7 Steps for Designing an Economical Net Zero Home

BUILD EQUINOX

SOLUTIONS FOR A HEALTHY, COMFORTABLE, AND SUSTAINABLE LIFESTYLE

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Webinar – May 25, 2017

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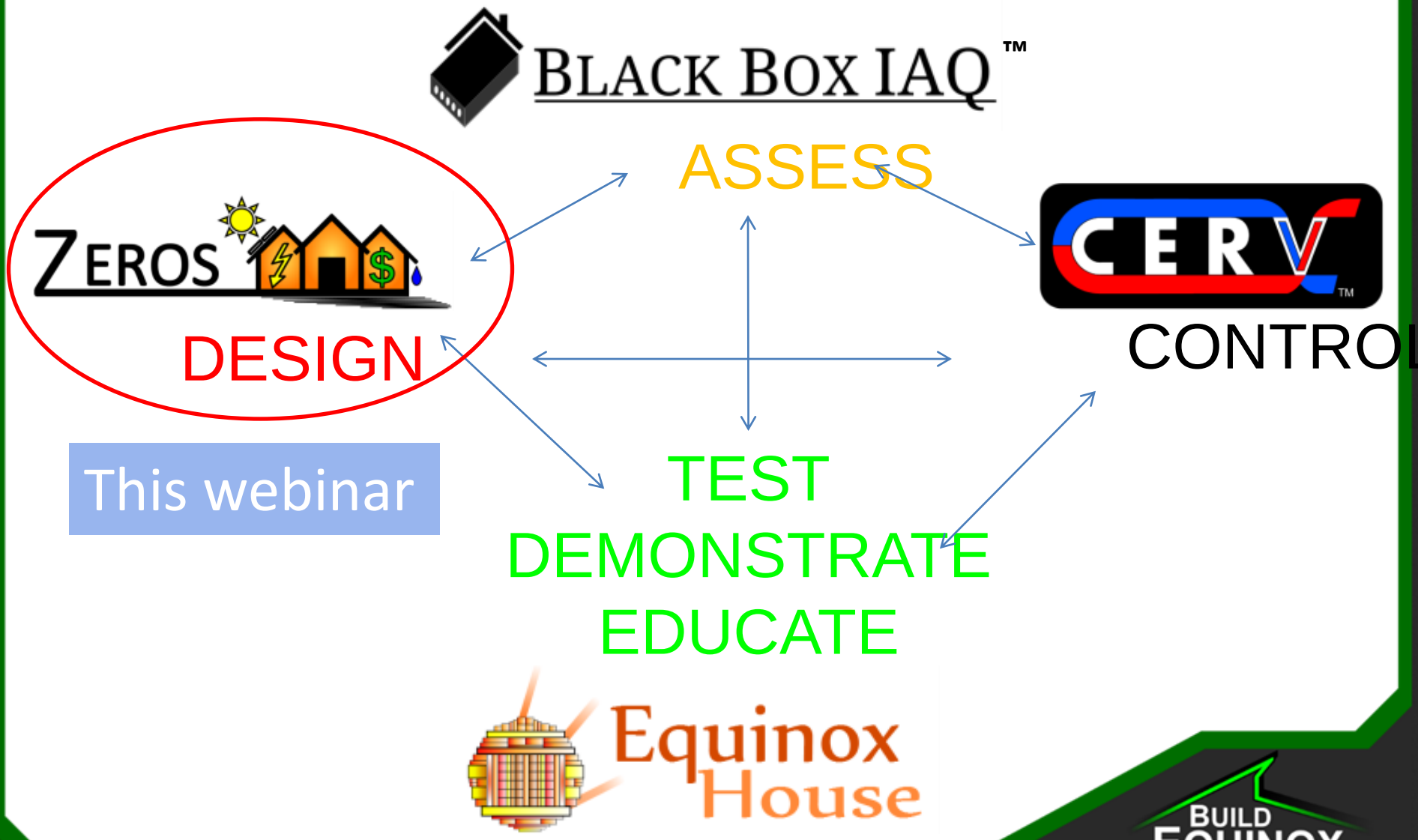
Build Equinox Activities



Build Equinox

- Build Equinox manufactures systems that automatically keep air fresh in residences
- “CERV” smart ventilators are manufactured in our facility in Urbana IL

100% Solar Powered Business!

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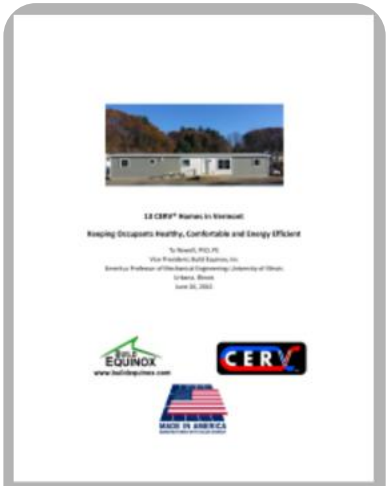
Mission

BUILD EQUINOX

Research & Education

Ben Newell

Ty Newell Alex Long



VERMOD CERV Report

Develop solutions for healthy, comfortable and sustainable lifestyles….learning to live on our daily allowance of solar energy.

How do we live on a piece of land without spoiling it?

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Why?

Newell Background

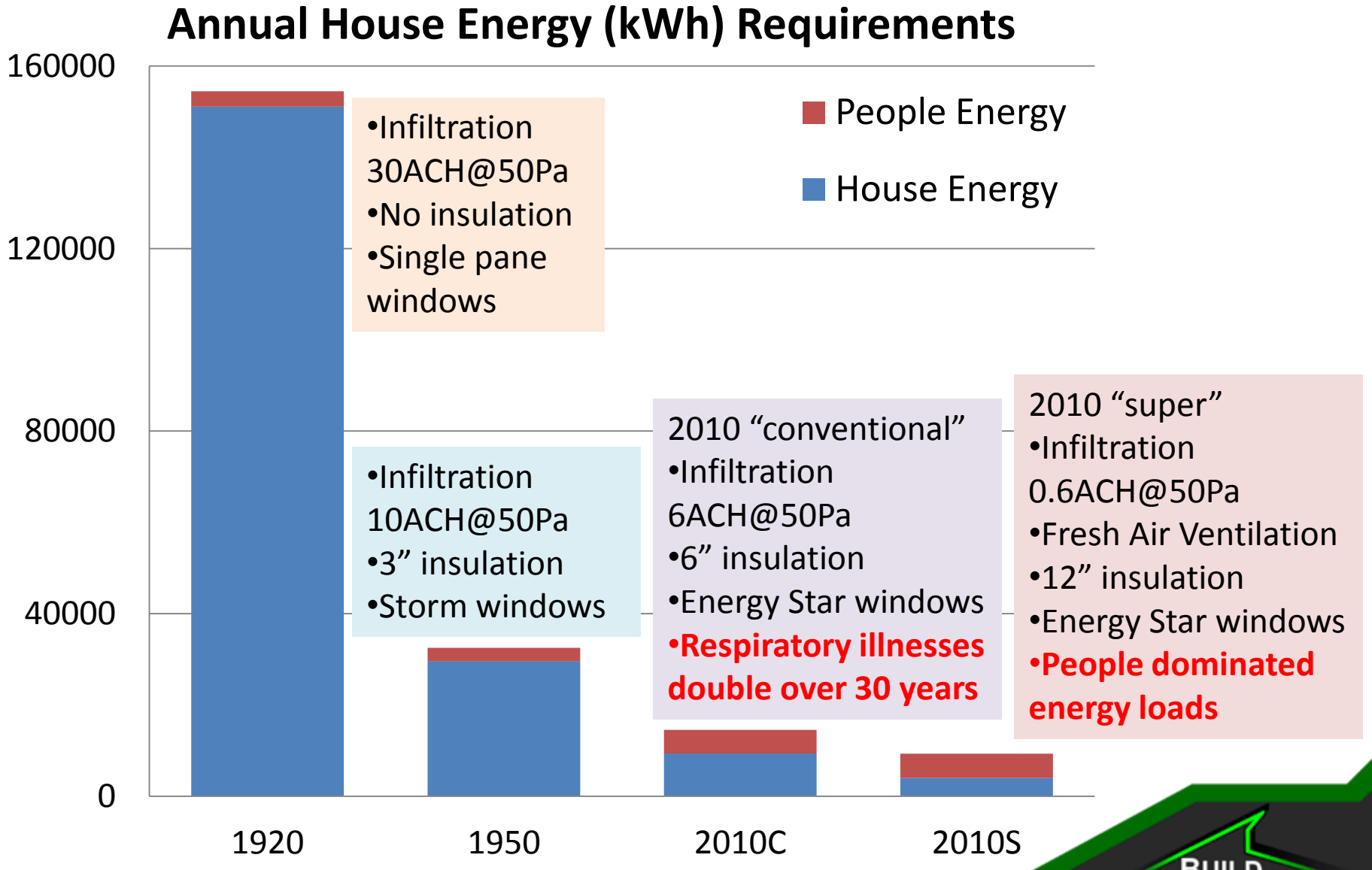
-Renewable Energy
-Energy Conservation
-Energy Efficiency
-Resource Conservation

Grad school 1970's


Univ of Illinois Solar Lab 1980's

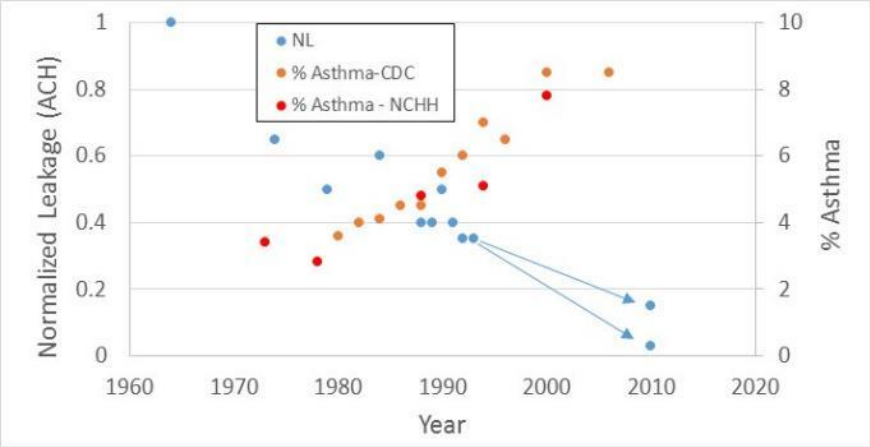

2007 Solar Decathlon

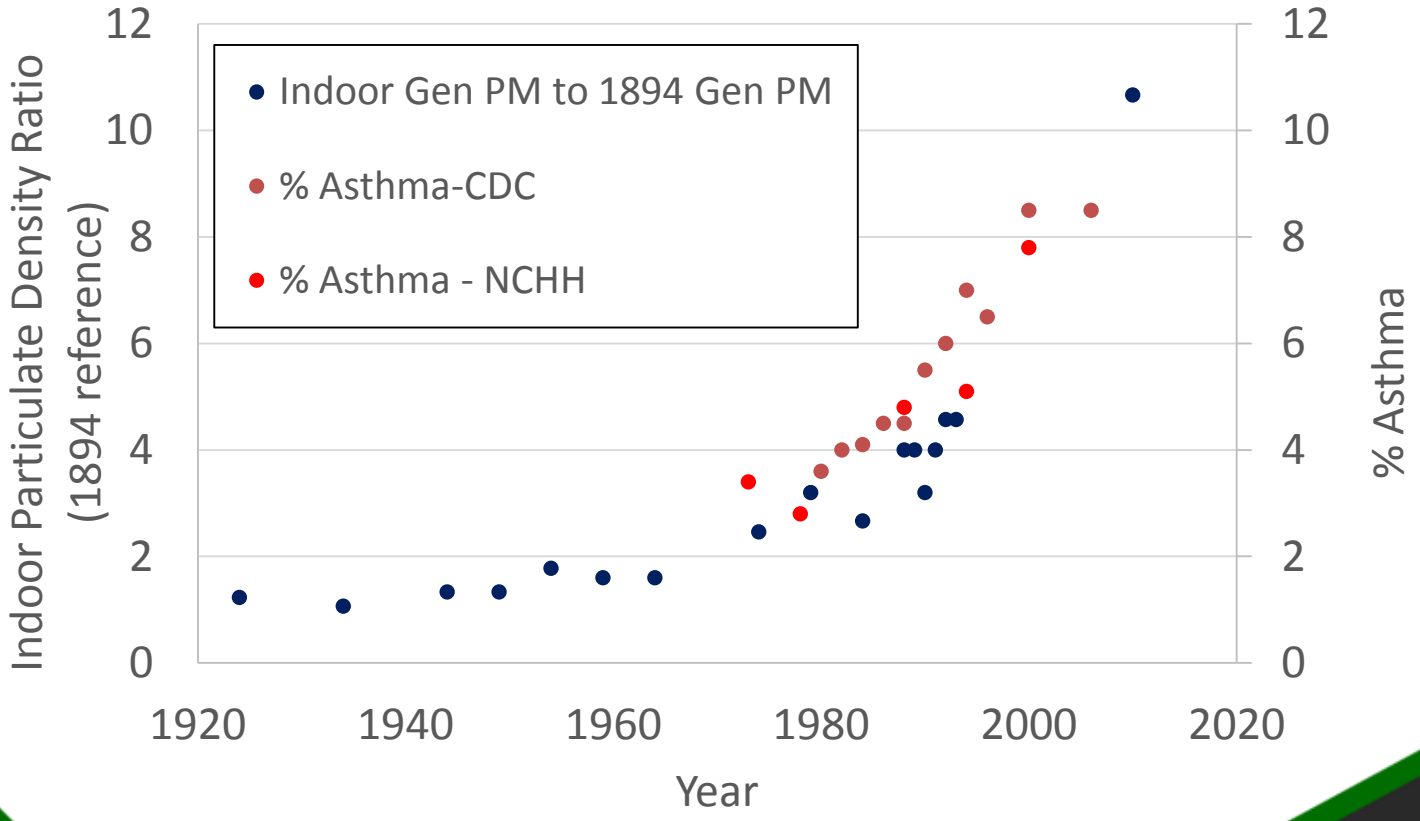
History of House Energy



Health Before Energy

US (100M homes; 325M people)
Efficient House energy = $160B/y
Influenza = $87B/y
Colds = $40B/y
Asthma = $60B/y
Cognition = $1.5T/y





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Designing a house is complicated!

…..energy, moisture, IAQ, economics, solar energy, finances, windows, insulation, heating, cooling, water heaters, appliances, lighting, water, wastes…..

Where do you begin and how do you find an end?

Which Way?

7 Steps

1. Conventional – no windows
2. Conventional – south windows
3. Case 1 - Sealed
4. Case 3 with Heat Pump (hybrid) Water Heater
5. Case 4 with Optimal Insulation
6. Case 5 with Solar PV for net zero home
7. Case 6 with enough Solar PV for 12,000miles EV transportation

Integrate Form & Function!

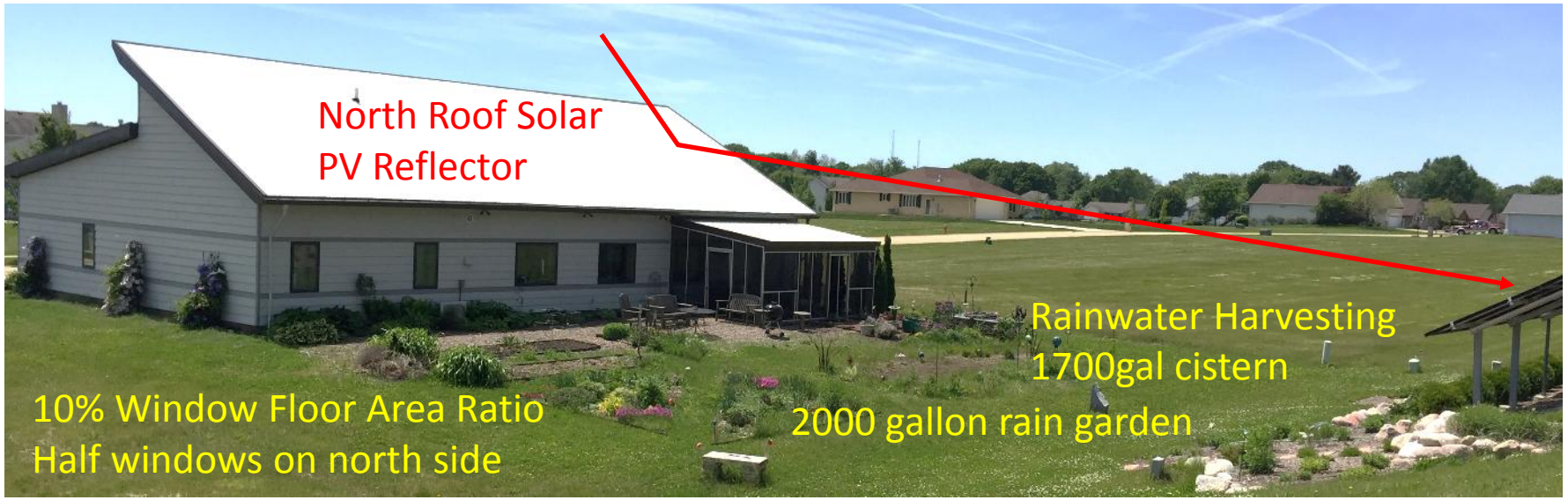
Equinox House

Chicken Coop or Porsche?

Equinox House – a modern Usonian, designed for function with wonderful form by Jean Ascoli, formerly of Taliesin Associated Architects

Best looking dumpster in the world!

If you're an FLLW fan, visit Florida Southern College



Equinox House

Equinox House

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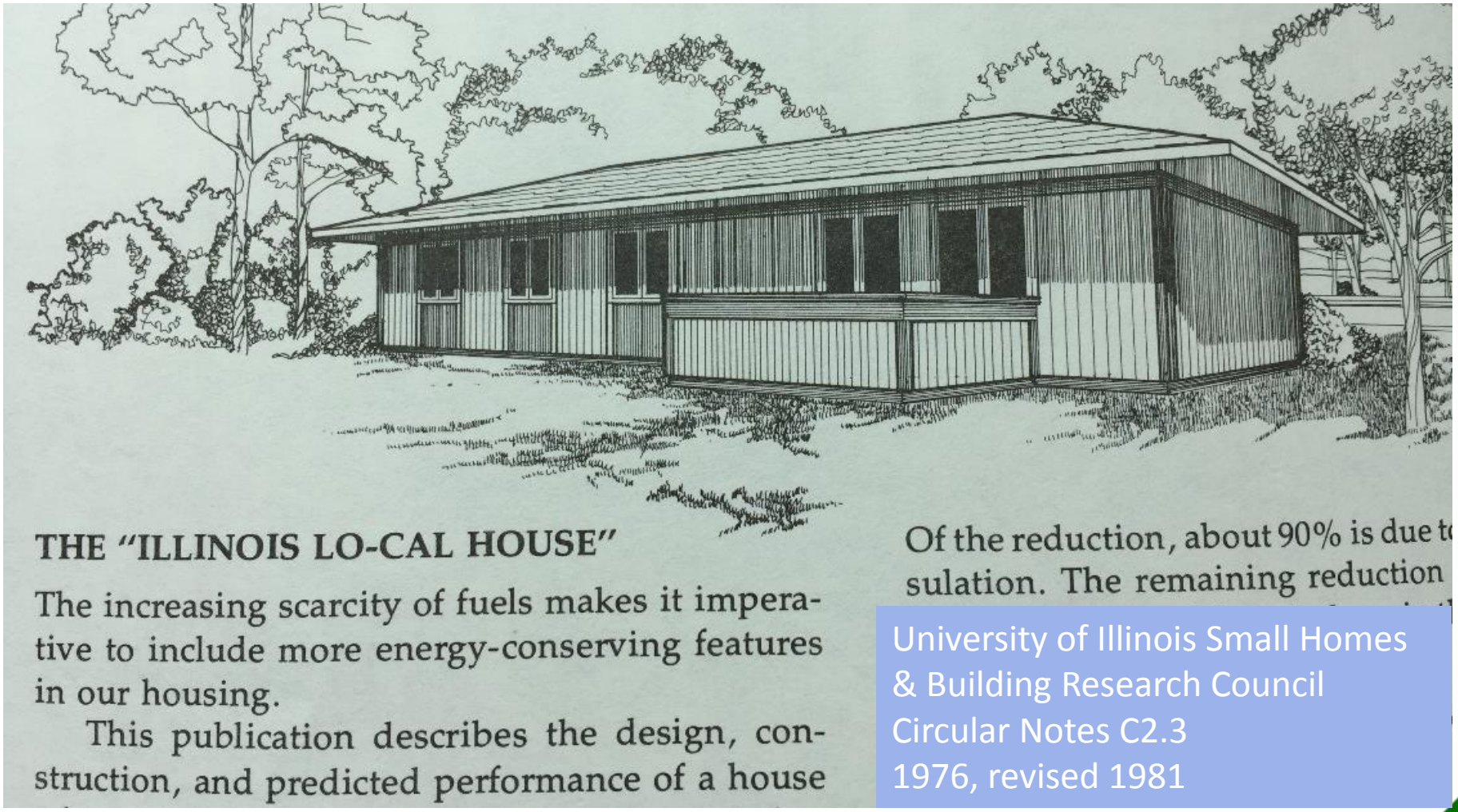
7 Steps Modeling



THE "ILLINOIS LO-CAL HOUSE"

The increasing scarcity of fuels makes it imperative to include more energy-conserving features in our housing.

This publication describes the design, construction, and predicted performance of a house

Of the reduction, about 90% is due t
sulation. The remaining reduction

University of Illinois Small Homes & Building Research Council
Circular Notes C2.3
1976, revised 1981

2000 square foot home; 50’ x 40’

1970's Super Insulated House
University of Illinois Lo-Cal House

Lo-Cal concept 1976; University of Illinois Small Homes Council
This home designed by Professor Michael McCulley ~1979

Home without Windows

Explore the Limits

Economical?
Marketable?
Aesthetics are important!

Looks Not Important

Get the Style you want-

Equinox House “looks” different than neighboring homes, but in fact, it is simply a 2100square foot ranch with a floor plan taken from a neighborhood home

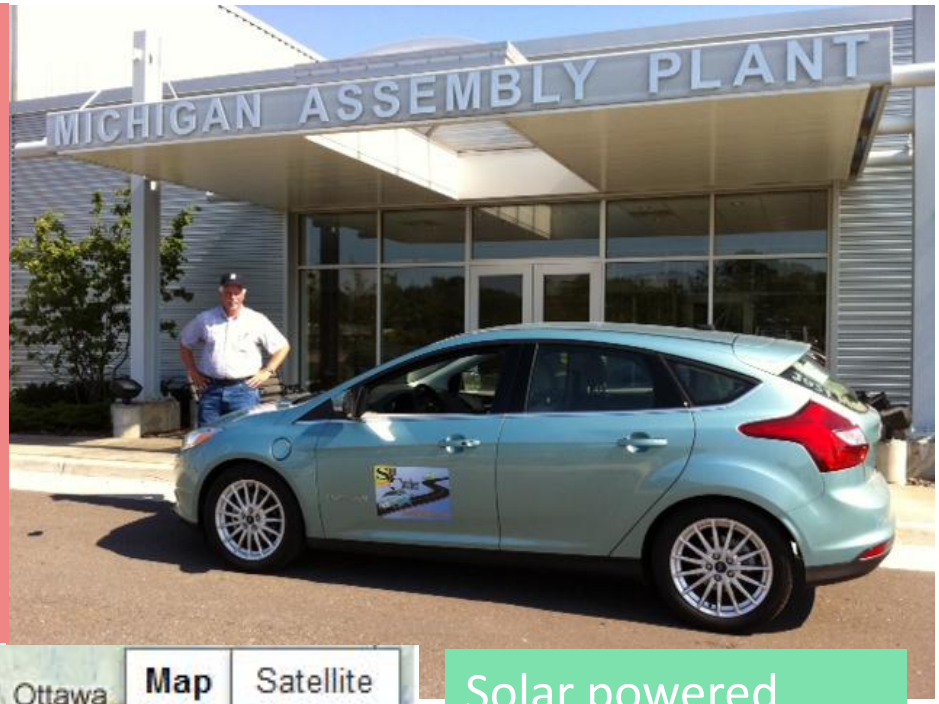
Electric Vehicles

Fisker Karma and Smart EV charging
Amsterdam NL

"Misery of Oil" statue
Rotterdam NL

2012 NY to Detroit to Urbana IL

- Retraced in reverse historic 1901 Oldsmobile journey from Detroit to NY
- Henry Ford's wife, Clara, used to drive an electric car
- Solar transportation 2-3cents per mile versus "cheap" gas or diesel at 10-12cents per mile

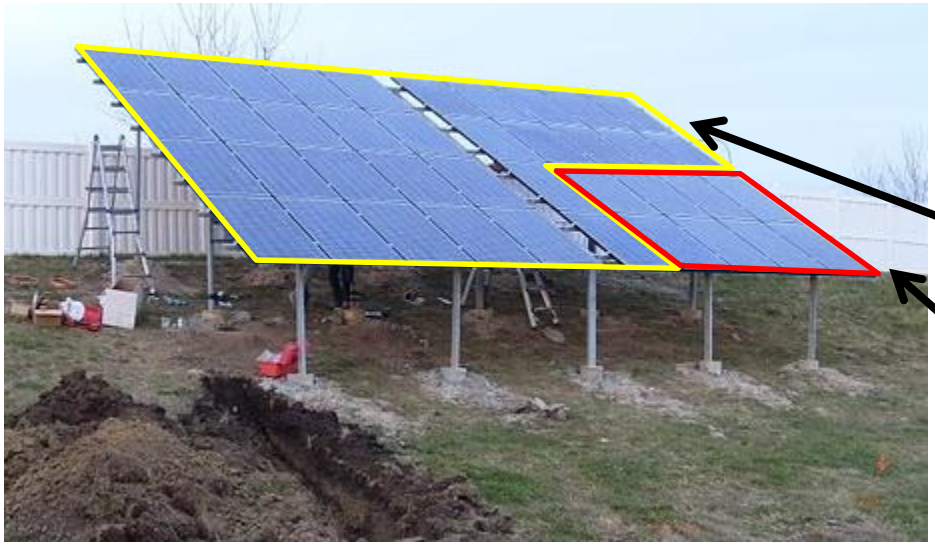


Solar powered Ford plant where our EV was born

Equinox House Solar System

8.2kW nominal system size
~4 days to install rack and panels
~600 to 750 sqft
~10,000kWh per year
8000kWh for house
2000kWh for electric car
Installed cost $4.50/Watt in 2010
Now < $3/Watt

Equinox House



House panel area

Car panel area (8000 miles per year)

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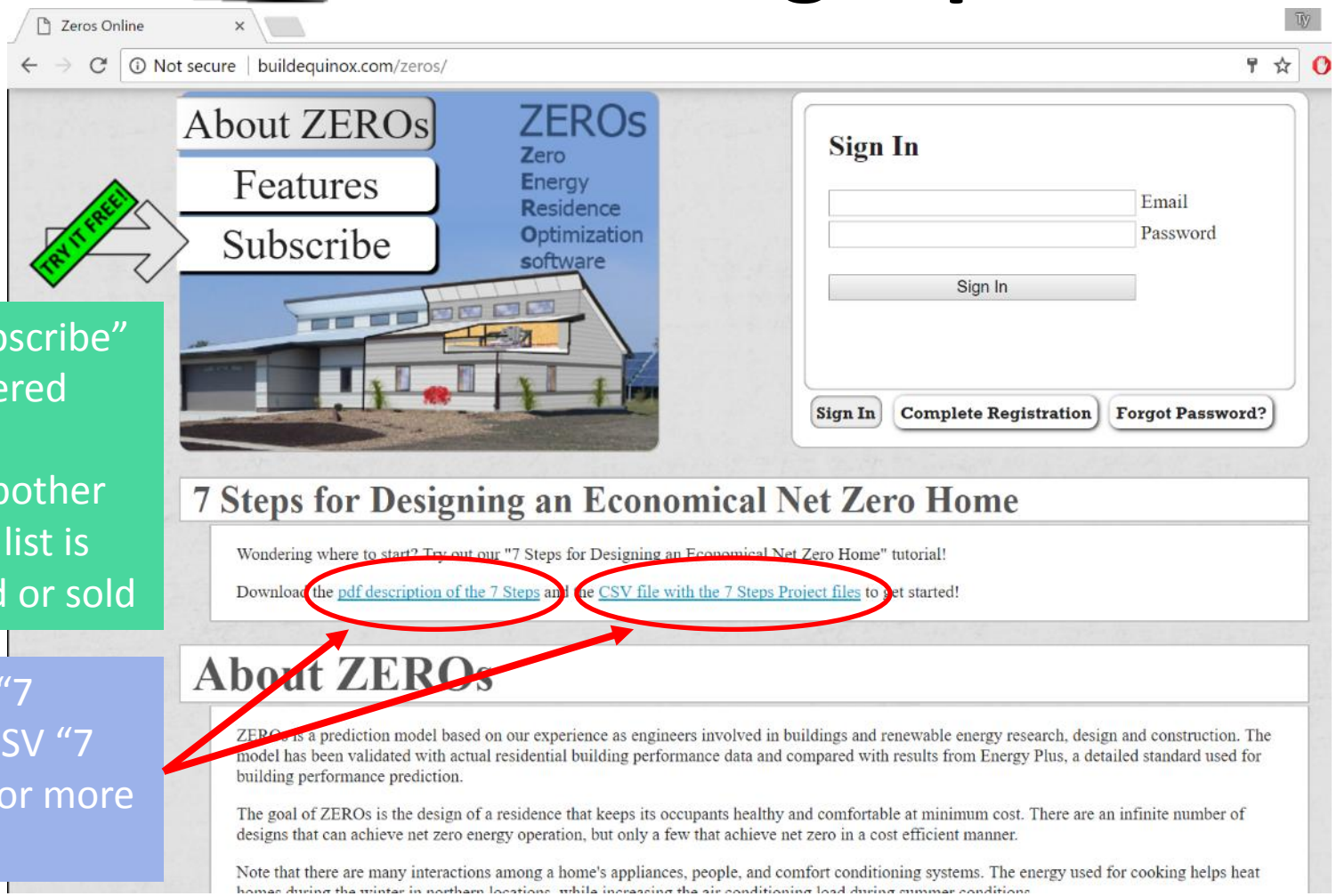
ZEROs Signup Free



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We will not bother you and this list is never shared or sold

Click on pdf “7 Steps” and CSV “7 Steps” files for more info

- Go to: BuildEquinox.com/zeros

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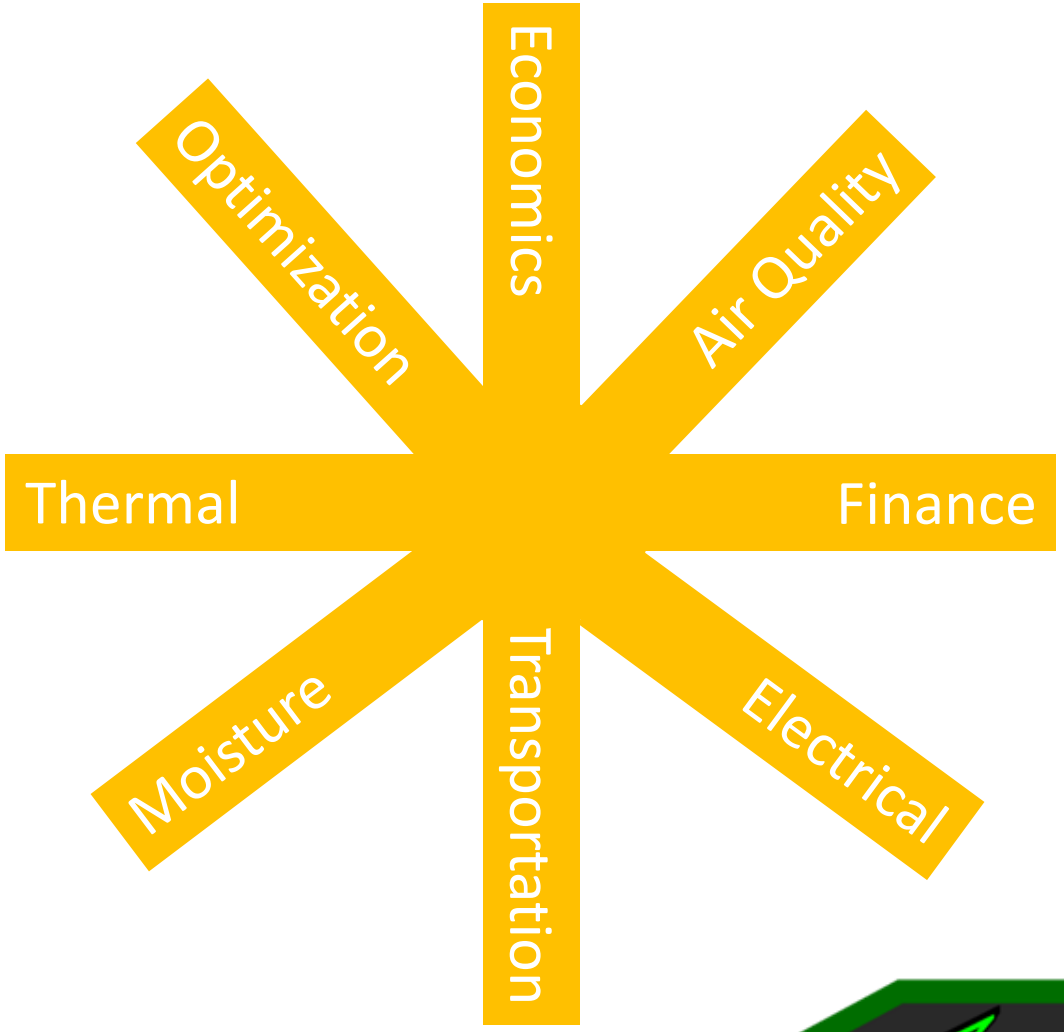
ZEROs Purpose

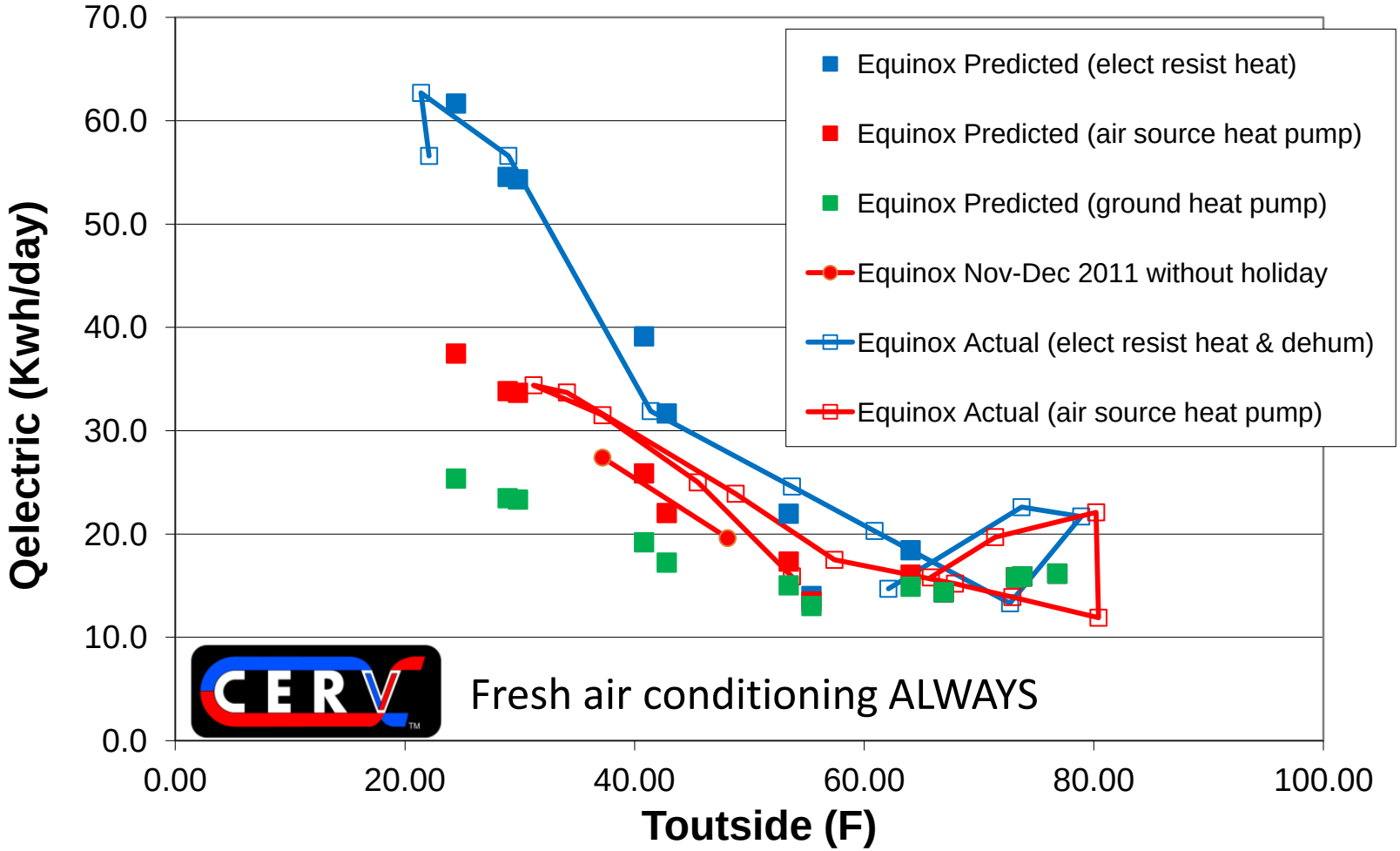
Sustainable living requires sustainable economics and finances as well as energy and resources



Validation

- NREL's (National Renwable Energy Laboratory, Golden CO) "BESTEST", **B**uilding **E**nergy **S**imulation **Test**; intermodal comparison to DOE 2.1, BLAST 3.0, and SERI Suncode 5.7 (Note: DOE 2.1 and BLAST 3.0 are now combined into E Plus)
- Model home with 10 variations in insulation, windows, orientation, internal energy, location, etc)
- Details in L. Martinez, "Simplified Floor-Area-Based Energy-Moisture-Economic Model for Residential Buildings", PhD Dissertation, 2009, Mechanical Science and Engineering, University of Illinois

Equinox Reality vs ZEROs Modeling



Dec 2010 – Sept 2011: 3kW Elect Resist & Dehum

Oct 2011 – Sept 2012: 1 ton mini-split

ZEROS & High Performance Homes

VERMOD CERV Report

13 Vermod Homes

CERV

ZEROs predictions for 1 and 3 occupants

- Conventional homes use ~20,000 to 30,000kWh
- 13 Vermod homes with CERV smart ventilation use ~4000 to 10,000kWh per year (~$500-$1200 per year)
- Vermod homes use 20% less energy than required for PHIUS and PHI certifications

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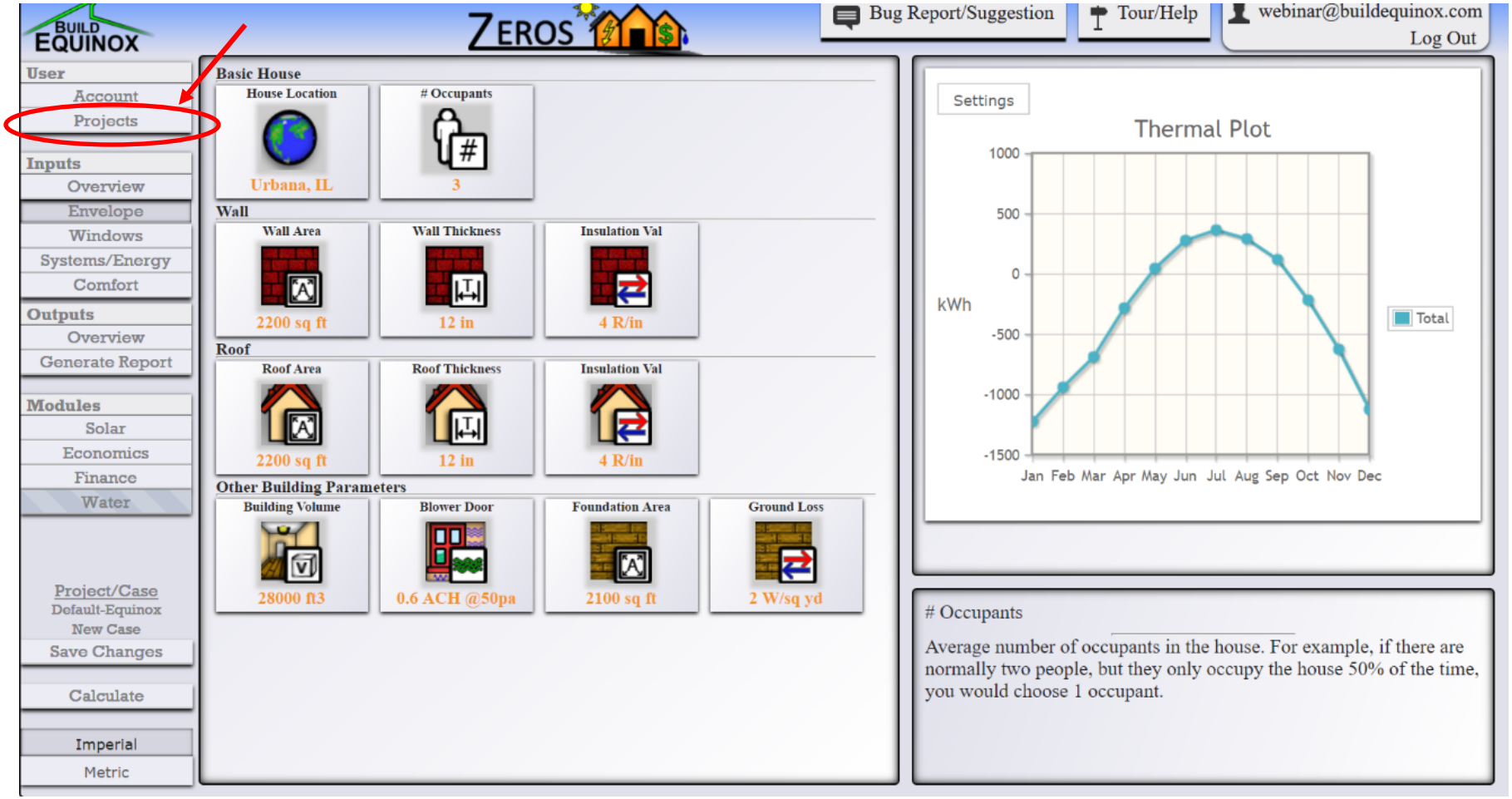
ZEROs – Envelope & Occupancy



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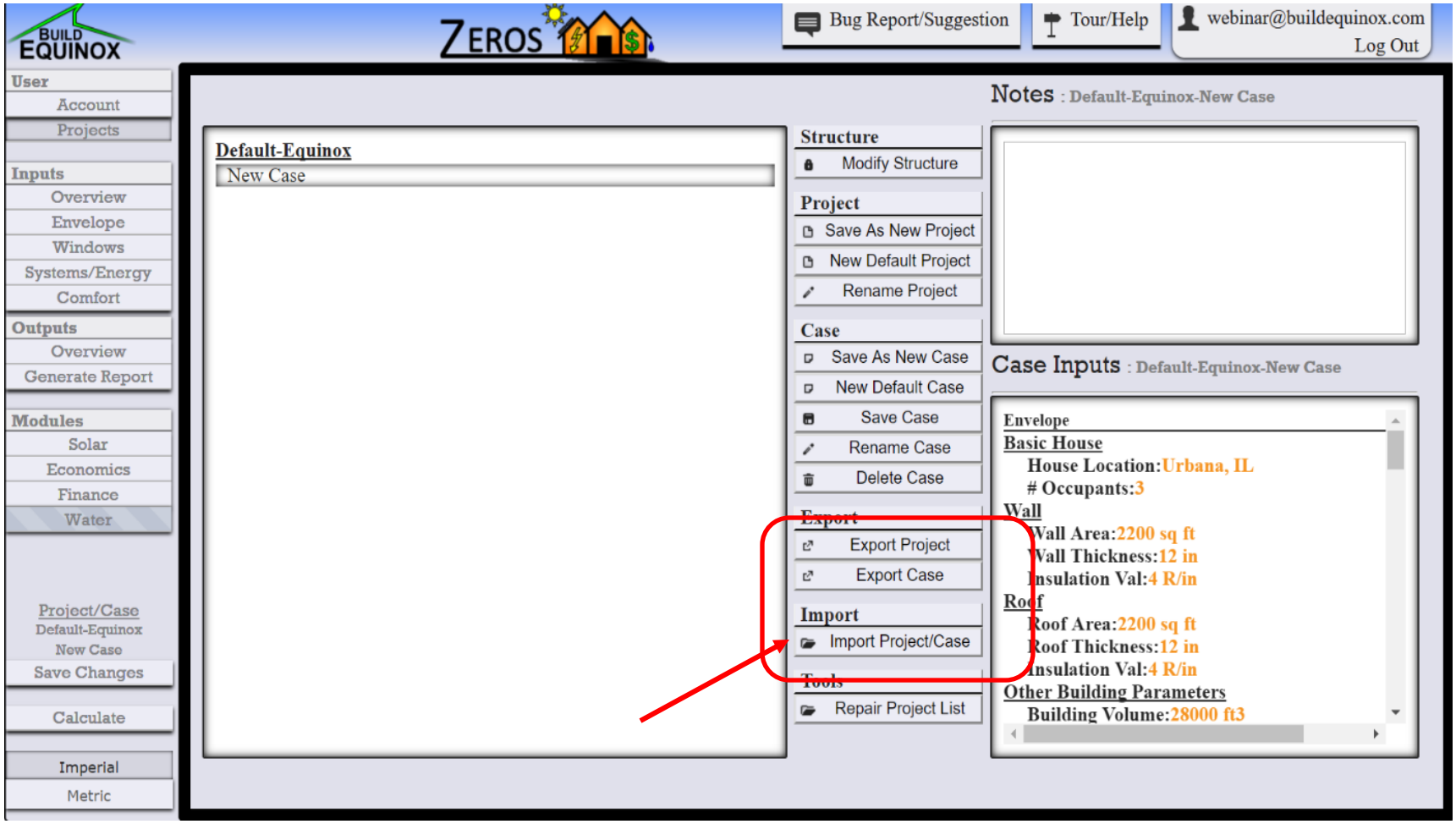
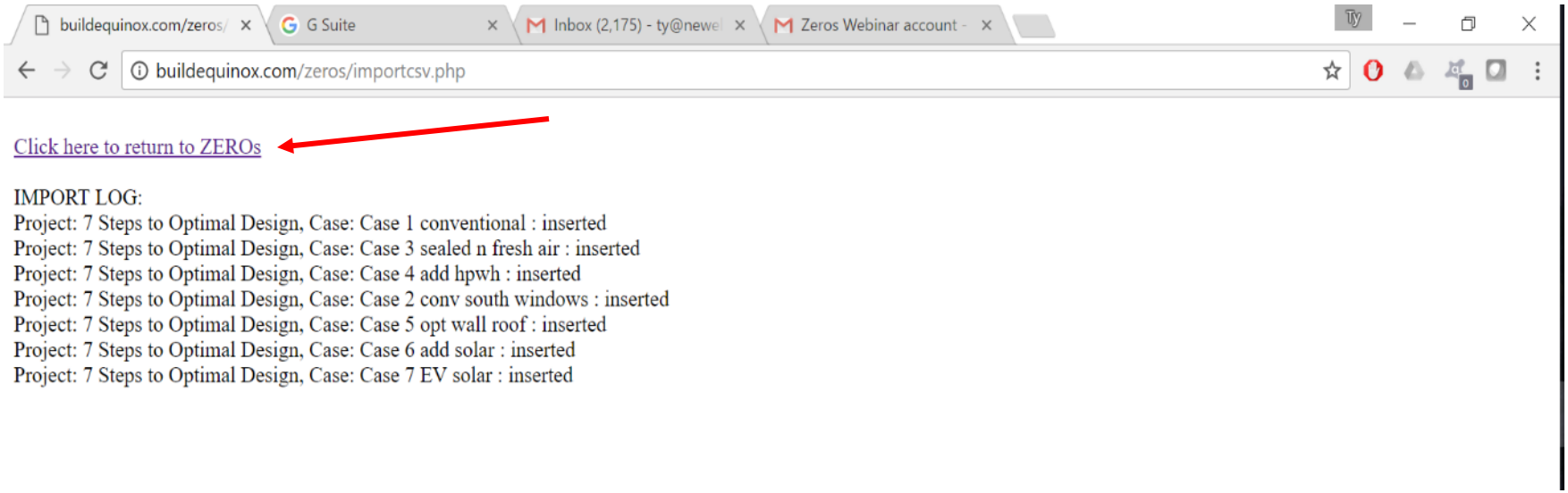
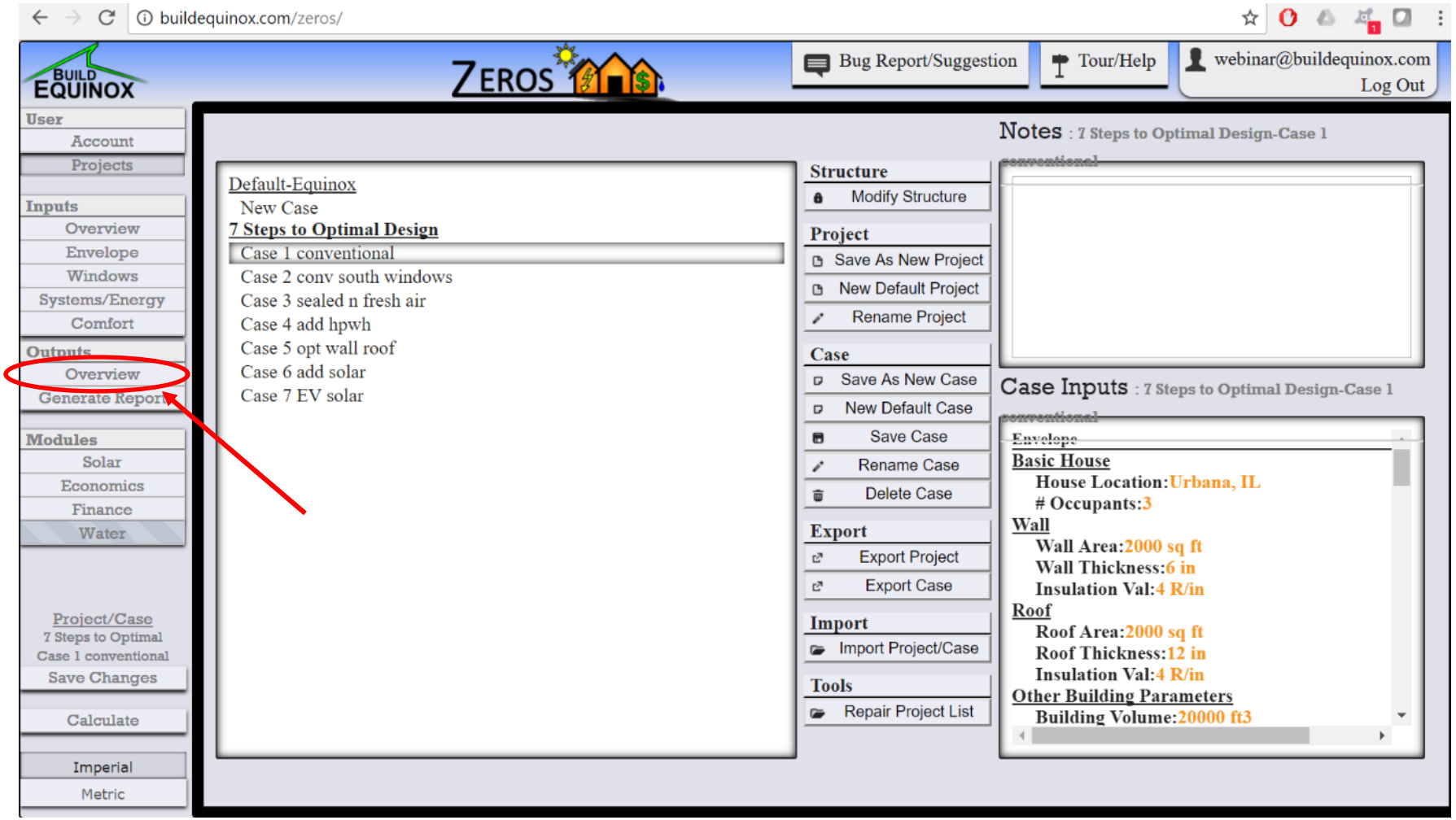
Project & Case Management

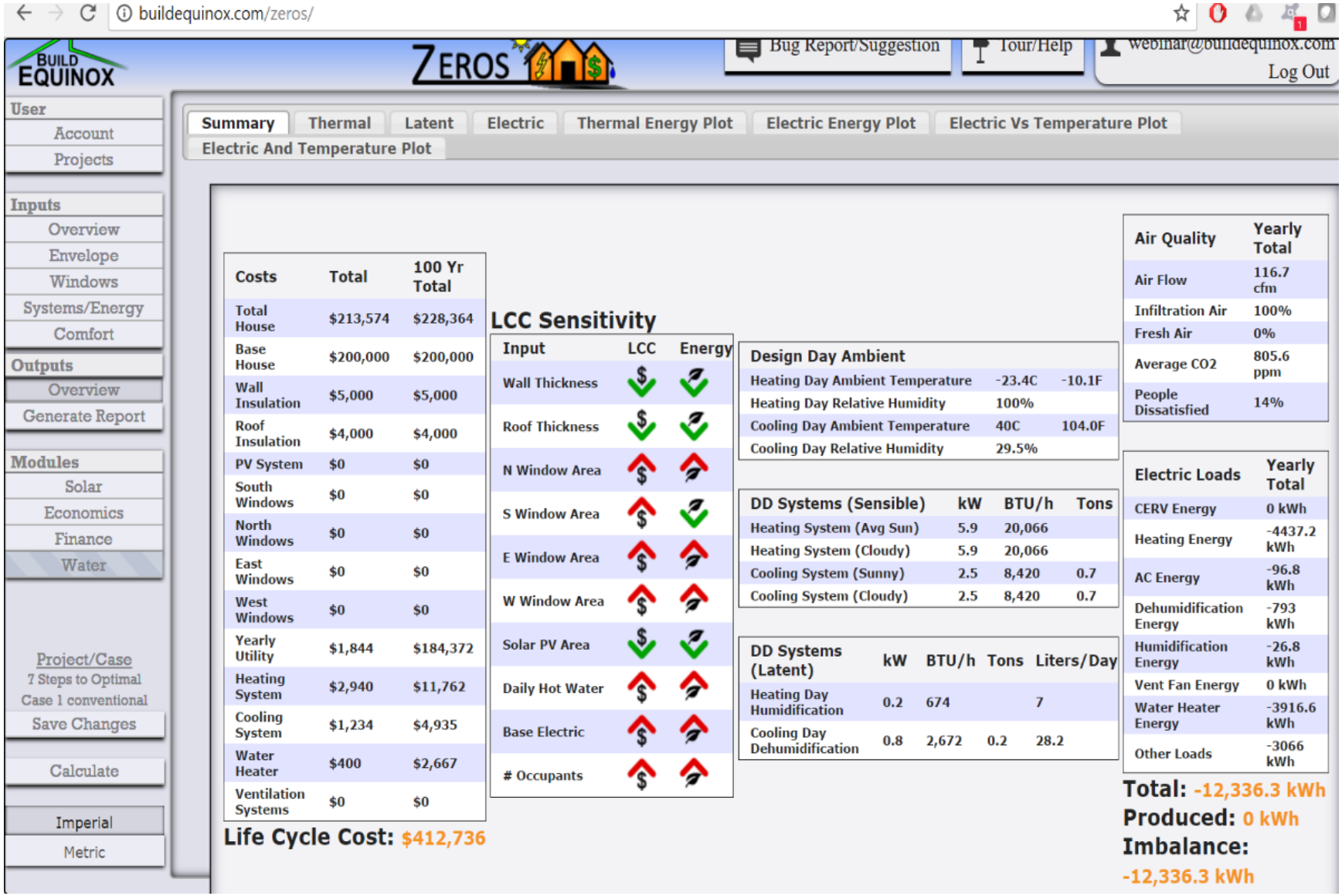


ZEROs Importing CSV Files



ZEROs – Cases 1-7 Loaded





Case 1 - Output Overview

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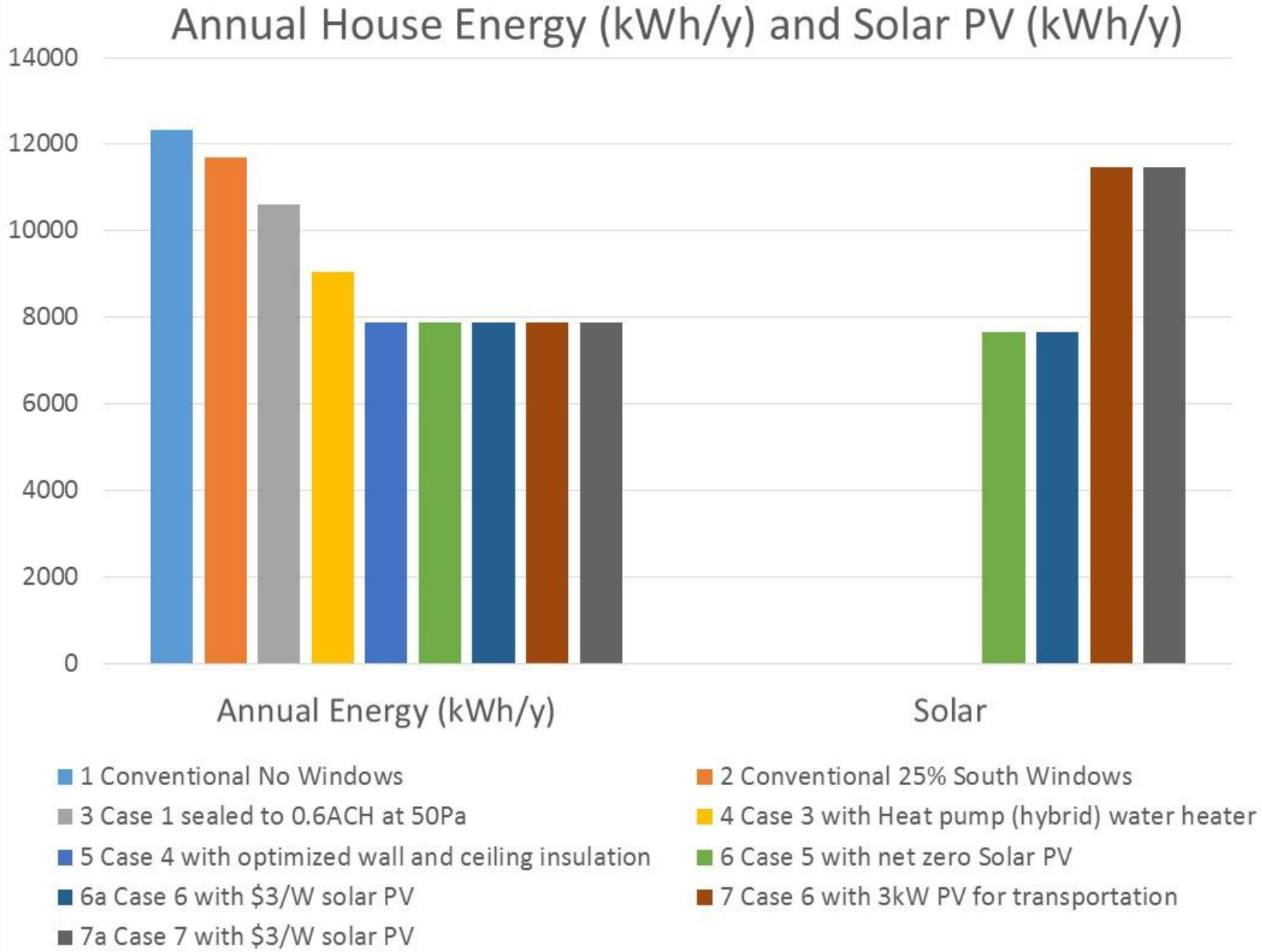
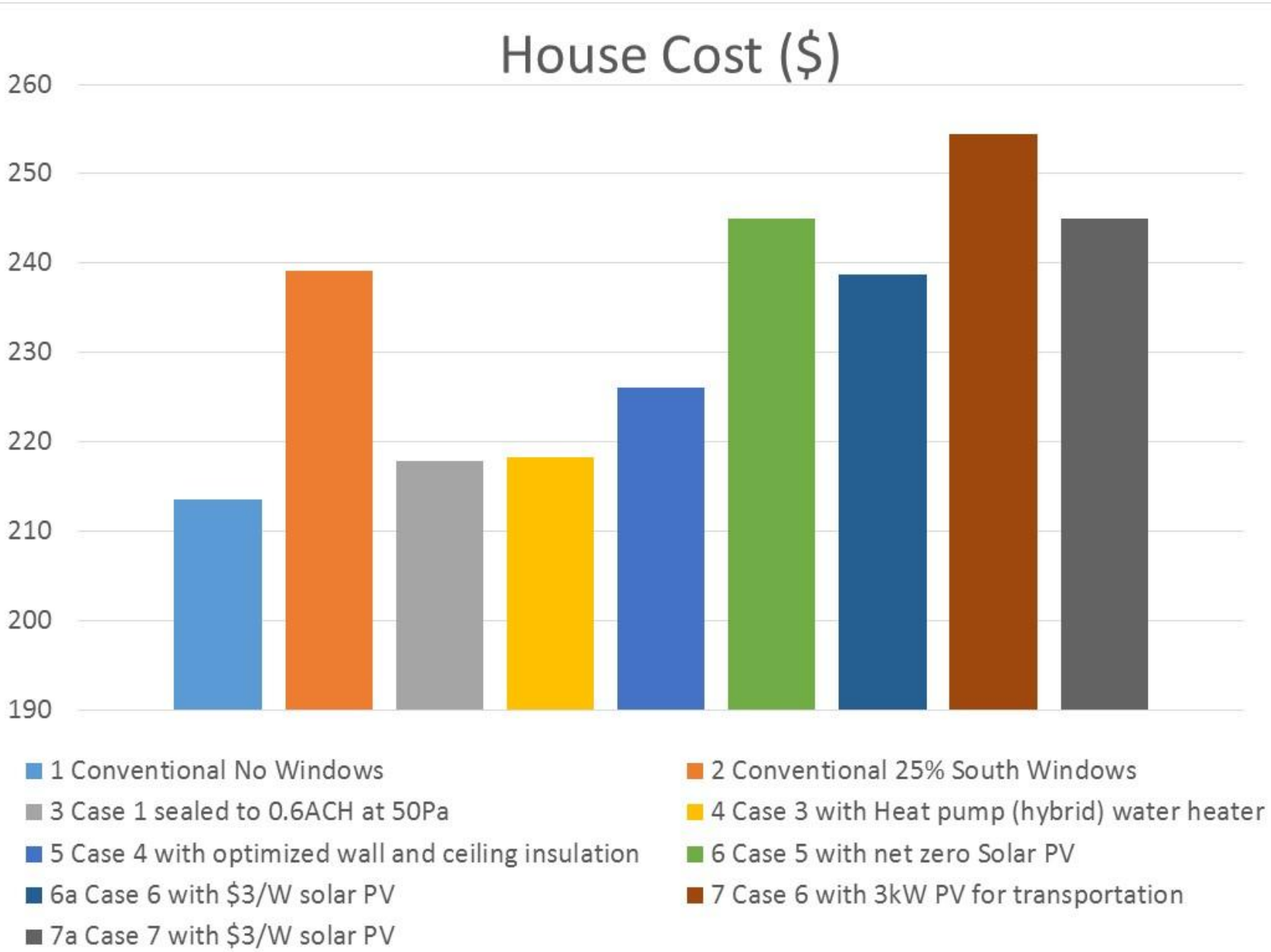
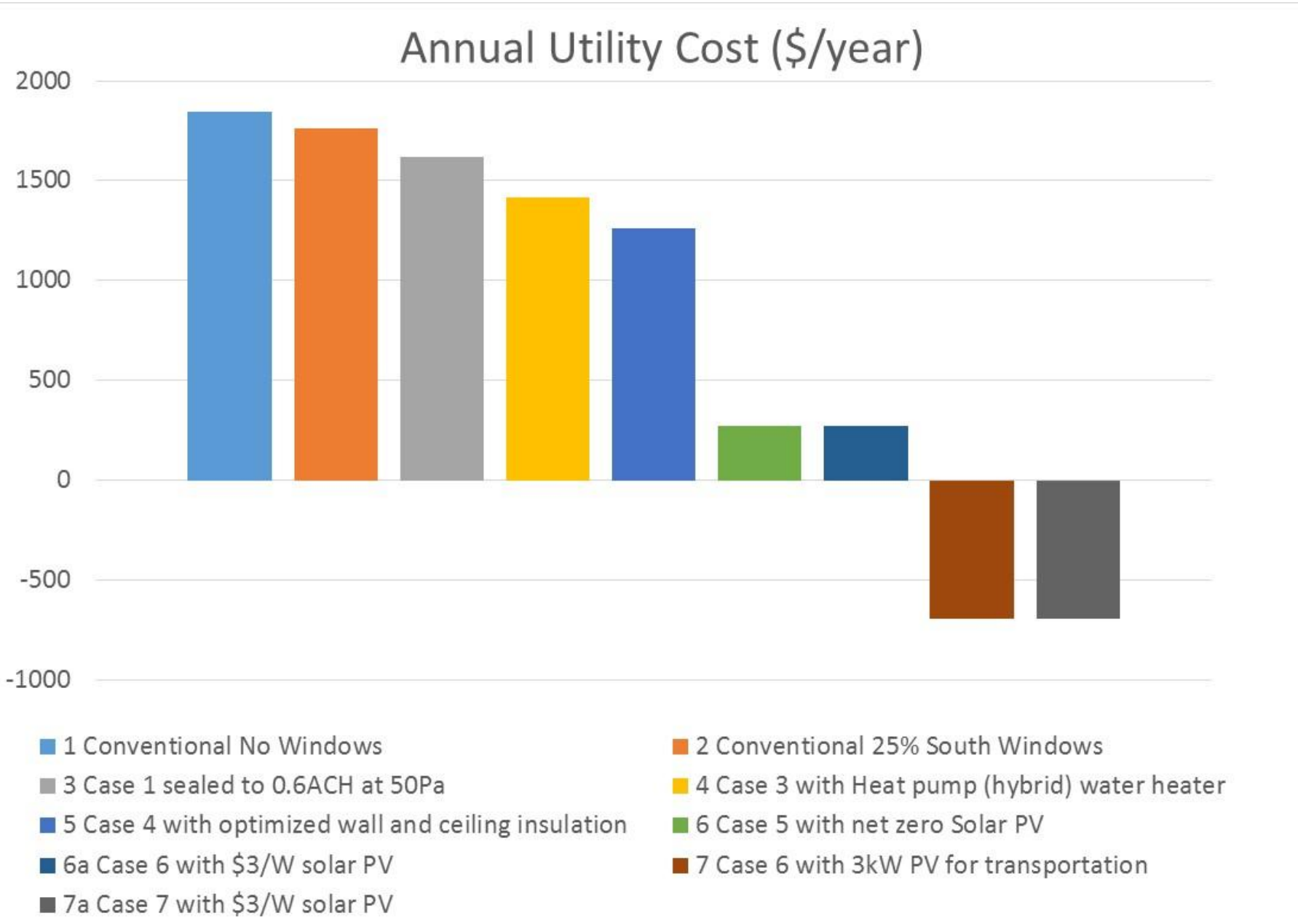



House Cost ($)
260
250
240
230
220
210
200
190
1 Conventional No Windows
2 Conventional 25% South Windows
3 Case 1 sealed to 0.6ACH at 50Pa
4 Case 3 with Heat pump (hybrid) water heater
5 Case 4 with optimized wall and ceiling insulation
6 Case 5 with net zero Solar PV
6a Case 6 with $3/W solar PV
7 Case 6 with 3kW PV for transportation
7a Case 7 with $3/W solar PV


Annual Utility Cost ($/year)
2000
1500
1000
500
0
-500
-1000
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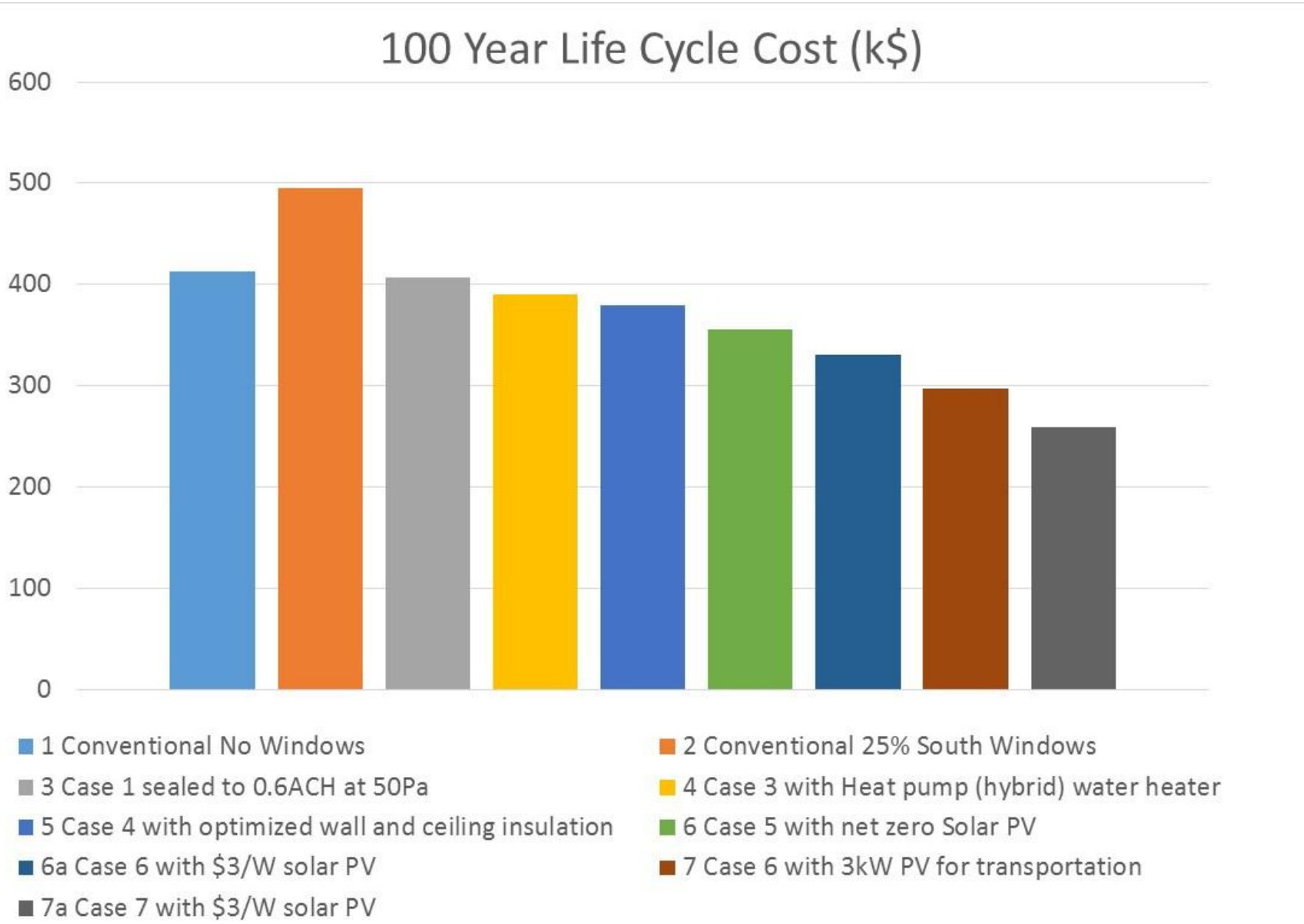
100 Year Life Cycle Cost (k$)
600
500
400
300
200
100
0
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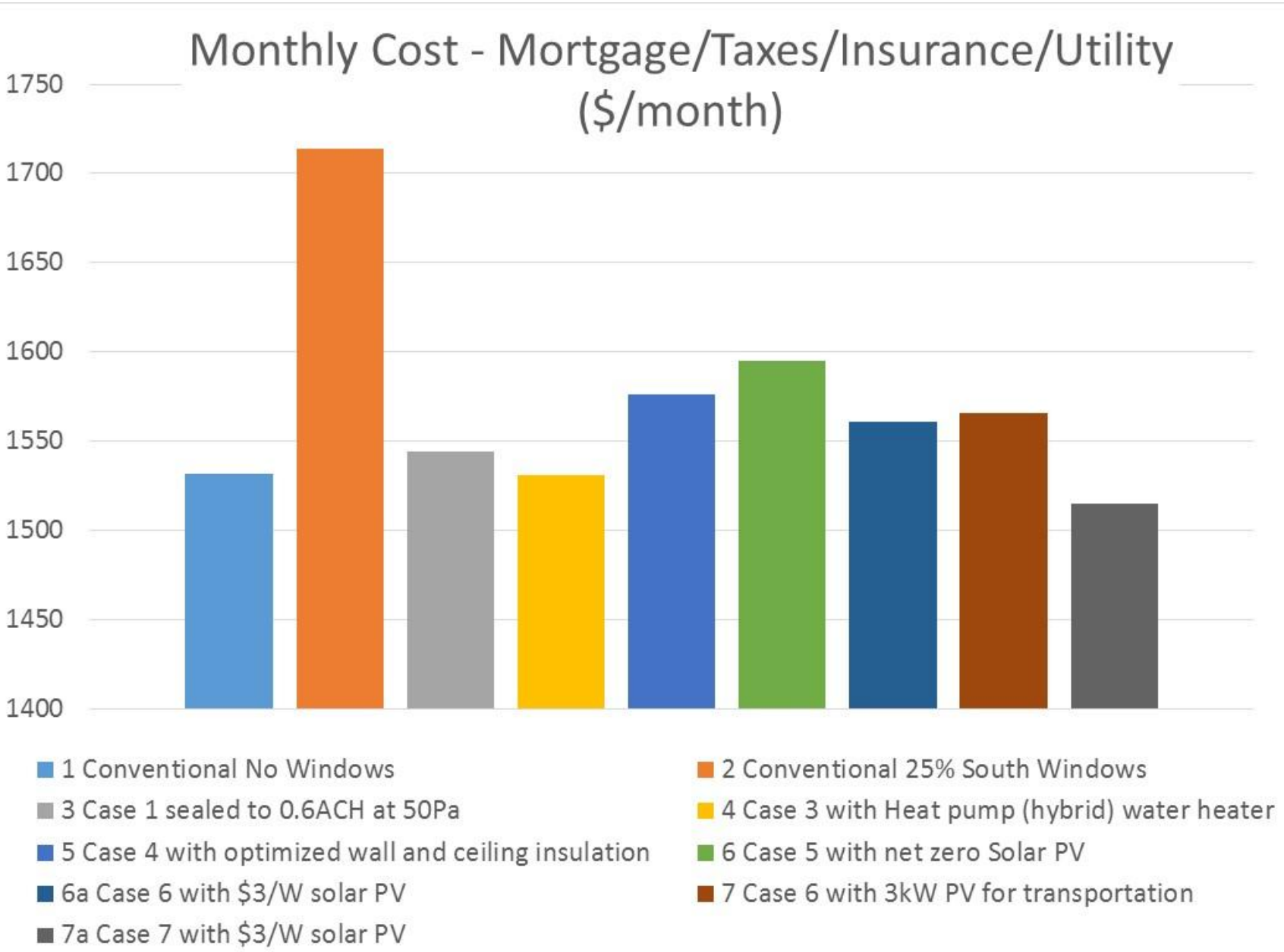
Monthly Cost - Mortgage/Taxes/Insurance/Utility ($/month)
1750
1700
1650
1600
1550
1500
1450
1400
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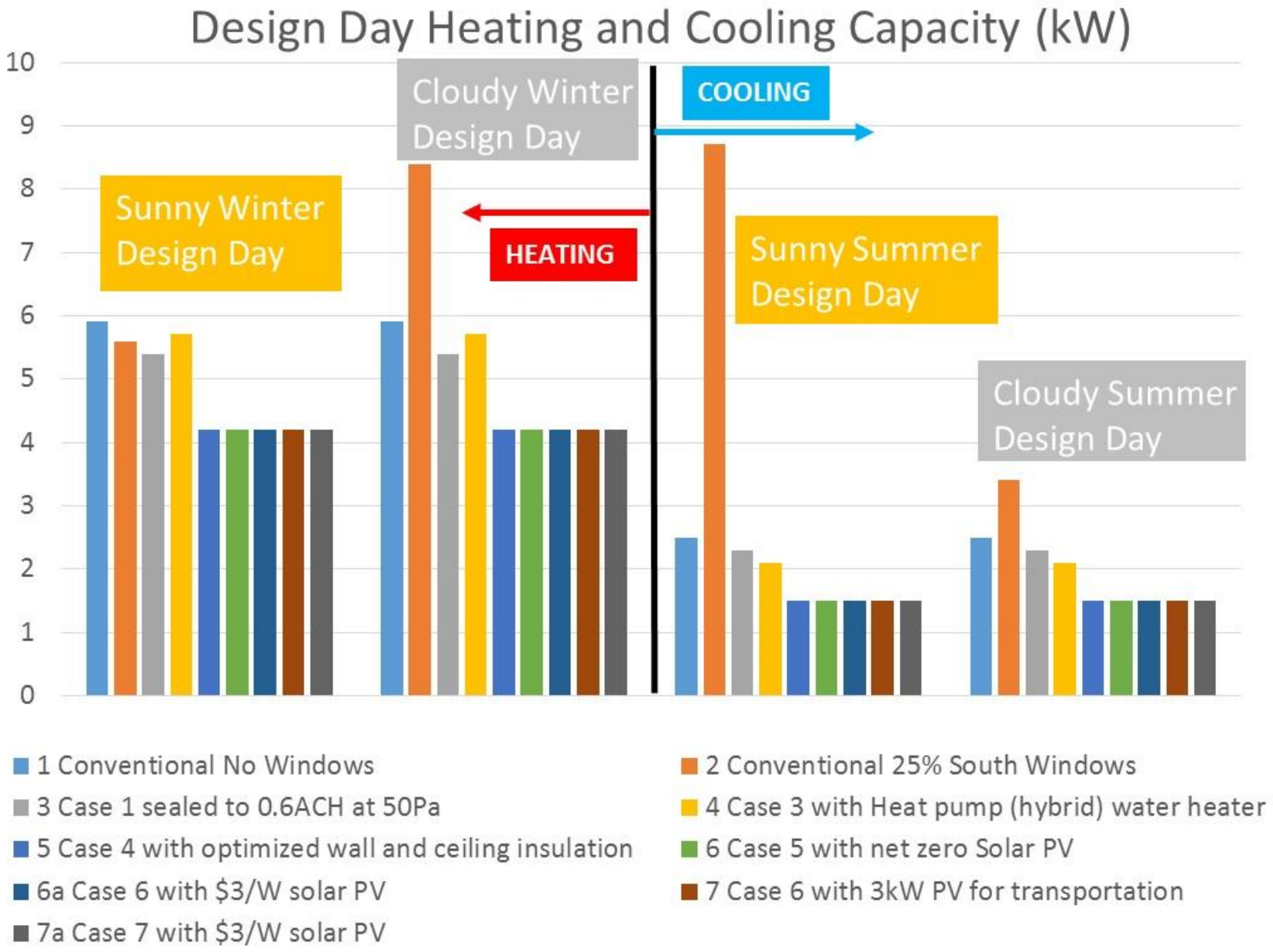
Design Day Heating and Cooling Capacity (kW)
10
9
8
7
6
5
4
3
2
1
0
Cloudy Winter Design Day
COOLING
Sunny Winter Design Day
HEATING
Sunny Summer Design Day
Cloudy Summer Design Day
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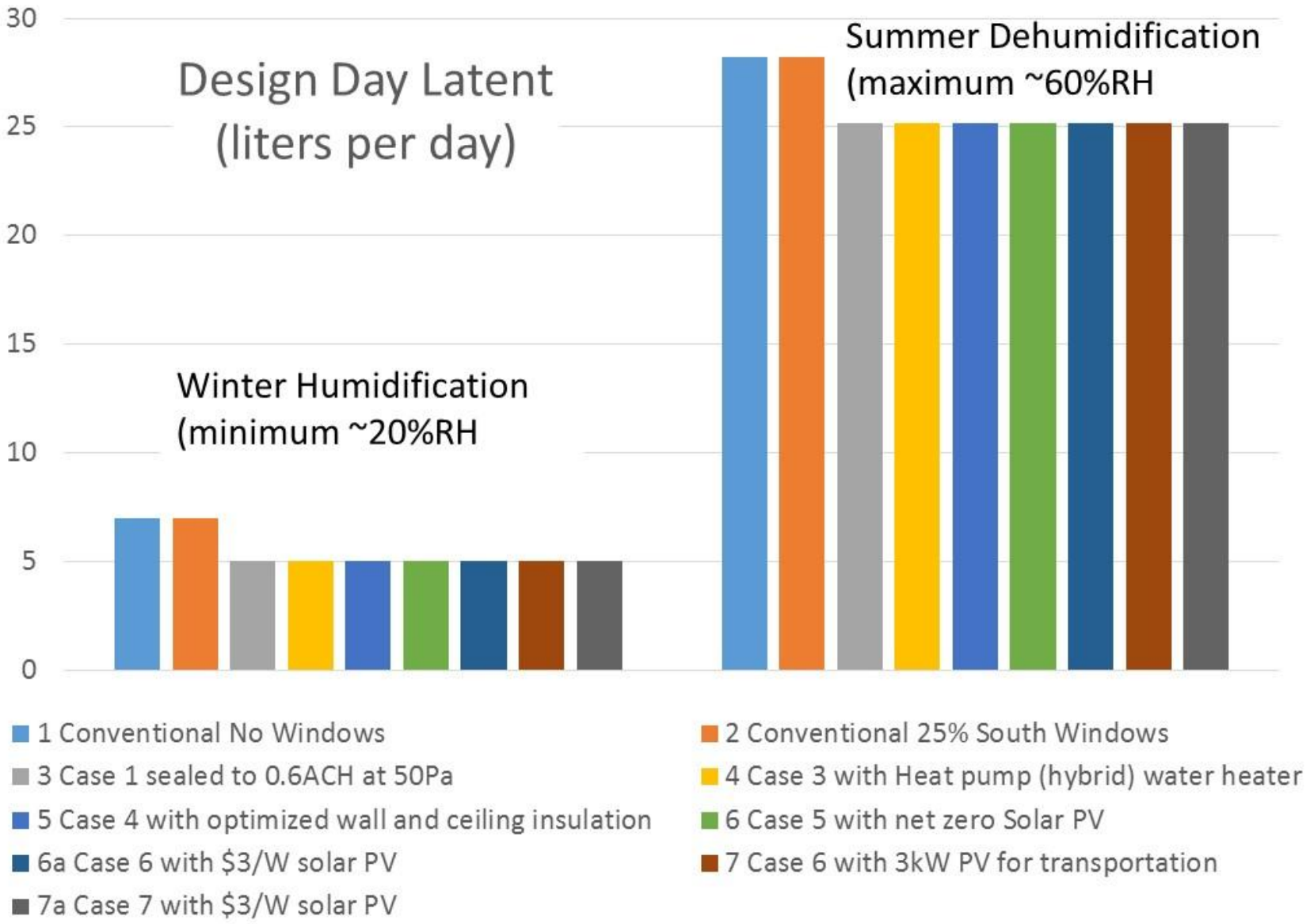
Design Day Latent
(liters per day)
Summer Dehumidification
(maximum ~60%RH
Winter Humidification
(minimum ~20%RH
30
25
20
15
10
5
0
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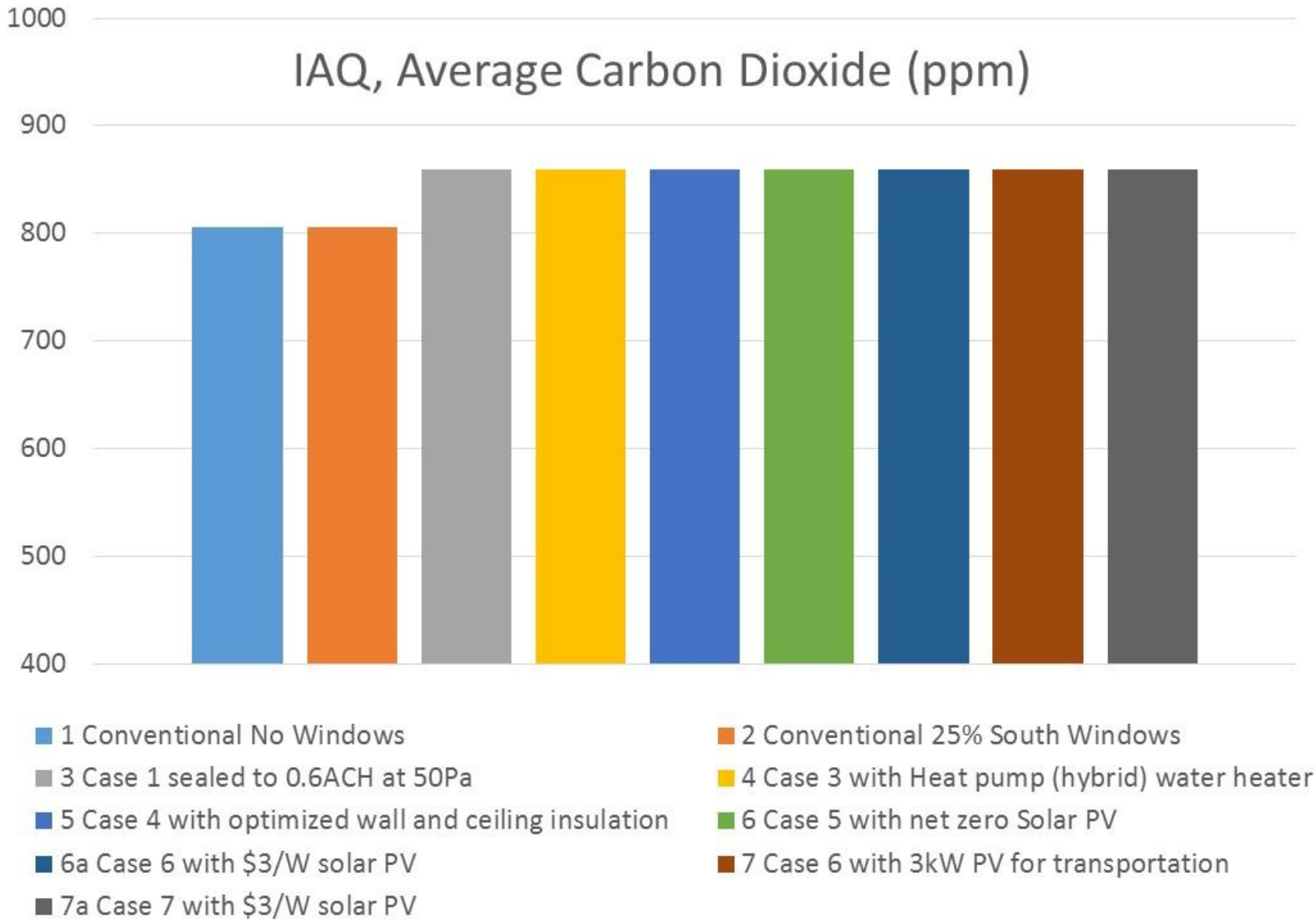
IAQ, Average Carbon Dioxide (ppm)
1000
900
800
700
600
500
400
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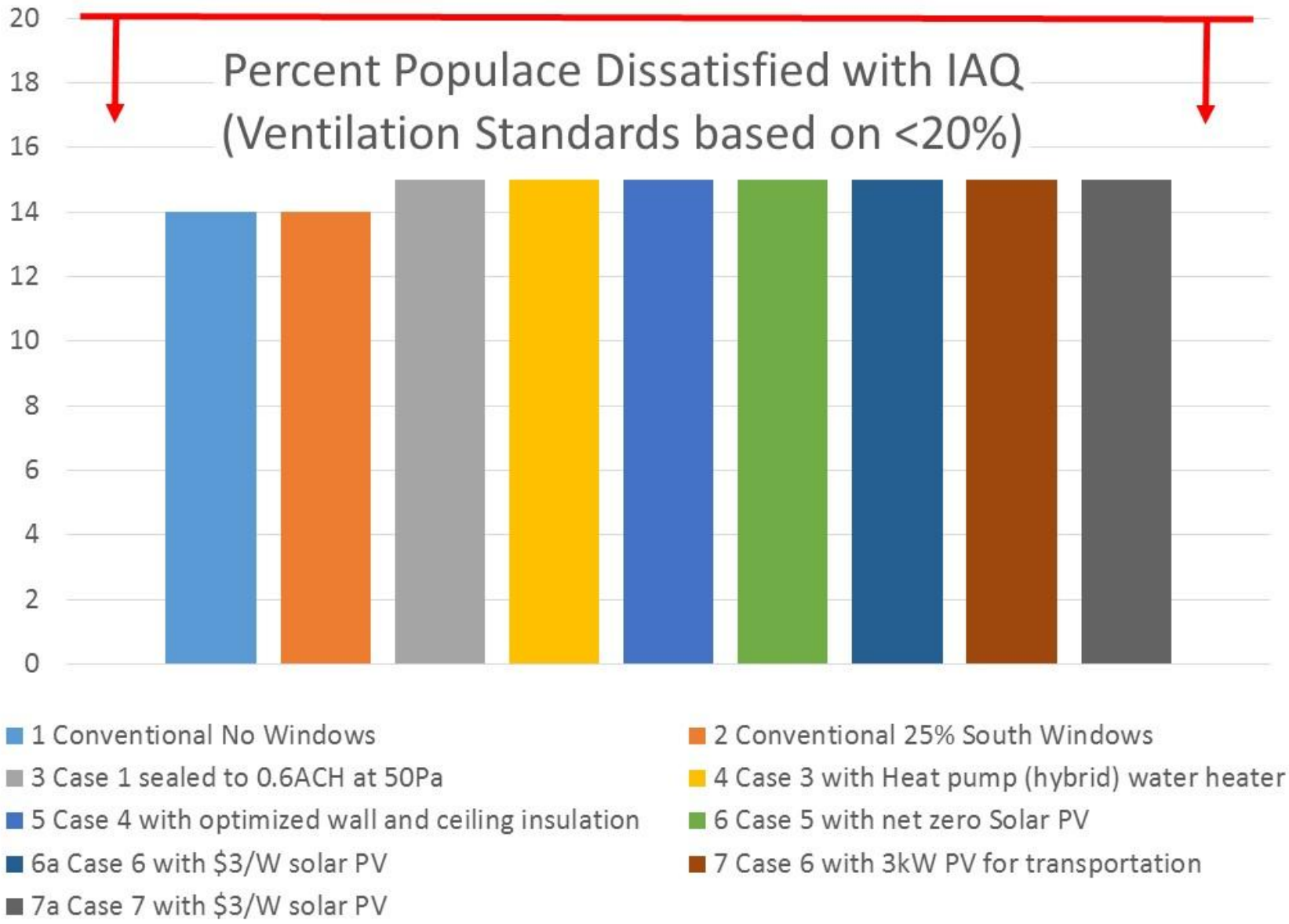
Percent Populace Dissatisfied with IAQ
(Ventilation Standards based on <20%)
20
18
16
14
12
10
8
6
4
2
0
1 Conventional No Windows
2 Conventional 25% South Windows
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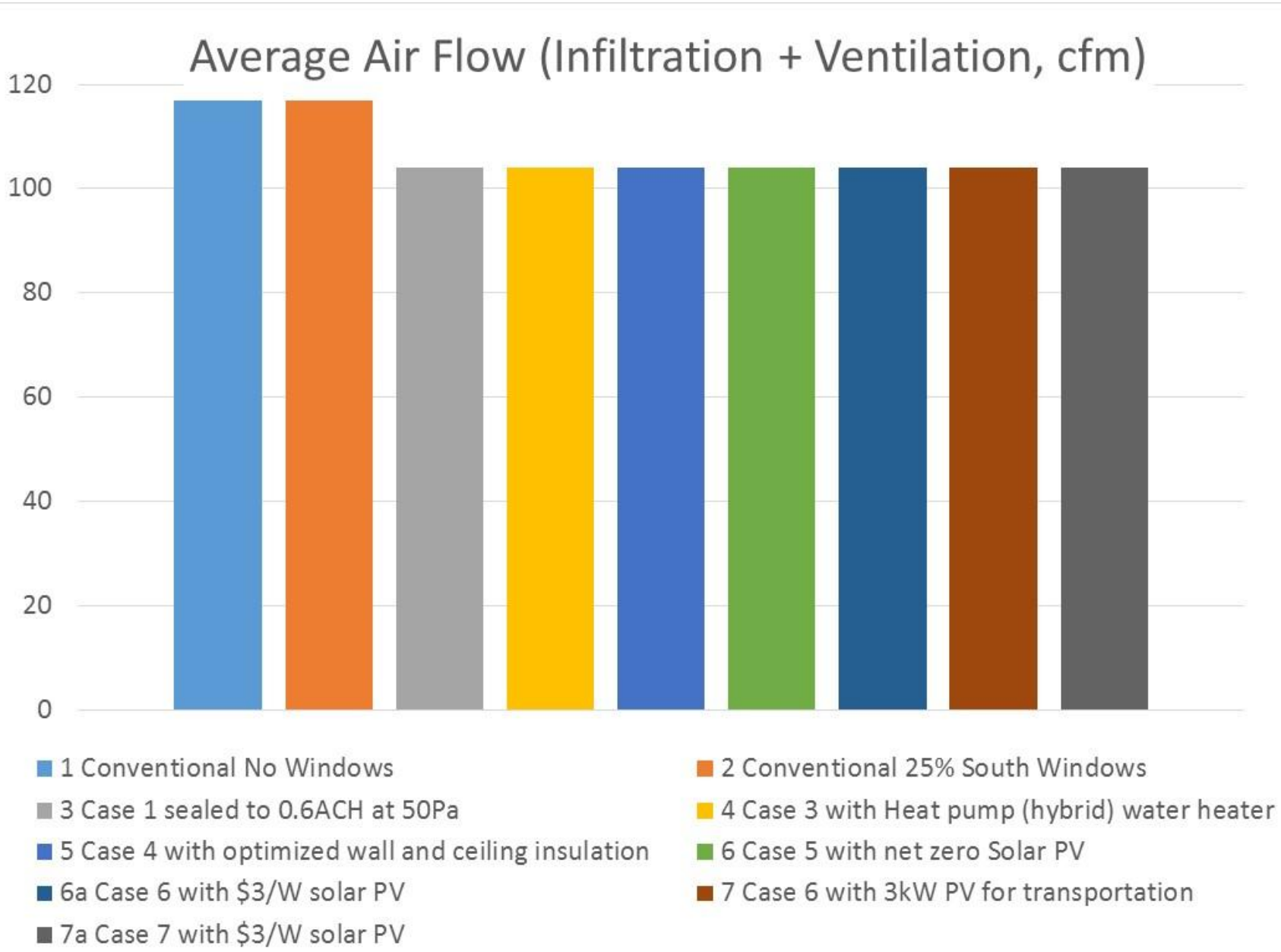
Average Air Flow (Infiltration + Ventilation, cfm)
120
100
80
60
40
20
0
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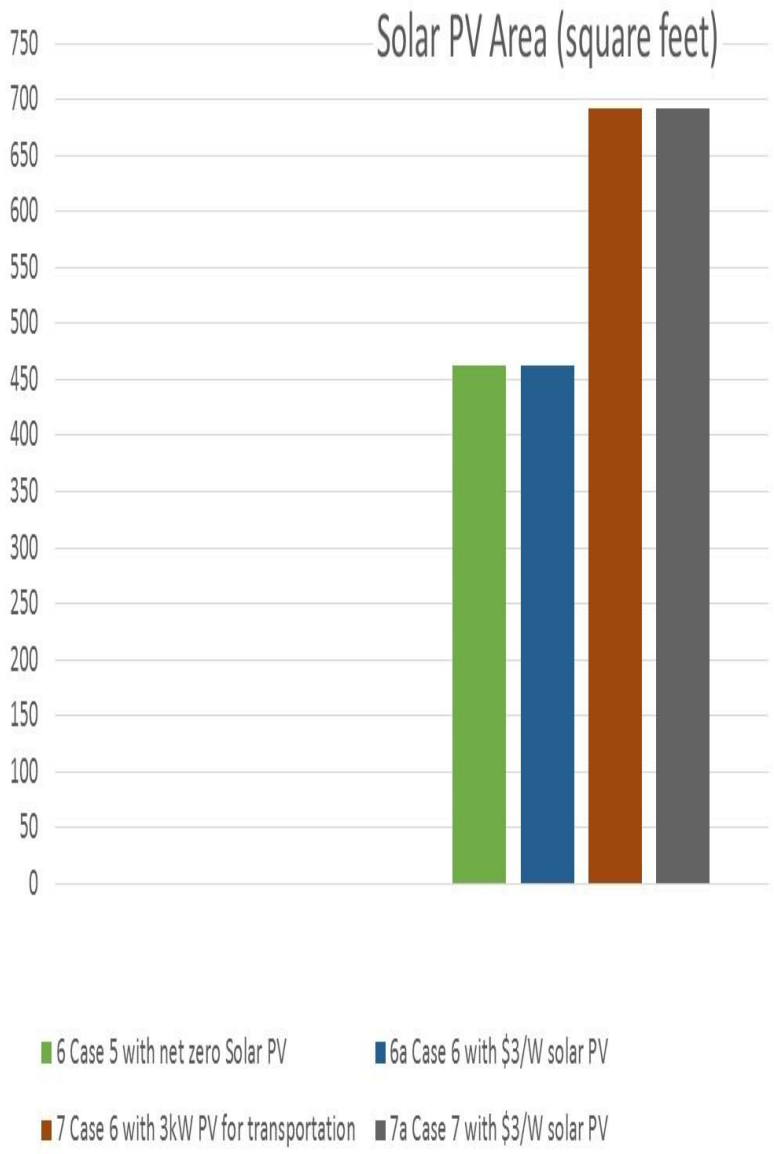

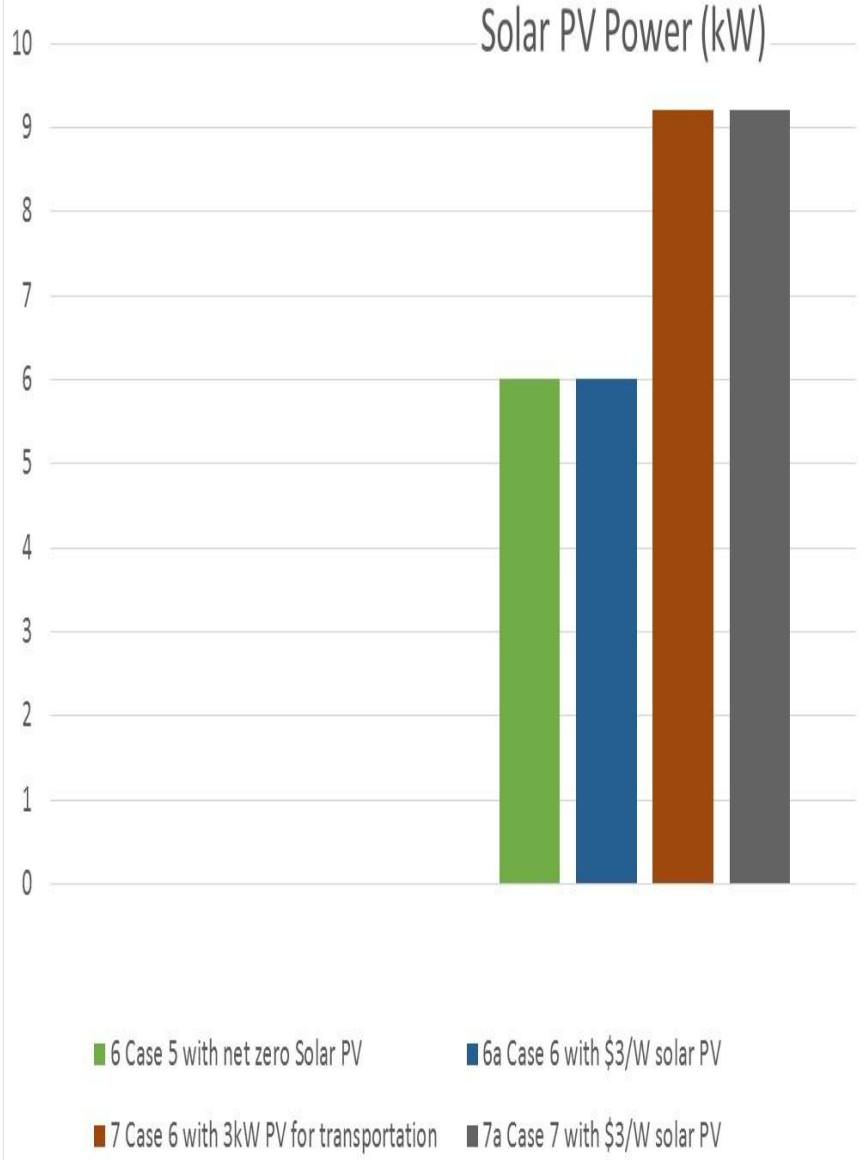

Build Equinox 100% Solar Powered

- Constructed in 1988; geothermal heat pump, CERV smart ventilation
- 4500sqft; slab-on-grade (no perimeter insulation); R30 walls; R50 ceiling; 3ACH@50Pa

If this steel sided, farm building can be net zero, your home can be, too!

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Summary

THANK YOU!

- ZEROs is a design tool for saving your time and making you more efficient
  - Let us know how to improve it!
- Today's economics favor high performance, solar powered homes
  - Heat pump conditioning (air source or geo)
  - Super Sealing with smart ventilation
  - Hybrid (heat pump) water heaters and clothes dryers
  - Economically optimized insulation
  - Solar PV (where practical) for home and transportation
- Economically optimized solar powered homes
  - Lower energy usage and healthier IAQ
  - Lower Life Cycle Cost
  - Lower Monthly expenses
- Our grandchildren will appreciate our efforts