



DOE Zero Energy Ready Home



The Easy Lift to Zero from
ENERGY STAR Homes

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Newport Partners

Technical Director, DOE ZERH

- **~230,000**
- **62**
- **~85,000**



**10,000s of homes are
within reach of DOE Zero
Energy Ready Home. Now.**



Specifications: The Easy Lift from ENERGY STAR

Eligible Building Types

- Same as *ENERGY STAR* Homes



- SFD and SFA dwellings



- MF buildings up to 5 stories;
- Central HVAC and DHW is allowed



- Focus is New Construction; Substantial Rehabs can be qualified;

Context...

			Solar Ready
			Eff. Comps. & H ₂ O Distrib.
			EPA Indoor Air Package
			Optimized Duct Location
	HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV
	Water Management	Water Management	Water Management
	Independent Verification	Independent Verification	Independent Verification
IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Enclosure
HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55
IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH

Stepping up to ZERH...

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DOE ZERH Target Home Sets the HERS Value

Exhibit 2: DOE Zero Energy Ready Home Target Home ^{7, 20}

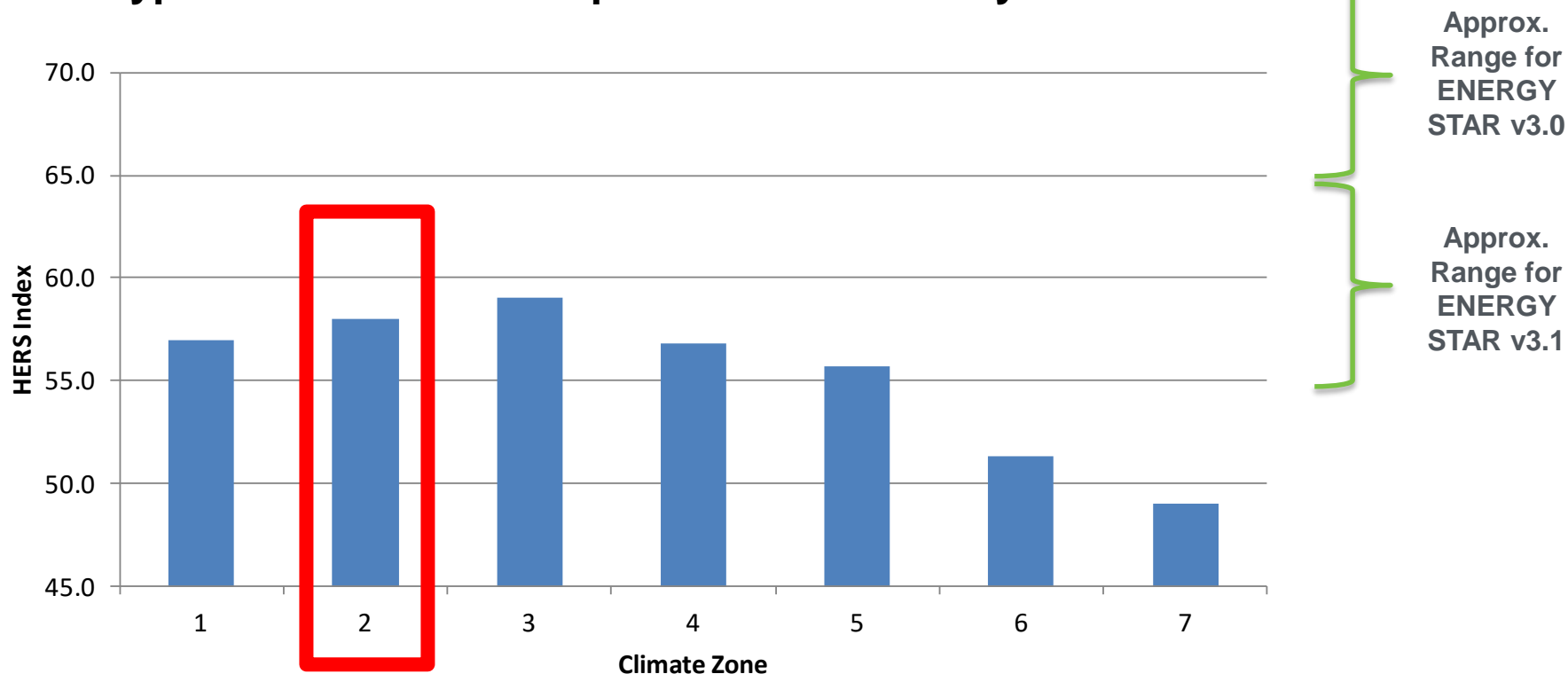
HVAC Equipment ²¹			
	Hot Climates (2012 IECC Zones 1,2) ²²	Mixed Climates (2012 IECC Zones 3, 4 except Marine)	Cold Climates (2012 IECC Zones 4 Marine 5,6,7,8)
AFUE	80%	90%	94%
SEER	18	15	13
HSPF	8.2	9	10 ²³
Geothermal Heat Pump	ENERGY STAR EER and COP Criteria		
ASHRAE 62.2 Whole-House Mechanical Ventilation System	1.4 cfm/W; no heat exchange	1.4 cfm/W; no heat exchange	1.2 cfm/W; heat exchange with 60% SRE
Insulation and Infiltration			

Reaching Lower HERS: Target Home Air-Tightness

ACH50 Requirements/Targets						
Climate Zones	Zero Energy Ready Home Target - Detached	Zero Energy Ready Home Target – Attached*	ENERGY STAR V3.0	ENERGY STAR V3.1	2012 & 2015 IECC	Passive House
1-2	3.0	3.0	6.0	4.0	5.0	0.6
3-4	2.5	3.0	5.0	3.0	3.0	0.6
5-7	2.0	3.0	4.0	3.0	3.0	0.6
8	1.5	3.0	3.0	3.0	3.0	0.6

ENERGY STAR to Zero Energy Ready Home HERS Threshold *(pre ANSI/RESNET 301)*

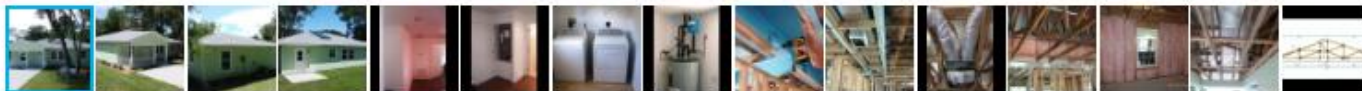
Typical DOE ZERH-Compliant HERS Index by Climate Zone



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

Warm Climate, Affordable HERS 49

DOE TOUR OF ZERO: VISTA PALM DRIVE BY SOUTHEAST VOLUSIA HABITAT FOR HUMANITY



Cold Climate, Production HERS 3 (low 40s w/o PV)

DOE TOUR OF ZERO: THE HALE PLAN BY NEW TOWN BUILDERS



Hot/Dry Climate, Production HERS 48

DOE TOUR OF ZERO: VIA DEL CIELO BY PALO DURO HOMES



Performance Path Example – Austin, TX CZ2 Prototype - 4 BR, 2400 SF



Energy Efficiency &
Renewable Energy

Specification	Target Home Spec	Design Home
AGW Insulation	R13 (U 0.084)	R15 (U 0.079)
Attic Insulation	R38 (U=0.030)	R38 (U=0.030)
Basement Walls	N/A	N/A
Windows	U=0.40; SHGC=0.25	U=0.35 ; SHGC=0.25
Infiltration	3.0 ACH50	3.0 ACH50
Ducts	Total ≤ 8% cfm25/CFA (192 CFM25) LTO ≤ 4% cfm25/CFA (96 CFM25)	Total: 96 CFM25 LTO: 30 CFM25
AFUE or HSPF	8.2 HSPF	8.2 HSPF
A/C SEER	18	16
Whole-House Mech. Vent.	62 cfm; 1.4cfm/W no heat exchange;	62 cfm; 0.70 cfm/W supply ventilation
Water Heater	HPWH (EF 2.0)	HPWH (EF 2.4)
Hot Water Dist.	RESNET Reference Home	On-Demand (occ sensor)
Lighting	80% Energy Star	80% Energy Star
HERS Index	59 (Target)	59 COMPLIES!

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- Compliance with next generation code
- Three Options for Compliance:
 - ✓ Prescriptive
 - ✓ Alternative equivalent U-factor
 - ✓ **Total UA calculation**
 - allow for modest trade-offs of insulation levels from one part of the envelope to others.

	CZ 2	CZ 3
Walls	R-13 (rec. R13+5)	R-20 or R-13+5 (rec. R-13+5)
Ceiling	R-38	
Floor	R-13	R-19
Basement	R-0	R-5/13
Crawl Space	R-0	R-5-13
Slab	R-0 (rec. R-5 slab edge)	

2012 IECC Building UA Compliance

Property
ZERH Reference Home Model
,

Organization
Builder

HERS
Based On Plans
Rater ID:

Weather: Austin, TX
Austin, TX
CZ 2 - 2400 SF Austin, TX.blg

Elements

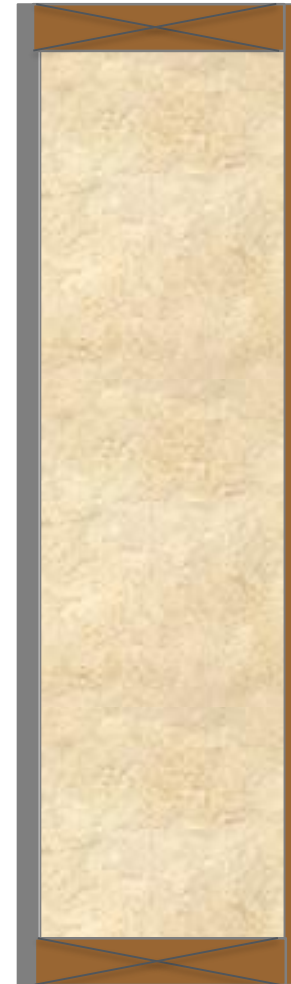
Insulation Levels

	2012 IECC	As Designed
Shell UA Check		
Ceilings:	36.0	36.4
Above-Grade Walls:	173.5	175.0
Windows and Doors:	160.0	155.6
Slab Floor:	51.1	51.1
Overall UA (Design must be equal or lower):	420.6	418.1

- Run UA compliance report within HERS Rating software
- Design Home UA must be \leq 2012 IECC version of the home

High-R Wall Options

- R-17 – R-21 (U
0.052-0.060)
- Higher Framing
Factor (~12-15%)
- Multiple insulation
options



2x6 with Staggered Studs

- 2x6 plates with 2x4 staggered studs at 12"/24" O.C.
- Can reduce thermal bridging by 80-90%
- Cost competitive with traditional 2x6 wall



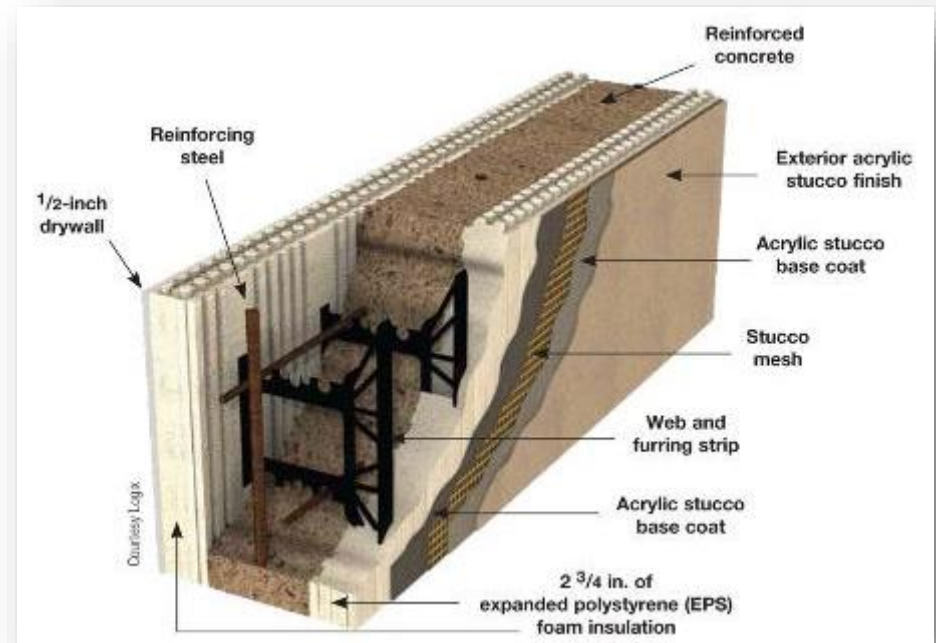
- R-18 Wall (U 0.054)
- Complete Thermal Break
- WSP should be kept above T_{DP}
- Can Combine Sheathing w/ Weather Resistant Barrier
- Cladding Installation Issues
 - Fastening – follow man. specs
 - Furring – follow man. specs



- R-26 Walls (6") (U 0.034)
- Substantial Thermal Break (3 – 8% Framing Factor)
- Special Construction Practices Required
- Significantly Reduced Time-of-Construction
- Reduced Dimensional Variation Corrections



- ~R-24 Walls (U 0.038)
- Complete Thermal Break
- Useful Thermal Mass
- Foundation has to be Perfectly Level
- Panel option
- Disaster Resistant
- Termite Resistant



- R-26 Walls ($U \sim 0.034$)
- Studs offset for thermal break
- Condensation management at outside sheathing surface:
 - Modeling needed to assure moisture control
 - Vapor-open designs use higher-perm sheathing such as gypsum may be used



- Uses same material and techniques already understood by trade partners

ENERGY STAR Windows

- Updated Specs

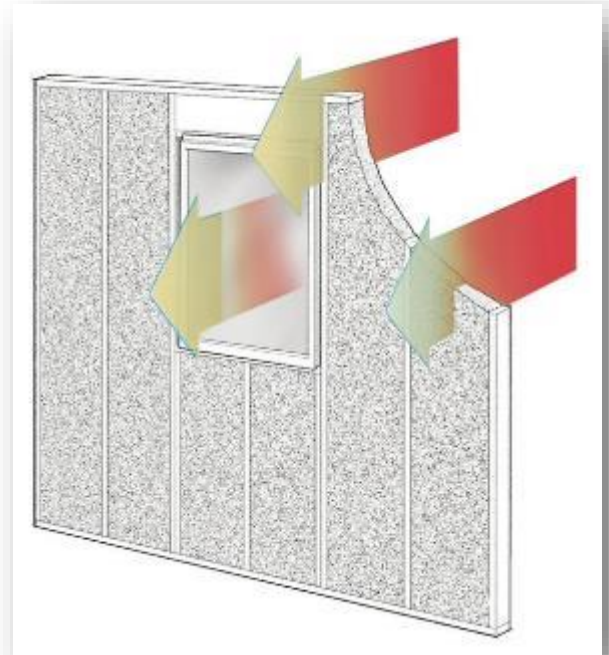
ENERGY STAR Window Specs to Apply to DOE Zero Energy Ready Home Projects ¹	Hot Climates IECC CZ 1-2		Mixed Climates IECC CZ 3-4 except Marine		Cold Climates IECC CZ 5-8 and 4 Marine ²	
	U-Value	SHGC	U-value	SHGC	U-Value	SHGC
	0.40	0.25	[CZ 3] 0.30 [CZ 4] 0.30	[CZ 3] 0.25 [CZ 4] 0.40	0.30 0.31 0.32	Any ≥0.35 ≥0.40

1. DOE Zero Energy Ready Home offers multiple compliance paths including area weighting and allowances for passive solar design. See the National Program Requirements, Exhibit 1 with footnotes, for details.

2. These U & SHGC values are based on the ENERGY STAR v5.0 Window Specifications. DOE ZERH will review the feasibility of adopting ENERGY STAR v6.0 Window Specifications, which entail lower U values, periodically. Any program update to require the v6.0 window specs will be announced with a minimum 1-year phase-in.

Windows Are a Big Deal

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



Sources:

“Holes in the Wall: To Improve the Energy Performance of Walls, Look at the Total R-Value,”

Journal of Light Construction, February 2014;

Multi-Assembly R-Value / U-Value Calculator – Cascadia Windows and Doors;

Michael Blasnik Presentation, 2014 ACI Conference

Stepping up to ZERH...



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IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	

95% Condensing Furnace

X

60% Efficient Duct
Distribution

57% System Efficiency

80% Furnace

X

90% Efficient Duct
Distribution

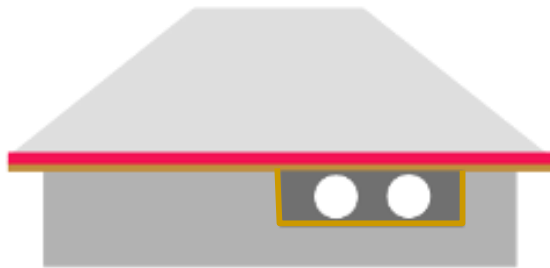
72% System Efficiency

Cooling:

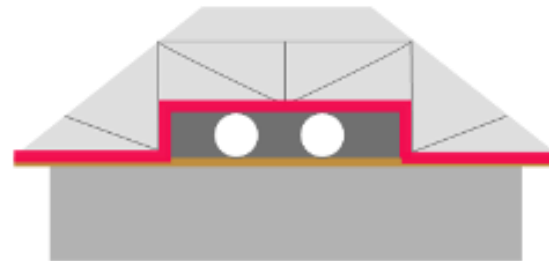
If we're using a SEER 21, variable speed A/C system...

- SEER 21 has **twice** the run time vs a SEER 13 system
- Ducts in conditioned space: SEER 21 gives 40% savings
- Ducts not in conditioned space: just 27% savings

Options for Optimized Duct Location



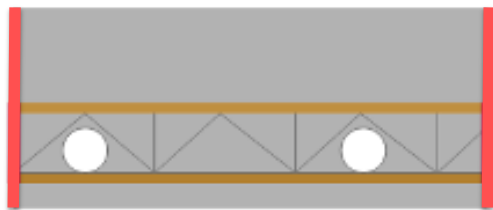
Ducts in Dropped Ceiling



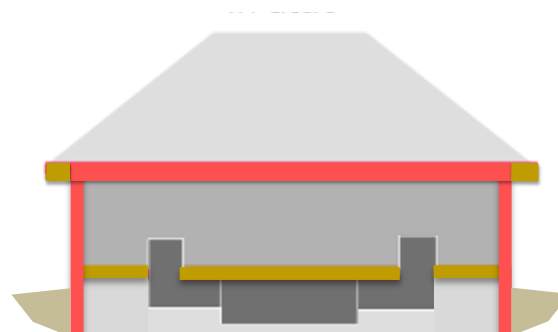
Ducts in Modified Attic Truss



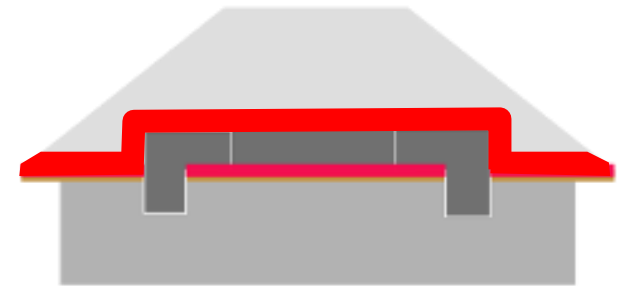
Ducts in Unvented Attic



Ducts Between Floors



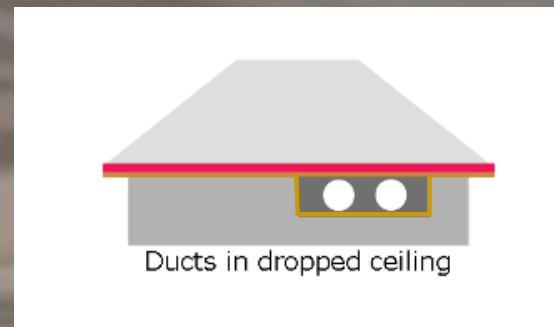
Ducts in Unvented
Crawl Space/Basement



Ducts in Vented Attic

- **Buried & SPF encapsulated**
- **Buried (2018 IECC)**

Ducts in Dropped Ceiling

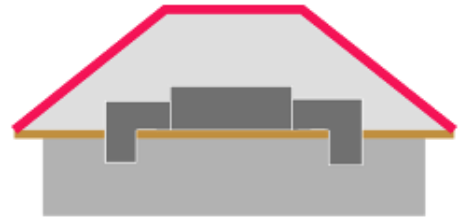


Ducts in Modified Attic Truss



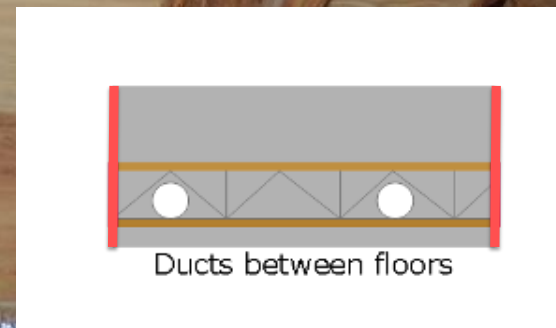
The main trunk line of the interior comfort delivery system runs within an insulated duct chase installed in a notch designed into the roof trusses. The trunk duct runs above the home's central hallway to supply conditioned air directly to most of the home's ceiling registers.

Ducts in Unvented Attic



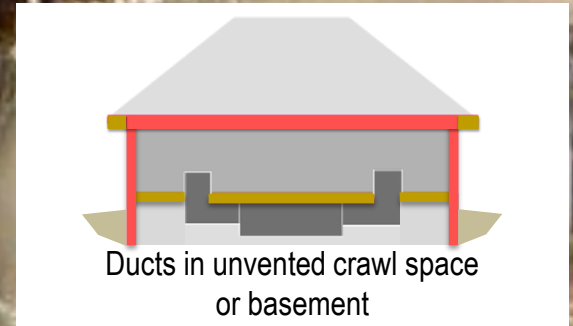
Ducts in unvented attic

Ducts Between Floors



Good fit for small duct high-velocity systems

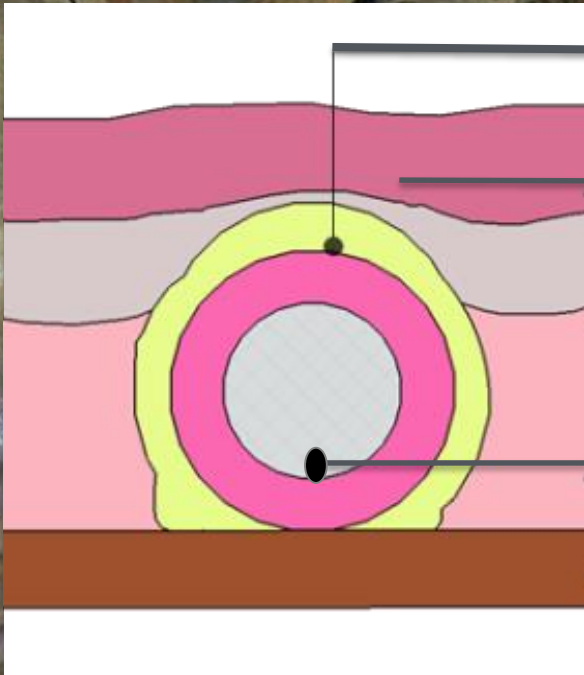
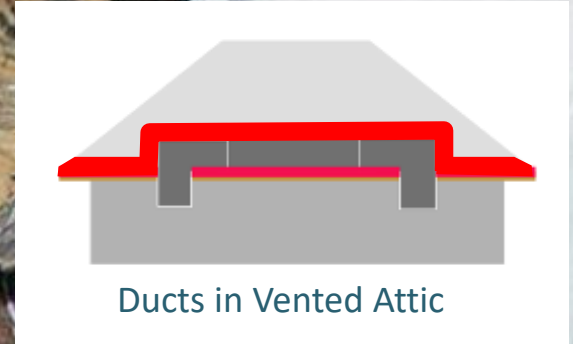
Ducts in Unvented Crawl/Basement



Ducts in Vented Attic

- *Buried & Encapsulated* – Humid Climates

Buried & Encapsulated Ducts



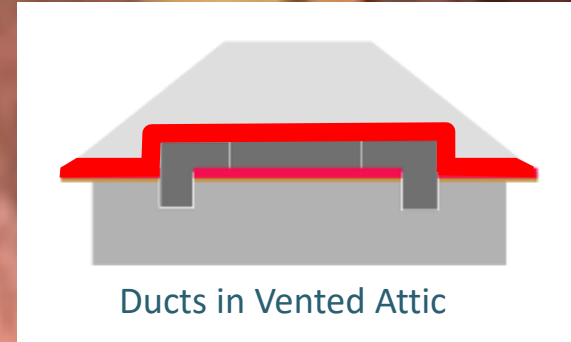
R-8 duct encapsulated with
min. 1.5" ccSPF

Duct buried $\geq 2''$ above top surface

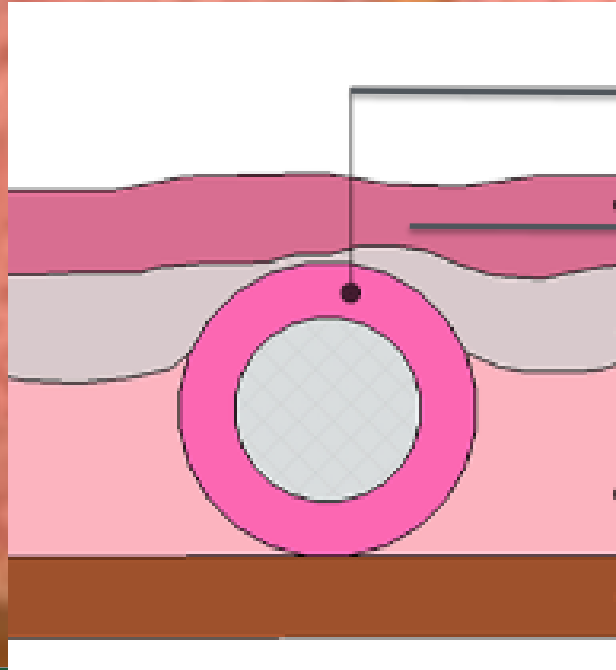
Sealed to 3 cfm25/100 SF CFA LTO

Ducts in Vented Attic

- Buried Ducts – Dry Climates



Buried Ducts – Dry Climates



**R-8 duct, sealed to 3
cfm25/100 SF CFA LTO**

**Duct buried $\geq 3.5''$ above
top surface**

- 2018 IRC recognizes buried duct approaches
 - Buried
 - Deeply buried
 - Buried / In Conditioned Space
- Buried / Ducts In Conditioned Space (ICS)
 - HVAC equipment in conditioned space
 - Sealed to 1.5 cfm25 /100 ft² CFA LTO
 - CZ 1A, 2A, 3A: R-13 supply ducts
 - R-8 elsewhere
 - R-value of insulation above the duct is at least the value of ceiling insulation value, minus the R-value of the duct
 - Recognized by DOE ZERH program as Optimized Duct Location

- **Short Duct Run**

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

- **Jump Ducts**

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

- **Ductless HVAC system**

Stepping up to ZERH...

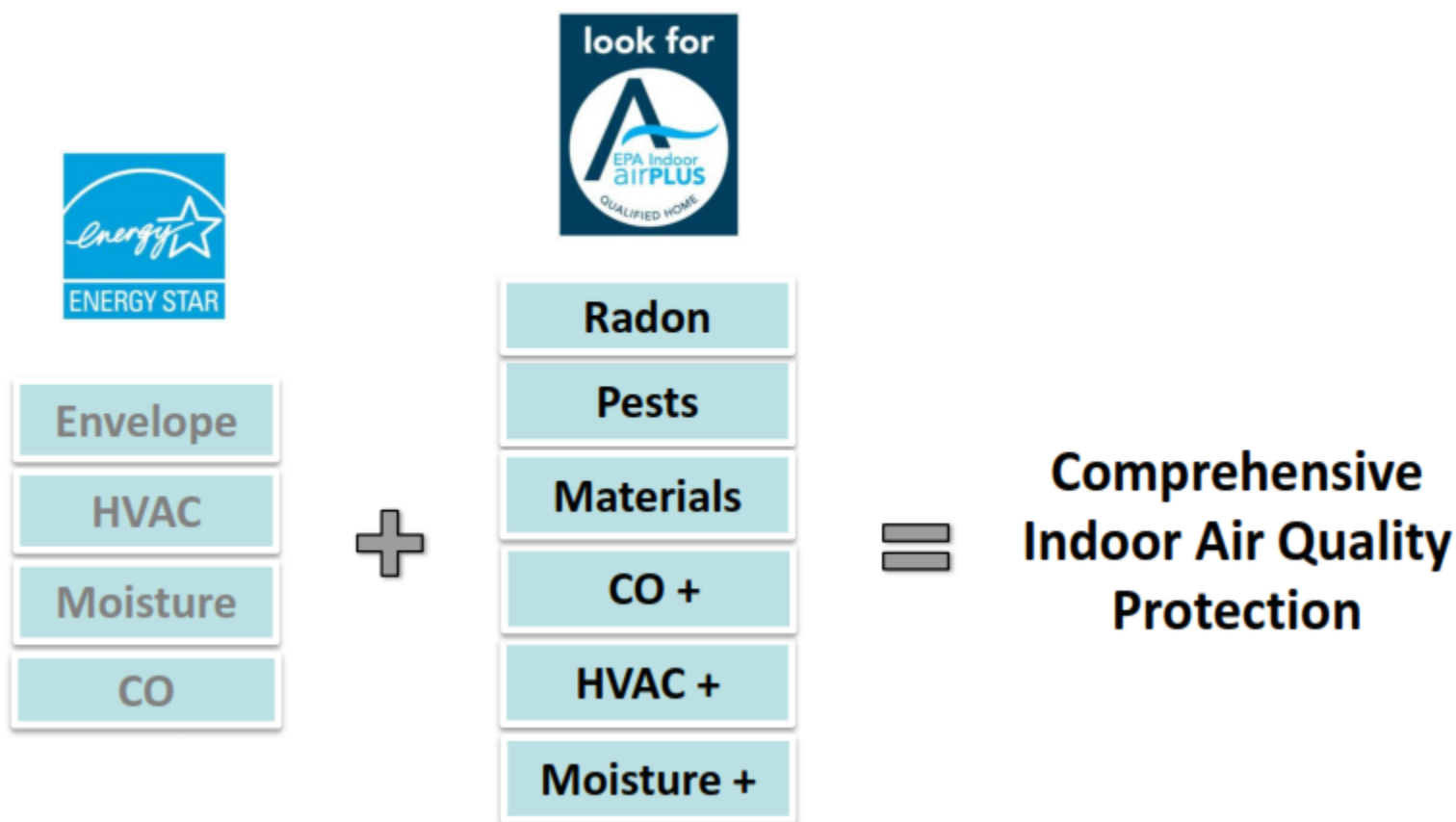


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IAP Certification

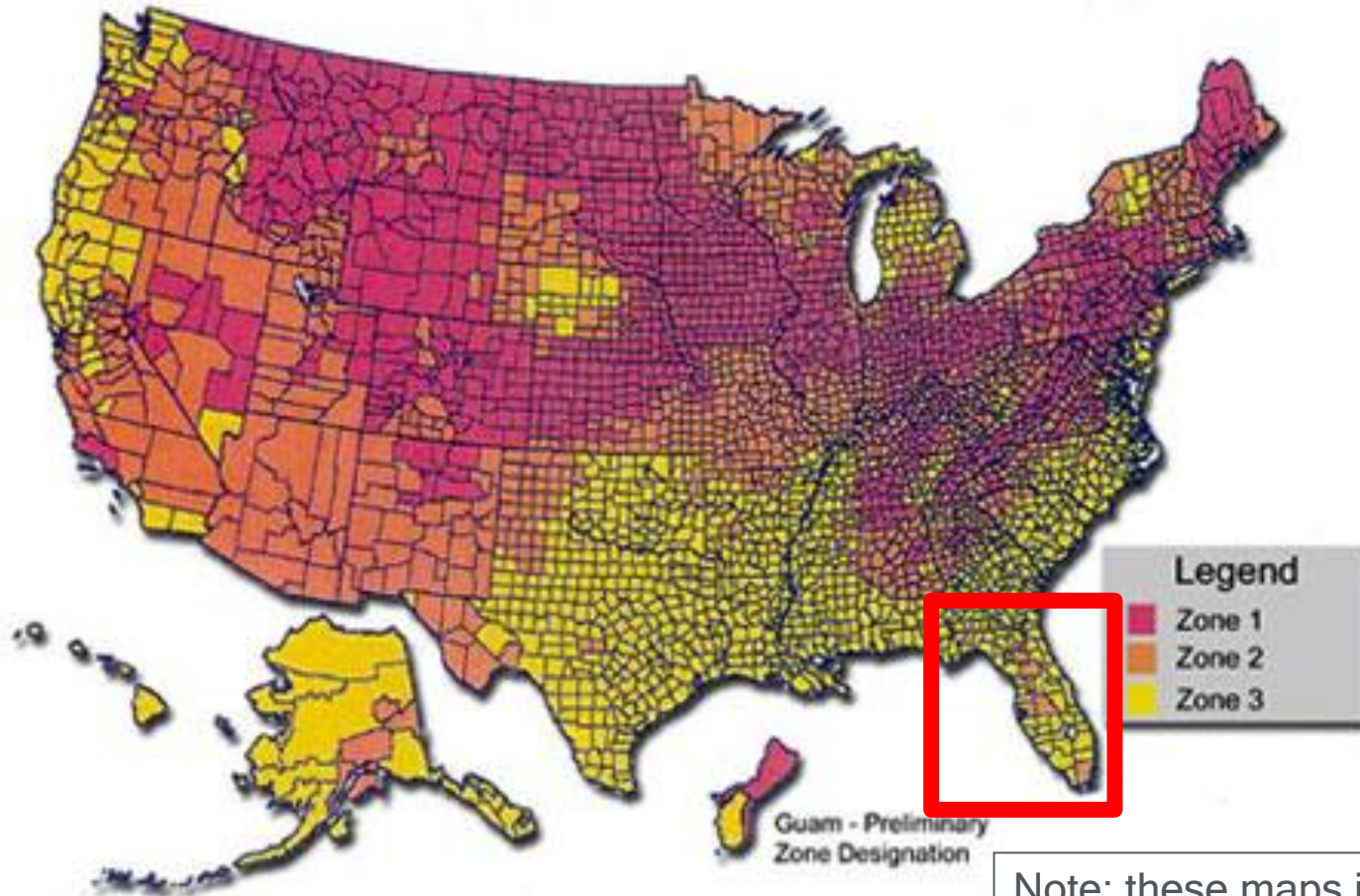


ENERGY STAR + Indoor airPLUS



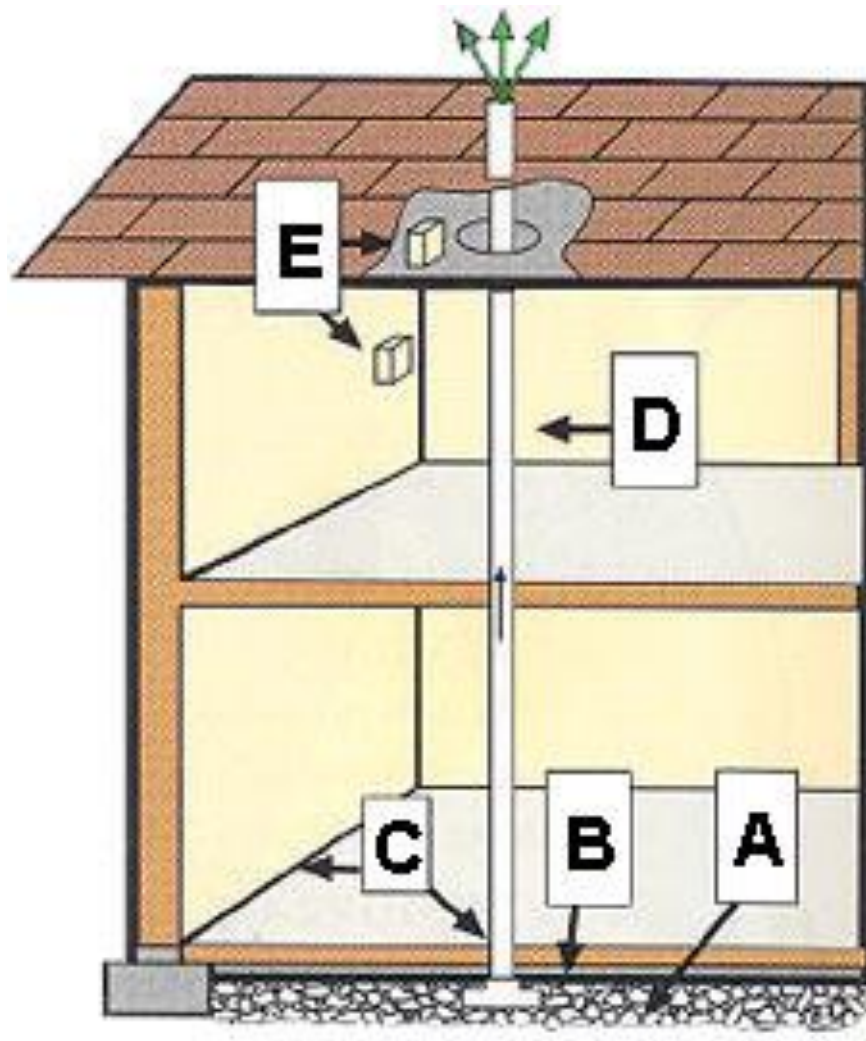
Radon: Radon Zones in U.S.

EPA Map of Radon Zones



**Surgeon General's Warning:
Radon Causes Lung Cancer**

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



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

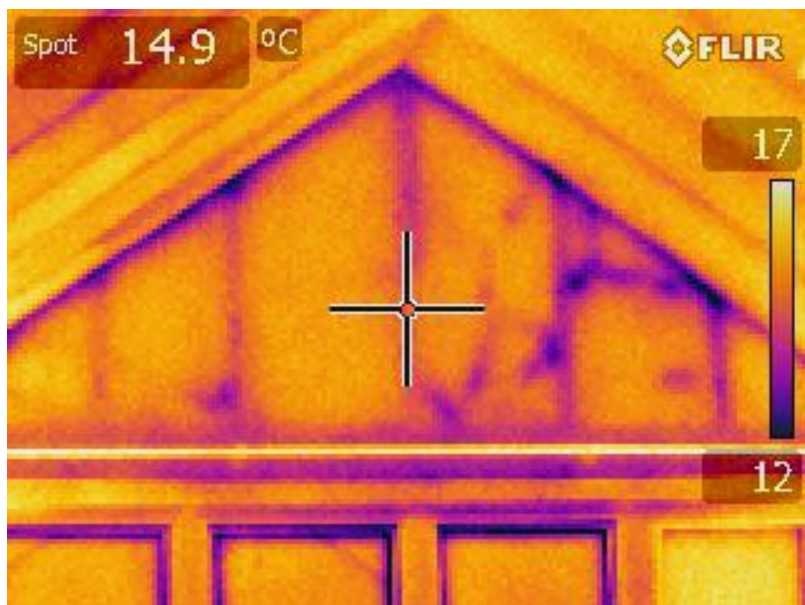
Pests: Screened Openings for Pests



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

Exception: clothes dryer vent

More IR Means More Rodent Info



Identifying Low-Emission Pressed Wood, Cabinets, Carpets, and Paints...

- Low emission materials and products are rapidly evolving
- Labels & certifications can be challenging to navigate
- To help partners identify sources and spec products, a new IAP resources is available:

How to Find Indoor airPLUS Compliant Low-Emission Products



How to Find Indoor airPLUS Compliant Low-Emission Products

Cabinetry

Requirement: Use Cabinetry made with component materials (plywood, particleboard, MDF) that are certified to comply with the appropriate standards above; OR registered brands or products produced in plants certified under the Kitchen Cabinet Manufacturers Association's (KCMA) Environmental Stewardship Certification Program (ESP 05-12); OR GREENGUARD or GREENGUARD Gold Certification for Cabinetry.



Meet at least one standard below

How to find compliant products

KCMA's Environmental Stewardship Program (ESP 05-12)

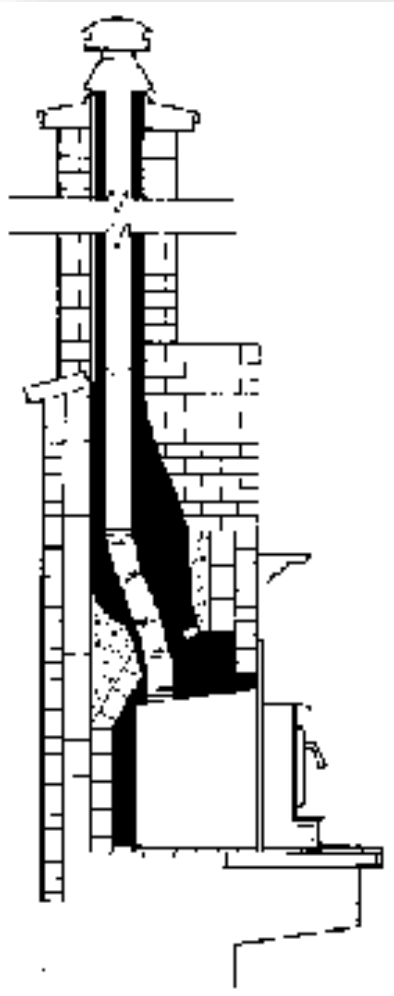
Look for the KCMA-ESP label on cabinets (often sink bases), product packaging, and/or spec sheets.

For a list of KCMA certified manufacturers that produce compliant cabinets, visit:
http://www.kcma.org/Members/ESP_Certified_Manufacturers

Note: Manufacturers listed in the link above can be used as a resource, but partners should request confirmation from the manufacturer or supplier that the product lines they are using are indeed compliant.



Combustion Safety+ Certified Fireplaces & Stoves



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

Combustion Safety+ Certified CO Alarms & ETS (for MF)

CO Alarm in each bedroom area



CO Alarm

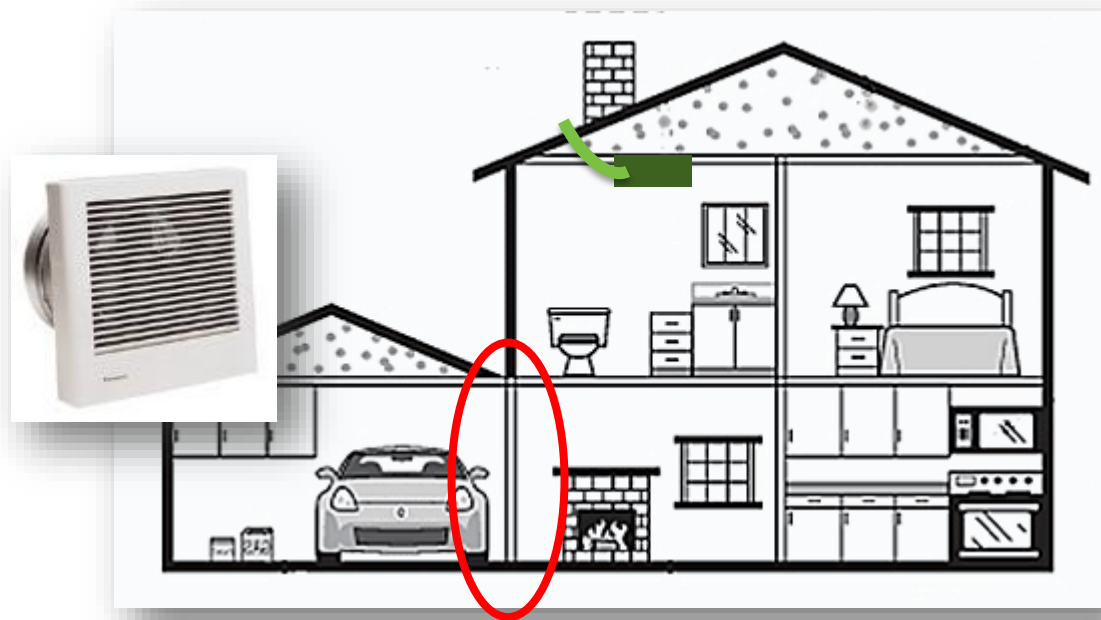


Combined CO
& Smoke Alarm



Enforceable policy in
Multi-family buildings

Combustion Safety+ Attached Garage Isolation



IF house has exhaust-based WHMV system, then:

- a. Install garage exhaust fan,
OR
- b. House WRT garage ≥ 45 Pa, when house is + 50 Pa relative to outdoors

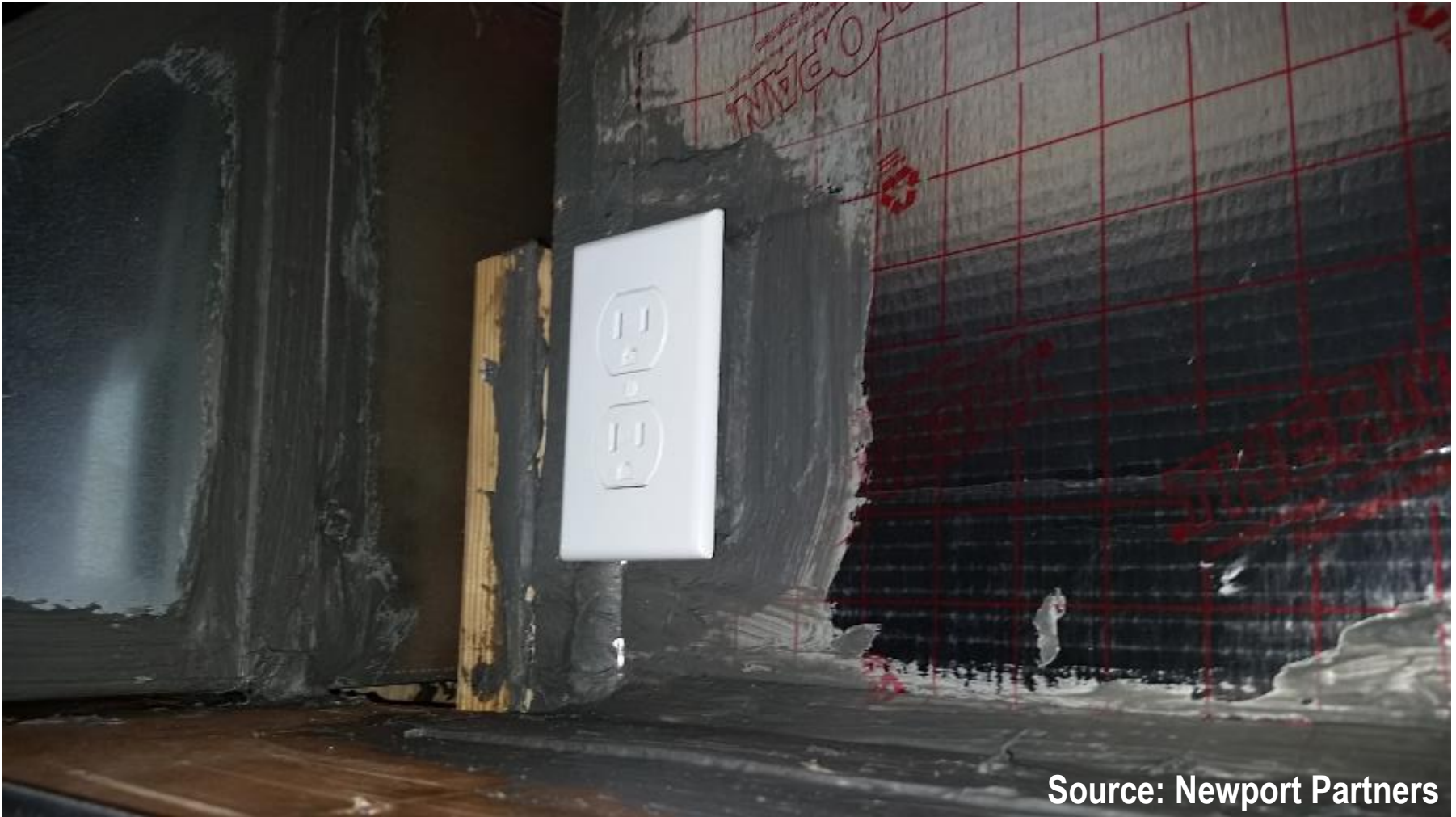
Automatically closing, gasketed door

No Air Handler in the Garage



Source: Construction Instruction

No Building Cavity Ducts



No Building Cavity Ducts

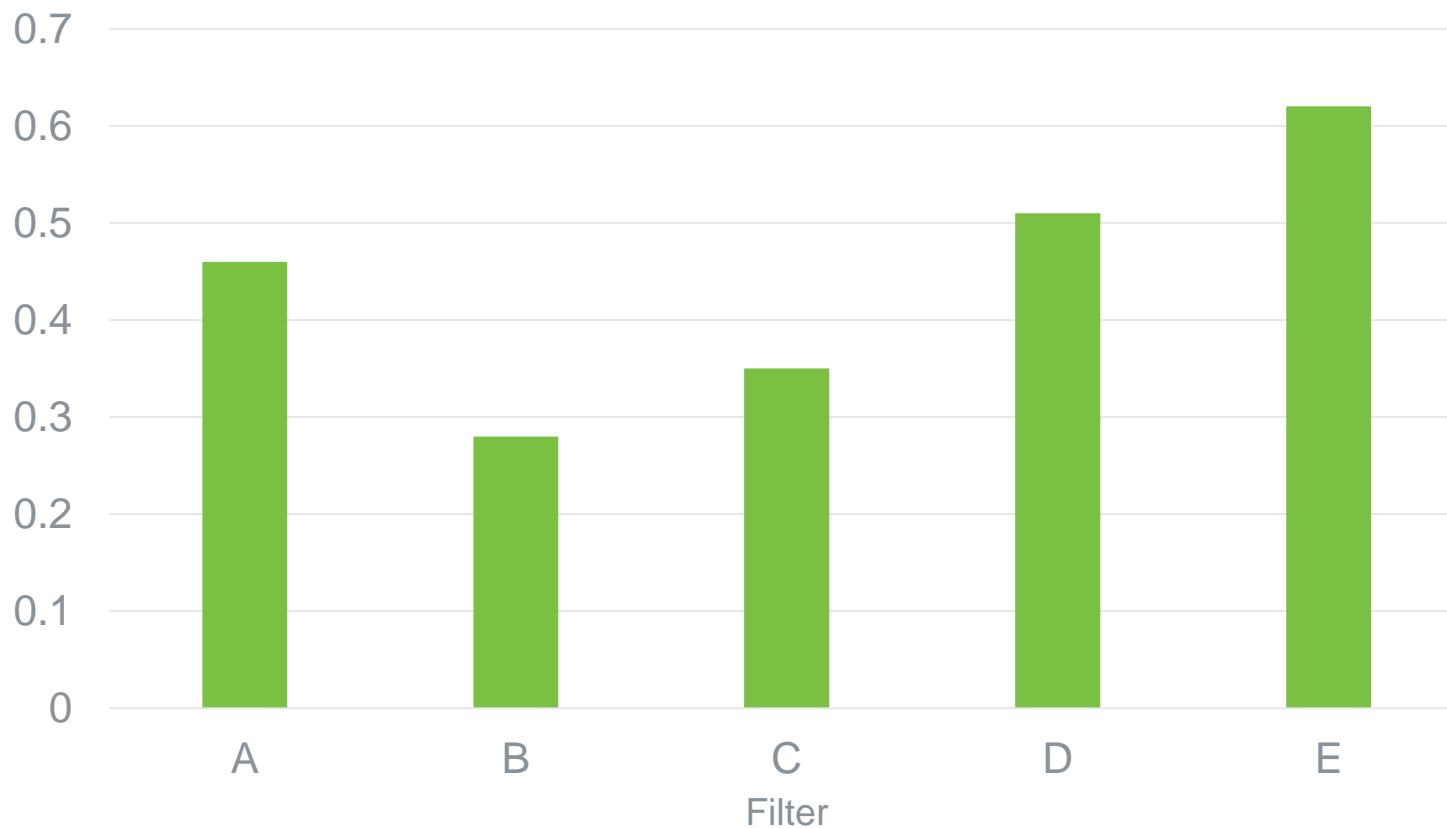


HVAC+ High-MERV HVAC Filter



8 MERV Filter Minimum

Pressure Drop (in. w.c.) of MERV 8 Filters

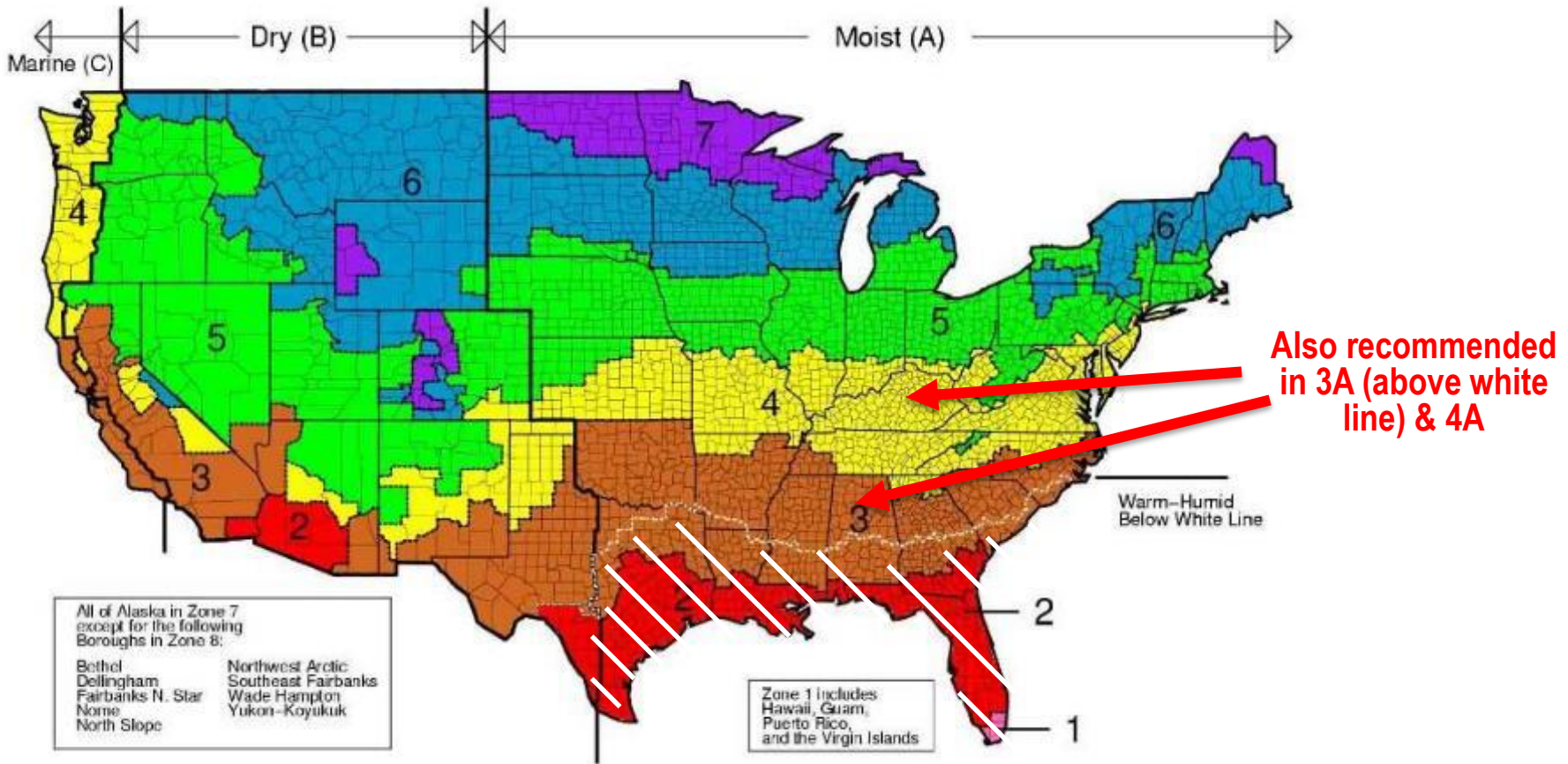


Source: Dave Springer, Davis Energy Group

Install equipment with sufficient latent capacity to maintain indoor RH \leq 60%.



HVAC+ Dehumidification in Warm-Humid CZs



- **Strategies** for maintaining indoor RH < 60% along with relatively low operating costs:
 - Stand-alone dehumidifier
 - Ducted dehumidifier
 - Central, variable speed A/C system with a dehumidification mode & controls
- **Energy Consumption:**
 - About 170 kWh/yr could be expected for a HERS 50 house (~ DOE ZERH level) with a 60% RH setpoint.
 - With a 50% RH setpoint – energy consumption is **about 5X**

Supplemental Dehumidification for Humid Climates. Presented by Armin Rudd, Building Science Corp, at ACI National Conference May 2013. Supported in part by DOE Building America

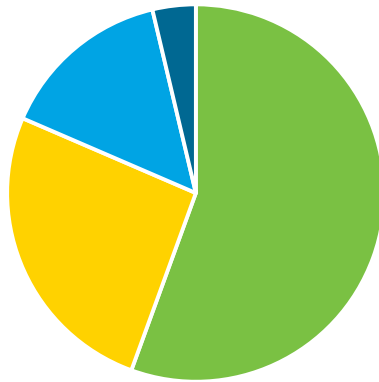
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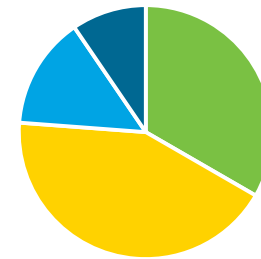
Components and MEL's are increasingly larger part of total energy use in low-load homes (~50%).

Energy Use - Then



- Heating & Cooling
- Lighting & Appliances
- Hot Water
- MELs

Energy Use - Now



- Heating & Cooling
- Lighting & Appliances
- Hot Water
- MELs

Zero Energy Ready 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)
- **WaterSense Hot Water Distribution**

*Only where installed by builder

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

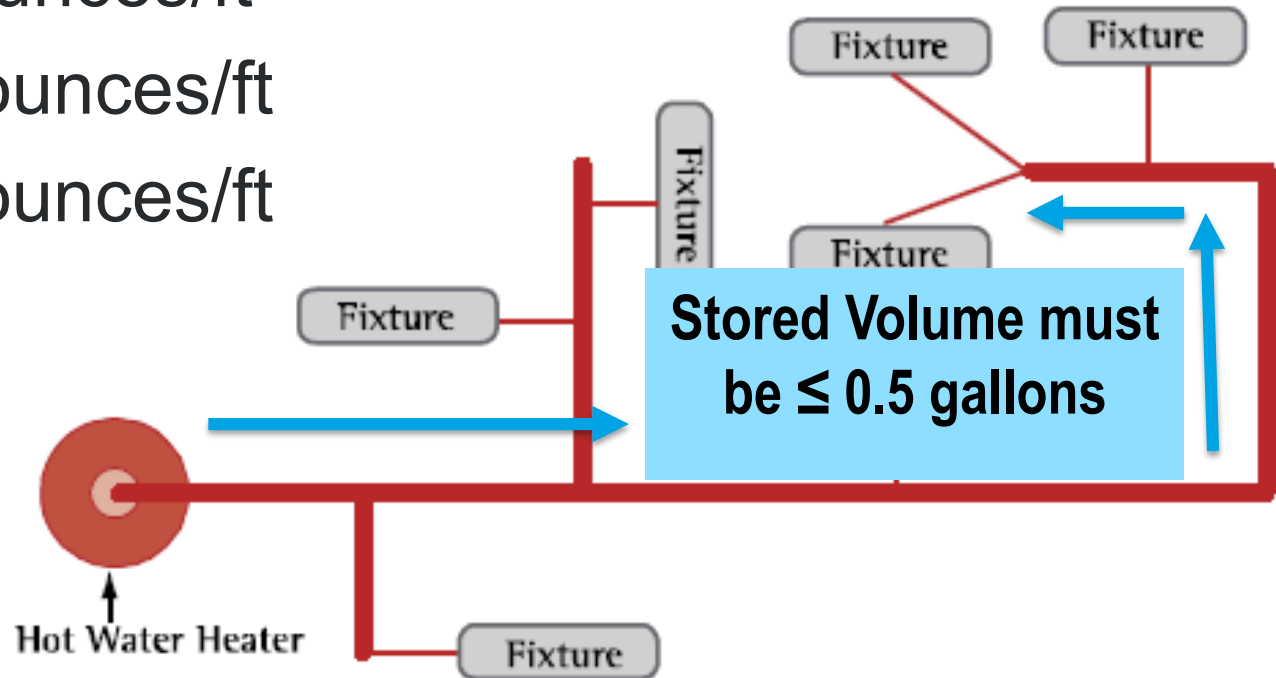
Example: Volume:

30' trunk

10' branch

Wait Time: 1 – 1.5

minutes
2 GPM showerhead



- Based on EPA WaterSense Specifications:

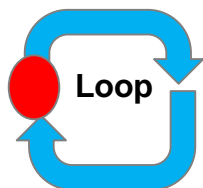
Hot Water Source



≤ 0.5 gallons of water



Furthest Fixture



Hot Water Volume Estimating Tool

1

2 Type of system: Whole House Manifold

3

4 manifold/main line:

5 Main line piping: PEX-AI-PEX ASTM F 1281 diameter 3/4" volume

6 length (feet) 4 ounces/ft: 3.93 (oz): 15.72

7

8 Number of ports in the manifold: 12 volume (oz): 19.968

9 Total volume (oz): 35.688

10

11 Fixture 1 Fixture 1

12

13

14

15 Line:

16 piping: PEX-AI-PEX ASTM F 1281 diameter 1/2" volume

17 length (feet) 24 ounces/ft: 1.31 (oz): 31.44

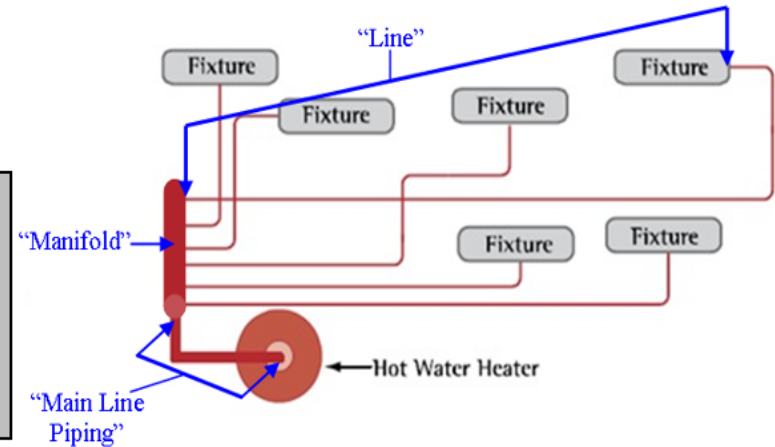
18

19

30 total volume (oz): 67.128

31

32



Main Line Piping: The large diameter tubing connecting a water heater to a whole house manifold.

Line: The individual run connecting a single fixture with the manifold.

Add to List

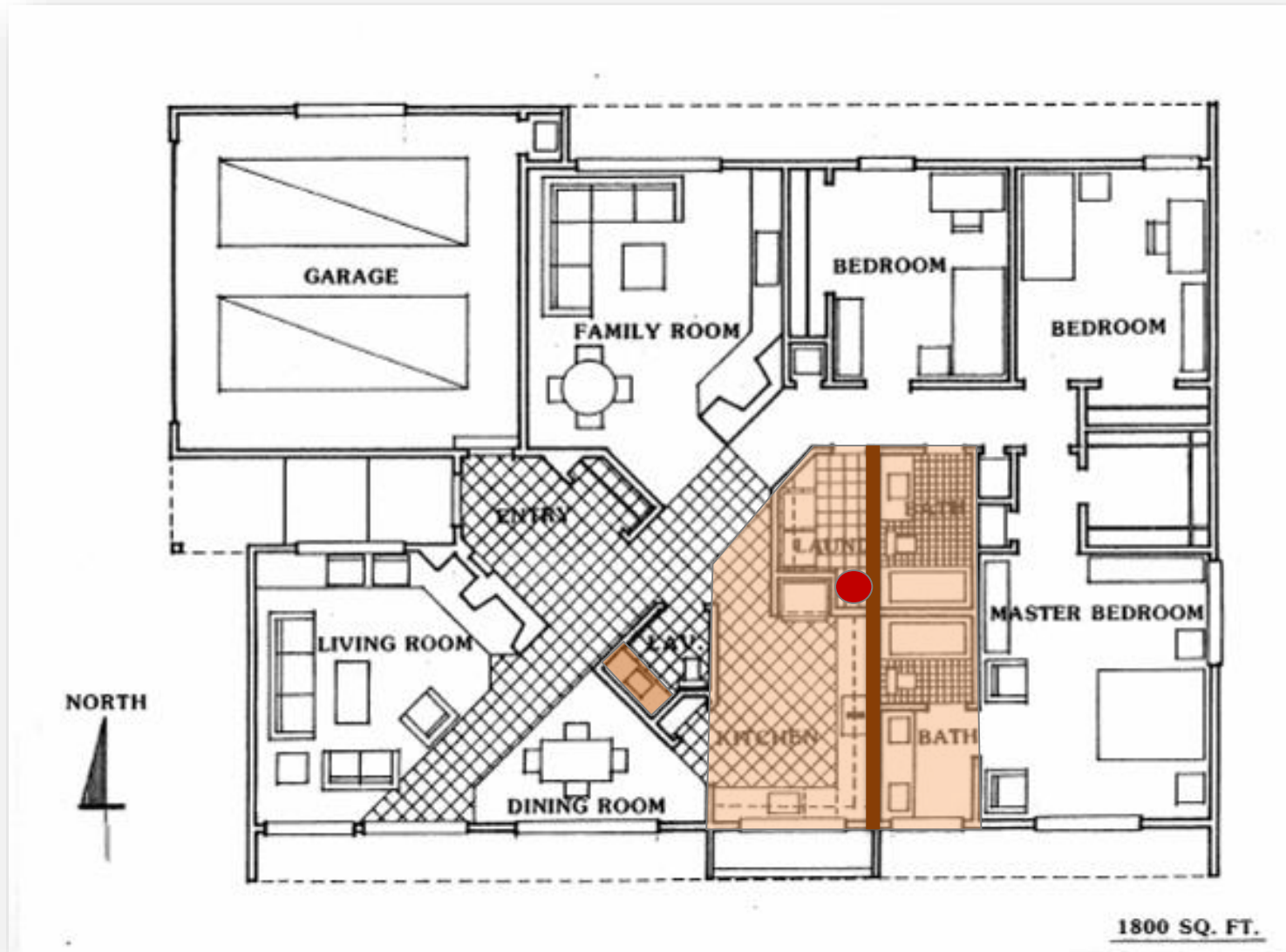
- Available at DOE ZERH website under Participation Guidelines

1. Core Plumbing Layout (wet wall)
2. Manifold System
3. Demand Pumping System

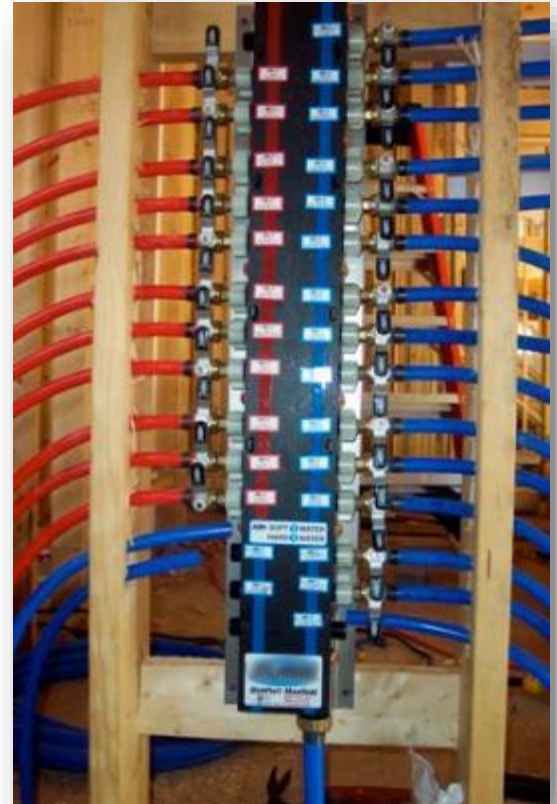
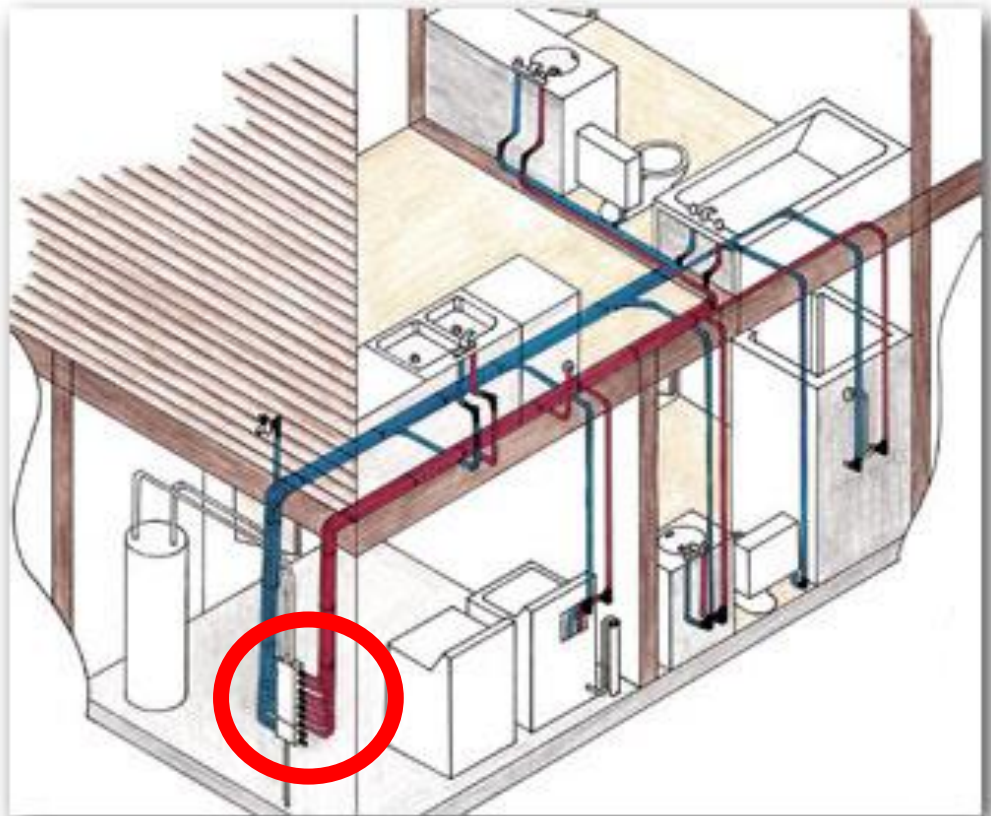
Multifamily

- CDHW systems permitted with modified requirements

Core Plumbing Layout



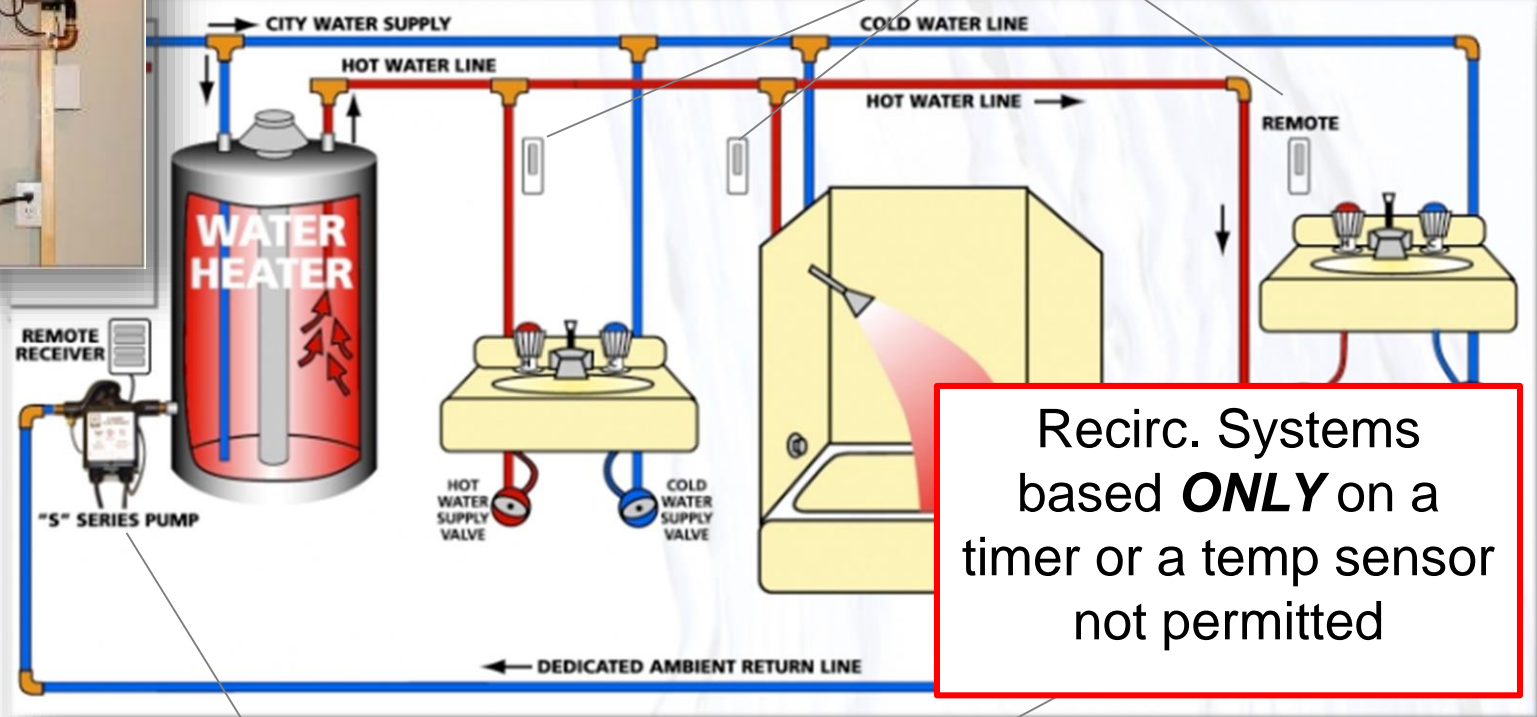
Manifold Plumbing System



Demand Pumping System



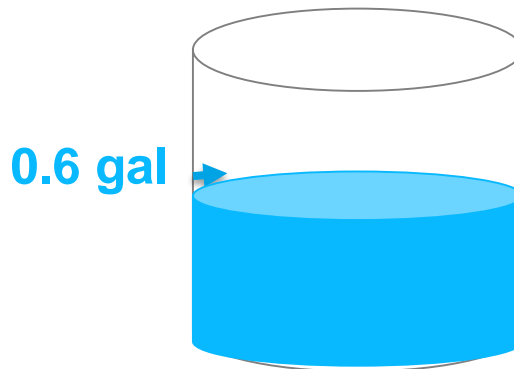
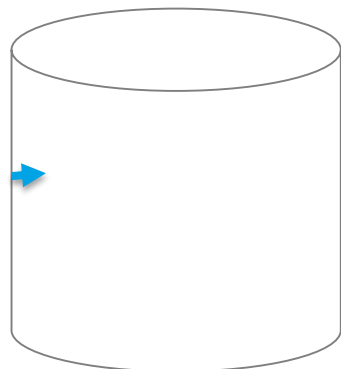
Sensor or Controls
(or "Smart" Systems)



Recirc. Systems based **ONLY** on a timer or a temp sensor not permitted

Demand Pump

Dedicated Return



$T_{fin} - T_{init}$
must be at least 10 F

Prime loop (if applicable)

Start flow

Take T_{init} (of flow)

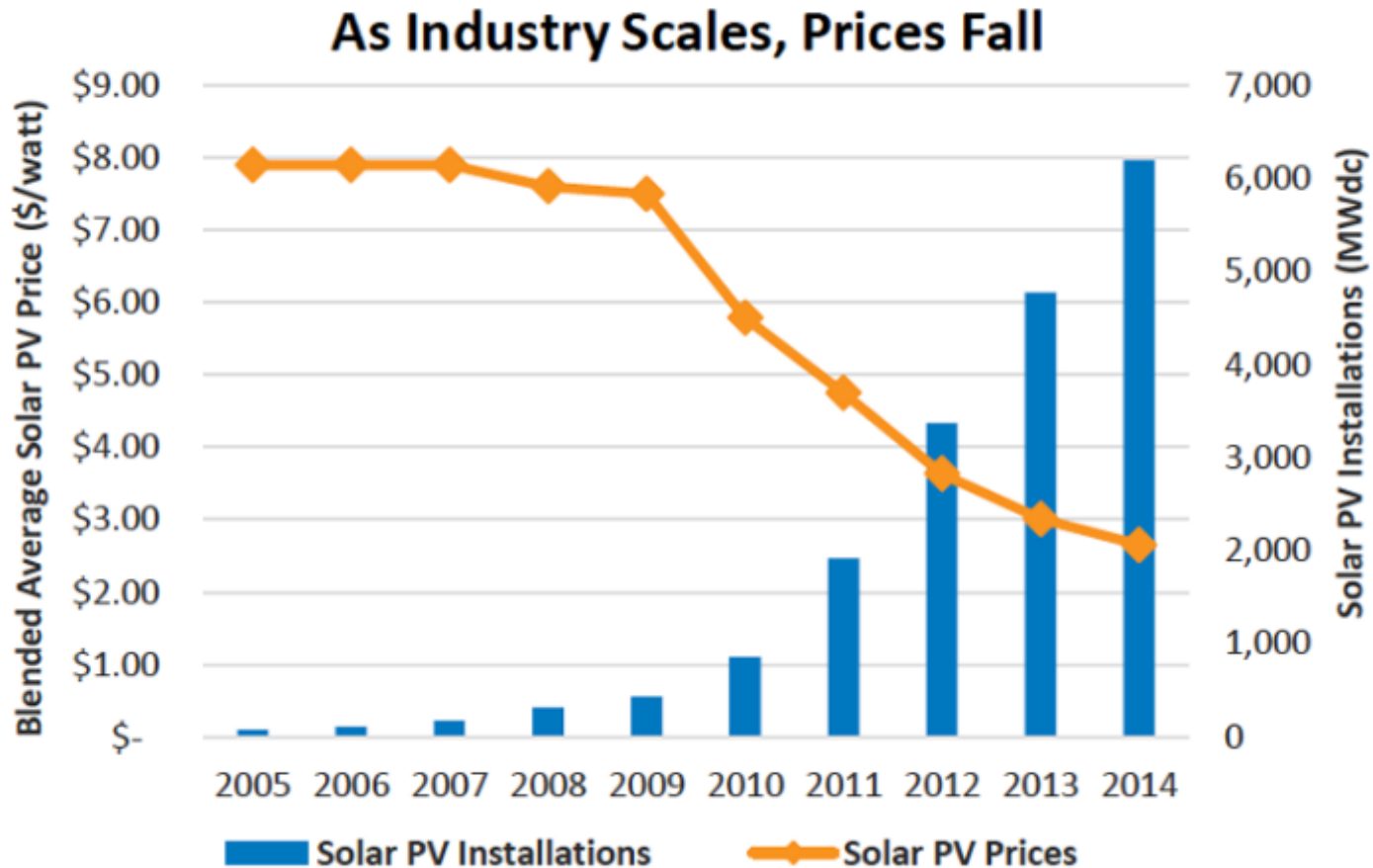
Stop at 0.6 gallons

Take T_{fin} (of flow)

Stepping up to ZERH...



			Solar Ready	←
			Eff. Comps. & H ₂ O Distrib.	✓
			EPA Indoor Air Package	✓
			Optimized Duct Location	✓
	HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV	
	Water Management	Water Management	Water Management	
	Independent Verification	Independent Verification	Independent Verification	
IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Enclosure	✓
HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55	✓
IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	

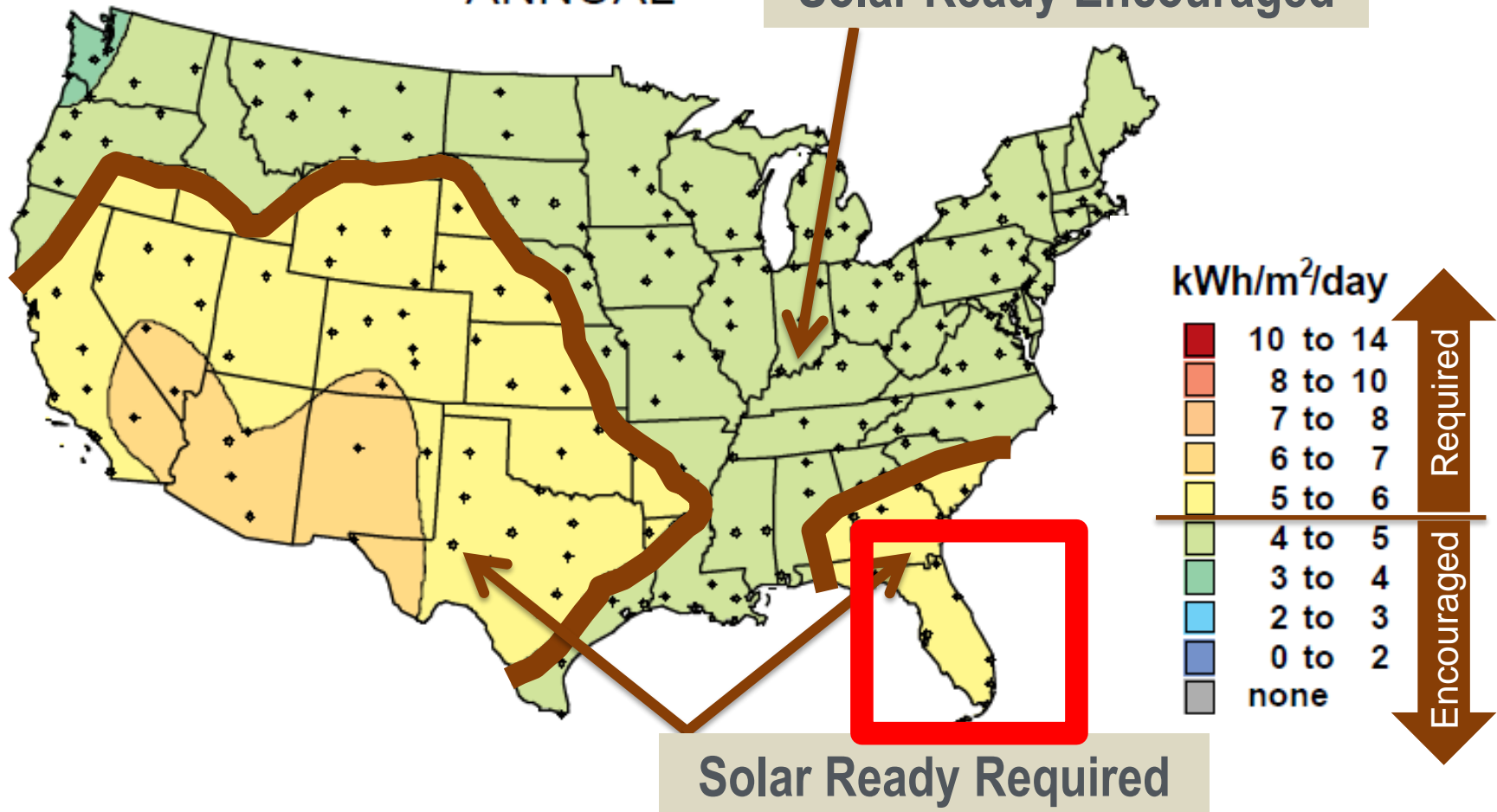


Source: SEIA / GTM Research

Average Daily Solar Radiation Per Month

ANNUAL

Solar Ready Encouraged



Not required in areas lacking access to significant solar resources:

- Tree Shading
- Tall Buildings
- Available South Facing Roof

Multifamily Building Allowances:

- PV-ready features may be provided for the common space instead of at the dwelling level



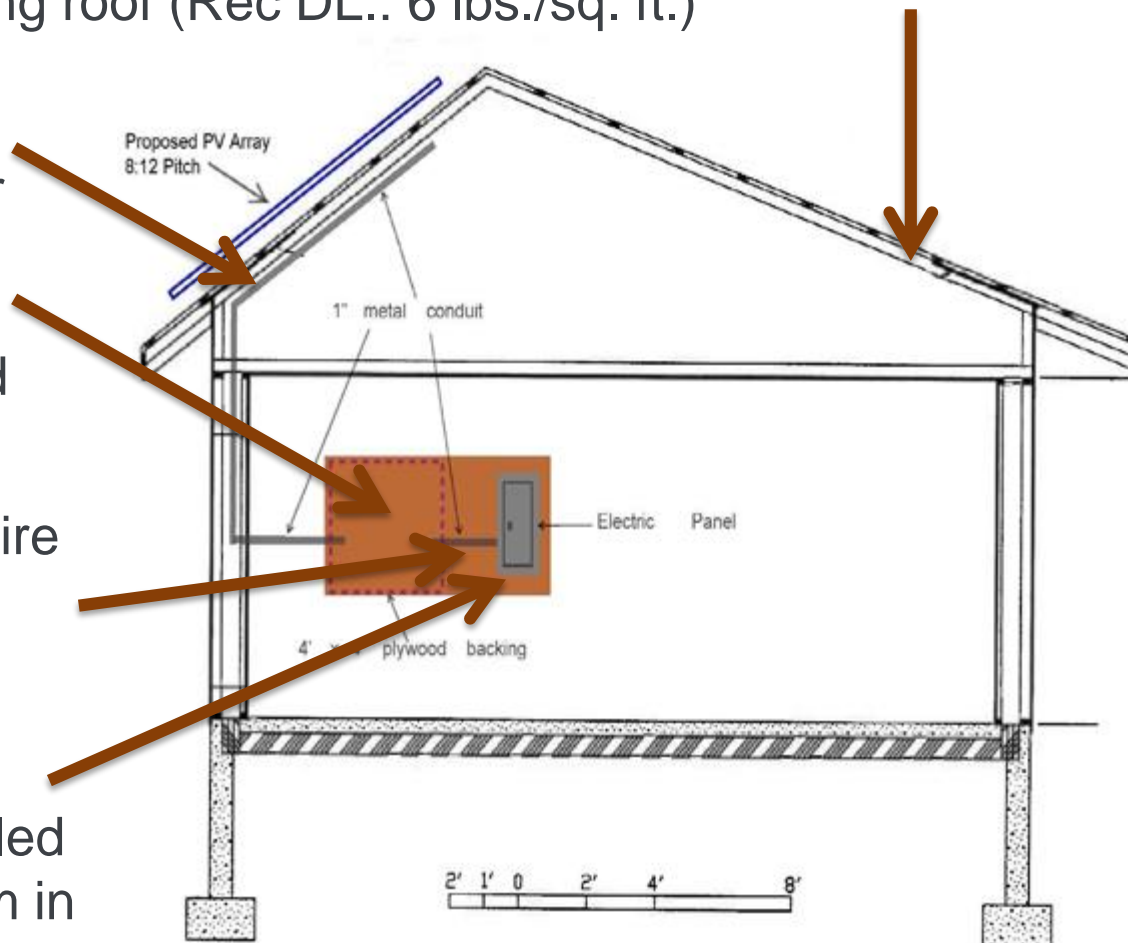
Documentation of the maximum allowable dead load and live load ratings of the existing roof (Rec DL.: 6 lbs./sq. ft.)

Conduit to run DC wire from roof to inverter

Dedicated Area for installing inverter and balance of system

Conduit to run AC wire from inverter location to electric panel

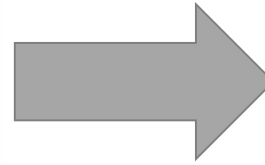
Circuit Breaker designated and/or installed for use by the PV system in the electric panel



Stepping up to ZERH...



			Solar Ready	✓
			Eff. Comps. & H ₂ O Distrib.	✓
			EPA Indoor Air Package	✓
			Optimized Duct Location	✓
	HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV	
	Water Management	Water Management	Water Management	
	Independent Verification	Independent Verification	Independent Verification	
IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Enclosure	✓
HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55	✓
IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	



“It depends”

- Base energy code?
- ENERGY STAR v3.1?
- Is the builder already...
 - Including Passive Radon Reduction? (Zone 1)
 - Including Dehumidification? (Hot/Humid)
 - Optimizing the duct location?
 - Using a manifold or hot water recirc?

- Compares costs and savings for ZERH relative to 2009 and 2012 IECC code-minimum homes
- In all scenarios, monthly energy savings are greater than added monthly mortgage add-on
- Available on ZERH website under Resources

DOE Zero Energy Ready Home

Savings & Cost Estimate Summary



October 2015

www.buildings.energy.gov/zero



Zero Energy Ready Home Getting Started

ENERGY STAR & DOE ZERH

- Same rater network
- Same modeling software (at least 3 different options)
- Same plan review & site inspection protocol



Process:

- Become a Builder or Rater partner (online)
- No need to pre-register projects; no program fees
- Recommend integrated design process (MEPs)
- Rater: plan review & site inspections
- Project Certification
 - Rater sends compliance report (generated by modeling software) to DOE or RESNET Registry
- Builder credited with certified home on DOE website

Thank You!

Resources & Next Steps

www.buildings.energy.gov/zero/

- Become a Partner
- Program Specs
- DOE Tour of Zero
- 24+ Recorded Webinars
- Marketing Took Kit

