DOE Zero Energy Ready Home



Energy Efficiency & Renewable Energy



Zero Energy Ready Home Training

SAM RASHKIN Chief Architect Building Technologies Office

For More Information

U.S. DEPARTMENT OF EI

Energy Efficiency & Renewable Energy



For More Information:

www.buildings.energy.gov/zero/

e-mail Contact:

doechallengehome@newportpartnersllc.com

Outline

Zero Energy Ready Home:



Part I:

- Definition
- Value Proposition
- Business Case

Part II:

- Technical Specifications
- Recognition w/Challenge Home
- Local Solution



Energy Efficiency & Renewable Energy



Zero Energy Ready Home Definition

Zero Definition Concept



Energy Efficiency & Renewable Energy

Energy Efficiency First

Ensure High-Performance

Renewable Last

Zero Starts with the Enclosure

U.S. DEPARTMENT OF ENERGY Rer

Energy Efficiency & Renewable Energy

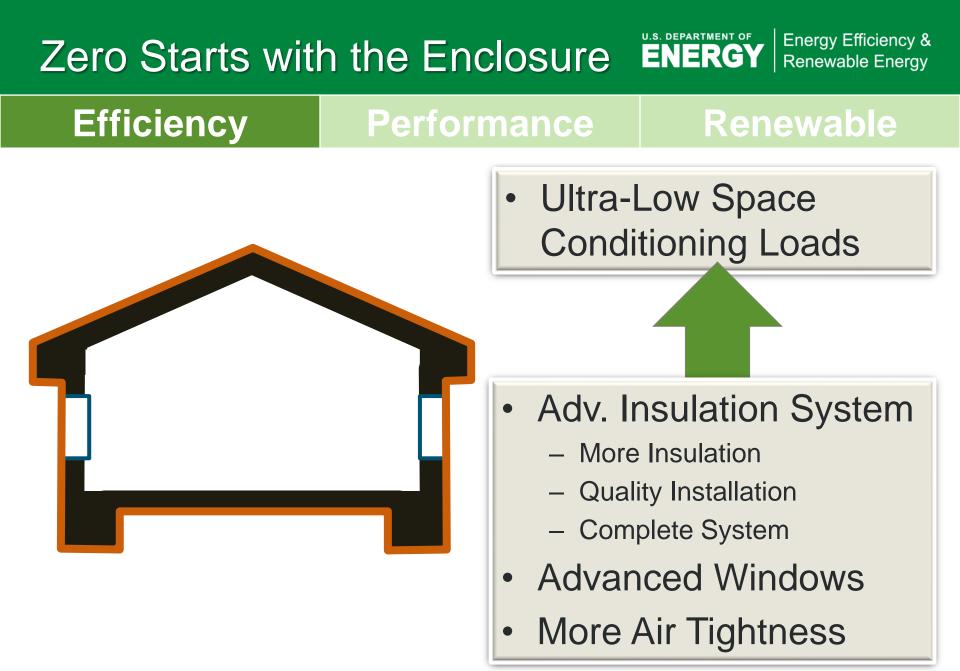
Efficiency

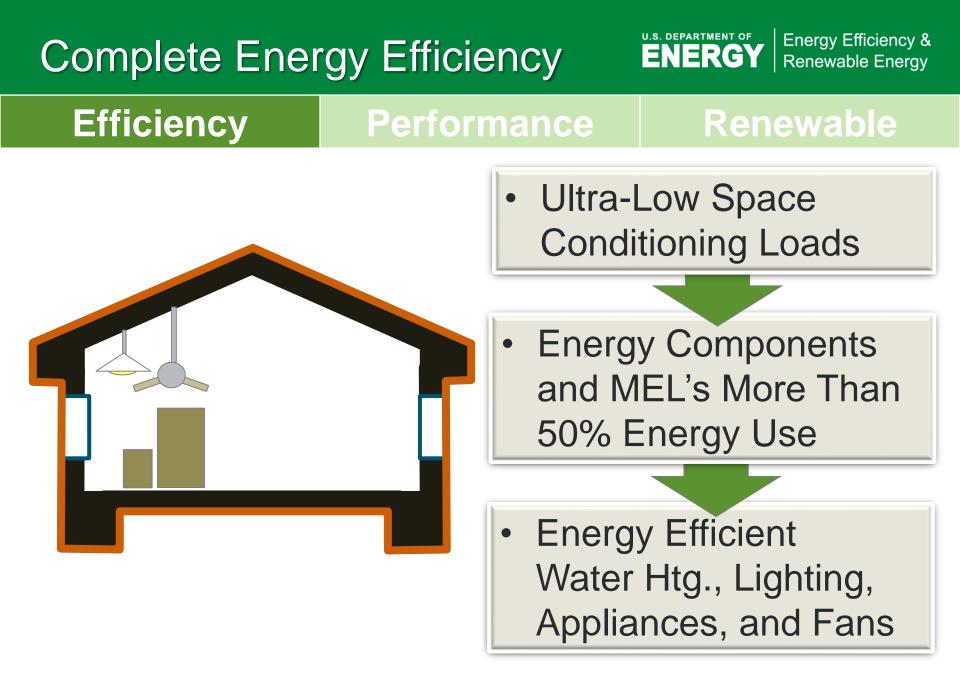
Performance

Renewable

- More Rigorous Codes
- Rising Energy Costs
- Consumer Demand
- Adv. Insulation System
 - More Insulation
 - Quality Installation
 - Complete System
- Advanced Windows
- More Air Tightness







Renewable Opportunity

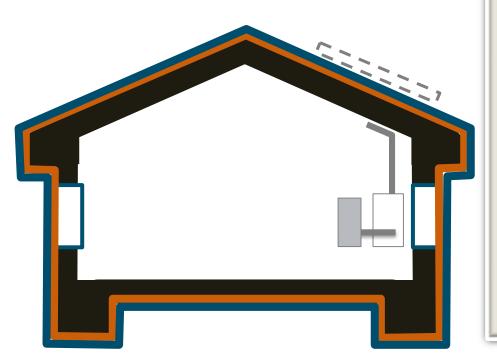


Energy Efficiency & Renewable Energy

Efficiency

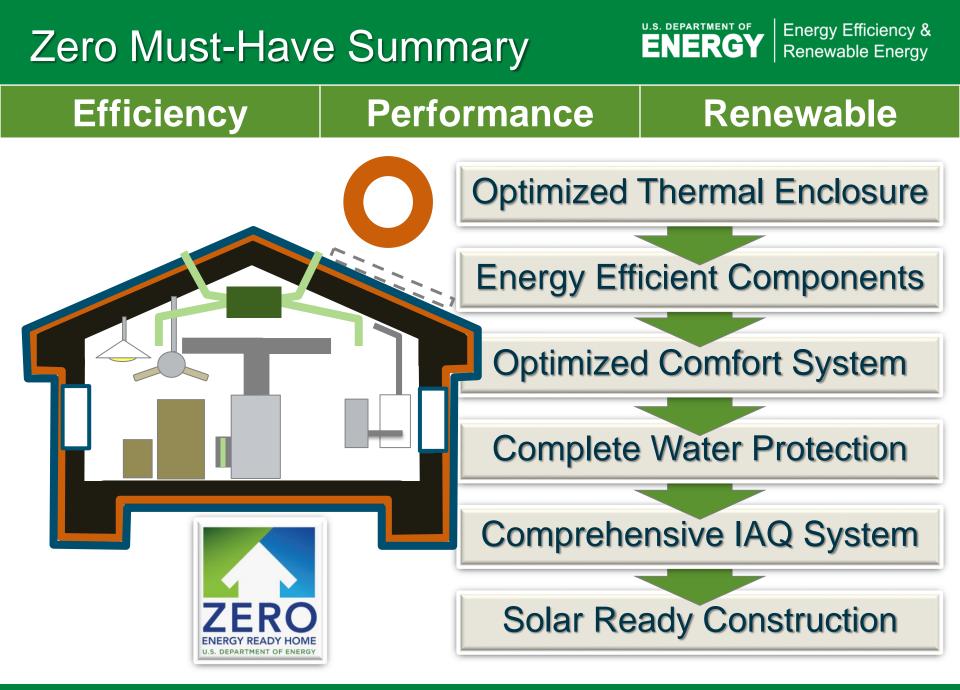
Performance

Renewable



- 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





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



Energy Efficiency & Renewable Energy



Zero Energy Ready Home Value Propositions



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.



Energy Efficiency & Renewable Energy

What's Missing in Green Definition

Complete Systems that Ensure Bankable Value Propositions

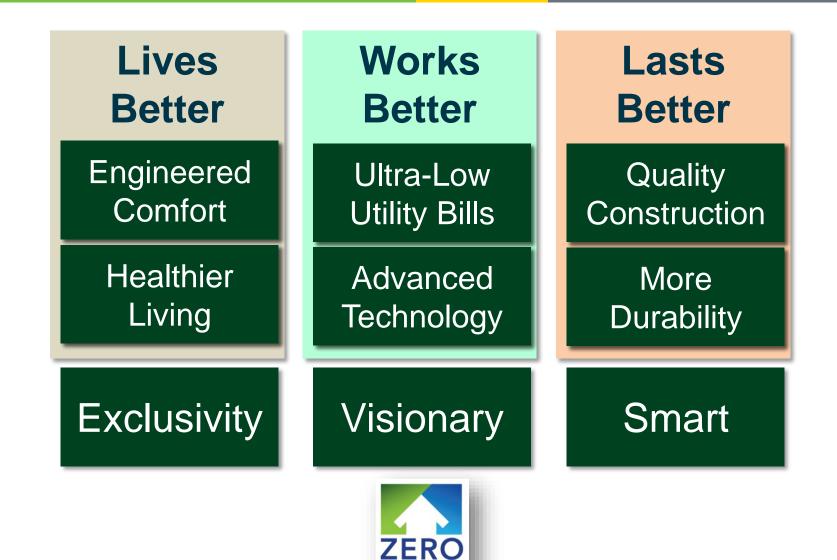
What's Included in Zero Energy Ready Definition



DOE ZERH Bankable Value



Energy Efficiency & Renewable Energy



Translating ZERH Value Proposition **ENERGY**

Energy Efficiency & Renewable Energy

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.

88	
сом	FORT PLUS
	NCED TECHNOLOGY
JLTR	A EFFICIENT
-	
	LITY BUILT
-	
DURA	BILITY
KEY	DOE Zero Energy Ready Home
	ENERGY STAR® Certified Home
	Existing Home



NEW SE TOWN

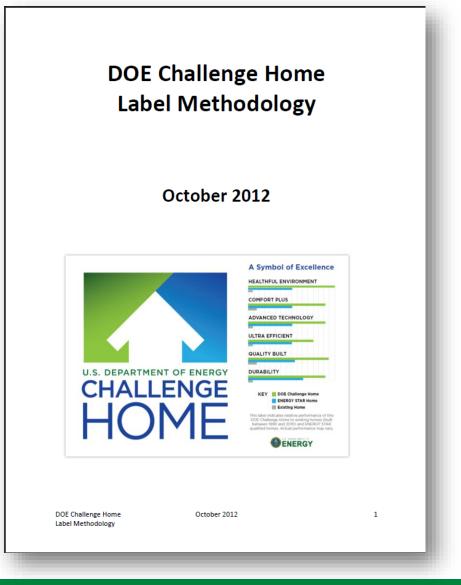
303-231-4567 NewTown@net.com 123 Main Street. Denver. CO 34567

STAR Certified Homes. Actual performance may vary.

Value Proposition Transparency



Energy Efficiency & Renewable Energy



Translating ZERH Value Proposition **ENERGY** Rene

Energy Efficiency & Renewable Energy

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ADVANCED TECHNOLOGY ULTRA EFFICIENT DUALITY BUILT	HEALTHFUL ENVIRONMENT	
ADVANCED TECHNOLOGY		
DULTRA EFFICIENT	COMFORT PLUS	_
DULTRA EFFICIENT		
DUALITY BUILT	ADVANCED TECHNOLOGY	
DUALITY BUILT		
DURABILITY	JLTRA EFFICIENT	
DURABILITY	22	
EY DOE Zero Energy Ready Home	QUALITY BUILT	
EY DOE Zero Energy Ready Home	anness.	
	DURABILITY	
ENERGY STAR® Certified Home	KEY DOE Zero Energy Ready Home	
	ENERGY STAR® Certified Home	

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.



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Energy Efficiency & Renewable Energy

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 Proposition **ENERGY**

Energy Efficiency & Renewable Energy



Excellence

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



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 worldclass 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.

LEARN MORE AT: buildings.energy.gov/zero



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.

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.



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A Symbol of Excellence

HEALTHFUL ENVIRONMENT

ADVANCED TECHNOLOGY
ULTRA EFFICIENT
QUALITY BUILT
DURABILITY

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Front Cover

Inside Spread

Flap



Translating ZERH Value Proposition **ENERGY** Renew

Energy Efficiency & Renewable Energy

New Town Builder; NEW Lives Better: Healthful Environment NEW

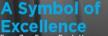
· Fresh Air:

- 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 Proposition **ENERGY**

Energy Efficiency & Renewable Energy





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A Symbol of Excellence

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Front Cover

Inside Spread

Flap



Translating ZERH Value Proposition **ENERGY**



30 | INNOVATION & INTEGRATION: Transforming the Energy Efficiency Market

Energy Efficiency & Renewable Energy

Translating ZERH Value Proposition **ENERGY** Renewable Energy **Ce youg 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

CERTS GAN AND ELECTRIC COMPANY VINNE THE RESERVE STATEMENT Invite Reserved to 10.000 to August 0.3000 (Theory productions for WHI to The WHI)

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



Energy Efficiency & Renewable Energy



Zero Energy Ready Home Business Case

U.S. DEPARTMENT OF

Energy Efficiency & Renewable Energy

"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"

More Informed Consumers



Energy Efficiency & Renewable Energy

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



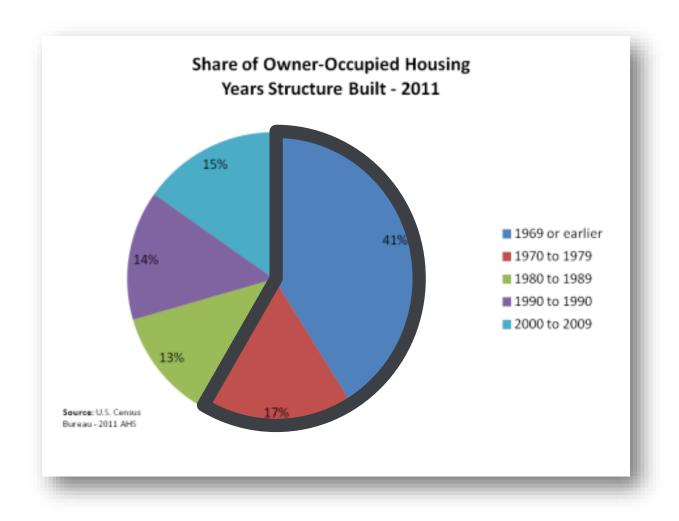
Home-shopping consumers are not only exponentially increasing their reliance on the Internet but are also developing distinct patterns for using it in their housing searches. Google and the National Association of

Aging Housing Stock

U.S. DEPARTMENT OF

Energy Efficiency & Renewable Energy

Change Information Innovation



Aging Housing Stock

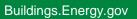
Change

Existing Homes = Innovation Opportunity

Information

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

Meet 85% of Your Competition





Innovation



New Innovation Business Model: Exceed Customer Expectations

New 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"

Innovation Graveyard

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Energy Efficiency & Renewable Energy

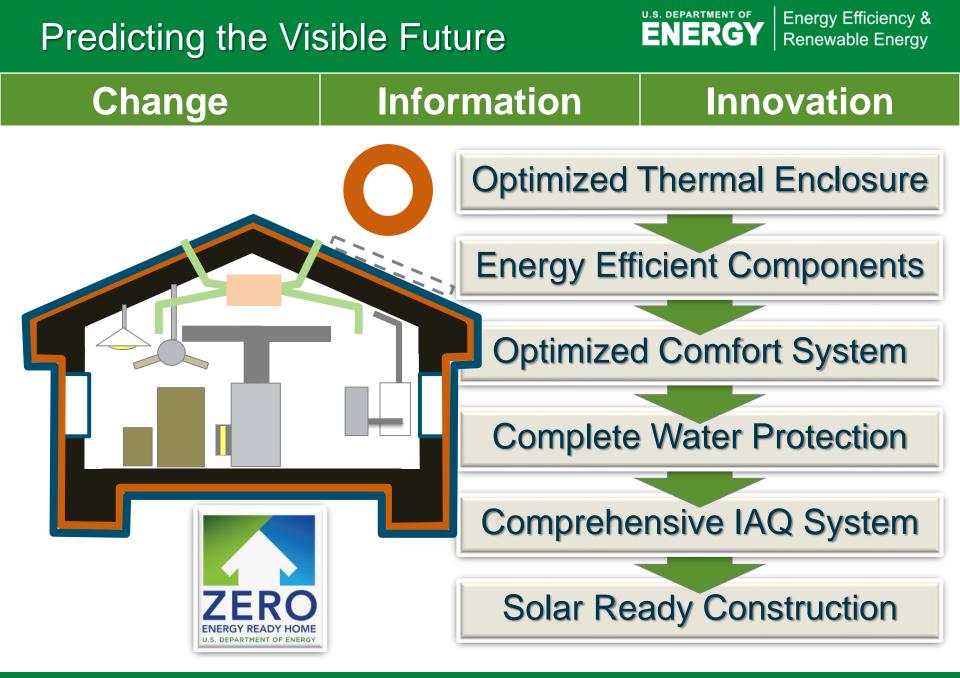
Change

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



Energy Efficiency & Renewable Energy

Change

Information

Innovation

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**



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**



Minimize Cost

NAHB estimates for every **\$1,000 increase** in sales price, nearly **250,000 households** fail to qualify for a mortgage on a typical new home.

[http://www.nahb.org/fileUpload_details.aspx?contentTypeID=3&contentID=40372&subContentID=112293]



Maximize Value

with proven innovations homebuyers have to have once they try them (e.g., make new housing compelling again).

ZERH 'Brand' Recognition



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Independent Voice of Authority vs. "Trust me."

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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



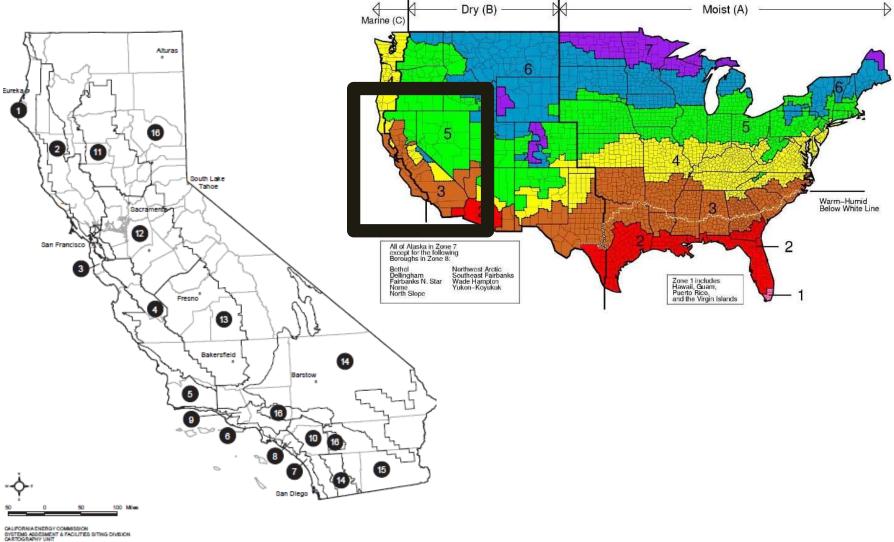


Zero Energy Ready Home Technical Specifications

California vs. IECC Climate Zones

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Energy Efficiency & Renewable Energy



SYSTEMS ASSESSMENT & FACILITIES SITING DIVE GARTOGRAPHY UNIT MARCH 2005





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 CA Framework

U.S. DEPARTMENT OF

Energy Efficiency & Renewable Energy

	Exhibit 1: DOE Cha	Illenge Home Mandato	ry Requirements for A	II Labeled Homes	
	Area of Improvement	Mandatory Require	ments		1
	1. ENERGY STAR for Homes Baseline	Certified under ENERO requirements for the S	GY STAR Qualified Homes V itate of California ^{i, ii}	ersion 3 program	
Mandatory	2. Envelope ⁱⁱⁱ	California 2013 Buildir	et or exceed latest ENERGY ng Energy Efficiency Standar ver is more stringent ^{iv, v}		
Regts.	z. Livelope	or California 2013 Bui	slab insulation shall meet or ding Energy Efficiency Stand 150.1-A, <i>whichever is more</i> s	dards insulation	Must
incqus.	3. Duct System	Ducts located within the	e home's thermal and air bar	rrier boundary ^{vii}	Comply
	4. Water Efficiency	Hot water delivery syst	ems shall meet efficient desi	gn requirementsviii	
	5. Lighting &	STAR qualified.	rs, dishwashers, and clothes		·
	Appliances ^{ix}	lamps (bulbs) in minim			
	6. Indoor Air Quality		ventilation and ceiling fans an erification Checklist and Con	•	
			gy Ready Home Solar Electric	•	
	7. Renewable Ready ^{xi}		gy Ready Home Solar Therm	al Checklist and	
	8. Air Infiltration	achieve air infiltration	nes 1-16, must be tested ^{Errort} evels at or below: 3 ACH50 for attached single-family dv	for single family detached	
'Target	Exhibit 2: DOE Challenge	Home Target Home for	Performance Option (A)	(or Prescriptive Option)	
	HVAC Equipment ⁱ		1 ()	<u>, , , , , , , , , , , , , , , , , , , </u>	Trade-Off
Home'		Hot Climates	Mixed Climates	Cold Climates	Trade-Off
Specs		(2012 IECC Zones 1,2) ⁱⁱ	(2012 IECC Zones 3, 4 except Marine)	(2012 IECC Zones 4 Marine 5,6,7,8)	Flexibility
Specs	AFUE	80%	90%	94%	
	SEER	18	15	13	Y.
	HSPF Geothermal Heat Pump	8.2 ENE	9 RGY STAR EER and COP C	10 ⁱⁱⁱ	1
	ASHRAE 62.2 Whole-	1.4 cfm/W;	1.4 cfm/W:	1.2 cfm/W;	1
	House Mechanical Ventilation System	no heat exchange	no heat exchange	heat exchange with 60% SRE	
	Insulation and Infiltration				
	 Insulation levels shall me Infiltration^{iv} (ACH50): in IECC CZ 8 	eet the 2012 IECC and achiev 3 in IECC CZ's 1-2		ESNET standards. 2 in IECC CZ's 5-7 1.5	
	Windows ^{v, ,vi, vii}				
		Hot Climates (2012 IECC Zones 1,2,)	Mixed Climates (2012 IECC Zones 3,	Cold Climates (2012 IECC Zones	
		(2012 1200 20103 1,2,)	4 except Marine)	4 Marine 5,6,7,8)	
	SHGC	0.25	· · · · ·	4 Marine 5,6,7,8) any	
Size Adjust.	SHGC U-Value		4 except Marine)		Identical to
Size Adjust.	U-Value	0.25 0.4 Exhibit 3: Benchi	4 except Marine) 0.27 0.3	any	Identical to
Size Adjust. Factor		0.25 0.4 Exhibit 3: Benchi suilt 0	4 except Marine) 0.27 0.3	any 0.27 5 6 7	Identical to Energy Star



Energy Efficiency & Renewable Energy



Zero Energy Ready Home **Technical Specifications Mandatory Requirements:**

CA Mandatory Requirements



Are	ea of Improvement	Mandatory Requirements
1.	ENERGY STAR for Homes Baseline	 Certified under ENERGY STAR Qualified Homes Version 3 program requirements for the State of California^{i, ii}
2.	Envelope ⁱⁱⁱ	 Fenestration shall meet or exceed latest ENERGY STAR requirements or California 2013 Building Energy Efficiency Standards window requirements in table 150.1-A, <i>whichever is more stringent</i>^{1V, V} Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels or California 2013 Building Energy Efficiency Standards insulation requirements in table 150.1-A, <i>whichever is more stringent</i>.^{VI}
3.	Duct System	 Ducts located within the home's thermal and air barrier boundary^{vii}
4.	Water Efficiency	□ Hot water delivery systems shall meet efficient design requirements ^{viii}
5.	Lighting & Appliances ^{ix}	 All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified. 90% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 90% of sockets All installed bathroom ventilation and ceiling fans are ENERGY STAR qualifier
6.	Indoor Air Quality	EPA Indoor airPLUS Verification Checklist and Construction Specifications ^{ii,x}
7.	Renewable Ready ^{xi}	 EPA Renewable Energy Ready Home Solar Electric Checklist and Specifications^{xii} EPA Renewable Energy Ready Home Solar Thermal Checklist and Specifications^{xiii}
8.	Air Infiltration	For all CA Climate Zones 1-16, must be tested ^{Error! Bookmark not defined.} to achieve air infiltration levels at or below: 3 ACH50 for single family detached dwellings, or 4 ACH50 for attached single-family dwellings and dwellings in multifamily buildings

Encouraged:

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



Energy Efficiency & Renewable Energy

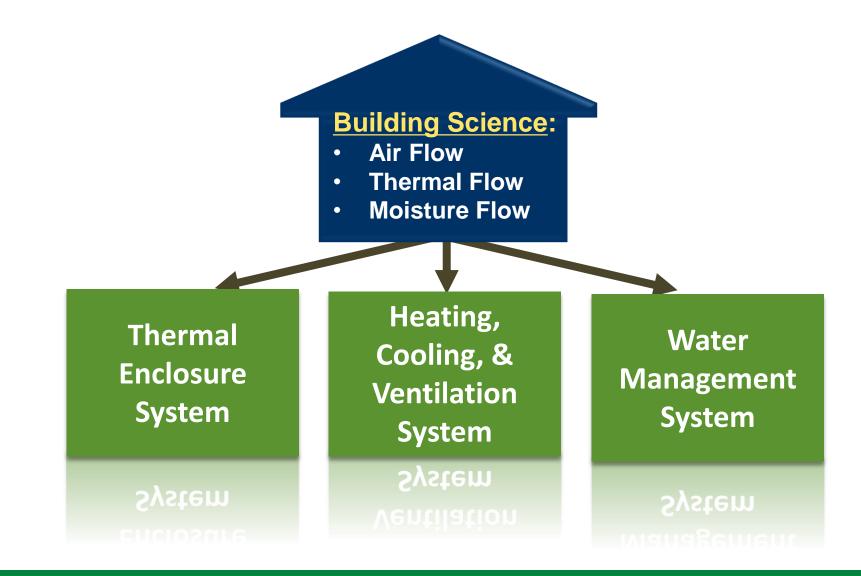


Zero Energy Ready Home **Technical Specifications Mandatory Requirements: ENERGY STAR for Homes Version 3 Baseline**

What is Building Science



Energy Efficiency & Renewable Energy



System 1: Thermal enclosur	e system	U.S. DEPARTMENT OF ENERGY Renewable Energy
Thermal	Heating, Cooling	Water
Enclosure	& Ventilation	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
What We're Trying to AvoidLs. DEPARTMENT of
ENERGYEnergy Efficiency &
Renewable EnergyThermal
EnclosureHeating, Cooling
& VentilationWater
Management

Attic air infiltration into the wall

System 1: Thermal Enclosure System
Drywall Sealed at Top Plates



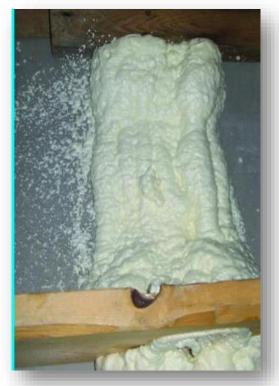
Energy Efficiency & Renewable Energy

The	ermal
Enc	losure

Heating, Cooling & Ventilation

Water Management

Default: Foam Alternative: Sill sealer Alternative: Constr. Adhesive







System 1: Thermal Enclosure System Air and Thermal Flow Control



Energy Efficiency & Renewable Energy

Water

Management

Thermal Enclosure Heating, Cooling & Ventilation

- Air Sealing
- Air Barriers
 - Thermal Bypass - Wind Intrusion
- Insulation
 - Adequate Quantity
 - Proper Installation
 - Minimum Thermal Bridging

Adv. Windows

Thermal Enclosure Checklist

System 2: HVAC System



Water

Management

Thermal Enclosure

Heating, Cooling & Ventilation

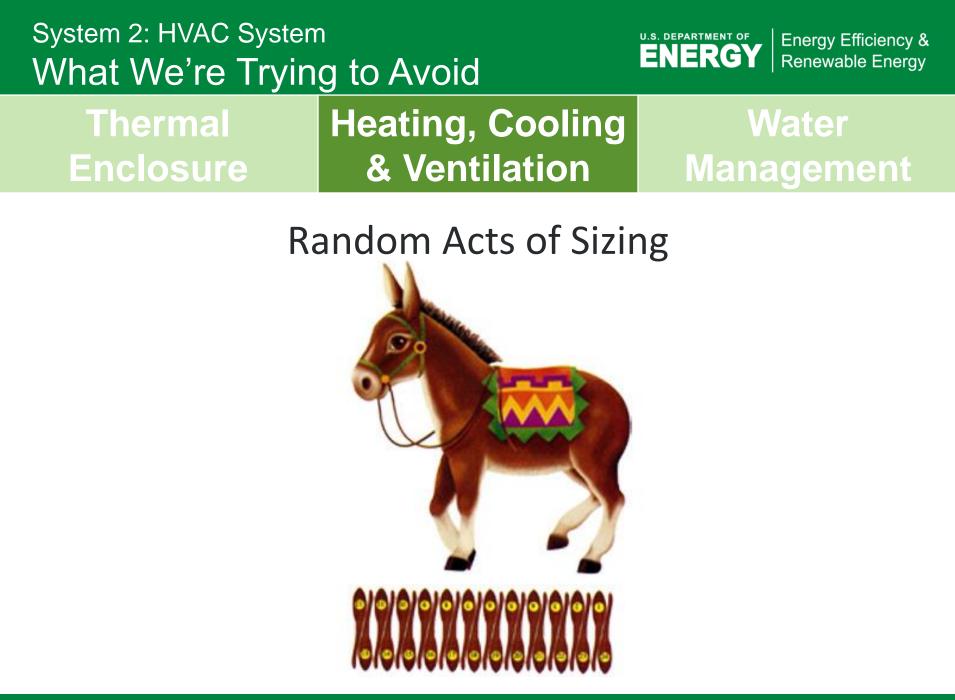
Heating and Cooling Equipment:

- 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

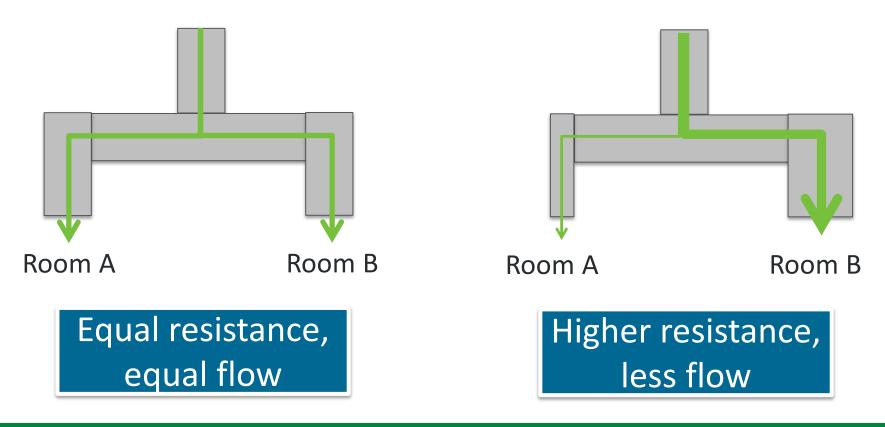


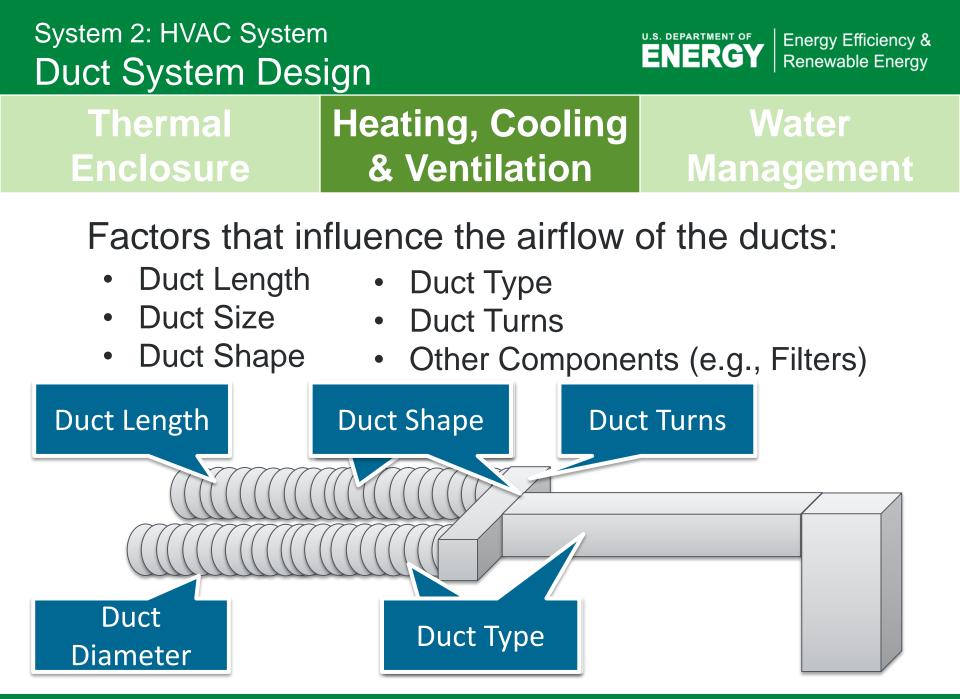
System 2: HVAC System HVAC-C (3.12); H		U.S. DEPARTMENT OF ENERGY Energy Efficiency & Renewable Energy	
Thermal	Heating, Cooling	Water	
Enclosure	& Ventilation	Management	

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

System 2: HVAC System Duct System Des		U.S. DEPARTMENT OF	Energy Efficiency & Renewable Energy
Thermal	Heating, Cooling		later
Enclosure	& Ventilation		agement

1. Air follows the path of least resistance.







System 2: HVAC System HVAC-R Item 1.4	, Sections 2,3, & 4	U.S. DEPARTMENT OF	Energy Efficiency & Renewable Energy
Thermal	Heating, Cooling		later
Enclosure	& Ventilation		agement

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

91 | INNOVATION & INTEGRATION: Transforming the Energy Efficiency Market

System 2: HVAC System Basic Concepts

Design:

Thermal

Enclosure

- 1. Calculate Heating/Cooling Loads
- 2. Select Equipment that Meets Loads

Heating, Cooling

& Ventilation

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



Checklist

Water

Management



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System 3: Water Management



Energy Efficiency & Renewable Energy



Moisture Vapor (Air Flow)

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

Thermal Enclosure Checklist

HVAC Quality Installation Checklist

System 3: Water Management Basic Concept

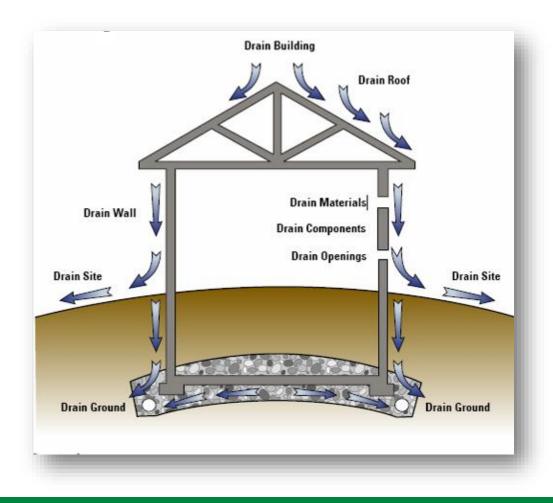


Energy Efficiency & Renewable Energy

Thermal Enclosure

Heating, Cooling & Ventilation

Water Management





Missing step & kick-out flashing

System 3: Water Manager Step and Kick-Ou		U.S. DEPARTMENT OF	Energy Efficiency & Renewable Energy
Thermal	Heating, Cooling		Vater
Enclosure	& Ventilation		agement

- 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

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Energy Efficiency & Renewable Energy

Thermal	Heating, Cooling	Water
Enclosure	& Ventilation	Management

Bulk Moisture

- weather resistant barriers
- flashing
- capillary breaks

Water Management Checklist

Ensuring Comple	ete Bldg. Science	ENERGY Renewable Energy
Thermal	Heating, Cooling	Water
Enclosure	& Ventilation	Management

US DEPARTMENT OF

ENERGY STAR for Homes v3:

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

aray Efficien





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
- Windows must also meet • California 2013 BEES window requirements (Table 150.1-A) in cases when they're more stringent



U.S. DEPARTMENT OF





	IECC	imates CZ 1-2	IECC except	Marine	IECC and 4	limates CZ 5-8 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



Energy Efficiency & Renewable Energy

Window 15% of Wall Area		R-Value v ed Wall In			
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



Energy Efficiency & Renewable Energy



Zero Energy Ready Home **Technical Specifications: Best Practices Super Air-Tight Construction**



Energy Efficiency & Renewable Energy

	ACH50 Requirements/Targets				
IECC Climate Zones	DOE Zero Energy Ready Home – CA*	ENERGY STAR V3	2012 IECC	Passive House	
1-2	3.0 / 4.0	6.0	5.0	0.6	
3-4	3.0 / 4.0	5.0	3.0	0.6	
5-7	3.0 / 4.0	4.0	3.0	0.6	
8	N/A	3.0	3.0	0.6	

* For all CA Climate Zones 1-16, homes must be tested to achieve air infiltration levels:

- ≤ 3 ACH50 for single family detached dwellings
- ≤ 4 ACH50 for attached single-family dwellings and dwellings in multifamily buildings

Seal Usual Suspects



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

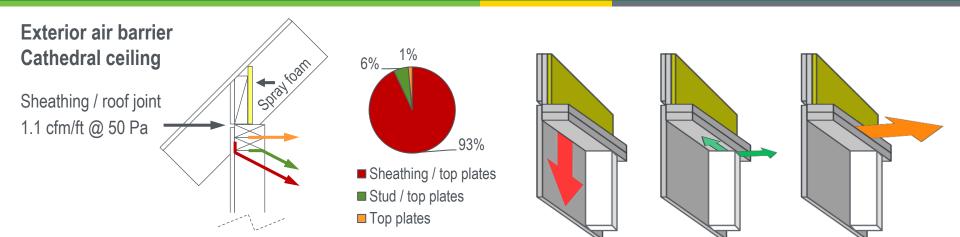
Odd Geometry:

- Cantilevers
- Knee-walls

Air Leakage Distribution

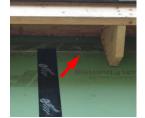
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Energy Efficiency & Renewable Energy











2-Story house (Floor area = 2,000 ft²) Sheathing / roof joint unsealed $\cong 0.5 \text{ ACH}_{50}$

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



Energy Efficiency & Renewable Energy



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]
- Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 IECC levels or California 2013 BEES insulation requirements (Table 150.1-A), whichever is more stringent.

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Climate Zone 3:

Walls: R-20 or R-13+5 Ceiling: R-38 Floor: R-19 Basement: R-5/13 Crawl Space: R-5/13 Slab: R-0 (R-5 recommended by ZERH)



Energy Efficiency & Renewable Energy



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



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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





Rigid Insulation w/Recessed Studs ENERGY

- 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

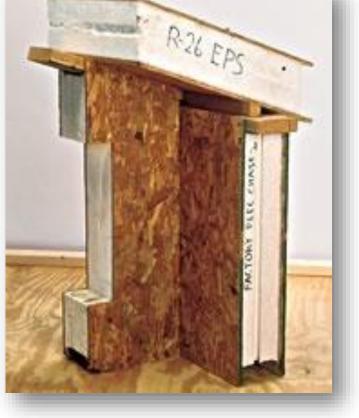


Energy Efficiency & Renewable Energy

- Significantly Reduced Time-of-Construction
- Reduced Dimensional Variation
 Corrections
- Killer Applications

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

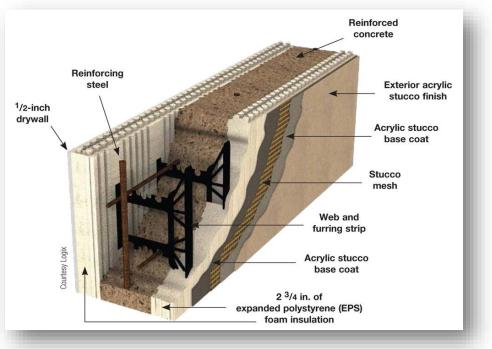


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Energy Efficiency & Renewable Energy

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





Energy Efficiency & Renewable Energy



Zero Energy Ready Home High-R Roofs

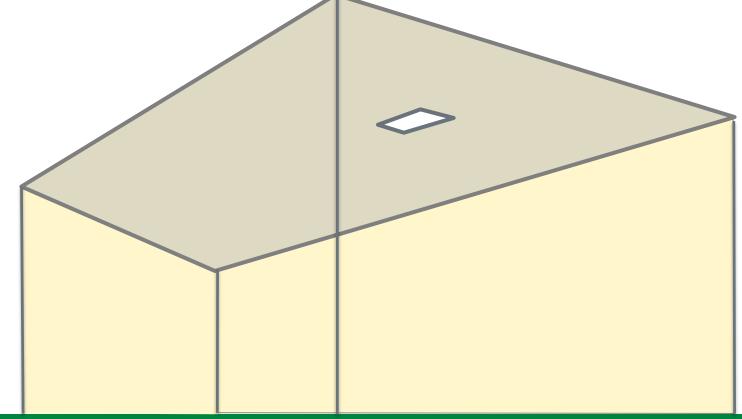


Energy Efficiency & Renewable Energy

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

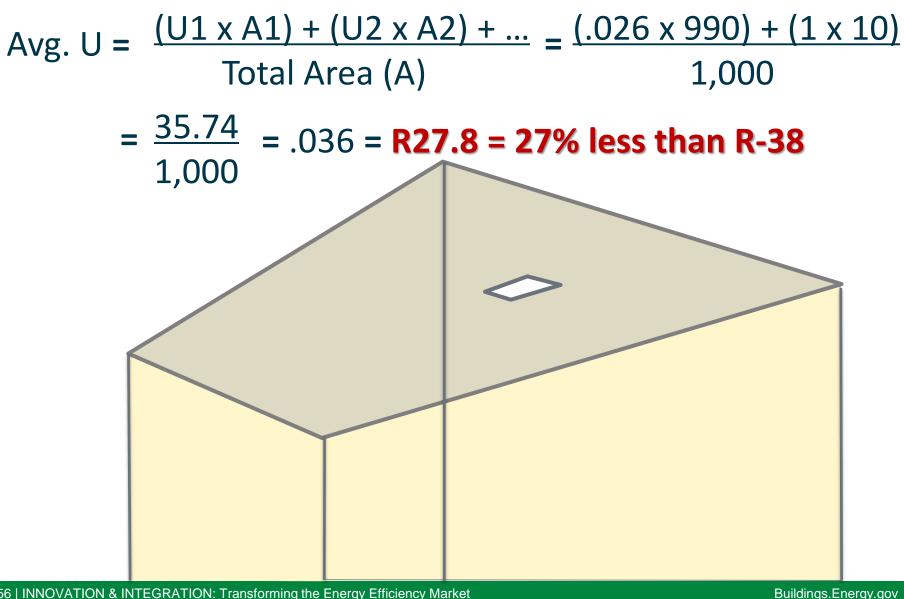
Add 10 sq. ft. R-1 Drop-Down Access Steps (1% of area)

How Much Percent Loss in R-38 Insulation?



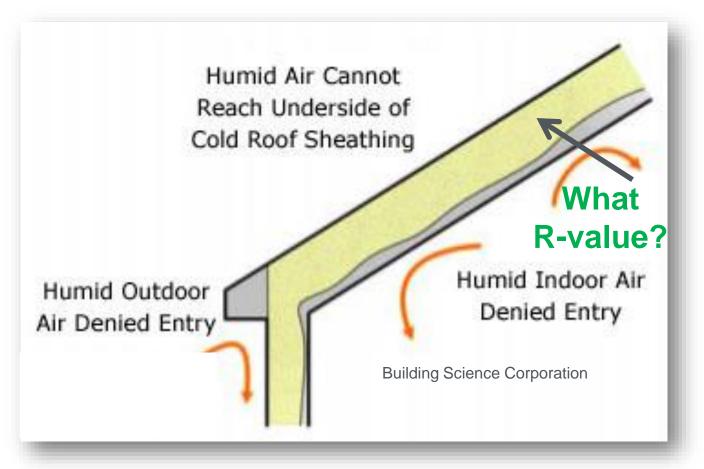
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5.1 AIR-IMPERMEABLE: In direct contact with the underside of the sheathing



Minimum R-value of Impermeable Insulation

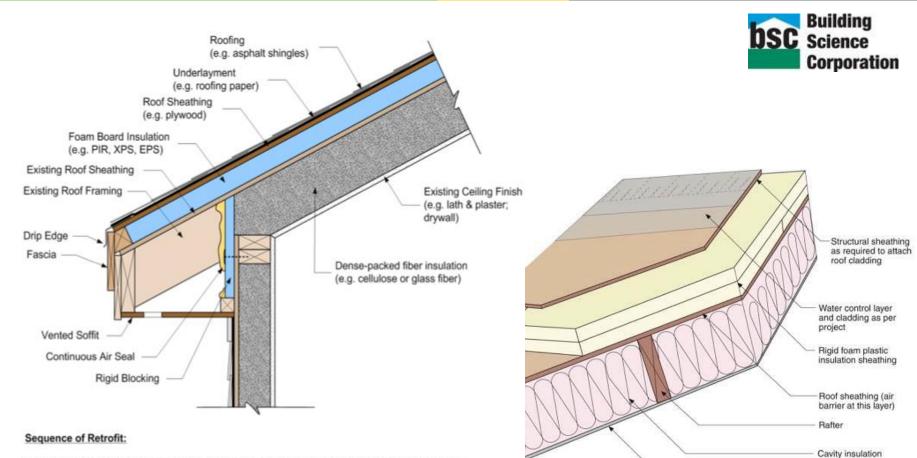
Climate Zone	Minimum Impermeable Insulation R-Value*	2012 IECC Ceiling R-Values
2B and 3B Tile Roof	None Required	30
1, 2A, 2B, 3A, 3B, 3C	R-5	38
40	K-10	38
4A, 4B	R-15	49
5	R-20	49
6	R-25	49
7	R-30	49
8	R-35	49

*contributes but doesn't supersede 2012 IECC insulation requirements

Top Insulated Roof Deck



Energy Efficiency & Renewable Energy



 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. Interior ceiling covering



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Zero Energy Ready Home **Technical Specifications Mandatory Requirements: Ducts in Conditioned Spaces**

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- 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-todrywall, are fully air sealed with mastic

Ductless HVAC system



Energy Efficiency & Renewable Energy

- Conditioned Floor Space [3 options] within the thermal boundary
- Unvented Crawl Space/Basement
 which is within the home's thermal boundary

Unvented Attic

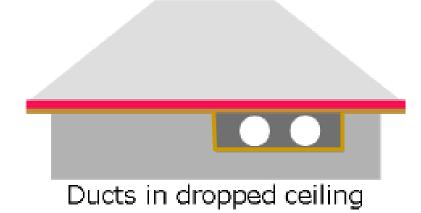
regardless of whether conditioned with a supply register

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





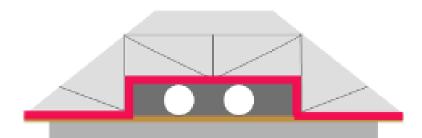
- Architectural Integration
- Good Fit w/Simple Plans
- Longer Throws (ACCA Man T)



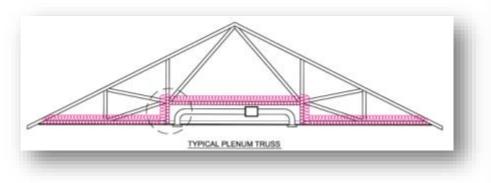


Ducts in Conditioned Floor Space Option 2: Modified Attic Truss





Ducts in modified truss in attic



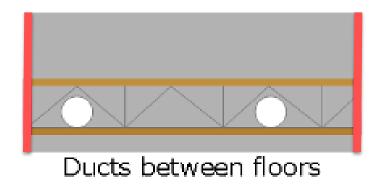
- Design Integration
- Good Fit w/Narrow Plans
- Sealed Air Barrier Critical



Ducts in Conditioned Floor Space Option 3: Ducts Between Floors

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





Ducts in Conditioned Floor Space Option 3: Ducts Between Floors

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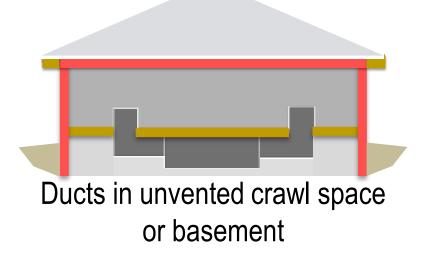
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Unvented Crawl Space/Basement



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Issues:

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



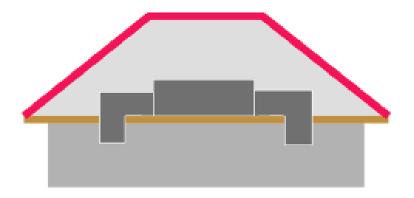
Ducts Outside Picture Source: Construction Instruction



Buildings.Energy.gov

Ducts in Unvented Attic





Ducts in unvented attic

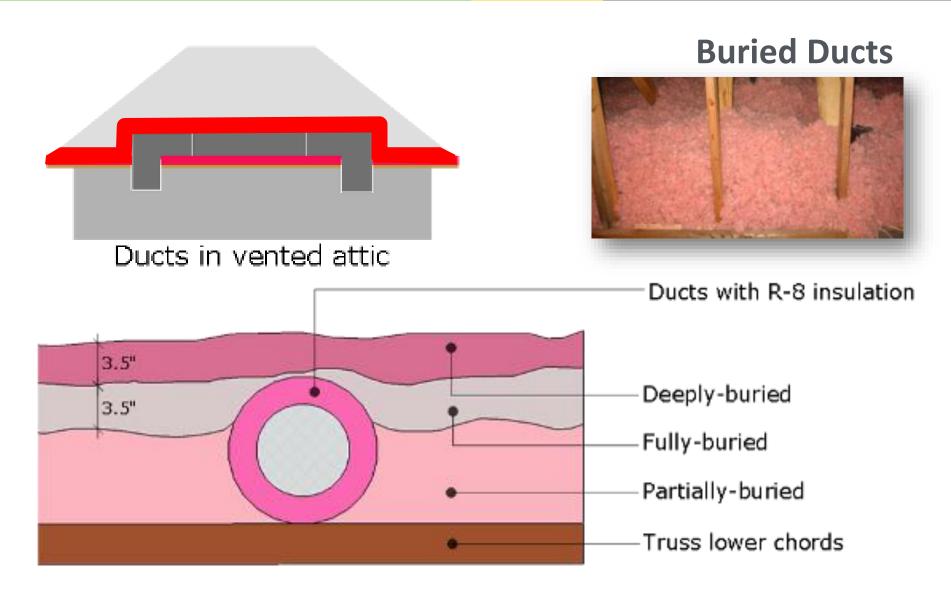
- CZ 5+, air impermeable plus a Class II VT or Class III VT in direct contact
- No Class I VR on attic floor





Ducts in Vented Attic: Dry CZs

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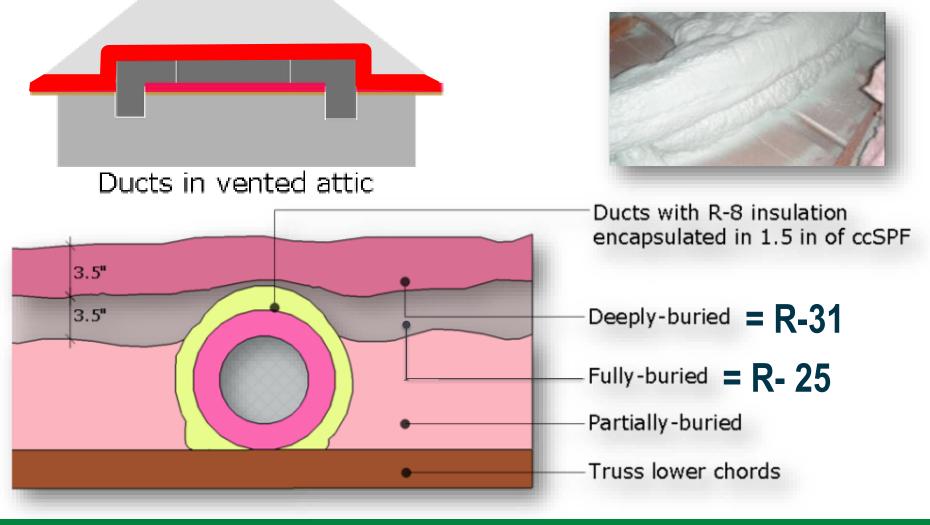


Ducts in Vented Attic: Humid CZs

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Buried Encapsulated Ducts (BEDs)

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Zero Energy Ready Home **Technical Specifications Mandatory Requirements: Efficient Hot Water** Distribution

Water Efficiency as a System



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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.

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

Fixture

Fixture Fixture Fixture **Stoned** Volume: Fixture 306tgallons 10' branch **Wait J** ime: 1 – 1.5 minuteshowerhead Hot Water Heater Fixture



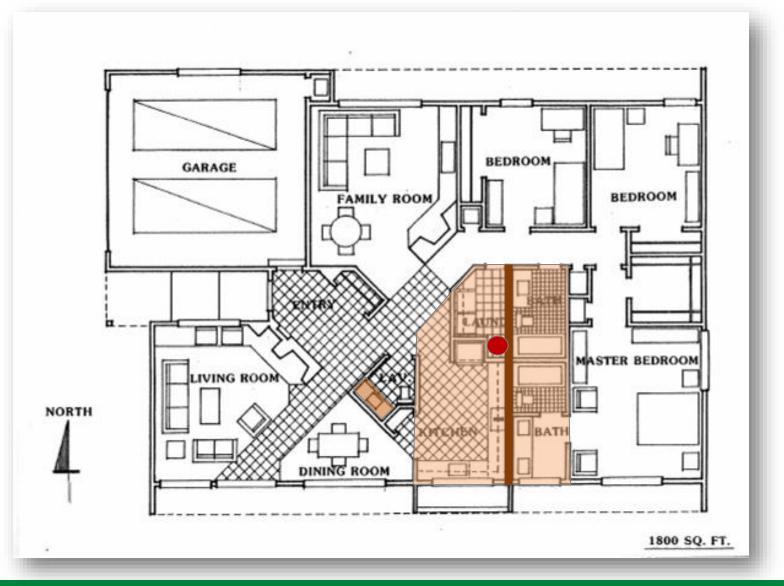
Fixture

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



Core Plumbing Layout



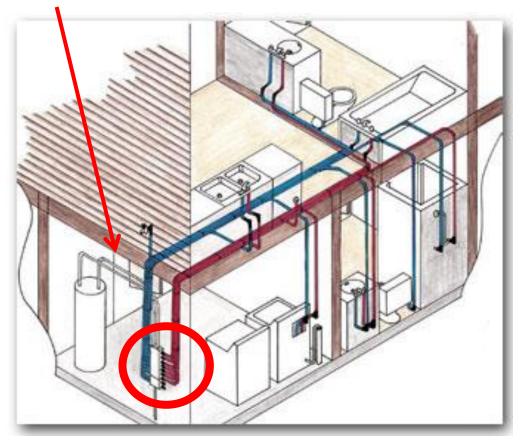


Manifold Plumbing System



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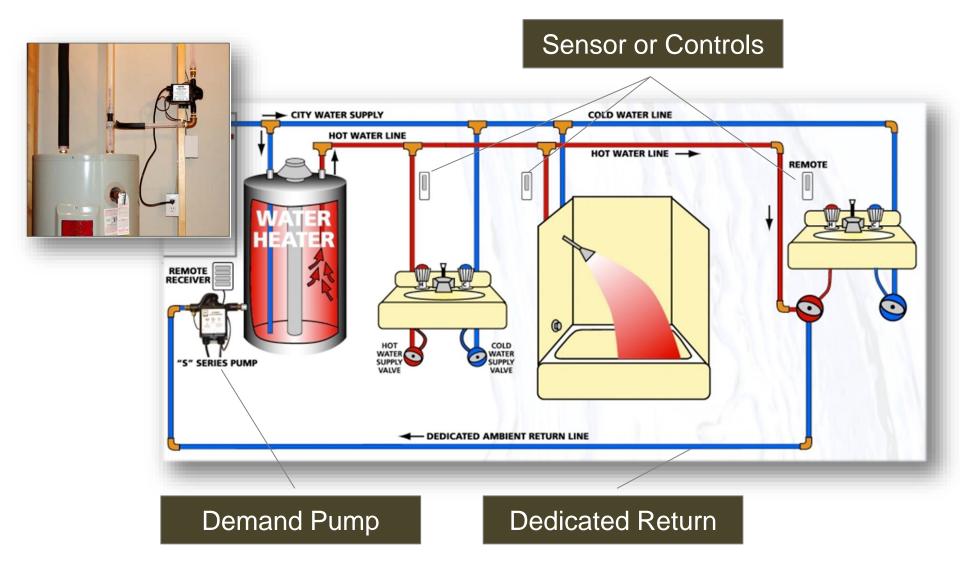
10' Max





Demand Pumping System







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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



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Zero Energy Ready Home **Technical Specifications Mandatory Requirements: Indoor Air Quality**

Increasing Health Concerns



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\$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

Increasing Health Concerns



Energy Efficiency & Renewable Energy

> Energy

> Health

> Innovation

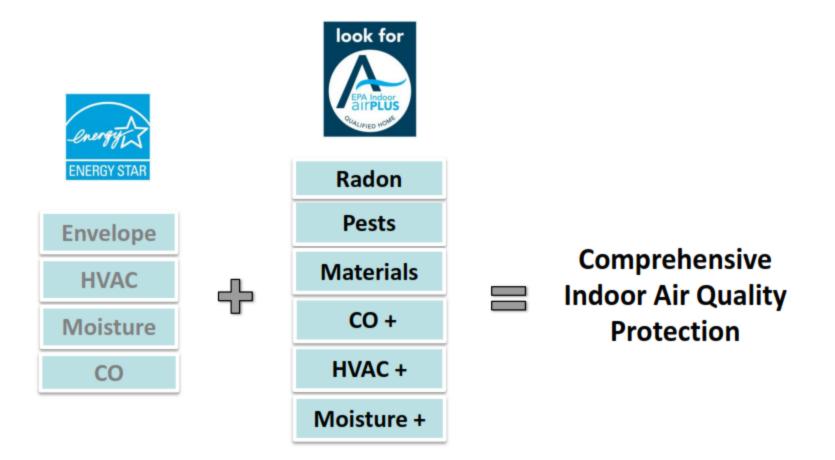
"If your child doesn't use an inhaler, consider yourself a lucky parent because,

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 Energy Efficiency & Renewable Energy

ENERGY STAR + Indoor airPLUS



Indoor Air Quality as a System



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Source Control

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

Dilution

• Filtration

HVAC Quality Installation System

Source Control: Moisture Moisture Control System

- Moisture Vapor:
 - Air Sealing
 - Air Barriers
- Bulk Moisture:
 - Water-Managed Roofs
 - Water-Managed Walls/Openings
 - Water Manage Foundation/Site
 - Water Managed Materials
- Dehumidification [Warm-Humid Climates]



Energy Efficiency &

Thermal Enclosure System

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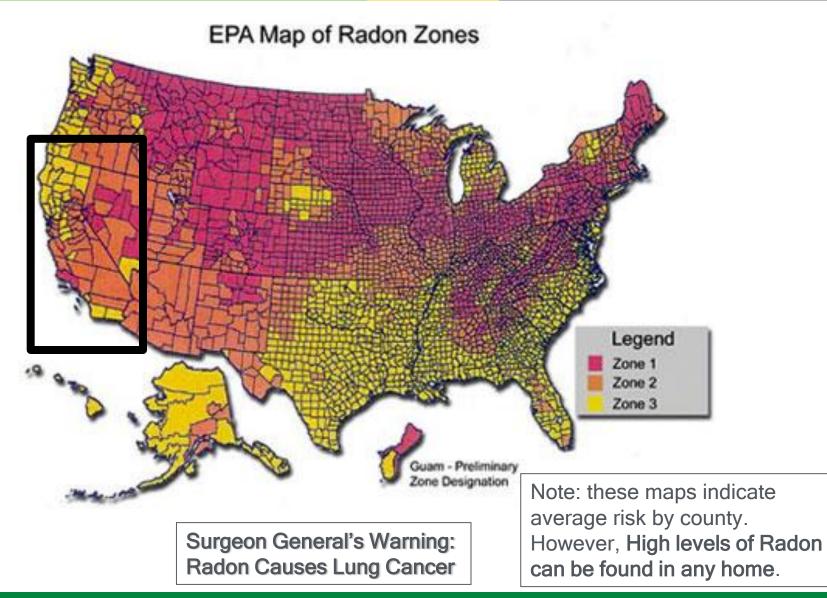
Water Managed Construction





Source Control: Radon Radon Zones in U.S.

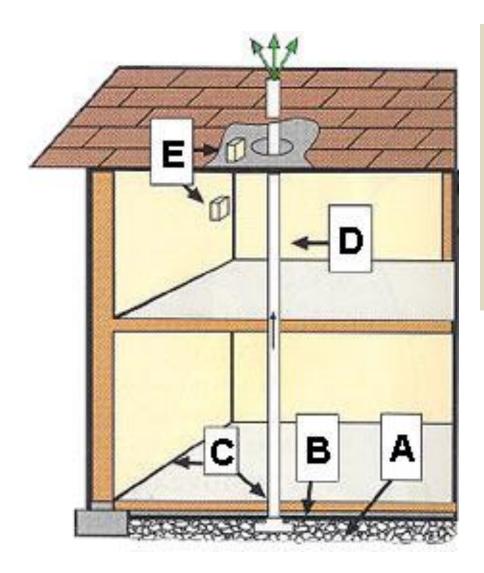




Source Control: Radon Radon Resistant Construction



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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 Screened Openings for Pests



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Corrosion-proof rodent/bird screens for openings (e.g., copper or stainless steel mesh) <u>Exception</u>: clothes dryer vent

Source Control: Biological Contaminants/Moisture Foundation Sealing



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Sealed Sump Pump



Air Sealing

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



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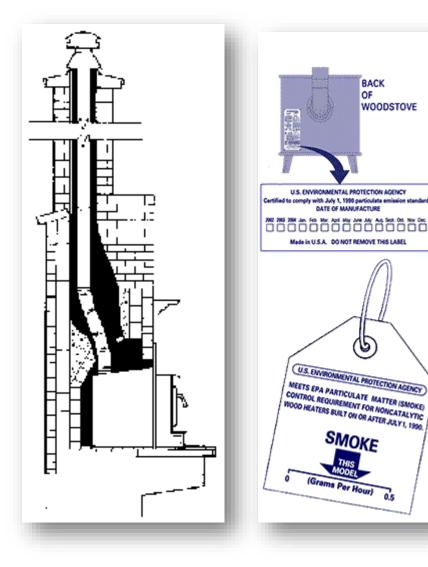
Power Vented Water Heater



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



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CO Alarm in each bedroom area



CO Alarm



Combined CO & Smoke Alarm

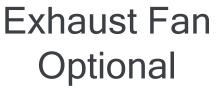


Enforceable policy in Multi-family buildings



Source Control: Combustion By-Products Attached Garage Isolation



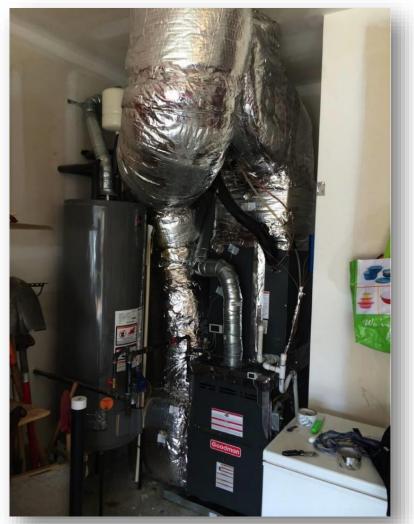






Energy Efficiency & Renewable Energy

No Air Handler in the Garage



Picture Source: Construction Instruction



Three Options:

- Exhaust-Only
- Supply-Only
- Balanced

ASHRAE 62.2 2010 Continuous Ventilation Rate: [7.5 cfm * (# bedrooms + 1)] + [.01 x Sq. Ft.] 2,000 sq. ft., 3 Bedroom Home Example: [7.5 * (3+1)] + [.01 * 2,000] = [30 + 20] = 50 cfm

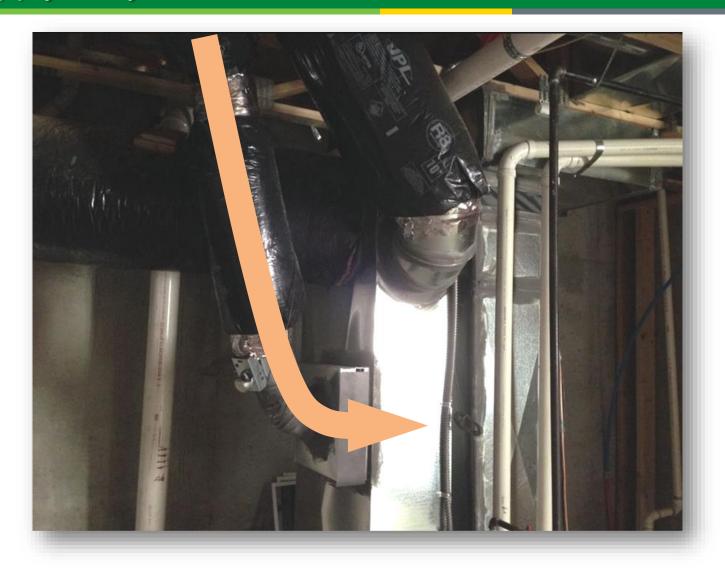
Dilution: Whole-House Ventilation Exhaust-Only Ventilation



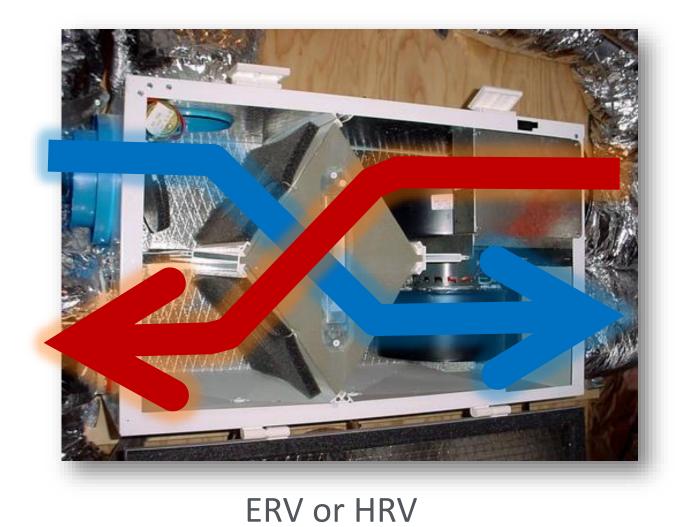


Dilution: Whole-House Ventilation Supply-Only Ventilation









Dilution: Spot Ventilation

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





Filtration: High-MERV HVAC Filter



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8 MERV Filter Minimum



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



More than half of all U.S. homebuilders

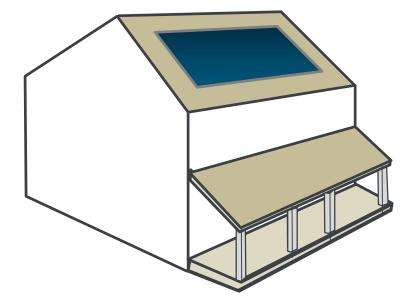
are expected to offer solar PV energy systems as an option in new single-family homes by 2016, up from just 12 percent in 2013.

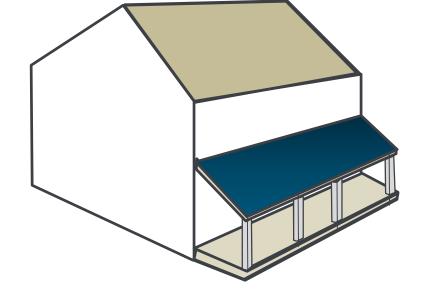
Source:

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



Energy Efficiency & Renewable Energy





PV Mounted on Roof

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



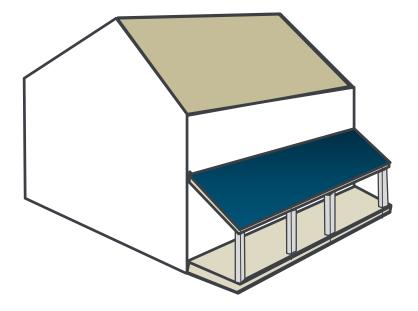
Energy Efficiency & Renewable Energy

> Innovation

> Energy Eff. > Performance

Benefits:

- Cost
- Appearance
- Maintenance
- Daylighting



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







Energy Efficiency & Renewable Energy







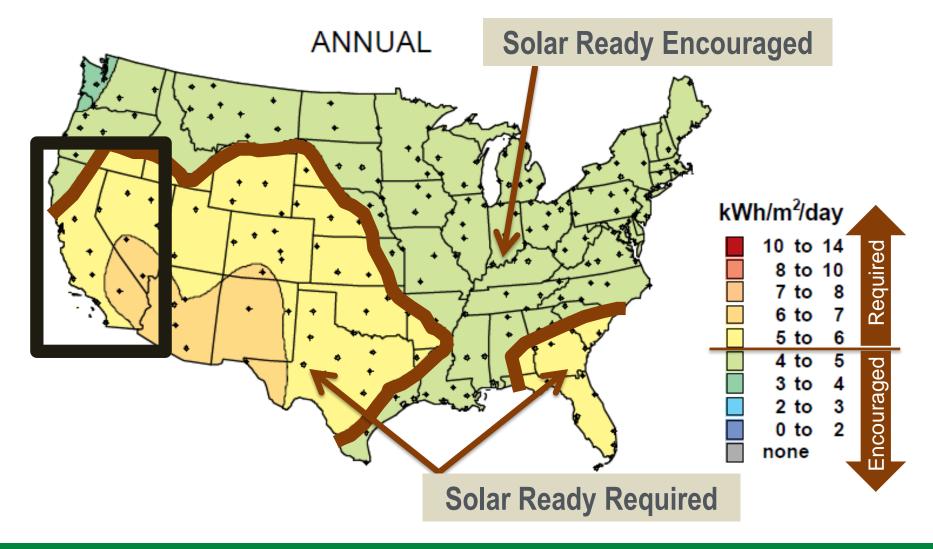
- Not required in areas lacking significant solar resources or shaded
- Recognition of high performance water heating systems



RERH Applicability



Average Daily Solar Radiation Per Month



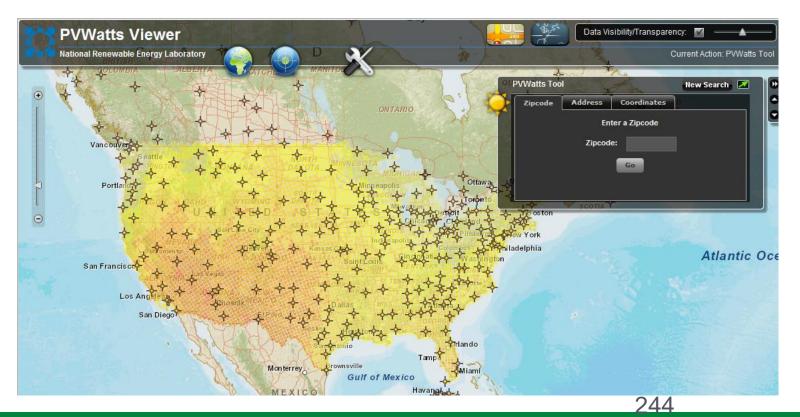
Screen for RERH Applicability



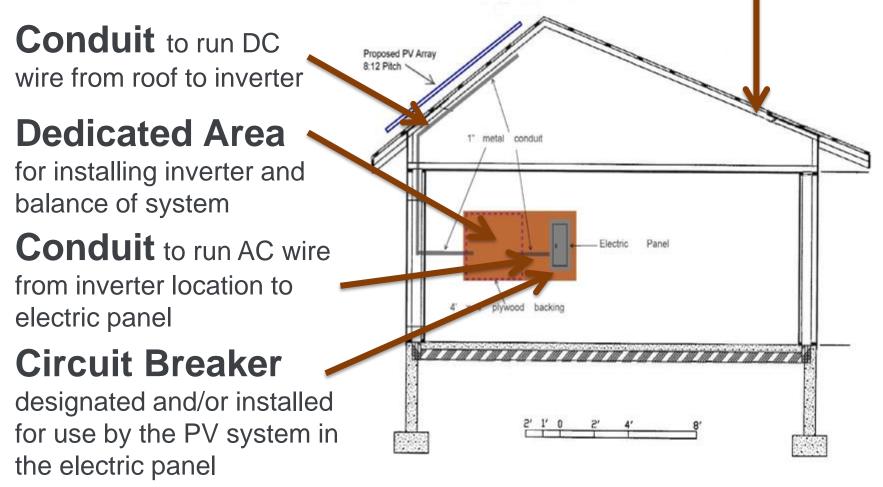
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Renewable Energy Ready Checklists

- Determine applicability by zip code
- <u>http://gisatnrel.nrel.gov/PVWatts_Viewer/index.html</u>
- 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.)





Energy Efficiency & Renewable Energy



Zero Energy Ready Home **Technical Specifications: Putting It All Together**

Zero Energy Ready Home Systems **ENERGY** Energy Efficiency & Renewable Energy

7FR ENERGY READY HOME S. DEPARTMENT OF ENERG Building Efficient Best Indoor Solar Water Disaster Air Quality Science **Practices** Components Resistance Ready Efficiency Hot Water HVAC Solar Therm<u>al</u> Ducts in Source Weather Condit. Sp. Distribution Enclosure System Control Electric **HVAC** 2012 IECC Water Htg. Solar Indoor Natural Dilution QI Insulation **System** Thermal **Fixtures Events** Water Super Lighting/ Outdoor Filtration Pests Appliances Managemt. Air-Tight Irrigation Super Windows Low-Load Eff. HVAC **Encouraged in** Quality Int. Design Construction QM **Challenge Home** Process Documents Program Management



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Zero Energy Ready Home Performance Threshold

California Compliance Options



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Renewable Energy



	2008 CA	2013 CA	DOE ZERH Target H.
CZ3 (CA13)	82	68	58
CZ4 (CA12) CZ4	91	78	59
CZ4 Gas	88	74	60
CZ5 (CA 16)	91	75	53
CZ5 Gas	89	73	55

Compliant Example (Perf. Path B)



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Climate Zone	CA Zone 12; IECC Zone 3
Size	2400 Sq ft; 4 bedrooms
Wall Insulation	2x4; R-13 Cavity; R-5 Continuous Exterior Insulation
Ceiling Insulation	R-38; vented attic
Slab Insulation	Uninsulated
Envelope Tightness	2.5 ACH 50
Windows	U-0.3; SHGC 0.25
HVAC	90 AFUE Gas Furnace; 15 SEER A/C
Ducts	In conditioned space
Water Heating	0.67 EF Gas Tank
Lighting and Appliances	Efficient Lighting; Energy Star Appliances/fans
Results:	29% better than 2013 Title 24 (TDV)
These are DOE ZERH	I prescriptive minimums



Energy Efficiency & Renewable Energy

Climate Zone	CA Zone 8; IECC Zone 3
Size	2400 Sq ft; 4 bedrooms
Wall Insulation	2x4; R-13 Cavity; R-5 Continuous Exterior Insulation
Ceiling Insulation	R-38; vented attic
Slab Insulation	Uninsulated
Envelope Tightness	2.5 ACH 50
Windows	U-0.3; SHGC 0.25
HVAC	90 AFUE Gas Furnace; 15 SEER A/C
Ducts	In conditioned space
Water Heating	0.67 EF Gas Tank
Lighting and Appliances	Efficient Lighting; Energy Star Appliances/fans
Results:	28% better than 2013 Title 24 (TDV)
These are DOE ZER	I prescriptive minimums

I can't get to 25%!!!!





- In most cases, minimum DOE Zero Energy Ready Home specifications will achieve the 25% ≥ Title-24 target.
- In some situations, minimum specifications will not reach 25% savings
- There are solutions

What are the Drivers?



Energy Efficiency & Renewable Energy

Climate

- It is harder to reach 25% in milder climates
- CA zones 3 and 5 may need to add additional measures to reach 25%

Electric Water Heating

- Penalized in TDV Analysis
- Can still achieve 25% in some climates
- Most estimates show electric water heating is 10% or less of the residential market in CA

House Size

- Houses that are larger than the benchmark size have to hit a more aggressive savings target
- This is also true with the national program's size adjusted HERS

Solutions



Add Efficiency	 Many DOE Zero Energy Ready Home builders already build beyond minimum efficiency specifications Increasing efficiency beyond minimums may be an economical option
Prescriptive Compliance	 If the home is equal to or less than the benchmark size, compliance can be demonstrated prescriptively All mandatory items must be met as well as national prescriptive minimums for the appropriate climate zone
RESNET Compliance	 In some cases California builders have demonstrated compliance through the national program using national HERS Software California mandatory minimums must still be met
Side by Side	 This method involves running two Title 24 models. In one case the prescriptive minimums are modeled. In the other case the proposed design is modeled. The proposed design must be more efficient than the prescriptive minimums on a TDV Basis Must still meet code

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

Exhibit 3: Benchmark Home Size²⁸

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

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

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

Rating & Verifying Homes



- 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 <u>doechallengehome@newportpartnersllc.com</u>
 - Otherwise builders will not receive "credit" on DCH website
 - Considering RESNET National Homes Registry for future

Verifying Homes – Indoor airPLUS

- 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

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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.



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



Renewable Energy



Zero Energy Ready Home Recognition

Lots of Recognition Choices...

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Energy Efficiency & Renewable Energy



ZERH Partner Registration



Review

- Technical Guidelines
- Partnership Agreement Terms

Register

- Electronically Sign Agreement

Choose Optional Commitments:



- 100% of homes meet DOE Challenge Home Guidelines
- Homes meet EPA's WaterSense Guidelines



Homes meet IBHS's Fortified Home Guidelines



Meet DOE Challenge Home Quality Management Program

ZERH Partner Benefits



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
- Profiles/Virtual Parade of Home [coming]



Links Buyers to Leading Edge Builders:

- Contact Information
- Optional Commitments



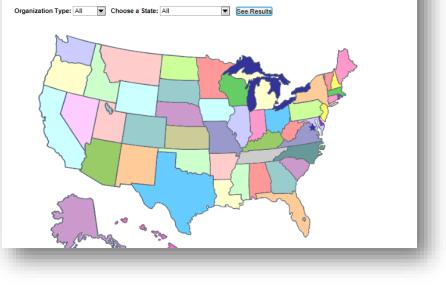
- # Labeled Homes
- Website link

For All Active Partners

DOE Challenge Home Partner Locator

Find out who is taking the challenge. Locate <u>DOE Challenge Home</u> 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.



ZERH Partner Locator Tool



About	DOE Challenge H	ome: Results			
Take Action to Save Energy	-	are located (or do business) in Minnes	ota.		
Partner With DOE	[Modify Search] [New Search]				
Activities		_			
Solar Decathlon	First Prev 1 2 Next La	st			
Building America	100% Partners				
Home Energy Score	Name	Commitments	City	State	# of DOE
Home Performance with ENERGY STAR			,		Challenge Home
Better Buildings Neighborhood Program	0				Projects
Challenge Home	A Building Science Institu	<u>ute Inc.</u> 👾 💚 👐 🖤	HINSDALE	IL	
- Partner Log In	A Habitat for Humanity of	Obia Ku 👜 🧰 🧰 🏧			
- Become a Partner	Habitat for Humanity of	<u>Ohio-Ky</u> 🗰 🥌 🥶 🖤	HAMILTON	OH	
- Criteria	A Midwestern Energy Sol	lutions LLC 🏟 🚥	OELWEIN	IA	
- Partner Locator			OLEWEIN		
- Events	SustainMax, LLC	🥯 \multimap 🖤	MINNEAPOLIS	MN	
Guidelines for Home Energy Professionals					
Technology Research, Standards, & Codes	Name	Commitments	City	State	# of DOE Challenge Home Projects
	م <u>Bluegill Energy Manage</u>	ement	KATY	ТХ	

CH Housing Innovation Awards



Energy Efficiency & Renewable Energy





ZERH Profiles



Energy Efficiency &

ENERGY Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

DOE CHALLENGE HOME CASE STUDY

e2 Homes Winter Park, Florida

BUILDER PROFILE

e2 Homes President: Rob Smith P.O. Box 3300 Winter Park, FL 32790 407-923-4229 rob@e2homes.com

FEATURED HOME/DEVELOPMENT:

- First Certified Challenge Home-October 2012, Wilson Residence, Winter Park, FL
- 4 bedrooms, 4 baths 4,305 conditioned space
- (8,000 with lanai, garage, etc.)
- Date completed: May/June 2012 · Performance Data: HERS Index
- without Solar PV: 57 · HERS Index with Solar PV: -7
- · Modeled utility bills for a standard home of this size in this utility area: \$3,378
- · Projected utility costs for this home: \$2 297
- · Projected annual energy cost savings for this home (without solar): \$1.081 PV Production = \$2.420
- · Projected annual energy cost savings for this home (with solar): \$-123





The Nation's First Certified DOE Challenge Home Leaves a BIG impression with a SMALL Footprint

The first certified DOE Challenge Home-the "Wilson Residence" in Winter Park, Florida-produces more energy than it uses with construction costs one-third less than originally proposed. Completed in May 2012, this 4-bedroom, 4-bath 8,000-ft2 (4,305-ft2 in conditioned space) custom home scores a HERS 57, which is well below the HERS 100 for a standard home built to code. With its photovoltaic system, the home produces better than net-zero energy, with a score of HERS -7, which translates into no electric utility bills and even \$123 annually in the homeowner's pocket from the utility.

The homeowner, Mr. Wilson, hired e2 Homes to build his dream home. From the start, Rob Smith (the president of e2 Homes) worked with the homeowner, his HERS rater, and his mechanical contractor to study how differing efficiency measures would impact cost, energy-efficiency, comfort, and durability. "The DOE Challenge Home is data driven and performance driven, based on all the standards...and it addresses concerns of different climates," said Smith. The team used the Challenge Home requirements (along with specifications from LEED for Homes, the Florida Green Building Coalition, the Florida Water Star Gold, and other programs) to analyze best practices in their climate zone compared to costs.

As specified in the Challenge Home requirements, the envelope was designed to meet all ENERGY STAR Version 3 requirements and 2012 IECC insulation levels. Final blower door tests show a tight envelope at 1.77 ACH 50.

The exterior walls were constructed of Aercon Autoclaved Aerated Concrete (AAC) blocks. "My client wanted AACs to avoid using drywall [in this hot humid climate]," said Smith. Like concrete block, AAC is also mold-resistant, non-combustible, and not penetrable by termites or pests, but the unique foam-like structure of the AAC also makes it insulating (R-8 for an 8-inch block), sound resistant, lightweight (one-fifth the weight of concrete), easy to saw or drill, and strong (AAC blocks and panels come structurally reinforced with rebar).

The window package they ultimately selected is ENERGY STAR, low-E 366 glass (blocks 95% of ultraviolent and infrared light), double-pane, and vinyl with a U-factor of 0.27.

The roof is light-colored Galvalume standing-seam metal assembled over engineered roof trusses that are spray foamed underneath to R-20, to create a sealed, conditioned attic that keeps summer temperatures down to 85°F instead of a typical 150°F.

DOE CHALLENGE HOME 02 HOMES

All of the 962-square-foot porch roof is comprised of solar panels with a 13.4-Kw solar array system. The 69 panels don't sit on top of the roof, they are the roof. The completely water-tight structure allows about 15% of natural light to filter through the panels, lighting the space below. The panels are dual surface meaning they can produce power from any sunlight reflected up onto their lower surface, for up to 30% greater than rated power production. All wiring is hidden within the canopy's aluminum support beams.



CHALLENGE HOME CERTIFIED:

BASELINE Certified ENERGY STAR home

- 2 ENVELOPE meets or exceeds 2012 IECC levels 3 DUCT SYSTEM
- located with the home's thermal boundary
- **4 WATER EFFICIENCY** meets or exceeds the EPA WaterSense Section 3.3 specs
- 5 LIGHTING AND APPLIANCES ENERGY STAR qualified
- 6 INDOOR AIR QUALITY meets or exceeds the EPA Indoor airPLUS Verification Checklist
- 7 RENEWABLE READY meets EPA Renewable Energy-Ready Home Solar Electric and Thermal Checklists

Every DOE Challenge Home combines building science specified by ENERGY STAR for Homes and advanced technologies and practices from DOE's Building America research program



As required by the Challenge Home, the ducts and air handler are located within conditioned space-in the unvented, insulated attic. The home is heated and cooled by three systems: on the first floor a heat pump (SEER-18, HSPF 9.5), in the master bedroom a ducted mini-split heat pump (SEER 16, HSPF 10), and on the second floor another heat pump (SEER 16.5, HSPF 9).

The team designed the ventilation system to create a slight positive pressure in the house to help control humidity. The "economy ventilation system" includes a fresh air duct to the outside of the home that is set to an electric damper regulated by the thermostat to meet ASHRAE ventilation standards.

The home is water efficient in several ways. Two tankless, propane-fired water heaters are located as close to their points of use as possible to minimize water and energy waste (i.e., one near the master bedroom and the other near the kitchen, laundry room, and other bedrooms). Also, the house is double piped so that a 7,000-gallon cistern collects and supplies rain water to all toilets, urinals, and plants in the backvard.

With the home designed for maximum energy and water conservation, the 13.5-kw Sanyo photovoltaic system completes the house. Rather than mounting the 69 solar panels on the roof, the company Superior Solar, fit them together to form a watertight structure that literally is the roof of the home's 962-ft2 lanai. The Sanyo HIT Double 195 Watt solar panels are bifacial, meaning they can generate some electricity from reflected light that hits the bottom side of the panels. The panels also permit about 15% of the daylight to filter through them, lighting the porch area beneath. The hybrid inverter, a SolarEdge Power Optimizer and Inverter system, converts the panel-produced direct current power into a utility-compatible alternating current, using a unique technology that overcomes the limitations of traditional central string. inverter systems but at a much lower cost than micro-inverter systems.

"At the end of the day, my message for builders considering [building to] Challenge Home is that this program is very rigorous, so it should help builders stand out from the crowd," said Smith. "If you start early in the process, there doesn't have to be a cost differential to implement high-performance building."

ENERGY Energy Efficiency & Renewable Energy

For more information on the DOE Challenge Home go to www.buildingamerica.gov/challenge PNNL-SA-XXXXX November 2012





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

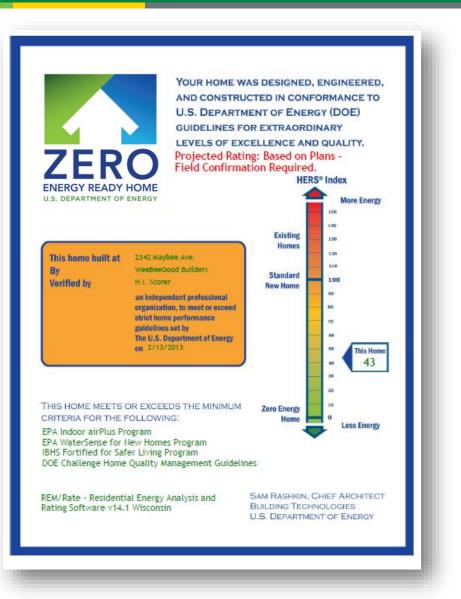


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Rater Prints
 Certificate

directly from rating software

- Certificate
 Includes:
 - Rating Details
 - Graphic HERS Index
 - Optional Programs



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'Test Drive' Zero Energy Ready 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'





Energy Efficiency & Renewable Energy

Thank You



For More Information:

www.buildings.energy.gov/zero/

e-mail Contact:

doechallengehome@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

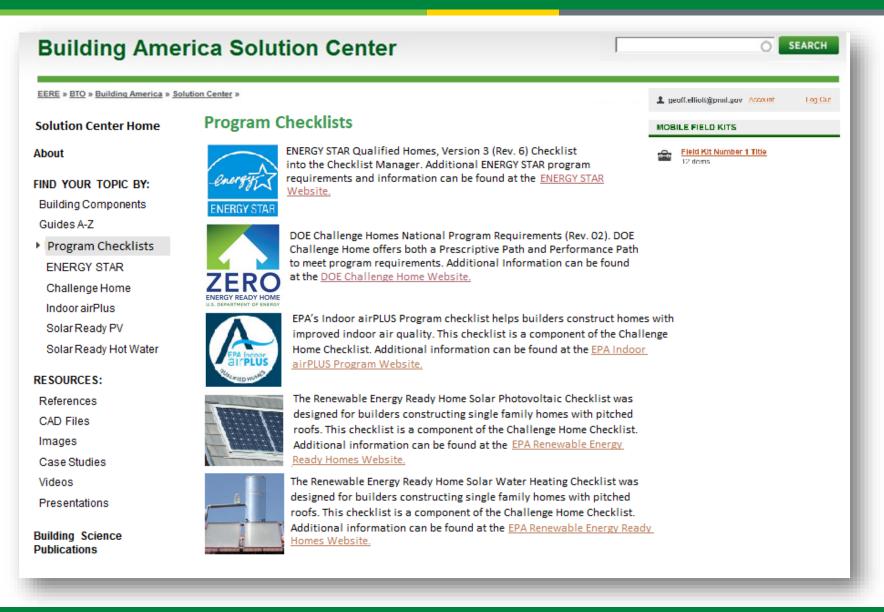
You can also find images, CAD drawings, references, and other resources under FIND RESOURCES.

Building Science Publications

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

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DOE Challenge Home Program Requirements (Rev. 02) Solution Center Home Help The Building America Solution Center has integrated the DOE Challenge FIND YOUR TOPIC BY: Homes National Program Requirements (Rev. 02) into the Program Checklists. Use the boxes to access specific parts of the Requirements, **Building Components** which have been numbered and titled to be consistent with the DOE ZERC Challenge Home National Program Requires. Additional information can Guides A-Z be found at the DOE Challenge Home Website Program Checklists ENERGY STAR ory Requirements for All Labeled Homes EXNIDIT 1: IVIANO Challenge Home STAR for Homes Baseline Indoor airPlus ler ENERGY STAR Qualified Homes Version 3.0 ied Renewable Ready > 2. En 0 FIND RESOURCES: References and ▶ 3. Du m δy: Resources ▶ 4. Wa iency ٢Ε CAD Files ▶ 5. Lig Appliances hg Image Gallery ▶ 6. Ind or Air Quality Case Studies EPA Ir oor airPLUS Verification Checklist and Construction Specifications FIND PUBLICATIONS: Alterr ive: ENERGY STAR for Homes V3 Water Management System Builder Check **Building Science** Publications ▶ 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



Ext e ND e Building America e Solution Center to Education Solution Center and Component Explorer Dicklist Manager Exercy STAR Building Science Explorer Outsis Carse Studies Carse Studies Bage Galary References Mach Cyster Management System Builder Checklist (HVAC/R) • Water Management System Builder Checklist (WMS)	Building A	merica S	olution Center	O SEARCH
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	References	→ Water M	lanagement System Builder Checklist (WMS)	
				USA.gov



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Image Gallery		S 2. Quality-Installed Insulation		
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		S 4. Reduced Thermal Bridging		
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Building A	merica Solution Center	Login Register
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Image Gallery	TES 2. Quality-Installed Insulation	
References	▼ TES 3. Fully-Aligned Air Barriers	
	TES 3.1. Walls	
	TES 3.1.1. Walls behind showers and tube	
	TES 3.1.2. Walls behind fireplace	•
	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 cond	litioned 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 of	or unconditioned crawlspace
	TES 3.3. Ceilings	
	TES 3.3.1. Dropped ceiling / soffit below uncondit	tioned attic
	TES 3.3.2. All other ceilings	

BASC Component Explorer



Energy Efficiency & Renewable Energy



Walls/Openings 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**

HVAC

WHOLE HOUSE PERFORMANCE

COMPONENTS



QA/QC

DESIGN



Explorer

Browser

Guides

CAD Files

Case Studies

Image Gallery

References

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



Energy Efficiency & Renewable Energy

Solution Center Home

Component Explorer

Checklist Manager

Building Science Explorer

Browser

Guides

CAD Files

Case Studies

Image Gallery

References

Attic Knee Walls

Please <u>Register</u> or <u>Login</u> to Provide Feedback.

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 along 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.



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



Energy Efficiency & Renewable Energy

Solution Center Home

Component Explorer

Checklist Ma

Building Scier Explorer

Browser

Guides

CAD Files

Case Studie

Image Galler

References

Attic Knee Walls

Please Register or Login to Provide Feedback.

E	nsuring Success
	ower door testing, conducted as part of whole-house energy performance testing, may help indicate hether 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 ad the conditioned space of the house to see the leakage. An experienced technician can also check
fo	r air leaks beneath the knee walls with a smoke pencil or by feeling for leaks with the back of the
ha	and.



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.



Energy Efficiency & Renewable Energy

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.

Climate				
ENERGY STAR Version 3, (Rev. 6) Thermal Enclosure Checklist, Fully-Al fully aligned with the insulation at exte				
surface of walls for Climate Zones 4-8			ate zones, and als	o at interior
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Exhibit 2: DOE Challenge Home Targe 5-7: 2; Zone 8: 1.5. Envelope leakage approved testing protocol.				
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4 2 3	- Hora	PD.	-5 M6	3
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MOBILE FIELD KIT

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

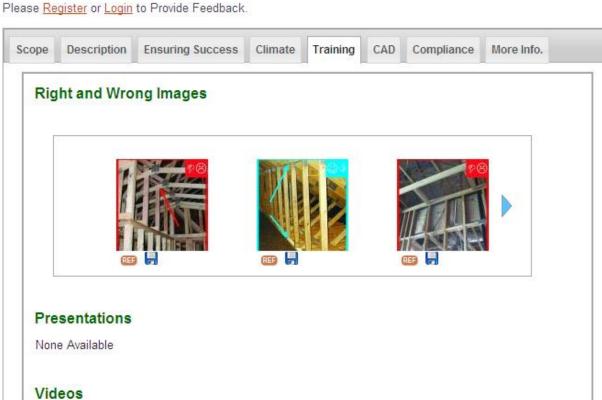


Climate: Climate-specific codes, standards, ENERGY STAR, and Challenge Home guidance.



Energy Efficiency & Renewable Energy

Attic Knee Walls Solution Center Home Component Explorer Checklist Manager Scope **Building Science** Explorer Browser Guides CAD Files Case Studies Image Gallery References





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



Energy Efficiency & Renewable Energy

Solution Center Home	Attic Knee Walls	
Component Explorer	Please Register or Login to Provide Feedback.	
Checklist Manager		
Building Science Explorer	Scope Description Ensuring Success Climate Training CAD Compliance More Info.	
Browser	CAD Images	
Guides		
CAD Files		MOBILE FIELD KIT
Case Studies		The Building America Field Kit allows you to
Image Gallery		save items to your profile
References	The second	for review or use on-site.
		Sign Up
		or
		Log In

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



Energy Efficiency & Renewable Energy

Solution Center Home Attic Kno

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.

ENERGY STAR Version 3, (Rev. 6)
Thermal Enclosure Checklist, Fully-Aligned Air Barriers. A complete air barrier shall be provided that i 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

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.



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

Explorer

Browser Guides



More Info.

Energy Efficiency & Renewable Energy

Attic Knee Walls Solution Center Home Component Explorer Please Register or Login to Provide Feedback. Checklist Manager Ensuring Success CAD Compliance Description Climate Training Scope **Building Science** Case Studies 1. David Weekley Homes: Eagle Springs & Waterhaven, Houston, TX PNNL, 2012, Building America Case Study: David Weekley Homes, Eagle Springs & CAD Files Waterhaven, Houston, TX, PNNL-SA-87333, prepared by the Pacific Northwest National Case Studies Laboratory for the U.S. Department of Energy. Link to Document 📆 Image Gallery 2. Tommy Williams Homes: Longleaf Village & Belmont, Gainesville, FL References 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 1. 2009 IECC—International Energy Conservation Code 2009 IECC, International Energy Conservation Code, International Code Council, Washington, More Info: References - Full citations with links for content ·Case Studies - Whole-house best practices ·Resources - Relevant info not previously cited



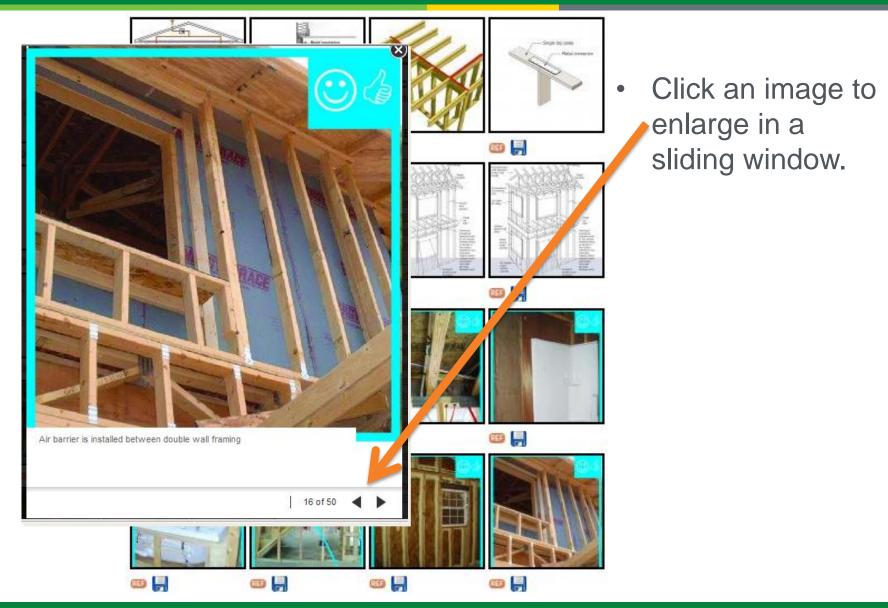
313 | INNOVATION & INTEGRATION: Transforming the Energy Efficiency Market

Buildings.Energy.gov

BASC Browser Image Gallery

U.S. DEPARTMENT OF

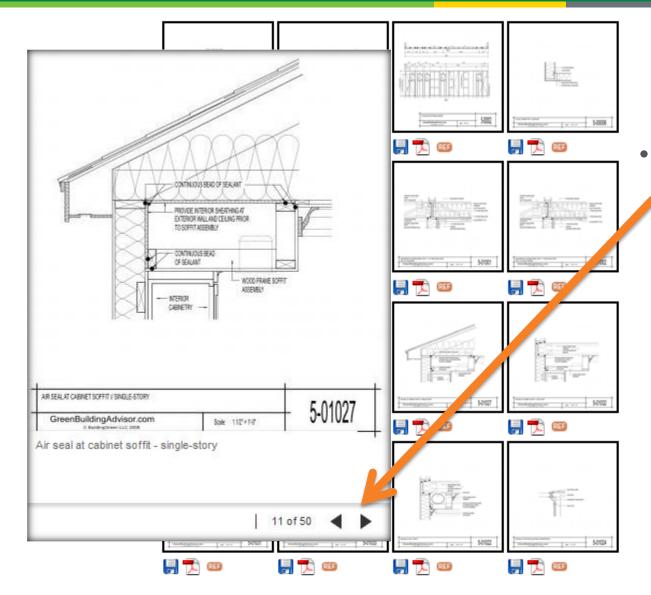
Energy Efficiency & Renewable Energy



BASC Browser Cad Files



Energy Efficiency & Renewable Energy



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

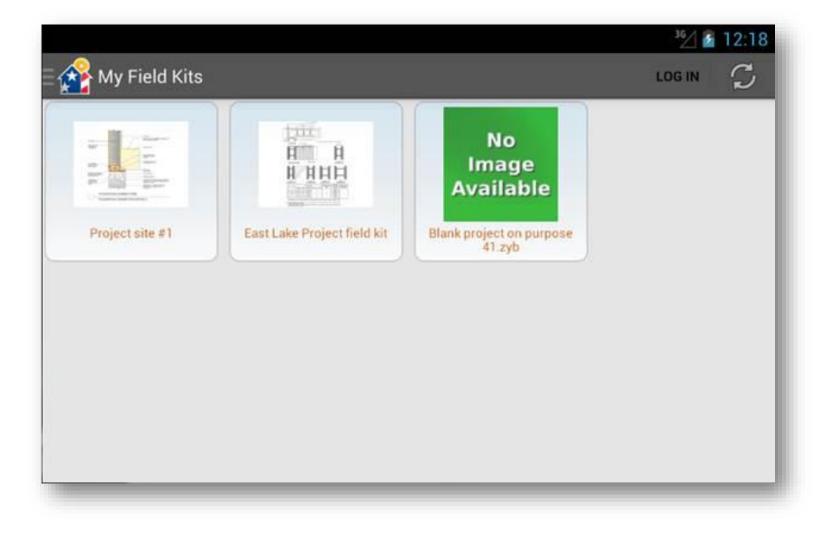
BASC Mobile Application





BASC Mobile Application





DOE Zero Energy Ready Home



Energy Efficiency & Renewable Energy



The Appraisal Process: Be Your Own Advocate

SAM RASHKIN Chief Architect Building Technologies Program

Energy Efficiency & Renewable Energy

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	1372
Estimated annual energy use	Estimated annual energy savings
Electric: 10825 kWh \ Natural Gas: 773 Therms	Electric: 4081 kWh \ Natural gas: 1171 Therms
Energy cost rates	Estimated annual emissions reductions
Electric: 0.08 \$/kWh \ Natural Gas: 0.50 \$/Therms	CO2: 10.2 tons / SO2: 16.4 lbs / NOx: 31.2 lbs

U.S. DEPARTMENT OF

ENERGY

DOE Challenge Home Certification

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

- X Compliance with all ENERGY STAR Qualified Homes Version 3 requirements and checklists
- X Compliance with Mandatory Fenestration Requirements
- X Compliance with Mandatory Insulation Requirements
- X Compliance with Mandatory Duct Location Requirements
- X Compliance with Mandatory Appliance Requirements
- X Compliance with Mandatory Lighting Requirements
- X Compliance with Mandatory Fan Efficiency Requirements
- X Compliance with Mandatory Indoor Air Quality Requirements
- X Compliance with Mandatory Renewable Energy Ready Solar Electric Requirements
- X 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:

х

- YES NO DON'T Optional Home Builder Commitments for Recognition
 - 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 Two: Specify Green Appraiser



Energy Efficiency & Renewable Energy

6/12/13 8:54 PM

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.

							Home Join	Media	Help Se	arch 💽
							Need Help	? Call 88	8-7JOINA	1 (756-4624)
							incou morp		0.1001111	
Al Resources Find a	n Appraiser	Education	Publications /	Store F	rofessional Practice	Lu	m Library	News / A	dvocacy	About Us
	Home > Fin	vd An Appraiser > Pi	rofessional Develope	ment Program	Registry > Valuation of Sus	stainable	Buildings: Resi	dential		
n this Section	Find an	Appraiser								
Find An Appraiser	1 11154 5111 2									
Minority & Women Directory	Professio	onal Develop	ment Program	n Registr						
Professional Development Program Registry			-	-						
- Valuation of Conservation	Valuatio	on of Sust	ainable Bu	ildings	Residential					
Easements	NOTE: This R	agistry only lists Apr	praisal Institute Desi	anated Memb	ars who have successfully p	assed t	he Valuation of S	iustainable E	Suikhings Prafi	asional
Appraising Historic Preservation Easements	Development i	Program examinatio	r15.							
= Litigation	There may be	other qualified Appr	aisal Institute Desig	nated member	s, Candidates for Designation	ion, or P	racticing Affiliate	s who may h	andle green/s	ustainability
" Valuation of Sustainable	members, Car	ut have not taken to ididates for Designe	tion, or Practicing A	filiates who h	gs Professional Developme we identified green/sustains	ability as	am. Visit the Pin a specialty.	d an Apprais	ar directory to	and Designated
Buildings: Commercial Valuation of Sustainable	View Program	FAQs								
Buildings: Residential	Please read th	tis notice regarding i	Perfossional Develo	nmant Proors						
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Business Enterprise	Commercial V	aluation of Solar to r	remain on the registr	valuation or 5 ty.	olar course. Those on the re	ignary is	ave uncernary 1,	2014 to com	pete reacter	and artcl
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- Attorneys										
= Accountants										
- Bankers									Accepts Fee	
Help and Search Hints	Na	2014		Company		(City, State		Assignment	is .
Affintes	SELECT Sar	ndra K. Adomatis, S	RA	Adomatis Ap	praisal Service	F	Punta Gorda, FL		Yes	
Life-Retired Members Retired Members	SELECT Joh	hn T. Ashworth, III, S	SRA *	Ashworth Ap	praisal Services		Auburn, CA		Yes	
In Memoriam		bert D. Blincow, MA		Principal Re	al Estate Investors		Des Moines, IA		Yes	
Manage My Account		wid P. Bouverat, SR		Key Apprais			Sarasota, FL		Yes	
		mald N. Briggs, MAI,		Briggs Asso			Emmitsburg, MD		Yes	
Designated		eddi W. Chappell, M		Sustainable			Park City, UT		Yes	
Member?		nn N. Christensen, S aven D. Clauson, M/		Real Estate	nsen Appraising Inc.		ayton, UT		Yes Yes	
Add a Profile		oven D. Clauson, Mr chael D. Collas, SR/		JP Morgan (Nashington, DC Fampa, FL		No	
Update your 🛛 📀		njamin B. Davidson.		~	ssociates, LLC		Conifer, CO		Yes	
Account Information		a K. Desmarais, SR			k Appraising, LLC		Broomfield, CO		Yes	
		ristopher B. Dollard,		P Bak to P Ba	Appraising, LLC		Skilman. NJ		Yea	
		mar H. Ellis, III, SRA					Vilanta, GA		Yes	
		thony L. Ginesi, Jr.,		Real Proper	y Consultants, Inc.		Clark, NJ		Yes	
		ren L Goforth, MAI *			Bank - RETECHS		St. Petersburg. F	L	Yea	
		anklin Frederick Griff			Estate & Appraisals		Tampa, FL		Yea	
	SELECT Ste	eve L. Hales, SRA*			opraisal Services, LLC	(Ogden, UT		Yes	
		argaret A. Hambletor	1, SRA *	Hambleton,	inc.	(Columbus, OH		Yes	
	SELECT Ch	ristopher T. Hansen	MAI*	Appraisal Gr	oup, Inc.	,	Vidvale, UT		Yes	
	SELECT Mic	chael H. Hatch, SRA		Michael Hat	h Real Estate Appraisal, In	ic l	as Vegas, NV		Yes	
	SELECT Cra	aig S. Heaton, SRA		C. S. Heator	Appraisais, Inc.	,	Mesa, AZ		Yes	
	SELECT Rol	bert D. Hensley, MA	4.	CB Richard	Ellis, Inc.	1	Nainut Creek, C.	ñ,	Yea	
	and the second s	ni L. Hemdon, SRA		Real Proper	y Analysts/Gulf Coast	1	Fampa, FL		Yes	
		chael Hobbs, SRA			aisal & Consultancy		Chicago, IL		Yes	
		niel J. Houlihan, MA		Houlihan & I	Malley Real Estate Service		Bronzville, NY		Yea	
		shard W. Hughes, M					Adel, IA		Yea	
Visit Lum Library		thony C. Iaccio, MAI		Blake & lacc			Manhattan, NY		Yes	
Sign up for		ske Ingram, SRA *			Appraisal Group, Inc.		Salt Lake City, U	T	Yes	
Appräiser News Online 🖡		ary A. Jewell, SRA *		Morgan Star			Fempe, AZ		No	
	SELECT Jef	ffrey R. Jorgensen, S	SRA 1	Jorgensen P	esidential Appraisal	t	Draper, UT		Yes	

http://www.appraisalinstitute.org/findappraiser/green_sustainability_residential.aspx

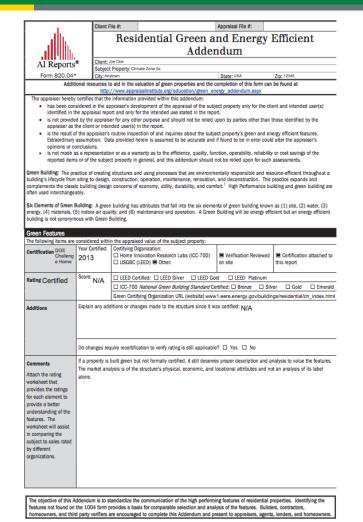
Valuation of Sustainable Buildings: Residentia



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.



¹ U.S. Environmental Protection Agency at <u>www.epa.gov/greenbuildings/pubs/about.htm</u>.

^{*}NOTIC: The Approximation and the specific method of the specific

Residential Green and Energy Addendum

U.S. DEPARTMENT OF **ENERGY**

Client File #:

Client:

Joe Doe

Energy Efficiency & Renewable Energy

Client:	Joe Doe						Client File #				
Subject Property:	Climate Zor	ne 5					Appraisal Fi	e #:			
ENERGY EFFICIENT	ITEMS										
The following items are	e considered within	the app	raised val	ue of the subj	ect p	property:					
Insulation	Fiberglass Blo	wn-In	🗏 Foam li	nsulation 🛛	Cel	lulose 🗆 Fibe	rglass Batt Insu	lation	R-Value:		
	Other (Describ Other (Describ	e):							U Walls	35	
	Basement Ins	ulation (Describe):	High Den	sit	y SPF			Ceilin	e	
									E Floor		
	HERS Insulation	on Instal	led Rating	:01 02		3 (See Glossar	Y)			30	
	Envelope Tightne		05			Unit: CFM	25 CFM5		ACH50 E	ACHnatural	
Envelope							20 LI CFM0		KCHOU L		
	Envelope Tight Reclaimed Water			lower Door Tes	ι			Locatio	n of cistern		
Water Efficiency	(Explain):			Cistem	- Siz	te: Gallons					
	Greywater reu	co curtor	-			dallena					
	WaterSense®			🗆 Rain Ba	rrels	s Provide Irrigation					
Windows	ENERGY	Low	E	High Impa	ct	Storm	Double Pan	е от	nted	Solar Shades	
	STAR®		- r Tubes -	Other (Exc			Triple Pane			ENERGY STA	
Day Lighting	#:	#:								Light Fixtures	
Appliances	ENERGY STAR®		Water He	ater:		pliance Energy So					
	Appliances: Dishwasher		Solar	Pump	Propane Electric Natural Gi Other (Describe):				as		
	Refrigerator a	efrigerator all 🔲 Tankles		ess 🗖 Coil	ss 🗖 Coil						
		es	Size:	Gal.							
HVAC (Describe	High Efficience	, HVAC	Heat I								
in Comments Area)	SEER: 14	, IIIAC	Efficiency	y Rating:				Passive Solar			
	Efficiency Rating: AFUE* 95	% %	COP:			Thermostat/Contr	ollers				
	*Annual Fuel-Uti		HSPF: §	9					(Defined in Glossary)		
	Efficiency		SEER: EER:								
	E Programmable	e Thermo	stat		Radiant Floor Heat Geothermal				rmal		
	ENERGY STAR	^e Home	- Version:		-						
Energy Rating				3							
	C Other (Describ	e):									
	Home Energy Sco	ore (HES) (Score ra	ange 1-10): 4	6						
	Certification A	ttached									
Indoor Air Quality	Indoor Air PLU Package	S	Energ System	y Recovery Ve	ntila	tor Unit or Whole	Building Ventila	tion	Non To	xic Pest Control	
HERS Information	Rating: 46			Energy Saving	s on	Rating: \$ 18.5	0		Date Rate	₫5/15/13	
Utility Costs	Average Annual L	Utility Co	st: \$ 14	1 per	mo	nth based on: RE	M/rate		# of Occup	pants: 4	
Energy Audit N/A	Infrared Photo	graph At	tached								
						bject property?	🗆 Yes 🗆	No	Unkno	nwo	
	If yes, comment of										
Comments	Information was	provided	by: Rate	er's Name	an	nd Company					
(Include source for information provided											
in this section)						reports, fille					
Attach documents or						enewable rea		olar e	lectric a	nd EPA	
reference them in			rene	wable fea	±OY	home solar	mermai				
your workfile											
The energy element											
is the most											
measurable element											
of green or high performance housing.											
performance housing.											

*NOTICE: The Appraisal Institute publishes this form for use by appraisers where the		
need to provide additional data, analysis and work product not called for in this form	 The Appraisal Institute plays no role in completing the form and dise 	claims any responsibility for
the data, analysis or any other work product provided by the individual appraiser(s).		
Al Reports® AI-820.04 Residential Green and Energy Efficient Addendum	C 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 co			value of the subj		RENEWAB	LE READY HOME	
Description N/A		Leased Owned	Array #2	Leased Owned	Descript	ion	Solar Thermal Water
		Li Owned	-	LI Owned			Heating System
kW (size)					If Active	System - type	Direct D Indirect
Manufacturer of							E
Manufacturer of Panels					IT Passr	ve System - type	Integral collector Thermosyphon
raneis							
Warranty on Panels					Storage	Tank Size	
manually on Fanois					otorage	Talik oleo	# Gallons:
Age of Panels					Collecto	or Type	
							Flat-Plat Collector
					1		Integral Collector
Energy Production kWh							Evacuated-Tube Solar
per Array							
Source for Energy					Deals II.	o System	Conventional Water Ht
Production Estimate					Dack-U	o aystem	Tankless On Demand
							Tankless Heat Pump
Location (Roof,					Age of S	System	
Ground, Etc.)						.,	
Tilt/Slope for Array					Warrant	ty Term	
Azimuth per Array					Manufa	cturer	
Age of Inverter(s)					Solar Fr	ergy Factor (SEF)	
APE OF INVENTION(S)							
						range 1 to 11 -	
Manufacturer						umber is more	
					efficient)	
Warranty Term							
Name of Utility Company:			Cost per kWh cl	harged by Cor	npany:	\$ /kWh	
Comments	Discuss source of	information	and define othe	r renewable e	nergy sou	rces, such as wind, h	ydropower, biomass power,
(Discuss incentives	etc.						
available for new	This home is	ronow	able ready f		o otrio d	and thormal	
panels, condition of	This nome is	stellewa	able ready it	or solar er	ecuic a	anu mermai.	
current panels, and any							
maintenance issues. If							
leased, provide the							
lease terms.)							
A free online tool and							
manual for valuing the	1						
energy production	1						
of the Solar PV	1						
System is available							
at www.pvvalue.com							
Download the							
PV Value™ Manual							
for explanation of							
the solar terms on this	1						
form and inputs used in							
the PV Value Tool.							
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*NOTCE: The Approximation instants provided by the parameters where the appropriate deems use of the firm appropriate. Deparading on the assignment of the segment appropriate decars and appropriate decars a January 2013

Residential Green and Energy Addendum

U.S. DEPARTMENT OF ENERGY

Energy Efficiency & **Renewable Energy**

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

Loca

The f Walk

Pub

Con

Ince

Ap

ation - Site										
following items are considered within the appraised value of the subject property:										
k Score N/A	Score:	Source: (Example: http://www.walkscore.com)								
lic Transportation	Bus - Distance:	Blocks	Train - Distance:	Blocks	Subway - Distance:	Blocks				
1	Orientation - front faces:		Landscaping:	Natural						
nments	DOE Challenge H and its high perfor			tes only on	the actual physical	building				
	I									
entives - Amount of Incentive and Terms										
following items are considered within the appraised value of the subject property:										
terro die t	and a second and a second a s		in any construction of the							

The following items are	considered within the appra	ised value of the s	ubject property:		
Federal					
State					
State					
Local					
Source					
(For example					
www.dsireusa.org)					
Comments					
Incentives offset cost					
and should be					
reported in the cost					
approach section of the report.					
Incentives are typically					
not a sales					
comparison approach					
concession since they					
do not transfer with					
the property.					
Completed by: Build	der or Rater		GC or Rater	Date: 5/15/	/13



Residential Green and Energy Efficient Addendum Glossary and Resources

ICC-700 National Green Building Standard (NGBS): An ANSI-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 lot development techniques and address energy, water & material resource efficiency and indoor environmental quality. Also, all owners 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/generic/sectionID=2510 or http://www.homeinnovation.com/

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?CMSPageID=1988

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.energystar.gov/index.cfm?c=new_homes.hm_index

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 homes' 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://www1.eere.energy.gov/buildings/residential/hes_index.html

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.resnet.us/hers-index This Index is assessed by a qualified third party certifier based on the physical characteristics of the house. The energy estimates from this assessment may vary depending on the lifestyle of the occupants, increasing utility expenses, and changes in the maintenance or characteristics of the energy features.

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 owno uses the constant below ground temperature of soil or water to heat and cool your home. http://energy.gov/energysaver/articles/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 ultra violet rays are blocked and insulation enhanced.

Whole Building Ventilation System: A whole building ventilation system assists in 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 Ventilators (HRV). These systems replenish the indoor air without wasting all the energy already used to heat the indoor air. In some climates, these systems are 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://rredc.nrel.gov/solar/glossary A complete passive solar building design has the following five elements: (1) aperture (collector) (2) absorber (3) thermal mass (4) distribution (5) control. http://www.nrel.gov/docs/fy01osti/27954.pdf

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/index.cfm?c=tax_credits.tx_definitions&dts=ssps,mcs,seer,ee

Water Sense: EPA released its Final Version 1.1 WaterSense New Home Specification. This specification will be effective January 1, 2013 and establishes 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 homes/homes final.html

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

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

HERS Insulation Installed Rating: Rating 1 is the best with 3 the lowest rating. http://www.resnet.us/standards/Enhancements_to_National_Rating_Standards.odf

SAVE Act: The SAVE Act is proposed legislation to improve the accuracy of mortgage underwriting used by federal mortgage agencies by ensuring that energy costs are included in the underwriting process. http://www.imt.org/finance-and-leasing/save-act

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Business Metrics



Cost

- True Credit/Debit Costs
- Time of Sale
- Profit Margins
- Call-Back Expenses

Marketing

- Homebuyer Visits
- Media Exposure
- Referrals

Performance

- Customer Satisfaction
- Actual Billing Data



Energy Efficiency & Renewable Energy

Zero Net-Energy Ready **Technical Specifications Encouraged:** Water Conservation



Energy Efficiency & Renewable Energy

• **1950 – 2000**:

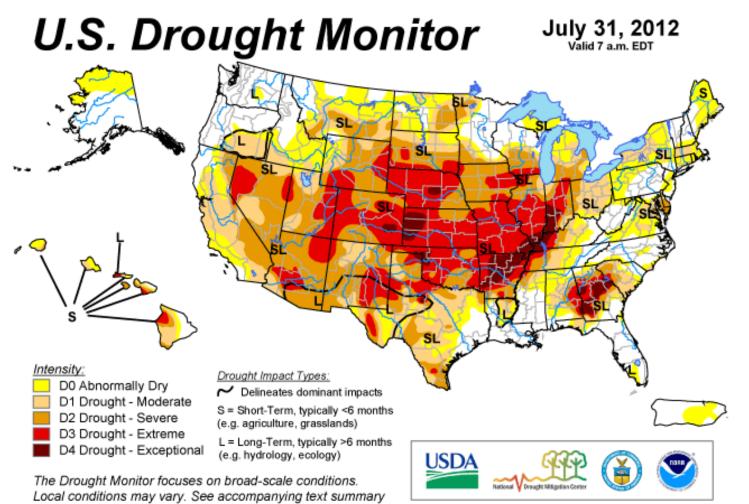
U.S. Population Doubled Public Supply Water Demand More than Tripled

Since 2011: > Half the U.S. with

Some Level of Drought.



ENERGY Energy Efficiency & Renewable Energy



Released Thursday, August 2, 2012 Author: Mark Svoboda, National Drought Mitigation Center

http://droughtmonitor.unl.edu/

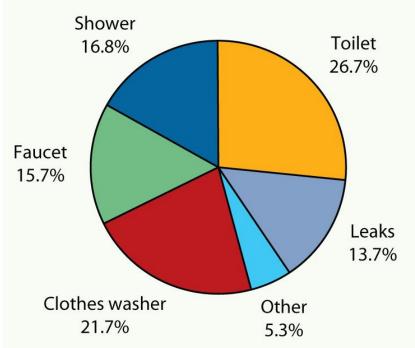
for forecast statements.

Water Use at Home



- More than 1.2 million homes were constructed in 2010 and 2011 in U.S.
- Average water use is 70% indoors, 30% outdoors.
- Outdoor use is higher in Southwest and other dry regions.
- 20% savings readily achievable

Residential Indoor Water Use



Water Efficiency as a System



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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)

WaterSense Labeled Products



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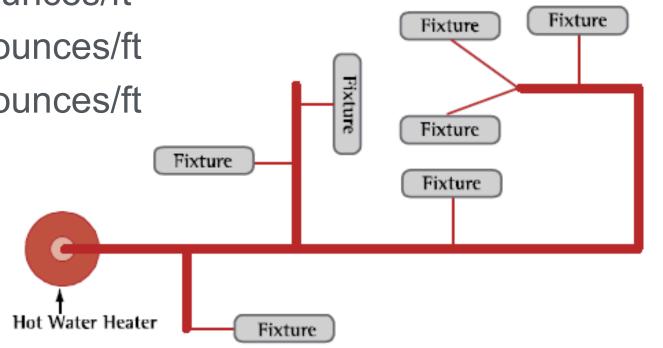


Labeled products are listed at: www.epa.gov/watersense/products

Built for when water was free and energy was cheap!

Copper L piping:

- 1" = 5.53 ounces/ft
- ³/₄" = 3.22 ounces/ft
- 1/2" = 1.55 ounces/ft



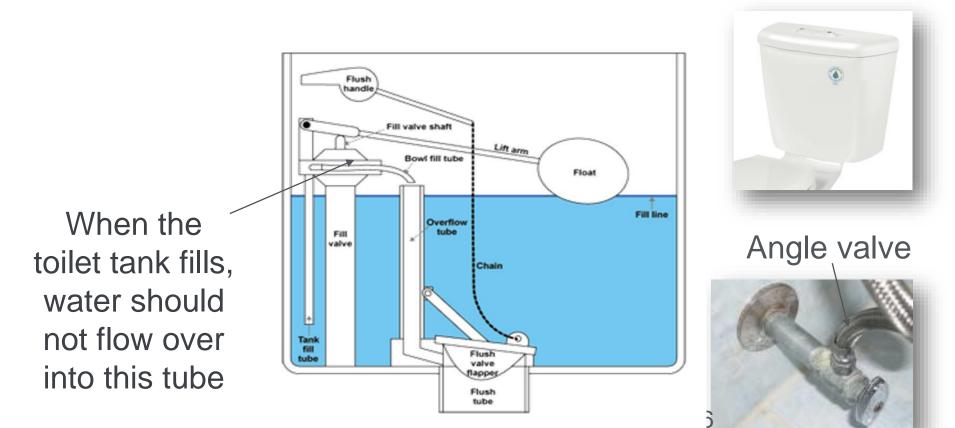


- The system shall store no more than 0.5 gallons in any piping/manifold between the hot water source and any hot water fixture.
- No more than 0.6 gallons of water shall be collected from the fixture before hot water is delivered (accounts for water that must be removed from the system before hot water can be delivered).
- Recirculation systems must be demand initiated (push button or motion sensor).
 - Timer and temperature activated recirculation systems do not meet this requirement.



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All toilets shall be WaterSense labeled tank-type.





All bathroom sink faucets or faucet accessories (e.g., aerators) shall be WaterSense labeled.

Bathroom sink flow test





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All kitchen sink faucets must have a maximum flow rate of 2.2 gpm.



Valve and connection hoses

Kitchen sink flow test



Shower compartment requirements:

- The total allowable flow rate of water flowing at any given time from all showerheads must be limited to 2.0 gpm per 2,160 square inch (in²) increment or less of shower compartment floor area.
- Additional showerheads are allowed for each additional 2,160 in² floor area increment, provided the total flow rate from all flowing devices in each compartment is less than or equal to 2.0 gpm and the additional showerheads are operated by separate controls.

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Showerhead requirements:

- All showerheads shall be WaterSense labeled.
- In cases where more than one showerhead or hand-held shower is provided in combination with others in a single device intended to be connected to a single shower outlet, the entire device must meet the maximum flow requirement in all possible operating modes.







Showerhead flow test





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- If a dishwasher is installed, it shall be ENERGY STAR[®] qualified.
- If clothes washer are installed, including those in common-use laundry rooms, they shall be ENERGY STAR qualified with a water factor (WF) ≤ 6.0 gallons per water cycle per cubic foot capacity.



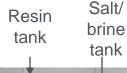
If an evaporative cooling system is installed, it must meet the following criteria:

- Shall use a maximum of 3.5 gallons of water per ton hour of cooling when adjusted to maximum water use.
- Blowdown shall be based on the time of operation, not to exceed 3 times in 24 hours.
- Once-through or single-pass cooling systems, systems with continuous blowdown/bleedoff, and systems with timer-only mediated blow-down management do not meet the requirements.

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If a water softener is installed, it shall be certified to meet NSF/ANSI 44 including Section 7 voluntary requirements for efficiency rated systems, including:

- Use demand-initiated regeneration controlled by a flow meter or water hardness sensor.
- Have a rated salt efficiency ≥ 3,350 grains of total hardness exchanged per pound of salt (NaCl equivalency).
- Must not include devices that use a clock timer to set regeneration on a fixed time schedule.
- Must not regenerate using more than 5.0 gallons of water per 1,000 grains or hardness removed during the service cycle.





Drinking Water Treatment



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- If a drinking water treatment system is installed, it must be certified to meet applicable NSF/ANSI standards:
 - NSF/ANSI 42 Drinking Water Treatment Units Aesthetic Effects
 - NSF/ANSI 53 Drinking Water Treatment Units Health Effects
 - NSF/ANSI 55 Ultraviolet Microbiological Water Treatment Systems
 - NSF/ANSI 58 Reverse Osmosis Drinking Water Treatment Systems
 - NSF/ANSI 62 Drinking Water Distillation Systems
- Such systems shall yield at least 85 gallons of treated water for each 100 gallons of water processed (i.e., it shall have an efficiency rating equal to or greater than 85%).

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In multi-family buildings, each unit must be individually metered, submetered, or equipped with an alternate technology capable of tracking water use and making the information available to the residents of the individual unit.

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WaterSense Water Budget applied to:

- Front Yard only for single-family homes
- All areas improved upon by the builder for single-family and multi-family buildings
- Temporary landscapes (e.g., straw over bare soil) may be installed if permanent landscapes cannot be installed due to climate conditions.

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If an Irrigation System is installed, it must:

- Be designed or installed AND audited by a professional certified by WaterSense program
- Use fixed spray irrigation on turfgrass only and achieve at least a 65 percent distribution uniformity
- Use drip or micro irrigation on all plants other than turfgrass
- Include WaterSense labeled irrigation controllers
 or soil moisture sensors



Zero Net-Energy Ready **Technical Specifications Encouraged: Disaster Resistance**

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Disaster Resistance as a System

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Weather

- Wind
- Hurricanes
- Tornado/Hail
- Severe Winter Storms

Natural Events

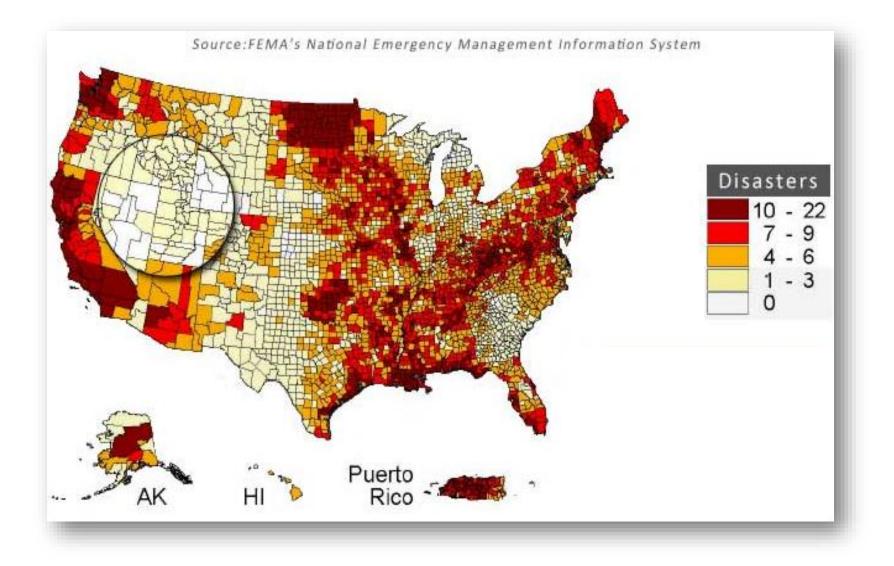
- Floods
- Wildfires
- Earthquakes

Pests

- Termites
- General Pests

U.S. Disaster Map

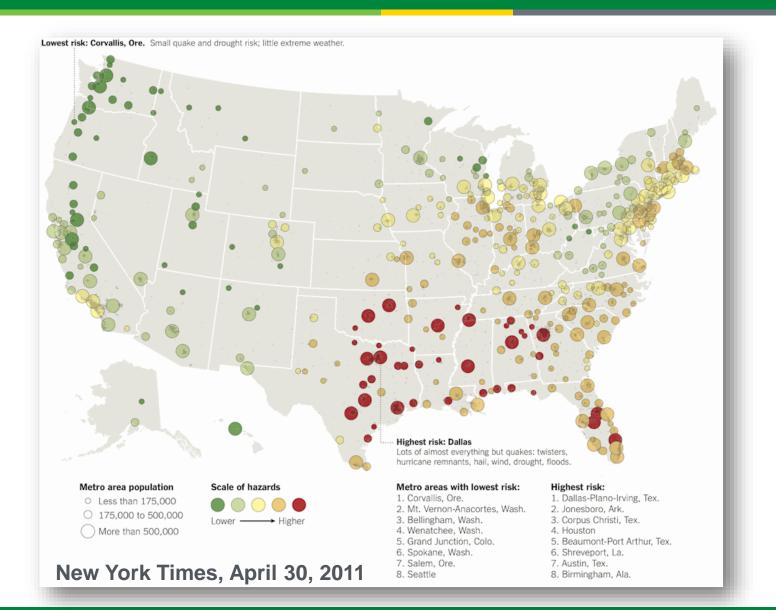




Disaster Risk in the U.S.

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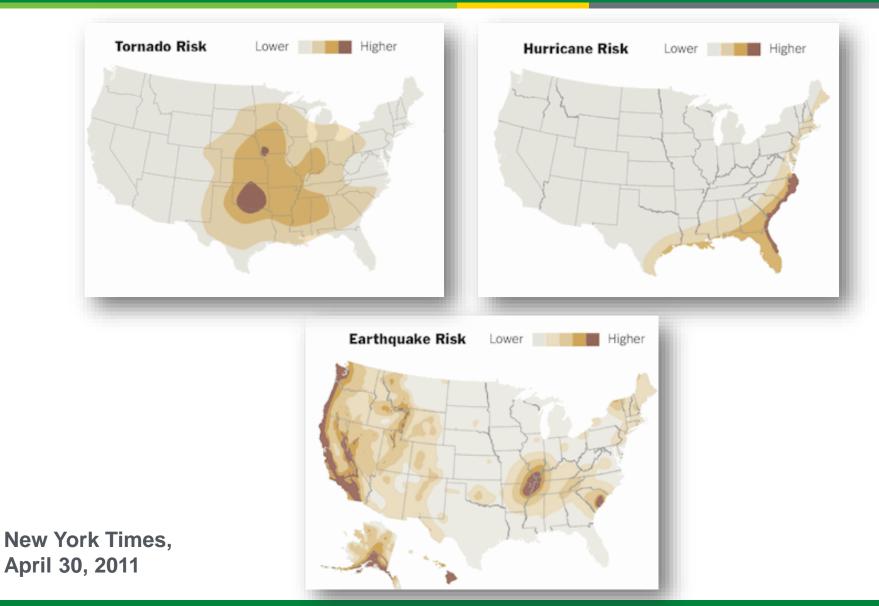
Energy Efficiency & Renewable Energy



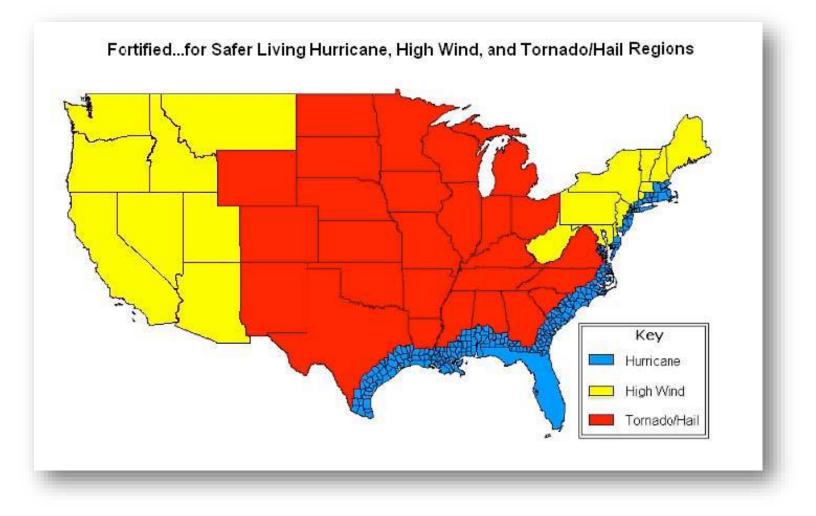
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Disaster Risk in the U.S.

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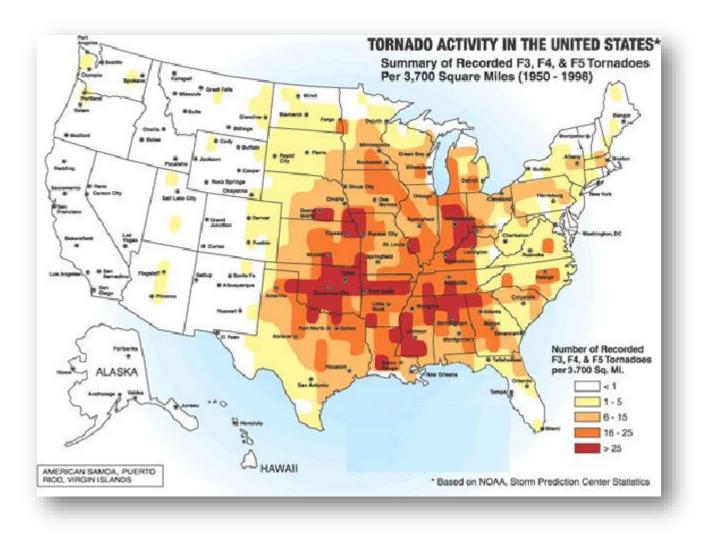
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Weather: Tornado Risk Map



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Weather: Hurricane Risk Map



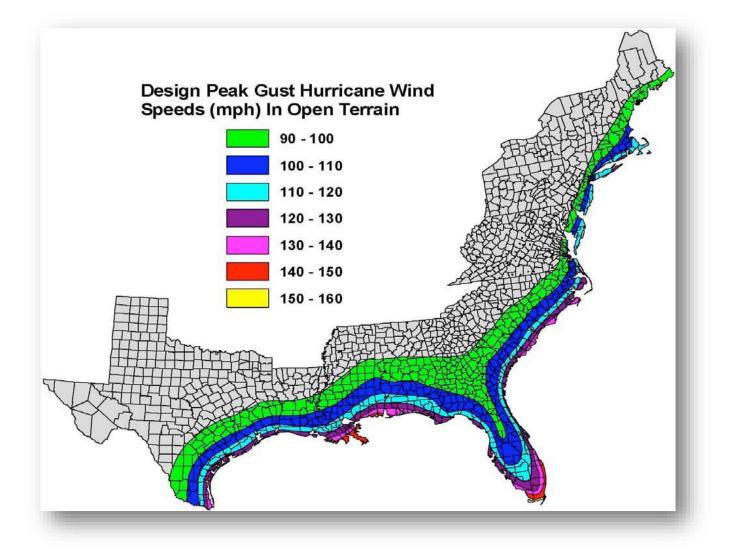




Table 3-2: Adding 20 MPH to ASCE 7 basic wind speeds for FORTIFIED Design Wind Speed requirements (MPH)

ASCE 7 Wind Speed	Building Code Design Wind Speed (or interpolate between values)	FORTIFIED Design Wind Speed
< 90	90	110
90 - 100	100	120
100 - 110	110	130
110 - 120	120	140
120 - 130	130	150
130 - 140	140	160
140 – 150	150	170
> 150	150	170



One Requirement:

Install an impact resistant roofing

[UL 2218 Class 4 or FM 4473 Class 4 which is appropriate for flexible roofing products like asphalt shingles and metal panels or shingles]

A continuous load path in wood frame construction:

- 1. metal connectors between the rafters/trusses and the double top plate,
- 2. various systems involving connectors, sheathing, rods, hold-downs, etc to transfer loads from the top plate through the wall and into the foundation
- 3. properly designed and detailed foundations

A continuous load path in masonry construction:

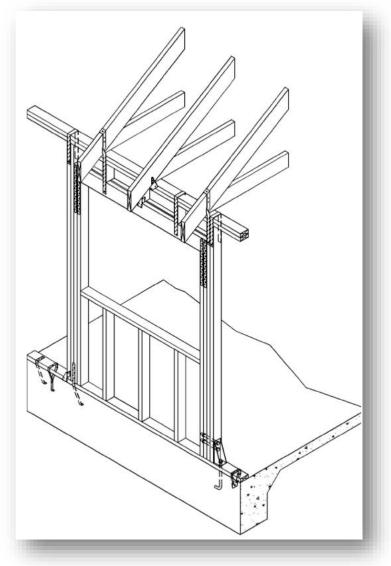
- 1. metal connectors between the rafters/trusses and the bond/tie beam,
- 2. horizontal re-bar installed in the bond/tie beam,
- 3. vertical re-bar in fully grouted cells (number and location depends on design conditions) connecting to
- horizontal steel in the footing/foundation (Figure 3-10)

Weather: Wind Continuous Load Path



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Typical wall connections with stud spacing the same as truss/rafter spacing. Figure 305G-1, IBHS Guide





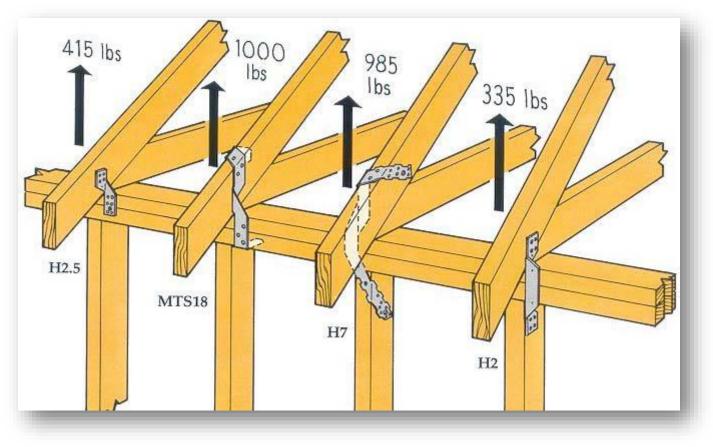
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Installation of secondary water resistance using self-adhering strips.





Metal straps, clips, and connectors installed on the outside of the wall.

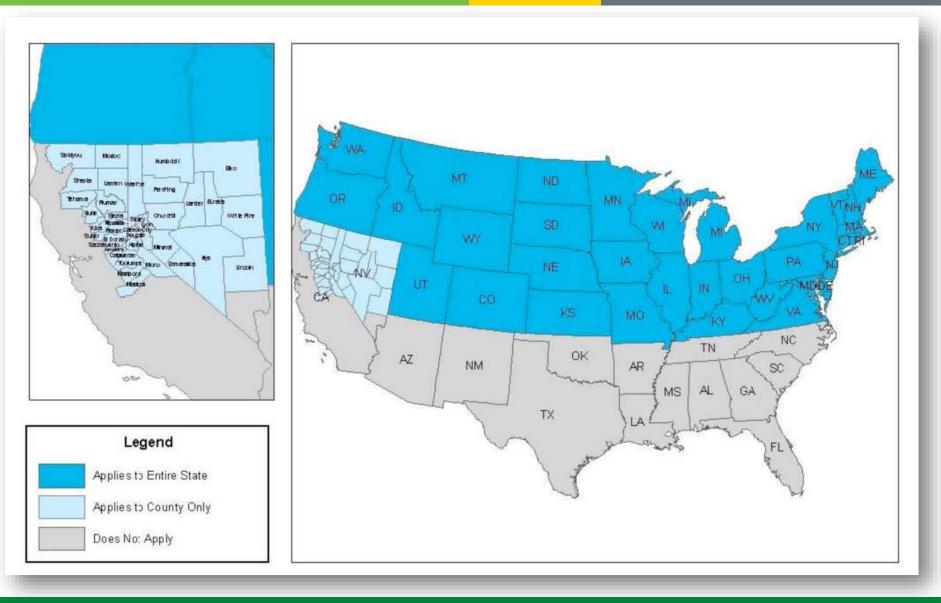




Metal straps, clips, and connectors installed on the inside of the wall.



Weather: Severe Winter Weather Risk Map



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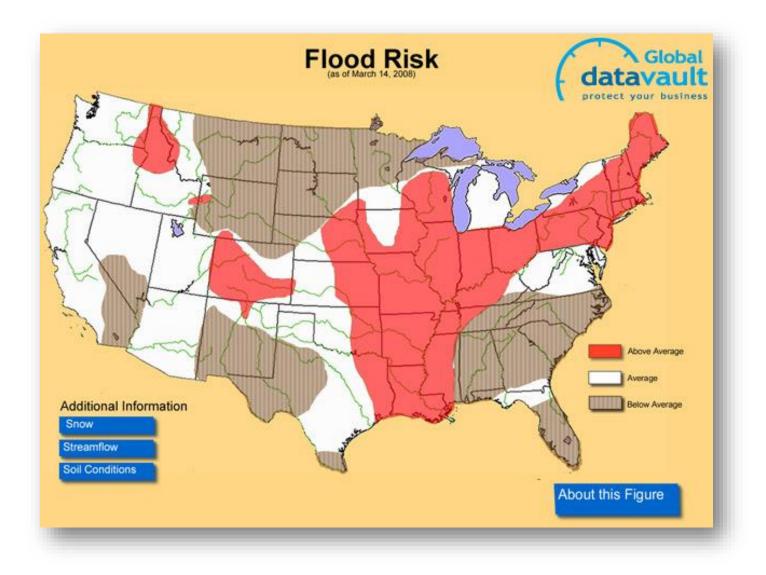
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- Added moisture barrier at roof eaves (ice flashing)
- Heating strips at drains on flat roofs
- No heat source installed in unconditioned attic
- No uninsulated recessed lights
- All attic access doors treated as exterior doors (insulated, sealed, and weather stripped/gasketed)
- All hidden attic penetrations (stack vents, partition walls, electric chases, etc.) properly sealed
- Sufficient insulation on piping in exterior assemblies or prohibit pipes in external assemblies or unheated spaces

Natural Events: Flood Risk Map

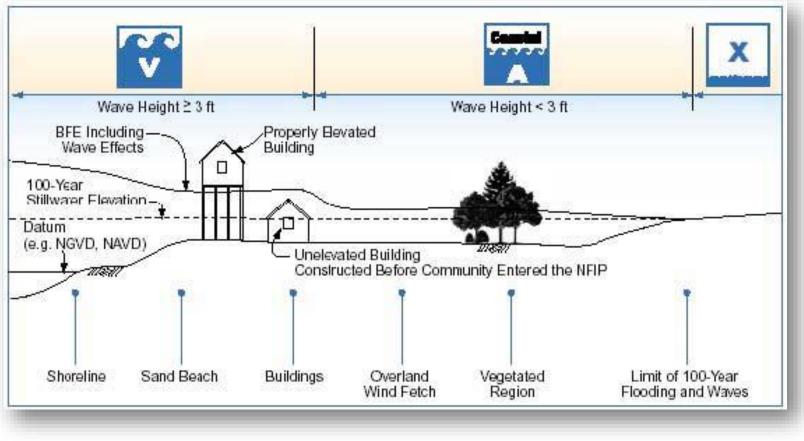




Minimum Requirements of the National Flood Insurance Program (NFIP) except:

- The building must be at least 3' higher than the BFE (Base Flood Elevation)
- The foundations in Coastal A zones must adhere to same requirements as those in V zones. That is, only open elevated foundations are allowed.



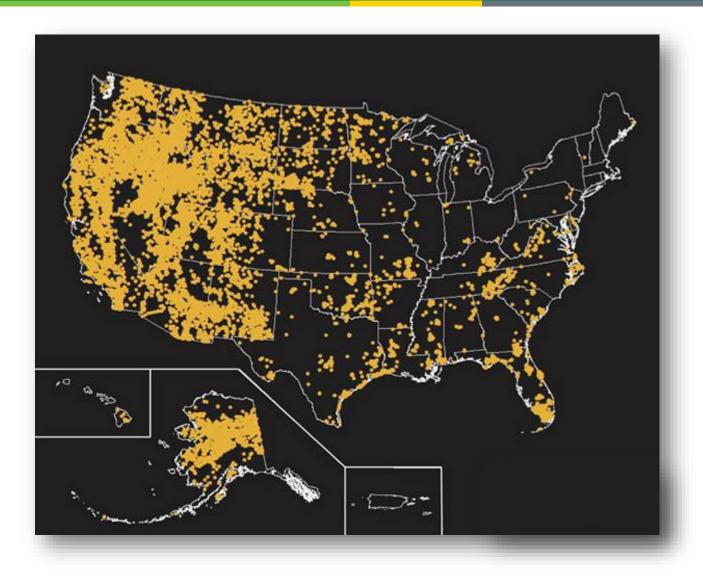


Typical shoreline elevation showing flood zones V, Coastal A and X (Coastal Construction Manual, 3rd edition, FEMA 55).

Natural Events: Wildfire Risk Map



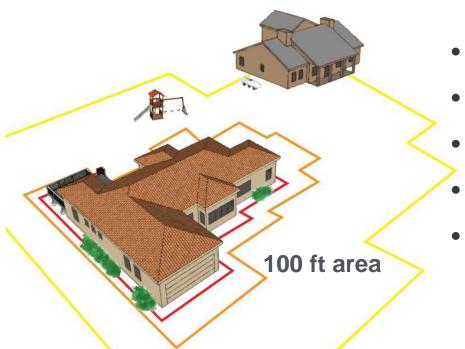
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- Non-combustible street number at least 4' high
- Firewood Storage and LP Containers at least 50' away from home structure and at least 15' defensible space
- Non-combustible screening covering attic/sub-floor vents
- Gutters and downspouts of noncombustible materials
- Min. 12' wide driveways with min. 13.5' vertical clearance
- Gates must open inward and at least 2' wider than driveway
- Individual fire extinguishers
- Spark arrestors in all chimneys
- Defensible space that varies by hazard area classification
- Additional requirements base on hazard area classification (extreme, high, or moderate)

Defensible Space Varies:

- Extreme Hazard Area -100'
- High Hazard Area 50'
- Moderate Hazard Area 30'



Defensible Space Characteristics:

- Grass mowed below 6"
- Regular Irrigation
- For trees >18', prune lower branches within 6' of ground

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- Trees at least 10' apart
- No tree limbs within 10' of home
- All plants or plant groups >20' apart
- No vegetation under decks
- Remove all dead/dying vegetation



Combustible and Non-combustible Soffit Materials Combustible

- Vinyl
- PVC
- Wood boards or panels less than or equal to ¹/₂" thick (including plywood and OSB)

Noncombustible

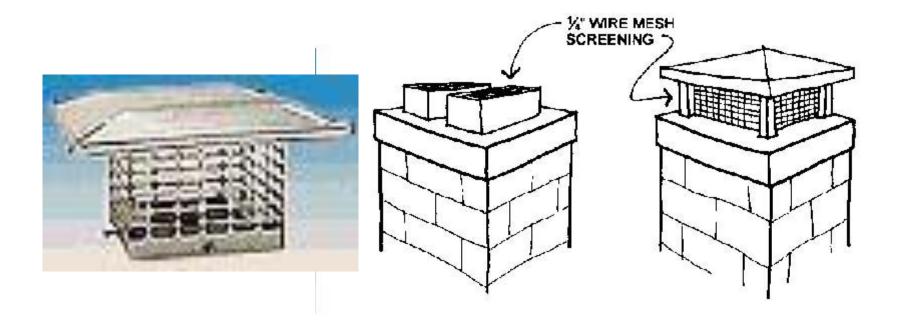
- Aluminum
- Wood boards or panels greater than ¹/₂" in thickness (including plywood and OSB)
- Cementitous soffit board

Wildfire Protection Criteria that Varies by Wildfire Hazard Level

Natural Events: Wildfire Spark Arrestors

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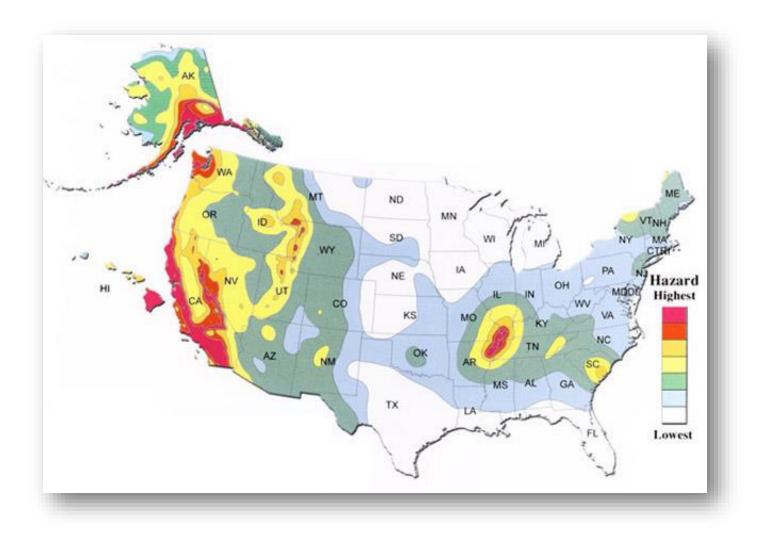
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Spark Arrestor for chimney

Natural Events: Earthquake Risk Map

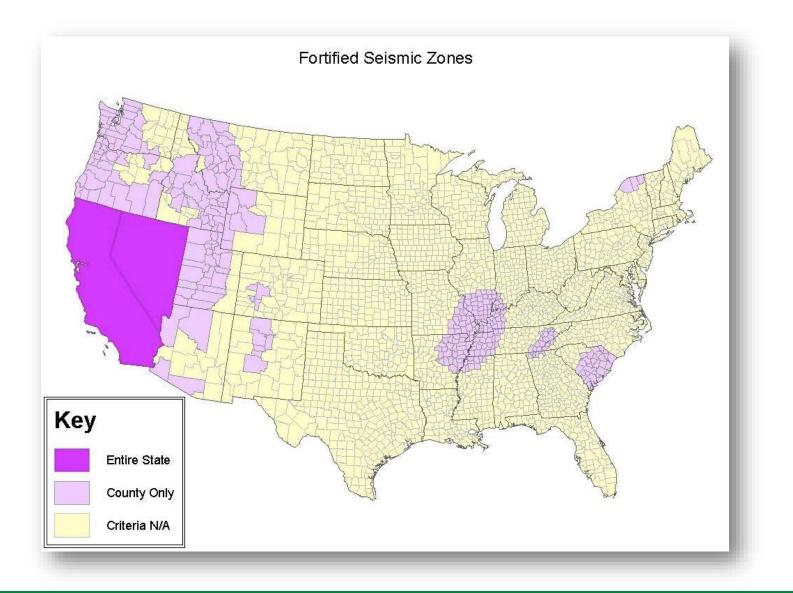




Natural Events: Earthquake Risk Map

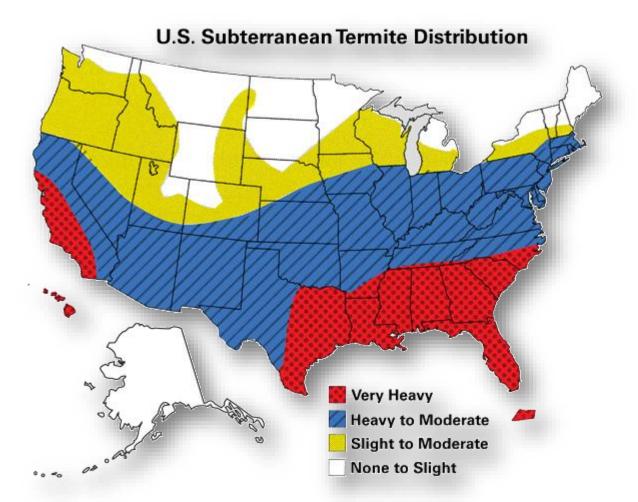


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Pests: Termite Infestation Chart





Note: Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.

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- Termite Resistant Construction
 - Treated Wood Framing (e.g., Borate)
 - Steel Framing (but need to address thermal bridging)
 - Masonry Construction

Pest Control

- Air-Tight Construction
- Screened Openings
- Integrated Pest Management (IPM)



Zero Net-Energy Ready **Technical Specifications Encouraged: Quality Management**

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1. Complete Construction Documents

- Qualify as Designed to Earn ENERGY STAR
- Document all Challenge Home specifications

2. Integrated Design Process

- Meet with all trades/rater early in the design process
- Document all meeting outcomes
- LEED for Homes Integrated Process Prerequisite complies

3. Formal Quality Management Program

- Written procedures and field checklists
- In-house inspections and field-test protocols
- Training requirements for staff and contractors



Zero Net-Energy Ready **Technical Specifications: Best Practices Efficient Low-Load HVAC**

Efficient Low-Load HVAC



Challenge Home Target Home Specifications:

	Hot Climates IECC CZ 1-2	Mixed Climates IECC CZ 3-4 except Marine	Cold Climates IECC CZ 5-8 and 4 Marine
AFUE	80%	90%	94%
SEER	18	15	13
HSPF	8.2	9	10
Geo HP	ENERGY STAR EER and COP Criteria		
ASHRAE 62.2 Whole-House Ventilation	1.4 cfm/W: no heat exch.	1.4 cfm/W: no heat exch.	1.2 cfm/W: w/heat exch. 60% SRE



- Challenge Home Technology Options
 - Variable-Speed or multi-stage
 - Ductless Mini-Split Heat Pump Systems
 - Optimized distribution
 - GSHPs
 - Combi-Systems [e.g., heat, water heating, vent.]



Zero Net-Energy Ready **Technical Specifications: Best Practices Efficient Components**

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- ENERGY STAR Gas Water Heating
 - Storage with $EF \ge 0.67$
 - "Extra Credit":
 - Whole-Home Tankless with $EF \ge 0.82$
 - Condensing with $EF \ge 0.8$
- ENERGY STAR Electric Water Heating
 - Heat Pump Water Heater with $EF \ge 2.0$
- ENERGY STAR Solar Water Heating
 - Solar with SF \geq 0.5
- Oil Water Heating
 - Any oil-fired water heater with EF ≥ 0.6

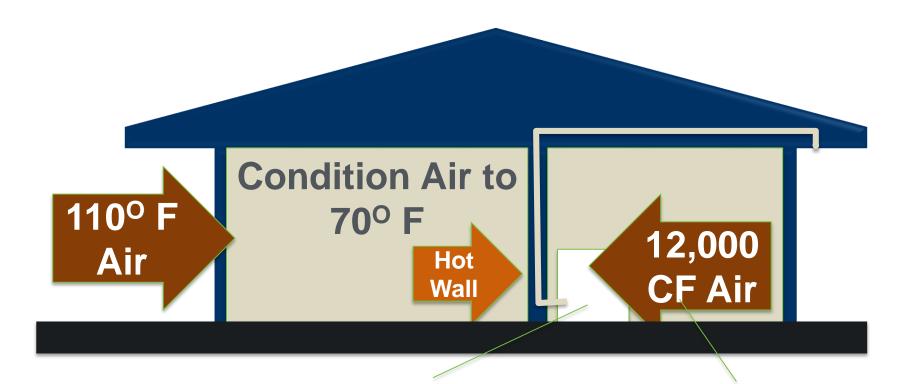


- Heat Pump Clothes Dryer
- Induction Cooktop

Typical Clothes Dryer Inefficiency

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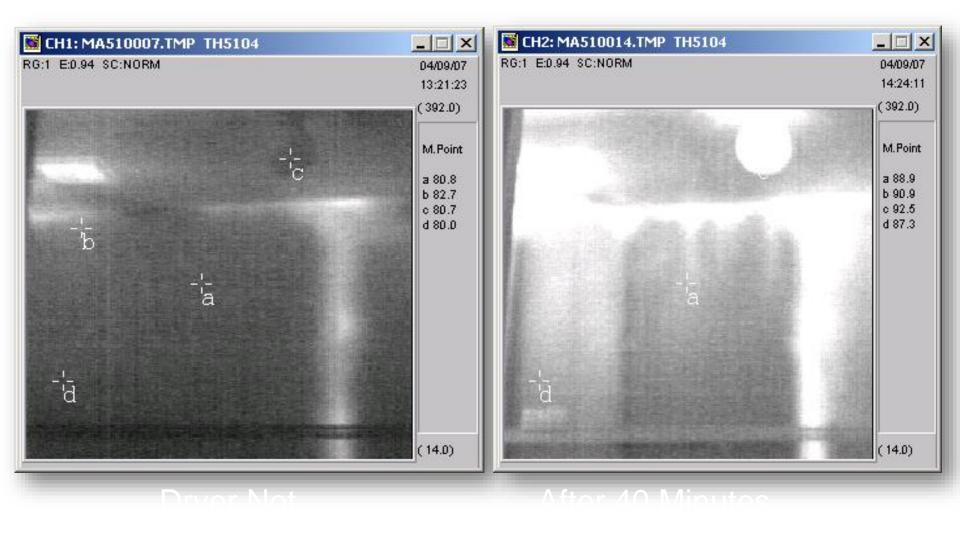
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Heat 70^o F air to 125^o F, circulate to remove moisture, and then exhaust All air in a 1,500 sf home exhausted out over 60 minute cycle

Typical Clothes Dryer Hot Wall

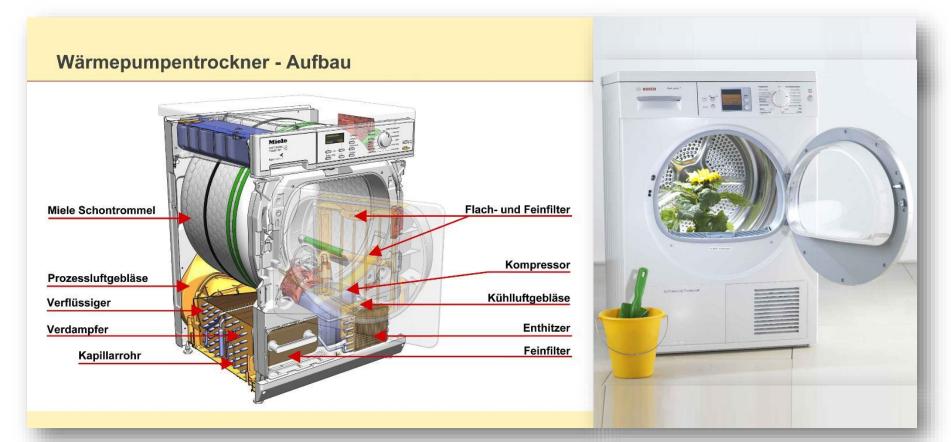
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Advanced Heat Pump Clothes Dryer

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4.5 vs. 12,000 CF Air Plus No Exhaust Vent

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Advanced Induction Cooktop

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