



HELIOSPITI NET-ZERO CASE STUDY: DESIGN, CONSTRUCTION, AND LESSONS

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CEUS - AIA | LEED | BPI



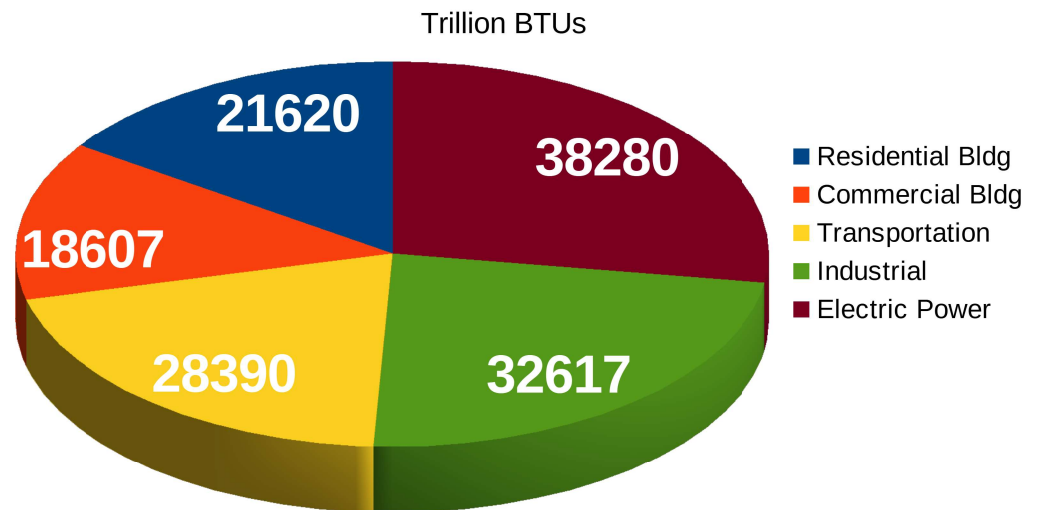
AIA Number: 50111106

Why Net-Zero?

- Locally: Save money, high comfort and safety levels
- Globally: Minimal carbon footprint and environmental impact

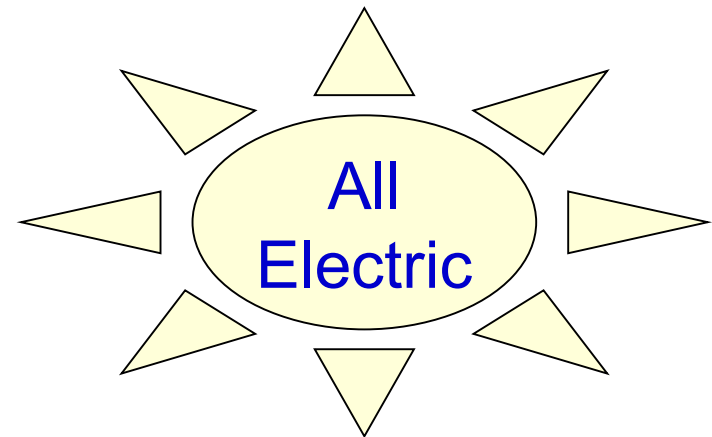
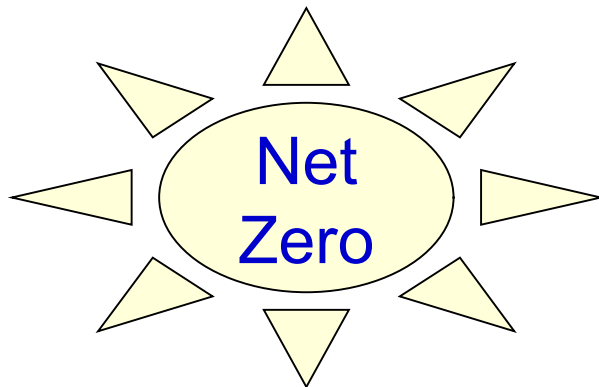
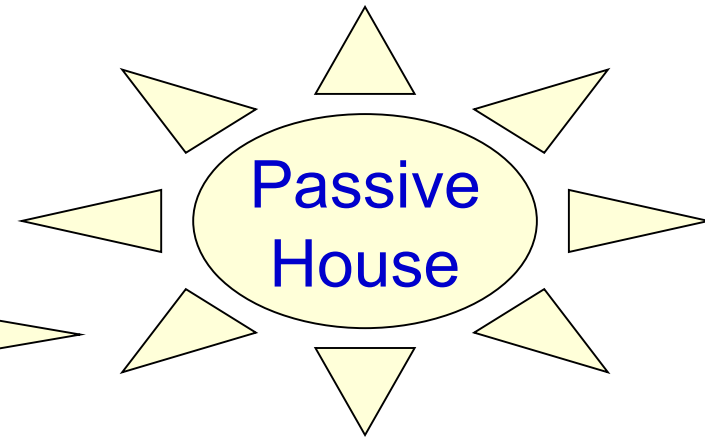
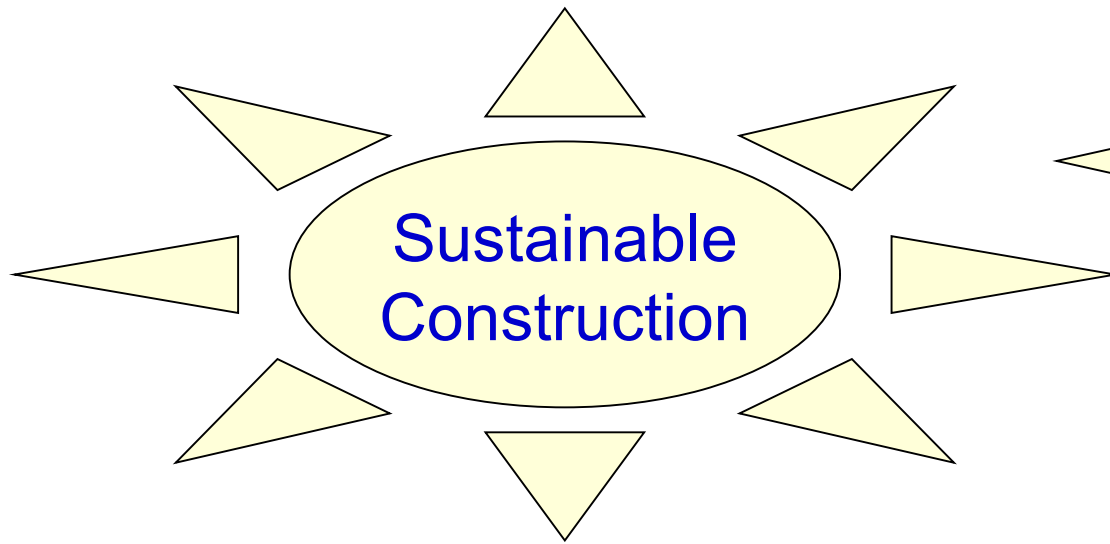
Any meaningful plan to mitigate climate change must address building energy consumption

2018 U.S. Energy Consumption by Sector



Source: US Energy Information Administration; www.eia.gov

Design Philosophy



Additional Considerations

- Wildfire resistance
- Minimal water consumption
- High indoor air quality
- Resistance to moisture damage

Getting Started- Climate

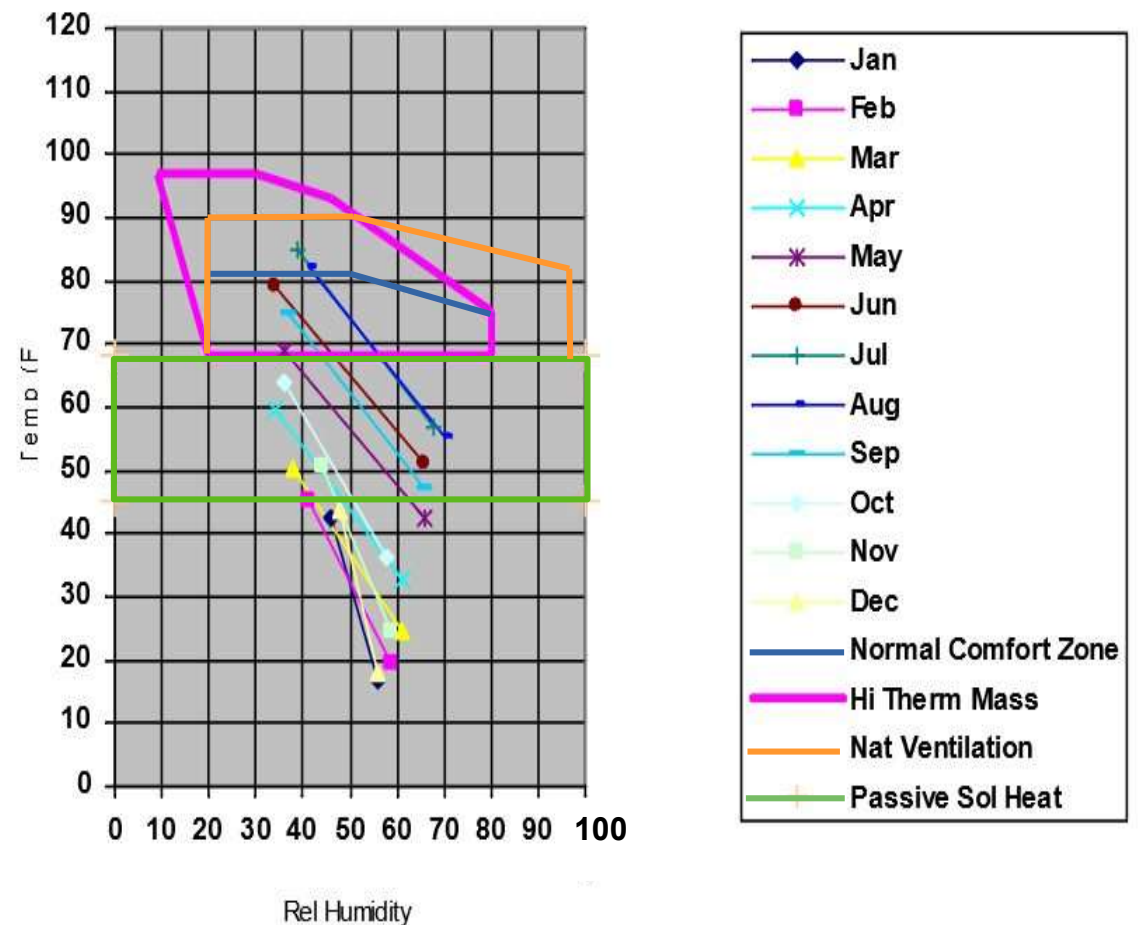
Monument, Colorado
6324 Heating Degree Days
149 Cooling Degree Days
Elevation 7000'

Bioclimatic Data

- Excellent passive cooling potential
- Moderate passive heating potential

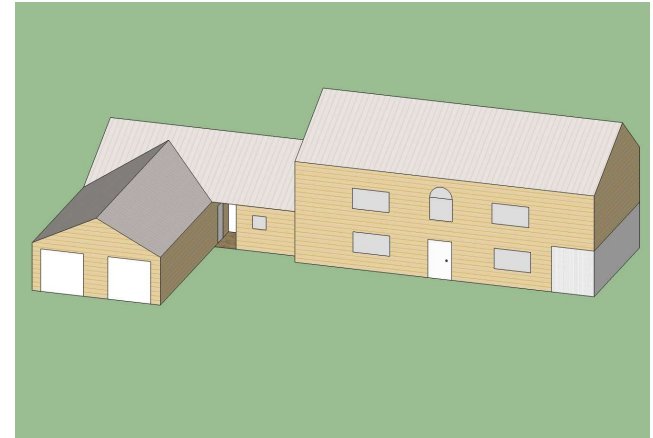


Bioclimatic Graph- Col Springs



Getting Started- Layout

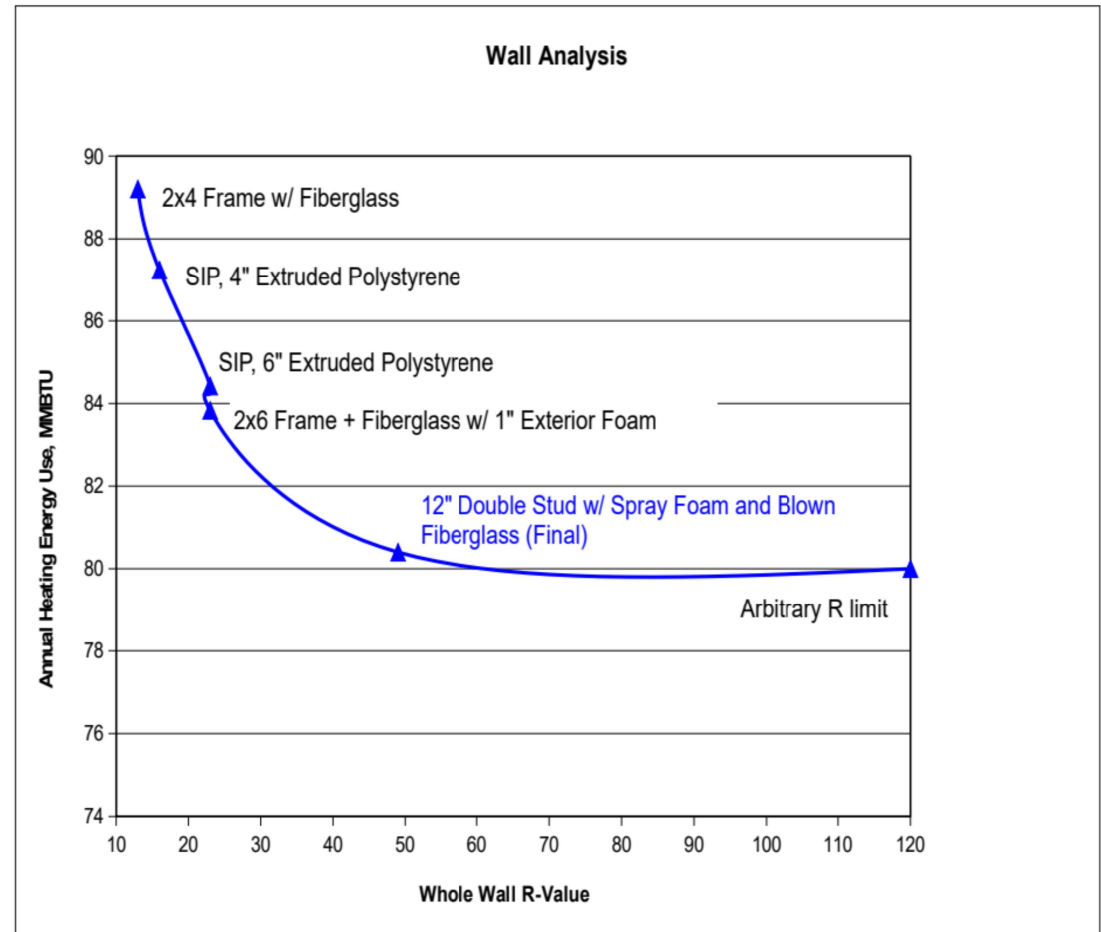
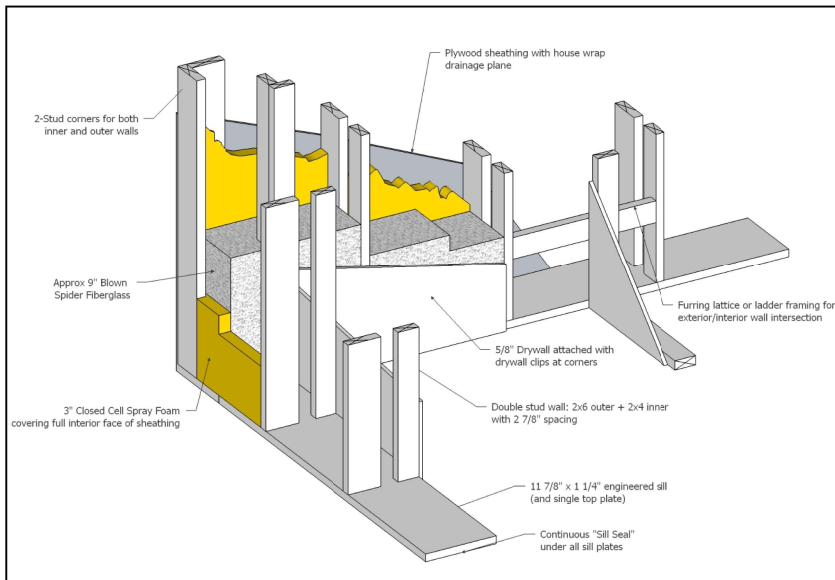
- Passive solar
- Slab on Grade
- Maximize volume:surface area ratio
- South roof pitch 39 degrees for PV production
- Floor Plan purchased from www.sunplans.com



Shell: Walls

Computer Modeling: ENERGY 10

- Walls 12" double-stud, R-49
 - Advanced framing techniques



SIP = Structural Insulated Panel

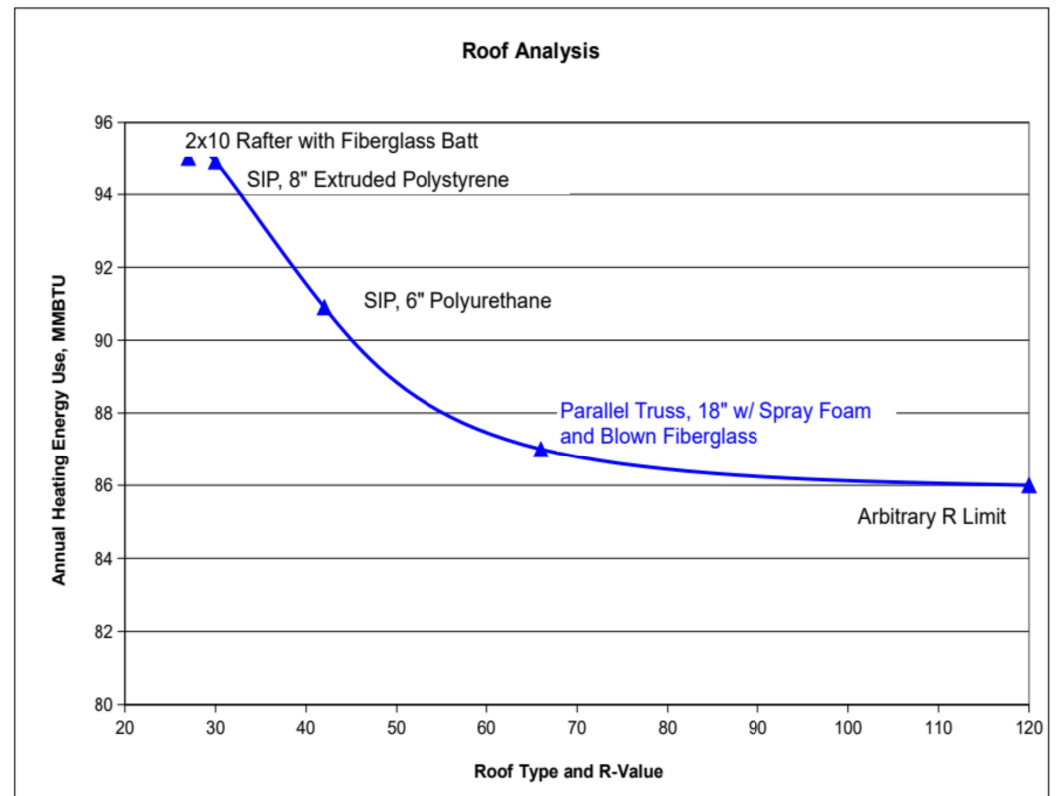
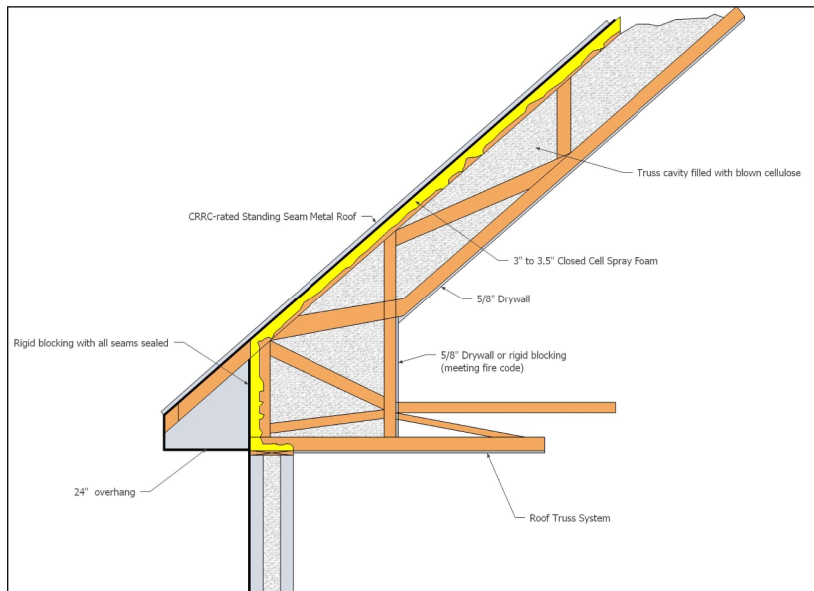
Shell: Walls R-49 (Whole Assembly)

- Double stud, 12" thick
- Advanced Framing Techniques



Shell: Roof

- Roof 18" Parallel Chord, R-67
 - Unvented attic



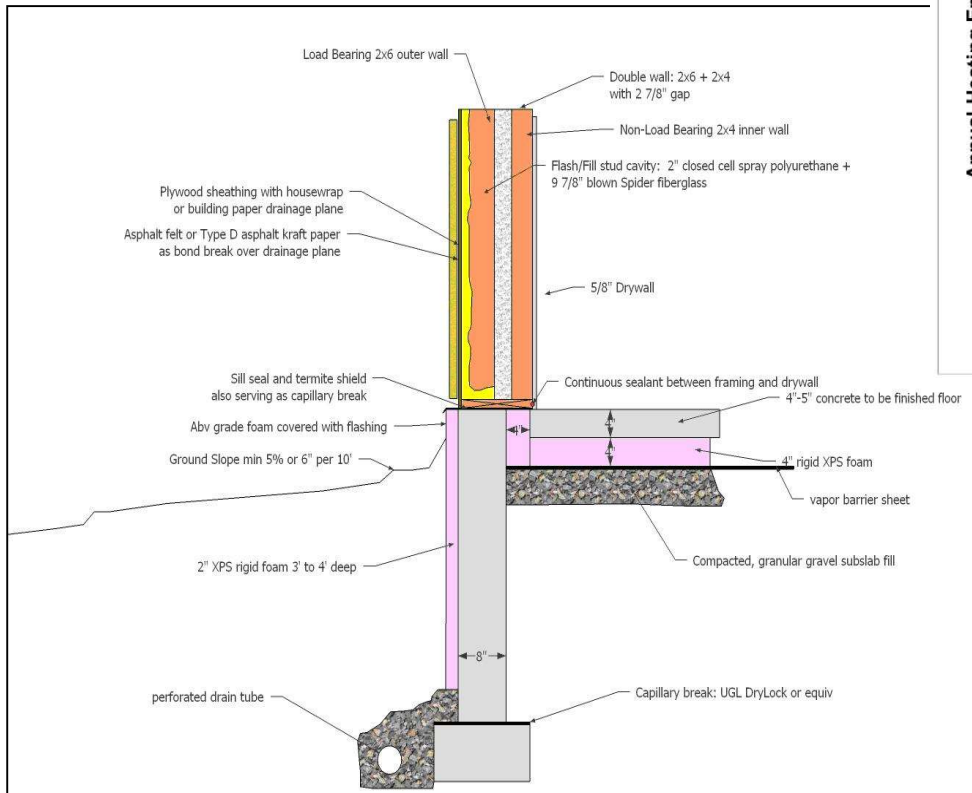
Shell: Roof R-67 (Whole Assembly)



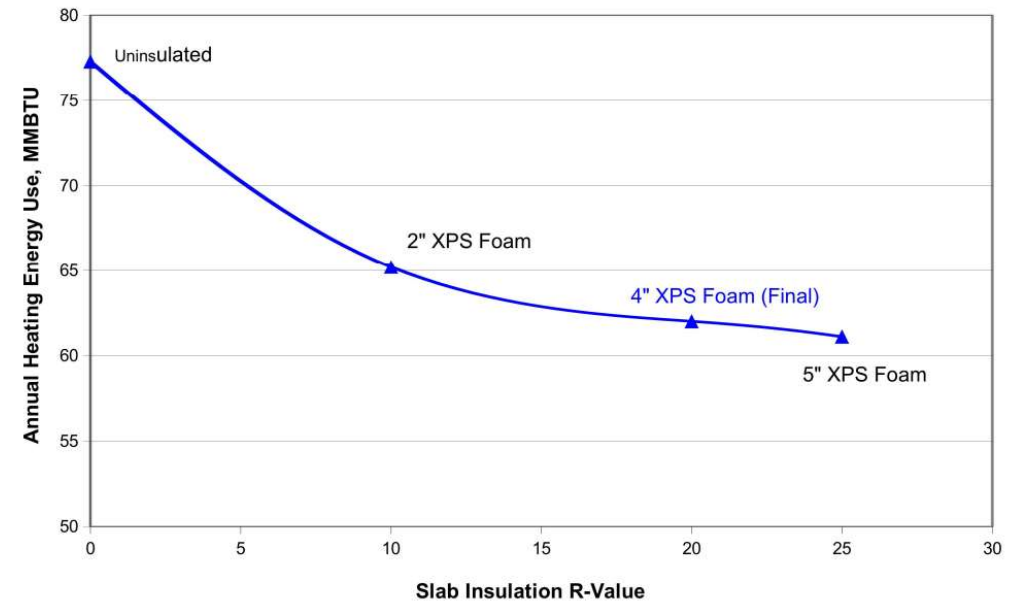
01/05/2011

Shell: Foundation

- Foundation Slab on Grade, R-23
 - Capillary breaks
 - Termite shield



Analysis: Insulation for 4" Thick Concrete Slab

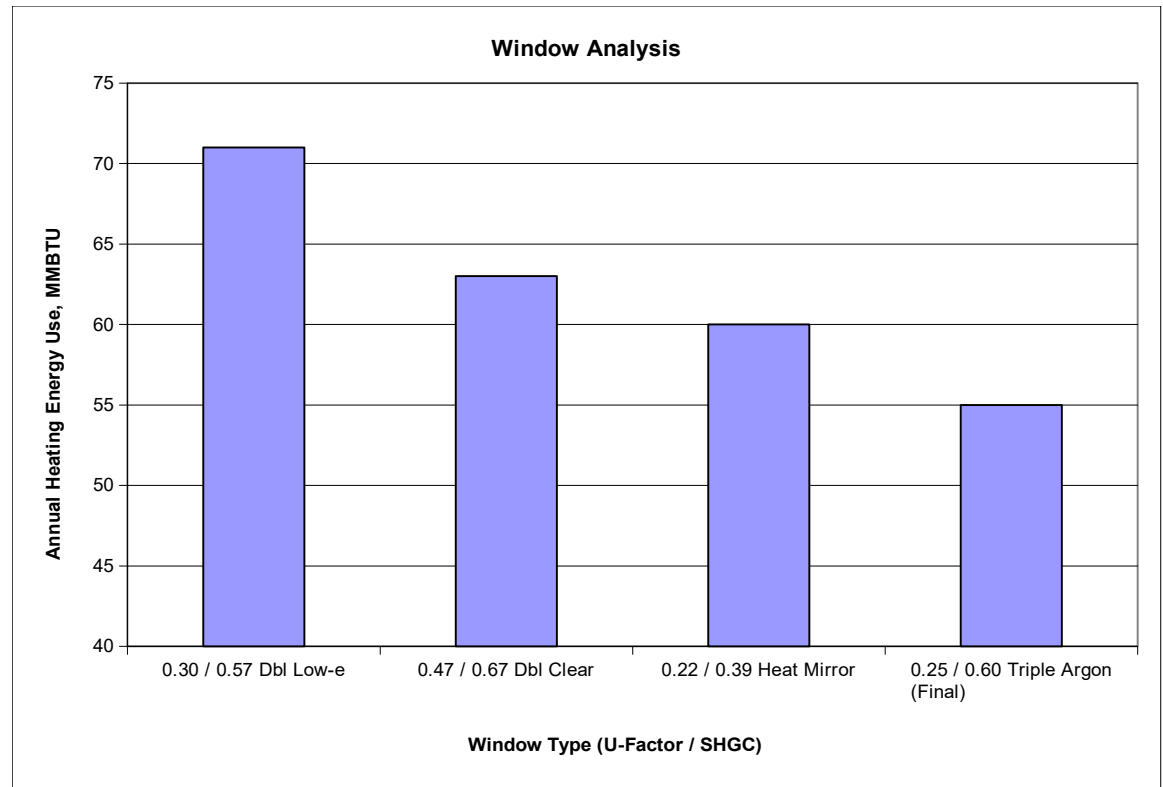


Shell: Foundation R-23 Perimeter & Under



Shell: Windows

- Windows
 - N, E, W: $U=0.16$, $SHGC=0.27$
 - S: $U=0.22$, $SHGC=0.60$



Annual savings between double pane and high performance triple pane:

16 MMBtu = 4688 kWh \Rightarrow \$172 per year if using heat pump

Passive Solar

- 8.7% south glass to floor area ratio
- Thermal mass
- High solar gain south-facing glass
- Optimized Overhangs
- Zero windows east and west, minimal north



Source: Sustainable by Design

Resources

- *The Sun Inspired House*, Debra Rucker Coleman, www.sunplans.com
- www.susdesign.com

Passive Solar

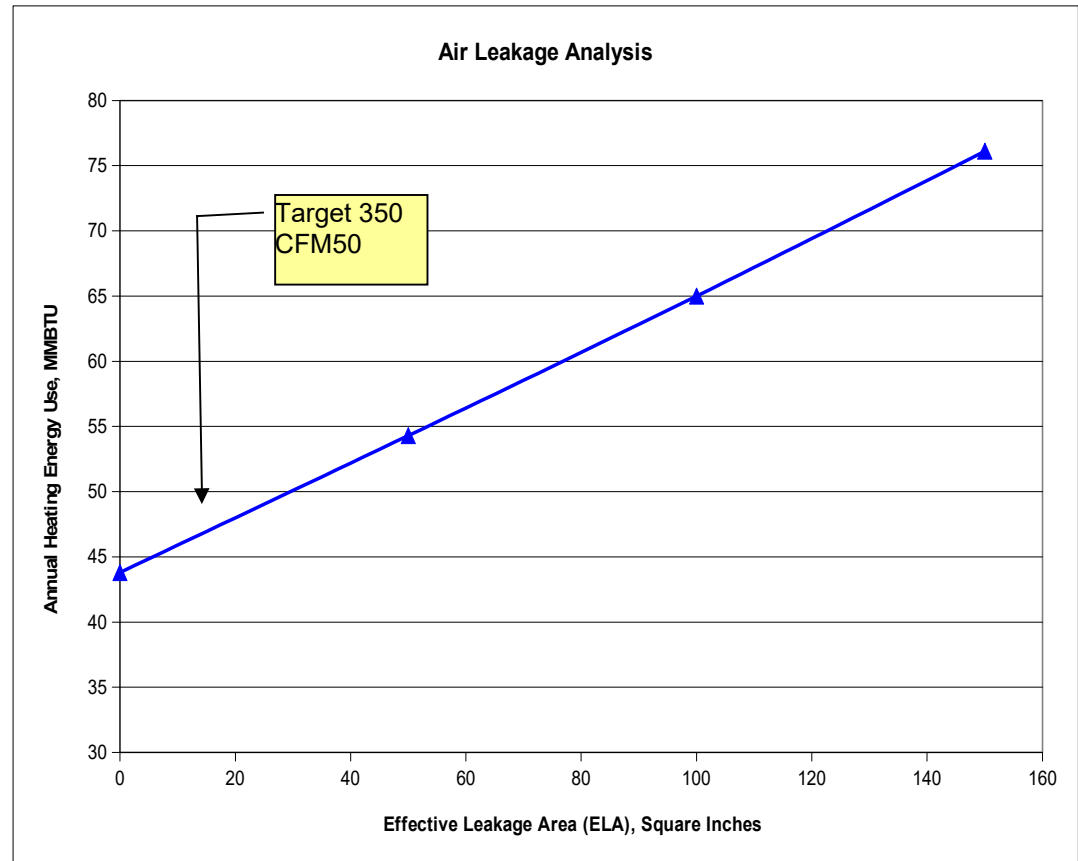
$U=0.22$, $SHGC=0.60$

Thermal Mass

05/02/2011

Shell: Air Leakage

- Spray foam:
 - Full interior sheathing and rim
 - Electric boxes
 - Window and door frame gaps
- No exhaust fans to outside
 - Non-venting dryer, range hood



“CFM50” = Cubic Feet per Minute
at 50 Pascals pressure difference

20 ELA = 364 CFM50
80 ELA = 1455 CFM50
140 ELA = 2545 CFM50

Air Sealing



Measured

280 CFM50

0.40 ACH50

0.02 NACH



Supplemental Heat

- Mitsubishi cold climate mini-split heat pump
 - Rated 10.9 kBTU/h @47°; 6.7 kBTU/h @17°
 - Coefficient of Performance (COP) @ 17° = 3.02
- Workshop heating: passive solar wall



Passive Cooling Performance

- Uses night chimney effect at central staircase
- Overhangs worked well... shoulder months challenging
- Transfer grills on all rooms
- “Econo-Cool” mode on ERV
- Max indoor temp= 79 °F
- Avg indoor temp= 75 °F



Ventilation & Earth Tube

- UltimateAir RecoupAerator Energy Recovery Ventilator
- 100' Earth Tube Ventilation Pre-Heat
- Plumbed for solar hot water pre-heat (not connected)



Domestic Hot Water



Lights and Appliances



- ENERGY STAR Appliances
- LED Lighting
- “Soft Start” Water Well Pump
- Induction Stove with Pressure Cooker
- Power Strips for Consumer Electronics
- Hot & Total Water Conservation

12-Year Electric Load Analysis

- House: 4113 kWh/year (avg)
 - 343 kWh/month
- EVs: 4358 kWh/year (avg)
- 106,077 kWh PV production (12 yrs)
- 4428 kWh net excess (12 yrs)
- Space cooling: 0 kWh
- Space heating: 4.8 kWh/year (avg)

Solar Photovoltaics



4.4 kW
Original- 2011

1.6 kW
Added Aug 2018

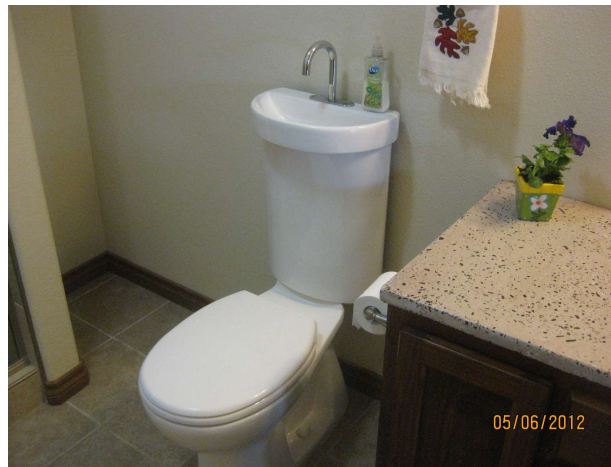
Water Conservation

- Designed to EPA WaterSense specs
- No outside irrigation: Xeriscape + 2 rain gardens



On-Demand Hot Water
Recirculation Pump

Toilets: Dual-flush with
hand washing sink



Sustainable Features

- Construction Recycling
- Recycled/Reused Content
 - Floor tiles
 - Hearth granite
 - 650 lbs glass bottle in counters
- Zero or very low VOC
 - No Formaldehyde cabinets and interior doors
 - Solid cork flooring
 - Zero VOC paints, dyes and finishes



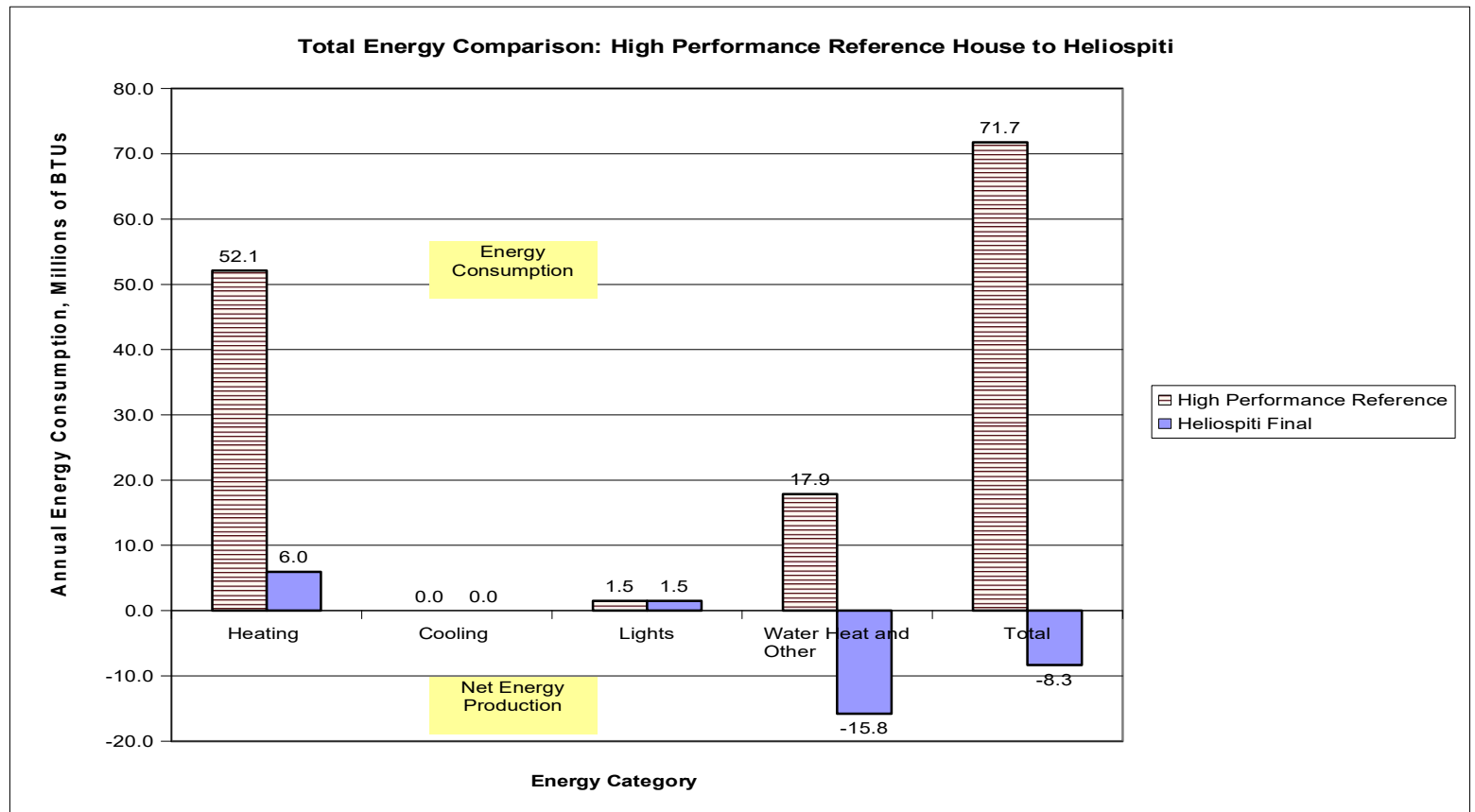
Substituting Sun for Gas



HOUSE ENERGY PERFORMANCE

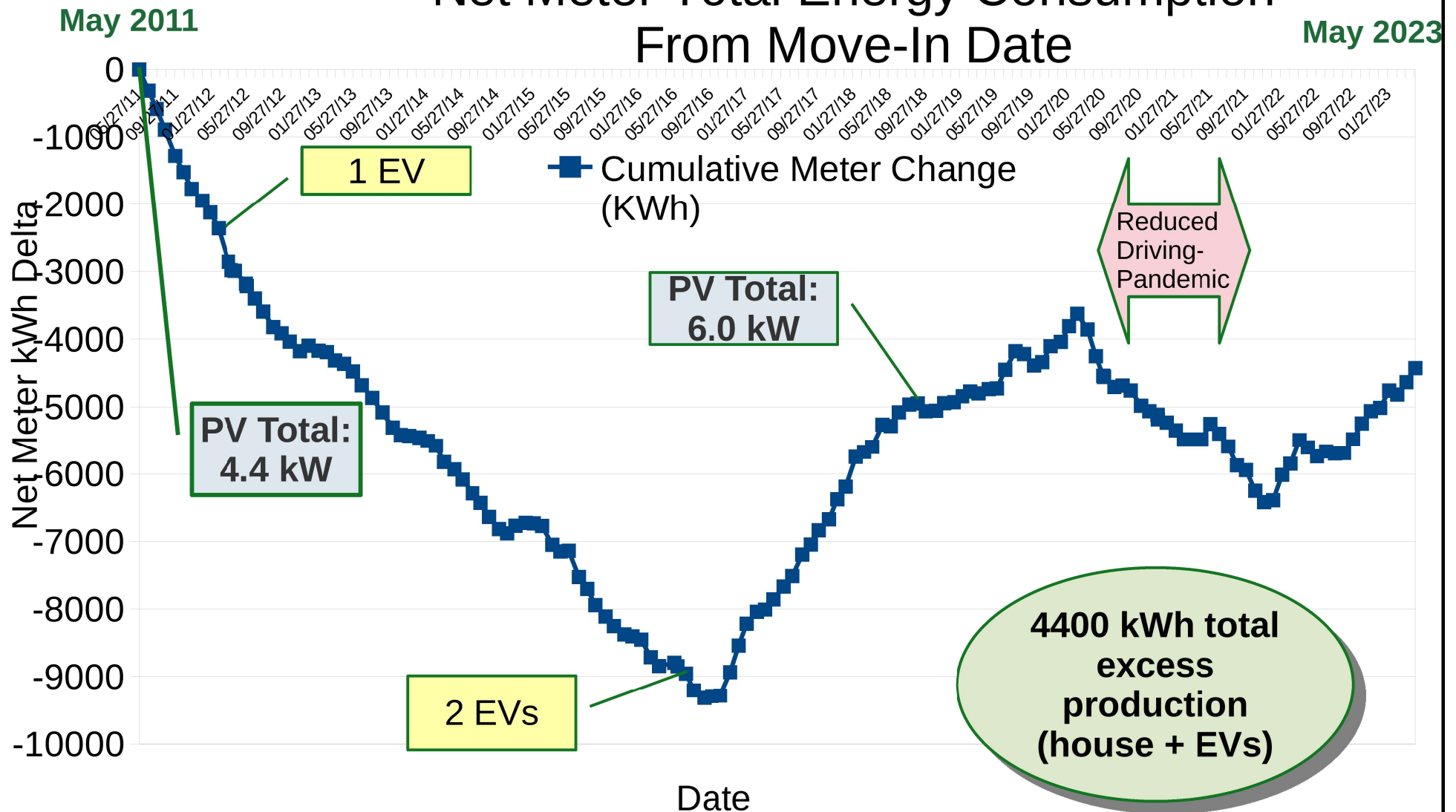
ENERGY-10 Model Results

- Predicted Peak Heating Loads:
 - 18.0 kBTU/h w/o passive solar
 - 5.9 kBTU/h w/ passive solar



12-Year Results

Net Meter Total Energy Consumption From Move-In Date



Lessons

- 1) Effective ambient energy use starts with efficient shell
- 2) Solar tube vs. LED lighting
- 3) Solar hot water system vs. heat pump water heater + additional PV
- 4) UV light impact at high gain south windows
- 5) Operable window placement
- 6) Remove hydronic heat exchanger from ventilation system

Conclusions

- “Passive House” philosophy works well
- Construction not complicated...just different focus areas
- Cost: 7.8% above conventional construction (includes solar tax credits)



Questions