

# Charting a Course to Energy Independence

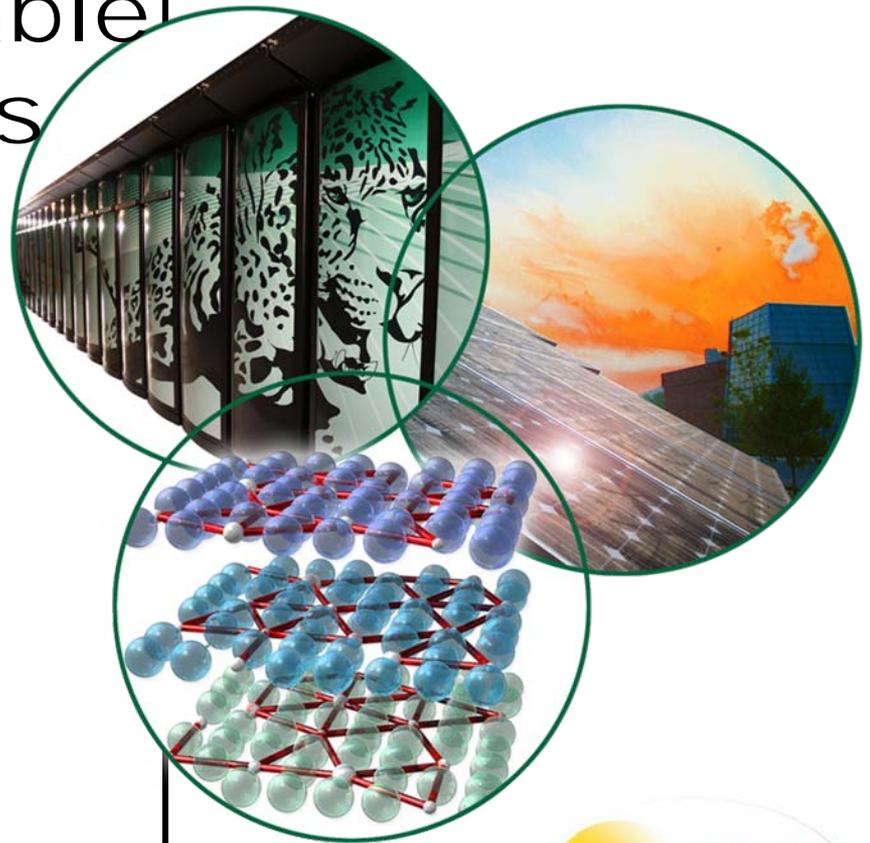
Providence, RI  
August 9-12, 2009

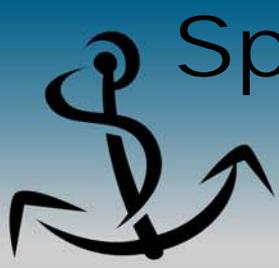


# Emerging Energy-Efficient and Renewable Building Technologies

Patrick Hughes, Director  
ORNL Building Technologies Research & Integration Center

Presented by John Shonder

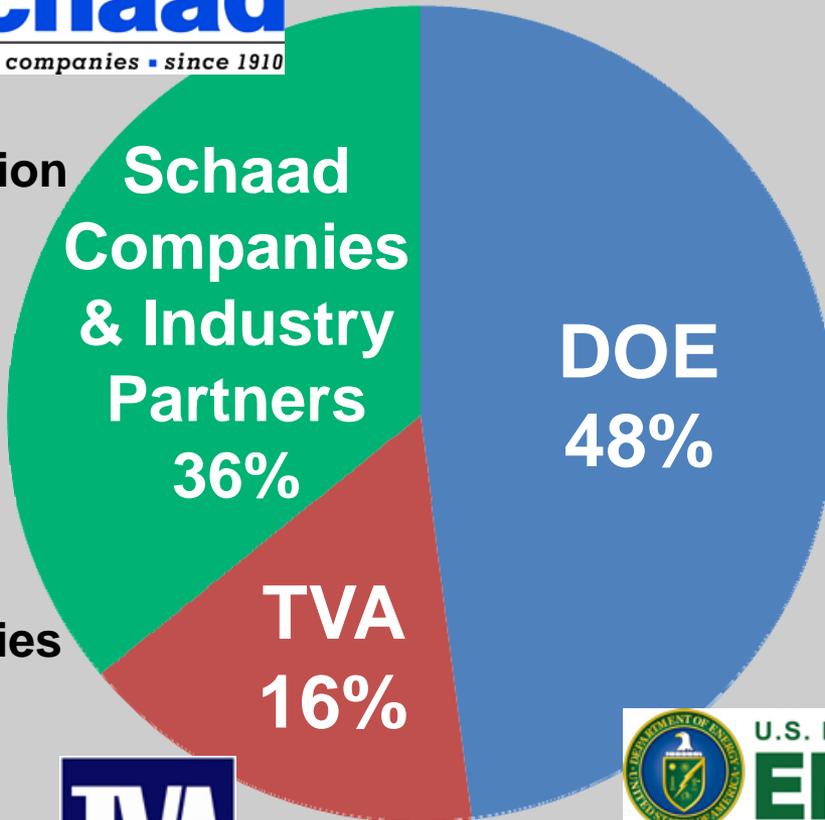




# Sponsors of the 1<sup>st</sup> ZEBRAAlliance Project



- Construction expertise
- Land
- Bricks
- Mortar
- Emerging technologies



## Breakout by DOE Building Technologies Program Element:

- Building America 10%
- HVAC/Water Heating 13%
- Envelope 10%
- Analysis Tools 15%



## ORNL's Research:

- More efficient components
- Affordable whole-house integration



# Partner Business Case is TN Valley Market



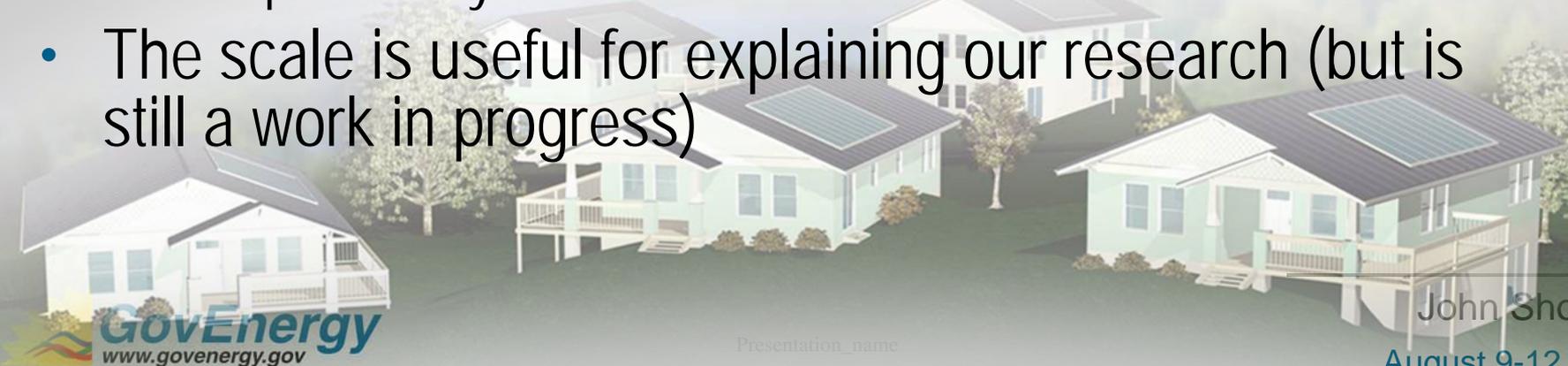
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# Home Energy Rating (Miles Per Gallon)



- E-Scale
  - + Over 100: existing homes
  - + 100: new home built to code
  - + 70 or less: DOE Builder's Challenge
  - + 0: Zero Energy Home
- Characteristics desired of a rating
  - + Available when investment decisions are being made
  - + Simple so any owner or tenant would understand
- The scale is useful for explaining our research (but is still a work in progress)



# 2002-09: 12 Houses (5 Habitat, 7 Full-Sized)

Recognizing the best energy performance, quality, comfort, health and safety in the market.

## Meets the Builders Challenge

Poor Energy Performance

ZEBRAlliance

Best Energy Performance



150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0



Typical existing home

Typical new home

Builders Challenge (70 or lower)

Net Zero Energy Home



One TVA 'Builder House'

One TVA 'Retrofit House'

One TVA 'Research House'

Four Schaad 'Research Houses'

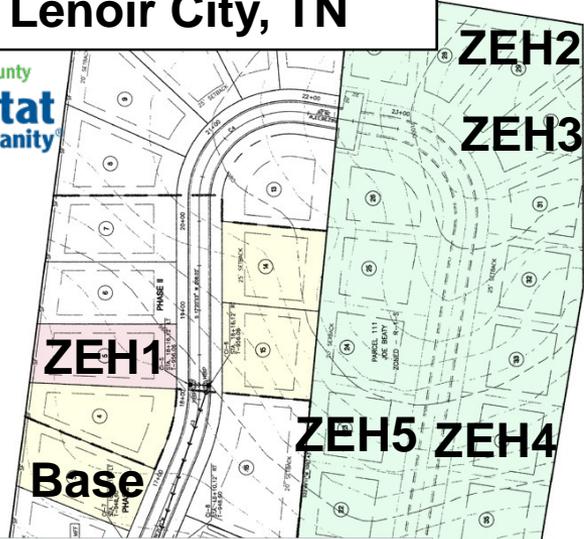
Five Habitat 'Research Houses'



U.S. DEPARTMENT OF ENERGY

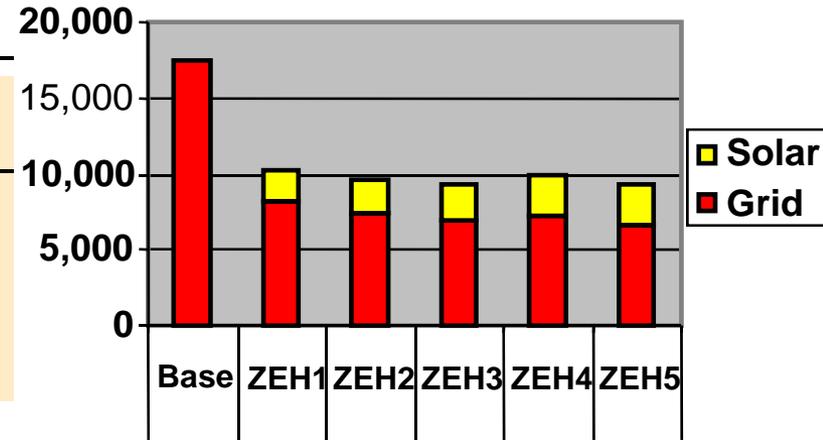
# Five Years (2002-07) Five Near Zero Energy Houses: 50% Savers in Mixed-Humid Climate

Habitat for Humanity  
Lenoir City, TN



40%  
Savers  
vs  
EnergyStar,  
(50% vs  
Code)

## Energy Consumption (kWh/yr)



Tennessee Valley Authority  
Residential rate: 9¢/kWh  
Solar power buyback rate: 15 ¢/kWh



# Motivation and Strategy for the Full-Sized Research Houses

- Habitat for Humanity research house experience
  - + Half the energy and same cost to own and operate
- 'Show me' in houses that are saleable to mainstream
- Strategy for Schaad Companies's four houses
  - + Determine true cost (in volume) and performance of
    - Four deep-savings envelope strategies
    - Several advanced equipment/appliance/controls configurations
    - Demand responsive grid integration (whether smart grid or not)

# Structural Insulated Panels (SIPs) Strategy



- **Airtight**
- **High-R**
- **Fast at the site**
- **Eliminates framing thermal short circuits**
- **New construction only**
- **Commercially available**



STRUCTURAL INSULATED PANEL ASSOCIATION

<http://www.sips.org/>

# Phase Change Material (PCM) Strategy



PCM-enhanced blown cellulose

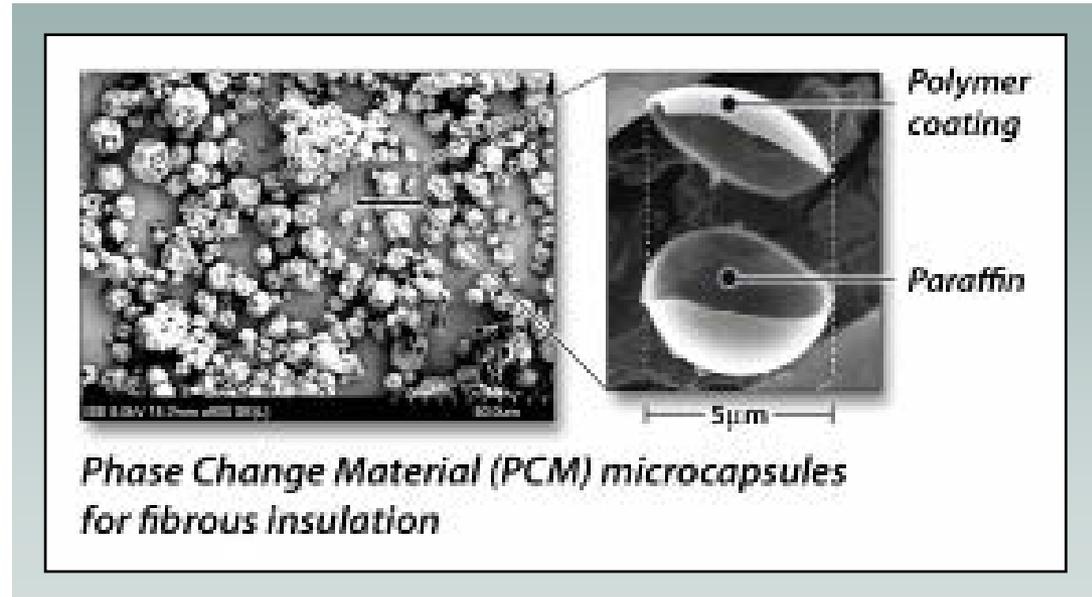
- Thermal energy storage (TES) insulation
- Cellulose with 20% by weight PCM
  - 12 in. insulation = 4 in. concrete
  - Insulation effective-R doubles
- Compatible with airtight systems
- This first whole-house demo will determine:
  - Energy and peak load reduction
  - Peak period comfort (shed HVAC)
- New & retrofit
- Commercially available



<http://www.advancedfiber.com/>

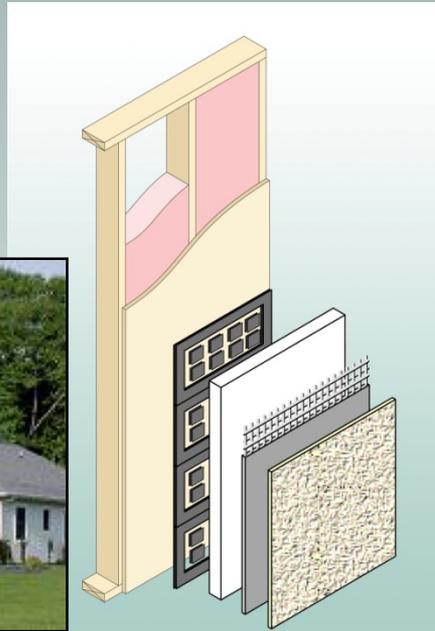
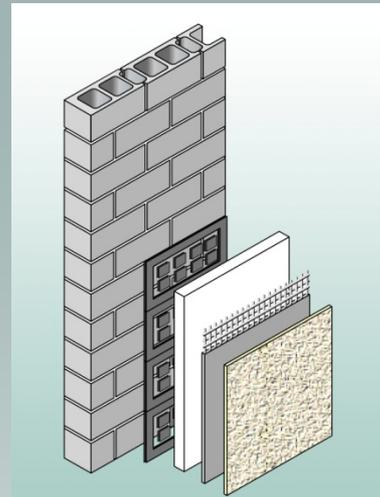


<http://www.microteklabs.com/>



# Exterior Insulation Finishing System (EIFS) Strategy

- **Aesthetic (many options)**
- **Airtight**
- **High-R**
- **Eliminates framing thermal short circuits**
- **New self-drying designs**
  - **Moisture durability no longer an issue**
- **New & retrofit**
- **Commercially available**



**EIFS Industry Members Association (EIMA)**

<http://www.eima.com/>



# Optimal Value Framing Strategy



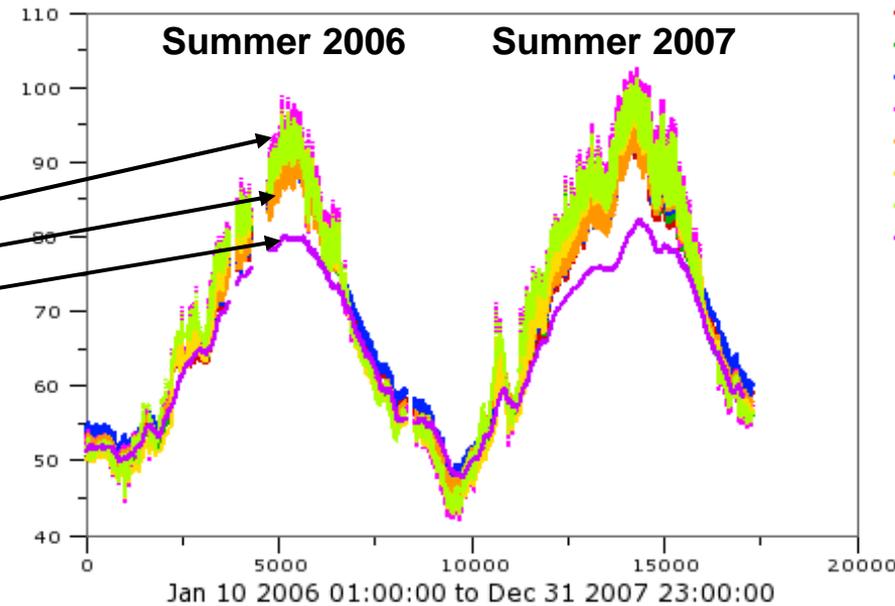
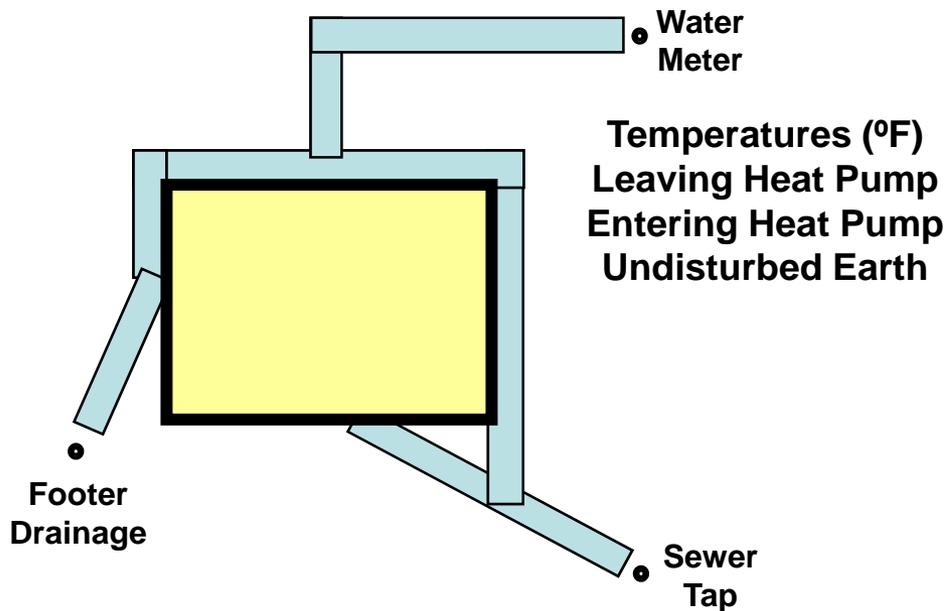
- 2x6's, 24 inches on center
- Studs aligned with rafters
- Cuts framing thermal short circuits in half
- Compatible with airtight systems
- New construction only
- Framers can do it
  - + With oversight

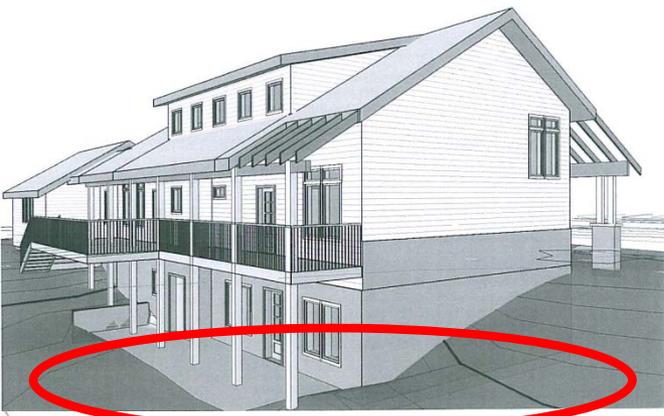


# Foundation Heat Exchanger (FHX)

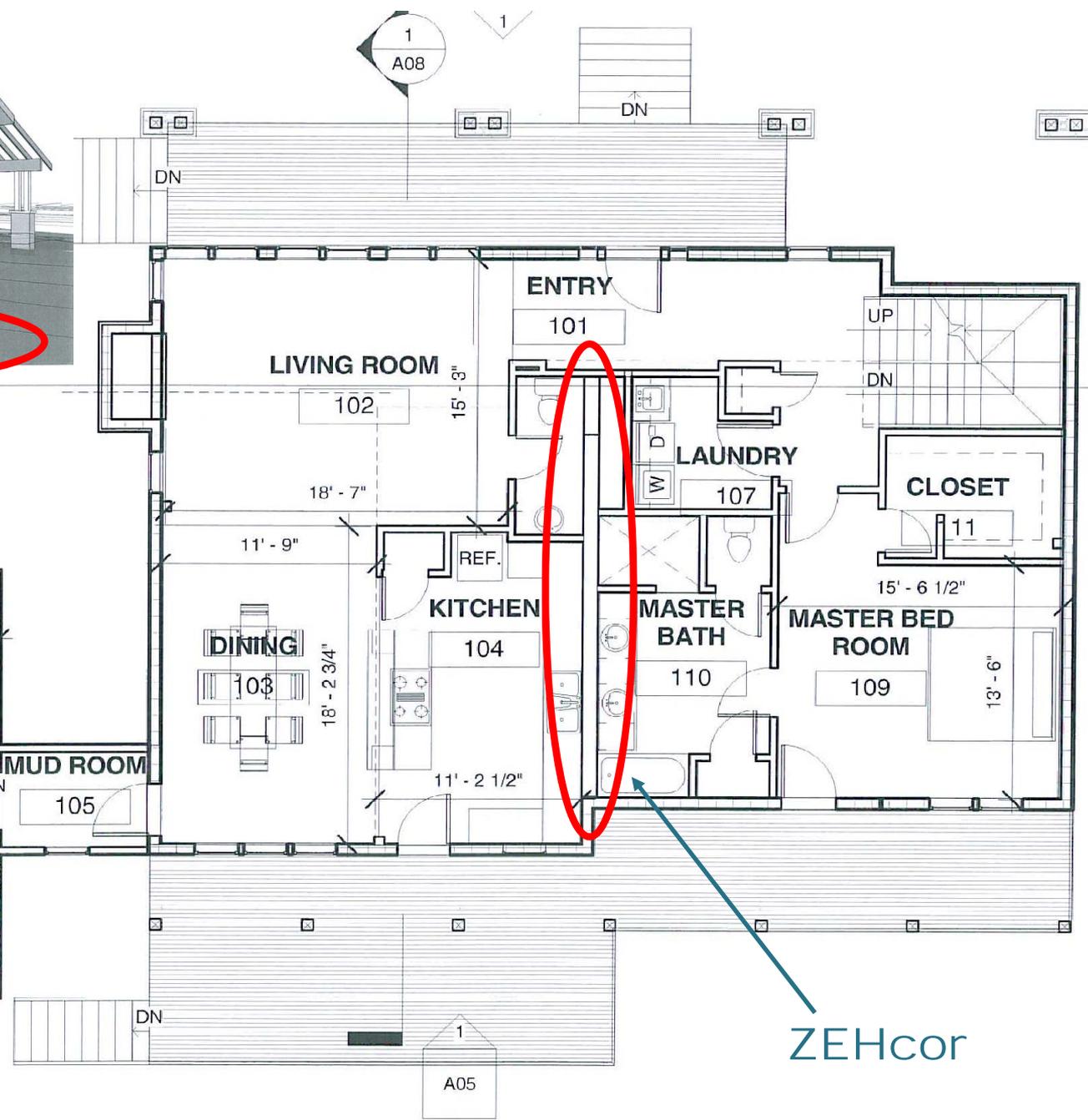
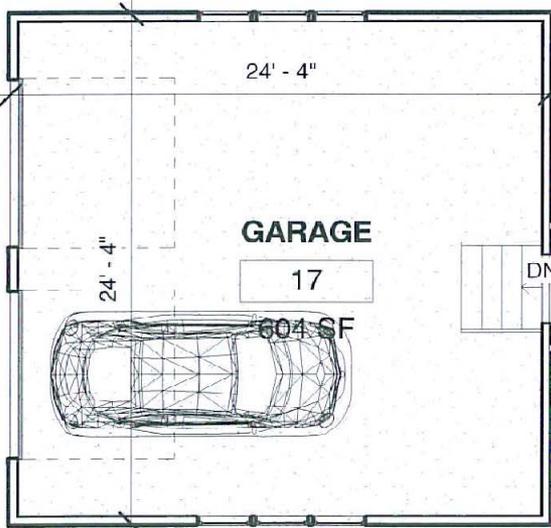


- **Saves energy & reduces peak demand**
  - Enables use of geothermal (ground-source) heat pump
- **Reduces cost**
  - Uses excavations needed anyway to build the house
  - No extra digging or drilling
- **Retrofit? (normal loops not FHX)**





FHX



A06 1

1  
A08

1  
A05

ZEHcor

1 FIRST FLOOR PLAN  
1/8" = 1'-0"



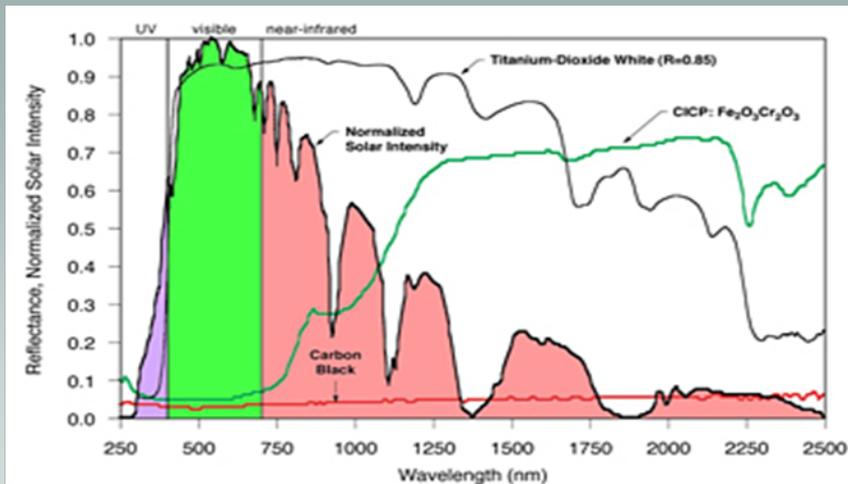
# 'Cool Colored' Roof and Wall Exteriors

Flat Roofs → White

Reduce "Bake Temp"  
→ Less Cooling



- Reflect solar, reduce cooling
- White is best
  - 'Dirty white' not appealing
- 'Cool colors' next best
  - Infrared reflective pigments
- 'Bake temp' 20 – 30°F lower
  - For cooling dominated climates
- Available for most roofing
  - Concrete or clay tile, painted metal, stone coated metal, asphalt shingle
- Available in wall paints
- New & retrofit



John Shonder

August 9-12, 2009



# Major Brand Name Firms are Bringing Heat Pump Water Heaters to Market in 2009

- ORNL's industry partner is GE
- DOE announced new ENERGY STAR water heater criteria April 2008
  - + Compared to electric storage WH
    - Same amenities 50% less energy
- GE announced product the next day
  - + For-sale in 4<sup>th</sup> quarter CY 2009
- Other major brands hinting they may do the same
- GE units are currently under test in lab and in houses
- New & retrofit
- GE's June 1, 2009 press release
  - + <http://www.genewscenter.com/Content/>

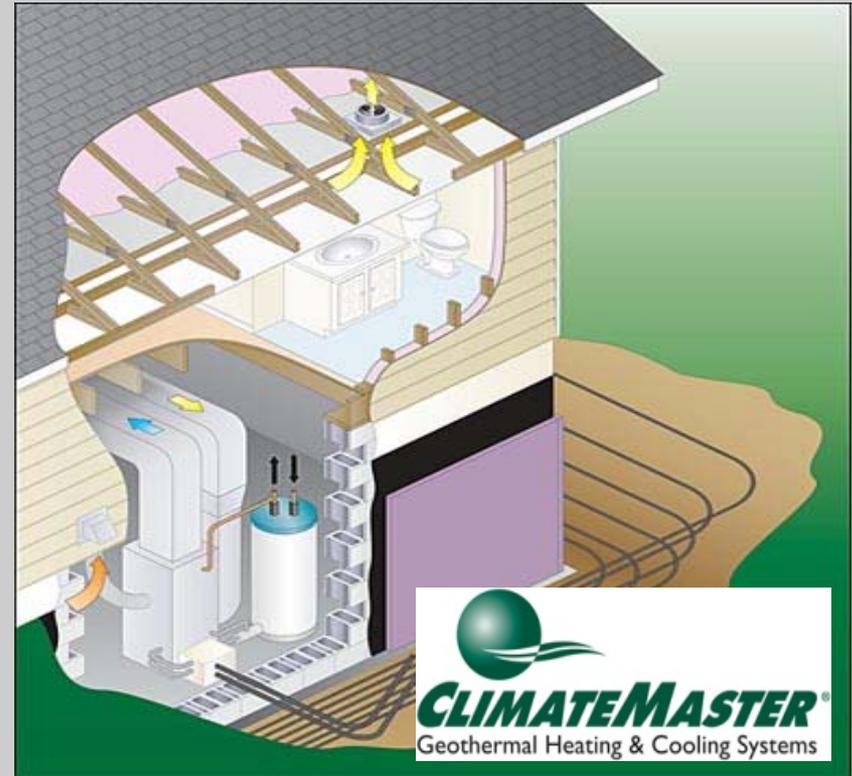


**Accelerated Durability Testing**



# Ground-Source Integrated Heat Pumps are Coming

- ORNL's industry partner is ClimateMaster
- A single unit in lieu of separate ones for heating and cooling, water heating, dehumidification
- Same amenities, 50-60% less energy
- Enables shorter loop (in areas where loop is sized on cooling)
- Prototype in ZEBRAAlliance house by summer 2010
- For sale in 2011



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[www.zebralliance.com](http://www.zebralliance.com)



<http://www.ornl.gov/info/ornlreview/>