Assessing the Engineering Performance of Purdue University’s INhome as an Example of Affordable Net Zero Energy Housing

"Ecological Principles in Building"

September 6, 2012

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Mechanical Engineering Technology
The Solar Decathlon
INhome Guiding Principles

- Net Zero
- Functional
- Affordable
- Comfortable
- Midwestern
Structurally Insulated Panels

- 4” walls – R 24
- 8” roof – R 50
- Greatly reduces thermal bridges
- Thermocore, Mooresville, IN
Passive Features

- Air sealing
- Shading
- Daylighting
- Natural Ventilation w/ operable clerestories
Open Kitchen / Living Room
Full-Sized Appliances

GE GeoSpring Heat Pump Water Heater

GE Profile Energy Star Appliances (induction stove top)
High Eff. Central HVAC

- Two stage heat pump for sensible loads
- Ducted dehumidifier for latent loads
- Energy Recovery Ventilator

Trane XL20i 2-ton Heat Pump
Trane Energy Recovery Ventilator
Biowall

- Living plant wall that provides natural air filtration
- Connected to the HVAC return
- Improves Indoor Air Quality
- Reduces heating & cooling
Photovoltaic Array

- 8.6 kW array
  - 36 Sunpower 238 W modules
  - 27 panels flush on south roof
  - 9 panels in a south-facing rack located on the north roof
- central inverter
- grid-tied
Control Equipment

- Smart home automation
- Energy monitoring
- Building Control
Overview of 2011 Competition

Juried Contests
- Architecture  ➤ 17th
- Home Entertainment ➤ 7th
- Engineering ➤ 6th
- Communications ➤ 6th
- Market Appeal ➤ 5th

Measured Contests
- Energy Balance ➤ 1st
- Affordability ➤ 2nd
- Comfort ➤ 2nd
- Hot Water ➤ 3rd
- Appliances ➤ 6th

2nd Place Overall
Redemption!
Weather During Contest

![Graph showing temperature and relative humidity from September 22 to September 30. The graph indicates fluctuations in temperature and humidity throughout the period.]
Overcast Weather Conditions
Comfort Zone Contest (2nd place)

Estimated HVAC Cost, $

Comfort Zone Points

Mini splits were popular, but problematic in the humid weather
Hot Water Contest (3rd place)

Solar Thermal
$4,000 and up
direct sunlight needed
< 1:1 thermodynamic ratio
More to install

Heat Pump
$1,250
Electrically driven
> 2:1 thermodynamic ratio
Less to install

INhome water heater electricity use during competition

5 of 7 teams that reached net-zero used heat pump water heaters
Appliance Contest (6th place)

Appliances
Oven / Cook Top
Dishwasher
Refrigerator/Freezer
Clothes Washer/Dryer

Mini-appliances not necessary

EnergySTAR rated
American made
Family sized
Off-the-shelf

GE Profile
Energy Star Appliances
(induction stove top)
## Fragmented Control

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Next Steps...

- Placed in Chatham Square
- Outreach & monitoring
- Sold to homeowner