar design are exempt from the U-factor and SHGC requirements
- Area-weighted averages for U-factor, SHGC permitted

ENERGY STAR® Qualified in All 50 States



World's Best Window Co.
Millennium 2000+
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: Vertical Slider
(per NFRC 100-97)

ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.27
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2

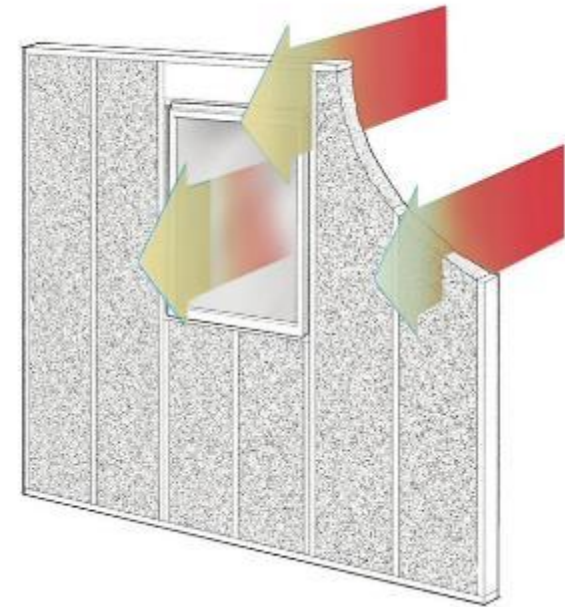
Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.
www.nfrc.org

Good, Better, Best Windows

	Hot Climates IECC CZ 1-2		Mixed Climates IECC CZ 3-4 except Marine		Cold Climates IECC CZ 5-8 and 4 Marine	
	SHGC	U-value	SHGC	U-value	SHGC	U-value
Mandatory: ENERGY STAR	0.27	0.60	[4] 0.40 [3] 0.30	[4] 0.32 [3] 0.35	Any 0.35 0.40	0.30 0.31 0.32
Performance: Target Home	0.25	0.4	0.27	0.3	Any	0.27
Encouraged: R-5	0.22	0.21	0.25	0.21	Any	0.21

Windows Are a Big Deal

Window 15% of Wall Area	Wall R-Value with Windows w/Variied Wall Insulation Levels			
U-Value	R-0	R-18	R-39	R-60
0.30	R-5	R-11	R-15	R-17
0.20	R-5	R-13	R-19	R-23
0.15	R-5	R-14.5	R-23	R-28
0.10	R-5.5	R-16	R-27	R-34



Sources:

“Holes in the Wall: To Improve the Energy Performance of Walls, Look at the Total R-Value,”
 Journal of Light Construction, February 2014;
 Multi-Assembly R-Value / U-Value Calculator – Cascadia Windows and Doors;
 Michael Blasnik Presentation, 2014 ACI Conference



Zero Energy Ready Home

Technical Specifications: Best Practices Air-Tight Construction

Why Air-Tight Construction

- 16 to 50% of HVAC Loads
- Moisture Problems
- Comfort Problems
- Indoor Air Quality

Target Home Air-Tightness

	ACH50 Requirements/Targets			
Climate Zones	Zero Energy Ready Home	ENERGY STAR V3	2012 IECC	Passive House
1-2	3.0	6.0	5.0	0.6
3-4	2.5	5.0	3.0	0.6
5-7	2.0	4.0	3.0	0.6
8	1.5	3.0	3.0	0.6

Penetrations:

- Plumbing
- Wiring
- Recessed Lights
- Vents
- HVAC Duct Boots

Shafts:

- Flues
- Ducts
- Plumbing



Cracks:

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

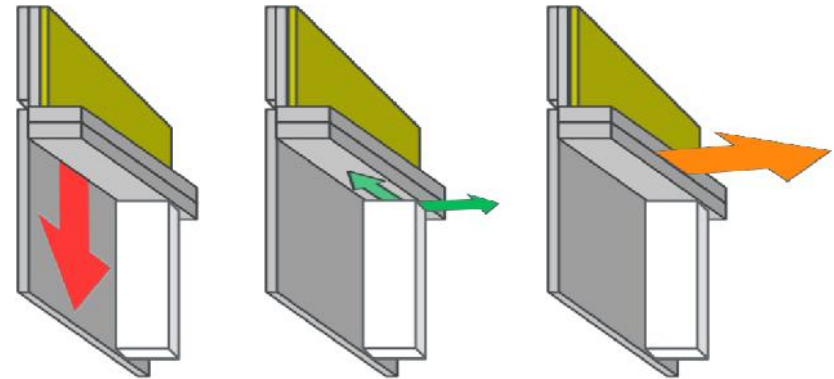
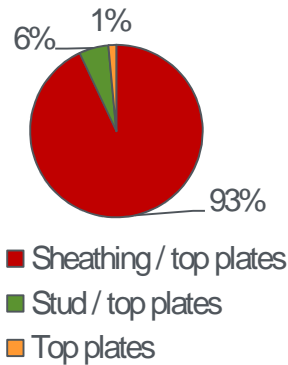
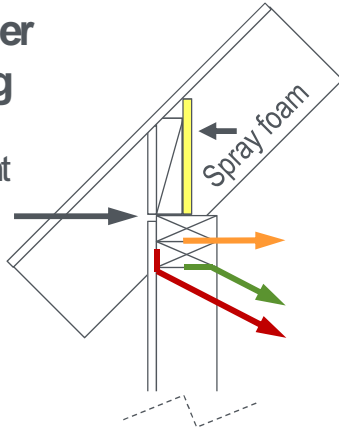
Odd Geometry:

- Cantilevers
- Knee-walls

Air Leakage Distribution

Exterior air barrier
Cathedral ceiling

Sheathing / roof joint
1.1 cfm/ft @ 50 Pa



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

Zones	DOE Challenge Home		IECC 2012	
	Requirement	Contribution to requirement (%)	Requirement	Contribution to requirement (%)
1 – 2	3	17	5	10
3 – 4	2.5	20	3	17
5 – 7	2	25	3	17
8	1.5	33	3	17

Air Sealing with Aerosol

You've probably seen this:



Air Sealing with Aerosol

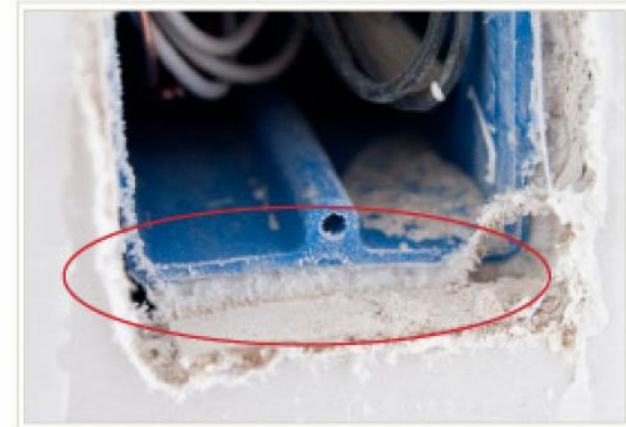
But now we are going to investigate this...



Engineer Curtis Harrington taping off areas in preparation for sealing.



Connecting controls for blower door, setting up compressor for aerosol injection and monitoring software.



Aerosol sealant sealed this leak between this electrical outlet and the wall.

Photos from wcec.ucdavis.edu



Zero Energy Ready Home

Technical Specifications Mandatory Requirements: Envelope: 2012 IECC Insulation

- Compliance with next generation code
- Three Options:
 - ✓ Prescriptive
 - ✓ Alternative equivalent U-factor
 - ✓ Total UA calculation
[allows window to be included]
- Allowances for ceilings without attic spaces
[up to 500 square feet or 20% of roof area,
whichever is smaller]

Prescriptive Requirements

Climate Zone	Fenestration	Skylight U-Factor	Glazed Fenestration SHGC	Ceiling R-Value	Wood Frame Wall R-Value
1	NR	0.75	0.25	30	13
2	0.40	0.65	0.25	38	13
3	0.35	0.55	0.25	38	20 or 13+5 ^h
4 except Marine	0.35	0.55	0.40	49	20 or 13+5 ^h
5 & Marine 4	0.32	0.55	NR	49	20 or 13+5 ^h
6	0.32	0.55	NR	49	20+5 or 13+10 ^h
7 & 8	0.32	0.55	NR	49	20+5 or 13+10 ^h

Prescriptive Requirements (cont.)

Climate Zone	Mass Wall R-Value ⁱ	Floor R-Value	Basement ^c Wall R-Value	Slab ^d R-Value, Depth	Crawl Space ^c Wall R-Value
1	3/4	13	0	0	0
2	4/6	13	0	0	0
3	8/13	19	5/13 ^f	0	5/13
4 except Marine	8/13	19	10 /13	10, 2 ft	10/13
5 & Marine 4	13/17	30 ^g	15/19	10, 2 ft	15/19
6	15/20	30 ^g	15/19	10, 4 ft	15/19
7 & 8	19/21	38 ^g	15/19	10, 4 ft	15/19

Equivalent U-Factors ^a

Climate Zone	Fenestration	Skylight U-Factor	Ceiling U-Factor	Frame Wall U-Factor
1	0.50	0.75	0.035	0.082
2	0.40	0.65	0.030	0.082
3	0.35	0.55	0.030	0.057
4 except Marine	0.35	0.55	0.026	0.057
5 & Marine 4	0.32	0.55	0.026	0.057
6	0.32	0.55	0.026	0.048
7 & 8	0.32	0.55	0.026	0.048

^A Non-fenestration U-factors shall be obtained from measurement, calculation, or an approved source.

Equivalent U-Factors (cont.)

Climate Zone	Mass Wall U-Factor ^b	Floor U-Factor	Basement Wall U-Factor	Crawl Space Wall U-Factor
1	0.197	0.064	0.360	0.477
2	0.165	0.064	0.360	0.477
3	0.098	0.047	0.091 ^c	0.136
4 except Marine	0.098	0.047	0.059	0.065
5 & Marine 4	0.082	0.033	0.050	0.055
6	0.060	0.033	0.050	0.055
7 & 8	0.057	0.028	0.050	0.055

^b When more than half of insulation is on interior, following maximum U-factors apply: CZ1-0.17, CZ2 – 0.14, CZ3 – 0.12, CZ4 (except Marine) – 0.087, CZ5 CZ4 Marine – 0.065, CZ6 -8 – 0.057.



Zero Energy Ready Home High-R Walls

- Advanced Framing with Thicker Wall
- Rigid Insulation Exterior Sheathing
 - Continuous Rigid Insulation w/Sheathing
 - Continuous Rigid Insulation w/o Sheathing
 - Continuous Rigid Insulation w/Recessed Studs
- Structural Insulated Panels (SIPs)
- Insulated Concrete Forms (ICFs)
- Double Wall

Adv. Framing w/Thicker Walls

- R-17 – R-21
- Higher Framing Factor (~12-15%)
- Blanket Insulation Issues:
R-19 is 6” Thick, which results in
R-17 Compressed in 2x6 Wall

R-21 is 5.5” Thick, which results in
R-21 in 2x6 Wall
- Blown-In Insulation Issues:
Settling and Proper Density (Bag Count)
- Spray Foam Issues:
High Cost
Closed Cell Enhances Structure Perf.
Still Need to Ensure Quality installation



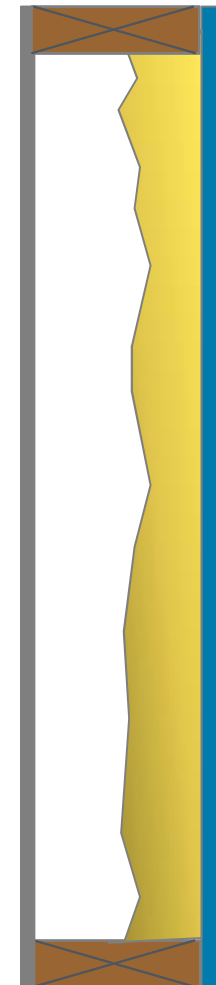
Rigid Insulation w/Sheathing

- R-18 Wall
- Complete Thermal Break
- Exterior Condensation Surface
- Can Combine Sheathing w/ Weather Resistant Barrier
- Installation Issues:
 - ≤ 1.5” Thick, Nails Okay
 - > 1.5” Thick, Screws Needed



BASF Patented Wall Assembly:

- R-17 Wall
- Complete Thermal Break
- Enhanced Racking Strength and Impact Resistance with CCSpf Enables No Sheathing
- Rigid Insulation Sheathing serves as Weather Resistant Barrier w/Liquid Membrane at Joints and Pan Flashing
- Substantially Reduced Framing including Single Plates
- BASF Claims Net Cost Competitive with Conventional Wall



Rigid Insulation w/Recessed Studs

- R-18 Wall
- 2x4 Studs with 2x6 Plates
- Sheathing Attached to Plates for Near Full Racking Strength
- Complete Thermal Break Except for Top and Bottom Plates
- Condensation Surface Inside Assembly, so Must Control Air Flow
- Much Easier Installation of Cladding



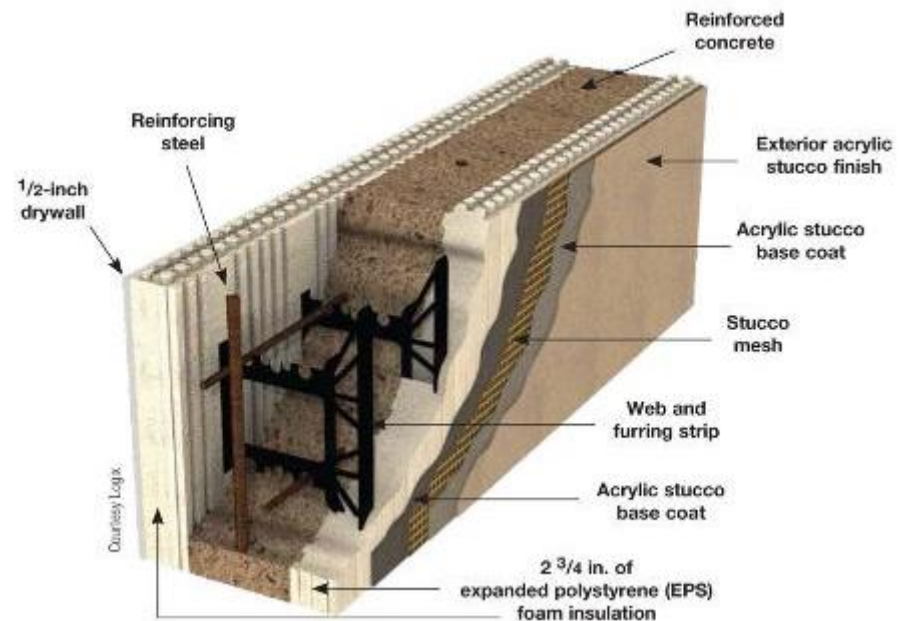
Structural Insulated Panels (SIPs)

- R-20 Walls (6")
- Substantial Thermal Break (3 – 8% Framing Factor)
- Special Construction Practices Required
- Foundation has to be Perfectly Level
- Significantly Reduced Time-of-Construction
- Reduced Dimensional Variation Corrections
- Killer Applications



Insulated Concrete Forms (ICFs)

- ~R-24 Walls
- Complete Thermal Break
- Useful Thermal Mass
- Foundation has to be Perfectly Level
- Longer Time-of-Construction
- Maximum Disaster Resist.
- Termite Resistant
- Reduced Dimensional Variation Corrections
- Much More Costly



Double-Wall

- R-26 Walls
- Studs Offset to Ensure Complete Thermal Break
- Coldest Outside Sheathing Surface Suggests Plywood Rather Than OSB to Ensure Drying
- Uses Exact Same Framing Techniques Already Understood by Trade Partners





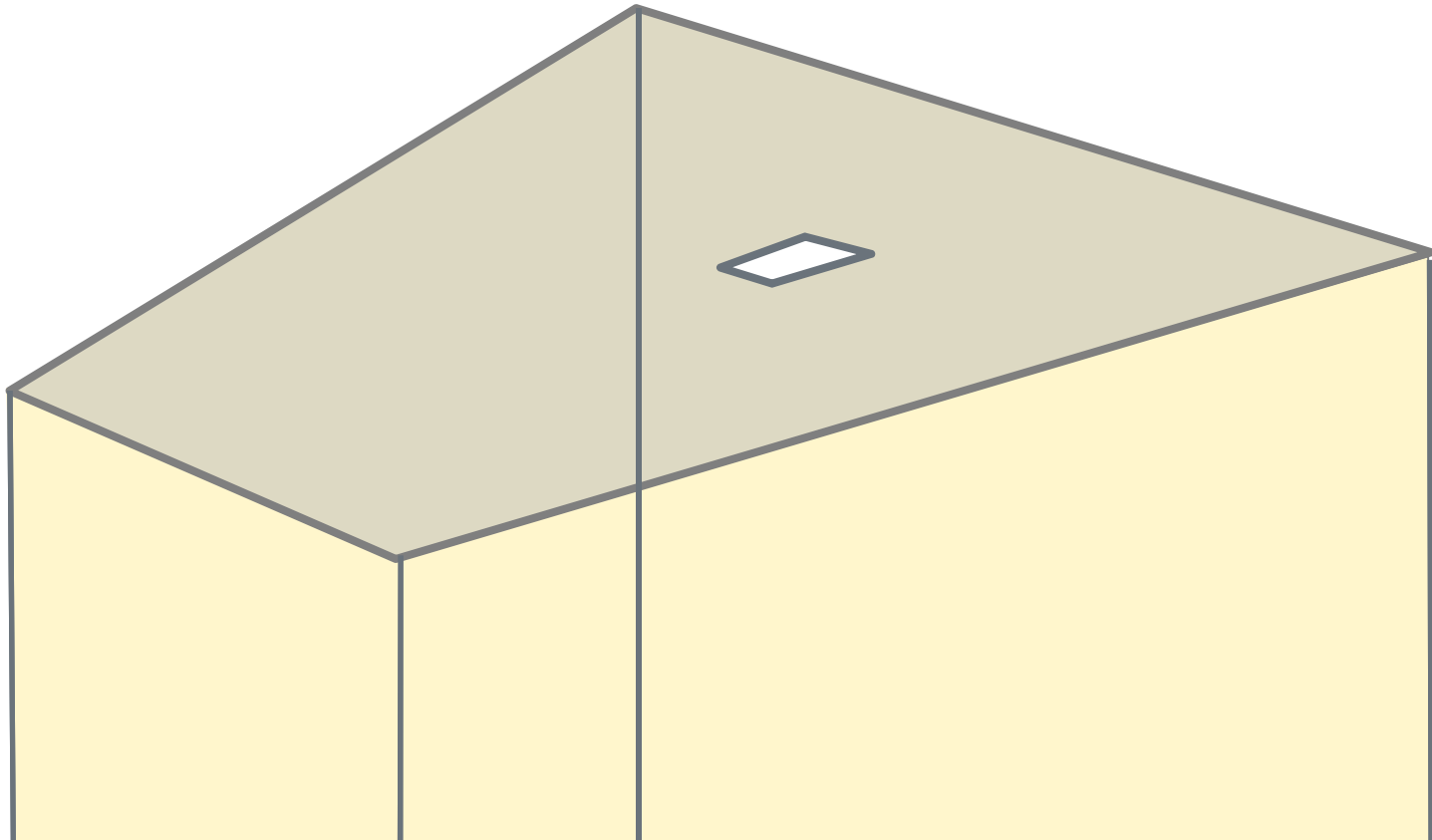
Zero Energy Ready Home High-R Roofs

Why Gaps in Insulation Important

1, 000 sq. ft. R-38 Attic Ceiling ($U = .026$)

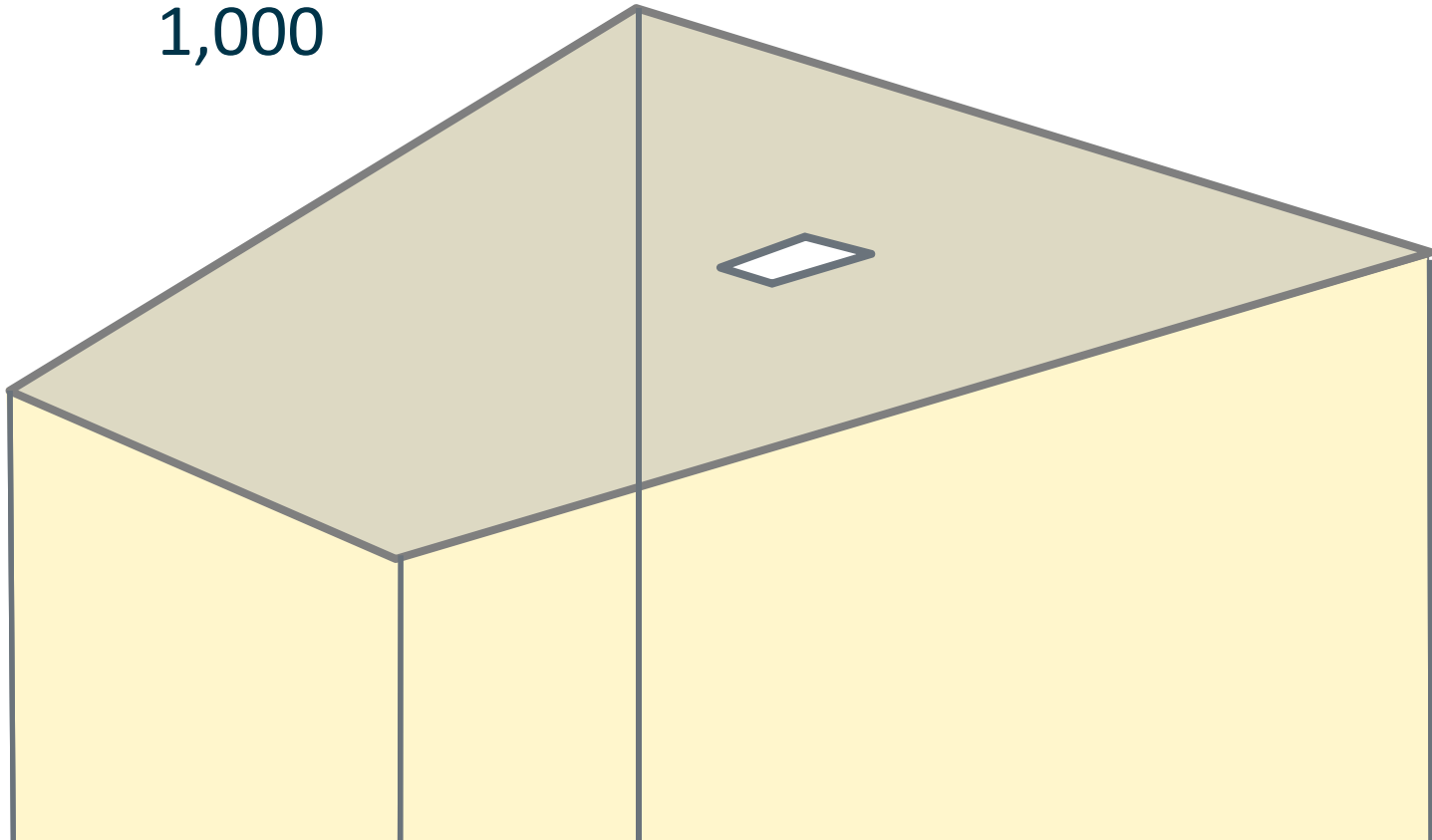
Add 10 sq. ft. R-1 Drop-Down Access Steps (1% of area)

How Much Percent Loss in R-38 Insulation?

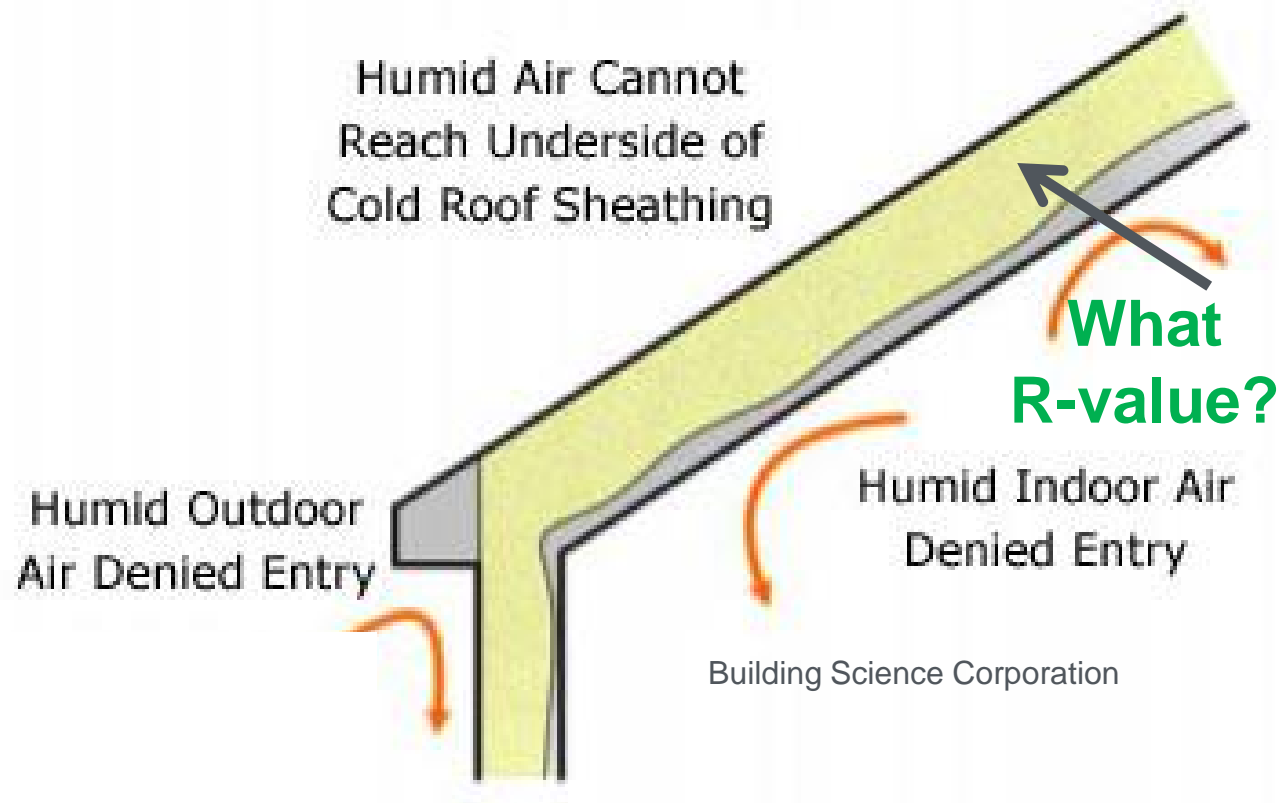


Why Gaps in Insulation Important

$$\begin{aligned} \text{Average } U &= \frac{U_1 \times A_1 + U_2 \times A_2 + \dots}{\text{Total Area (A)}} = \frac{(.026 \times 990) + (1 \times 10)}{1,000} \\ &= \frac{35.74}{1,000} = .036 = \mathbf{R27.8} = \mathbf{27\% \text{ less than R-38}} \end{aligned}$$



5.1 AIR-IMPERMEABLE: In direct contact with the underside of the sheathing

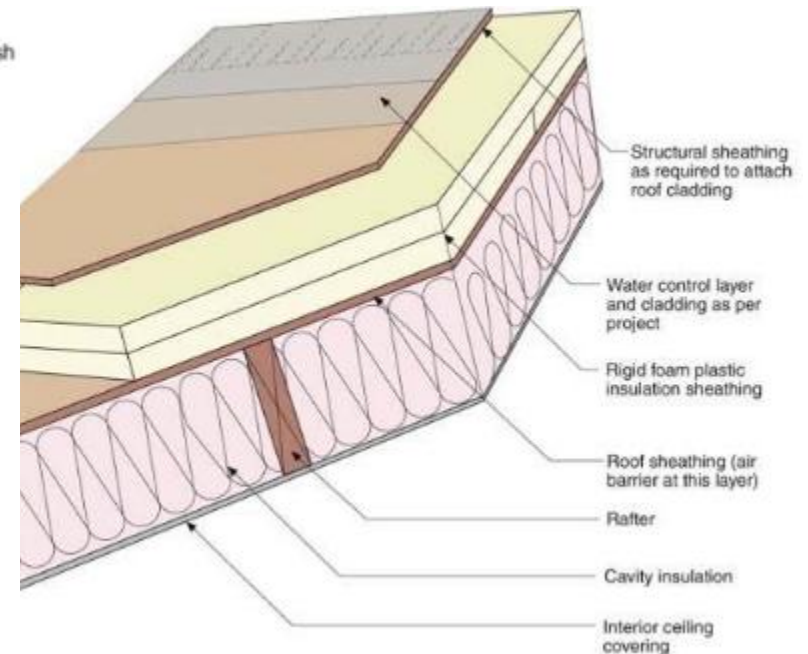
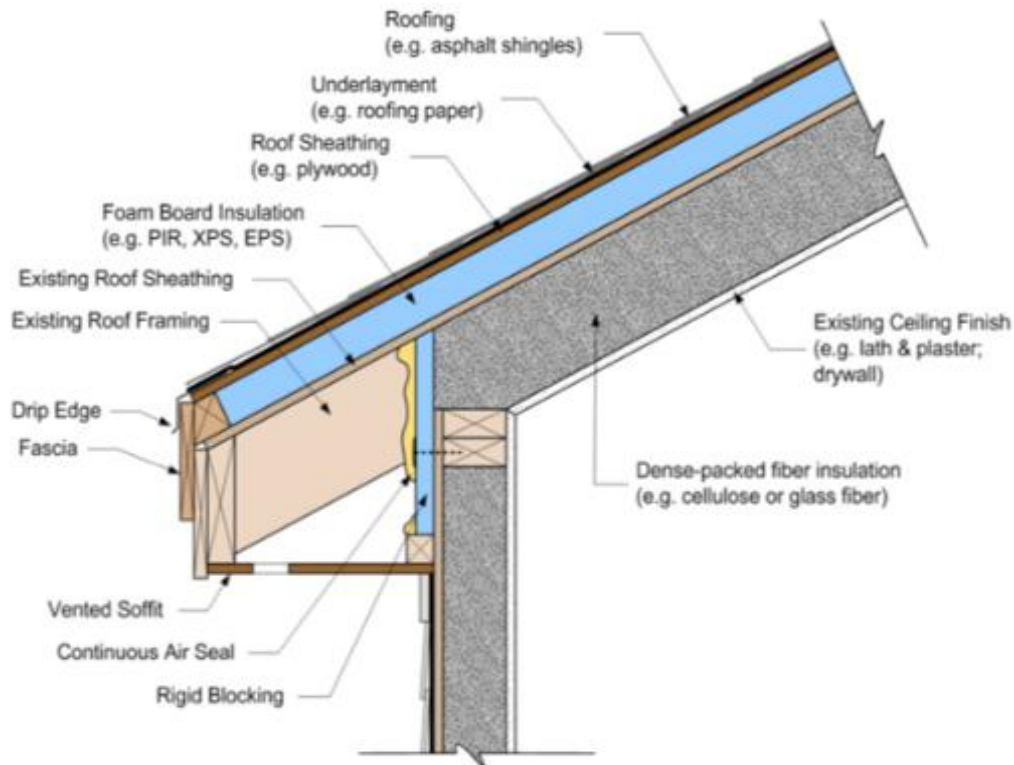


Minimum R-value of Impermeable Insulation

Climate Zone	Minimum Impermeable Insulation R-Value*	2012 IECC Ceiling R-Values
2B and 3B Tile Roof	None Required	30
1, 2A, 2B, 3A, 3B, 3C	R-5	38
4C	R-10	38
4A, 4B	R-15	49
5	R-20	49
6	R-25	49
7	R-30	49
8	R-35	49

*contributes but doesn't supersede 2012 IECC insulation requirements

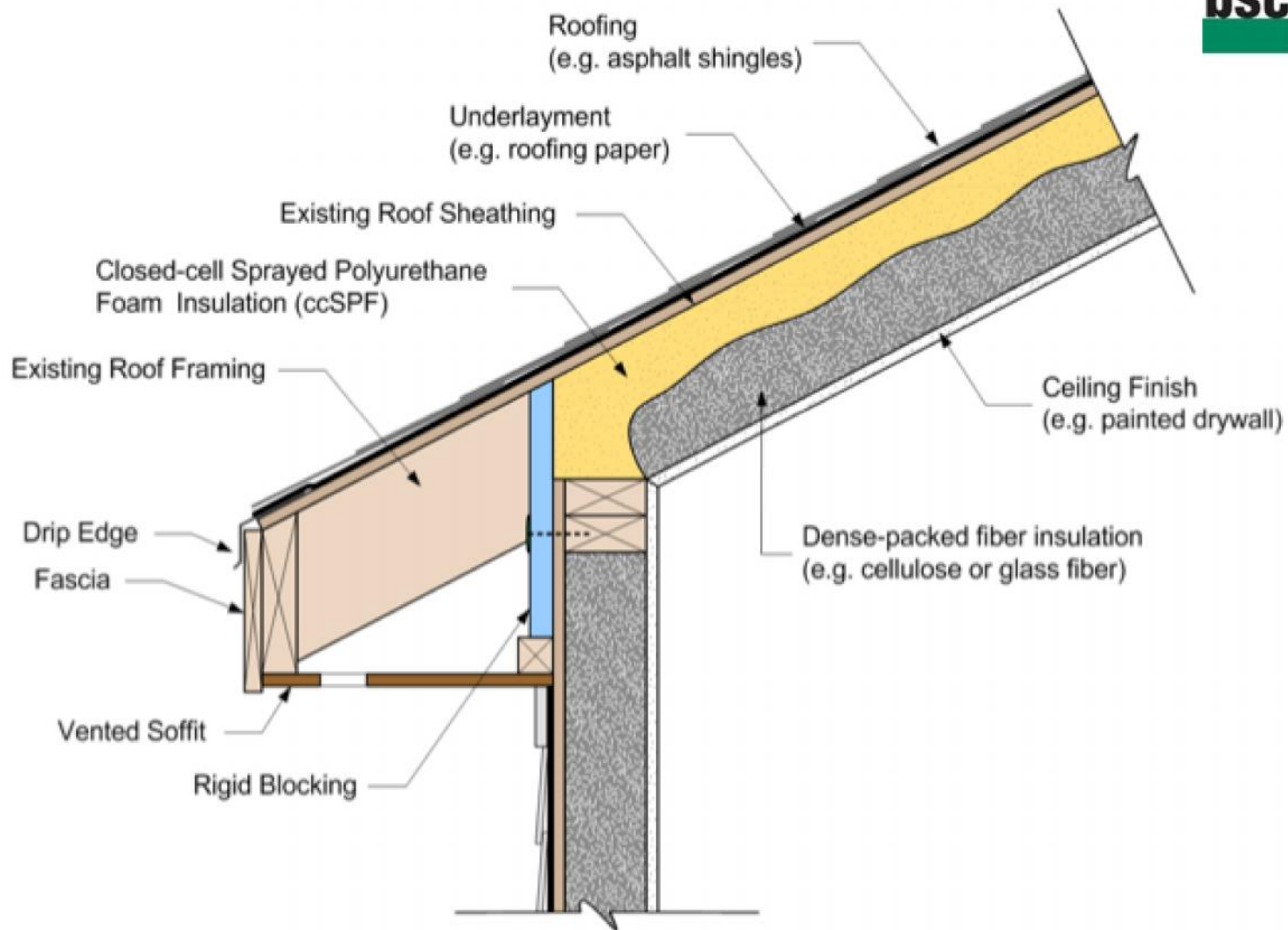
Top Insulated Roof Deck



Sequence of Retrofit:

- 1) Remove existing roofing and underlayment; inspect existing roof deck and framing and repair as necessary.
- 2) Install new exterior foam board insulation, roof sheathing, underlayment, flashings and roofing.
- 3) Remove existing soffit and install rigid blocking to prevent loose-fill fiber insulation from blowing into soffit; install continuous air seal at all joints and interfaces in blocking; replace soffit.
- 4) Dense-pack rafter cavities using approved cellulose or glass fiber insulation and following insertion tube techniques described in BPI RBE-WHALCI 2012.

Guidance for Dense Pack Roof Assemblies



Guidance for Spray Foam Under Roof Decks



	<p>Description</p> <ul style="list-style-type: none"> Built 2009 Cathedralized attic R21 - ~3.5" ccSPF below OSB roof sheathing
	<p>Exploration Findings</p> <ul style="list-style-type: none"> All sheathing locations investigated are within safe moisture content readings <p>Exploration Location 1 – North Lower</p> <ul style="list-style-type: none"> 6% moisture content reading No visible signs of moisture damage <p>Exploration Location 2 – West Upper</p> <ul style="list-style-type: none"> 7.5% moisture content reading No visible signs of moisture damage <p>Exploration Location 3 – East Upper</p> <ul style="list-style-type: none"> 6.5% moisture content reading No visible signs of moisture damage <p>Exploration Location 4 – West Lower</p> <ul style="list-style-type: none"> 7.0% moisture content reading No visible signs of moisture damage
<p>This information correlates well to modeling of warm locations with drives that enhance drying and have limited wetting.</p>	

Figure 1 – New Orleans, LA – June 2012 Collection of Sample of Spray Foam Under Roof Assembly in an Attempt to Compare Actual Performance with Idealized Performance

	<p>Description</p> <ul style="list-style-type: none"> 1941, Retrofit 2012 Cathedralized attic R21 - ~3.5" ccSPF below 1x board roof
	<p>Exploration Findings</p> <ul style="list-style-type: none"> All sheathing locations investigated are within safe moisture content readings
	<p>Exploration Location 1 – North West Lower</p> <ul style="list-style-type: none"> 9.2% moisture content reading No visible signs of moisture damage <p>Exploration Location 2 – South West Lower</p> <ul style="list-style-type: none"> 6.9% moisture content reading No visible signs of moisture damage

Figure 2 – Minneapolis, MN – July 2012



Zero Energy Ready Home

Technical Specifications Mandatory Requirements: Ducts in Conditioned Spaces

- **Significant Thermal Losses:**
 - Thermal losses triple for ducts in unconditioned vs. conditioned space
 - Total thermal losses can range from 10-45%
 - Extensive unconditioned space penetrations
- **Significant Performance Impacts:**
 - IAQ
 - Comfort
 - Durability

- **Short Duct Run**

up to 10' of total length is permitted to be outside of the home's thermal and air barrier boundary.

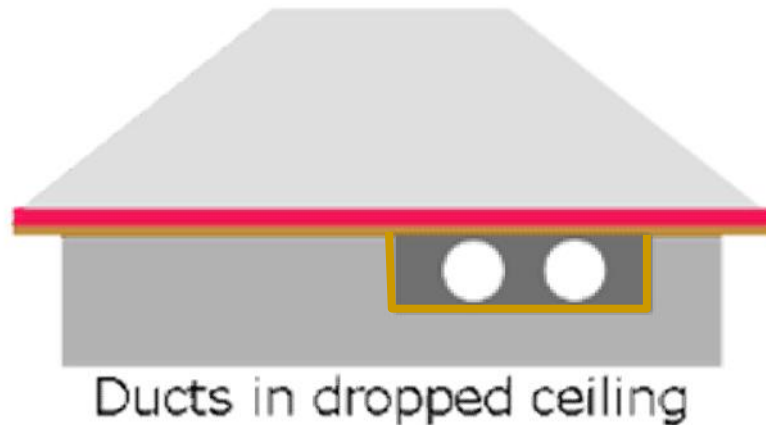
- **Jump Ducts**

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

- **Ductless HVAC system**

- **Conditioned Floor Space [3 options]**
within the thermal boundary
- **Unvented Crawl Space/Basement**
which is within the home's thermal boundary
- **Unvented Attic**
regardless of whether conditioned with a supply register
- **Vented Attic**
equivalent option where other locations in conditioned space are impractical, expensive, don't work well in specific climates, or increase envelope loads

Ducts in Conditioned Floor Space Option 1: Dropped Ceiling

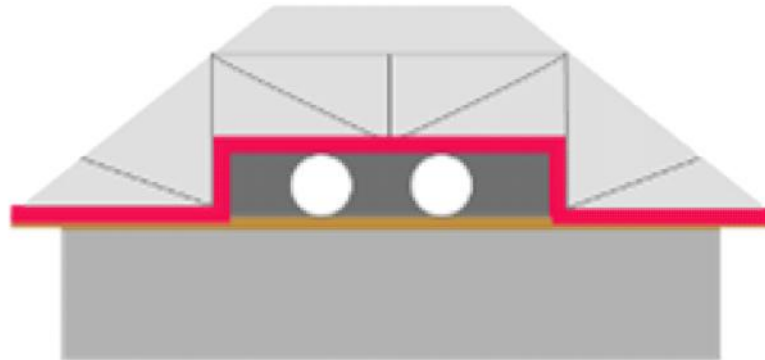


Issues:

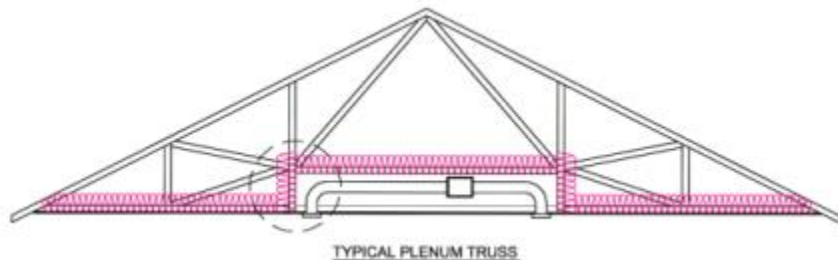
- Architectural Integration
- Good Fit w/Simple Plans
- Longer Throws (ACCA Man T)



Ducts in Conditioned Floor Space Option 2: Modified Attic Truss



Ducts in modified truss
in attic

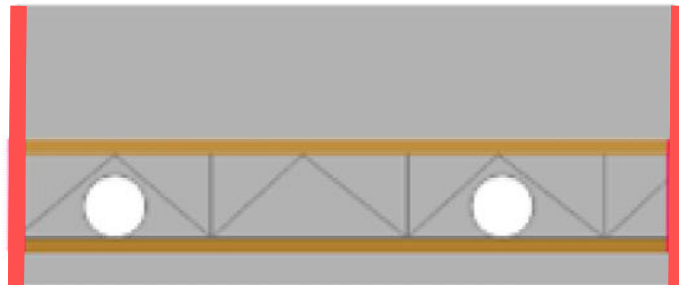


Issues:

- Design Integration
- Good Fit w/Narrow Plans
- Sealed Air Barrier Critical



Ducts in Conditioned Floor Space Option 3: Ducts Between Floors



Ducts between floors

Issues:

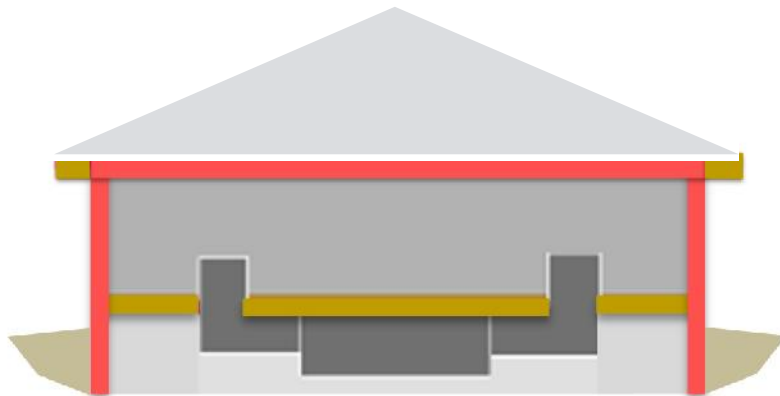
- Simple Installation
- Design Flexibility
- Cost-Effective
- Floor Registers Likely



Ducts in Conditioned Floor Space Option 3: Ducts Between Floors



Unvented Crawl Space/Basement



Ducts in unvented crawl space
or basement

Issues:

- Simple Installation
- Design Flexibility
- Cost-Effective
- Floor Registers Likely



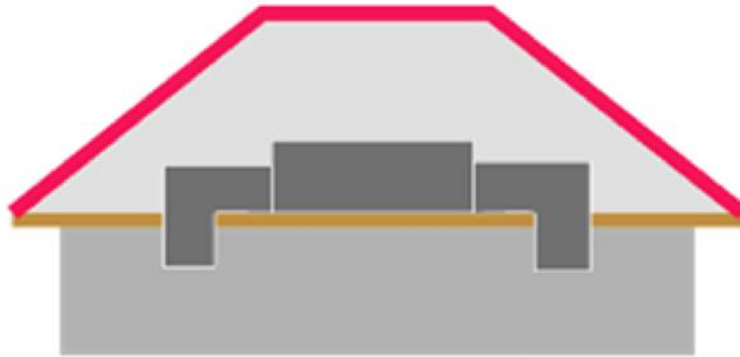
Ducts Outside

Picture Source: Construction Instruction



Ducts Inside

Ducts in Unvented Attic



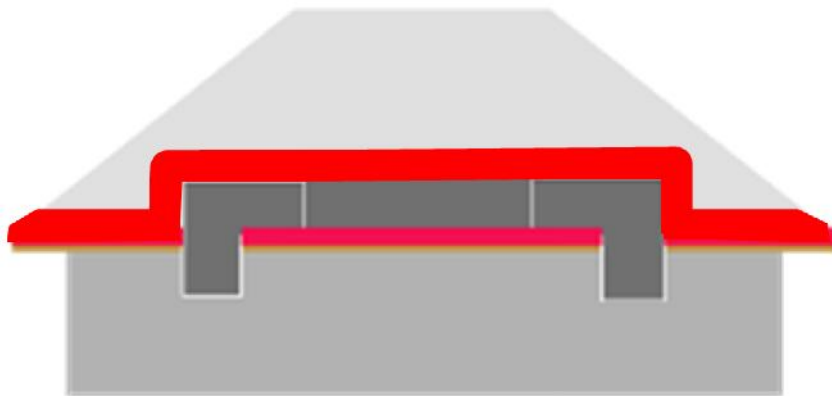
Ducts in unvented attic

Issues:

- CZ 5+, air impermeable plus a Class II VT or Class III VT in direct contact
- No Class I VR on attic floor

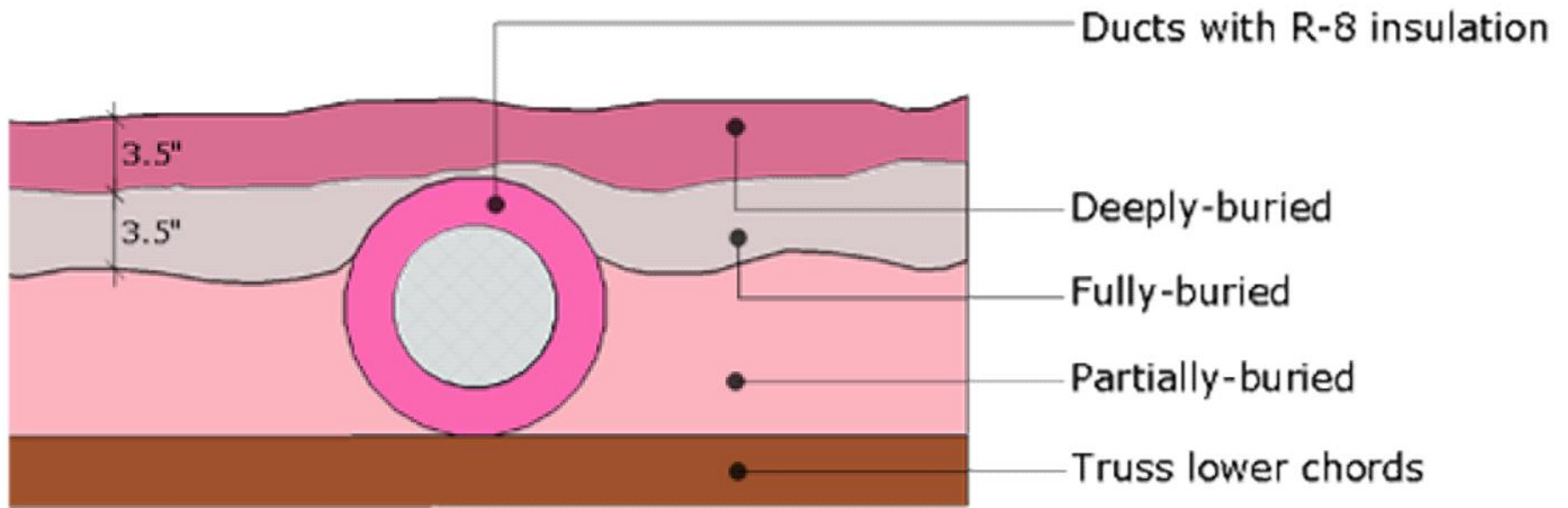


Ducts in Vented Attic: Dry CZs

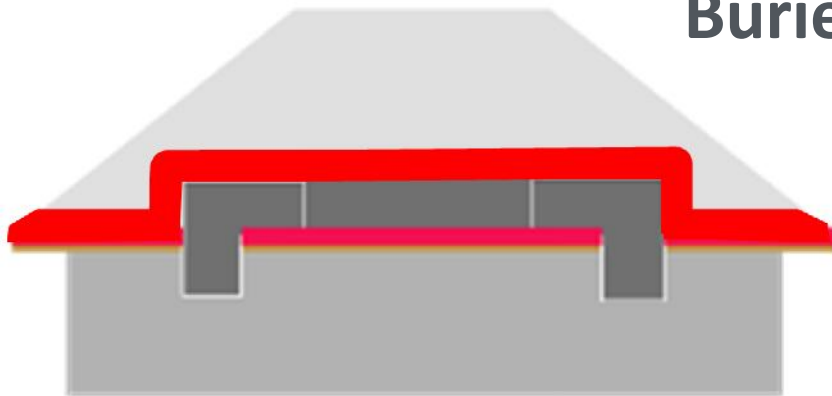


Ducts in vented attic

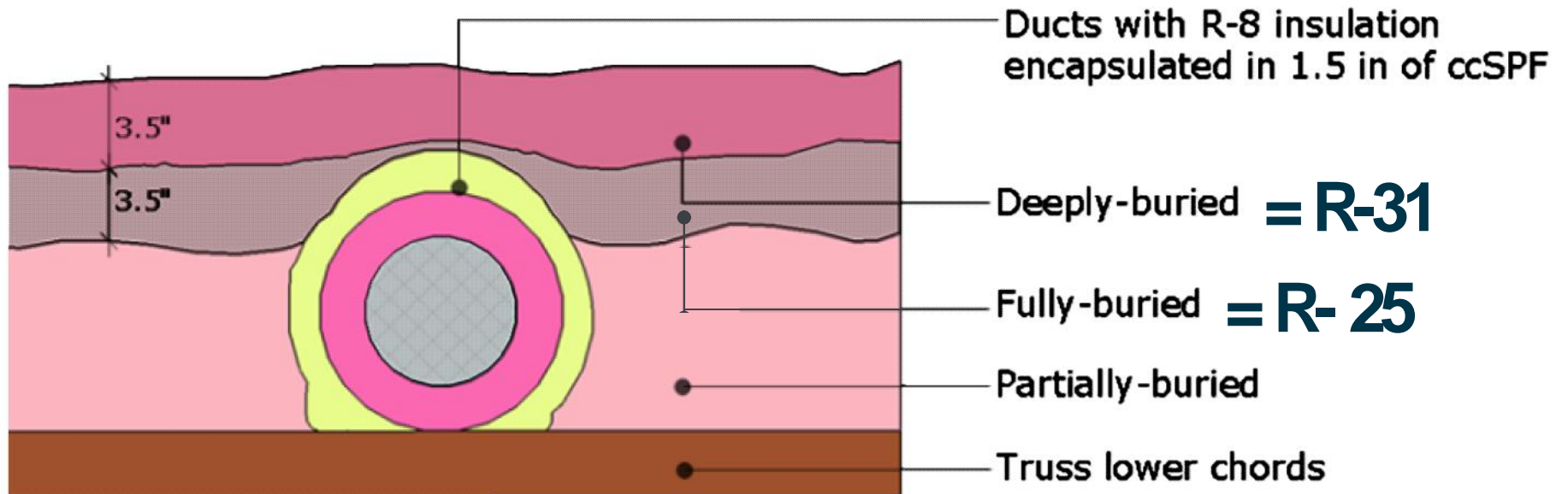
Buried Ducts



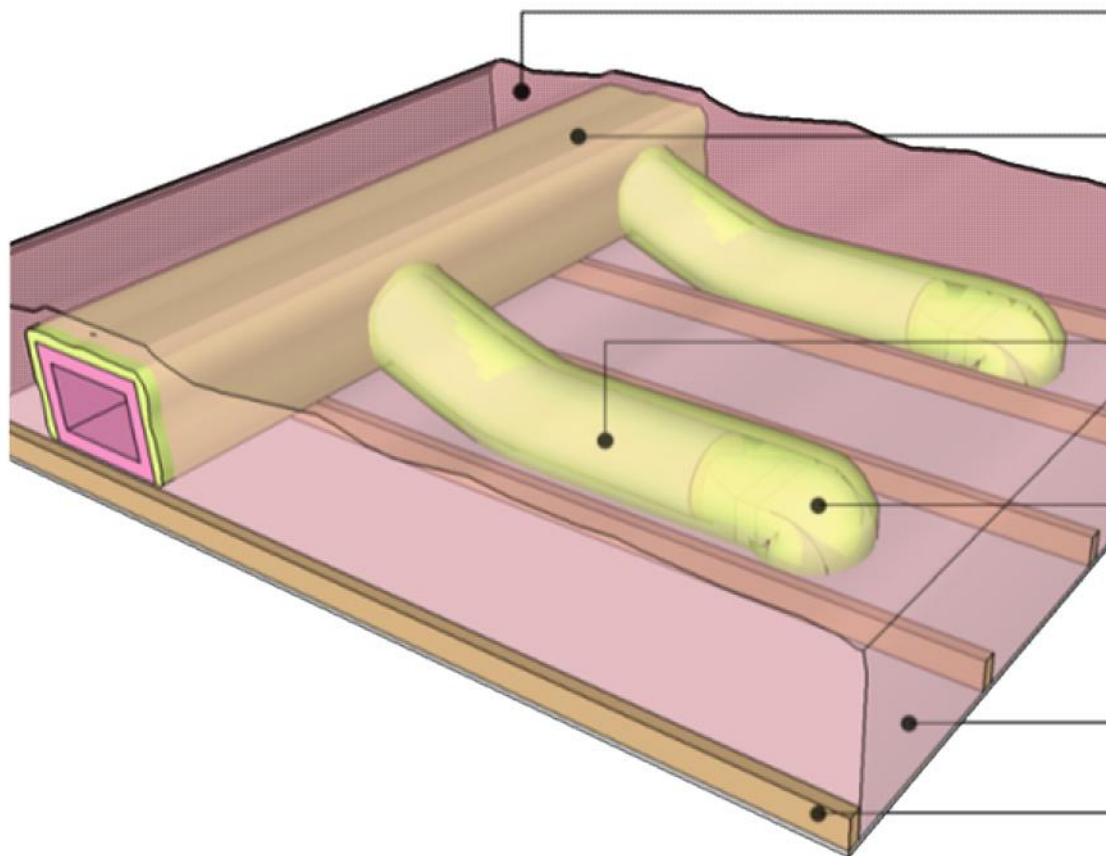
Buried Encapsulated Ducts (BEDs)



Ducts in vented attic



Buried Encapsulated Duct (BED)



Ducts buried under loose-fill insulation

R-8 ducts encapsulated in 1.5" ccSPF

R-8 flex duct encapsulated in 1.5" ccSPF

Duct boot connection encapsulated in 1.5" ccSPF

Drywall ceiling

Truss lower chords

Step 1: Install low-profile compact ducts on top of ceiling framing.



Option 1- prior to ceiling gypsum board



Option 2- after ceiling gypsum board

Step 2: Mastic seal ducts and perform leakage test.



Test total duct leakage to assure performance levels are met (total leakage ≤ 3 cfm25 per 100 ft² conditioned space)

Step 3: Apply 1.5” minimum ccSPF



Option 1- prior to ceiling gypsum board



Option 2- after ceiling gypsum board

Step 4: Install loose-fill insulation.



- Insulation must be ASTM classified as “mineral-fiber”, and cover the ccSPF by 2” min. (cellulose doesn’t qualify)*
- Some foams are exempt from this requirement

*Ignition barrier protection requirement

Building America Resources





Zero Energy Ready Home

Technical Specifications

Mandatory Requirements:

Efficient Hot Water Distribution

- **Indoor Fixtures**
 - Plumbing Fixtures
 - Appliances and Other Equipment
- **Distribution**
 - Service Pressure
 - Metering (for Multi-Family Homes)
 - Leak Prevention
 - **Hot Water Distribution**
- **Outdoor**
 - Landscape Design
 - Irrigation (if installed)



- “Must Have” for zero net-energy ready homes
- Based on EPA WaterSense Specifications:
 - No more than 0.5 gallons of water in any piping/manifold between the hot water source and any hot water fixture.
 - No more than 0.6 gallons of water shall be collected from the hot water fixture before hot water delivered.
 - Timer- and temperature-based recirculating systems shall not be used to meet the criteria.

Hot Water Distribution

Built for when water was free and energy was cheap!

Copper L piping:

- 1" = 5.53 ounces/ft
- $\frac{3}{4}$ " = 3.22 ounces/ft
- $\frac{1}{2}$ " = 1.55 ounces/ft

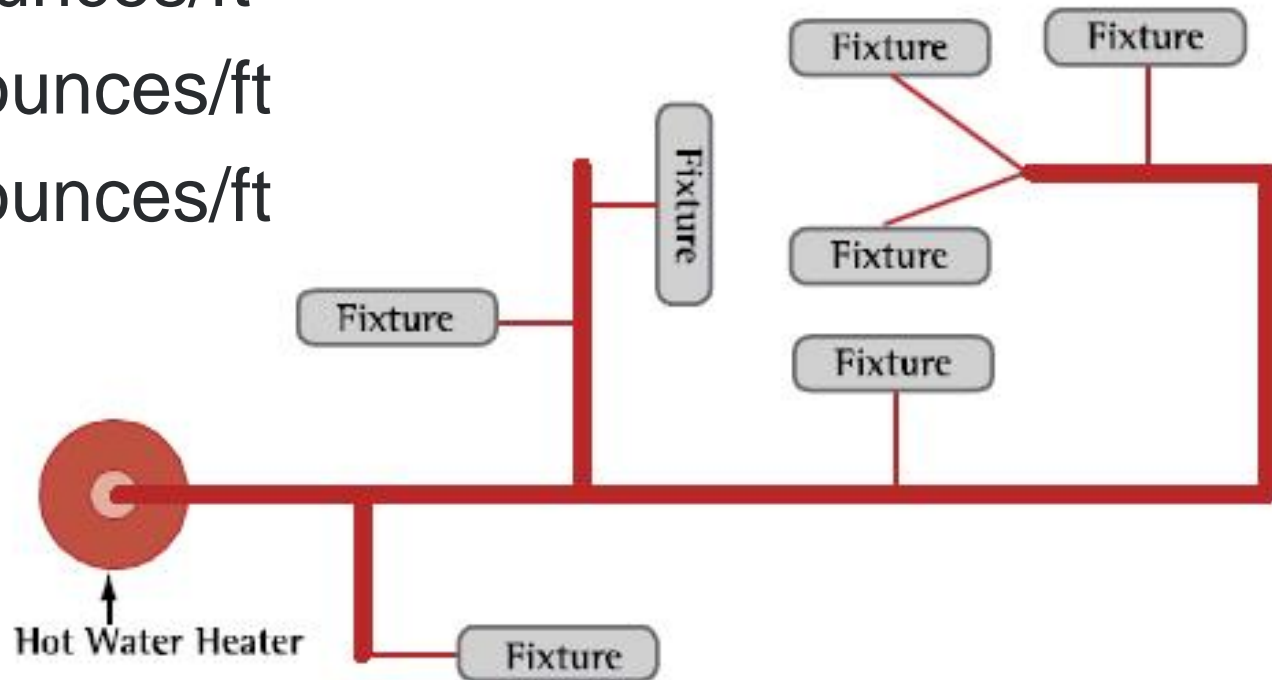
Sample Volume:

16 gallons

10' branch

Wait Time: 1 – 1.5 minutes

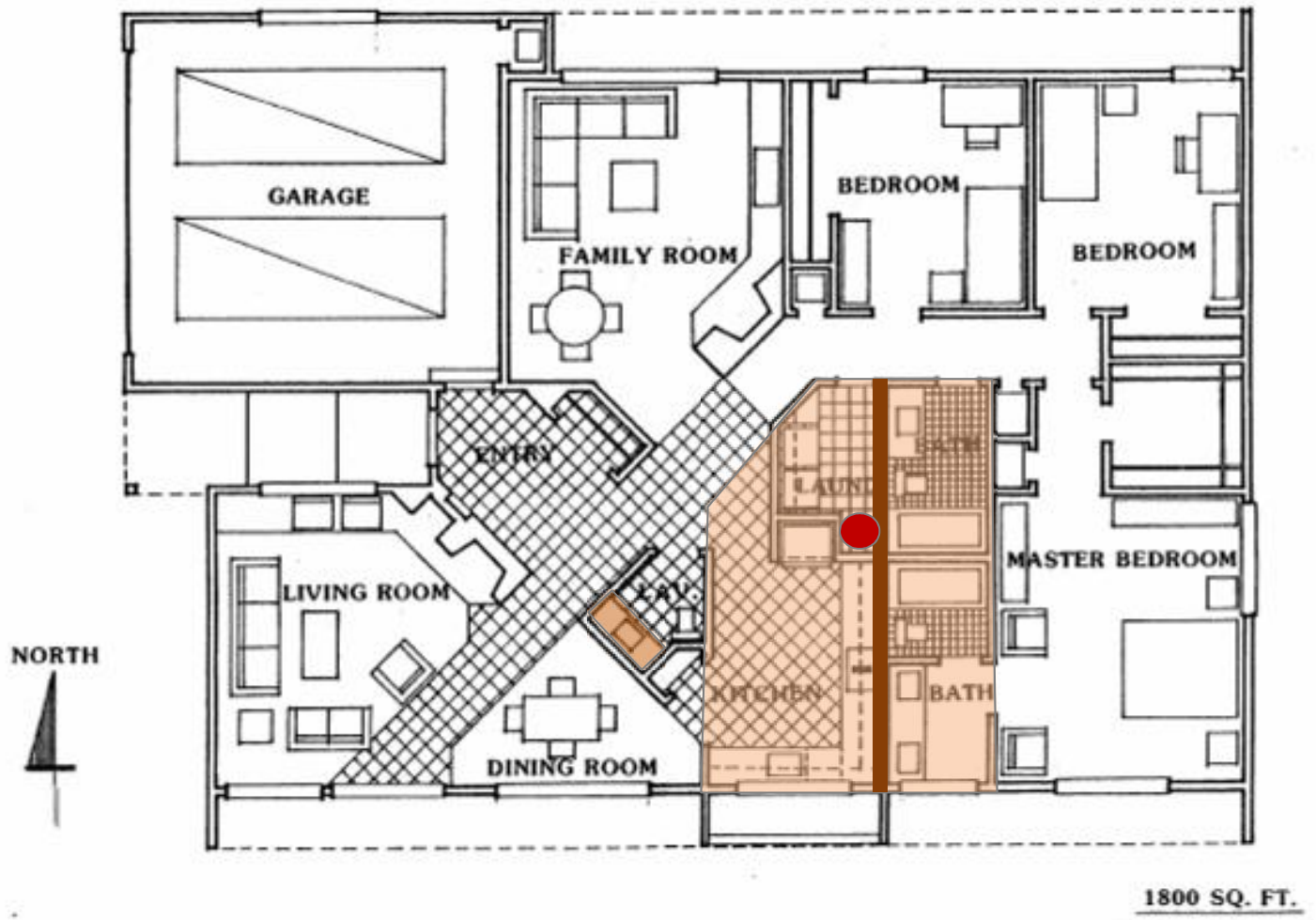
2 GPM showerhead



Hot Water Distribution Options

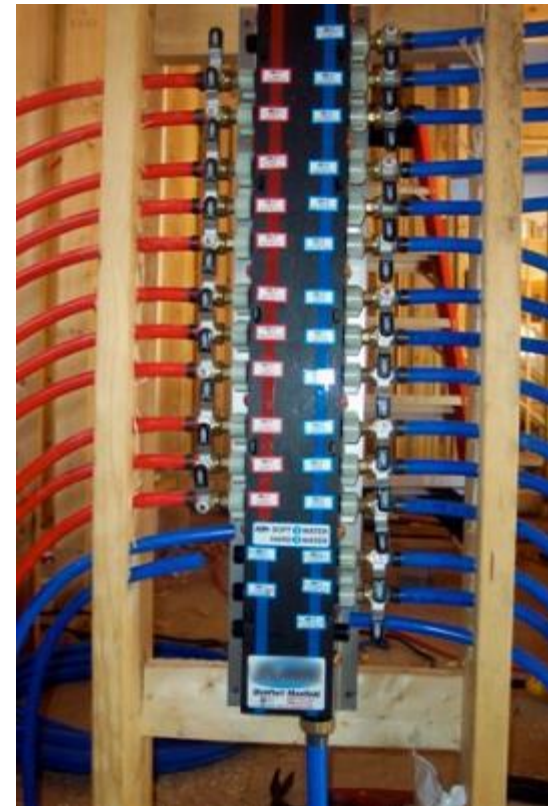
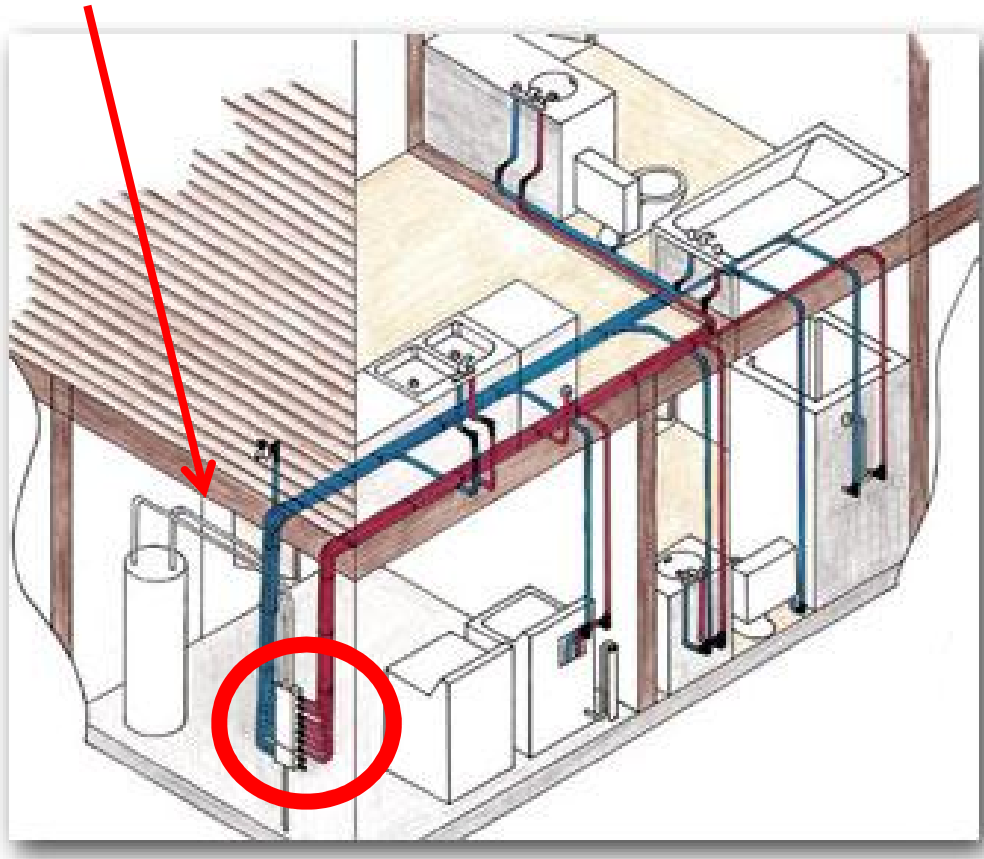
- Core Plumbing Layout (wet wall)
- Manifold System
- Demand Pumping System

Core Plumbing Layout

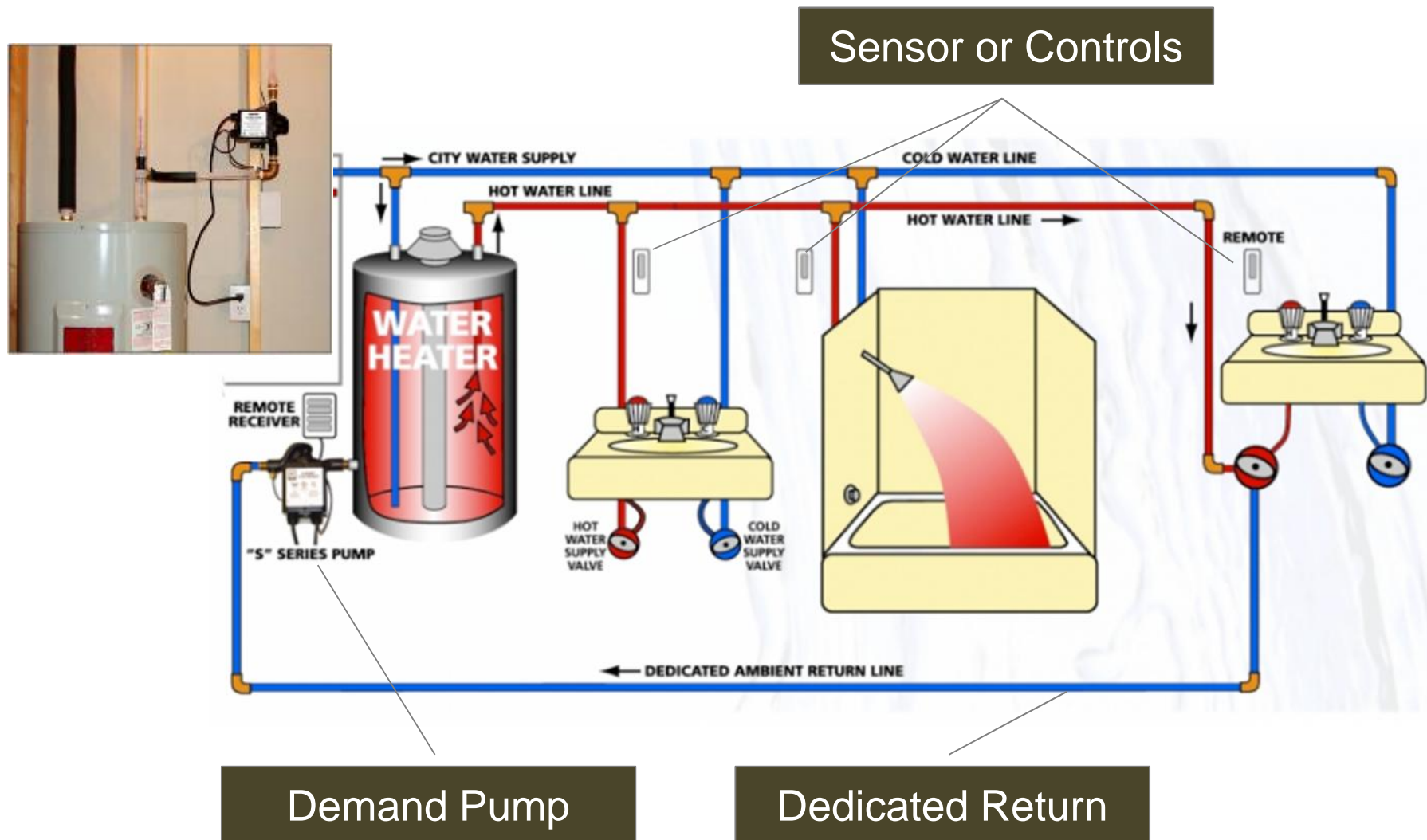


Manifold Plumbing System

10' Max



Demand Pumping System



Demand Pump

Dedicated Return



Zero Energy Ready Homes

Technical Specifications
Mandatory Requirements:
Efficient Components:
Lighting, Appliances, & Fans

Components and MEL's are increasingly Important in Low-Load Homes (~25 to 40%). Therefore, Challenge Home requires:

- **ENERGY STAR Certified Appliances:***
refrigerators, dishwashers, clothes washers
- **ENERGY STAR Certified Fans*:**
bathroom ventilation, ceiling fans
- **ENERGY STAR Certified Lighting:**
Min. 80% of fixtures or lamps (CFL or LED)

*Only where installed by builder



Zero Energy Ready Home

Technical Specifications Mandatory Requirements: Indoor Air Quality

Increasing Health Concerns



\$40 Billion



\$20 Billion

Indoor vs. Outdoor Air Pollutants:

On average **2-5 times greater**

Up to **100 times greater**

While Americans Spend

90% of time indoors

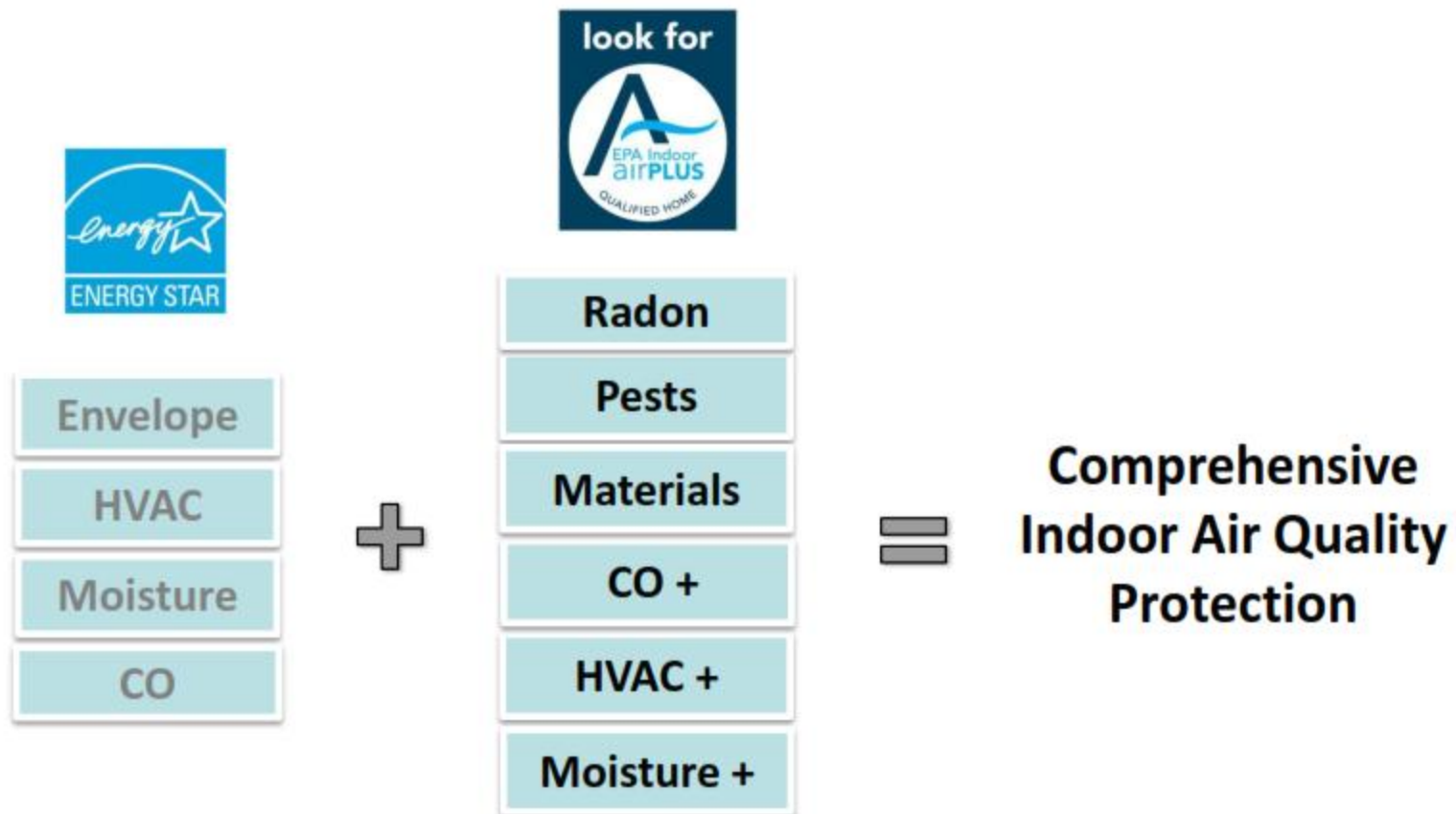
Source: EPA

“If your child doesn’t use an inhaler,
consider yourself a lucky parent because,

**1 in 10 children in the U.S.
suffers from asthma.”**

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

ENERGY STAR + Indoor airPLUS



Why IAQ is NOT A La Carte?

- 2000 SF Home
- 8.5' Ceilings
- 3 ACH50 Air Tightness
- 200 cfm Exhaust
(e.g. dryer, range hood)

- 5 Pa depressurization



- Dust Mites –asthma
- ~40% households with
significant respiratory issue
- Radon Control



- Source Control



Practices & Product Selection
That Limit Moisture,
Radon, Chemicals,
Combustion By-Products,
Biological Contaminants

- Dilution



HVAC
Quality Installation
System

- Filtration

Source Control: Moisture Moisture Control System

- **Moisture Vapor:**

- Air Sealing
- Air Barriers

**Thermal
Enclosure
System**

- **Bulk Moisture:**

- Water-Managed Roofs
- Water-Managed Walls/Opening
- Water Manage Foundation/Site
- Water Managed Materials

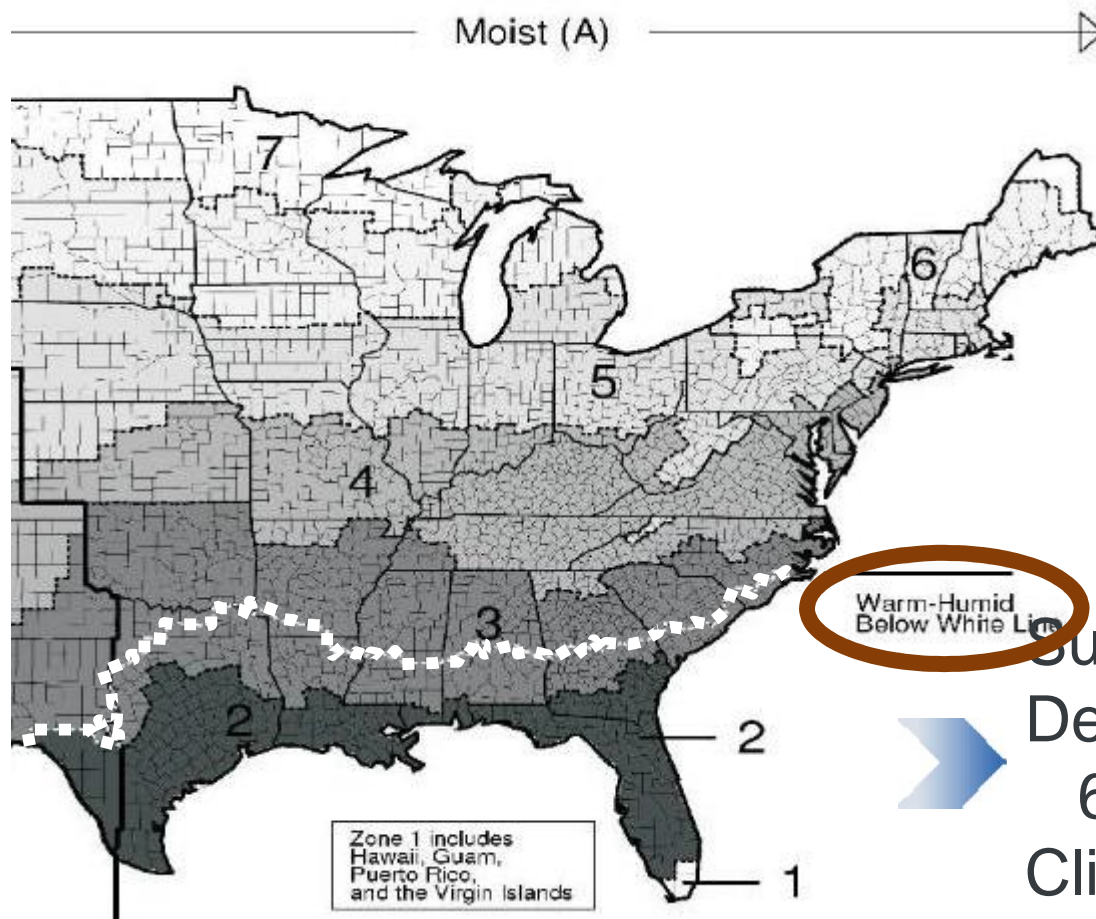
**Water
Managed
Construction**

- **Dehumidification
[Warm-Humid Climates]**

**HVAC System
or
Supplemental**

Source Control: Moisture Dehumidification in Warm-Humid CZs

Defined by 2009 IECC Figure 301.1 (i.e., Climate Zone 1 and portions of Zones 2 and 3A below the white line),



Dust mites in the billions at 60% RH or high

Supplemental Dehumidification to Ensure 60% RH in Warm-Humid Climates

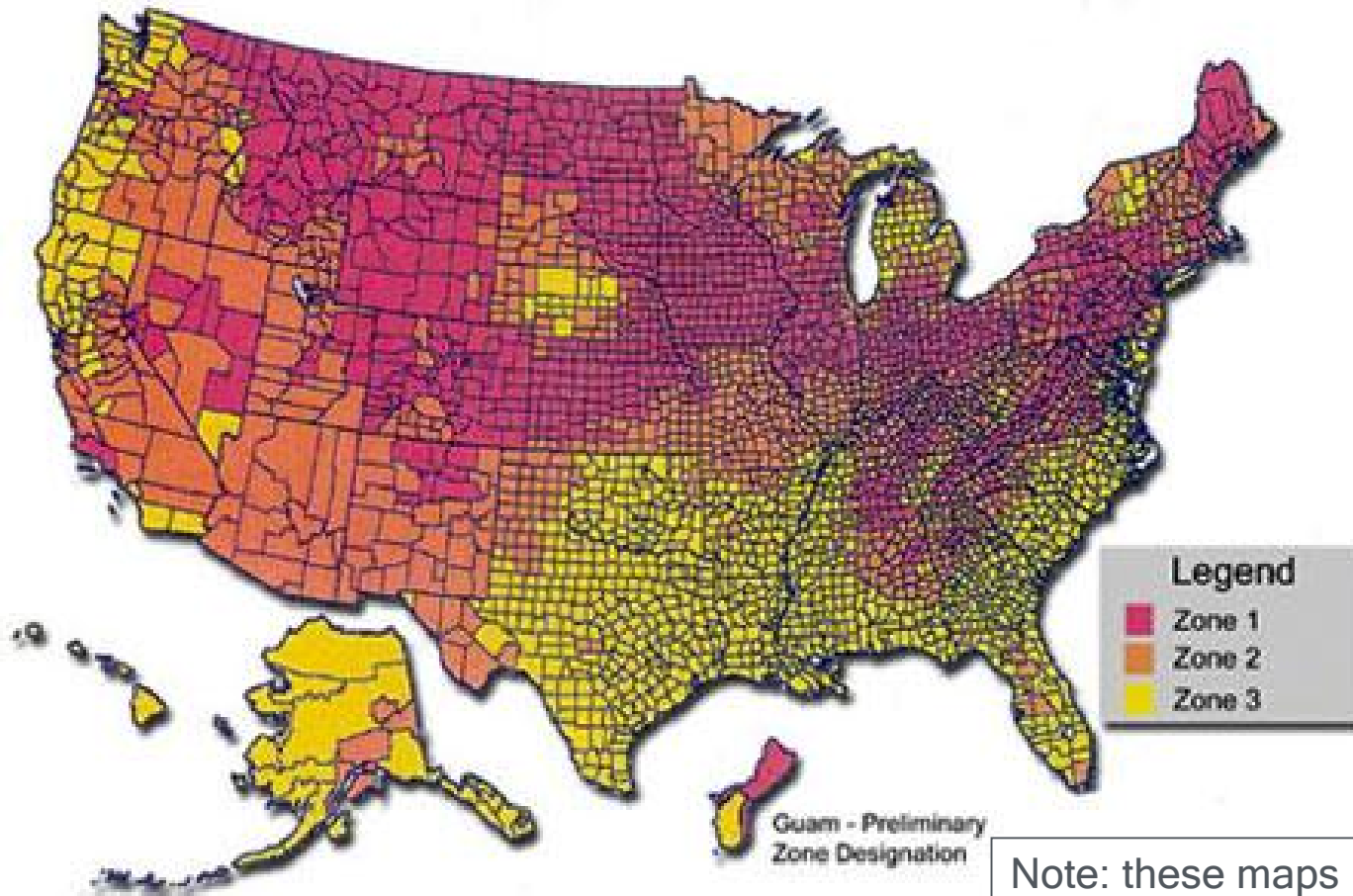
Equipment shall be installed with sufficient latent capacity to maintain indoor relative humidity (RH) 60%. This requirement shall be met by either:

- Additional dehumidification system(s), OR
- A central HVAC system equipped with additional controls to operate in dehumidification mode.

Exception: Climate Zones 4-8, 3B, 3C and the portions of 3A and 2B above the white line as shown by 2009 IECC Figure 301.1.

Source Control: Radon Radon Zones in U.S.

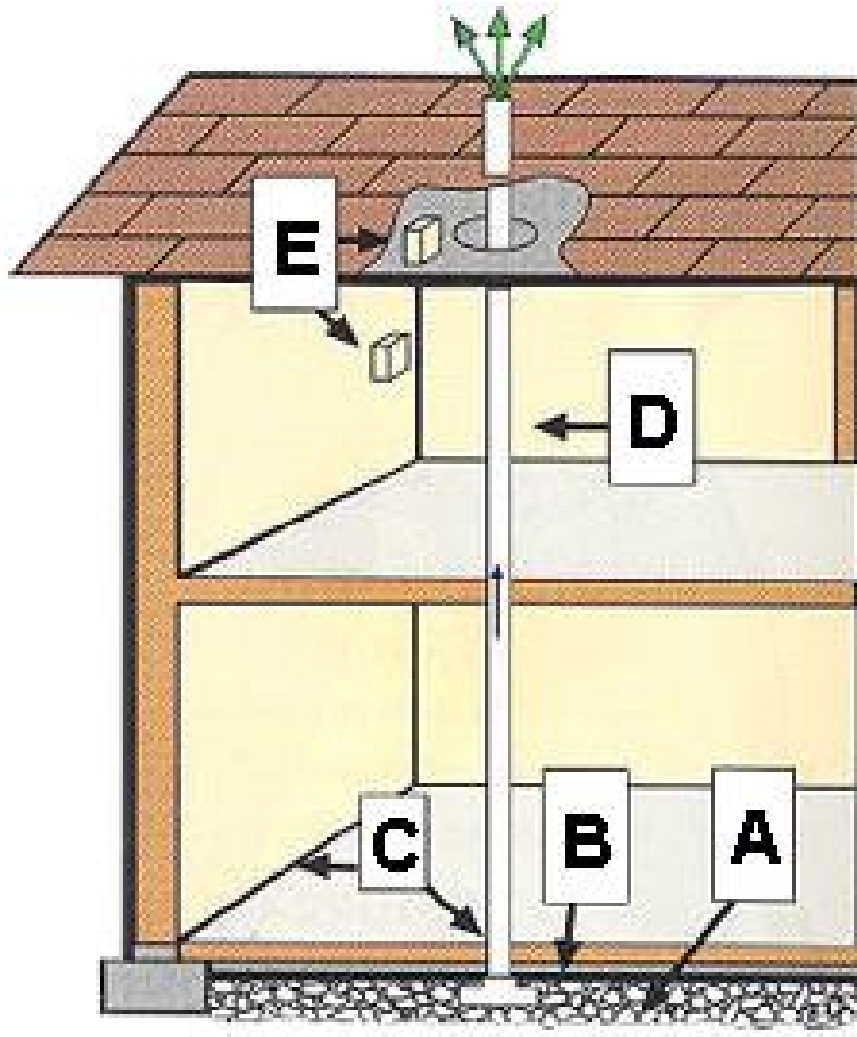
EPA Map of Radon Zones



Surgeon General's Warning:
Radon Causes Lung Cancer

Note: these maps indicate average risk by county. However, High levels of Radon can be found in any home.

Source Control: Radon Radon Resistant Construction



Required for Moisture Control:

- A. Gas Permeable Layer
(min. 4" clean gravel)
- B. Plastic Sheeting
(under slab)
- C. Sealing and Caulking
(all openings in concrete floor)
- D. Vent Pipe
(3 or 4 inch PVC pipe)
- E. Junction Box
(if fan needed later)

Radon Test Kits Not Required

Source Control: Biological Contaminants Pests



Source Control: Biological Contaminants Screened Openings for Pests



Corrosion-proof rodent/bird screens for openings
(e.g., copper or stainless steel mesh)

Exception: clothes dryer vent

Source Control: Biological Contaminants/Moisture Foundation Sealing



Sealed Sump Pump



Air Sealing

Source Control: Combustion By-Products Power/Direct Vent Equipment

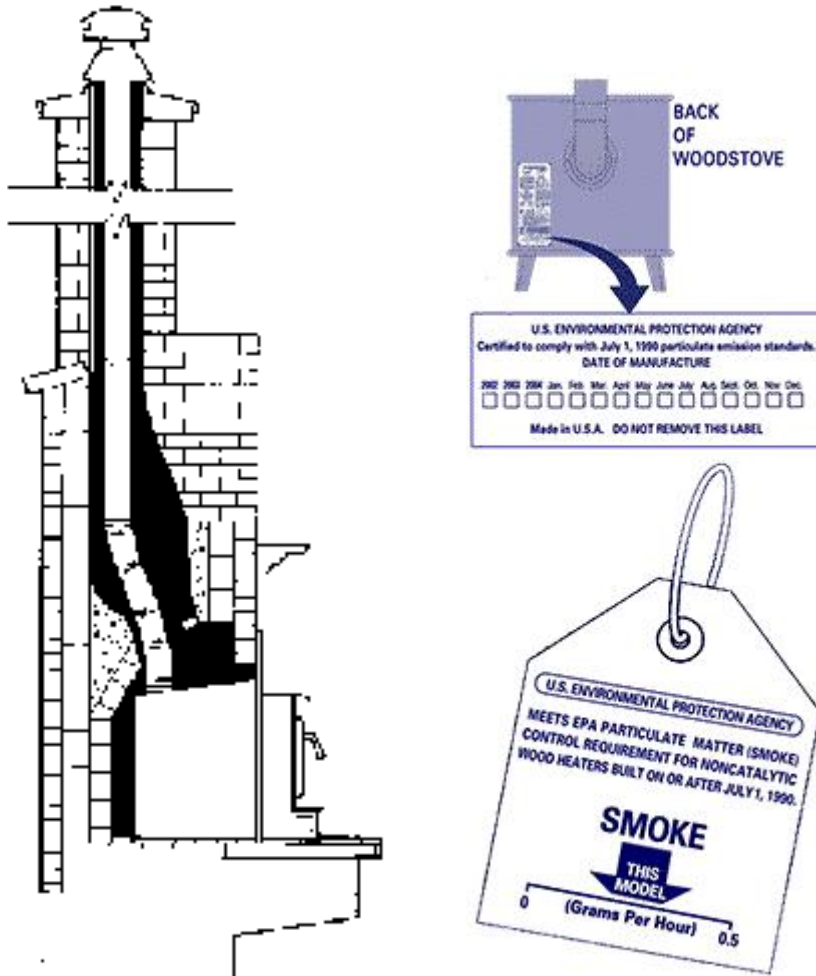


Power Vented Water Heater



Direct-Vent Furnace

Source Control: Combustion By-Products Certified Fireplaces & Stoves



- Vented to outdoors
- Adequate Combustion and Ventilation Air
- Gas fireplace power or direct vented
- Meet Specified Standards

Source Control: Combustion By-Products Certified CO Alarms

CO Alarm in each bedroom area



CO Alarm



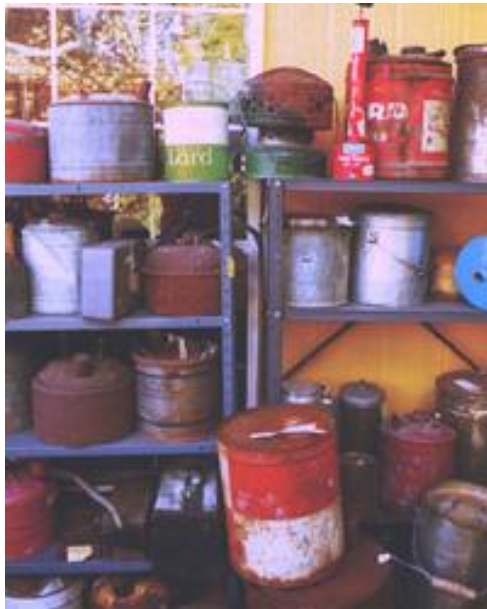
Combined CO
& Smoke Alarm



Enforceable policy in
Multi-family buildings



Source Control: Combustion By-Products Attached Garage Isolation



Exhaust Fan Optional



Air Sealing & Gasketed Door

Source Control: Combustion By-Products Attached Garage Isolation

No Air Handler in
the Garage



Picture Source: Construction Instruction

Source Control: Chemicals Low Formaldehyde Pressed Wood

MDF & Particleboard



Health Hazards of VOCs

VOLATILE Organic Compounds

Immediate

- Eye & Respiratory Tract Irritation
- Headaches
- Dizziness
- Visual Disorders
- Memory Impairment

Up to 6 years

- Eye, Nose, and Throat Irritation
- Headaches
- Loss of Coordination
- Nausea
- Damage to Liver, Kidney, and Central Nervous System
- Cancer



Interior paints and finishes, including 90% or more of such products applied to interior surfaces of homes, shall be certified low-VOC or no-VOC by one of the following:



- Green Seal Standard GS-11, OR
- Greenguard Certification for Paints and Coatings, OR
- Scientific Certification Systems (SCS) Standard EC-10.2-2007, Indoor Advantage Gold, OR
- Master Painters Institute (MPI) Green Performance Standards GPS-1 or GPS-2, OR
- A third-party low-emitting product list based on CA Section 01350, e.g., the CHPS List at chps.net/manual/lem_table.htm.

Source Control: Chemicals
Low VOC Carpet, Padding, Adhesives

Carpets and carpet adhesives shall be labeled with, or ***otherwise documented as meeting, the Carpet & Rug Institute (CRI) Green Label Plus or Green Label testing program criteria.*** Carpet cushion (i.e., padding) shall similarly be certified to meet the CRI Green Label testing program criteria.



Dilution: Whole-House Ventilation

Three Options:

- Exhaust-Only
- Supply-Only
- Balanced

ASHRAE 62.2 2010 Continuous Ventilation Rate:

$$[7.5 \text{ cfm} * (\# \text{ bedrooms} + 1)] + [.01 * \text{Sq. Ft.}]$$

2,000 sq. ft., 3 Bedroom Home Example:

$$[7.5 * (3+1)] + [.01 * 2,000] = [30 + 20] = 50 \text{ cfm}$$

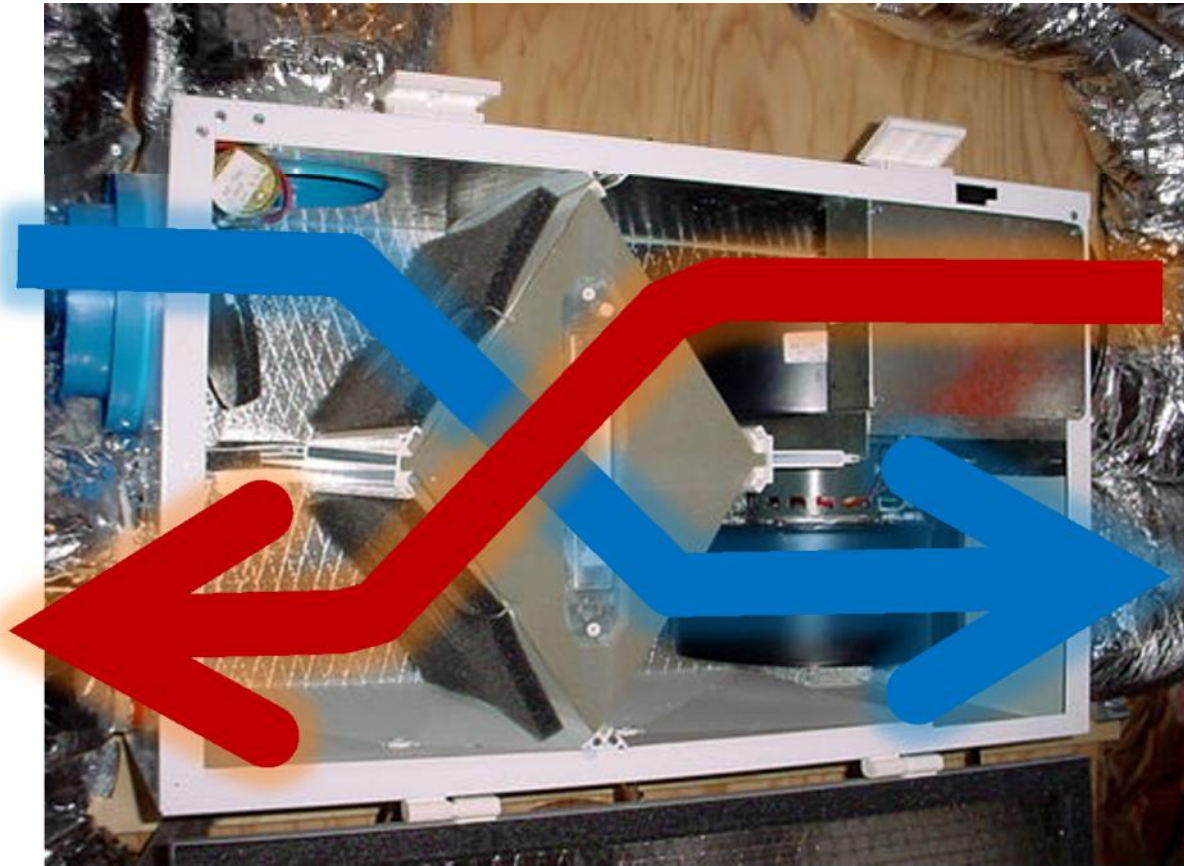
Dilution: Whole-House Ventilation Exhaust-Only Ventilation



Dilution: Whole-House Ventilation Supply-Only Ventilation



Dilution: Whole-House Ventilation Balanced Ventilation



ERV or HRV

Simple Thru-Wall ERV

- 90+% Heat Recovery
- 20-30% Humidity Recovery
- 1.4 – 2.8 W for 10/18/22 CFM



Dilution: Whole-House Ventilation Ventilation Persistence



Dilution: Spot Ventilation

- Kitchen:
 - 100 CFM Intermittent
 - 5 ACH Continuous
- Bathrooms:
 - 50 CFM Intermittent
 - 20 CFM Continuous



Filtration: High-MERV HVAC Filter



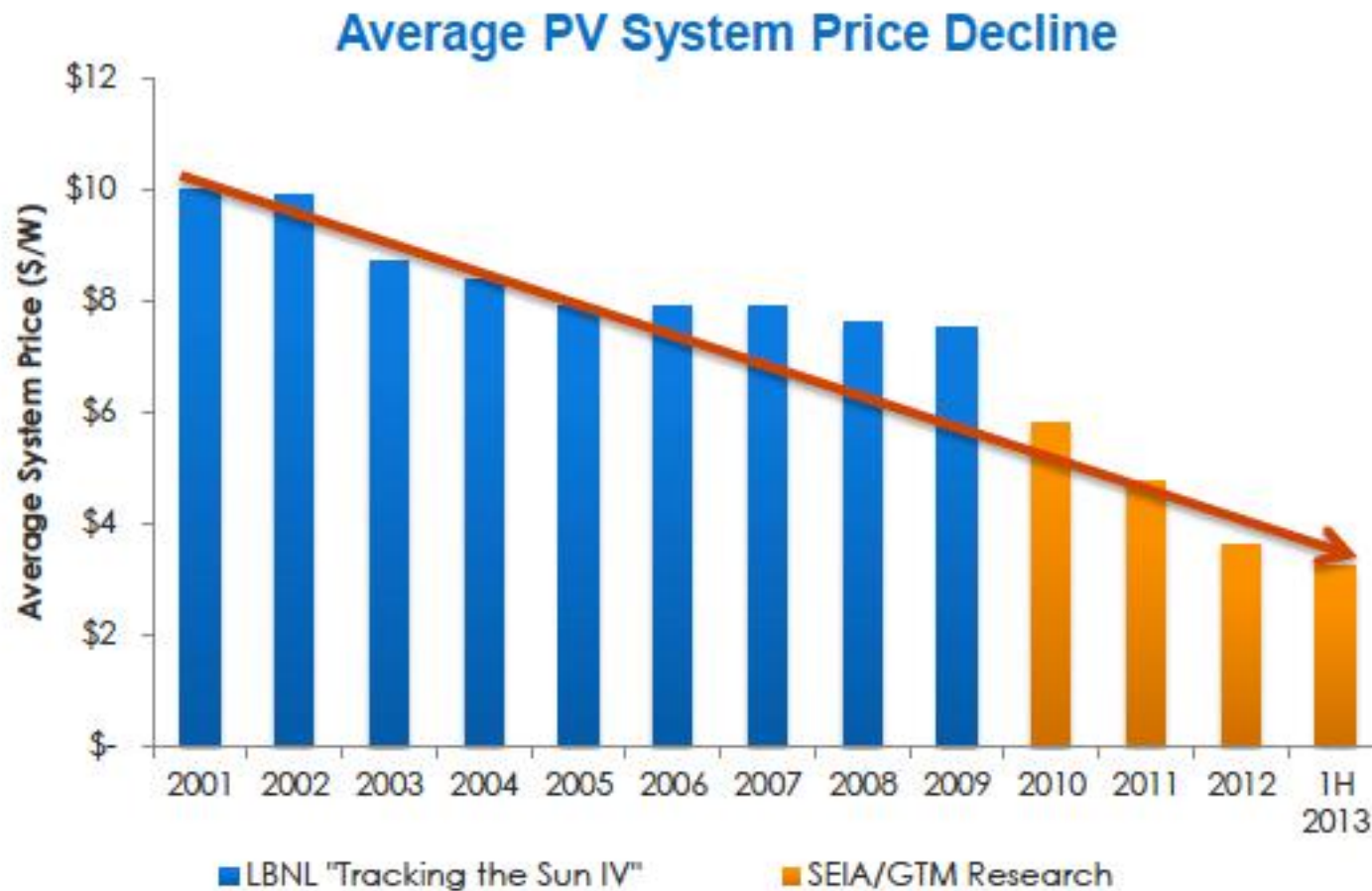
8 MERV Filter Minimum



Zero Energy Ready Home

Technical Specifications Mandatory Requirements: **Renewable Ready** [Where Applicable]

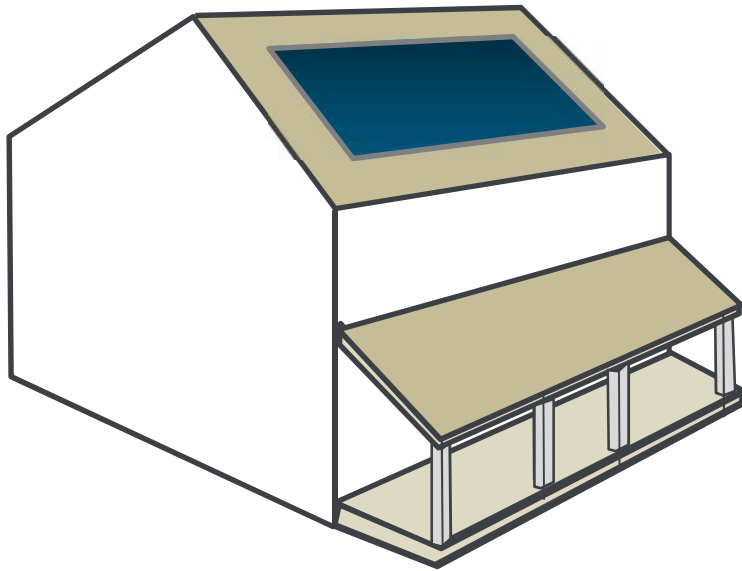
Decreasing Renewable Cost



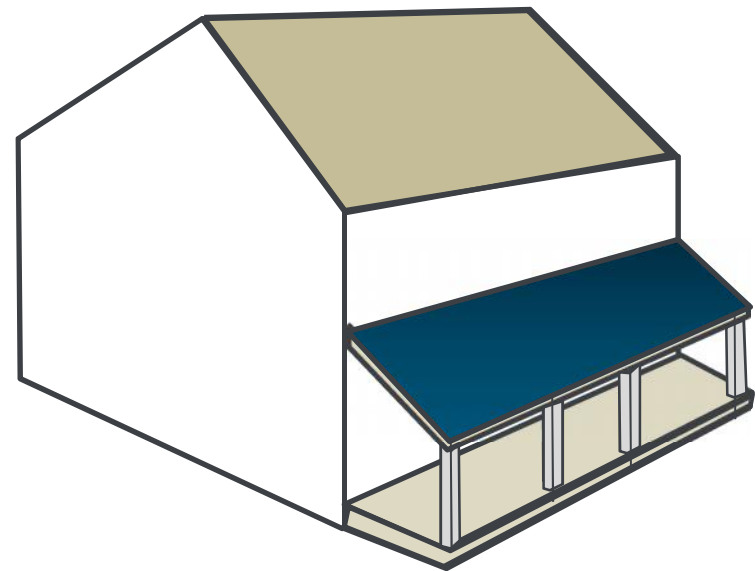
More than half of all U.S. homebuilders are expected to offer solar PV energy systems as an option in new single-family homes by 2016, up from just 12 percent in 2013.

Source:

Green Multifamily and Single Family Homes: Growth in a Recovering Market, McGraw Hill, NAHB, 2014



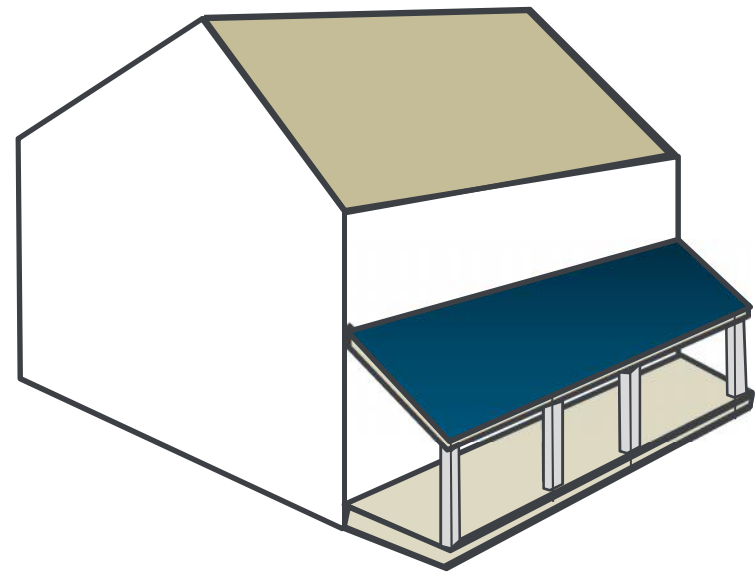
PV Mounted on Roof



PV Integrated into
Front or Rear Porch Roof
Directly on Porch Framing

Benefits:

- Cost
- Appearance
- Maintenance
- Daylighting



PV Integrated into
Front or Rear Porch Roof
Directly on Porch Framing

Integrated Renewable Energy

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



Integrated Renewable Energy



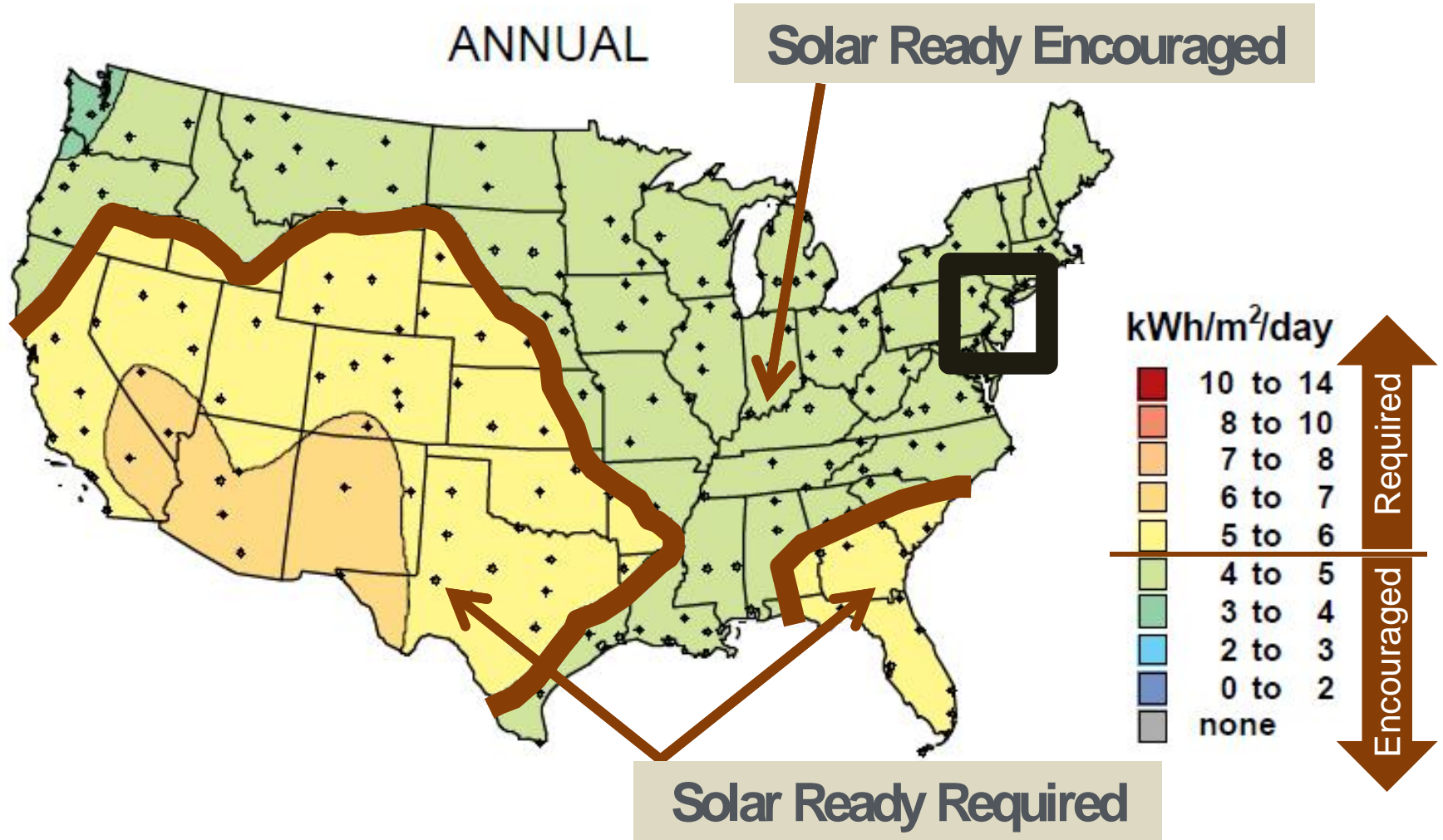
Renewable Ready Exemptions

- Not required in areas lacking significant solar resources or shaded
- Recognition of high performance water heating systems



RERH Applicability

Average Daily Solar Radiation Per Month



Screen for RERH Applicability

- **Renewable Energy Ready Checklists**
 - Determine applicability by zip code
 - http://gisatnrel.nrel.gov/PVWatts_Viewer/index.html
 - In this Mid-Atlantic example, solar resources = 4.8 kWh/m²/day



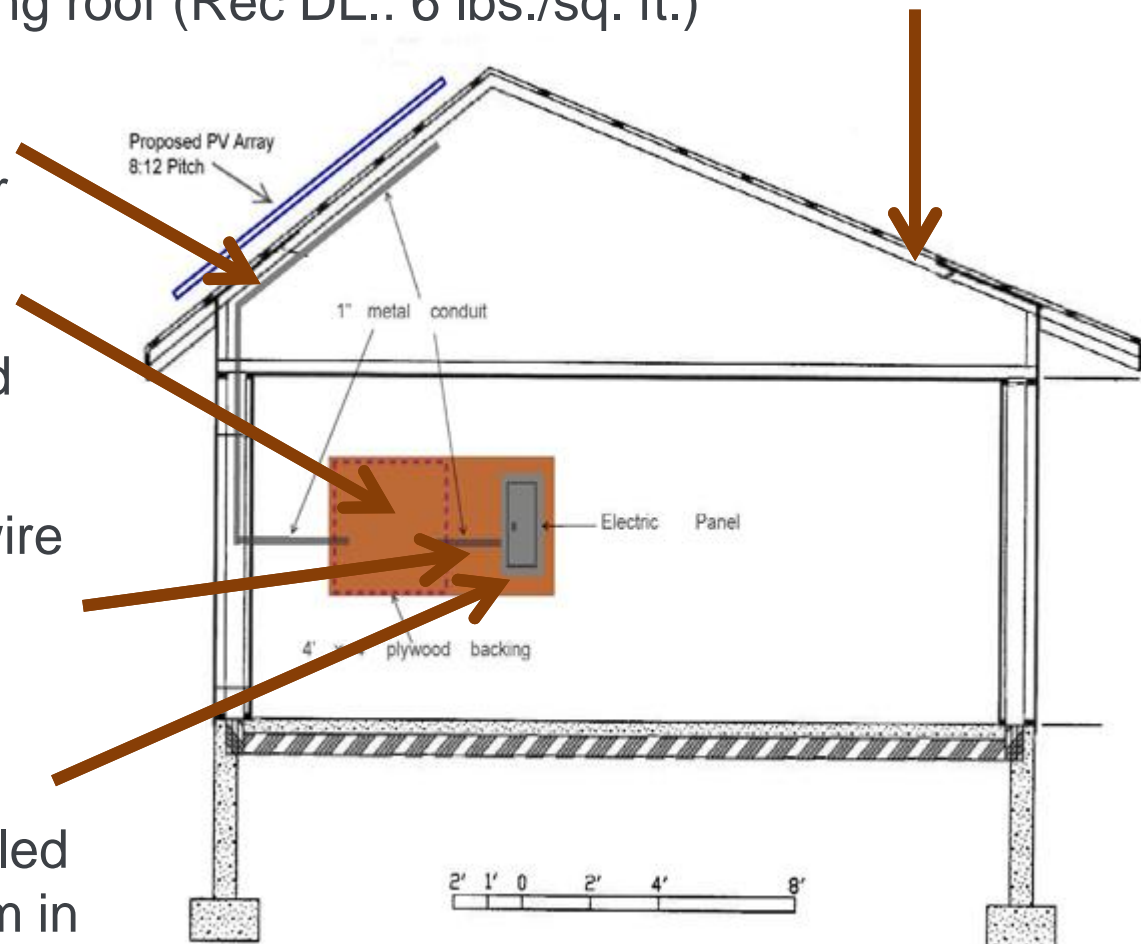
Documentation of the maximum allowable dead load and live load ratings of the existing roof (Rec DL.: 6 lbs./sq. ft.)

Conduit to run DC wire from roof to inverter

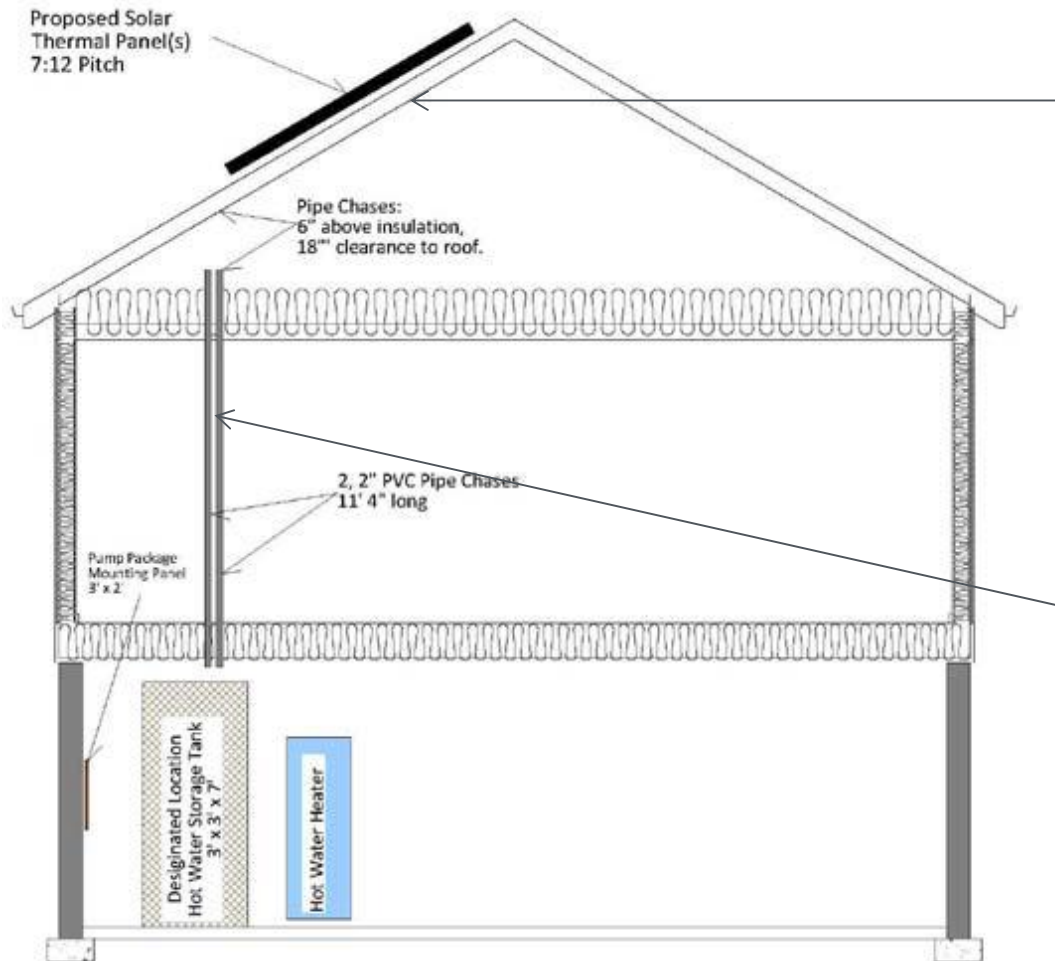
Dedicated Area for installing inverter and balance of system

Conduit to run AC wire from inverter location to electric panel

Circuit Breaker designated and/or installed for use by the PV system in the electric panel



Solar Hot Water Ready Reqts.



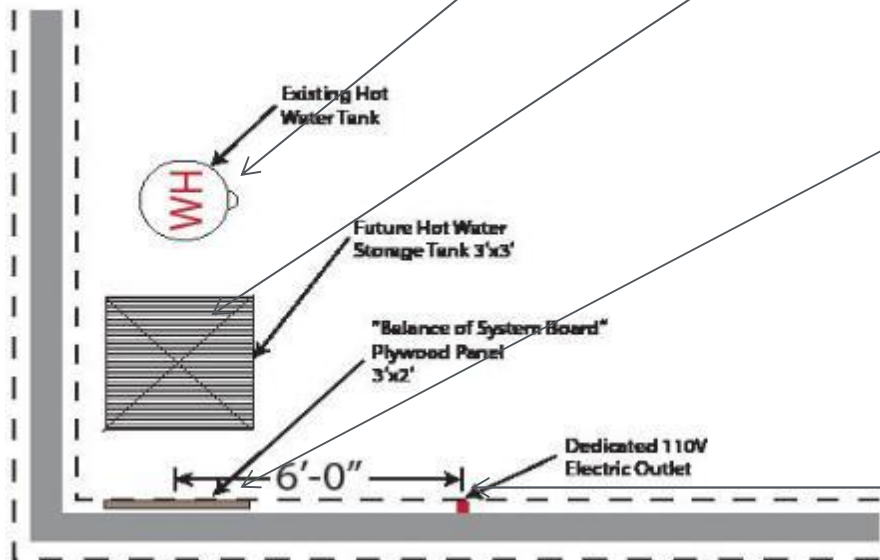
Documentation

of the maximum allowable dead load and live load ratings of the existing roof (Rec DL.: 6 lbs./sq. ft.)

Chases (a single 4" or 2-2") from utility room to the attic space below designated array location. Cap and label both ends.

Solar Hot Water Ready Reqts.*

- * Homes equipped with an **ENERGY STAR** whole-house tankless gas water heater or heat pump water heater are exempt from these requirements.



Solar Bypass Valve

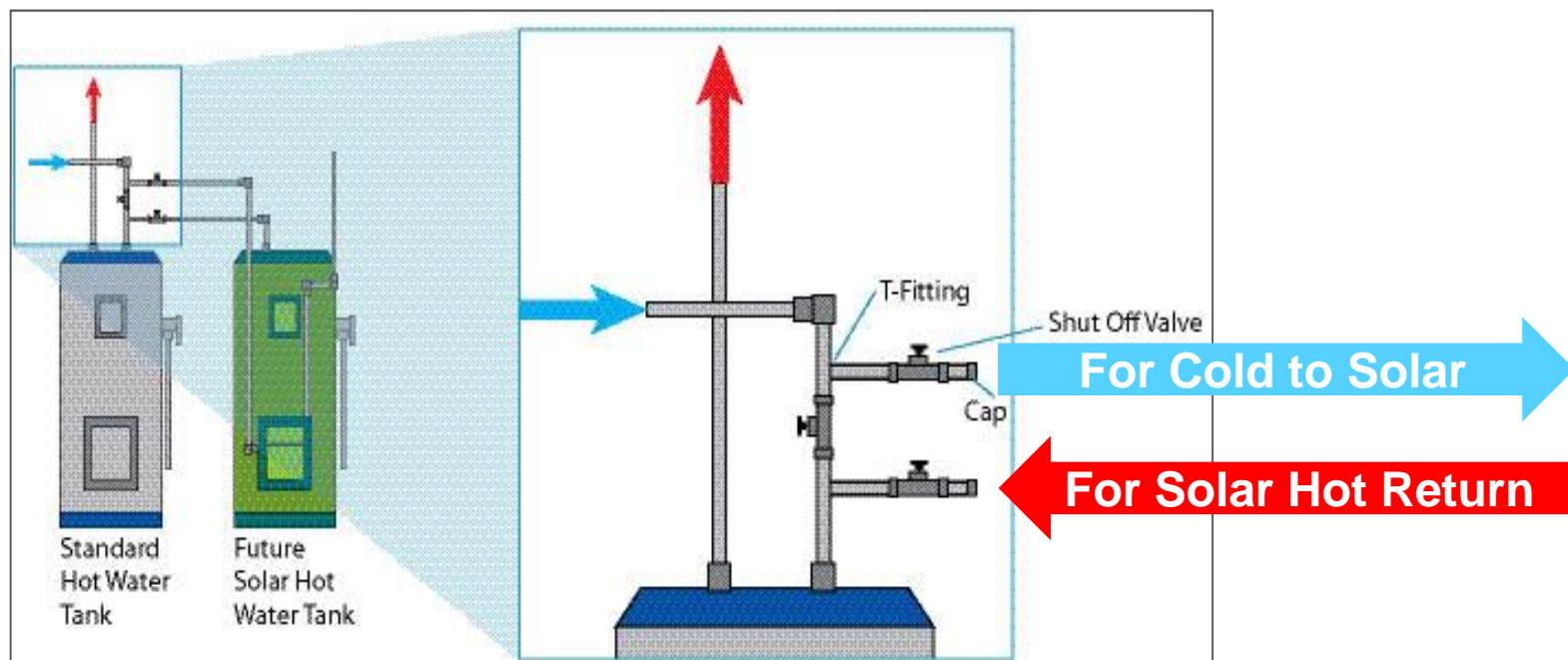
on the cold water feed of the water heater (cap and label both ends).

Dedicated Area (3' x 3' x 7') in the utility room adjacent to the existing water heater for a solar hot water tank.

Dedicated Area (3' x 2' plywood panel) adjacent to the solar hot water tank for the balance of system components/pumping package.

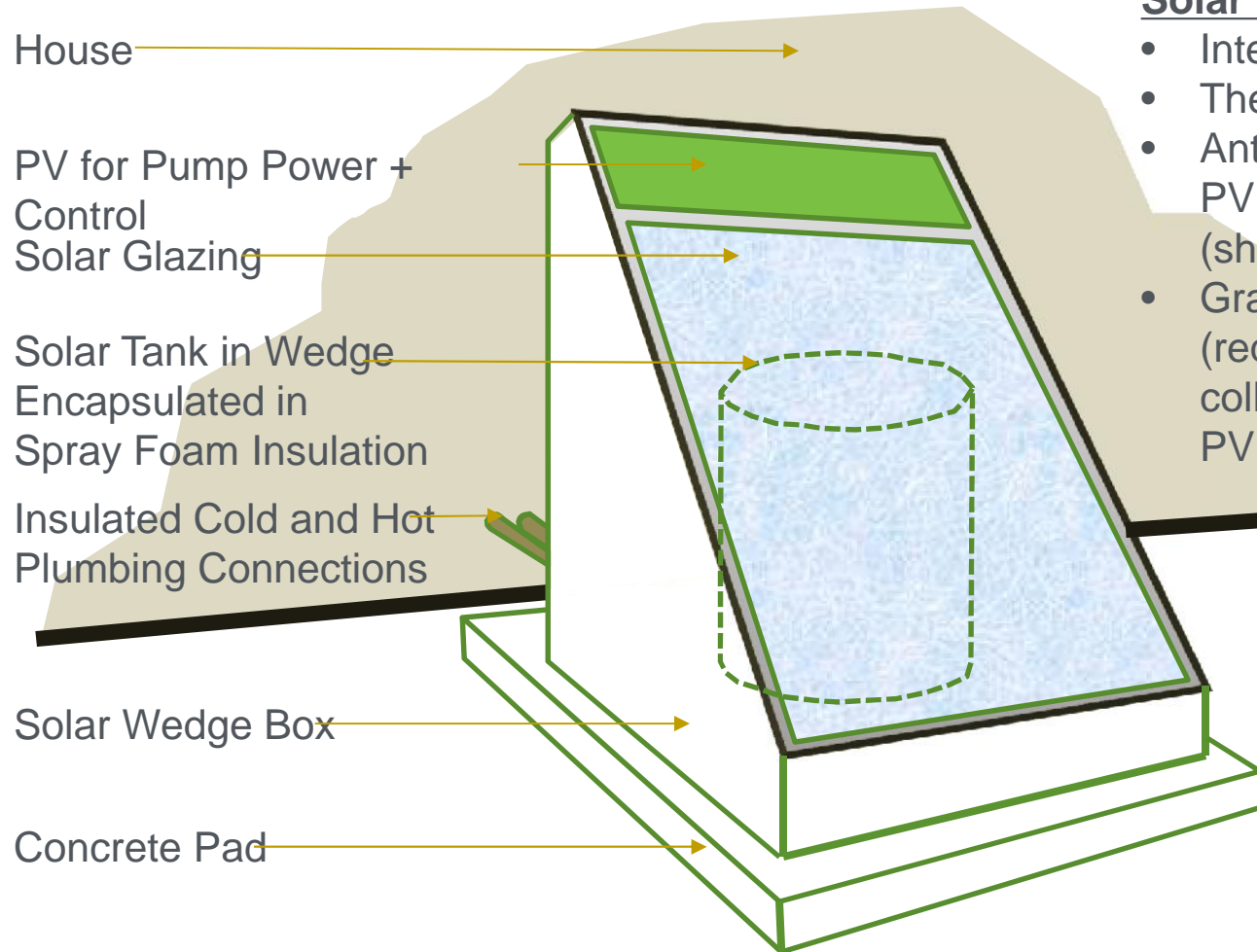
Electrical Outlet within 6' of the designated wall area.

Solar Water Heating Bypass Valve



Above: The cold water feed of the existing water heater should have a code-compliant valve assembly installed to connect to the future solar storage tank. Solar bypass valve assembly includes shut-off valves on each of the stubbed and capped “T” fittings, and one shut off valve in the main pipe between the two “T” fittings.

Low-Cost Solar Hot Water Heater



Solar Design Options:

- Integral Collector/Storage
- Thermo-Syphon
- Anti-Freeze with or without PV Powered Pump/Control (shown)
- Gravity Drain-Down (requires low tank w/higher collector) with or without PV

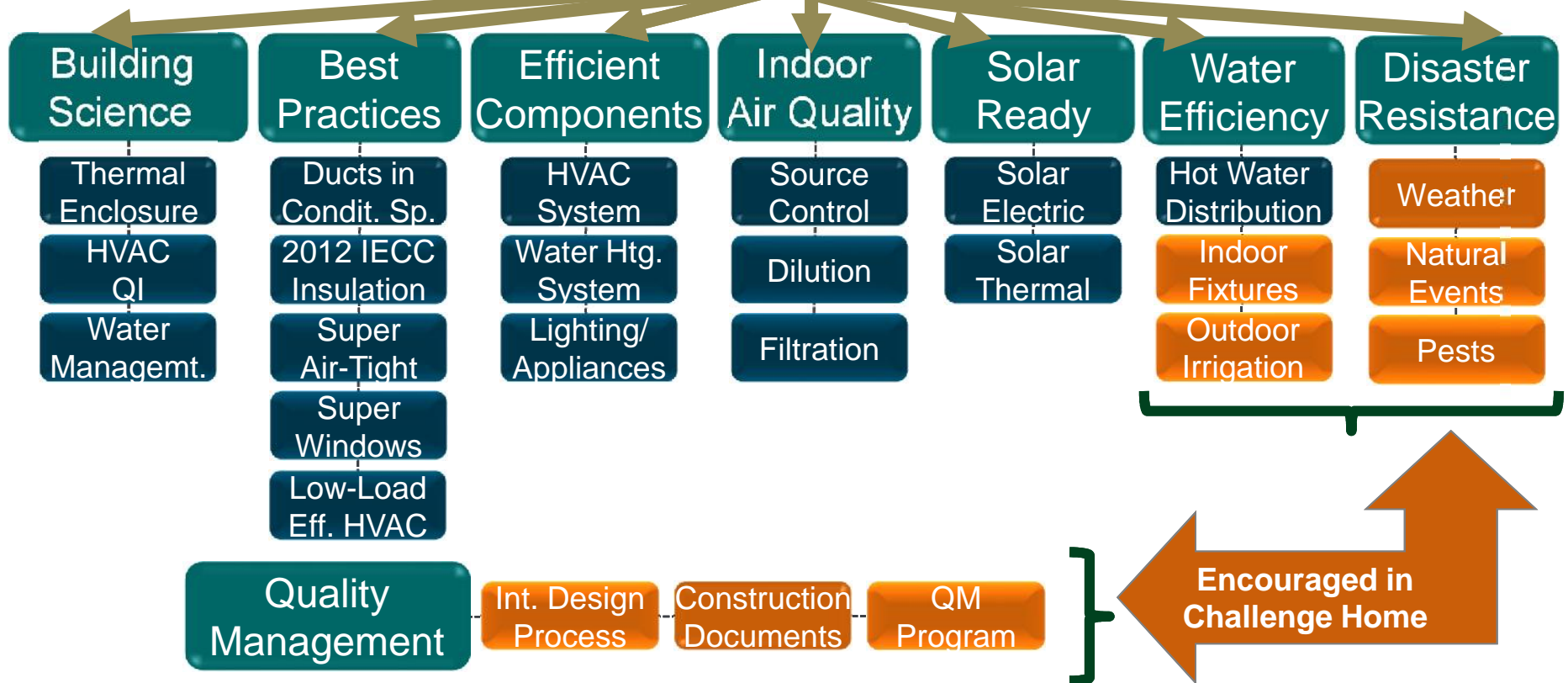
Solar Wedge made in factory. The **only field work** is installing wedge on concrete pad, hooking up hot and cold plumbing lines, and commissioning.



Zero Energy Ready Home

Technical Specifications: Putting It All Together

Zero Energy Ready Home Systems





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			
	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 80% SRF
Insulation and Infiltration			
<ul style="list-style-type: none"> Insulation levels shall meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards. Infiltration²⁰ (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 an additional U-values or SHGCs. ²⁴			
Water Heater			
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.

Washington 'Target Home' Spec

Exhibit 2: DOE Challenge National Home Target Home

Note: Exhibit 2 is for information only. It does not represent a prescriptive path as it does in the National Program. It represents the overall energy performance target for a DOE Challenge Home. ^{5, 21}

HVAC Equipment ²²			
	Hot Climates (2012 IECC Zones 1,2) ²³	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 ²⁴
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% SF
Insulation and Infiltration			
Insulation levels shall meet the 2012 IECC and achieve Grade 1 installation, per RESNET standards.			
Infiltration ²⁵ (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 ^{26, 27}			
	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
Water Heater			
ENERGY STAR minimum; for heating oil water heaters use EF = 0.60			
Thermostat ²⁸			
<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. 			

Higher Eff. HVAC Equip.

2012 vs. 2009 IECC Insul.

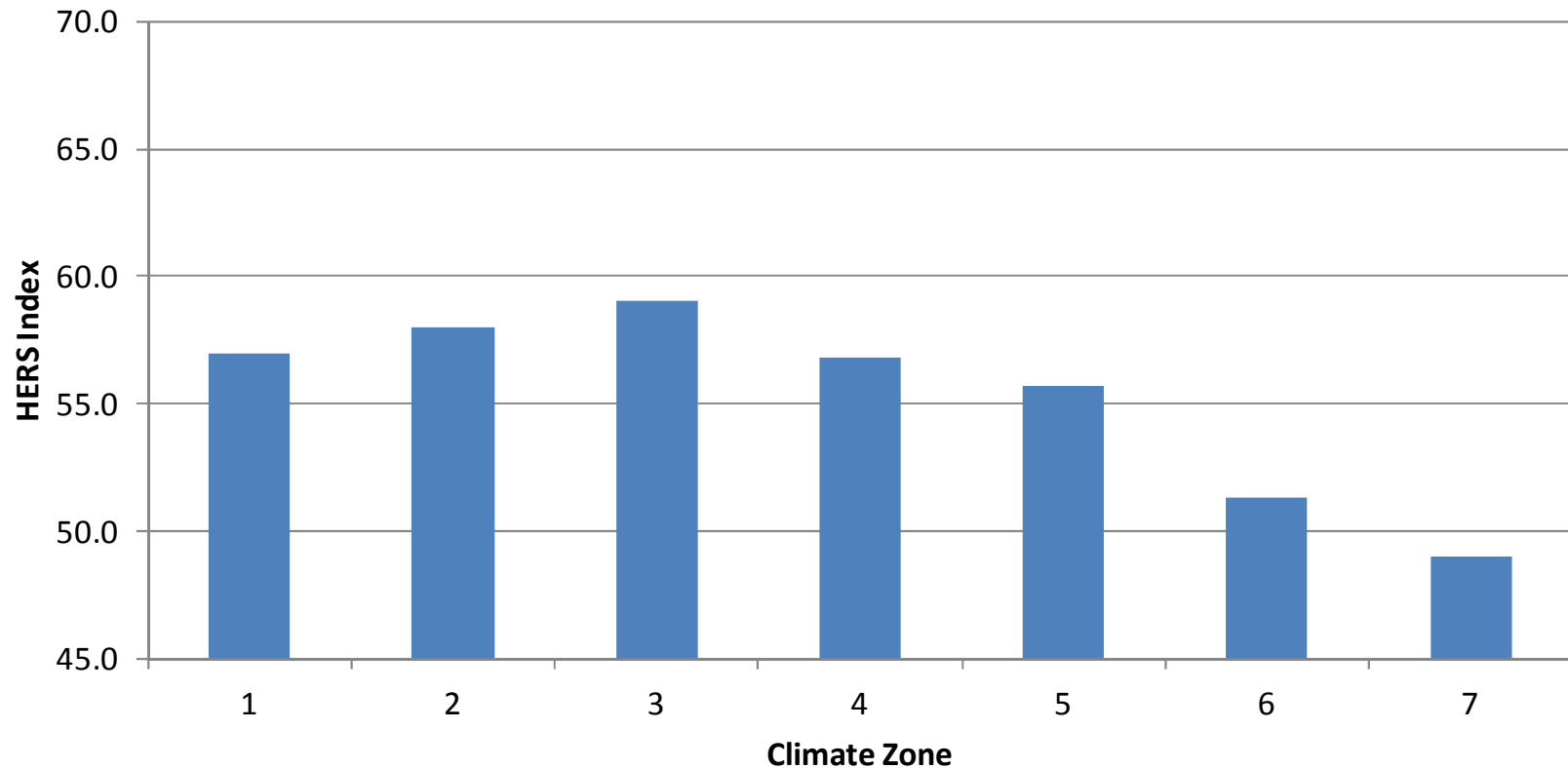
More Eff. Windows

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

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

Exhibit 3: Benchmark Home Size²⁹

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 Challenge Home HERS Index Target Score, but may be used for the incremental HERS Index points needed for the Size Adjustment Factor.

$$\text{Size Mod. Factor} = \left[\frac{\text{CFA}_{\text{Benchmark Home}}}{\text{CFA}_{\text{Home to Be Built}}} \right]^{0.25}$$

[Not to Exceed 1.0]

Performance Path Example CZ4 Prototype - 4 BR, 2400 SF

Specification	Target Home Spec	Design Home
AGW Insulation	R20 or R13+5	R21
Attic Insulation	R49 (U=0.026)	R50
Basement Walls	R10/13	R10
Windows	U=0.30; SHGC=0.27	U=0.30; SHGC=0.27
Infiltration	2.5 ACH50	3.0 ACH50
Ducts	Total \leq 8 CFM25 per 100 SF of CFA; Leakage to outdoors \leq 4 CFM25 per 100 SF of CFA	Total leakage 288 CFM25 Leakage to outdoors 140 CFM25
Furnace AFUE	90	90
A/C SEER	15	15
Whole-House Mech. Vent.	77 cfm; 1.4cfm/W no heat exchange;	77 cfm; 8.0 cfm/W exhaust-only
Water Heater	ENERGY STAR	Gas storage 0.67 EF
HERS Index	52	52 COMPLIES!

- Same: ENERGY STAR Homes framework
- New:
 - Indoor airPLUS Checklist;
 - Renewable Energy Ready Home Checklists (where applicable)
 - Hot Water Distribution test
- Submissions:
 - Send “DOE Challenge Home Verification Summary” electronically to doechallengehome@newportpartnersllc.com
 - Otherwise builders will not receive “credit” on DCH website
 - Considering RESNET National Homes Registry for future

- 1-page checklist
- Builder or Rater may verify
- Permissible methods:
 - Visual verification on site during construction
 - Reviewing photos taken during construction
 - Checking documentation
 - Equivalent methods as appropriate
- Sampling permitted per RESNET protocol

Verifying Hot Water Distribution

1. Initiate operation of occupant-controlled or occupancy sensor-based recirculation systems, if present,
2. Place bucket or flow measuring bag (pre-marked for 0.6 gallons) under the hot water fixture. Only fixture with greatest stored volume of hot water needs to be tested.
3. Turn on hot water; place digital thermometer into the stream of water just where it meets the water being collected; record starting temperature.
4. When water reaches 0.6 gallons record temperatures again. The temperature must increase by 10 F.

Verifying Homes – RERH

- RERH checklist for DOE ZERH Home
- builder or rater may verify



Zero Energy Ready Home **Recognition**

Lots of Recognition Choices...





Independent Voice of Authority vs. “Trust me.”

Nearly 1 in 3 consumers indicated they
do not trust
home building and real estate companies.

Source: The business of Trust – The Most Trusted Builders in America,
Lifestory Research, January 2013



“They didn’t have this [model] when we purchased our home” three doors down the street in October, said Nickiea Youmans, who along with her husband, Linzy, walked into the back yard to check out the house. “We would have been very interested in this,” she added.

- **Review**

- Technical Guidelines
- Partnership Agreement Terms

- **Register**

- Electronically Sign Agreement

- **Choose Optional Commitments:**



100% of homes meet DOE Zero Energy Ready Home Guidelines



Homes meet EPA's WaterSense Guidelines



Homes meet IBHS's Fortified Home Guidelines



Meet DOE Challenge Home Quality Management Program

- **Resources**

- Customizable Homebuyer Brochures
- Branding [Logos, Home Certificates and Labels]
- Electronic Newsletter [updates, policy changes, new innovations]
- Appraisal Guidance**

- **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
- Case Studies/Virtual Parade of Home [coming]

Links Buyers to Leading Edge Builders:

- Contact Information
- Optional Commitments



- # Labeled Homes
- Website link

For All Active Partners

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](#)



ZERH Partner Locator Tool

- Buildings Home
- About
- Emerging Technologies
- Residential Buildings
 - Solar Decathlon
 - Building America
 - Home Energy Score
 - Home Performance with ENERGY STAR
 - Better Buildings Neighborhood Program
- Zero Energy Ready Home
 - Partner Log In
 - Become a Partner
 - Criteria
 - Partner Locator
 - Resources
 - Events
- Housing Innovation Awards
- Guidelines for Home Energy Professionals
- Codes & Standards
- Commercial Buildings
- Appliance & Equipment Standards
- Building Energy Codes

DOE Zero Energy Ready Home: Results

Name	Type	Commitments	City	State	# of DOE Zero Energy Ready Home Projects	# of Builders Challenge Homes
100% Partners						
Boulder ZED Design Build	Builder		Boulder	CO	1	0
Eco Smart Building LLC	Builder		CHICAGO	IL	0	0
Edwards Design Group, Inc.	Builder		SCOTTSDALE	AZ	0	0
Elecyr Corporation	Builder		Dover	NH	0	0
Energy Tech	Builder		CARBONDALE	CO	0	0
Energy Tech Ltd	Builder		CARBONDALE	CO	0	0
GEOS Neighborhood Developer LLC	Builder		BOULDER	CO	0	0
Green Team Real Estate	Builder		FORT COLLINS	CO	0	0
Harrington Construction LLC	Builder		Fort Collins	CO	0	0
Maestic Estate Developers, Inc.	Builder		Wauconda	IL	0	0
Michael Hoggard LLC	Builder		Chesterfield	MO	0	0
Palo Duro Homes, Inc.	Builder		ALBUQUERQUE	NM	152	235
Zero-Energy Plans LLC	Builder		Coupeville	WA	0	1
AquaZephyr, LLC	Builder		Ithaca	NY	11	0
Bensonwood Homes	Builder		Walpole	NH	0	0
Chandler Design-Build	Builder		MEBANE	NC	0	1

CH Housing Innovation Awards

J.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy



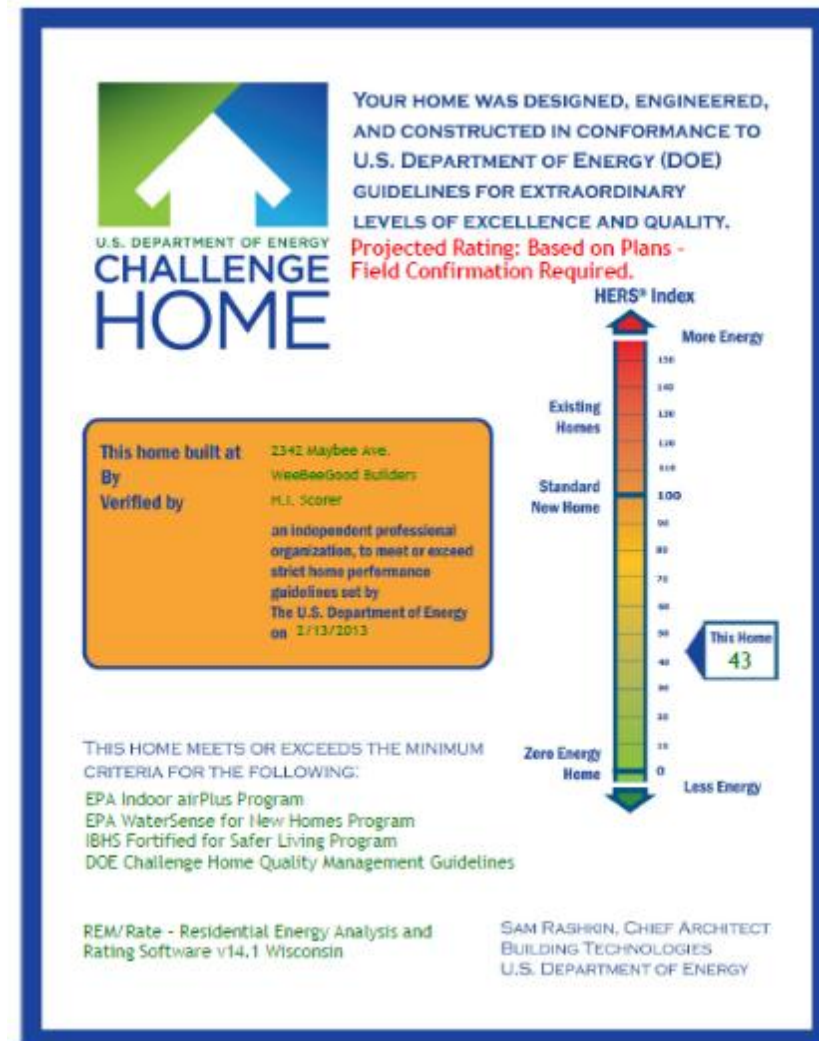
- **Take Orientation Training**
after registering and renew training every year
- **Provide Certificate**
for DOE Zero Energy Ready Home to each home owner
- **Adhere to Brand Identity Guidelines**
for proper use of the DOE Zero Energy Ready Home name and logo
- **Build/Verify at Least One Home/Year**
to maintain active partnership

To view the full Agreement terms and disclaimers, visit:

<http://www1.eere.energy.gov/buildings/zero/>

ZERH Certification Process

- **Rater Prints Certificate**
directly from rating software
- **Certificate Includes:**
 - Rating Details
 - Graphic HERS Index
 - Optional Programs



- **‘Test Drive’ Challenge Home**
[1- 5 homes; most not ready for wholesale change]
Offer Zero Energy Ready Home as *‘Limited Edition’*
- **Measure Profit Metrics:**
 - Cost
 - Marketing
 - Performance
- **High-Performance Looks Different!**
 - Architectural Appearance
 - ‘Mark of Excellence’

Questions?

Thank You



For More Information:

www.buildings.energy.gov/zero/

e-mail Contact:

zero@newportpartnersllc.com



World-Class Expert Guidance...

Building America Solution Center
BASC.energy.gov



...At Your
Fingertips

Building Components

Find how-to Guides and reference documents describing construction techniques for each part of the house.

ENERGY STAR Checklist

Find Guides to help you implement each item on the four ENERGY STAR Version 3 checklists.

Guides Alphabetically

You can also find images, CAD drawings, references, and other resources under **FIND RESOURCES**.

Building Science Publications

Use this information mapping tool to link to hundreds of references from the Building America library and beyond.

BASC Checklist Manager

Building America Solution Center

EERE » BTQ » Building America » Solution Center »

geoff.elliott@pnnl.gov Account Log Out

Solution Center Home

About

FIND YOUR TOPIC BY:

- Building Components
- Guides A-Z
- ▶ Program Checklists
 - ENERGY STAR
 - Challenge Home
 - Indoor airPlus
 - Solar Ready PV
 - Solar Ready Hot Water

RESOURCES:

- References
- CAD Files
- Images
- Case Studies
- Videos
- Presentations

Building Science Publications

Program Checklists



ENERGY STAR Qualified Homes, Version 3 (Rev. 6) Checklist into the Checklist Manager. Additional ENERGY STAR program requirements and information can be found at the [ENERGY STAR Website](#).



DOE Challenge Homes National Program Requirements (Rev. 02). DOE Challenge Home offers both a Prescriptive Path and Performance Path to meet program requirements. Additional Information can be found at the [DOE Challenge Home Website](#).



EPA's Indoor airPLUS Program checklist helps builders construct homes with improved indoor air quality. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Indoor airPLUS Program Website](#).



The Renewable Energy Ready Home Solar Photovoltaic Checklist was designed for builders constructing single family homes with pitched roofs. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Renewable Energy Ready Homes Website](#).



The Renewable Energy Ready Home Solar Water Heating Checklist was designed for builders constructing single family homes with pitched roofs. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Renewable Energy Ready Homes Website](#).

MOBILE FIELD KITS

[Field Kit Number 1 Title](#)
12 items

BASC Checklist Manager

Solution Center Home
Help

FIND YOUR TOPIC BY:

Building Components
Guides A-Z

Program Checklists

- ENERGY STAR
- Challenge Home
- Indoor airPlus
- Renewable Ready


FIND RESOURCES:

- References and Resources
- CAD Files
- Image Gallery
- Case Studies

FIND PUBLICATIONS:

- Building Science Publications

DOE Challenge Home Program Requirements (Rev. 02)



The Building America Solution Center has integrated the DOE Challenge Homes National Program Requirements (Rev. 02) into the Program Checklists. Use the boxes to access specific parts of the Requirements, which have been numbered and titled to be consistent with the DOE Challenge Home National Program Requires. Additional information can be found at the [DOE Challenge Home Website](#).

Exhibit 1: Mandatory Requirements for All Labeled Homes

- 1. ENERGY STAR for Homes Baseline
- 2. Energy Star Qualified Water ENERGY STAR Qualified Homes Version 3.0
- 3. Duct System
- 4. Water Efficiency
- 5. Lighting & Appliances
- 6. Indoor Air Quality
 - EPA Indoor airPLUS Verification Checklist and Construction Specifications
 - Alternative: ENERGY STAR for Homes V3 Water Management System Builder Checklist
- 7. Renewable Ready
 - Consolidated Renewable Energy Ready Checklist

Exhibit 2: Target Home

- HVAC Equipment
- Insulation and Infiltration
- Windows
- Water Heater
- Thermostat
- Lighting & Appliances

Exhibit 3: Benchmark Home Size

- Benchmark Home Size

[Solution Center Home](#)
[Help](#)

FIND YOUR TOPIC BY:

[Building Components](#)
[Guides A-Z](#)

▼ [Program Checklists](#)

[ENERGY STAR](#)

[Challenge Home](#)

[Indoor airPLUS](#)

[Renewable Ready](#)

FIND RESOURCES:

[References and Resources](#)

[CAD Files](#)

[Image Gallery](#)

[Case Studies](#)

FIND PUBLICATIONS:

[Building Science Publications](#)

Indoor airPLUS Qualified Homes Program Requirements



EPA's Indoor airPLUS Program checklist helps builders construct homes with improved indoor air quality. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Indoor airPLUS Program Website](#).

▶ [ENERGY STAR for Homes Baseline](#)

- Thermal Enclosure System Rater Checklist completed.
- HVAC System Quality Installation Contractor Checklist completed.
- HVAC System Quality Installation Rater Checklist completed.
- Water Management System Builder Checklist completed.

▶ [Moisture Control](#)

▶ [Radon](#)

▶ [Pests](#)

▶ [HVAC Systems](#)

▶ [Combustion Pollutants](#)

▶ [Materials](#)

▶ [Final](#)

BASC Checklist Manager

The screenshot shows the 'Building America Solution Center' website. At the top, there is a navigation bar with the U.S. Department of Energy logo and 'Energy Efficiency & Renewable Energy' text. Below this is a search bar with a 'SEARCH' button and links for 'Log In' and 'Register'. The main heading is 'Building America Solution Center'. A breadcrumb trail reads 'EERE > BTO > Building America > Solution Center > Checklists'. The left sidebar contains a 'Component Explorer' with 'Checklist Manager' selected, and sub-items for 'ENERGY STAR', 'Building Science Explorer', and 'Browser'. The 'Browser' section lists: 'Guides', 'CAD Files', 'Case Studies', 'Image Gallery', and 'References'. The main content area is titled 'ENERGY STAR Qualified Homes, Version 3 (Rev. 06)'. It features the Energy Star logo and a paragraph of text explaining the Checklist Manager's purpose. Below the text is a list of four checklist items, each with a right-pointing arrow: 'Thermal Enclosure System Rater Checklist (TES)', 'HVAC System Quality Installation Contractor Checklist (HVAC/C)', 'HVAC System Quality Installation Rater Checklist (HVAC/R)', and 'Water Management System Builder Checklist (WMS)'. An orange arrow points to the first item, 'Thermal Enclosure System Rater Checklist (TES)'. At the bottom of the page, there are links for 'Contact Us', 'Web Site Policies', 'U.S. Department of Energy', and 'USA.gov', along with a 'Content Last Updated: 12/13/2012' notice.

BASC Checklist Manager

The screenshot shows the 'Building America Solution Center' website. At the top, there is a navigation bar with the U.S. Department of Energy logo and 'Energy Efficiency & Renewable Energy' text. Below this is a search bar with a 'SEARCH' button. The main content area is titled 'ENERGY STAR Qualified Homes, Version 3 (Rev. 06)'. On the left, there is a sidebar menu with options like 'Solution Center Home', 'Component Explorer', 'Checklist Manager', 'Building Science Explorer', 'Browser', 'Guides', 'CAD Files', 'Case Studies', 'Image Gallery', and 'References'. The 'Checklist Manager' section is active, displaying a list of checklists. A large orange arrow points to the 'TES 3. Fully-Aligned Air Barriers' item. Below the list, there are links for 'HVAC System Quality Installation Contractor Checklist (HVAC/C)', 'HVAC System Quality Installation Rater Checklist (HVAC/R)', and 'Water Management System Builder Checklist (WMS)'. At the bottom, there is a footer with 'Contact Us', 'Web Site Policies', 'U.S. Department of Energy', 'USA.gov', and 'Content Last Updated: 12/13/2012'.

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

Build America Solution Center

Log In Register

SEARCH

ERE » BTD » Building America » Solution Center » Checklists

Solution Center Home
Component Explorer
Checklist Manager
ENERGY STAR
Building Science Explorer
Browser
Guides
CAD Files
Case Studies
Image Gallery
References

ENERGY STAR Qualified Homes, Version 3 (Rev. 06)

Checklist Manager provides links to technical guides that align with each measure included in the checklists for ENERGY STAR Qualified Homes, Version 3 (Rev. 06). The numbers and titles included in the Checklist Manager follow the same order as the four ENERGY STAR Inspection Checklists for National Program Requirements. To view programmatic footnotes, see the original [www.energystar.gov checklists](#). Portions of the programmatic footnotes have been added to the Scope tabs in the guides. For additional ENERGY STAR program requirements and information, visit the [ENERGY STAR Website](#).

▼ Thermal Enclosure System Rater Checklist (TES)

- ▶ TES 1. High-Performance Fenestration
- ▶ TES 2. Quality-Installed Insulation
- ▶ TES 3. Fully-Aligned Air Barriers
- ▶ TES 4. Reduced Thermal Bridging
- ▶ TES 5. Air Sealing

▶ HVAC System Quality Installation Contractor Checklist (HVAC/C)

▶ HVAC System Quality Installation Rater Checklist (HVAC/R)

▶ Water Management System Builder Checklist (WMS)

Contact Us | Web Site Policies | U.S. Department of Energy | USA.gov

Content Last Updated: 12/13/2012

BASC Checklist Manager

The screenshot shows the 'Building America Solution Center' website. At the top, there is a navigation bar with the 'ENERGY' logo and 'Energy Efficiency & Renewable Energy' text. Below this is a search bar with a 'SEARCH' button. The main content area is titled 'ENERGY STAR Qualified Homes, Version 3 (Rev. 06)'. On the left, there is a sidebar menu with options like 'Solution Center Home', 'Component Explorer', 'Checklist Manager', 'Building Science Explorer', 'Browser', 'Guides', 'CAD Files', 'Case Studies', 'Image Gallery', and 'References'. The 'Checklist Manager' section is active, showing a list of checklist items under the heading 'Thermal Enclosure System Rater Checklist (TES)'. The items are: TES 1. High-Performance Fenestration, TES 2. Quality-Installed Insulation, and TES 3. Fully-Aligned Air Barriers. Under TES 3, there are sub-items for Walls, Floors, and Ceilings. An orange arrow points to the 'TES 3.1.3. Attic knee walls' item.

ENERGY STAR Qualified Homes, Version 3 (Rev. 06)

Checklist Manager provides links to technical guides that align with each measure included in the checklists for ENERGY STAR Qualified Homes, Version 3 (Rev. 06). The numbers and titles included in the Checklist Manager follow the same order as the four ENERGY STAR Inspection Checklists for National Program Requirements. To view programmatic footnotes, see the original [program checklists](#). Portions of the programmatic footnotes have been added to the Scope tabs in the guides. For additional ENERGY STAR program requirements and information, visit the [ENERGY STAR Website](#).

▼ Thermal Enclosure System Rater Checklist (TES)

- TES 1. High-Performance Fenestration
- TES 2. Quality-Installed Insulation
- ▼ TES 3. Fully-Aligned Air Barriers
 - TES 3.1. Walls
 - TES 3.1.1. Walls behind showers and tubs
 - TES 3.1.2. Walls behind fireplaces
 - TES 3.1.3. Attic knee walls
 - TES 3.1.4. Skylight shaft walls
 - TES 3.1.5. Wall adjoining porch roof
 - TES 3.1.6. Staircase walls
 - TES 3.1.7. Double walls
 - TES 3.1.8. Garage rim / band joist adjoining conditioned space
 - TES 3.1.9. All other exterior walls
 - TES 3.2. Floors
 - TES 3.2.1. Floor above garage
 - TES 3.2.2. Cantilevered floor
 - TES 3.2.3. Floor above unconditioned basement or unconditioned crawlspace
 - TES 3.3. Ceilings
 - TES 3.3.1. Dropped ceiling / soffit below unconditioned attic
 - TES 3.3.2. All other ceilings

BASC 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:



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.

BASC Guide: Attic Knee Wall

[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.](#)

Description

Knee walls, the walls that separate conditioned from unconditioned space in an attic, can be a source of significant air leakage if a continuous air barrier is not provided to prevent unconditioned air from flowing under the knee wall and under the floor boards of the attic room. There are two ways to block off this air flow: either a continuous air barrier can be provided from the top of the knee wall down to the attic floor, including the spaces between the attic floor joists from the bottom of the knee wall to the ceiling deck below, or a continuous air barrier can be installed from the top of the knee wall along the attic roofline to the top plate of the home's exterior wall. With either method the air barrier should be installed before installing attic floor insulation to the unconditioned portion of the attic. 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 and adequate support to resist positive and negative pressures without displacement or damage. Air barrier material can include thin sheet goods such as rigid insulation, dry wall, OSB, plywood, or rolled batt insulation that is covered with spray foam. These materials may be installed by insulators, framers, or drywallers. This task should be included in the contract for the appropriate trade depending on the workflow at the specific job site.

Air barrier effectiveness is measured at the whole-house level. High-performance branding programs and the 2009 IECC require that builders meet specified infiltration rates at the whole-house level. See the "compliance" tab for these specified infiltration rates.



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](#)

Description: Provides an explanation of the building topic and in some cases specific “how-to” implementation steps.

[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.](#)

Ensuring Success

Blower door testing, conducted as part of whole-house energy performance testing, may help indicate whether air leakage at knee walls has been successfully sealed. An infrared camera may also be used to determine air leakage at the knee wall, if a sufficient temperature difference exists between the attic and the conditioned space of the house to see the leakage. An experienced technician can also check for air leaks beneath the knee walls with a smoke pencil or by feeling for leaks with the back of the hand.



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](#)

Ensuring Success: Related health, safety, durability, performance issues, test-in/test-out requirements, and scheduling and sequencing considerations.

BASC Guide: Attic Knee Wall

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.

Climate

ENERGY STAR Version 3, (Rev. 6)

Thermal Enclosure Checklist, Fully-Aligned Air Barriers. A complete air barrier shall be provided that is fully aligned with the insulation at exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8.

DOE Challenge Home

Exhibit 2: DOE Challenge Home Target Home. Infiltration (ACH50): Zones 1-2: 3; Zones 3-4: 2.5; Zones 5-7: 2; Zone 8: 1.5. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.



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

Climate: Climate-specific codes, standards, ENERGY STAR, and Challenge Home guidance.

BASC Guide: Attic Knee Wall

Solution Center Home

Attic Knee Walls

Component Explorer

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

Checklist Manager

Building Science Explorer

Browser

Guides

CAD Files

Case Studies

Image Gallery

References

Scope Description Ensuring Success Climate **Training** CAD Compliance More Info.

Right and Wrong Images



Presentations

None Available

Videos



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

Training: resources such as Right and Wrong/ Sequencing installation images.

COMING: Videos and presentations

BASC Guide: Attic Knee Wall

[Solution Center Home](#)

[Component Explorer](#)

[Checklist Manager](#)

[Building Science Explorer](#)

[Browser](#)

[Guides](#)

[CAD Files](#)

[Case Studies](#)

[Image Gallery](#)

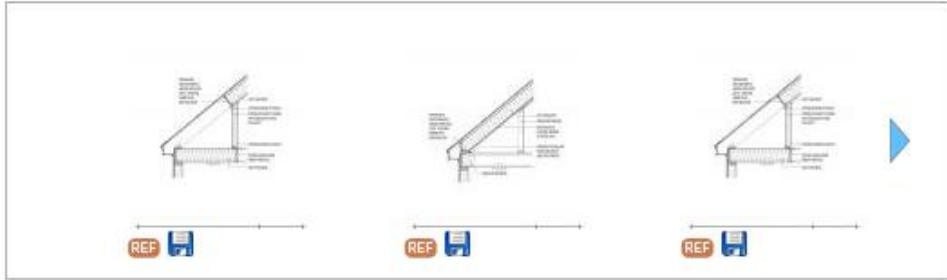
[References](#)

Attic Knee Walls

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

Scope Description Ensuring Success Climate Training **CAD** Compliance More Info.

CAD Images



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](#)

CAD: Architectural CAD files of the building topic in DWG and PDF forms.

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.

Compliance

ENERGY STAR Version 3, (Rev. 6)
Thermal Enclosure Checklist, Fully-Aligned Air Barriers. A complete air barrier shall be provided that is fully aligned with the insulation at exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8. All insulated vertical surfaces are considered walls (e.g., above and below grade exterior walls, knee walls) and must meet the air barrier requirements for walls, with the exception of adiabatic walls in multifamily dwellings.

DOE Challenge Home
Exhibit 2: DOE Challenge Home Target Home. Certified under ENERGY STAR Qualified Homes Version 3. Infiltration (ACH50): Zones 1-2: 3; Zones 3-4: 2.5; Zones 5-7: 2; Zone 8: 1.5. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol. Building envelope assemblies, including exterior walls and unvented attic assemblies (where used), shall comply with the relevant vapor retarder provisions of the 2012 International Residential Code.

ASTM E1677-11
Standard Specification for Air Barrier (AB) Material or System for Low-Rise Framed Building Walls. This specification covers minimum performances and specification criteria for an air barrier material or system for framed, opaque walls of low-rise buildings. The provisions are intended to allow the user to



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

Compliance: Specific compliance references/links from applicable codes and standards.

Solution Center Home

Attic Knee Walls

Component Explorer

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

Checklist Manager

Building Science Explorer

Browser

Guides

CAD Files



Case Studies

Image Gallery

References

Scope Description Ensuring Success Climate Training CAD Compliance More Info.

Case Studies

- David Weekley Homes: Eagle Springs & Waterhaven, Houston, TX**
PNNL. 2012. Building America Case Study: David Weekley Homes, Eagle Springs & Waterhaven, Houston, TX, PNNL-SA-87333, prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy.
[Link to Document](#) 
- Tommy Williams Homes: Longleaf Village & Belmont, Gainesville, FL**
PNNL. 2012. Building America Case Study: Tommy Williams Homes, Longleaf Village & Belmont, Gainesville, FL, PNNL-SA-87331, prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy.
[Link to Document](#) 

References

- 2009 IECC—International Energy Conservation Code**
2009 IECC, *International Energy Conservation Code*. International Code Council, Washington.



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](#)

- More Info:**
- References - Full citations with links for content
 - Case Studies - Whole-house best practices
 - Resources - Relevant info not previously cited

BASC Browser Image Gallery



- Click an image to enlarge in a sliding window.

Step Two: Specify Green Appraiser

In many markets you are eligible to specify with the lender that you will only accept an appraiser from the Certified Green Residential Appraiser List. These appraisers have been trained to recognize the value of high-performance home improvements in your DOE Challenge Home.

Valuation of Sustainable Buildings: Residential 6/12/18 8:54 PM

Home | Join | Media | Help | Search

Need Help? Call 888-7.JOIN.1A (756-4624)

All Resources | Find an Appraiser | Education | Publications / Store | Professional Practice | Loan Library | News / Advocacy | About Us

Home > Find an Appraiser > Professional Development Program Registry > Valuation of Sustainable Buildings: Residential

Find an Appraiser

Professional Development Program Registry Valuation of Sustainable Buildings: Residential

NOTE: This Registry only lists Appraisal Institute Designated Members who have successfully passed the Valuation of Sustainable Buildings Professional Development Program examinations.

There may be other qualified Appraisal Institute Designated members, Candidates for Designation, or Practicing Affiliates who may handle green/sustainability assignments but have not taken the Valuation of Sustainable Buildings Professional Development Program. Visit the [Find an Appraiser Directory](#) to find Designated members, Candidates for Designation, or Practicing Affiliates who have identified green/sustainability as a specialty.

[View Program FAQs](#)

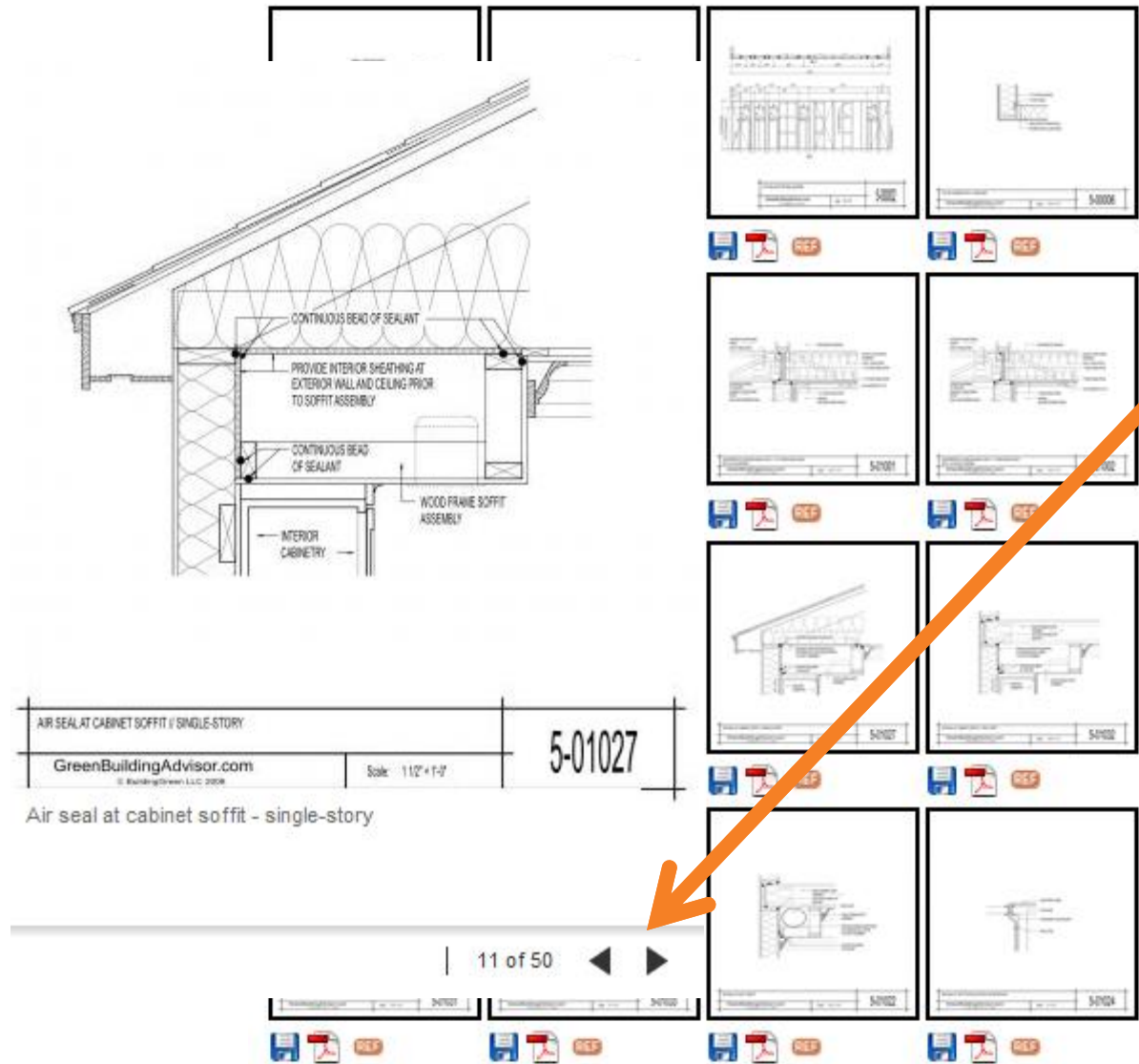
Please read this notice regarding Professional Development Programs

* Has not completed the Residential and Commercial Valuation of Solar courses. Those on the registry have until May 1, 2014 to complete Residential and Commercial Valuation of Solar to remain on the registry.

Select State/Province:

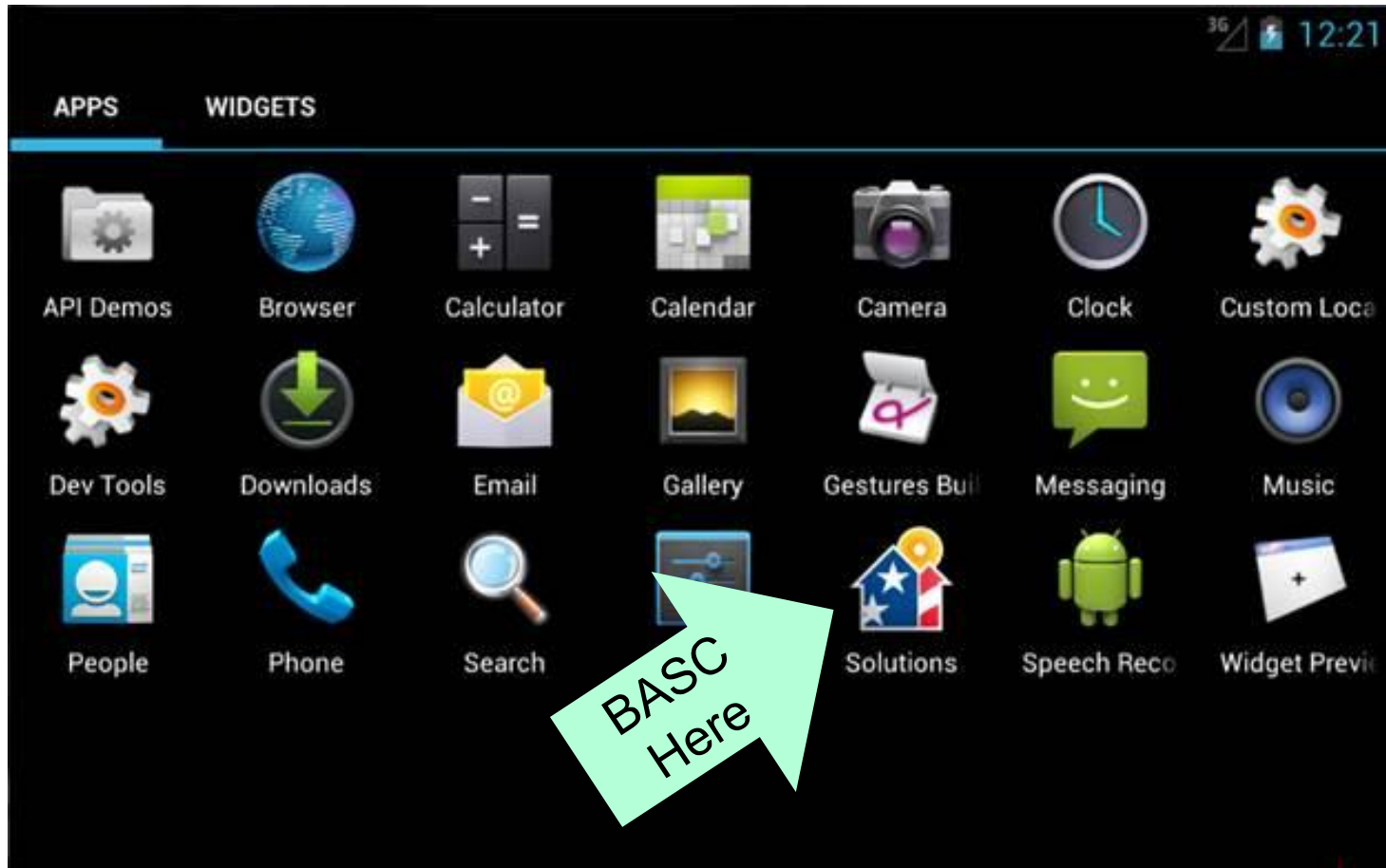
Name	Company	City, State	Accepts Fee Assignments
SELECT Sandra K. Adams, SRA	Atlanta Appraisal Service	Planta Grande, FL	Yes
SELECT John T. Ashworth, Sr. SRA*	Ashworth Appraisal Services	Auburn, CA	Yes
SELECT Robert D. Blouin, MN*	Principal Real Estate Investors	Des Moines, IA	Yes
SELECT David P. Stouten, SRA*	Key Appraisal Services	Sarasota, FL	Yes
SELECT Donald N. Briggs, MAE, SRA	Briggs Associates, Inc.	Erembsburg, MD	Yes
SELECT Thaddeus W. Chapman, MN	Sustainable Values, Inc.	Park City, UT	Yes
SELECT Lynn M. Christensen, SRA*	Lynn Christensen Appraising Inc.	Layton, UT	Yes
SELECT Steven D. Clauson, MAJ	Real Estate Science, Inc.	Washington, DC	Yes
SELECT Michael D. Collins, SRA*	J.P. Morgan Chase	Tampa, FL	No
SELECT Benjamin B. Davidson, MN*	Stable and Associates, LLC	Carlsbad, CO	Yes
SELECT Lisa K. Deermann, SRA*	Peak to Peak Appraising, LLC	Springfield, CO	Yes
SELECT Christopher S. Dubois, MN*		Salt Lake, NJ	Yes
SELECT Lamar H. Ellis, II, SRA*		Atlanta, GA	Yes
SELECT Anthony L. Green, Jr., NM*	Real Property Consultants, Inc.	Clark, NJ	Yes
SELECT Kaven L. Gulberti, MA*	Wells Fargo Bank - RETECHS	St. Petersburg, FL	Yes
SELECT Franckin Federico Giffie, SRA*	Giffie Real Estate & Appraisals	Tampa, FL	Yes
SELECT Steven L. Hahn, SRA*	Residential Appraisal Services, LLC	Ogden, UT	Yes
SELECT Margaret A. Hamblin, SRA*	Hamblin, Inc.	Columbus, OH	Yes
SELECT Christopher T. Hansen, MN*	Appraisal Group, Inc.	Meriden, UT	Yes
SELECT Michael R. Hesch, SRA*	Michael Hesch Real Estate Appraisal, Inc.	Las Vegas, NV	Yes
SELECT Craig S. Heston, SRA*	C. S. Heston Appraisals, Inc.	Mesa, AZ	Yes
SELECT Robert D. Hestley, MA*	CB Richard Ellis, Inc.	Warren Creek, CA	Yes
SELECT Janel L. Heston, SRA*	Real Property Analytical/Gulf Coast	Tampa, FL	Yes
SELECT Michael Hulse, SRA	Fabrizio Appraisal & Consultancy	Chicago, IL	Yes
SELECT Daniel J. Houlton, MA*	Houlton & O'Malley Real Estate Services	Brownville, NY	Yes
SELECT Richard W. Hughes, MN, SRA*		Adel, IA	Yes
SELECT Anthony C. Inacio, MN*	State & Inacio LLC	Marlton, NY	Yes
SELECT Shane Ingram, SRA*	State Ingram Appraisal Group, Inc.	Self Lake City, UT	Yes
SELECT Mary A. Jewell, SRA*	Morgan Stanley	Tampa, AZ	No
SELECT Jeffrey R. Jorgensen, SRA*	Jorgensen Residential Appraisal	Draper, UT	Yes

BASC Browser Cad Files

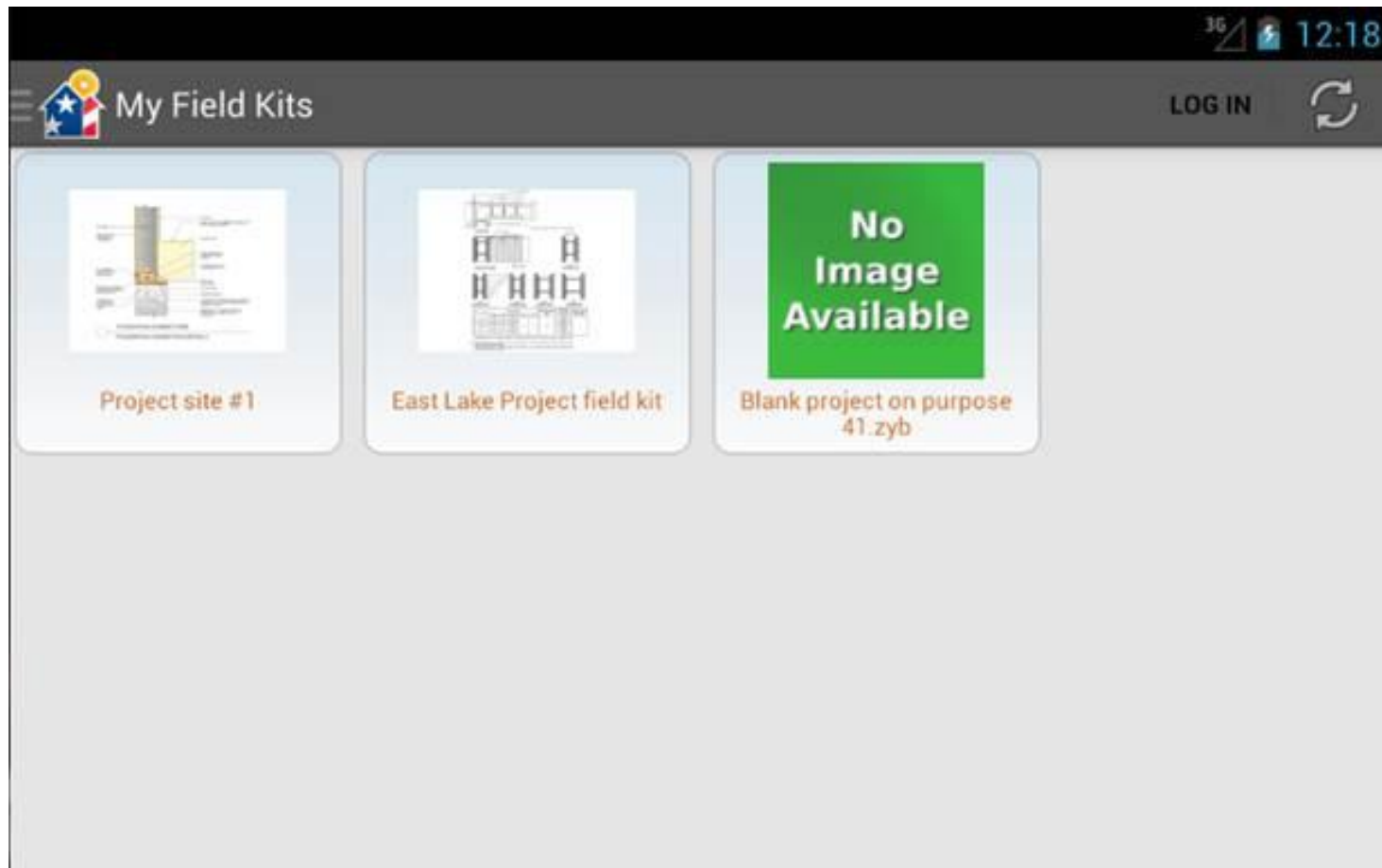


- Click the CAD file image to load in a slider window.

BASC Mobile Application



BASC Mobile Application





DOE Zero Energy Ready Home

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



The Appraisal Process: Be Your Own Advocate

SAM RASHKIN
Chief Architect
Building Technologies Program

Step One: Document 3rd-Party Certification

A wide array of programs qualify as green or energy efficient including the DOE Challenge Home. Use the DOE Challenge Home Verification Form to document compliance with the program.

DOE Challenge Home Verification

Projected Rating: Based on Plans - Field Confirmation Required.

Energy Performance	
House Type	DOE Challenge Home Builder Partner ID#
Single-family detached	12345
Year built	Square footage of Conditioned Space including Basement
2013	3968.0
Number of Bedrooms	Square footage of Conditioned Space without Basement
4	2368.0
Site address (if not available, list the site Lot #)	Registered Builder
555 Main Street	
Cold City	Certified Rater
MN, 20853	
HERS Index without On-site Generation	Date of Rating
46	
HERS Index with On-site Generation	Rating Software
46	REM/Rate - v14.2
HERS Index of the Target Home using size adjustment factor	Estimated annual energy costs(\$)
46	1172
Estimated annual energy use	Estimated annual energy savings
Electric: 10825 kWh \ Natural Gas: 773 Therms	Electric: 4081 kWh \ Natural gas: 1175 Therms
Energy cost rates	Estimated annual emissions reductions
Electric: 0.08 \$/kWh \ Natural Gas: 0.50 \$/Therm	CO2: 10.2 tons / SO2: 16.4 lbs / NOx: 31.2 lbs

DOE Challenge Home Certification

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

<input checked="" type="checkbox"/>	Compliance with all ENERGY STAR Qualified Homes Version 3 requirements and checklists
<input checked="" type="checkbox"/>	Compliance with Mandatory Fenestration Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Insulation Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Duct Location Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Appliance Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Lighting Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Fan Efficiency Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Indoor Air Quality Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Renewable Energy Ready Solar Electric Requirements
<input checked="" type="checkbox"/>	Compliance with Mandatory Renewable Energy Ready Solar Hot Water Requirements
	This home was qualified via sampling in lieu of testing, in accordance with allowable sampling provisions as stated in the DOE Challenge Home National Program Requirements

Optional Compliance for Builder Recognition

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

YES	NO	DONT KNOW	Optional Home Builder Commitments for Recognition
<input checked="" type="checkbox"/>			Certified under the EPA Indoor airPLUS Program*

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


REM/Rate - Residential Energy Analysis and Rating Software v14.2
This information does not constitute any warranty of energy cost or savings.
© 1985-2013 Architectural Energy Corporation, Boulder, Colorado.

Step Three: Complete Green Appraiser Form

Download Appraisal Institute Form 820.04: Residential Green and Energy Efficient Addendum from:

www.appraisalinstitute.org/education/green_energy_addendum.aspx

Complete the form and provide a copy to the lender as guidance to for including all DOE Challenge Home improvements in the final report.

 Form 820.04*	Client File #:	Appraisal File #:
	Residential Green and Energy Efficient Addendum	
Check Use Date: _____ Subject Property: Circle Date: _____ State: USA Zip: 12345 City/Town: _____		
Additional resources to call in the valuation of green attributes and the completion of this form can be found at: http://www.appraisalinstitute.org/education/green_energy_addendum.aspx		
The appraiser hereby certifies that the information provided within this addendum: <ul style="list-style-type: none"> has been conducted in the appraisal development of the appraisal of the subject property only for the client and intended user(s) identified in the appraisal report and only for the intended use stated in the report. is not provided by the appraiser for any other purpose and should not be relied upon by parties other than those identified by the appraiser as the client or intended user(s) in the report. is the result of the appraiser's visible inspection of and inquiries about the subject property's green and energy efficient features. Reasonable assumptions have been made to the extent that it is not possible to inspect or measure the features. is not made as a representation or as a warranty as to the efficiency, quality, location, operability, reliability or cost savings of the appraised items or of the subject property in general, and this addendum should not be relied upon for such assessments. 		
Green Building: The practice of creating structures and using processes that are resource-efficient throughout a building's lifecycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. The practice expands and complements the classic building design concerns of economy, utility, durability, and comfort. High Performance Building and green building are often used interchangeably.		
Six Elements of Green Building: A green building has attributes that fall into the six elements of green building known as (1) site, (2) water, (3) energy, (4) materials, (5) indoor air quality, and (6) environmental operation. A Green Building will be energy efficient but an energy efficient building is not synonymous with Green Building.		
Green Features The following items are recorded within the appraised value of the subject property.		
Certification DOE Challenge Home: <input type="checkbox"/>	Year Certified: 2015	Certifying Organization: <input type="checkbox"/> Home Innovation Research Labs (ICC-ICC) <input type="checkbox"/> International Brotherhood of Builders (IBB) <input type="checkbox"/> Other: _____
Rating Certified: _____	Score: N/A	LEED Certified: <input type="checkbox"/> LEED Silver <input type="checkbox"/> LEED Gold <input type="checkbox"/> LEED Platinum ICC-ICC Alliance Green Building Standard Certified: <input type="checkbox"/> Emerald <input type="checkbox"/> Silver <input type="checkbox"/> Gold <input type="checkbox"/> Emerald Green Building Organization (GBO) (web site: www.gbo.org)
Additions	Explain any additions or changes made to the structure since it was certified: N/A	
	Do changes require recertification to verify rating is still applicable? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Comments Attach the rating requirement that provides the ratings for each element to provide a better understanding of the features. The worksheet will assist in comparing the subject to other rated by different organizations.	If a property is built green but not formally certified, a cost/benefit analysis and analysis to value the features. The market analysis is of the structure's physical, economic, and locational attributes and not an analysis of its listed items.	
The objective of this Addendum is to standardize the communication of the high performing features of residential properties. Identifying the features not found on the 2004 form provides a basis for comparable selection and analysis of the features. Builders, contractors, homeowners, and third party verifiers are encouraged to complete this Addendum and present to appraisers, agents, lenders, and homeowners.		

Residential Green and Energy Addendum

Client:	Joe Doe	Client File #:	
Subject Property:	Climate Zone 5	Appraisal File #:	

ENERGY EFFICIENT ITEMS			
The following items are considered within the appraised value of the subject property:			
Insulation	<input type="checkbox"/> Fiberglass Blow-In <input checked="" type="checkbox"/> Foam Insulation <input type="checkbox"/> Cellulose <input type="checkbox"/> Fiberglass Batt Insulation		R-Value:
	<input checked="" type="checkbox"/> Basement Insulation (Describe): High Density SPF		<input type="checkbox"/> Walls: 35 <input type="checkbox"/> Ceiling: 49 <input type="checkbox"/> Floor: 30
Envelope	Envelope Tightness: 1.25 <input type="checkbox"/> CH20 <input type="checkbox"/> CH50 <input checked="" type="checkbox"/> ACH50 <input type="checkbox"/> ACH100		
	Envelope Tightness based on Blower Door Test		
Water Efficiency	<input type="checkbox"/> Recirculated Water System (Boiler): <input type="checkbox"/> Green - Shower <input type="checkbox"/> Toilet		Location of cistern:
	<input type="checkbox"/> Waterless urinal system <input type="checkbox"/> Rain Water: Ponds/Loggation		
Windows	<input checked="" type="checkbox"/> ENERGY STAR <input type="checkbox"/> Low E <input type="checkbox"/> High Impact <input type="checkbox"/> Storm <input type="checkbox"/> Double Pane <input type="checkbox"/> Triple Pane <input type="checkbox"/> Tinted <input type="checkbox"/> Solar Shades		
	<input type="checkbox"/> Skylight <input type="checkbox"/> Solar Tubes <input type="checkbox"/> Other (Explain): <input checked="" type="checkbox"/> ENERGY STAR Light Fixtures		
Appliances	<input checked="" type="checkbox"/> ENERGY STAR Appliances:		Appliance Energy Source:
	<input checked="" type="checkbox"/> Dishwasher <input checked="" type="checkbox"/> Heat Pump <input type="checkbox"/> Tankless <input type="checkbox"/> Coil <input type="checkbox"/> Other (Explain):		<input type="checkbox"/> Propane <input checked="" type="checkbox"/> Electric <input checked="" type="checkbox"/> Natural Gas
HVAC (Describe in Comments Area)	<input checked="" type="checkbox"/> High Efficiency HVAC SEER: 14 <input type="checkbox"/> Heat Pump Efficiency Rating:		<input type="checkbox"/> Thermostat/Controls <input type="checkbox"/> Passive Solar (Defined in Glossary)
	<input type="checkbox"/> ATU: 95 <input type="checkbox"/> COP: <input type="checkbox"/> Tankless Water Heater <input type="checkbox"/> Geothermal		
Energy Rating	<input checked="" type="checkbox"/> ENERGY STAR Home - Version: 3		
	<input type="checkbox"/> Other (Describe): Home Energy Score (HES) (Score range 1-10): 4B <input type="checkbox"/> Certification Attached		
Indoor Air Quality	<input checked="" type="checkbox"/> Indoor Air PLUS Package <input type="checkbox"/> Energy Recovery Ventilator Unit or Whole Building Ventilation System <input type="checkbox"/> Non-Fossil Fuel Combustion		
HERS Information	Rating: 46	Monthly Energy Savings on Rating: \$ 18.50	Date Rated: 5/15/13
Utility Costs	Average Annual Utility Cost: \$ 141 per month based on: REM/Rate # of Occupants: 4		
Energy Audit (N/A)	<input type="checkbox"/> Informal Photograph Attached Has an energy audit/rating been performed on the subject property? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Unknown If yes, comment on work completed as result of audit.		
Comments (Include source for information provided in this section)	Information was provided by: Rater's Name and Company Attach REMRate reports, filled out checklists for EPA Indoor airPLUS, EPA renewable ready home solar electric and EPA renewable ready home solar thermal		
Additional documents or references that in your records			
The energy document is the most reasonable statement of green or high performance building.			

*NOTES: The Appraisal Institute publishes this form for use by appraisers when the appraiser deems use of the form appropriate. Depending on the assignment, the appraiser may need to provide additional data, analysis and work product not called for in this form. The Appraisal Institute plays no role in completing, filing or disseminating any responsibility for the data, analysis or any other work product submitted by the individual appraiser.
 A. MAPPING AND/OR HISTORICAL DATA AND ENERGY EFFICIENCY ADJUSTMENT © Appraisal Institute 2013. All rights reserved. January 2013

Client:	Joe Doe	Client File #:	
Subject Property:	Climate Zone 5	Appraisal File #:	

Solar Panels					
The following items are considered within the appraised value of the subject property: RENEWABLE READY HOME					
Description	N/A	Array #1	<input type="checkbox"/> Leased <input type="checkbox"/> Owned	Array #2	<input type="checkbox"/> Leased <input type="checkbox"/> Owned
Size (sqft)					# Active System - type <input type="checkbox"/> Direct <input type="checkbox"/> Indirect
Manufacturer of Panels					# Passive System - type <input type="checkbox"/> Integral collector <input type="checkbox"/> Thermosiphon
Warranty on Panels					Storage Tank Size # Gallons:
Age of Panels					Collector Type <input type="checkbox"/> Flat-Plate Collector <input type="checkbox"/> Integral Collector <input type="checkbox"/> Concentration-Table Solar
Energy Production kWh per Array					Back-Up System <input type="checkbox"/> Conversion of Water Hk <input type="checkbox"/> Tankless On Demand <input type="checkbox"/> Tankless Hot Water
Source for Energy Production Estimate					Age of System
Location (Roof, Ground, Etc.)					Warranty Term
TH/Allow for Array					Manufacturer
Arrests per Array					Solar Energy Factor (SEF) (Rating range 1 to 11 - higher number is more efficient)
Age of Inverter(s)					
Manufacturer					
Warranty Term					
Name of Utility Company	Cost per kWh charged by Company: \$ /kWh				
Comments (Discuss incentives available for new panels, condition of current panels, and any maintenance issues. If leased, provide the lease terms.)	Discuss source of information and define other renewable energy sources, such as wind, hydropower, biomass power, etc. This home is renewable ready for solar electric and thermal.				
A free online tool and manual for estimating the energy production of the Solar PV System is available at www.nrel.gov/irec					
Download the PV Value SM Manual for implementation of this solar form on this form and inputs used in the PV Value tool.					

*NOTES: The Appraisal Institute publishes this form for use by appraisers when the appraiser deems use of the form appropriate. Depending on the assignment, the appraiser may need to provide additional data, analysis and work product not called for in this form. The Appraisal Institute plays no role in completing, filing or disseminating any responsibility for the data, analysis or any other work product submitted by the individual appraiser.
 © Appraisal Institute 2013. All rights reserved. January 2013

Residential Green and Energy Addendum

Client:	Joe Doe	Client File #:	
Subject Property:	Clinton Zone 5	Appraisal File #:	

Location - Site	
The following items are considered within the appraised value of the subject property:	
Walk Score N/A	Score: http://www.walkscore.com/
Public Transportation	<input type="checkbox"/> Bus - Distance: <input type="checkbox"/> Block <input type="checkbox"/> Train - Distance: <input type="checkbox"/> Block <input type="checkbox"/> Subway - Distance: <input type="checkbox"/> Block
Site	Orientation - Front Face: <input type="checkbox"/> East/West <input checked="" type="checkbox"/> North/South Landscaping: <input type="checkbox"/> Worst Efficient <input type="checkbox"/> Natural
Comments	DOE Challenge Home certification concentrates only on the actual physical building and its high performance aspects.

Incentives - Amount of Incentive and Terms	
The following items are considered within the appraised value of the subject property:	
Federal	
State	
Local	
Source	(For example www.doherty.org)
Comments	Incentives affect cost and should be reported in the cost approach section of the report. Incentives are typically not a sales completion approach consideration since they do not transfer with the property.

Completed by:	<u>Builder or Rater</u>	Date:	<u>5/15/13</u>
	<u>GC or Rater</u>	Date:	

NOTE: To provide additional data, analysis and more context, we added to the form. The Appraisal Institute places the sole responsibility for the data, analysis of any other work product provided by the individual appraiser. © Appraisal Institute 2013. All Rights Reserved. January 2013

Client:		Client File #:	
Subject Property:		Appraisal File #:	

Residential Green and Energy Efficient Addendum Glossary and Resources

ICC 700 National Green Building Standard (NGBS) An ASHRAE approved residential green building standard developed by the National Association of Home Builders (NAHB) and the International Code Council (ICC). It is applicable to single and multifamily projects, renovations and additions and residential land development. To comply, all buildings must incorporate sustainable design practices such as cost address energy, water & natural resource efficiency and indoor environmental quality. Also, all projects must be educated about building operation and maintenance, certification to the NGBS is provided by the Home Innovation Research Labs. <http://www.nahb.org/page.aspx?pageid=2310> or <http://www.icccodes.org/icc700/>

LEED Leadership in Energy and Environmental Design is redefining the way we think about the places where we live, work and learn. As an internationally recognized mark of excellence, LEED provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. <http://www.usgbc.org/DisplayPage.aspx?pageid=1588>

Energy Star® ENERGY STAR certified new homes must meet strict energy efficiency guidelines set by the U.S. Environmental Protection Agency. These homes are independently verified to be at least 15% more energy efficient than homes built to the 2009 International Energy Conservation Code (IECC), and feature additional measures that deliver a total energy efficiency improvement of up to 30 percent compared to typical new homes and even more compared to most resale homes. http://www.energy.gov/eere/buildings/energy_star_homes.html

Home Energy Score (HES) - The Home Energy Score is similar to a vehicle's mile per gallon rating. The Home Energy Score allows homeowners to compare the energy performance of their homes to other homes in the area. It also provides homeowners with suggestions for improving their home's efficiency.

The process starts with a home energy assessor collecting energy information during a brief home walk-through. The assessor then scores the home on a scale of 1 to 10, with a score of 10 indicating that the home has excellent energy performance. A score of 1 indicates that the home needs extensive energy improvements. In addition to providing the score, the home energy assessor provides the homeowner with a list of recommended energy improvements and the associated cost savings estimates. http://www.energystar.gov/building/what_is_hes

HERS Index - The Home Energy Rating System (HERS) Index is the industry standard by which a home's energy efficiency is measured. It's also the nationally recognized system for inspecting and calculating a home's energy performance. http://www.energystar.gov/building/what_is_hers_index

Building Envelope - The building envelope is everything that separates the building's interior from the exterior. This includes the foundation, exterior walls, roof, doors and windows.

Geothermal - A geothermal heat pump uses the constant below ground temperature of soil or water to heat and cool your home. <http://energy.gov/eere/buildings/geothermal-heat-pumps>

Low-E - Low emittance indicates a coating is added to the glass surface. The coating allows visible light to pass through the glass while stopping the radiant heat energy from the sun and heat sources in the building from passing through the glass. Approximately 40% of the sun's harmful solar visible rays are blocked and insulated enhanced.

Whole Building Ventilation System - A whole building ventilation system enables a controlled movement of air in tight envelope construction and may include air-purifying systems. Whole building ventilation equipment is often a part of the forced air heating or cooling systems.

Energy Recovery Ventilation System - Often called Heat Recovery Ventilator (HRV). These systems replenish the indoor air without wasting all the energy already used to heat the indoor air. In some climates, these systems can also used to handle water vapor in the incoming air.

Passive Solar - Passive solar is technology for using sunlight to light and heat buildings with no circulating fluid or energy conversion system. http://www.energystar.gov/building/what_is_passive_solar

SEER - Seasonal energy efficiency ratio - The higher the SEER rating, the more energy efficient the equipment is. A higher SEER can result in lower energy costs. http://www.energystar.gov/building/what_is_seasonal_energy_efficiency_ratio

Water Sense - EPA released its Final Version 1.1 WaterSense New Home Specification. This specification will be effective January 1, 2013 and will allow the criteria for new homes labeled under the WaterSense program and is applicable to newly constructed single-family and multi-family homes. http://www.epa.gov/watersense/new_home_spec_final.html

Water Heaters - Solar, Heat Pump, Tankless On-Demand or Tankless Coil water heaters are described at the following location: http://energy.gov/eere/buildings/water_heaters

Green Building Organizations - A partial list of organizations can be found at: <http://www.usgbc.org/ShowFile.aspx?DocumentID=2001>

HERS Innovation Network Rating - Rating 1 is the best with 3 the lowest rating. http://www.energystar.gov/building/what_is_hers_innovation_network_rating

SAFE Act - The SAFE Act is proposed legislation to improve the accuracy of mortgage underwriting used by Federal mortgage agencies by requiring that energy costs are included in the underwriting process. <http://www.fca.gov/Enforcement-and-Regulatory/SAFE-Act>

NOTICE: The Appraisal Institute publishes this form for use by appraisers when the appropriate terms and conditions apply. It is the appraiser's responsibility to ensure the appraiser's use of this form is appropriate. Declaring to use the Appraisal Institute's form does not constitute an endorsement of the form, analysis or any other work product provided by the individual appraiser. © Appraisal Institute 2013. All Rights Reserved. January 2013

