

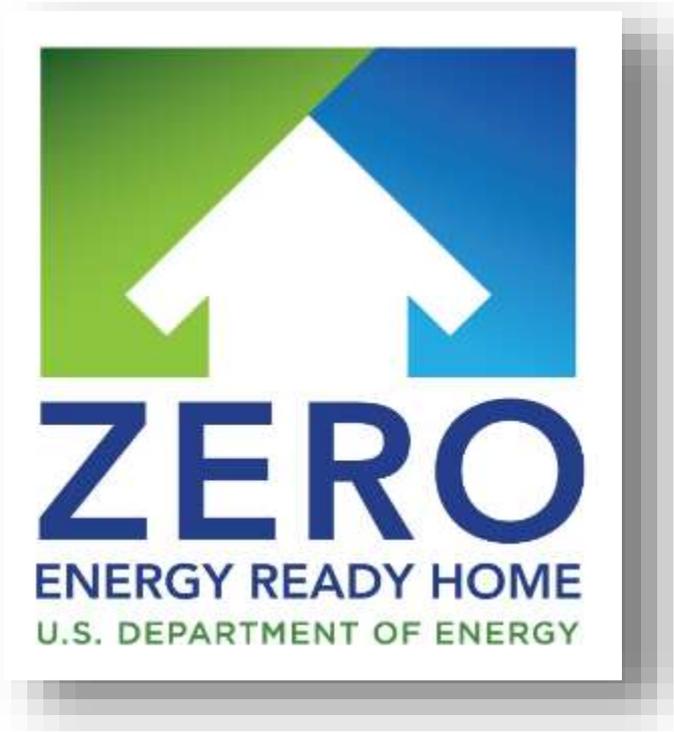
DOE Zero Energy Ready Home



DOE Zero Energy Ready Home for Affordable Housing Programs

Sam Rashkin, Chief Architect
DOE Building Technologies
Jamie Lyons, P.E.
Newport Partners
Technical Director, DOE Zero Energy Ready Home

- I. Why Zero Energy Ready Home is Affordable
- II. ZERH and Green, Efficiency, and Affordable Housing Programs
- III. Zero Specifications – The Lift from Energy Star Homes
- IV. Integrating DOE ZERH into State QAPs



Why Zero Energy Ready Home is Affordable



Image Basis: Building Energy Codes Program: National Benefits Assessment, 1992-2040,
https://www.energycodes.gov/sites/default/files/documents/BenefitsReport_Final_March20142.pdf



Risk Driver:
Advanced
Enclosure

+ Insulation
+ Windows
+ Air Sealing

Rigorous Codes
<HERS Scores

Why Zero Energy Ready Home is Affordable

1. Affordability Questions

Is a Home Affordable if it Doesn't: Provide Full Water Protection



Water Managed:

Roofs

Walls/
Openings

Site/
Foundation

Materials

Risk Driver:
Advanced
Enclosure

Outcome:
Colder Surfaces
Less Drying

Moisture Risk:
More Wetting
Potential

Is a Home Affordable if it Doesn't: Ensure Comfort



HVAC QI:

Right-Sizing/
Var. Speed

Ducts in
Cond. Space

Proper
Installation

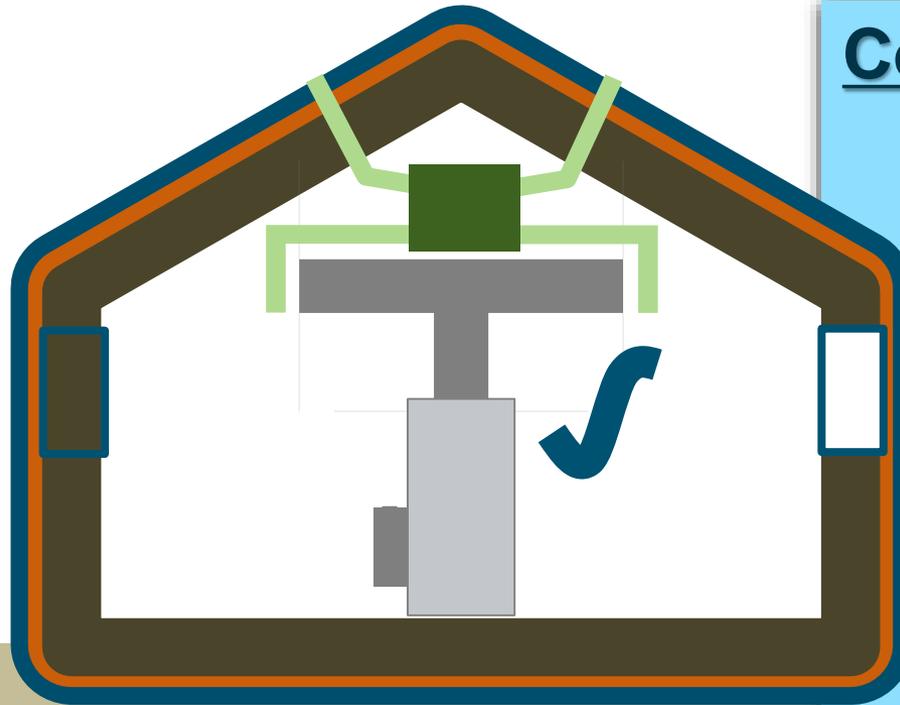
Complete

Risk Driver:
Advanced
Enclosure

Outcome:
Low Loads, >MRT Control
<Air Flow, >Swing Seasons

Comfort Risk:
<Mixing
<RH Control

Is a Home Affordable if it Doesn't: Protect Occupant Health



Comprehensive IAQ System:

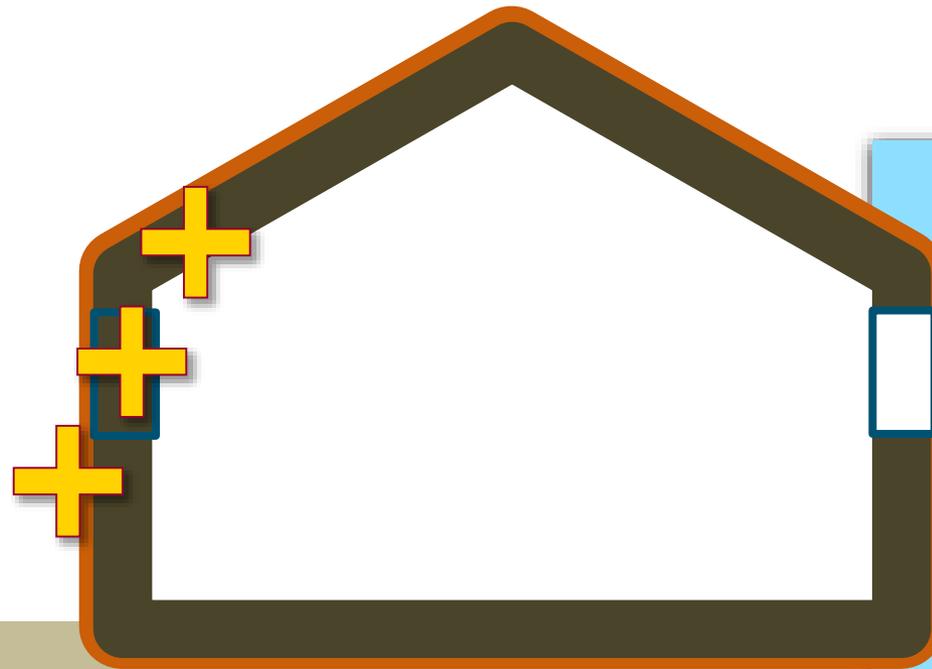
- Source Control
- Fresh Air System
- High-Capture Filtration

Risk Driver:
Advanced Enclosure

Outcome:
Less Air Exchange

IAQ Risk:
More Contaminants

Is a Home Affordable if it Doesn't: Protect Future Value



Future Code Enclosure:

- >Air Tightness
- >Window Eff.
- >Insulation

Risk Driver:
Optimized
Enclosure

Outcome:
3-Year
Code Cycle

Investment Risk:
Near-Term
Obsolescence

Is a Home Affordable if it Doesn't: Minimize Energy Bills



ENERGY STAR

Components:

Equipment

Lighting

Appliances

Fans

Risk Driver:
Optimized
Enclosure

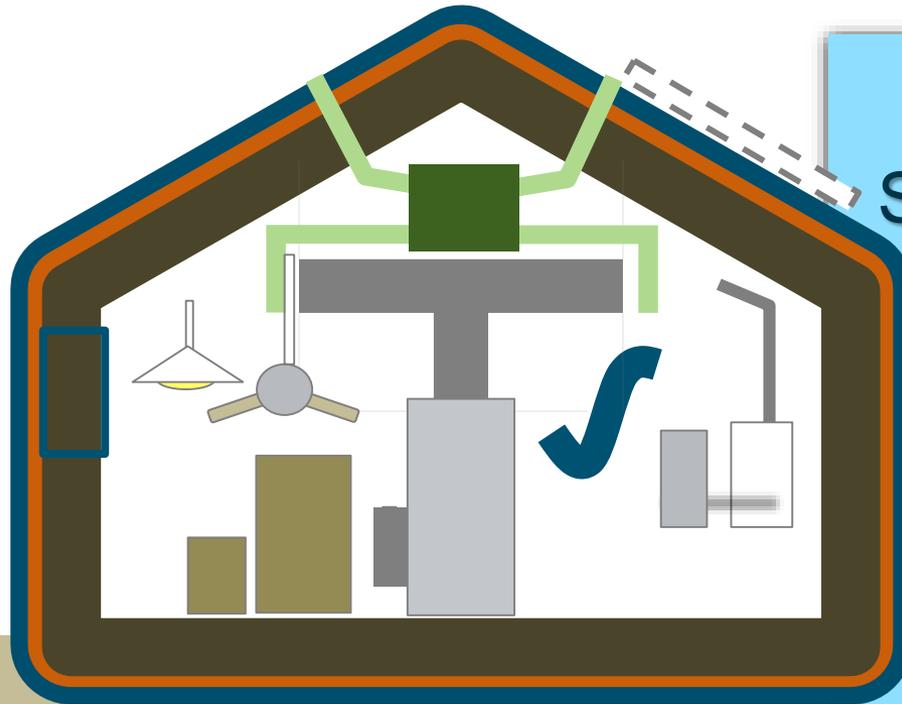
Outcome:
Heating/Cooling
= <50% Load

Efficiency Risk:
Components
Energy Use

Is a Home Affordable if it Doesn't: Provide a Path to Zero Energy Bills

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



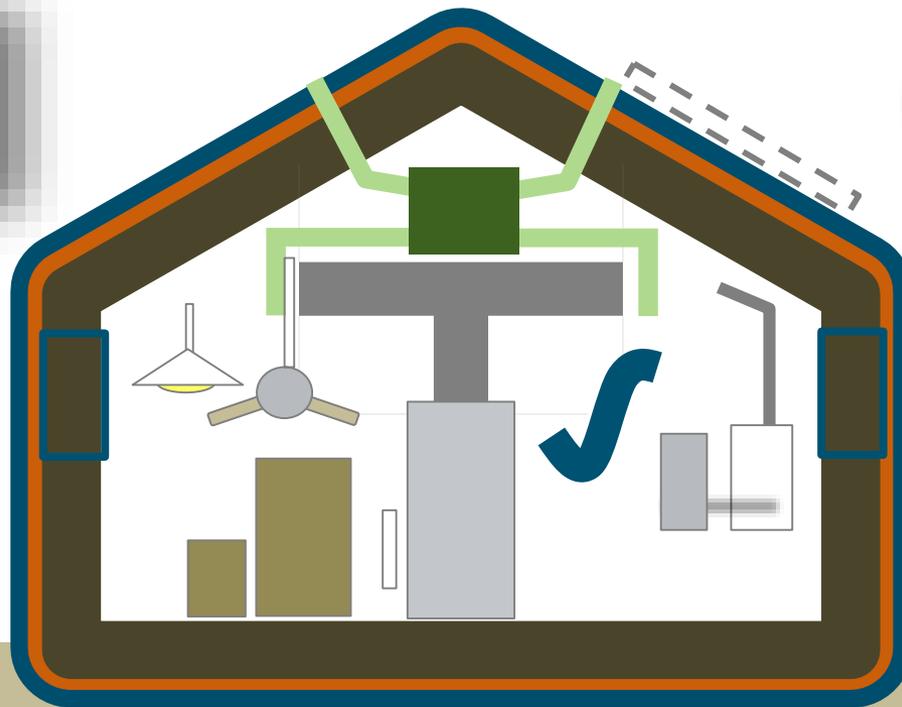
Solar Ready:
Structural Calcs
Conduit for
Wiring
BOS Space
Extra Circuit
Breakers

Risk Driver:
Optimized
Enclosure

Outcome:
Ultra-Low HVAC
Eff. Components

Solar Ready Risk:
Zero
Ready

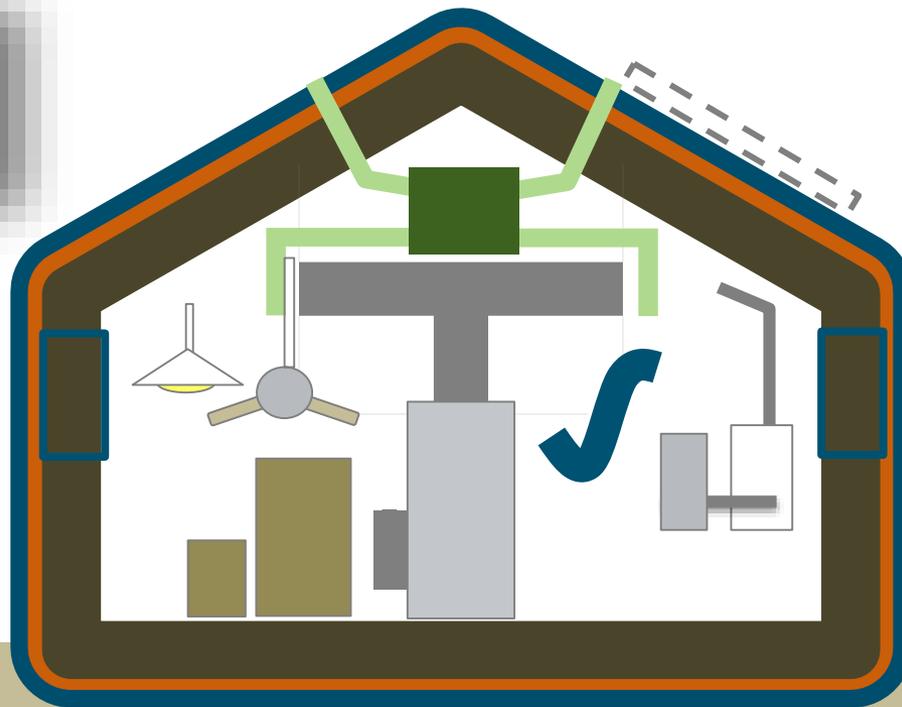
ZERH Spec = Affordability



Optimized Enclosure System	Water Protection System	Optimized Comfort System	Complete IAQ System	Efficient Comps System	Solar Ready System
----------------------------	-------------------------	--------------------------	---------------------	------------------------	--------------------

Six Complete Risk Management Systems

ZERH Spec = Clear Definition



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

Why Zero Energy Ready Home is Affordable

2. Affordability Informed

Informed Homebuyer Catalyst

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Energy Efficiency &
Renewable Energy



Cheap IR Cameras





Drone IR Cameras



Airborne IR Cameras



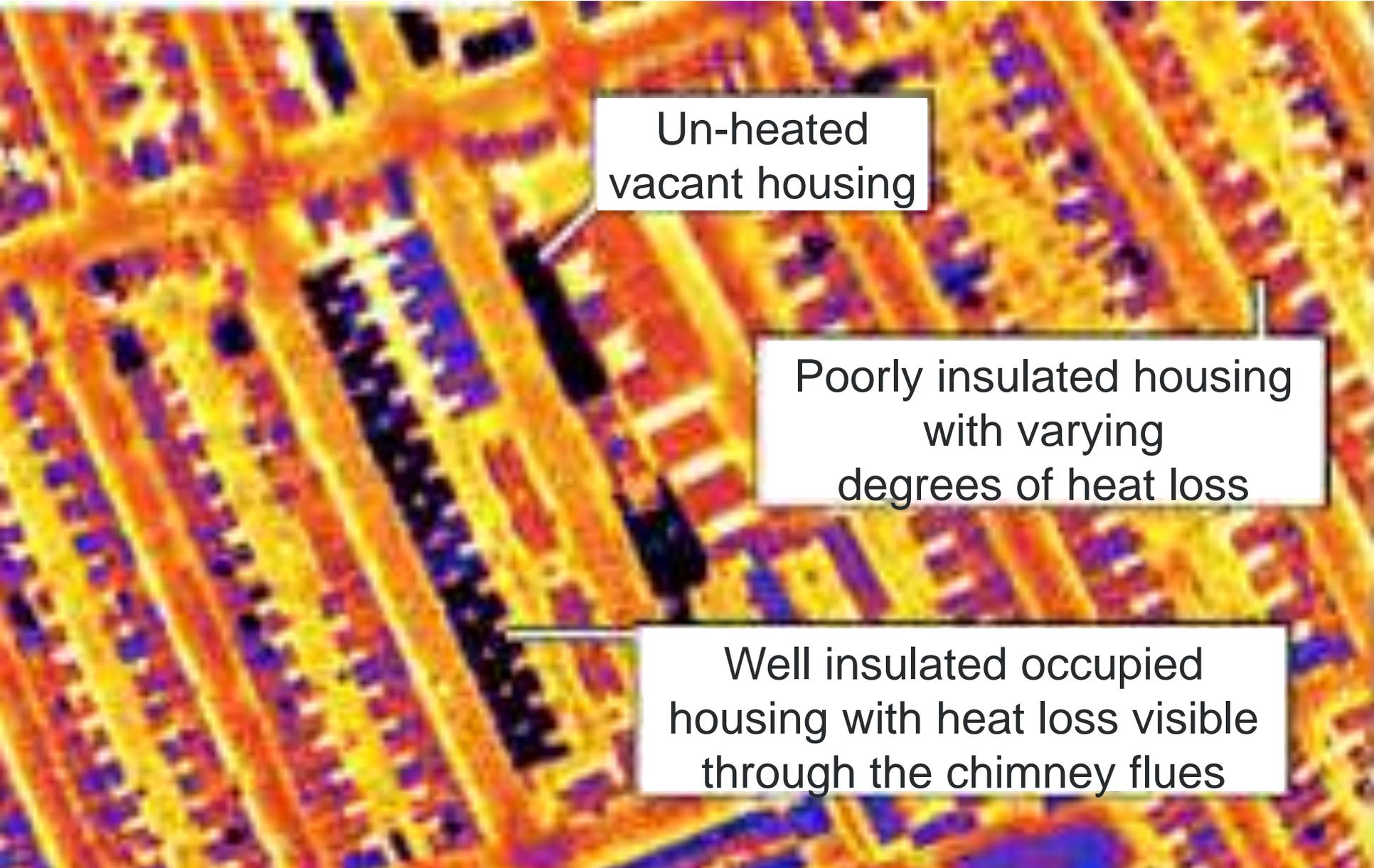
Energy made visible.

Make changes at home today that will have a global impact tomorrow.

[SELECT YOUR CITY](#) ▼

[LEARN MORE](#)

St. Albert, Alberta, Canada

A satellite infrared (IR) camera image of a residential area. The image shows a grid of houses and streets. The color scale represents temperature, with warmer areas in red and yellow, and cooler areas in blue and purple. Three callout boxes with white backgrounds and black borders point to specific areas: 1. A box labeled 'Un-heated vacant housing' points to a dark, cold area. 2. A box labeled 'Poorly insulated housing with varying degrees of heat loss' points to a large area of mixed colors. 3. A box labeled 'Well insulated occupied housing with heat loss visible through the chimney flues' points to a specific house with a chimney flue showing heat loss.

Un-heated
vacant housing

Poorly insulated housing
with varying
degrees of heat loss

Well insulated occupied
housing with heat loss visible
through the chimney flues



How to ...

Search.....

3-1-1

Green Vancouver

Your Government

About Vancouver

Parks, Recreation, and Culture

Home, Property, and Development

People and Programs

Streets and Transportation

Doing Business

Home > Green Vancouver > How you can go green > Programs to help reduce your footprint > At home > Thermal imaging program

Green Vancouver

- ▶ [Greenest City Action Plan](#)
- ▶ [Renewable City Strategy: our future to 2050](#)
- ▶ [Zero Waste Vancouver](#)
- ▶ [Climate Change Adaptation Strategy](#)
- ▶ [Neighbourhood Energy Strategy](#)
- ▶ [How you can go green](#)
 - ▶ [Programs to help reduce your footprint](#)
 - ▶ [At home](#)
 - ▶ [Smart Thermostat Pilot Program](#)
 - ▶ [Thermal Imaging program](#)
 - ▶ [At work](#)

Thermal Imaging program



We launched a thermal imaging pilot program in January to help homeowners identify energy loss in single family homes and to share information on energy saving incentives that are available. We've identified five neighbourhoods (220 KB) to participate in the pilot. The images will be taken throughout the month of January and staff will follow-up with homeowners later this spring.

What is a thermal image?

A thermal image is a picture of the heat that comes off of an object. Often in a thermal image, when something is hot, the image is bright yellow; if something is cold, it shows up as dark blue.

Thermal imaging is becoming an increasingly popular tool around the world to quickly identify opportunities for energy efficiency upgrades to a home that will also improve comfort and may improve health.

Discover your home's energy efficiency potential

In Vancouver, 55% of all greenhouse gas (GHG) emissions come from buildings, and detached homes account for 31% of all GHG emissions from buildings.

Through the Greenest City Action Plan, we are aiming to reduce emissions from existing buildings by 20% by 2020. This would eliminate 160,000 tonnes of GHGs per year - the equivalent of removing 40,000 cars from the road.



Buyers Will Know Thermal Defects

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Buyers Will Know Thermal Defects

U.S. DEPARTMENT OF
ENERGY

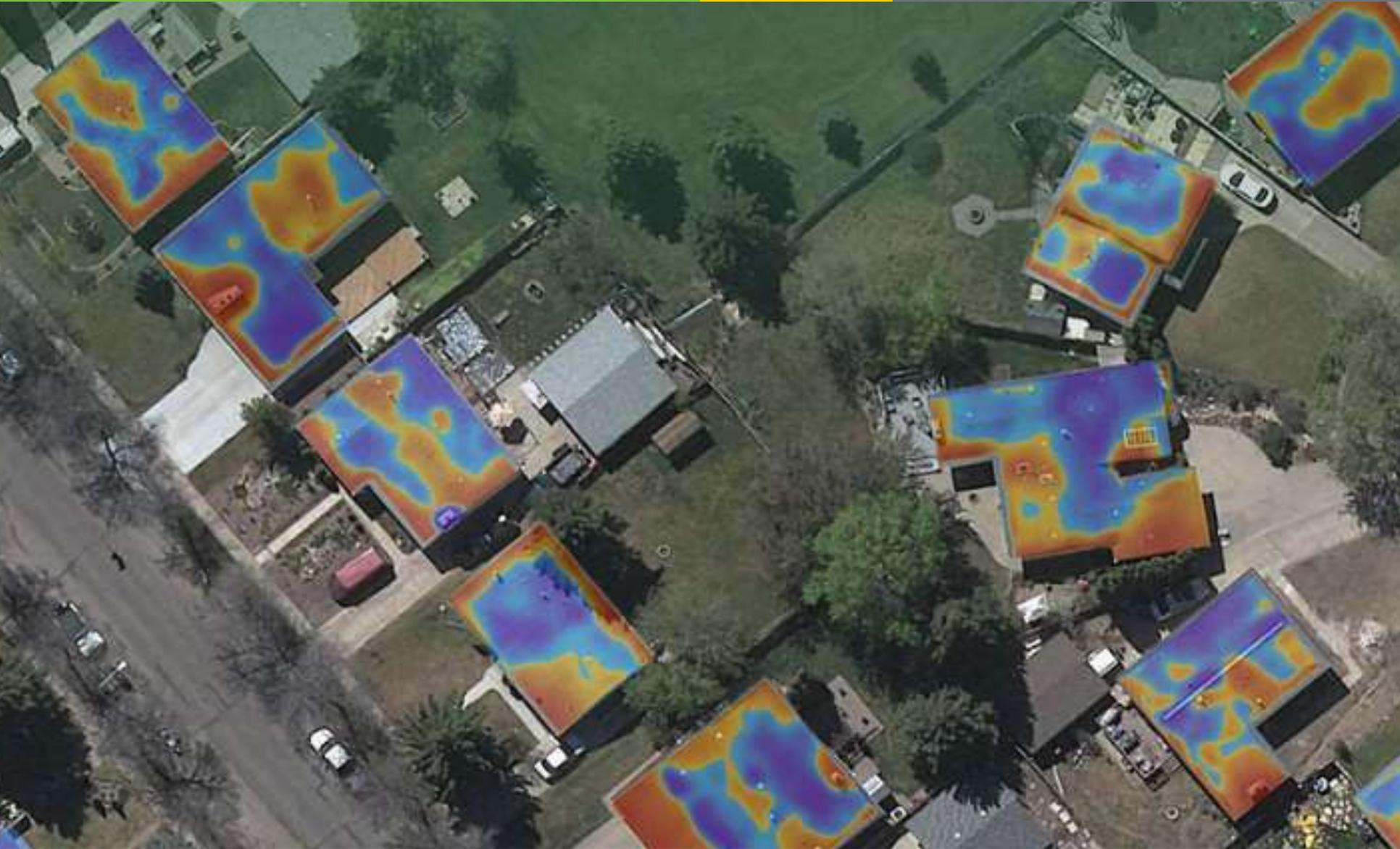
Energy Efficiency &
Renewable Energy



Buyers Will Know Thermal Defects

U.S. DEPARTMENT OF
ENERGY

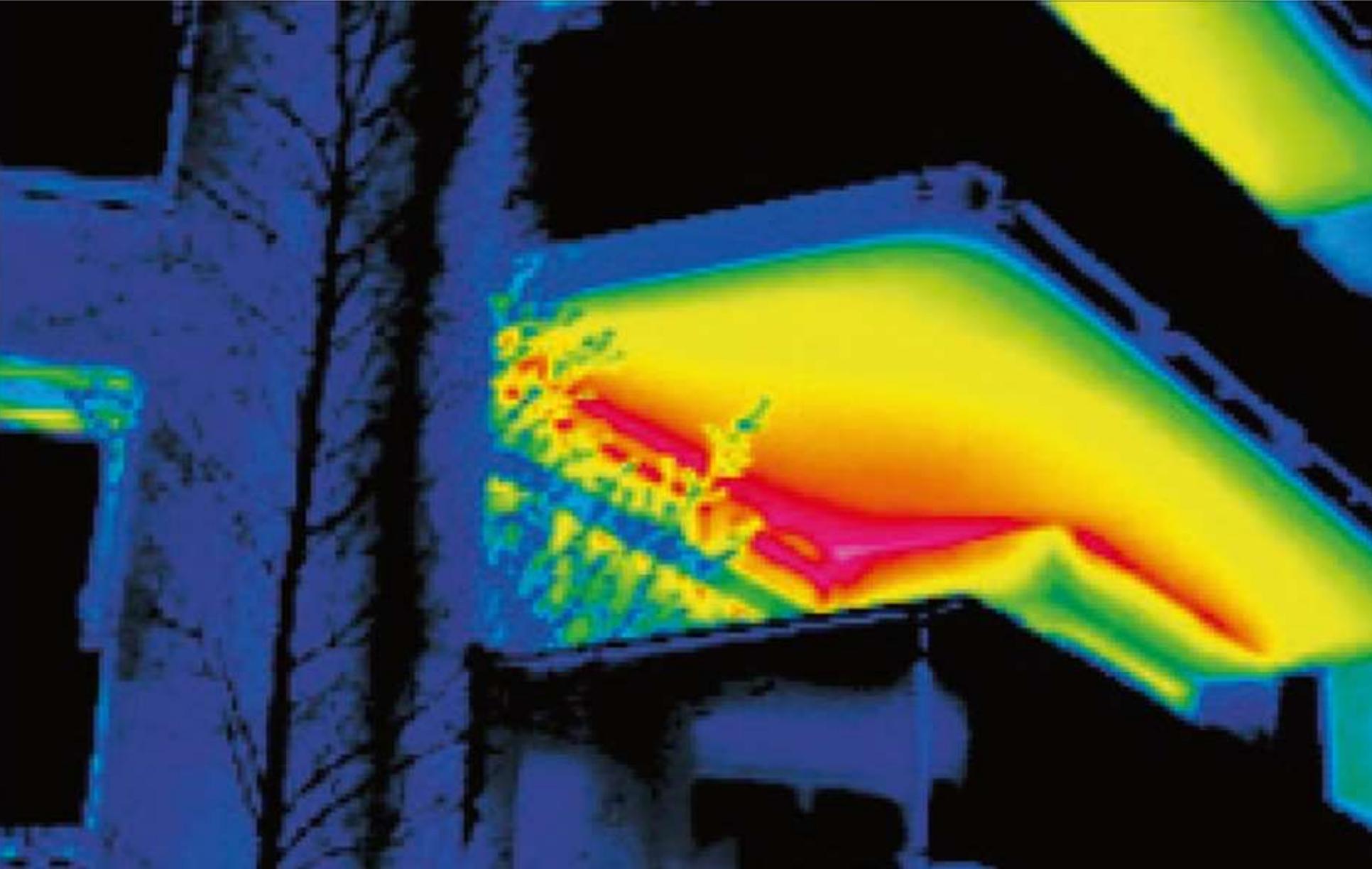
Energy Efficiency &
Renewable Energy



Buyers Will Know Thermal Defects

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ENERGY

Energy Efficiency &
Renewable Energy



...because it minimizes the risk of
Thermal Defects

Buyers Will Know Poor Windows



Buyers Will Know Poor Windows

U.S. DEPARTMENT OF
ENERGY

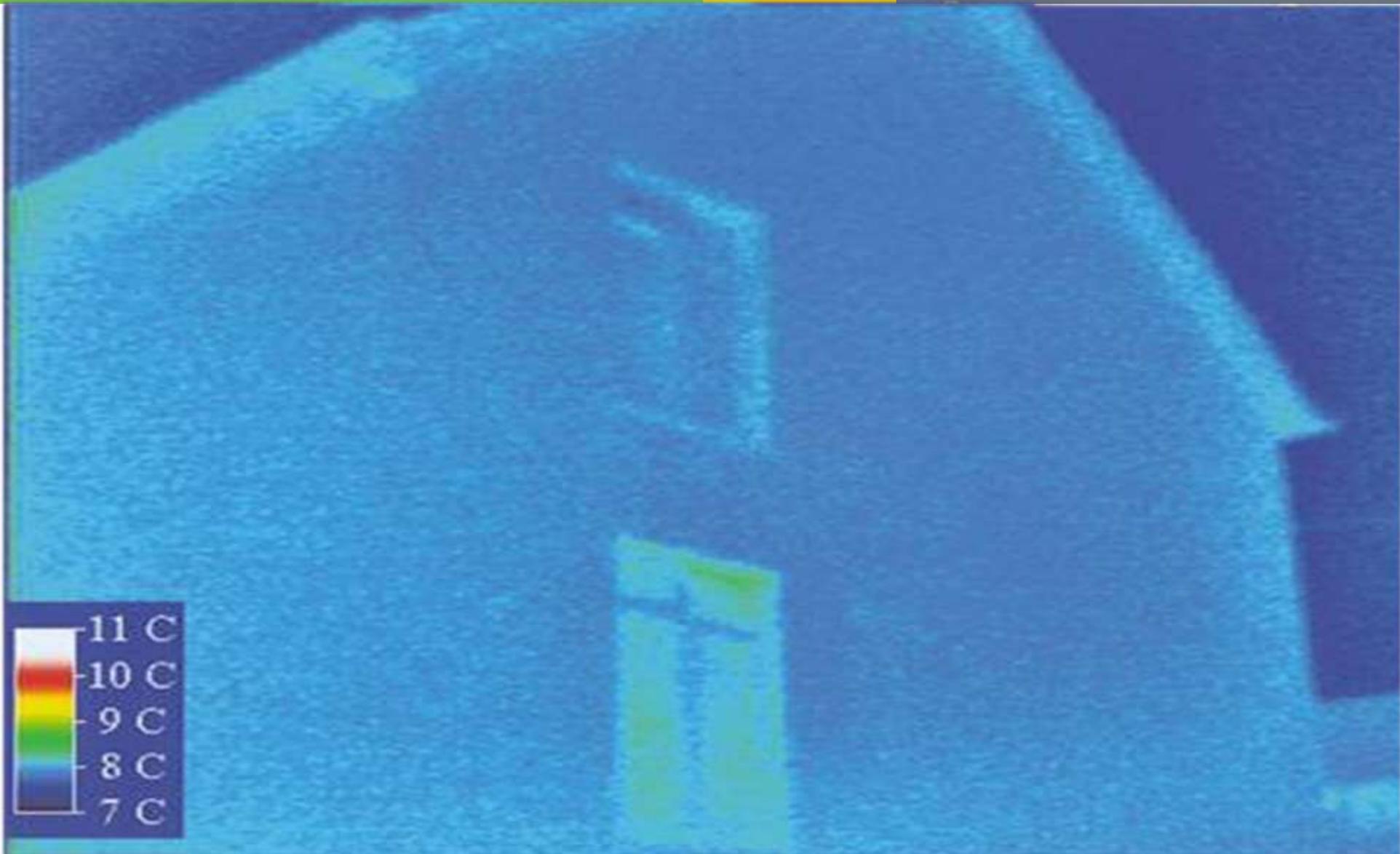
Energy Efficiency &
Renewable Energy



Buyers Will Know Good Windows

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Energy Efficiency &
Renewable Energy



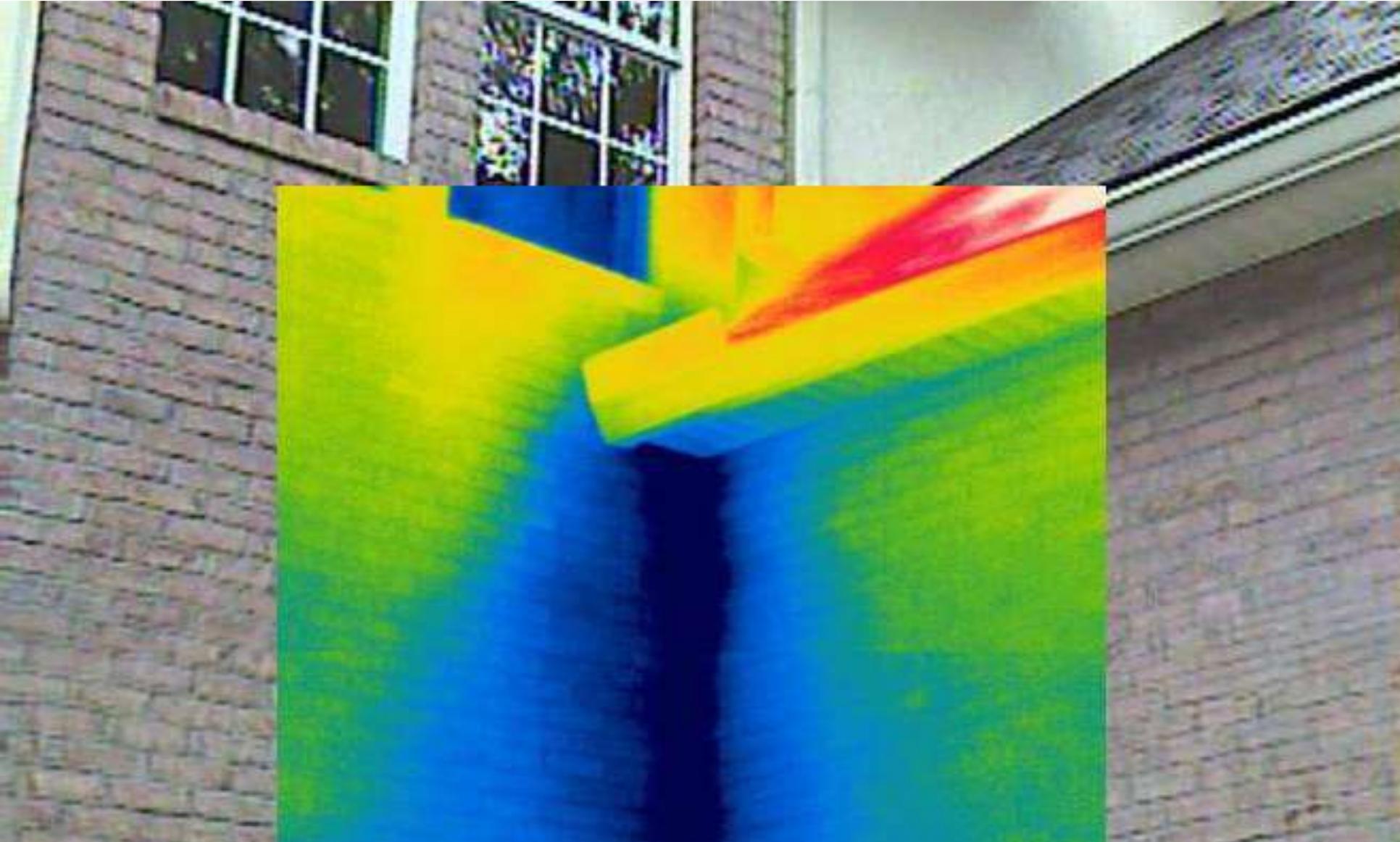
...because it integrates

Advanced Windows

Buyers Will Know Moisture Problems

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Energy Efficiency &
Renewable Energy



Buyers Will Know Moisture Problems

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ENERGY

Energy Efficiency &
Renewable Energy



...because it minimizes the risk of
Moisture Defects

Diagnostic System:

- **Six Sensors**
[Outdoor Condenser]
 - 3 Thermal
 - 2 Voltage
 - 1 Current
- **<15 Minutes Install**
- **\$50 Hardware**



Current RMS Configuration

AP & ED Total Cost \$95



End Device (ED)



Access Point (AP)



New Configuration: Direct Internet Connection – Total Cost < \$50

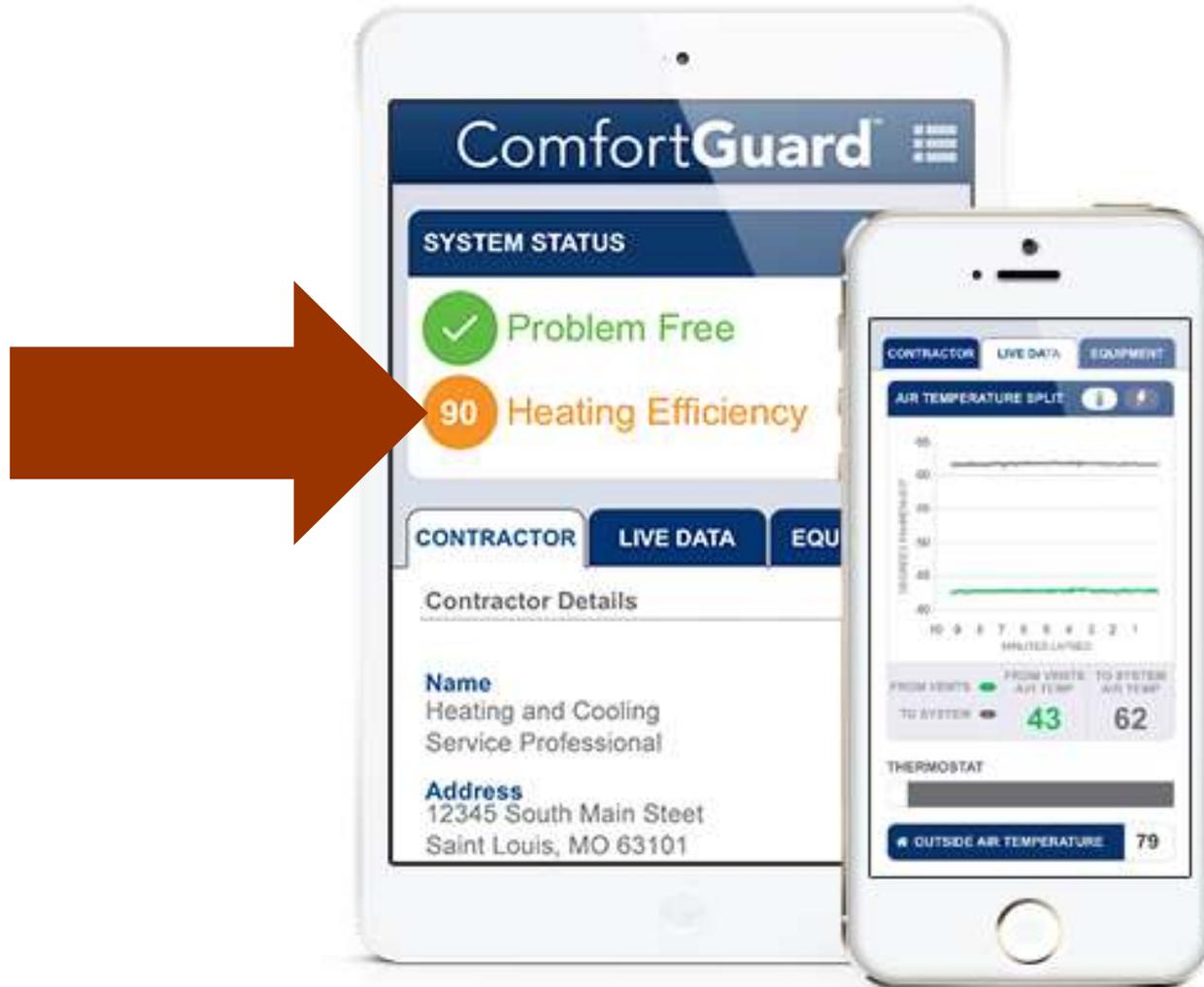
Page 18

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Mainstream Engineering Corporation

Diagnostic Capability:

- **Charge** [Low]
- **Capacitor** [Failed Start or Run]
- **Flow** [Condenser or Evaporator]
- **Operation** [Normal/Abnormal]
- **Performance** [COP]

Buyers Will Know HVAC Quality



...because it helps ensure
Quality HVAC

Indoor vs. Outdoor Air Pollutants:

On average **2-5 times greater**

Up to **100 times greater**

While Americans Spend

90% of time indoors

Source: EPA

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

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

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

Buyers Will Know Indoor Air Quality



Buyers Will Know Indoor Air Quality

 Air Mentor

2015-02-05 10:10:53

 Air Mentor



Particulate Matter **Good**

<5

Temperature **Good**

20.4 °C ✓

Gas Pollution **Moderate**

511 ↑

Humidity **Good**

53 % ✓

PM2.5 **Good**

<5

Current status:

The last hour average value is 5 ug/m3.



Recommendation Actions:

African Violet

African Violet will bloom throughout the year, and it has strong ability to reduce carbon dioxide and hold dust. It reduces carbon dioxide concentrations i...



Effects

PM 

CO2 

...because it helps minimize the risk of
Health Problems

DOE Zero Energy Ready Home	
Cost Factor	Estimated Benefits
Added First Cost ^{1, 2}	\$1500 - \$5000
Added First Cost, Amortized (0% 30-year fixed)	\$4 - \$14/month
Energy Savings (vs Code Minimum Home ³)	\$50/month
Homeowner Net	+ \$36 - \$46/month
Non-Energy Cost Savings	<ul style="list-style-type: none"> • Lower Health Cost • Lower Maintenance • Greater Future Value

1. Beyond minimum code home based on a DOE ZERH Case Study for a Florida affiliate & DOE Energy & Cost Savings Analysis

2. Does not account for federal tax credits, rebates, or in-kind product or labor.

3. Based on 3 Case Studies of DOE ZERH-qualified Habitat Homes (all in FL)

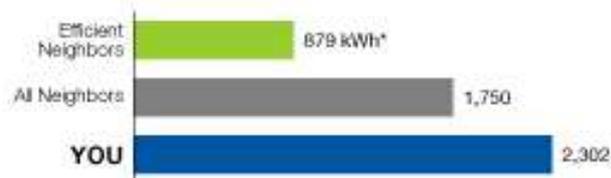
Buyers Will Know Operational Score



Last Summer Comparison

You used **32% MORE** electricity than your neighbors.

Your usage last summer: May '10 – Sep '10



* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

Great 😊😊
Good 😊
▶ BELOW AVERAGE

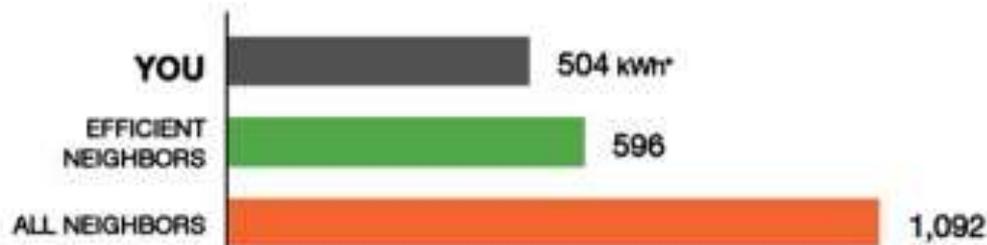
Who are your Neighbors?

All Neighbors: Approximately 100 occupied, nearby homes that are similar in size to yours (avg 1,362 sq ft)

Efficient Neighbors: The most efficient 20 percent from the "All Neighbors" group

Last Month Neighborhood Comparison

Last month you used **15% LESS** electricity than your efficient neighbors.

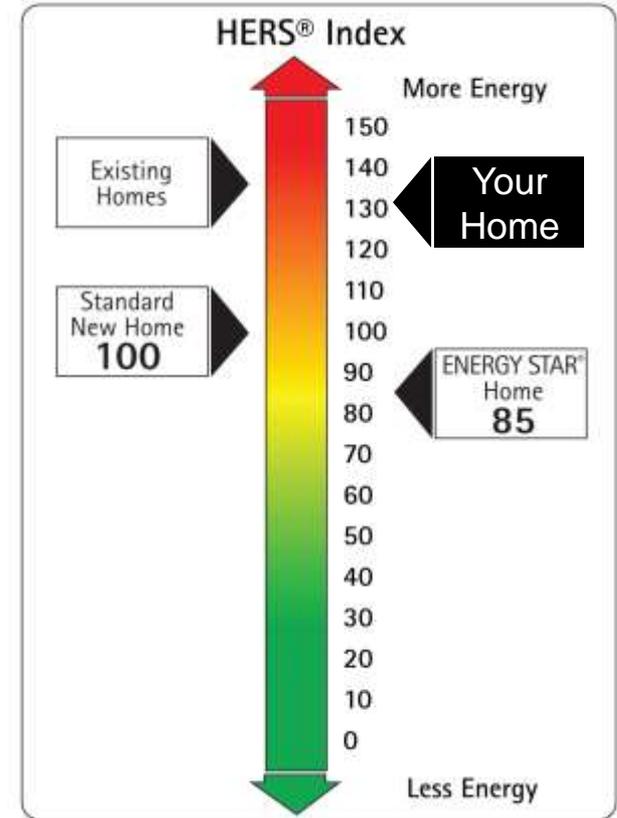
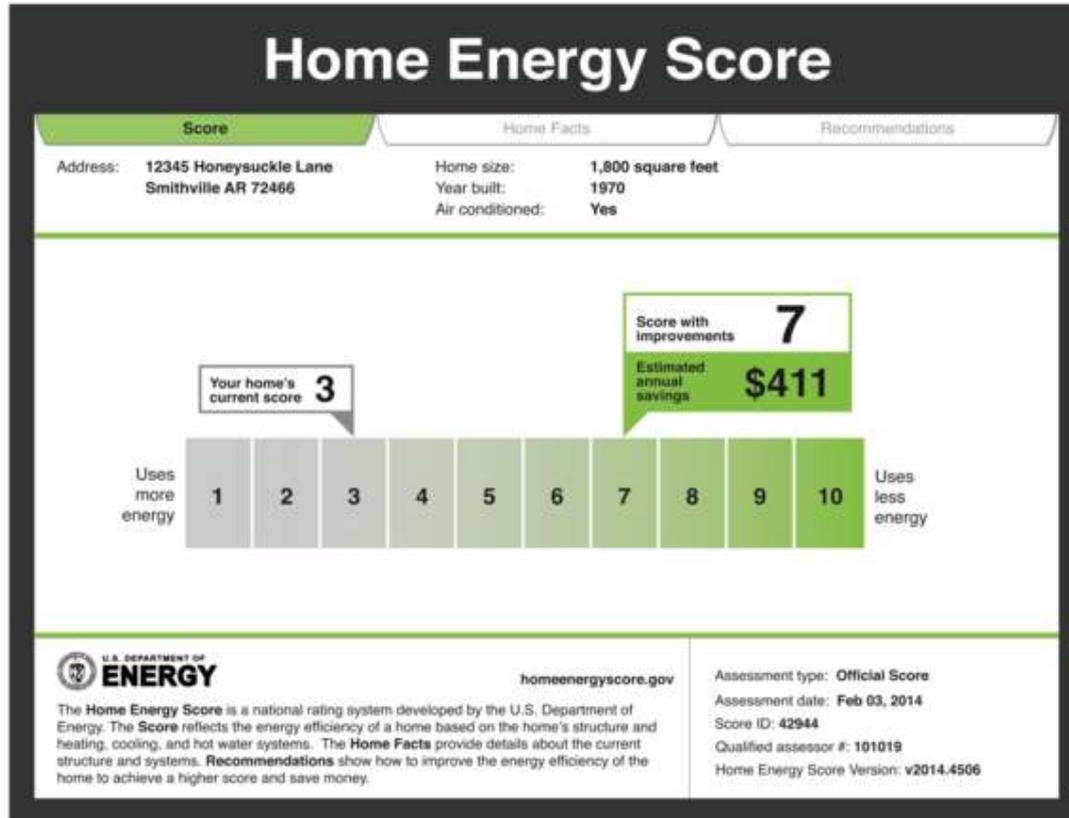


* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

YOUR EFFICIENCY STANDING:

▶ GREAT 😊😊
GOOD: 😊
BELOW AVERAGE

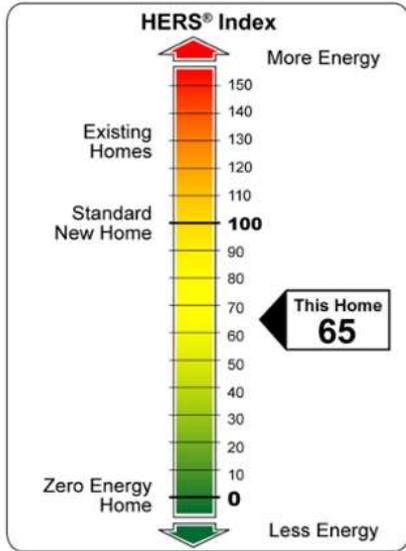
Buyers Will Know Asset Score



...because it optimizes

Energy Efficiency

Buyers Know Trusted Performance



Buyers Know Trusted Performance



...because it delivers

**Trusted
Performance**

Why Zero Energy Ready Home is Affordable

3. Affordability Communicated



Zero Energy Ready Home: **The Experts' Choice**

Making the Largest Purchase of a Lifetime
Just Got Easier



Homes to the Power of **ZERO**



A Symbol of Excellence

HEALTHFUL ENVIRONMENT



COMFORT PLUS



ADVANCED TECHNOLOGY



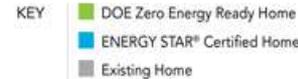
ULTRA EFFICIENT



QUALITY BUILT



DURABILITY



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

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?

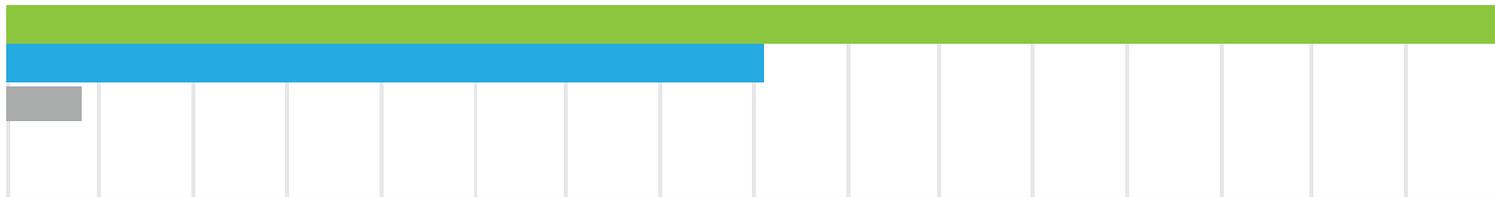
It is a high-performance home so energy efficient, all or most annual energy consumption can be offset with renewable energy. In other words, it is the Home of the Future.



FPO Le **NEW TOWN** ent

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

HEALTHFUL ENVIRONMENT



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

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



U.S. DEPARTMENT OF
ENERGY

Translating ZERH Value with Clarity



Front Cover



Inside Spread



Flap

Back Cover

Lives Better
A comprehensive, healthful home

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.

Works Better
Ultra-efficient, energy efficient.

ADVANCED TECHNOLOGY

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

Lasts Better
High quality, built to last.

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.

The Future of Housing—Today

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



LEARN MORE AT:
buildings.energy.gov/zero

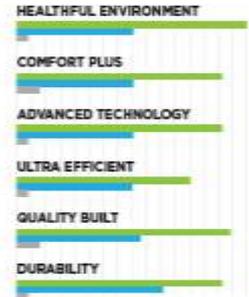


Call us at:
303-231-4567

NewTown@net.com



A Symbol of Excellence



KEY ■ DOE Zero Energy Ready Home
■ ENERGY STAR Certified Home
■ Existing Home

This table indicates relative performance of this DOE Zero Energy Ready Home to existing homes (built between 1990 and 2000) and ENERGY STAR Certified Homes. Actual performance may vary.





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

- Heather Robbins, Garbett Homeowner

garbettHOMES.com
Now you're living.

ZERO
ENERGY RATED HOMES

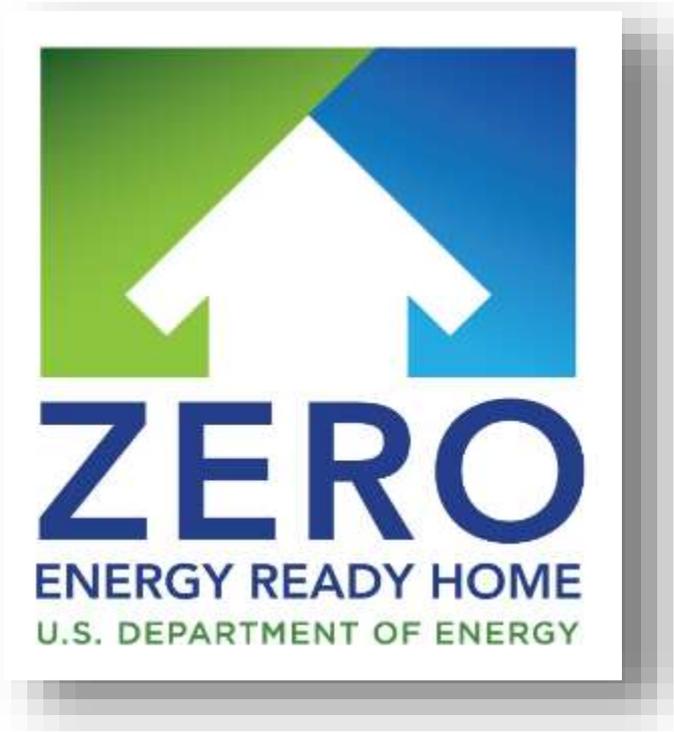
“Our daughter couldn’t breathe
without discomfort for years.
Within two months of moving into
our new Cobblestone home

**we threw away
the inhaler.**

**That was
priceless!”**

Charly and Mary Jones,
Cobblestone Homeowner





ZERH & Green, Efficiency, and Affordable Housing Programs

DOE ZERH Eligible Building Types

- SF Detached
- SF Attached
- Dwelling units in any MF building with 4 units or fewer
- Dwelling units in MF ≤ 3 stories above-grade
- Dwelling units in MF buildings 4 or 5 stories above-grade:
 - Dwelling units occupy $\geq 80\%$ occupiable SF of the building
 - Central HVAC – OK **(New)**
 - Central DHW – OK **(New)**
- New Construction & Gut Rehab



Enterprise Green Communities Criteria (2015 Version):

- New Construction projects must meet Mandatory criteria & gain 35 “optional” points to achieve EGC Certification
- DOE ZERH qualifies a project for **12** optional points under 5.2B in the Energy Efficiency section
- DOE ZERH also assures that SF and low-rise MF projects achieve the Mandatory ENERGY STAR Homes certification



LEED v4 BD+C: Homes:

- Recognizes that DOE ZERH projects (and the embedded IAP certification) can be awarded a minimum of 26.5 points
- DOE ZERH also satisfies most Prerequisites in Energy and Atmosphere and Indoor Environmental Quality categories.
- Additional points can be earned by having a HERS Index of 56 or better. Most DOE ZERH projects will be below this level.
- Projects must earn at least 40 points to meet the LEED certification at the Certified level.
- ZERH points are explained in LEED Interpretation ID# 10431.



Habitat for Humanity and ZERH



DOE Zero Energy Ready Home is a Prerequisite for PHIUS+ projects

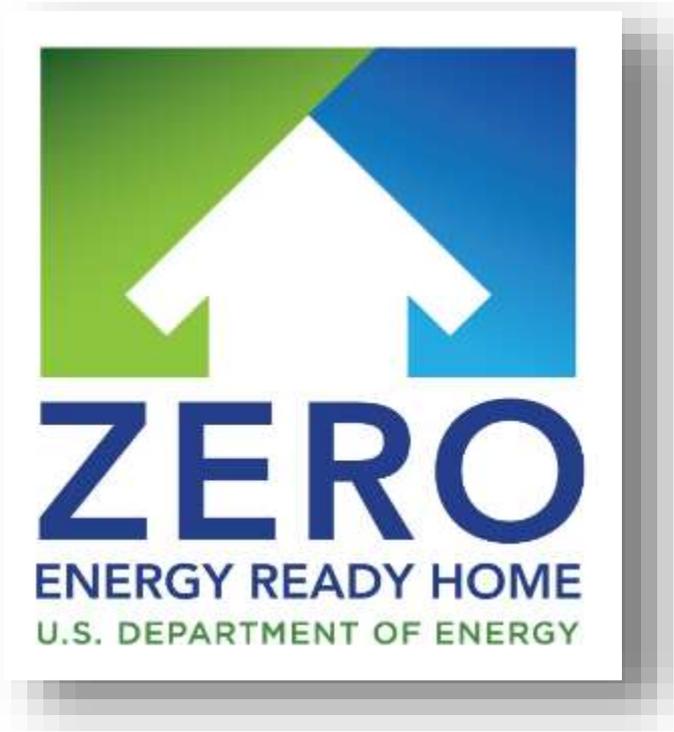


70% of states awarded points for Energy Efficiency in their 2014 QAPs ¹

DOE ZERH is recognized in 2017 by the following states:

- New Jersey
- Delaware
- Ohio
- Georgia

1. Source: National Housing Trust. “Low Income Housing Tax Credits & Energy Efficiency Policies.”



Zero Specifications

The Lift from ENERGY STAR Homes

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...

			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



Reaching Lower HERS: Target Home Efficiency Levels

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			

Southeast Volusia Habitat (FL) HERS 49



30 Year Energy Savings ~ \$28k

"I COULD NOT ASK FOR BETTER. I LOVE IT!!!!"

Southeast Volusia Habitat for Humanity

Vista Palm Drive
New Smyrna Beach, FL
habitatsev.org

"I keep my AC at about 72-75 degrees so you can see from the bills how efficient my home truly is. I have a friend who lives two streets over with only a two-bedroom home and her electric bill runs from \$250 to \$325. My home is so well-insulated I have not had to turn on my heat one time this winter. I could not ask for better. I love it!!!!"

— Homeowner



KEY FEATURES

- High-performance insulation system for enhanced quiet and comfort
- Comprehensive draft protection
- Fresh air system for cleaner, healthier indoor air
- High-efficiency comfort system
- High-efficiency appliances and advanced lighting technology for energy and water savings

[Read more.](#)



[More ...](#)

[Meet the Builder](#)

1,250 ft²
3 bedrm, 2 bath
1 floor
hot-humid climate
\$115,000 w/land

HERS 49 This home's score w/o PV

0 = a net zero energy home
100 = typical new code home
130 = average existing home



\$67 Average monthly energy bill*

\$655 saved per year*
\$27,857 saved over 30-yr mortgage**
* actual w/delivery charges; *calculated;
** calculated with fuel escalation rate per 2014 EIA Annual Energy Outlook

Mutual Housing at Spring Lake HERS 21 (including PV)



30 Year Energy Savings ~ \$40k

"THE DAY WE MOVED IN, MY 7-YEAR-OLD SON RAN INSIDE YELLING, 'I LOVE MY HOUSE, I LOVE MY HOUSE!'"

Mutual Housing California

Mutual Housing at Spring Lake
Sacramento, CA
mutualhousing.com

"Before moving into Mutual Housing at Spring Lake, my family and I lived in a two-bedroom apartment ...that had troubles... with heat, the plumbing, and battling with cockroaches. It was hard dealing with our children's medical issues ... and coming to an apartment that we dreaded living in. But



KEY FEATURES

- High-performance insulation system for enhanced quiet and comfort
- Comprehensive draft



More ...

Meet the Builder

64,604 ft²

Two 3-story apt bldgs; four 2-story bldgs; 62 units hot-dry

HERS 21 This home's score w/PV

0 = a net zero energy home
100 = typical new code home
130 = average existing home



\$12 Average monthly energy bill*

\$936 saved per year**
\$39,808 saved over 30-yr mortgage**
*avg of 62 units calculated vs 2008 CA Title 24; **calculated with fuel escalation rate per 2014 EIA Annual Energy Outlook

Ithaca Neighborhood Housing Services HERS 50



30 Year Energy Savings ~ \$25k

"I HAVEN'T HAD TO TURN ON MY HEAT AT ALL!"

Ithaca Neighborhood Housing Services

Holly Creek Lane
Ithaca, NY
ithacanhhs.org

"I love my new home at Holly Creek. ... My last gas and electric bill was only \$18, which is wonderful! I haven't had to turn on my heat at all!"

- Ithaca Neighborhood
Housing Services homeowner



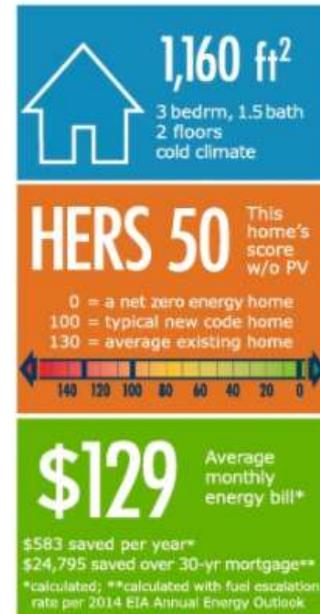
KEY FEATURES

- High-performance insulation system for enhanced quiet and comfort
- Comprehensive draft protection
- Fresh air system for cleaner, healthier indoor air
- High-efficiency comfort system
- High-efficiency appliances and advanced lighting technology for energy and water savings



More ...

[Meet the Builder](#)



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



- 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)	

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



The Importance of Duct Performance

95% Condensing Furnace

X

60% Efficient Duct
Distribution

57% System Efficiency

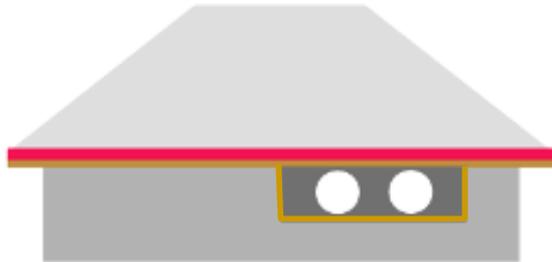
80% Furnace

X

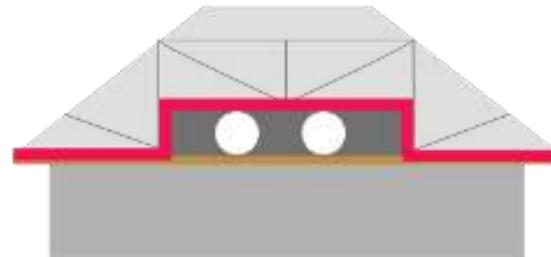
90% Efficient Duct
Distribution

72% System Efficiency

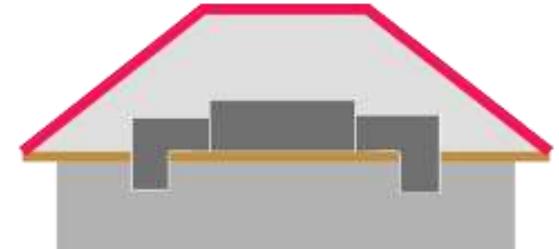
Options for Optimized Duct Location



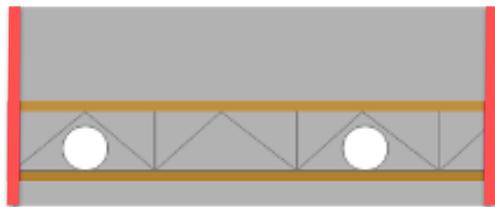
Ducts in Dropped Ceiling



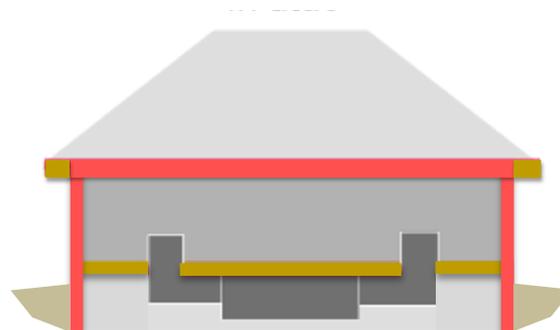
Ducts in Modified Attic Truss



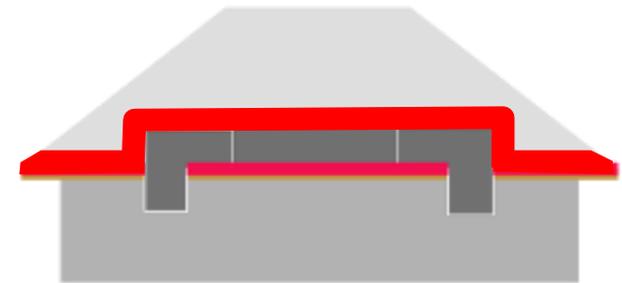
Ducts in Unvented Attic
Ducts in unvented attic



Ducts Between Floors



Ducts in unvented crawl space
or basement
Ducts in Unvented
Crawl Space/Basement



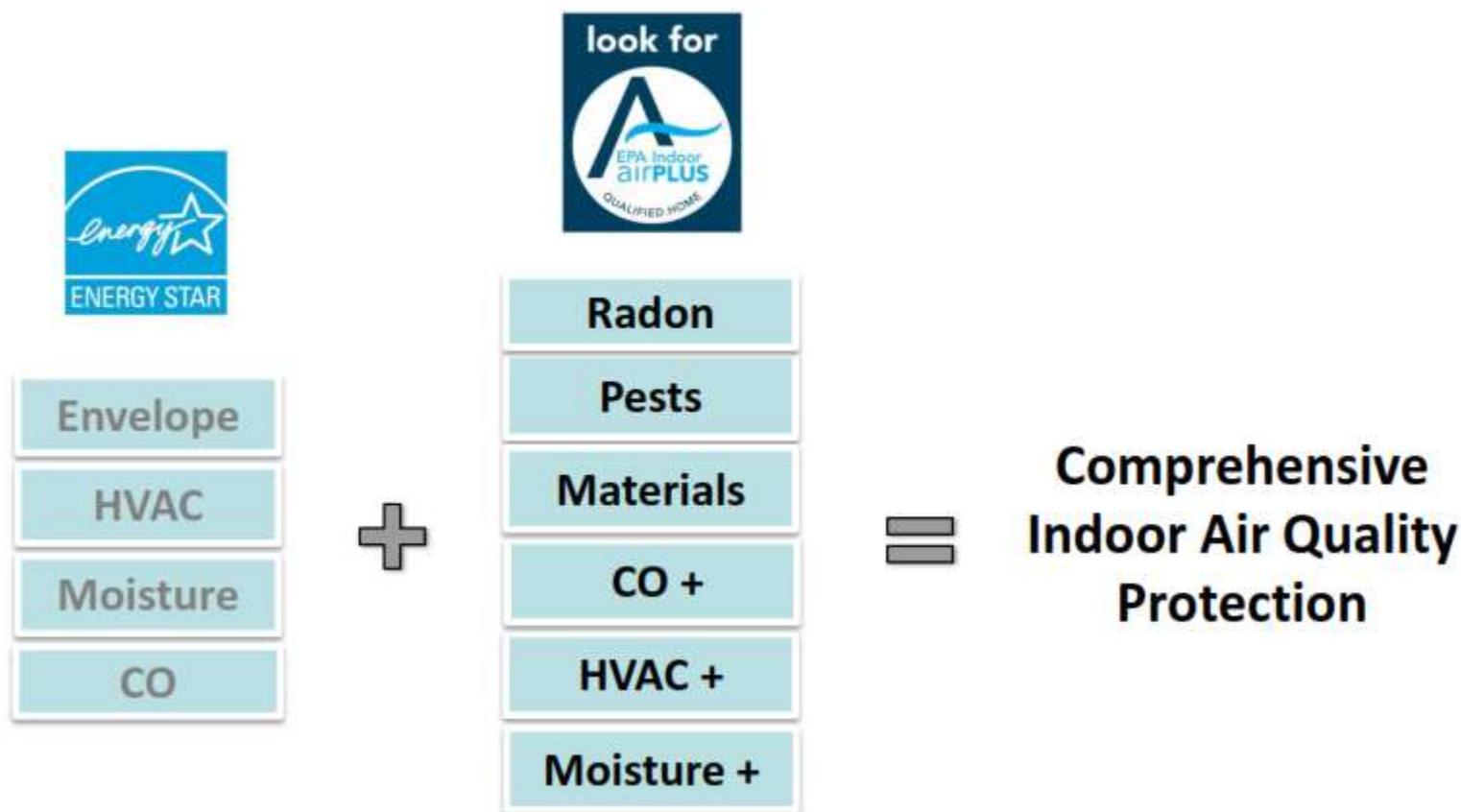
Ducts in vented attic
Ducts in Vented Attic

Stepping up to ZERH...



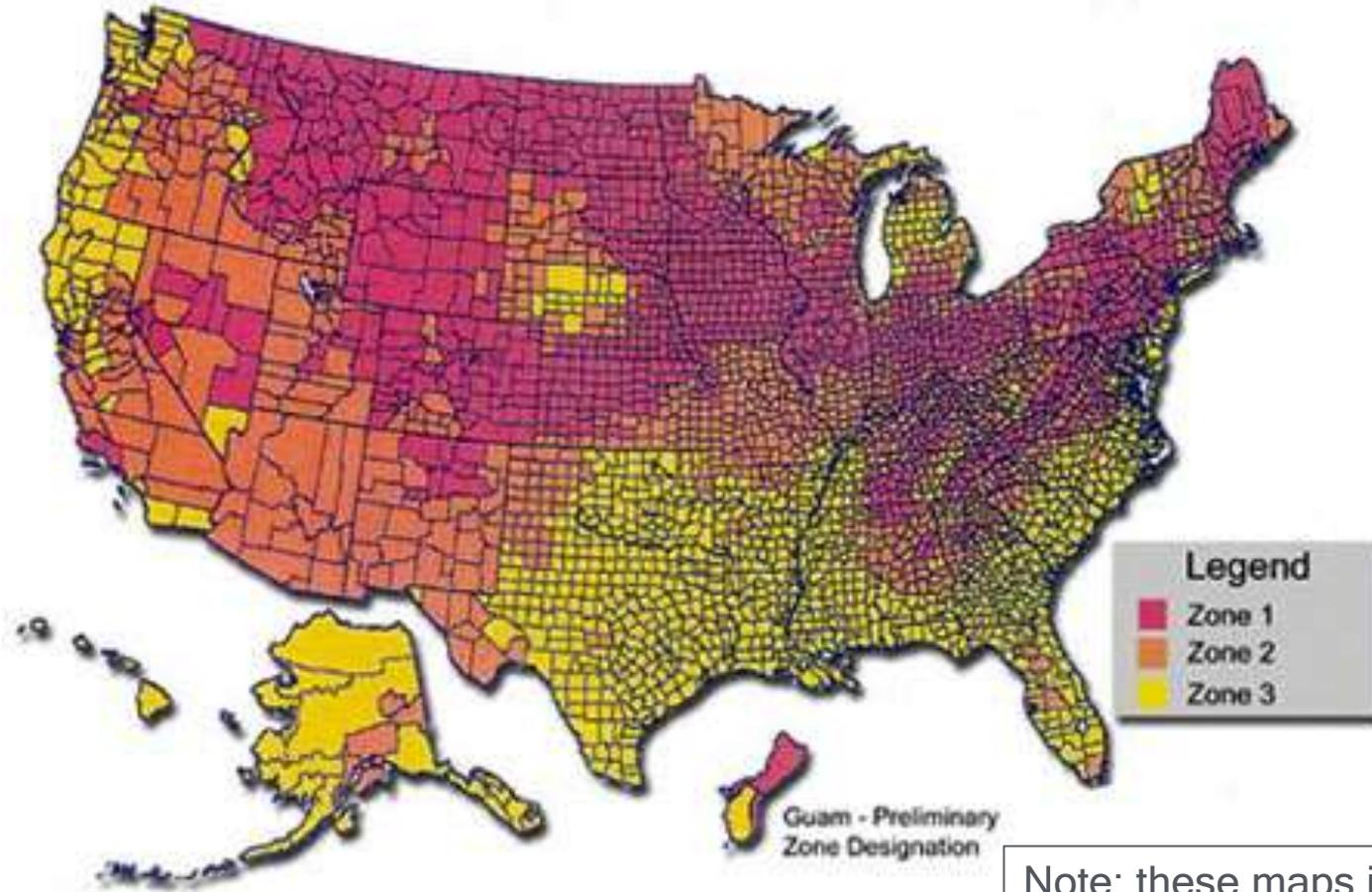
			Solar Ready	
			Eff. Comps. & H ₂ O Distrib.	
			EPA Indoor Air Package	←
			Optimized Duct Location	✓
	HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV	
	Water Management	Water Management	Water Management	
	Independent Verification	Independent Verification	Independent Verification	
IECC 2012 Enclosure	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	

ENERGY STAR + Indoor airPLUS



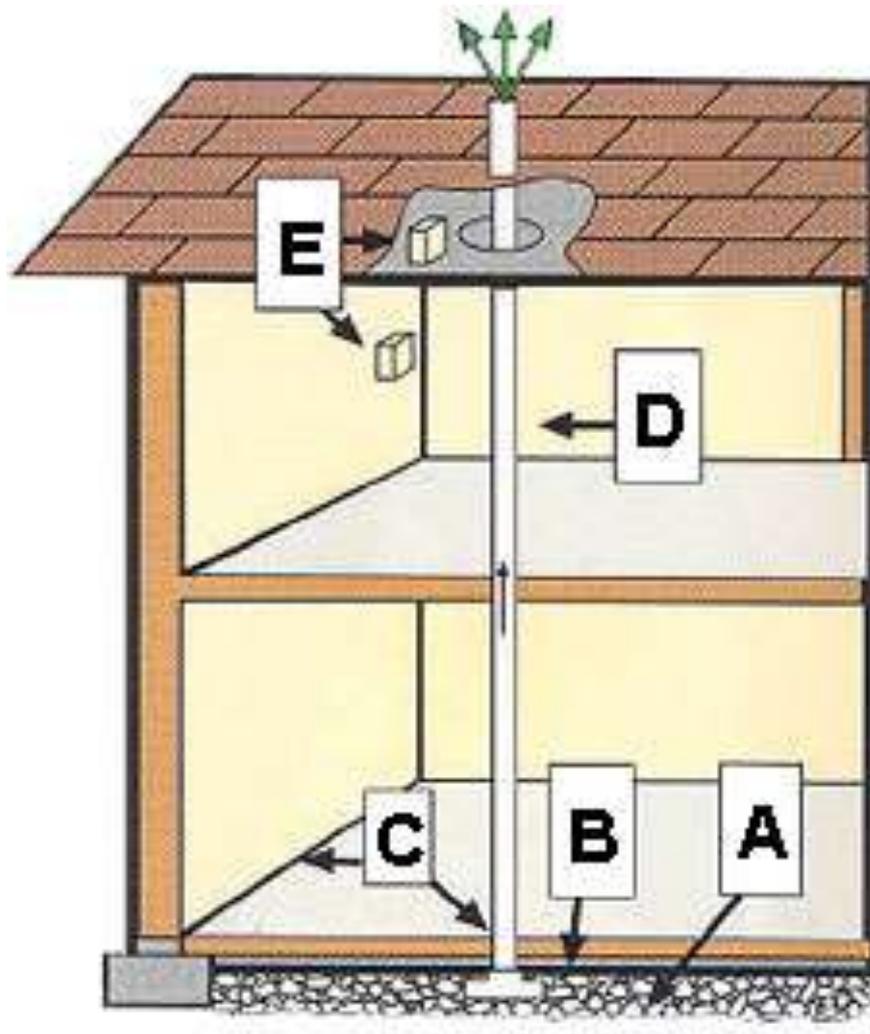
Radon: Radon Zones in U.S.

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:

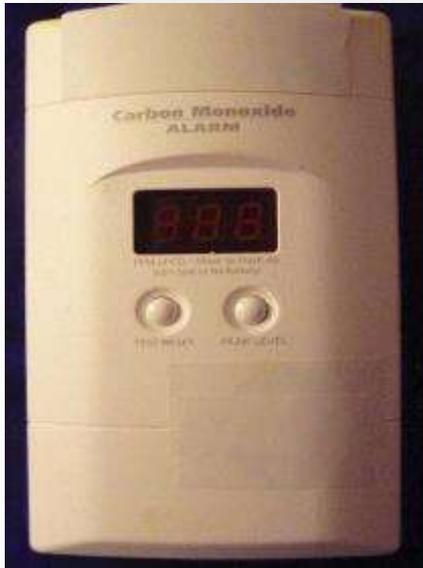
How to Find Indoor airPLUS Compliant Low-Emission Products



How to Find Indoor airPLUS Compliant Low-Emission Products

Cabinetry	
<p>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.</p>	
Meet at least one standard below	How to find compliant products
<p><i>KCMA's Environmental Stewardship Program (ESP 05-12)</i></p>	<p>Look for the KCMA-ESP label on cabinets (often sink bases), product packaging, and/or spec sheets.</p> <p>For a list of KCMA certified manufacturers that produce compliant cabinets, visit: http://www.kcma.org/Members/ESP_Certified_Manufacturers</p> <p><i>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.</i></p> 

CO Alarm in each bedroom area



CO Alarm



Combined CO
& Smoke Alarm



Enforceable policy in
Multi-family buildings



No Air Handler in the Garage



Source: Construction Instruction

No Building Cavity Ducts



HVAC+ High-MERV HVAC Filter



8 MERV Filter Minimum

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

Options are:

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



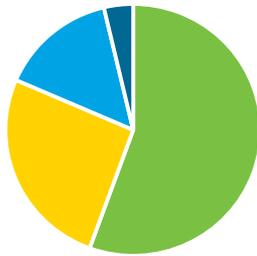
Stepping up to ZERH...



			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	

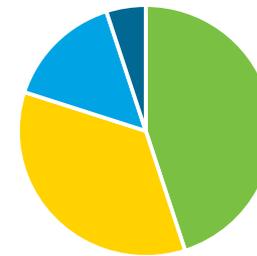
Components and MEL's are increasingly larger part of total energy use in low-load homes (~50%).

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

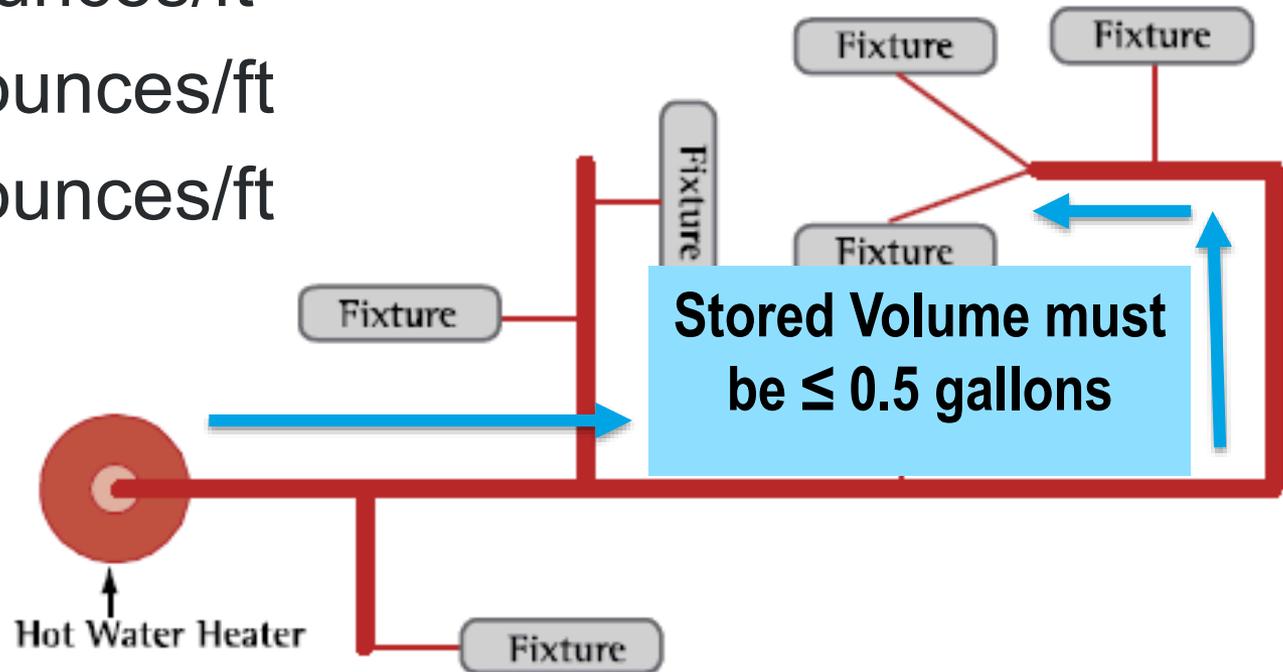
Example: Volume:

30' trunk

10' branch

Wait Time: 1 – 1.5

minutes
2 GPM showerhead



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

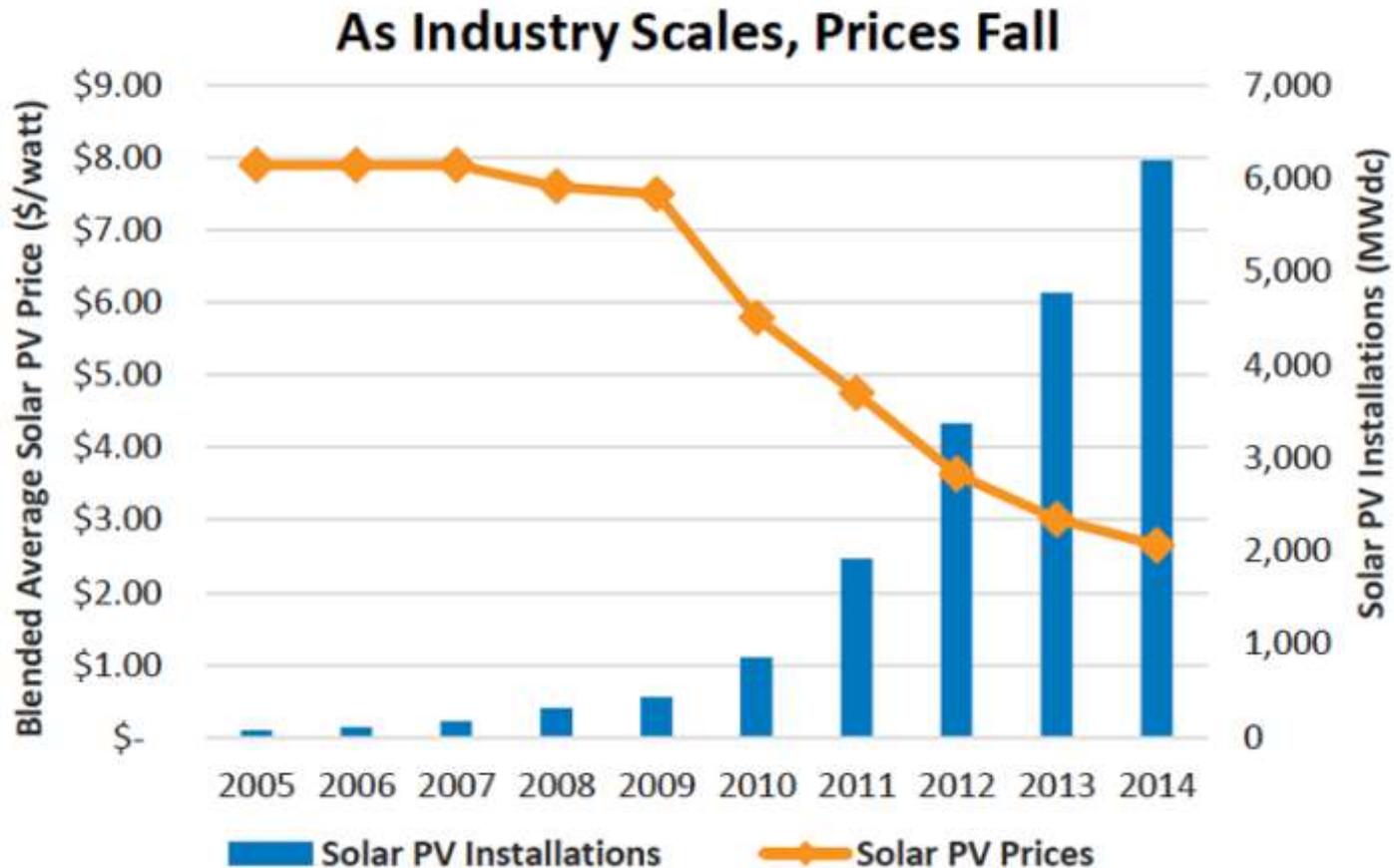
In multifamily with central hot water:

- On-demand recirculation based on loop temp and a demand indicator
- Storage volume ≤ 1 gallon recommended

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	



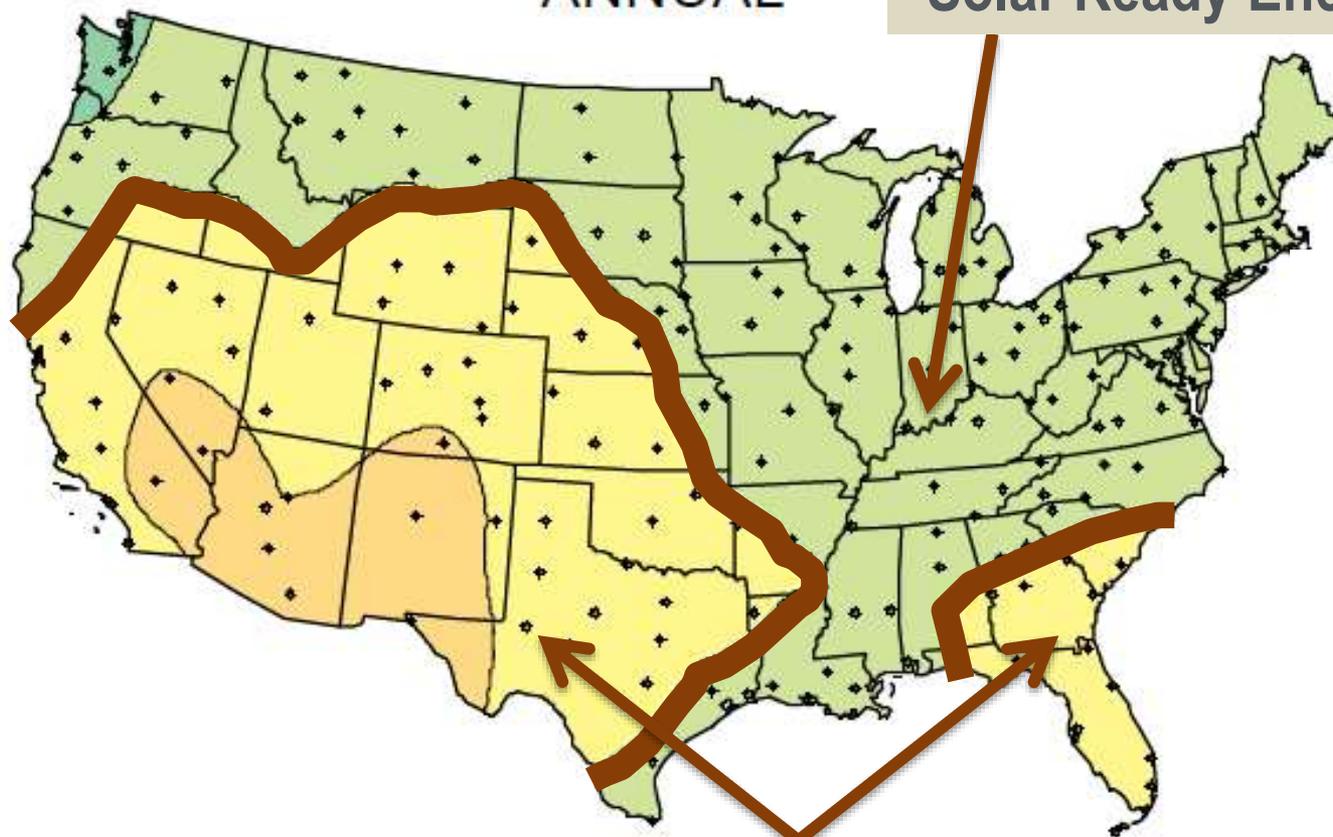
Source: SEIA / GTM Research

RERH Applicability

Average Daily Solar Radiation Per Month

ANNUAL

Solar Ready Encouraged



kWh/m²/day



Required

Encouraged

Solar Ready Required

Not required in areas lacking access to significant solar resources:

- Tree Shading
- Tall Buildings
- Available South Facing Roof



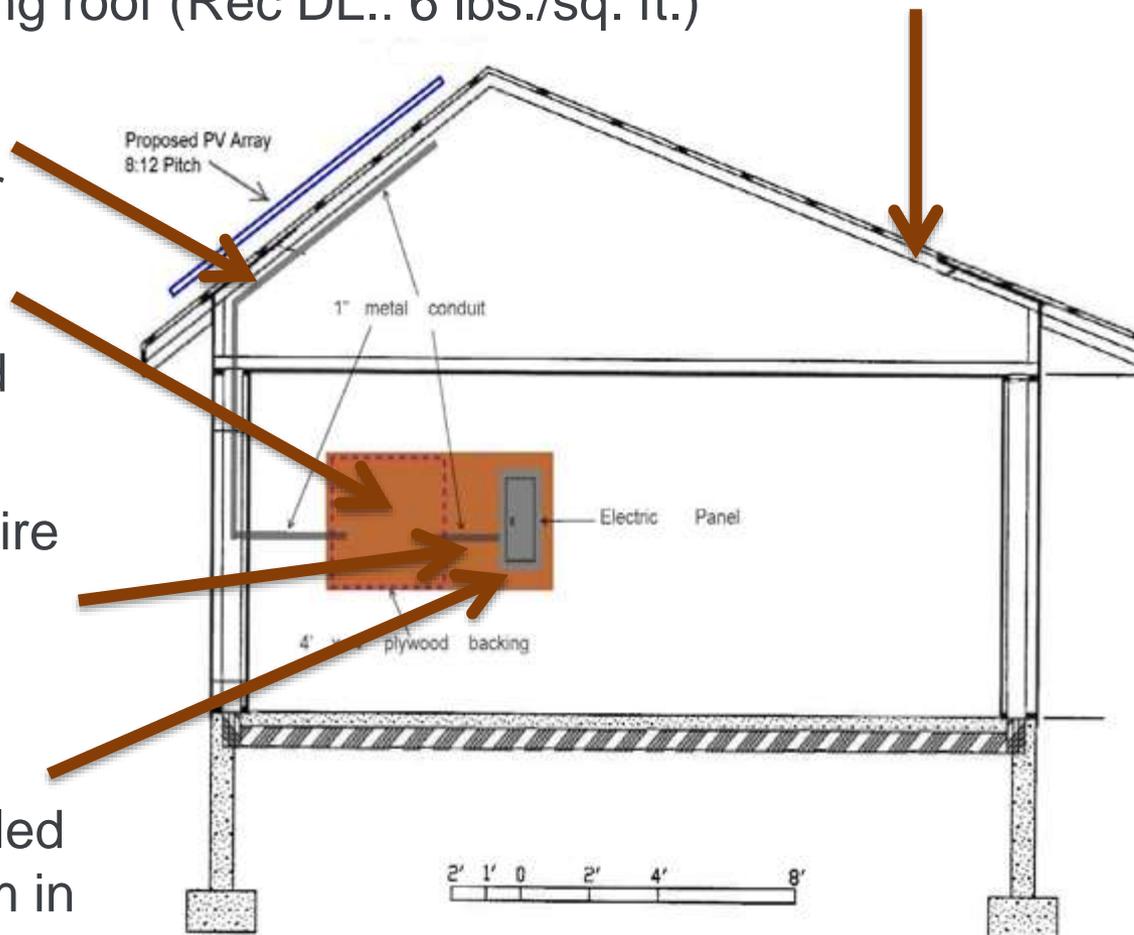
Documentation of the maximum allowable dead load and live load ratings of the existing roof (Rec DL.: 6 lbs./sq. ft.)

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	
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IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	

- 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



Integrating ZERH into State QAPs

1. Program specs are cost-effective, thoroughly vetted, and tailored for a lower total cost of ownership
2. ZERH builds off existing efficiency rating infrastructure:
 - Same Raters as used for ENERGY STAR and other programs
 - Same rating software checks compliance for DOE ZERH
 - Same site inspection process of dwelling units
3. Developers and builders can quickly become partners
4. ZERH orientation training available 24/7 as remote learning
5. No registration fee or pre-registration of ZERH projects with DOE
6. Certified ZERH projects uploaded to RESNET buildings registry and tracked on the DOE ZERH website

- Fact Sheet: **Leveraging DOE Zero Energy Ready Homes within State QAPs**
- Energy Savings and Cost Analysis
- Recording of this webinar for future reference
- DOE ZERH webinars for LIHTC developers and partners
- Tour of Zero project examples
- DOE ZERH Account Manager for State Housing Agencies:
 - Alex Krowka

Leveraging DOE Zero Energy Ready Homes within State QAPs



U.S. DOE Zero Energy Ready Homes are the Homes of the Future... Today. DOE Zero Energy Ready Homes are high performance homes which are so energy efficient, that most or all of their annual energy use can be offset by renewable energy. A lower total cost of ownership and a straightforward program design make the DOE ZERH certification well suited for state QAPs and other affordable housing programs. Here's why:

ZERHs offer a lower total cost of ownership.
 "ZERHs" typically have HERS scores in the mid-50s or lower, meaning energy savings of 40%+ compared to standard new homes. Added costs (amortized) to build to DOE ZERH are often lower than the monthly energy cost savings. Beyond energy savings, every Zero Energy Ready Home must pass comprehensive construction checklists for water management, HVAC installation quality, and indoor air quality. These crucial features included in every ZERH can translate into lower costs to maintain and live in the dwelling.

DOE ZERH Certification is straightforward and cost-effective for partners.
 If your program already recognizes Energy Star Homes, certifying to DOE ZERH is simple. The steps of plan review, energy modeling, and site inspections by an energy rater are essentially the same between Energy Star Homes and DOE ZERH. The rater/verifier will verify a few additional items such as efficient hot water delivery, and may add a small cost for this extra scope. DOE ZERH builds off Energy Star Homes and goes beyond for added efficiency and performance (see figure). There is no program registration fee for DOE ZERH projects, and DOE offers extensive training resources for builders, developers, and raters. DOE ZERH accepts single-family and multi-family buildings up to 5 stories, and central HVAC and hot water systems may be used.

Base Array			
IECC 2012			
ENERGY STAR v3			
ENERGY STAR v3.1			
DOE ZERH			
HERS 75-88	HERS 65-75	HERS 55-65	HERS 48-55
HVAC Q: 40% WHF Water Management Independent Verifier	HVAC Q: 30% WHF Water Management Independent Verifier	HVAC Q: 40% WHF Water Management Independent Verifier	IECC 2012 ENERGY STAR v3 ENERGY STAR v3.1 DOE ZERH

Additional efficiency and performance measures in DOE ZERH compared to 2012 IECC and Energy Star homes:

Need More Info?
 To learn more about states and other affordable housing programs which are already leveraging DOE ZERH in their QAPs and further details about the program, please contact Alex Krowka (202-405-4149 or akrowka@energypedia.com) or visit the program website: www.buildings.energy.gov/zero.

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

DOE ZERH Account Manager for State Housing Agencies:

- Alex Krowka; 202-406-4149
- akrowka@energetics.com

