Net Zero Energy House Evaluation

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July 11 -14, 2016
Introduction

- **Indiana Home (INhome):**
  - Net zero energy home created & built by Purdue University student team for 2011 Solar Decathlon
  - Goal of competition was to build home taking into account:
    - Aesthetics
    - Comfort
    - Practicality
    - Affordability
    - Energy efficiency
Project Goal

- After the Solar Decathlon, the INhome moved to affordable neighborhood in Lafayette, Indiana
- Evaluate INhome’s net zero performance after 3 full years of occupancy (2013 – 2015)
Street View of INhome
Floor Plan of INhome

- **Layout:**
  - 1000 square feet (92.9 m²)
  - Living room
  - Kitchen
  - Bathroom
  - 2 bedrooms
  - Garage
  - Utility room
Solar Photovoltaic System

- 9.0 kW solar array
- 36, 240 W solar panels
- connected to electric grid
- designed to provide 100% of home’s annual electricity
Passive Energy Reduction

- High levels of insulation
- Triple pane windows
- Clerestory windows
  » Provide day lighting and fresh air
  » Allow natural ventilation
- Overhangs provide external shading to walls of home

INhome constructed from SIPS panels
R-24 & R-50
Energy Efficient Equipment

- Smart home controls
  - Web based apps
- Energy Recovery Ventilator
  - Helps reduce heating & cooling loads
- High efficiency appliances
  - Minimize electric loads in water heating, kitchen, & laundry

Heat Pump

Water Heater
Air Source Heat Pump

- All-electric
- Provides heating & cooling
- Has two individual compressors for less cycling
- SEER rating of 19

2 Ton Heat Pump
INhome has been net zero last three years

- 2013 & 2014 years:
  - Home producing excess solar energy

- 2015 year:
  - Consumption & production nearly equal
  - Homeowners utilized excess solar energy
Electricity Use of INhome

- **HVAC system:**
  - Single largest consumer of energy

- **Controls:**
  - Used surprisingly large amount of energy

- **Kitchen:**
  - Smallest amount of energy

- **Overall energy use is less than 10,000 kWh**
Annual Energy Consumption/Solar Production

- **Energy Consumption:**
  » consumed at steady rate

- **Solar Production:**
  » Varies over course of year

- **Energy Consumption & Solar Production offset one another**
  » Overall result is a net-zero energy home
Homeowner Survey

- Informal survey given to current homeowners to gauge overall satisfaction after 3 years occupancy
- 10 question survey:
  » Installation of solar powered panels
  » Energy efficient appliances
  » Overall comfort of home
- Survey revealed that overall the homeowners very much enjoy living in the home
Solar Array & Appliances Survey

- Solar Photovoltaic Panels:
  - Homeowners recognize panels produce more power than home requires
  - Only energy cost is service fee
- Energy Efficient Appliances:
  - Induction cooktop
    - Aesthetically pleasing and performs very well
Heat Pump & ERV Survey

- **Air source heat pump:**
  - Provides consistent temperature and humidity control

- **ERV system:**
  - Well received in terms of reliability, functionality, and practicality for providing fresh air
  - Consistent in automatically turning on/off when needed
  - Described as being nearly flawless in functionality
Comfort & Controls Survey

● **Overall Comfort:**
  » Described as a “delight to live in”
  » Layout, architecture, and outside wraparound deck as a few of the most enjoyable features

● **Smart Home Controls:**
  » Features were not used on day to day basis
  » Homeowners placed higher value on simplicity than high tech gadgets
Conclusions

- INhome achieved goal of being consistently net zero from 2013 to 2015
  - First years show homeowners not utilizing all energy produced by solar panels → excess energy
  - 2015, consumption and production levels were nearly equal
- HVAC appliances used most energy every year
- Overall INhome described as perfectly designed home to showcase energy efficiency and solar energy of today
Thank You!

QUESTIONS?