

Equinox House

Solar Powered Living and Transportation How and How Much?

Notre Dame Energy Expo
September 25, 2010



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www.newellinstruments.com





Project Sponsors:

My wife, Deb

Blomberg/Arçelik
Appliances



Sustainability

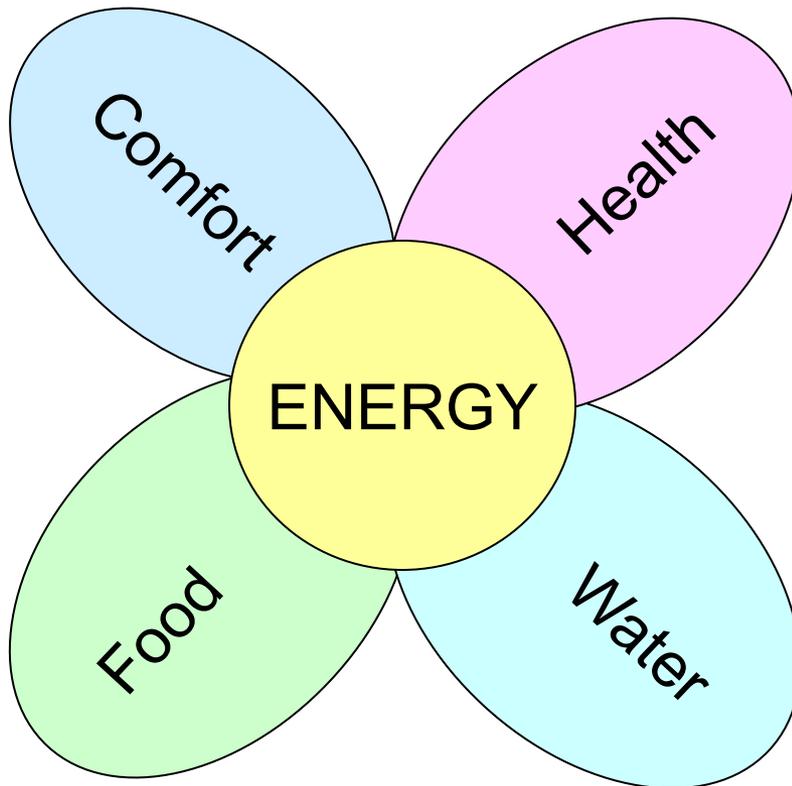
My definition:

Providing a future for our children.

“Do right, use your head, everybody must be fed”

Ginger Baker; Blind Faith album;
“Do What You Like” Great drum solo

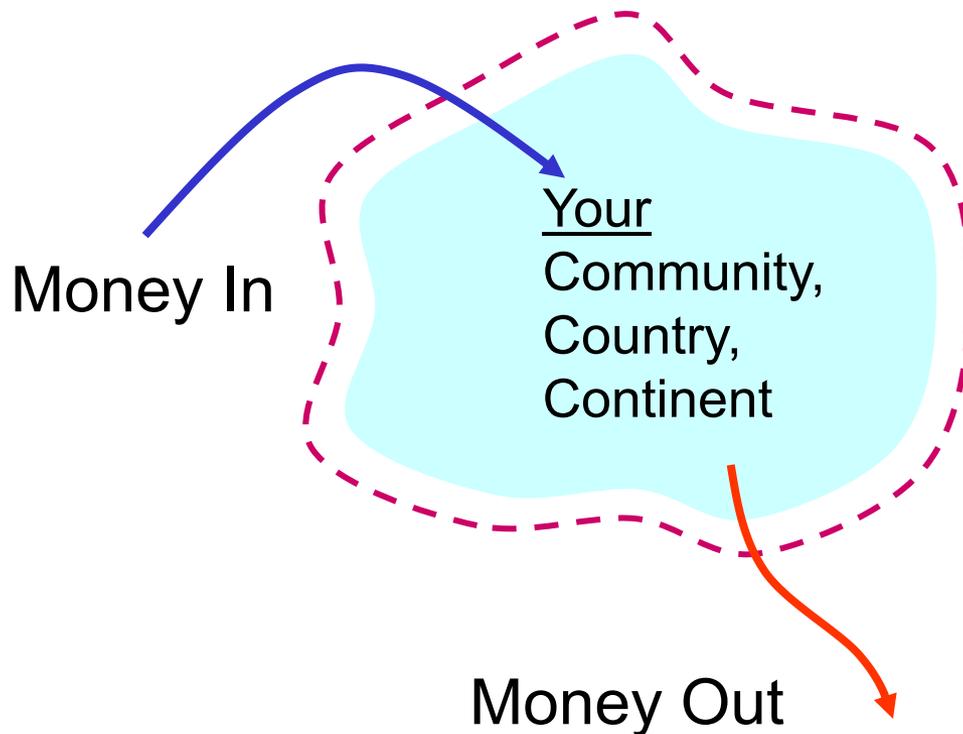
Our Needs are Simple



- But, obtaining these things are dependent on a complex network:
- A common factor is energy:
 - Processes utilizing energy must be efficient
 - Resources supplying energy must be sustainable

Economic Sustainability

To keep from getting poorer, must have:
Money Coming In > Money Going Out



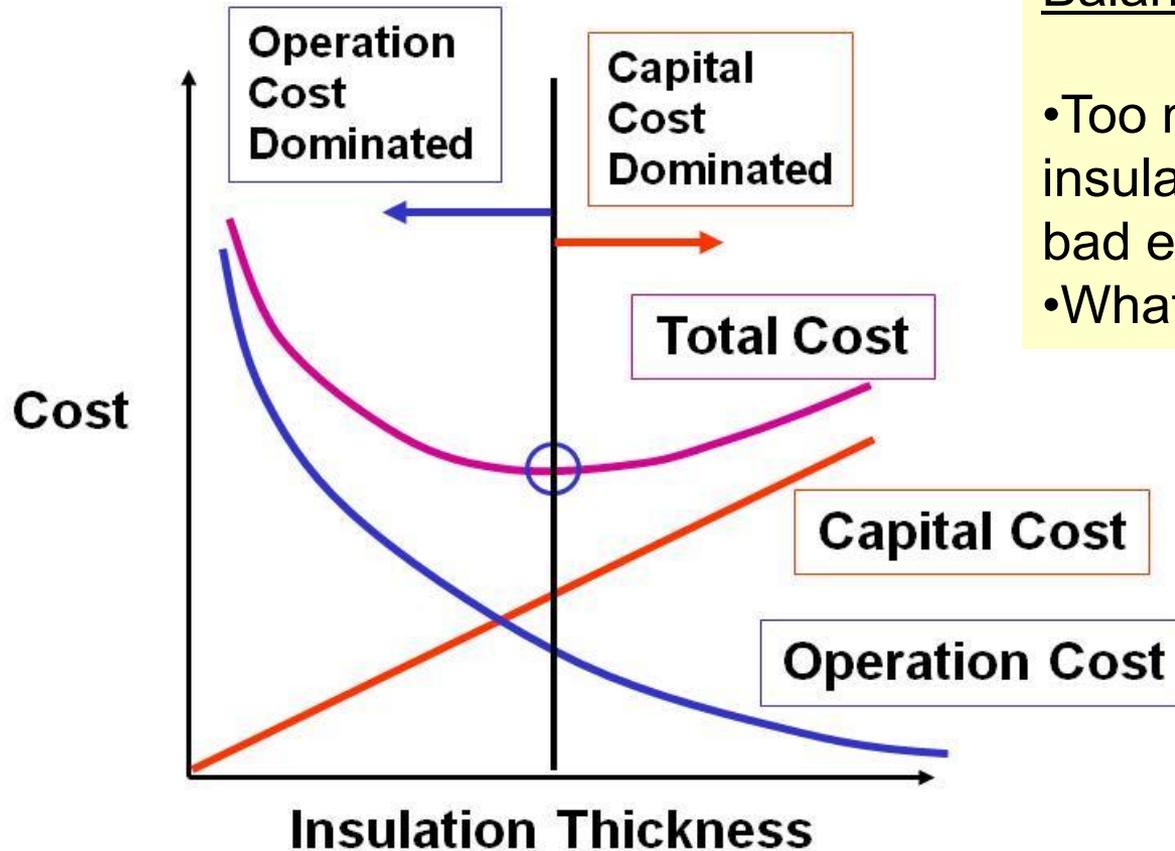
Recycling Example:

- \$150/ton to collect and process recyclables
- \$120/ton revenue for sales of recyclables
- Net "cost" = \$30/ton

- Landfill cost = \$30/ton

- Which is better???

Economic Optimization



Balancing Cost:

- Too much or too little insulation in a building is bad economically
- What is the optimum?

Newell Background

- Renewable Energy
- Energy Conservation
- Energy Efficiency
- Resource Conservation



Grad school 1970's



Univ of Illinois Solar Lab
1980's

1986 - University of Illinois 2000 sqm Solar Pond



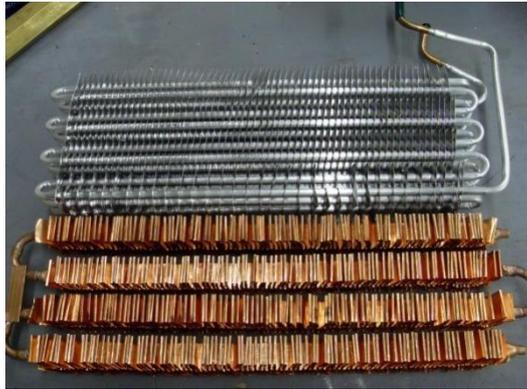
Today – 24 years later

2007 Univ of Illinois Solar Decathlon Team

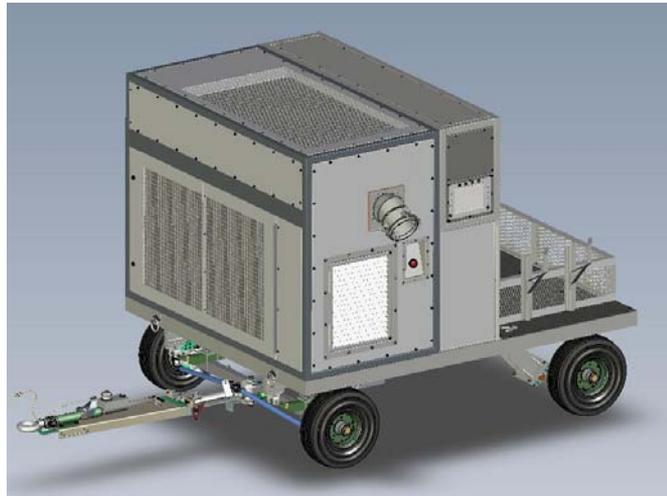


Now, located at the
Chicago Center for
Green Technology

Newell Instruments



appliances



military cooling systems



automotive



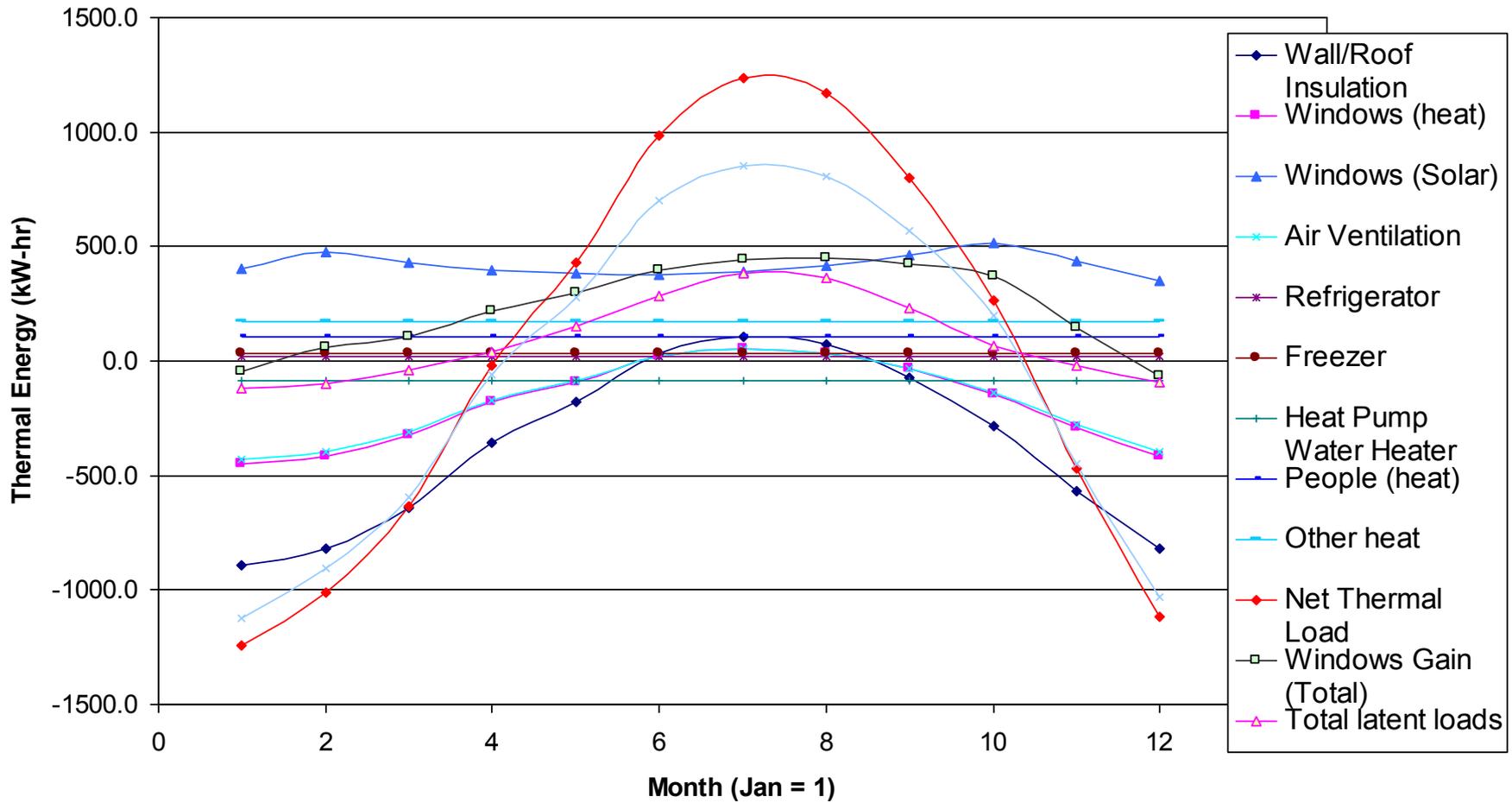
NI Laboratory is
solar powered
We believe in solar!

Equinox Project Motivation and Objectives

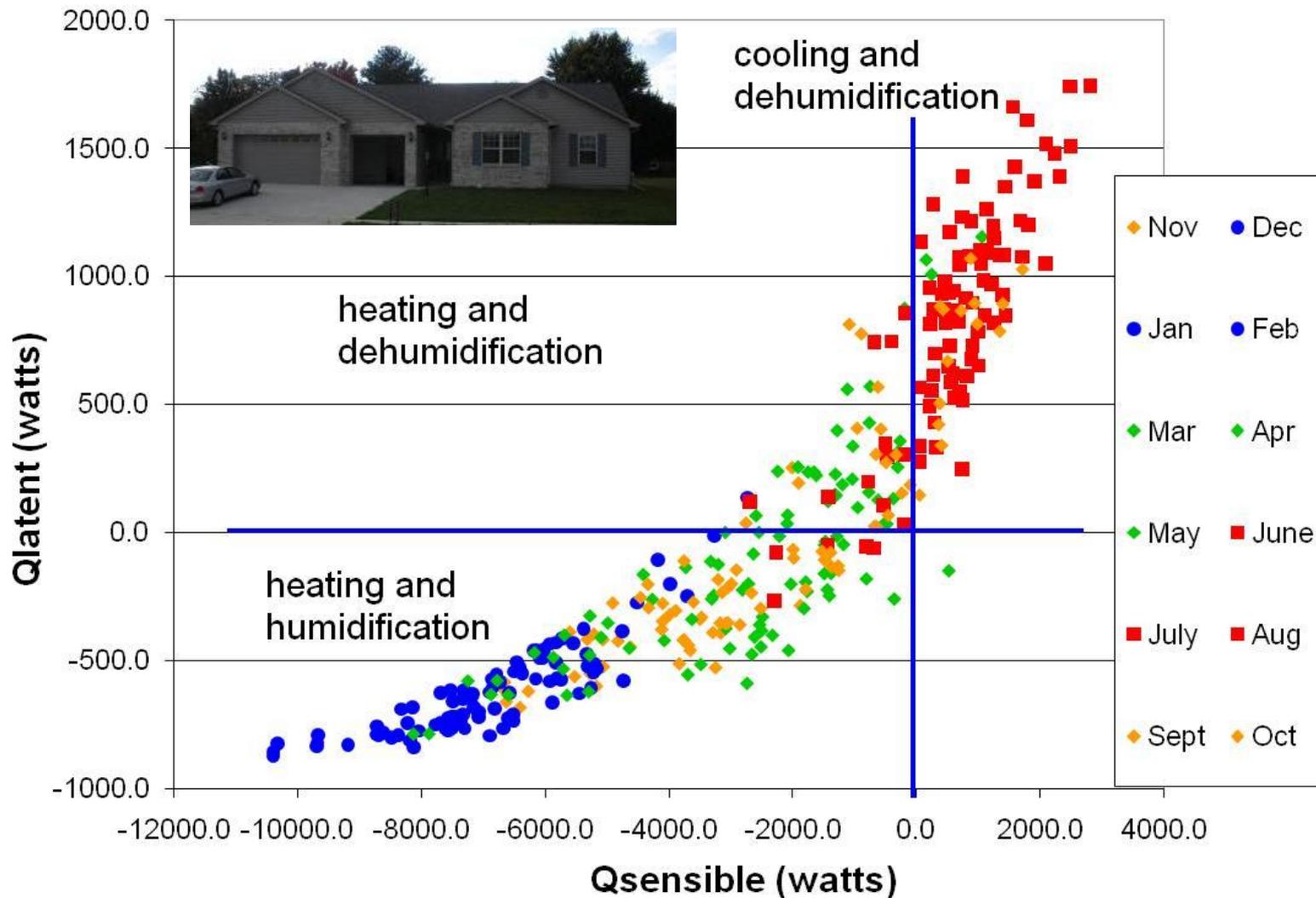
- Newell Instruments: Combine our knowledge of air conditioning and heating systems to create a product for meeting the energy needs of a super efficient home
- Demonstrate that an energy efficient home can be fully powered (house and transportation) by solar energy in a cost effective manner ... even in central Illinois
- Learn home construction costs and processes firsthand
 - File **lots** of permit applications
 - Fill out **lots** of lien waivers
 - Schedule **lots** of inspections
 - Write lots & **lots** of checks!



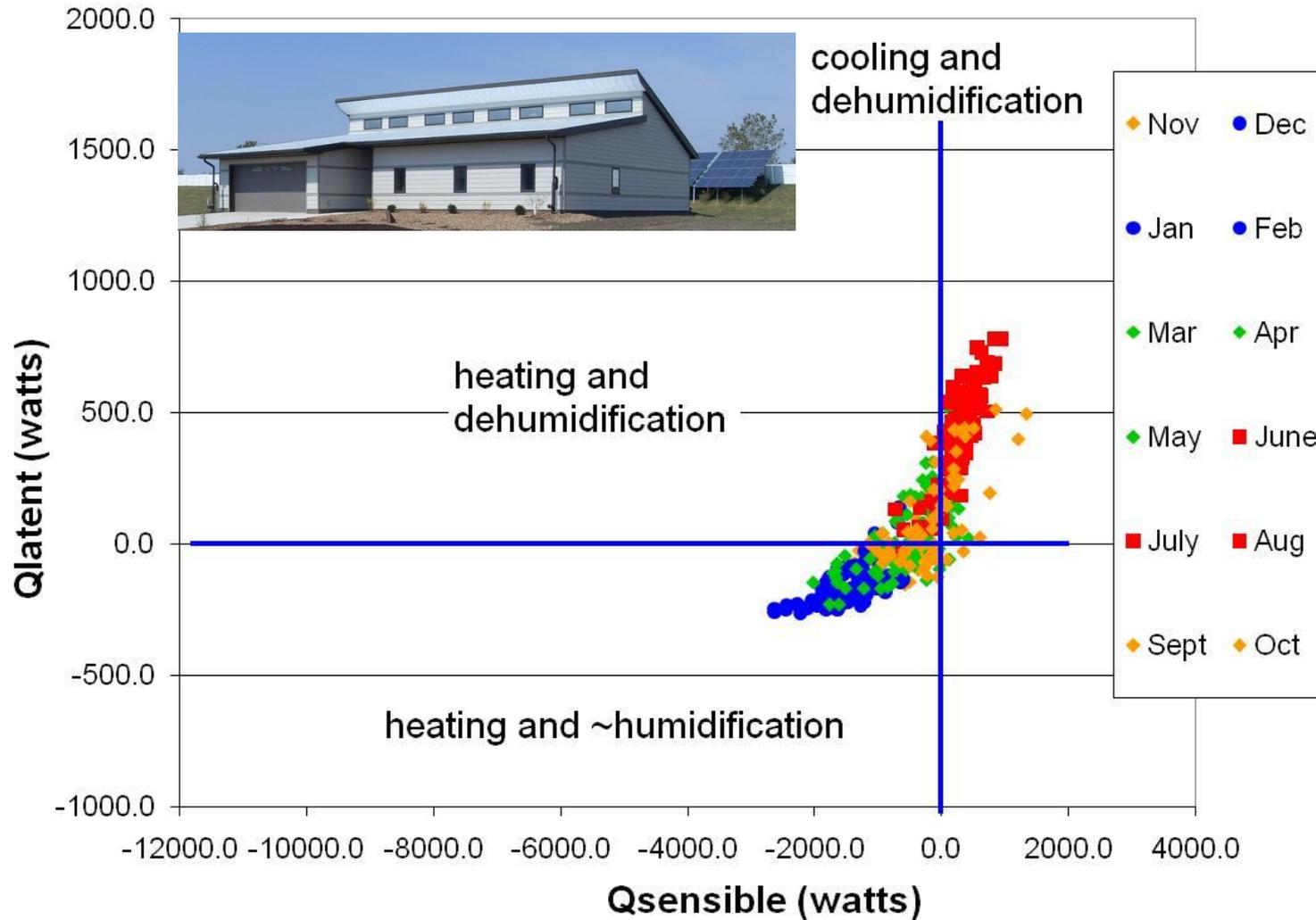
Residential Energy Interactions



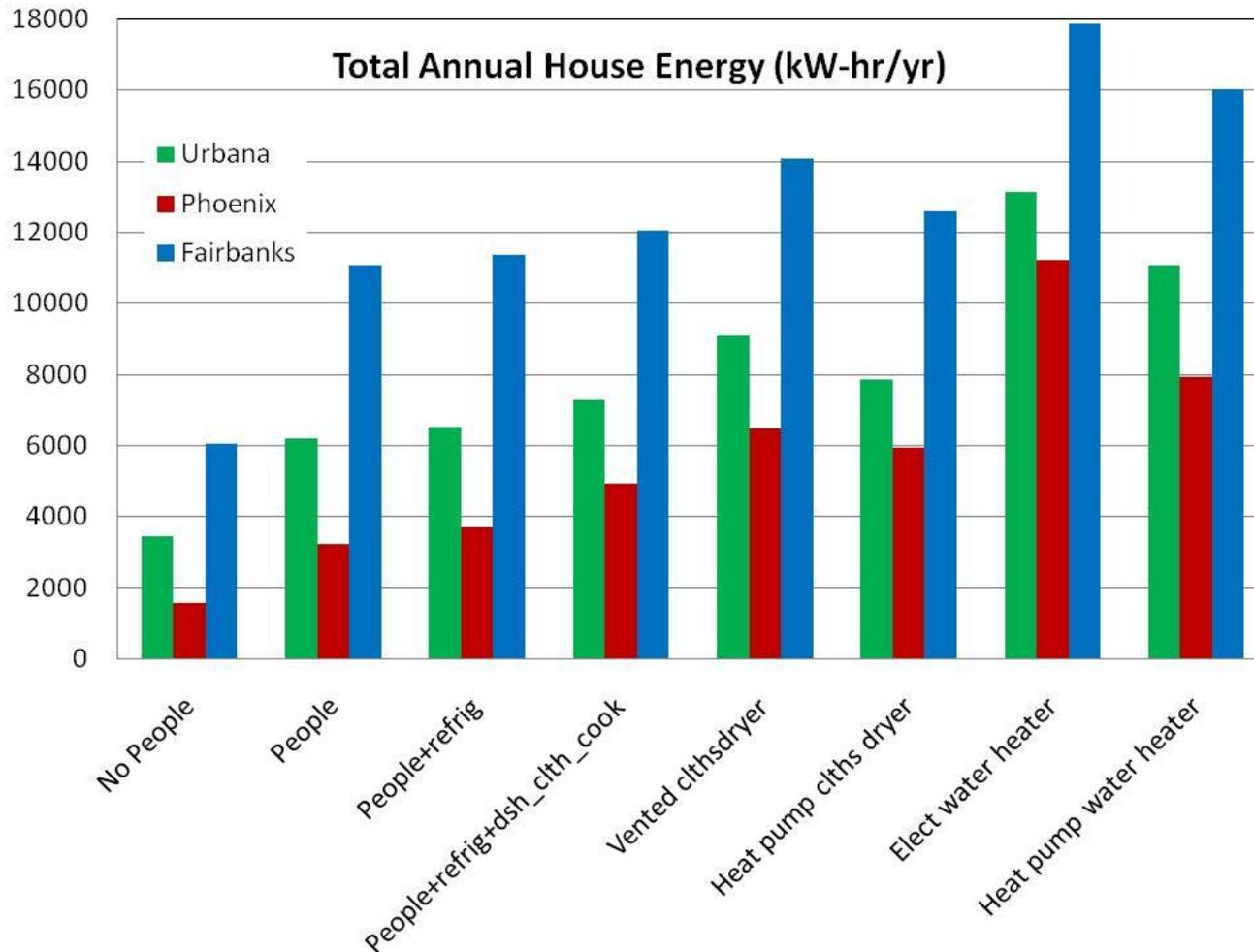
“Conventional” House 2100 sq ft



Equinox House 2100 sq ft



Impact of People



Solar Powered Dwelling

- Lots of insulationR40 to R50
- Adequate windows for light and view
 - Triple to quadruple glazed, low e
- Supersealed with controlled ventilation
- “Flexible” conditioning system (large variation of sensible to latent ratios)

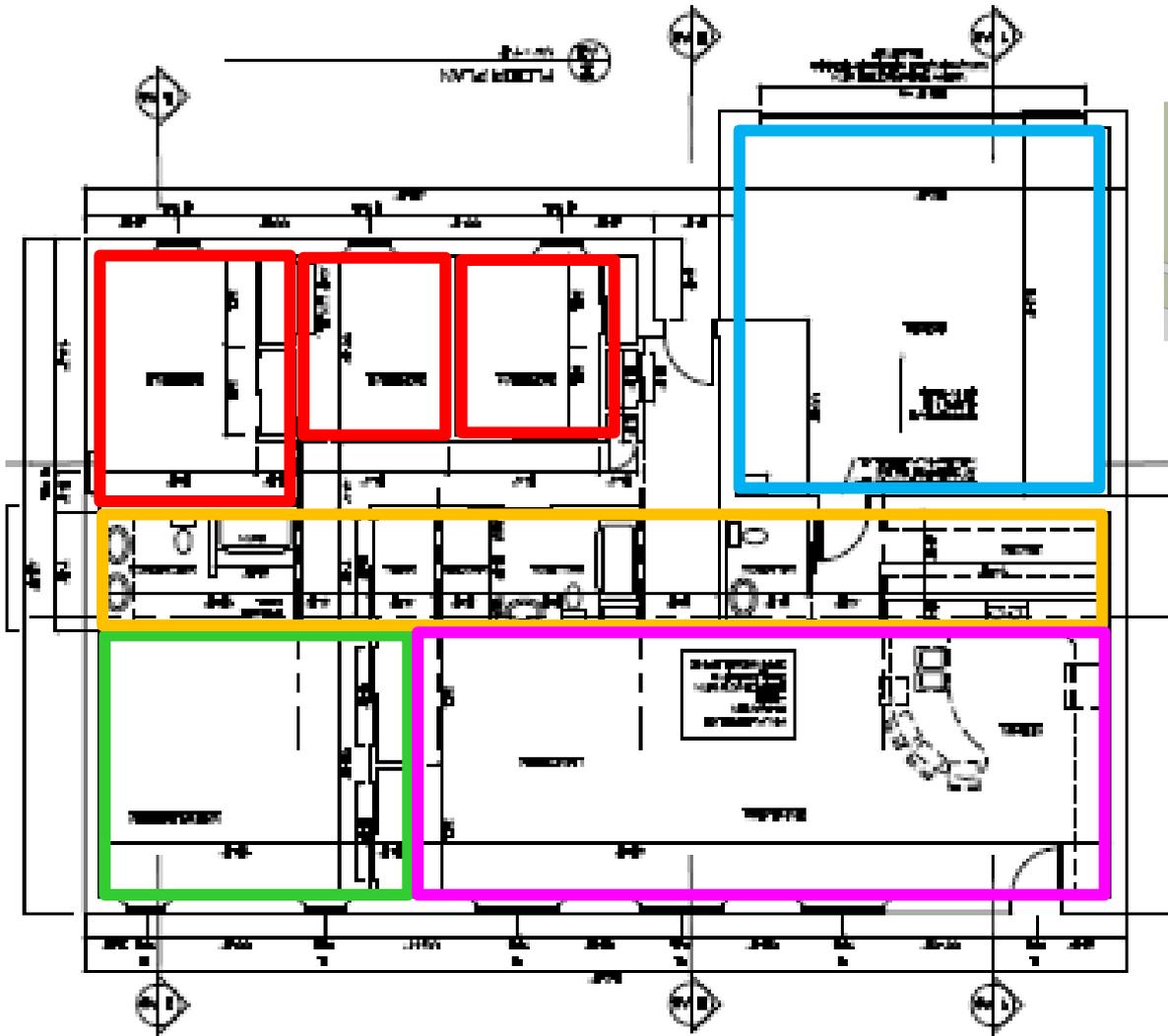
Single Story, Slab Floor Construction

~2,100 sq ft Living ~500 sq ft Garage



- Easy-to-maintain design (accessible electric, plumbing, ductwork)
- 4 bedrooms (master and 3 small bedrooms)
- 2 ½ baths (modest size)
- Open living space floor plan

House Floor Plan – 2,100sqft



-  Open Living
-  Master Bedroom
-  3 Bedrooms
-  Utility corridor (bathrooms, laundry, pantry)
-  Garage

House Panels Arrive



- Three trucks
- Plastic wrap and banding recyclable



SIPs

Structural Insulated Panel



- 1st panel installed
- Walls and roof 1 foot thick, ~R44
- Follow the numbers, ~80 panels (walls and roof total)
- Heaviest panel (8' by 24') weighs ~400 pounds
- Again virtually no waste, whole house up in 1 week

Shell Completion



House wrap

Roof Paper



Windows



Shell Completion



North side windows
-Great view and light
-But, ~\$25/month per
100 sq ft of window
(\$15/mo for window and
\$10/mo for energy)

Equinox has ~75sqft of north window
for view and code requirements

Extra thick walls allow
double doors



House Complete! well, almost



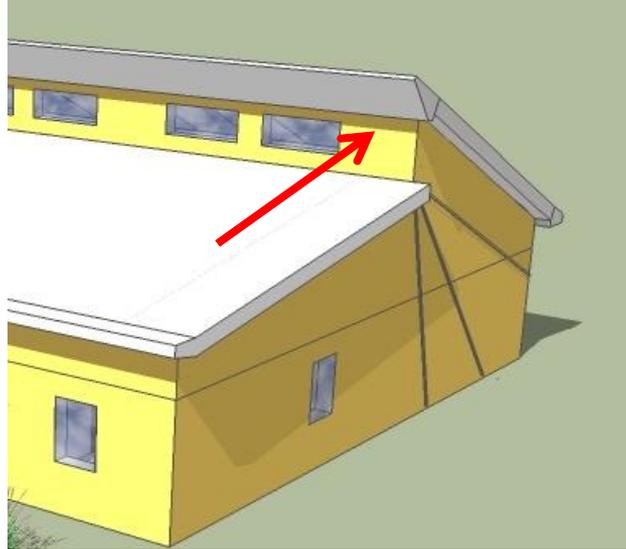
Waiting on custom Italian cabinets (“eco modern” Demode by Valcucine)

...should be installed shortly, and move in after that

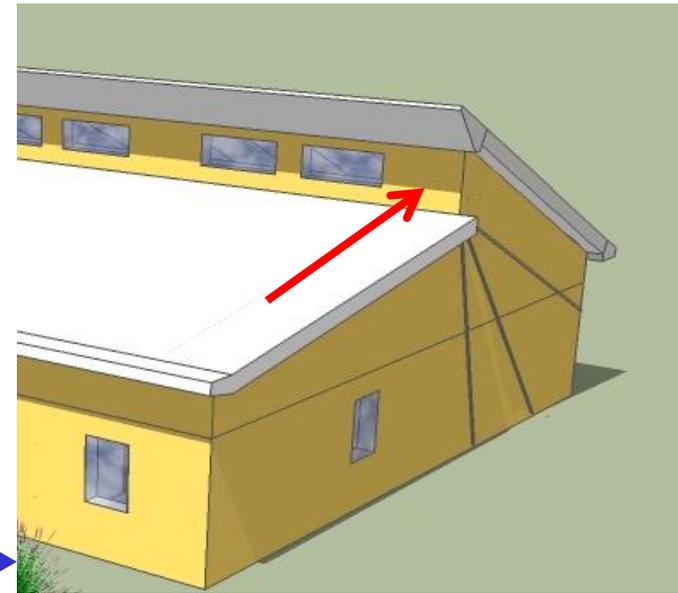


Outdoor Shading

For Illinois, equinox is a good time to shade & unshade



Clerestory shading on March 21
and September 22



Clerestory shading on April 14
and September 1

Indoor Daylighting



Winter Solstice pattern
(Dec 21)

Fall Equinox pattern
(September 22)
Direct Sunlight enters
for first time since
spring



Lighting



All lighting is mercury free
LED bulbs



Wireless switches eliminate electrician's holes through walls

Comfort



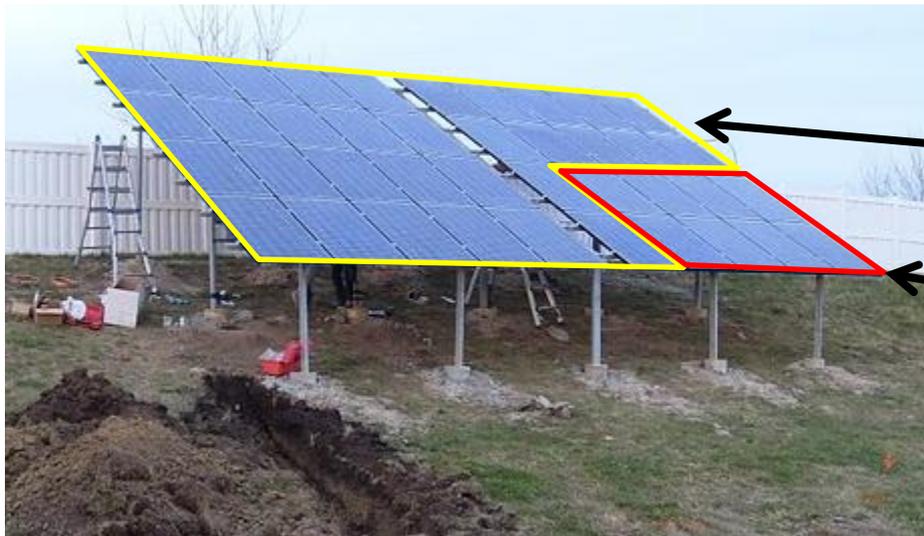
Superinsulating and supersealing creates very uniform interior temperatures and comfort

- 20 ft ceiling and concrete floor within 1-2F all year with no ceiling fans



Solar System Installation

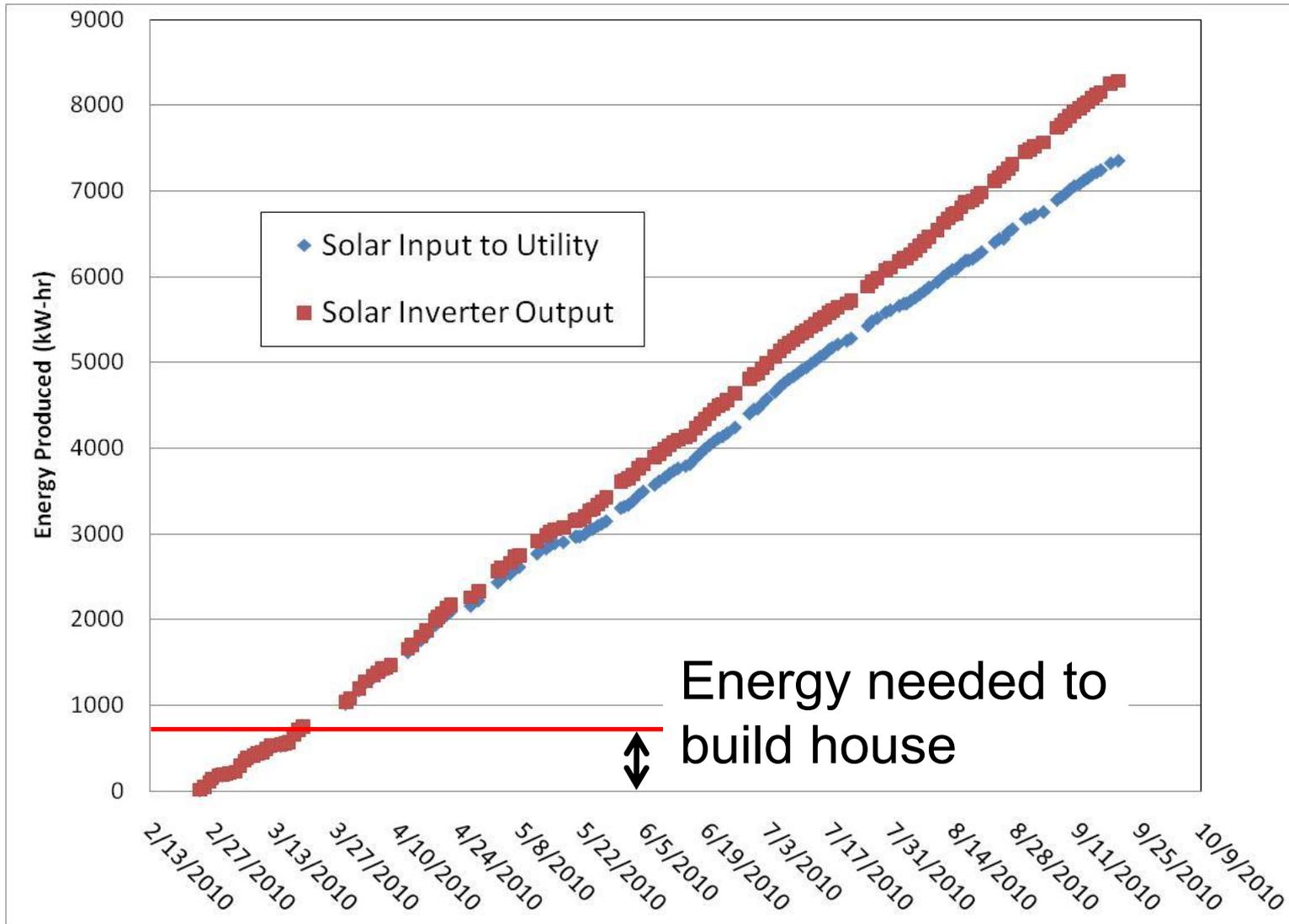
8.2kW nominal system size
~4 days to install rack and panels
~600 to 700sqft (~25% roof area)
~10,000kW-hr per year
8000kW-hr for house
2000kW-hr for car



House panel area

Car panel area (6000
to 8000 miles per year)

Total Solar Energy Production



Clean, Fresh Air!



- Equinox is so well sealed it could be used as a boat
- Continuous fresh air and exhausted stale air
- All fresh air is filtered
- Air is purged through the house
- Fresh air supplied to living and bedrooms, stale air exhausted from bathrooms, laundry and kitchen areas

“Smart” Electrical System for Monitoring and Control



- Monitor activity anytime from anywhere
- Control circuits based on time-of-day and/or cost
- Monitor “health” of house, health of people

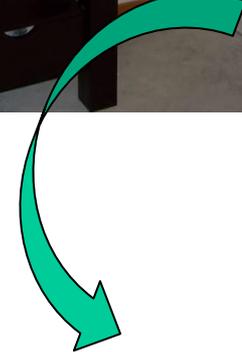
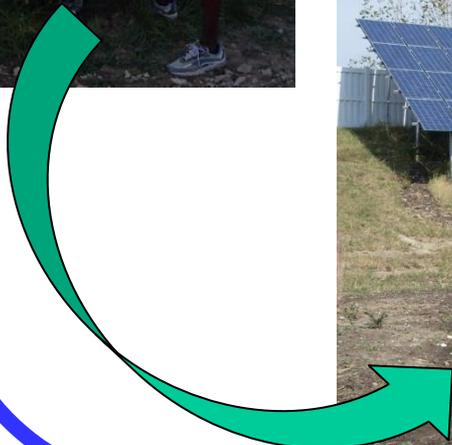
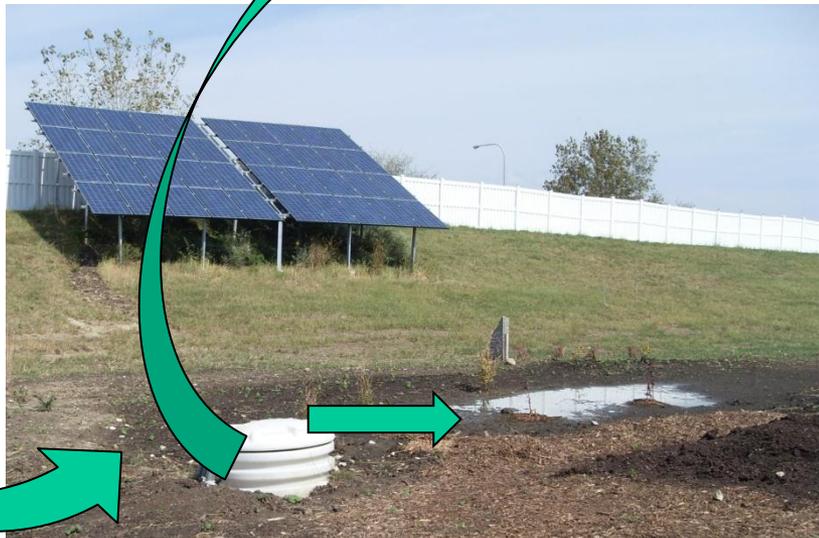


Water



- Aquifer levels are dropping
- Good time to learn about rainwater harvesting in Illinois
- 1700 gallon cistern
 - ~1" rainfall = 1000 gallons
 - Rain garden catches overflow
 - System cost ~\$3000
- Designed for 80% of house water
 - Approved for toilets by Illinois State Dept of Public Health

Rainwater Harvesting and Storm Water Retention



Equinox Energy and Cost

- So, is it worth it?
- What barriers are keeping solar powered homes and transportation from being common place?

“Life Cycle” Cost (20 year) Equinox and Conventional

- Assume a 2000 square foot home with 4 people
- Central Illinois weather
- Base house costs \$100/sq ft (\$200,000 for 2000 sq ft)
- “Conventional” energy assumed equivalent to \$0.10/kW-hr (no increase) and requires 5x energy of Equinox
- ~\$20,000 pv system for ~8000 kW-hr annual production needed for house

20 yr Net Zero Home Cost		20 yr Conv Home Cost	
House Cost (\$)	= 200000	House Cost (\$)	= 200000
Insulation Cost (\$)	= 20000	Insulation Cost (\$)	= 0
PV System Cost (\$)	= 20000	20 year Utility Cost (\$)	= 38000
Total House Cost (\$)	= 240,000	Total House Cost (\$)	= 238,000

Difference is less than the cost of granite counters



Monthly Cost – Net Zero vs Conventional

- Assume 6% loan over 20 years
- No escalation in utility price

Net Zero Monthly Cost

House Cost =	\$240,000
20% down=	48,000
Mortgage =	192,000
Monthly pay =	1,380
Monthly utility cost =	0
Total monthly cost =	\$1380

Conv Monthly Cost

House Cost =	\$200,000
20% down=	40,000
Mortgage =	160,000
Monthly pay =	1,150
Monthly utility cost =	160
Total monthly cost =	\$1310

Monthly mortgage payment difference ~ \$230/month

Net monthly payment difference ~ \$70/month

.... If utility rates don't increase



Some Big Issues

- Appraisers do not value insulation and solar system
 - Same cost per sq ft as “comparables”
- Bank loan based on appraisal
 - Lost financing opportunity for bank
 - Extra mortgage is money left in local economy rather than “exported” to utility company
 - “Extra” money spent on house goes to manufacturing and construction labor (jobs) rather than energy (no jobs)
- Without bank financing of extra insulation and solar panels, down payment of \$80,000 required....who has that?
 - Boomers
 - Community incentives/loans



The Future Can Be Bright!

Because:

- 30 years ago, we could not have imagined a computer in every home
- 30 years ago, we could not have imagined communicating by cell phone, twittering, and facebook
- 30 years ago, we could not have imagined many things that today are commonplace

•And, we cannot imagine 30 years from now, but we can help build the path taken.



Thank You!

Questions?

