



DOE Zero Energy Ready Homes Is it doable?

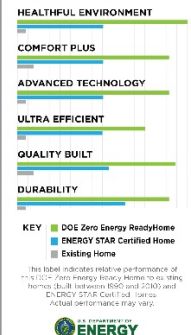
Presented By: Bill Rectanus and Robby Schwarz

Making the Leap to the *Zero Energy Ready Home*

- Bill Rectanus , New Town Builders



A Symbol of Excellence



Our Goals

Today's Goals Are Simple

- o Discuss the process of change in a homebuilding business
 - o Change, done right, is a continuous process
- o Learn about a path towards DOE's Zero Energy Ready Home
- o Get inspired to make the "right" change for your company



The Process of Change

Change takes time!

Years To Reach 10% Market Share

- o Hardie Board - 21 yrs
- o Truss Joist TJI - 25 yrs
- o Huber Advantec - 5 yrs
- o Icynene Open Cell - 30 yrs and still only about 7%



The Process of Change

- o Assess the Change Potential
- o Make the Decision
- o Complete the Due Diligence
- o Implement the Change
- o Invest in the Change
- o Analyze the Results
- o Assess the Next Change



Where Did We Start?

Single Family Detached

- o New Urbanist Style
 - o Rear Load
 - o Tight Setbacks
 - o Large Useable Front Porches
 - o Traditional Architecture
 - o 1800 – 2200 SqFt
 - o 3 – 4 Bedrooms
 - o 5 Piece Masters
 - o Open Main floor with Study
 - o Rear Family Foyer
- o Stapleton – Conservatory Green
 - o Mixed Use Community
 - o Retail, Office, Residential, Schools
 - o 10 year project with projected 5 to 7 additional years
 - o Redevelopment of Stapleton International Airport



Where Did We Start?

Energy Star V3

- o 2x6 – Advanced Framed Walls
- o Blown Cellulose Insulation
 - o R-20 Walls
 - o R-38 Attic
- o Standard HVAC
 - o 92.1% Gas Forced Air Furnace
 - o 13 SEER AC
- o Energy Star Windows – $U = 0.3$, $SHGC = 0.3$
- o Air Tightness – 2 to 2.5 ACH 50
- o Continuous Exhaust Ventilation



HERS Rating = Mid 50's



Where Did We Start?



What was our Competition?

Mix of National and Regional Builders

- o All Energy Star V3
 - o HERS 65 to 55
 - o No Solar

Large Master Planned Community

- o Well Segmented by square footage and Price



Assess and Implement the Change

Solar Started to Seem Possible in 2008

- o Large incentives in the market
- o What about solar?
 - o Give buyers something unavailable elsewhere
 - o Make it standard
- o The economics of the prepaid solar lease
 - o From \$16,000 to \$3,000
- o The birth of Solaris with **standard** solar



Assess the Next Change

Cheap Solar with High Rebates — Zero Energy Might Be Possible in 2009

- o “Let’s do a demonstration house”
- o Consulted with NREL
- o Developed our version of the double 2 x 4 wall
- o Decided to “GO” in Spring 2010
- o Depended solely on HERS



Analyze the Results

- o Sold only one house with it—what was wrong?
 - o Was sales committed?
 - o Was \$36,000 too expensive?
 - o Why wasn't the "You are going to spend the \$100" pitch working?



Analyze the Results

The Showdown at Bluff Lake

- o Before giving up
 - o Spec-ed in 50% of homes with the Zero Energy Option.
 - o Forced sales to sell and buyers to buy.
 - o We would have caved if it didn't work, but we didn't TELL anyone that!



Assess the Change Potential

What was our Environment?

The Local Environment

- o The Solar Coaster
 - o Solar rebates interrupted and going to zero.
 - o The death of the Solar Lease?
 - o Complex Solar Rewards Program by Xcel is hurting our buyers and our reputation.
 - o Solar costs doubled since we started.



Assess the Change Potential

What was our Environment?

National Environment

- 2012 – The 2012 International Energy Conservation Code is released
- 2012 - Duties of 24% to 36% imposed on Chinese solar cells
- 2013 – The DOE Challenge Home Program is released
- 2013 – The Colorado Mortgage Incentive Act is passed
- 2015 – The 2015 IECC due to be released
- 2016 – The Tax Credit for Solar is due to expire.... No more solar lease?
- 2018 – Another Energy Code is due to be released!!



Make the Decision

The Decision— What now?

Questions we had to ask -

- o Can we remain the “Solar Standard Builder”?
- o If not, who are we as a builder?
- o What’s our advantage without the “Solar hook”?
- o What will the new energy codes require? How do we stay ahead?
- o Is this an opportunity?

Leads to more challenging questions –

- o Can we stay at a HERS 40 without solar?
 - o Can this advancement replace standard solar?
 - o Can we do it with little to no cost penalty?

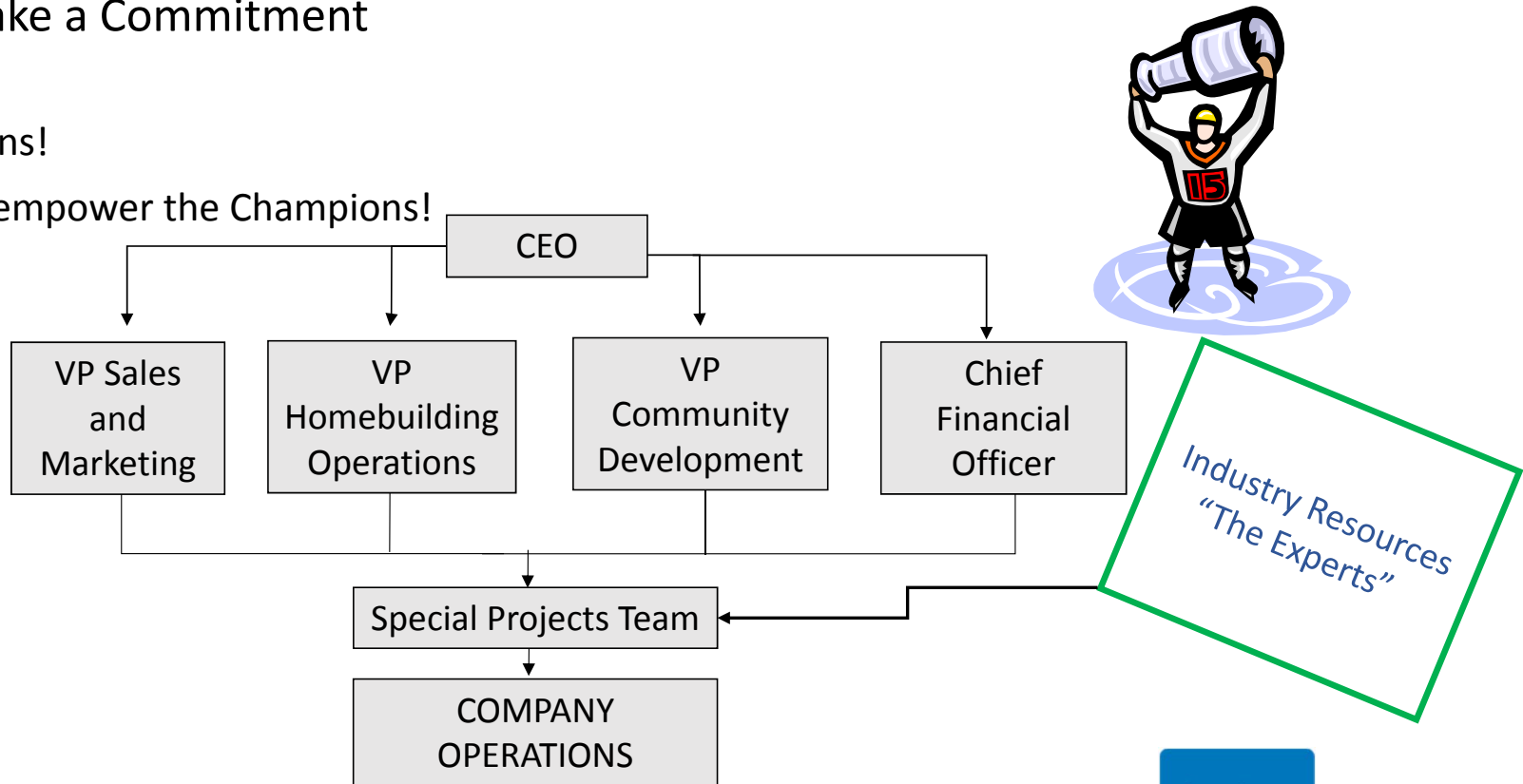


The journey begins.....

Complete the Due Diligence

The Decision- Make a Commitment

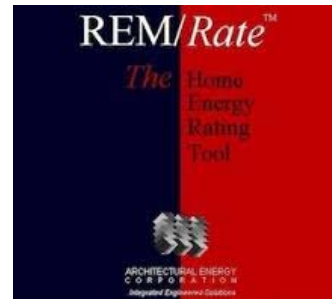
- o FROM THE TOP!
- o Select a Champions!
- o Define roles and empower the Champions!



Complete the Due Diligence

o What can we learn from?

- o Passive House
- o WUFI
- o BeOpt
- o RemRate
- o NREL



o Who can we learn from?

- o Robby Schwarz – Energy Efficiency Consultant and Rater
- o Graham Irwin – Passive House Consultant
- o John Semmelhack – Passive House Consultant
- o Achilles Karagiozis – Owens Corning Global Dir. Building Science

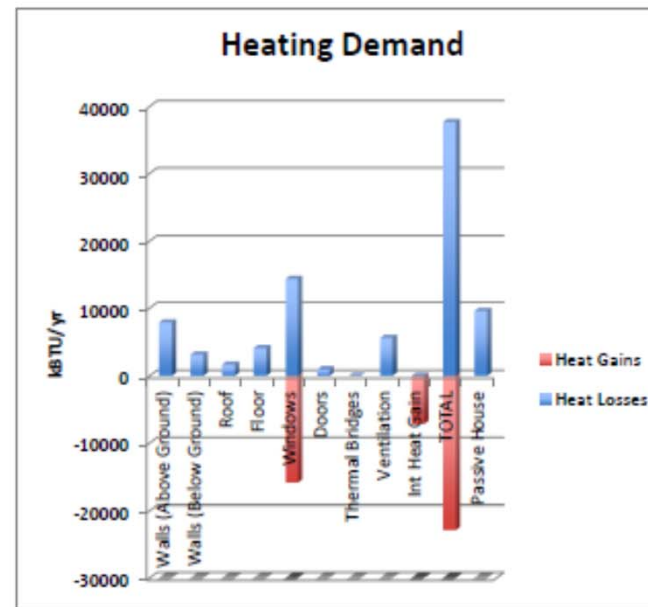


Complete the Due Diligence

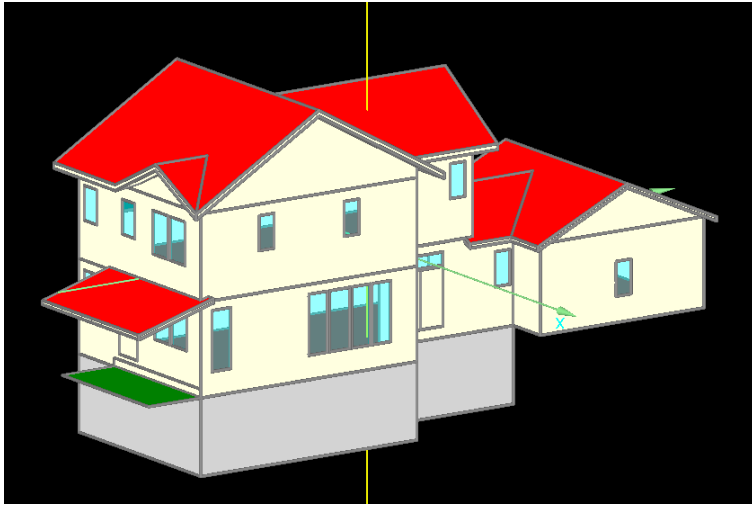
Typical Construction

Envelope Heating Demand	Losses kBTU/yr	Gains kBTU/yr
Walls (Above Ground)	7916	
Walls (Below Ground)	3129	
Roof	1599	
Floor	4111	
Windows	14352	-15812
Doors	926	
Thermal Bridges	0	
Ventilation	5570	
Int Heat Gain	0	-7109
TOTAL	37603	-22922
Passive House	9560	

Envelope Cooling Demand	Losses kBTU/yr	Gains kBTU/yr
Walls (Above Ground)	-4896	
Walls (Below Ground)	-2978	
Roof	-989	
Floor	-3912	
Windows	-8878	27547
Doors	-573	
Thermal Bridges	0	
Ventilation	-10442	
Int Heat Gain		11724
TOTAL	-32668	39272
Passive House		9560

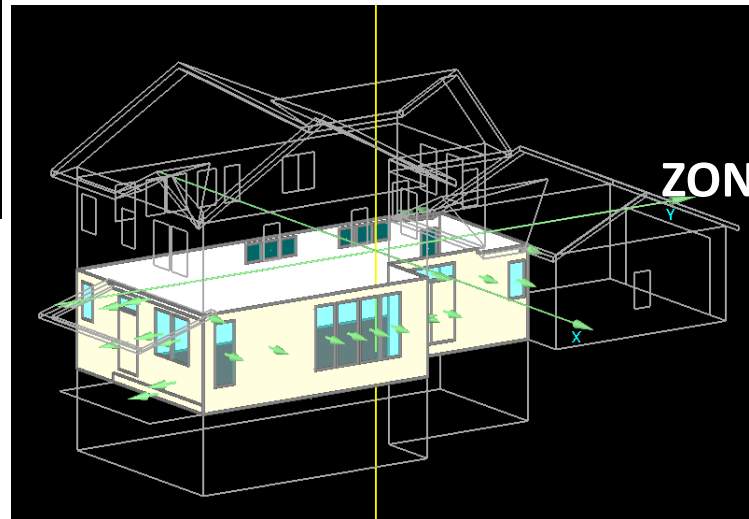


Complete the Due Diligence



5 Zones in House

Each surface
Includes properties

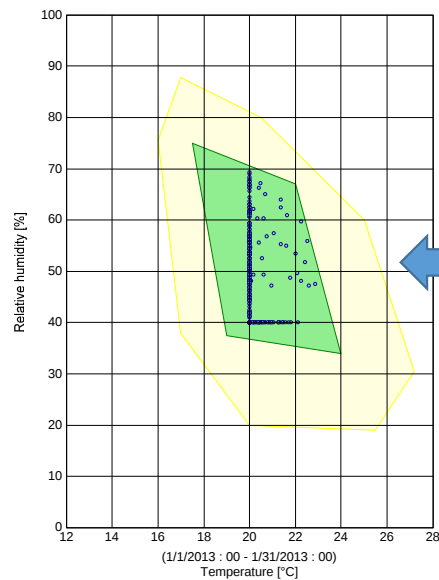


Complete the Due Diligence

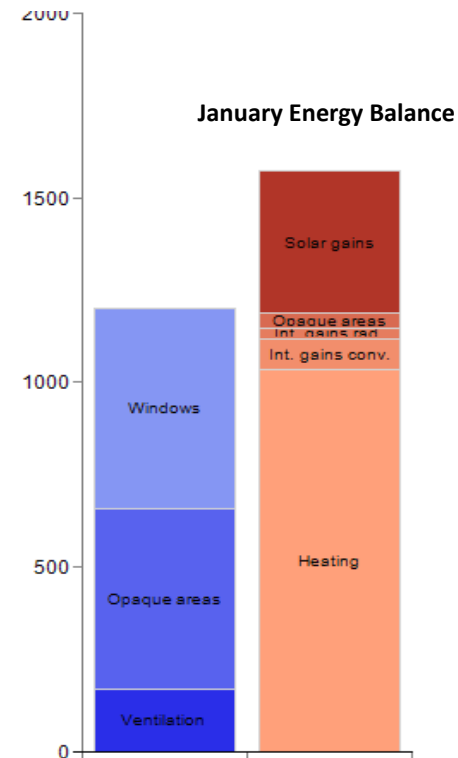
Full Dynamic Analysis Heating Energy

What we ended up with: 459 kWh

What we used to do: 1951 kWh

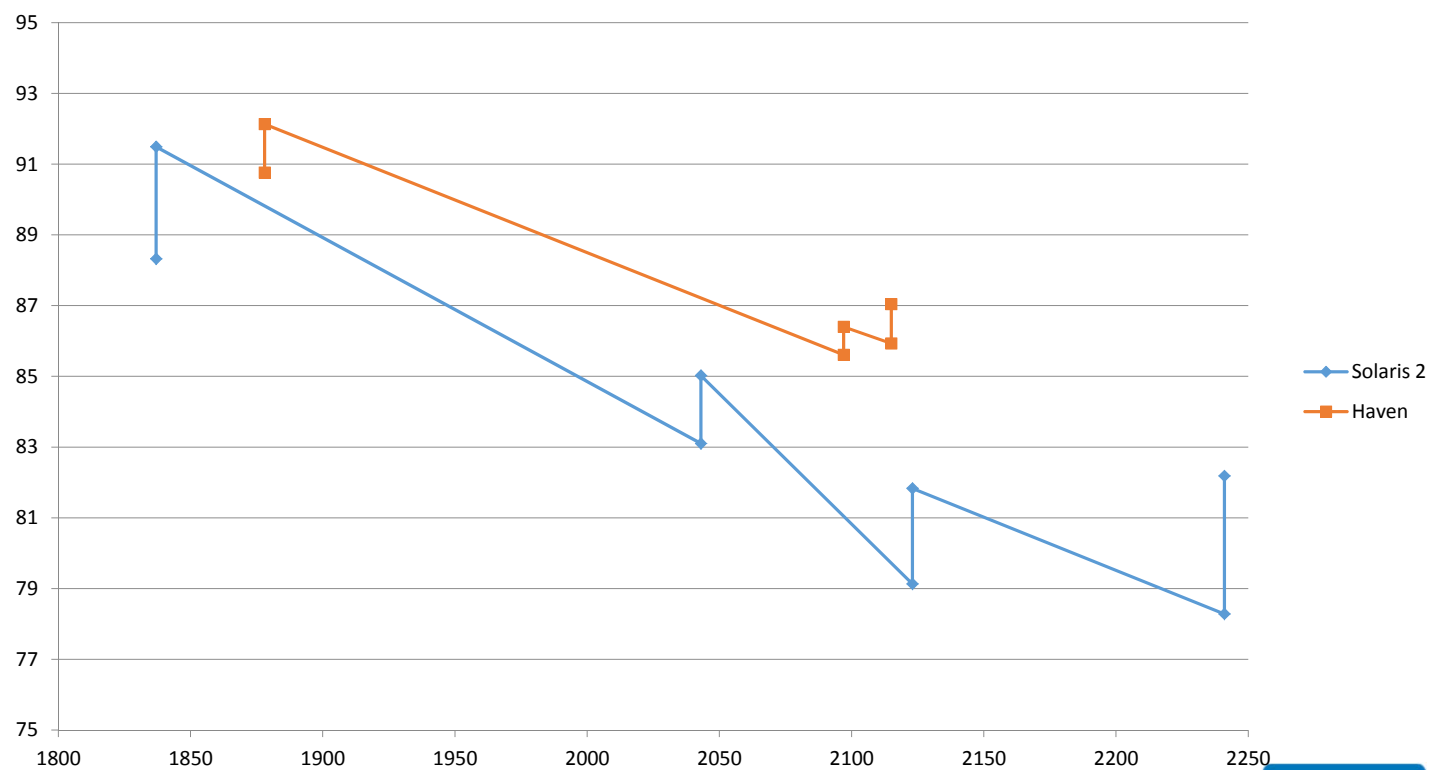


Perfect Comfort
for
Month of January
new solution



Complete the Due Diligence

We Did It—Haven hits HERS 40 with little or no cost premium



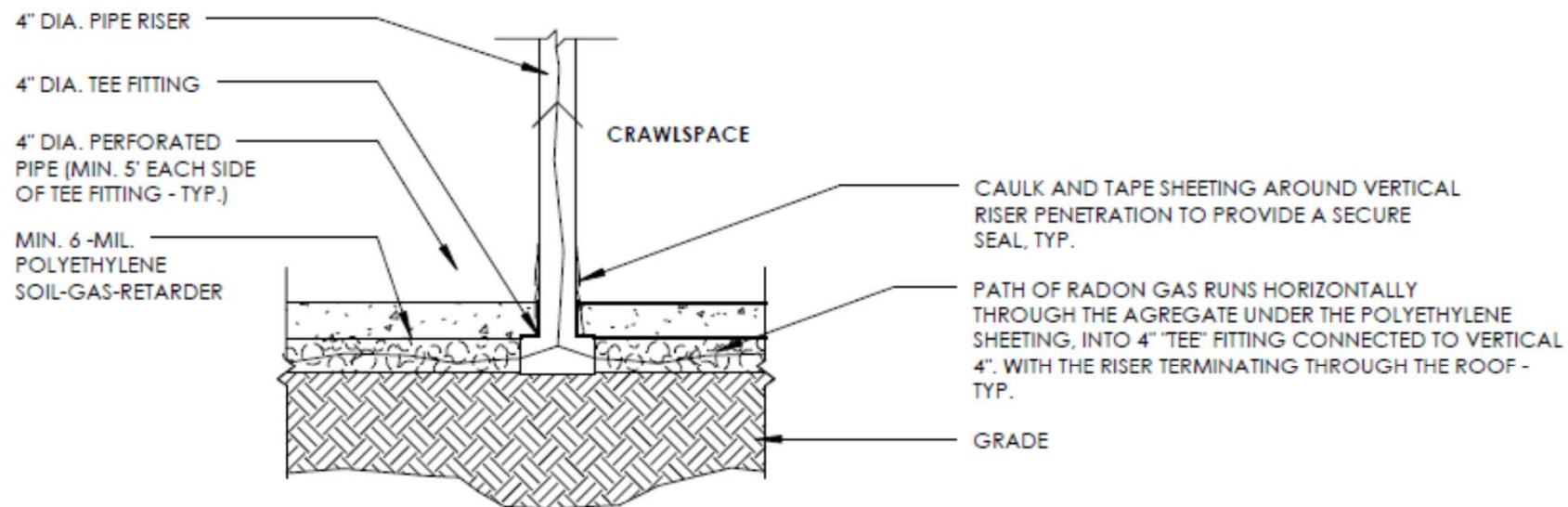
Implement The Change



Invest in the Change



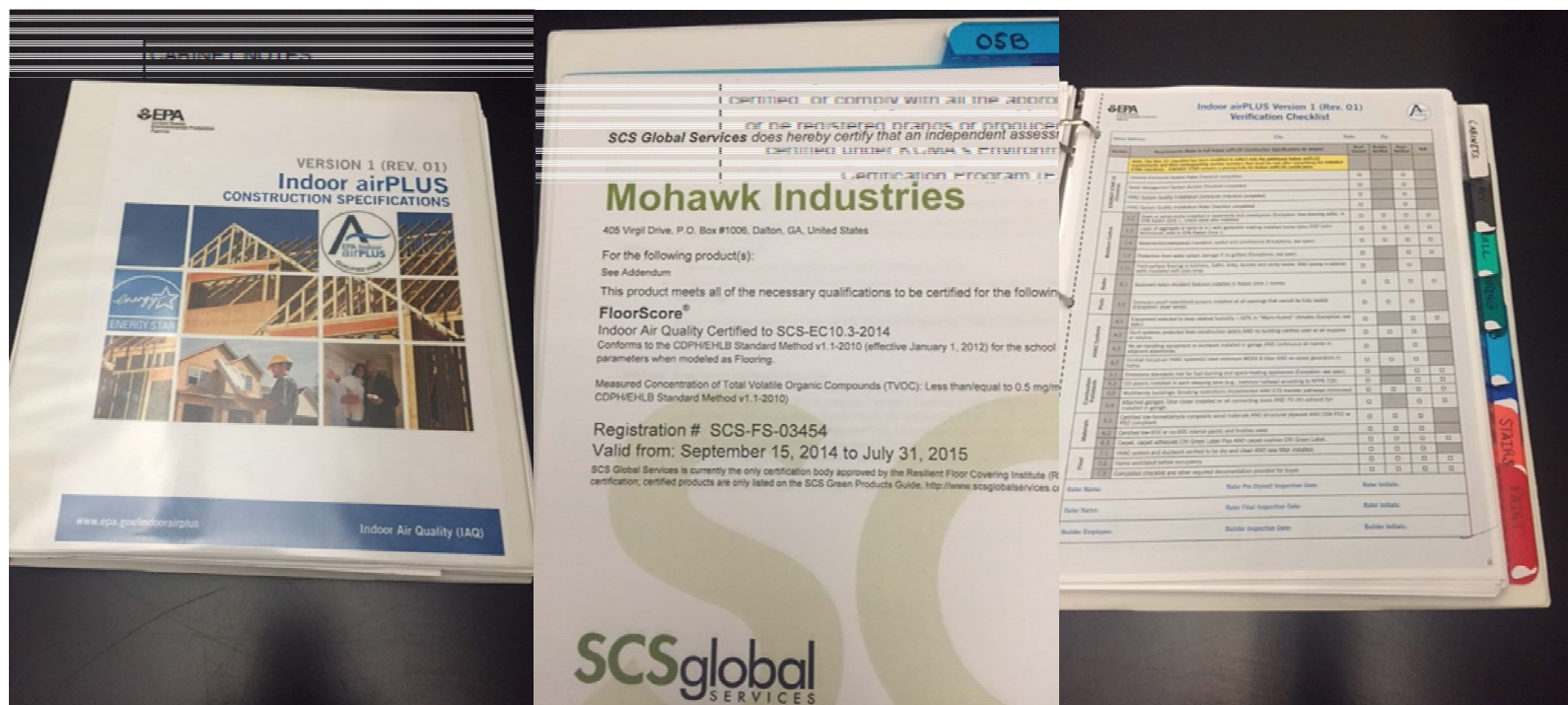
The Challenges



3 UNDER SLAB DETAIL

1/2" = 1'-0"

The Challenges



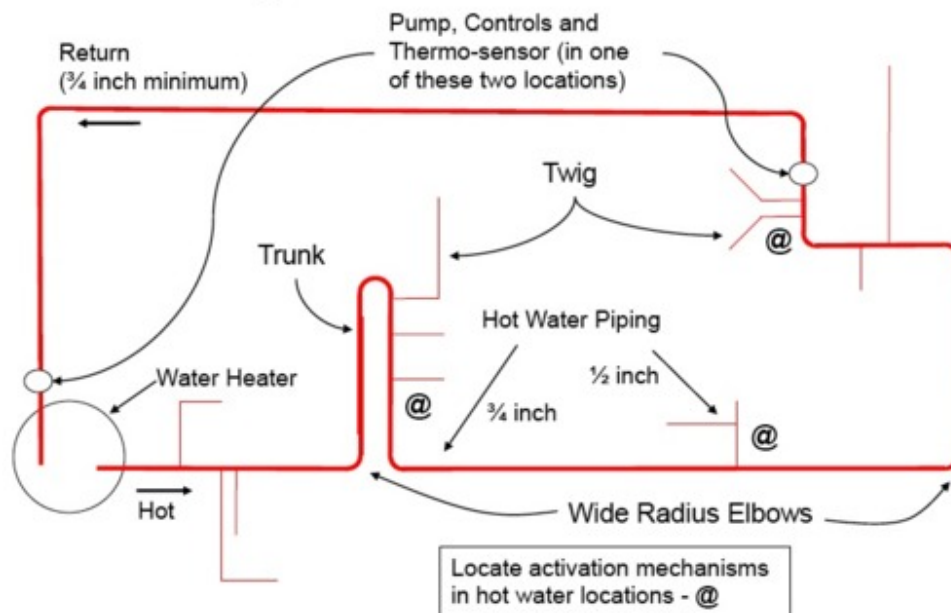
The Challenges

Exhibit 1: DOE Zero Energy Ready Home Mandatory Requirements for All Labeled Homes

Area of Improvement	Mandatory Requirements
1. ENERGY STAR for Homes Baseline	☐ Certified under ENERGY STAR Qualified Homes Version 3 or 3.1 ^{9, 10}
2. Envelope ¹¹	☐ Fenestration shall meet or exceed ENERGY STAR requirements ^{12, 13} ☐ Ceiling, wall, floor, and slab insulation shall meet or exceed 2012 or 2015 IECC levels ^{14, 15}
3. Duct System	☐ Duct distribution systems located within the home's thermal and air barrier boundary or optimized to achieve comparable performance ¹⁶
4. Water Efficiency	☐ Hot water delivery systems shall meet efficient design requirements ¹⁷
5. Lighting & Appliances ¹⁸	☐ All installed refrigerators, dishwashers, and clothes washers are ENERGY STAR qualified. ☐ 80% of lighting fixtures are ENERGY STAR qualified or ENERGY STAR lamps (bulbs) in minimum 80% of sockets ☐ All installed bathroom ventilation and ceiling fans are ENERGY STAR qualified
6. Indoor Air Quality	☐ Certified under EPA Indoor airPLUS ¹⁰
7. Renewable Ready	☐ Provisions of the DOE Zero Energy Ready Home PV-Ready Checklist are Completed; (Solar Hot Water Ready provisions are encouraged but not required) ¹⁹

The Challenges

Structured Plumbing Layout Using a Dedicated Return Line



The Challenges



The Challenges

Was it
Worth
it?



Analyze the Results

One year Later.....

- o Z.E.N. Series Sells Out!
 - o Z.E.N. Outsells non-zero energy Solaris 2 to 1
 - o Z.E.N. Sells at an average \$38,000 over Solaris **AND**
 - o **Contributes a 37% higher pre-tax net margin!**
- o Stapleton Developer doubles our lot supply

What about the intangibles?

- o Better land opportunities with better terms.
- o The Cities like us. Easier entitlement and project opportunities.
- o The reputation of being the “Expert.”
 - o Market Leader
 - o Credibility
 - o Earned media



Analyze the Results

- o 2012 – Green Home of the Year, Green Builder Magazine
- o 2012 – Green Home of the Year, Denver HBA MAME Awards
- o 2013 – Housing Innovation Grand Award, US Department of Energy
- o 2013 – Green Home of the Year, Denver HBA MAME Awards
- o 2014 – Housing Innovation Grand Award, US Department of Energy
- o 2014 – Green Home of the Year, Denver HBA MAME Awards
- o 2014 – Best in Green, National Association of Home Builders
- o 2014 – Best In Green/Sustainable Design, The Nationals
- o 2015 – Housing Innovation Award, US Department of Energy



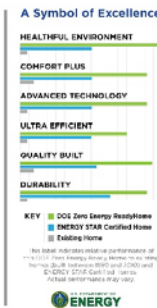
Assess the Next Change

What's Next?

- o 100% DOE Zero Energy Ready program across all product lines
- o Building America research on advanced HVAC systems
 - o Fresh Air Ventilation??
- o Panacea
- o Zero Energy Ready Home Proof of Concept!
 - o Take it to the suburbs?



The Process of Change



Why?

o Product Differentiation

- o Competitive Market
 - o Large National Competition

o Building The Brand

- o Market Recognition
 - o Municipalities
 - o Developers
 - o Realtors
 - o Consumer

o Third Party Validation

- o Certification backed by the DOE and EPA
 - o Consumer Confidence



A Symbol of Excellence



DOE ZERH a Raters Perspective

- Engaging a Builder
- What is Zero Energy **Ready**?
- Interesting Findings
- Sticking Points
- Program relationships



Engaging Builders

- A Builder wants it
- Quest for differentiation
- Marketing
 - HERS Index, Code, Energy Star, IAP, WaterSense(?), DOE ZERH
- Better Performance
- Builder Risk Management
- The next step is small



Boil it Down



Exhibit 1: DOE Zero Energy Ready Home Mandatory Requirements for All Labeled Homes

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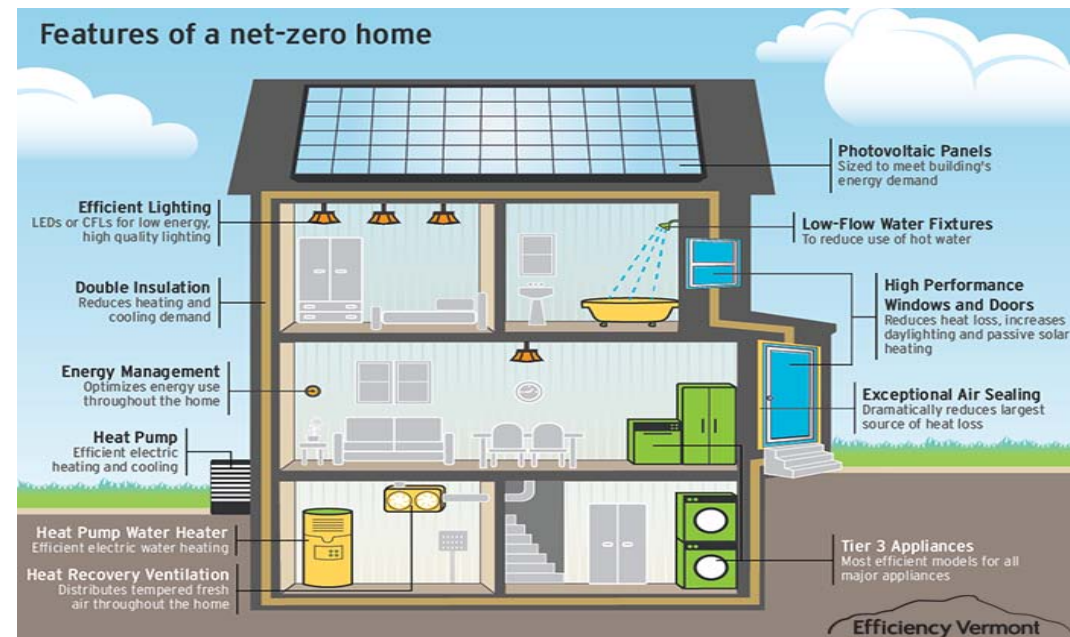
In This Case

- Foundation R-11
- Basement slab R-0
- Fiberglass Batt R-30
- Rim R-19
- Walls blown R-23
- Windows **U-30/SHGC.30**
- Doors R-5/ R-2.2
- Attic R-38
- Furnace 93.5 AFUE
- **100% Duct inside**
- Water Heater 67 EF
- AC 13 Seer
- 3 ACH50
- Ventilation ASHRAE 62.2 - Exhaust
- Energy Star Appliance / 90% CFL
- HERS 55
- 12.5K PV system to get to a HERS 0



What is Zero Energy Ready?

- Can a HERS 55 home get to Zero Energy?



Define what you mean by Ready

- Are you going to use the HERS Index?
- 0-10 HERS Index
- Future Proof
 - Rock solid envelope and system that will not be replaced in 10-15 years
 - No need for the deep energy Retrofit
 - As technology advances you can get the home to be truly energy neutral



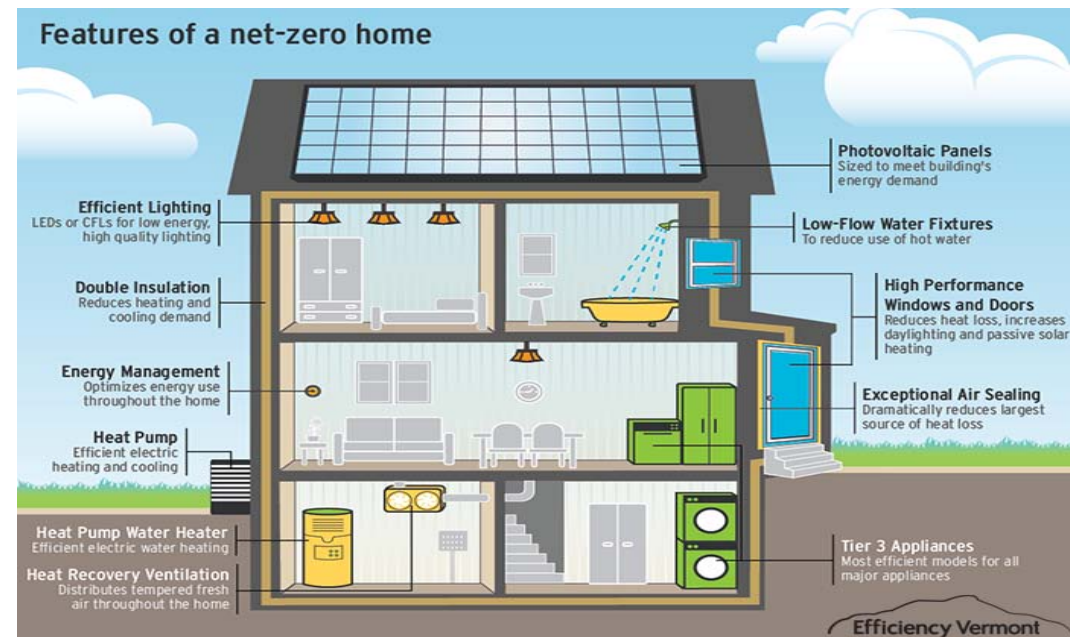
New Town's Specification

- Foundation R-19
- Basement slab R-0
- Floor Blown R-50
- Rim R-26
- Double Walls blown R-40+
- Windows U-.26/SHGC.21
- Doors R-6.2/ R-2.2
- Attic R-50
- Air source Heat Pump HSPF 12.2
 - Back up Furnace AFUE 97.4
- 100% Duct inside
- Tankless Water Heater 97 EF
- 2 ACH50 or less
- Ventilation ASHRAE 62.2 – Exhaust
- Tamarac Whole house fan
- Energy Star Appliance 100% CFL
- HERS 39 before PV
- 8.5K PV system to get to a HERS 0



What is Zero Energy Ready?

- Maximize
 - Thermal Envelope
 - Mechanicals
 - Everything else
 - Lowest you can get is a HERS 36-40



Not the same animal at all!

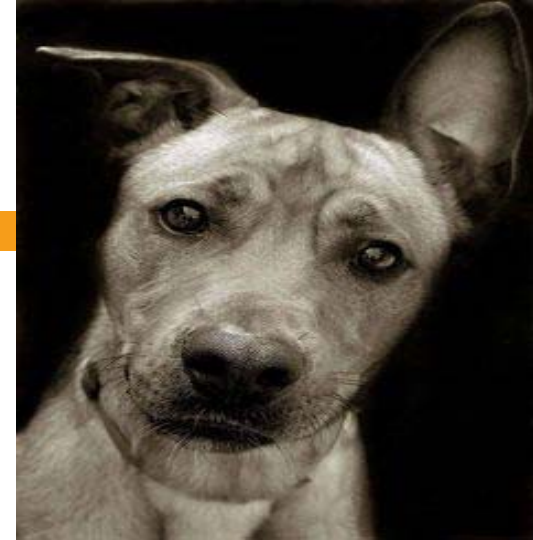
Single Family Homes



Row/Town Homes



Interesting Findings



- REM Modeling
 - Mandatory 2012 IECC insulation levels
 - you can pass DOE ZERH but not 2012 IECC
 - Air leakage rate Duct leakage Rate
- Mandatory
 - Windows
 - UA Trade offs allowed in REM but Window U-value is Mandatory
 - Rem models the UA trade off and .34 windows passed in the REM model
 - 100% Duct inside envelope
 - REM will demonstrate compliance with duct located outside
- You need to know this or you will be out of compliance



Marking any given checkbox certifies that the home complies with all mandatory requirements referenced by that checkbox. Needed for showing compliance on various reports.

IECC - Mandatory Requirements

- | | | |
|---|---|---|
| ☒ 2004 IECC | ☒ 2009 IECC | ☒ 2015 IECC |
| ☒ 2006 IECC | ☒ 2012 IECC | ☐ NY-ECCC 2010 |

ENERGY STAR Version 2.5, 3.0 and 3.1

Checklists Fully Enforced for 3.0 and 3.1

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

ENERGY STAR Product Count

- | | |
|---|--------------------------------|
| ☒ # Refrigerators | <input type="text" value="1"/> |
| ☒ # Ceiling Fans | <input type="text" value="1"/> |
| ☒ # Exhaust Fans | <input type="text" value="1"/> |
| ☒ # Dishwashers | <input type="text" value="1"/> |

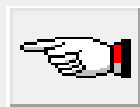
Conditioned Basement Exclusion

- ☒ Basement Qualifies for SAF exclusion?

Basement Conditioned
Floor Area:

- ☐ Slab Insulation exemption from Thermal Enclosure Rater Checklist

- ☒ Indoor airPLUS - can no longer substitute for Water Management Checklist



REM



REM

Marking any given checkbox certifies that the home complies with all mandatory requirements referenced by that checkbox, per the DOE Zero Energy Ready Home National Program Requirements.

DOE Zero Energy Ready Home

Home Builder ID#:

Mandatory Requirements

- | | | |
|--|---|--|
| ☒ Fenestration | ☒ Appliance | ☒ EPA Indoor airPLUS |
| ☒ Insulation | ☒ Lighting | ☒ Fan Efficiency |
| ☒ Renewable Energy Ready Solar Electric | ☒ Duct Location | |
| ☒ Renewable Energy Ready Solar Hot Water | | |

Optional Home Builder Commitments for Recognition

- | | |
|-----------------------------------|--|
| <input type="text" value="No"/> ▼ | Certified under the EPA WaterSense for New Homes Program |
| <input type="text" value="No"/> ▼ | Certified under the IBHS fortified for Safer Living Program |
| <input type="text" value="No"/> ▼ | Followed the DOE Zero Energy Ready Home Quality Management Guidelines |
| <input type="text" value="No"/> ▼ | The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year. |



Interesting Findings



■ Constructability

- Mandatory items
 - Raised Heel Truss
 - Energy Star requires $\geq R-21$ over the top plate
 - DOE ZERH requires $\geq R-30$ over the top plate
 - 100% ducts inside the envelope
 - Inside, outside, or within?
 - All Four Energy Star Checklists
 - Water circulation
 - IAP qualified
 - MERV 8
 - Renewable ready



ZERH Builder Sticking Points

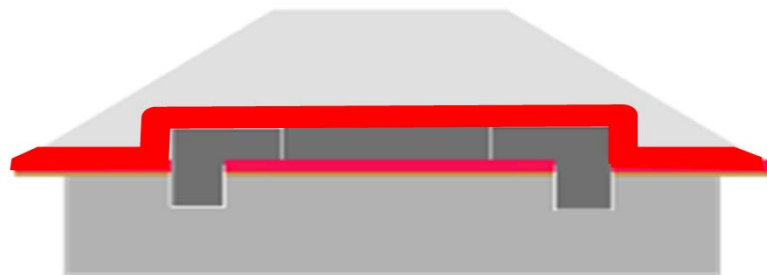


- IAP (Rev3)
- **Moisture control** – Aggregate under slabs
 - **Radon Systems** – Poly under slabs
 - **Duct system**
 - Protection / Cleaning
 - No HVAC Building cavities used per IAP
 - 100% in conditioned space
 - **Attached garages**
 - You can now test the connection
 - **Materials**
 - Dimensional woods,
 - Particle boards and **hidden** particle/composite boards
 - Paints, carpets

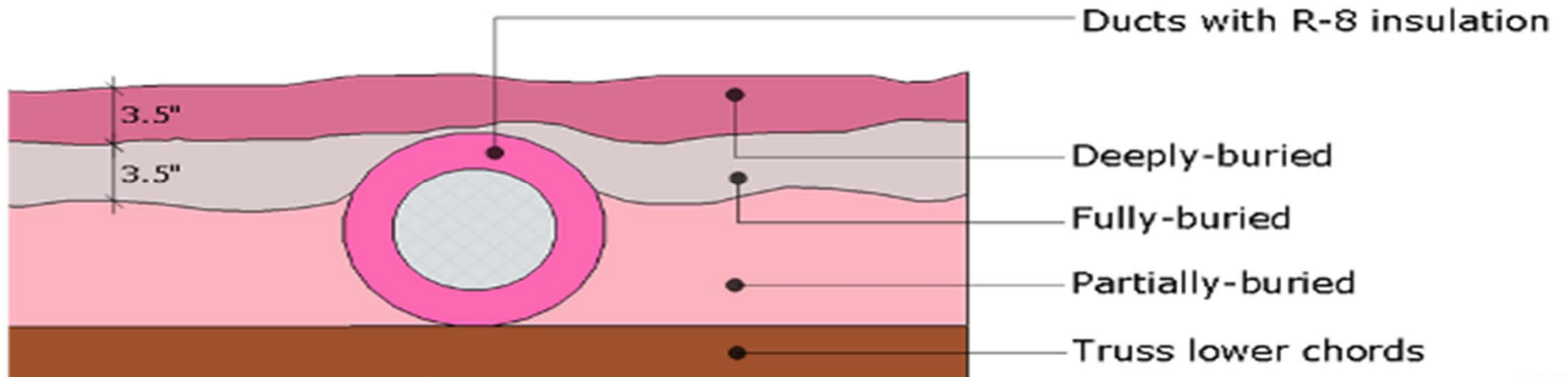


Ducts in Vented Attic: Dry CZs

Buried Ducts



Ducts in vented attic



- Doe Zero Energy Homes Rev5
- Energy Star Rev8
- Indoor Air Plus Rev3



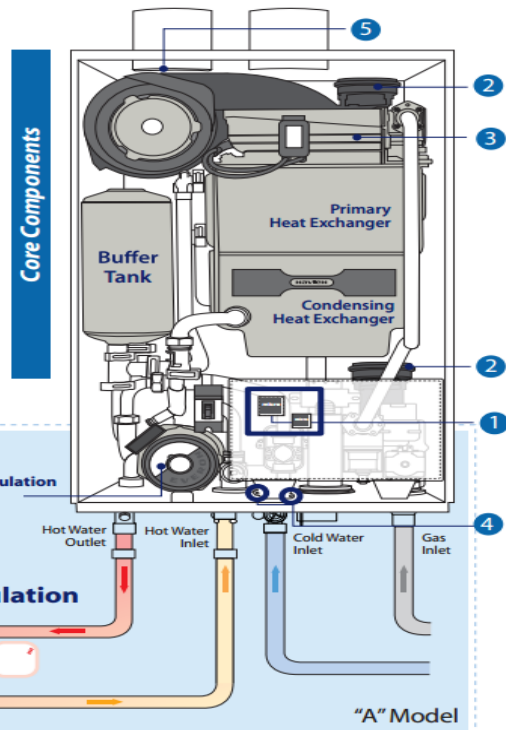


EnergyStar v3 vs. Indoor Air Plus

- **Moisture control**
 - **Water Managed site & foundation**
 - Drainage, Capillary break, damp proofed, Etc.
 - **Water managed Wall assemblies**
 - Drainage plane, flashing details
 - **Water managed Roof assemblies**
 - Gutters and flashing
 - **Interior water management**
 - Moisture resistant materials
- **Radon control**
 - Radon resistant features including at least a passive radon system
- **Pest Barriers**
 - Minimize pathway for pests
- **HVAC Systems**
 - **Heating & Cooling equipment**
 - Sizing and design
 - **Ventilation**
 - ASHREA 62.2
 - **Air cleaning and filtration**
 - **Dehumidification**
- **Combustion pollutant control**
 - **Combustion source Controls**
 - Sealed or power vented equipment
 - **Attached garages**
 - Insolated
- **Low emission materials**
 - Engineered woods, Paints, Carpets
- **Home commissioning**
 - **Duct testing, Pressure balancing, Flows, Etc.**



ZERH Builder Sticking Points



Hot water circulation systems

- No more than 0.5 gallons of water can be stored within the pipe between the heater and any fixture
- No more than 0.6 gallons of water can go down the drain before hot water is delivered.
- The water temperature must be 10° or more higher than when the water first came out of the faucet
- Recirculation systems must have occupant control switch or adaptive learning technology
 - Right now no testing required



ZERH Builder Sticking Points

Solar Electric Ready Checklist

- Install a 1" conduit
- Designate ***proposed*** array location and square footage
- Identify orientation (azimuth) ***of proposed location***
- Blocking is permitted to be used as an alternative to the 4' x 4' or 3'x2' wood panel
- 70 Amp double-pole breaker in electrical service panel or a labeled slot Solar Thermal Checklist



DOE Zero Energy Ready Home

Projected Rating: Based on Plans - Field Confirmation Required.

Energy Performance	
House Type	DOE Zero Energy Ready Home Builder Partner ID#
Single-family detached	210
Year built	Square footage of Conditioned Space including Basement
2015	2800.0
Number of Bedrooms	Square footage of Conditioned Space without Basement
3	1953.0
Site address (if not available, list the site Lot #)	Registered Builder
1887 Place to live	
Denver	Certified Rater
CO, 80221	Robby Schwarz
HERS Index without On-site Generation	Date of Rating
58	2/10/2015
HERS Index with On-site Generation	Rating Software
58	REM/Rate - v14.6
HERS Index of the Target Home using size adjustment factor	Estimated annual energy costs(\$)
59	1487
Estimated annual energy use	Estimated annual energy savings
Electric: 6858 kWh \ Natural Gas: 723 Therms	Electric: 4101 kWh \ Natural gas: 417 Therms
Energy cost rates	Estimated annual emissions reductions
Electric: 0.11 \$/kWh \ Natural Gas: 0.98 \$/Therms	CO2: 6.1 tons / SO2: 7.8 lbs / NOx: 16.6 lbs



DOE Zero Energy Ready Home Certification

As the certified Rater for this house, I certify this house meets/complies with all mandatory requirements of the DOE Zero Energy Ready 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 EPA Indoor airPLUS
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 Zero Energy Ready Home National Program Requirements

Optional Compliance for Builder Recognition

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

YES	NO	DON'T KNOW	Optional Home Builder Commitments for Recognition
-----	----	---------------	---

*Certification under the DOE Zero Energy Ready 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 v14.6

This information does not constitute any warranty of energy cost or savings.

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DOE Zero Energy Ready Home

Projected Rating: Based on Plans - Field Confirmation Required.

Optional Compliance for Builder Recognition

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

YES	NO	DON'T KNOW	Optional Home Builder Commitments for Recognition
	X		Certified under the EPA WaterSense for New Homes Program
	X		Certified under the IBHS Fortified for Safer Living Program
	X		Followed the DOE Zero Energy Ready Home Quality Management Guidelines
	X		The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year

*Certification under the DOE Zero Energy Ready 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.





YOUR HOME WAS DESIGNED, ENGINEERED,
AND CONSTRUCTED IN CONFORMANCE TO
U.S. DEPARTMENT OF ENERGY (DOE)
GUIDELINES FOR EXTRAORDINARY
LEVELS OF EXCELLENCE AND QUALITY.

**Projected Rating: Based on Plans -
Field Confirmation Required.**

This home built at **1887 Place to live**
By
Verified by **Robby Schwarz**
an independent professional
organization, to meet or exceed
strict home performance
guidelines set by
The U.S. Department of Energy
on **2/16/2015**

THIS HOME MEETS OR EXCEEDS THE MINIMUM
CRITERIA FOR THE FOLLOWING:

REM/Rate - Residential Energy Analysis and
Rating Software v14.6



SAM RASHKIN, CHIEF ARCHITECT
BUILDING TECHNOLOGIES
U.S. DEPARTMENT OF ENERGY





AN ENERGY STAR[®]
QUALIFIED HOME

Address:

1870 Place to live
Denver, CO 80221

Built by:

Best Builder Ever

Verified by:

EnergyLogic. Inc.

Date:

Date evaluation completed

Optional information:

This house received a HERS 50 Rating

ENERGY STAR qualified homes are independently verified
to meet strict energy efficiency guidelines set by
Natural Resources Canada. Each home that
earns the ENERGY STAR can keep 2.4 tonnes of
greenhouse gases out of our air each year.

www.energystar.gc.ca



Indoor airPLUS Qualified Home

This home built at
1887 Place to live
Denver, CO 80221
was verified by
Robby Schwarz

to meet Indoor airPLUS construction
specifications as established
by the
U.S. Environmental Protection Agency.



Indoor airPLUS qualified homes are
designed to contribute to improved
indoor air quality.

2/10/2015



Indoor airPLUS Features

- Moisture and Mold Control
- Radon Resistant Construction
- Pest Barriers
- Effective Heating, Ventilating, and Air-Conditioning Systems
- Safe Combustion
- Healthier Building Materials

Not all features are required in all cases. To learn more about indoor air quality features in your home, ask your builder to review the Indoor airPLUS verification checklist with you, or visit www.epa.gov/indoorairplus.

Thank you!



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