Equinox House

Solar Powered Living and Transportation

How and How Much?

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Newell Instruments, Inc. 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





Grad school 1970's

Newell Background -Renewable Energy -Energy Conservation -Energy Efficiency -Resource Conservation



Univ of Illinois Solar Lab 1980's







2007 Univ of Illinois Solar Decathlon Team





Now, located at the Chicago Center for Green Technology



Newell Instruments



appliances





automotive

military cooling systems



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



People – 2/3 House Energy



Solar Powered Dwelling

•Lots of insulationR40 to R50

Adequate windows for light and viewTriple 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 ¹⁄₂ baths (modest size)
- •Open living space floor plan

House Floor Plan – 2,100sqft



House Panels Arrive



Three trucksPlastic 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



Indoor Daylighting



Fall Equinox pattern (September 22) Direct Sunlight enters for first time since spring Winter Solstice pattern (Dec 21)





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!



Continuous fresh air and exhausted stale air
All fresh air is filtered
Fresh air supplied to living and bedrooms, stale air exhausted from bathrooms, laundry and kitchen areas
Radon ~2.5pCuries/liter





High Performance Appliances and Comfort Conditioning System



- Ventless, heat pump dryer
 High spin speed washer
 (1200 rpm)
- •(Blomberg/Arçelik products)



•CERV and HPWH
•Conditioning Energy Recovery Ventilator
•Heat Pump Water Heater
•(Newell Instruments)

"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



Aquifier levels are dropping

 Good time to learn about rainwater harvesting in Illinois

1700 gallon cistern
~1" rainfall = 1000 gallons
Bain garden catches

•Rain garden catches overflow

•System cost ~\$3000

•Designed for 80% of house water

•Approved for toilets by Illinois State Dept of Public Health



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		Conv Monthly Cost	
House Cost =	\$240,000	House Cost =	\$200,000
20% down=	48,000	20% down=	40,000
Mortgage =	192,000	Mortgage =	160,000
Monthly pay =	1,380	Monthly pay =	1,150
Monthly utility cost	= 0	Monthly utility cost =	160
Total monthly cost	= \$1380	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 communicating by cell phone, twittering, and facebook
•And we cannot imagine 30 years from now but we can help build the path taken



Your Impact Can Be Felt Anywhere ...and in ways you may never know



John Garvey house; Urbana, Illinois B. Goff, 1954

"our tools are better than we are, and grow better faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it."

Professor Aldo Leopold; 1938 University of Wisconsin Engineering and Conservation speech

Thank You! Questions?