Zero Energy Home Project

EDSGN 100

Section: 8

Team 3: Zack Beitz

Eric Carey

Zach Biddle

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Abstract

Team Avenger's goal was to build a self-efficient zero energy home. We went about doing this by meeting regularly with the group and in small groups. First, the team came together and came up with a design for the house, after coming up with that we dove into the project. Zach Biddle and Zack Beitz started working on the infrastructure, while Shealyn Williamson and Eric Carry figured out the materials and prices. The Zachs drew rough sketches and then made the 3D model using cardboard as the material. After making the 3D model they sat down and designed the house on Solidworks. Shealyn and Eric found the solar panels we needed, appliances, a geothermal unit, and finally a contractor. Next the two small groups came together to put all the research together. When they came together they also worked on the PowerPoint presentation and the report reparation.

Introduction

With growing concerns over the protection of the environment and the rising cost of energy, technology is hard pressed to keep up with the rise in population and affluence. One possible solution to slow environmental damage and reduce the cost of living is converting our homes to zero energy homes. A zero energy home is essentially a home that is self-sustaining and requires no outside energy input to sustain it throughout the year. This is achieved through the use of passive solar heating to warm the house and the use of renewable energy sources such as solar power and wind

turbines. A zero energy home not only saves the resident money in the long run, but it also helps reduce the strain on the environment around it.

Mission Statement

Our mission is to develop a zero energy home that is completely self-sustaining while at the same time it is visually appealing to attract potential buyers.

Customer Analysis

Customer Statements	Needs Statements
I want a self-sustaining home.	The house will produce all the needed energy.
I want big windows.	The windows will be large and open.
I want a modern looking home.	The house will be a 21st century designed.
I want energy efficient appliances.	The appliances will save on energy costs.
I want a large kitchen.	There will be open spaced rooms.
I want high quality material.	The materials used will be of high quality.

Our surveys revealed two primary concerns for people if they were going to have a zero energy home. First the house obviously had to be self-sustaining as explained in the directions but the more important concern of the handful of people we asked was that the house was something people would actually want to live in. In order to meet our customer needs we needed to make an efficient house that at the same time didn't sacrifice either its visual appeal or its comfort of living.

Preliminary Research

Location (city, state)	
House size (floor area in square feet)	2,188
Number of floors	2
URL of web site where info is found	http://amazingplans.com/2188tu.html
Number of occupants	
Number of bedrooms	3
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	Forced-air and radiant floors
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Two-zone heating tube layout, it has a lower level fan coil that forced-air heating and cooling system for the upper level.
Size of photovoltaic system (kilowatts)	
Solar water heater (yes or no)	no
R-value of wall insulation	
R-value of ceiling insulation	
Ventilation air heat recovery (yes or no)	yes
Predicted or measured annual energy use	
Any other pertinent info	

Location (city, state)	Upstate New York
House size (floor area in square feet)	6,300
Number of floors	2
URL of web site where info is found	http://www.icfmag.com/articles/green_building/zero_energy_homes.html
Number of occupants	2
Number of bedrooms	
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Geothermic heating and cooling
Size of photovoltaic system (kilowatts)	Unsure of size but it uses photovoltaic cells on the roof for electricity
Solar water heater (yes or no)	no
R-value of wall insulation	
R-value of ceiling insulation	
Ventilation air heat recovery (yes or no)	
Predicted or measured annual energy use	
Any other pertinent info	This house generates more energy than needed

Location (city, state)	Walpole, New Hampshire
House size (floor area in square feet)	?
Number of floors	2
URL of web site where info is found	http://www.homedesignfind.com/green/zero-energy-prefab-homebuilder-takes-leed/
Number of occupants	?
Number of bedrooms	2
Type of heating system (forced air,	Passive Solar Heating, Geothermal Heat

hydronic, radiant floor, heat pump, etc.	pump, and a heat recovery ventilator
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Solar Electricity
Size of photovoltaic system (kilowatts)	R-67 EPA rating?
Solar water heater (yes or no)	Yes
R-value of wall insulation	R-40
R-value of ceiling insulation	R-67
Ventilation air heat recovery (yes or no)	Yes
Predicted or measured annual energy use	Cannot find
Any other pertinent info	Photovoltaic panels Passive solar heating Geothermal heat pump Air lock entry system Heat recovery ventilator Low VOC paints, finishes and stains Extensive use of recycled materials Minimal construction waste

Location (city, state)	Wells, Idaho
House size (floor area in square feet)	?
Number of floors	1
URL of web site where info is found	http://www.svsolar.com/aboutsolarenergy/zeroenergy.htm
Number of occupants	1
Number of bedrooms	2
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	?
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Solar Electricity
Size of photovoltaic system (kilowatts)	3990
Solar water heater (yes or no)	Yes
R-value of wall insulation	?
R-value of ceiling insulation	?
Ventilation air heat recovery (yes or no)	Yes
Predicted or measured annual energy use	15kw/day
Any other pertinent info	Photovoltaic panels

Location (city, state)	Montage urban homestead, MA
House size (floor area in square feet)	1152
Number of floors	1
URL of web site where info is found	http://www.builditsolar.com/Projects/SolarHomes/MAZeroEnergy/MAZeroEnergy.htm
Number of occupants	4
Number of bedrooms	3
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	Heat pump
Main heating	Solar Electricity

fuel (electricity, natural gas, wood, oil, etc.)	
Size of photovoltaic system (kilowatts)	4.94
Solar water heater (yes or no)	Yes
R-value of wall insulation	42
R-value of ceiling insulation	100
Ventilation air heat recovery (yes or no)	Yes
Predicted or measured annual energy use	Energy used:1949 kWH Energy produced: kWH
Any other pertinent info	

Location (city, state)	Pittsburgh, PA
House size (floor area in square feet)	1,850 square feet
Number of floors	48 Unit Townhouse
URL of web site where info is found	Please See Below
Number of occupants	Information not given
Number of bedrooms	Information not given
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	Geothermal heat pump
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Efficient HVAC systems
Size of photovoltaic system (kilowatts)	8,000 watt roof mounded array
Solar water heater (yes or no)	Information not given, but most likely, yes
R-value of wall insulation	Tightly sealed building envelop and duct work
R-value of ceiling insulation	Reflective roof instillation
Ventilation air heat recovery (yes or no)	Yes

Predicted or measured annual energy use	-4
Any other pertinent info	○ The First Zero Energy Home of that Region ○ LED Lighting, also takes advantage of orientation to maximize lightning ○ Located within walking distance of the citylife ○ Energy-Star rated products ○ House listed at $489,000, geothermal tax incentive

Sources:

- ✓ http://www.popcitymedia.com/devnews/netzerohouse041410.aspx?utm_campaign=It%27s%20Okay%20to%20Fail.%20Really.&utm_medium=Email&utm_source=VerticalResponse&utm_term=South%20Side%27s%20Riverside%20Mews%20includes%20Pittsburgh%27s%20first%20Net-Zero%20Energy%20home
- ✓ http://www.mnn.com/lifestyle/responsible-living/stories/pittsburgh-gets-its-first-net-zero-energy-home
- ✓ http://www.sotahomeliving.com/riverside-mews/features.php

Location (city, state)	Ohio Township
House size (floor area in square feet)	1,850 square feet
Number of floors	Information not given
URL of web site where info is found	Please See Below
Number of occupants	Information not given
Number of bedrooms	Information not given
Type of heating system (forced air, hydronic, radiant floor, heat pump, etc.	100% LED & CFL lighting are set on image sensors
Main heating fuel (electricity, natural gas, wood, oil, etc.)	Horizontal Loop Ground Source Heat Pump System (Geothermal)

Size of photovoltaic system (kilowatts)	2kw solar array
Solar water heater (yes or no)	Yes
R-value of wall insulation	2×8 exterior walls that feature staggered 2×4 construction with R-40 insulation for superior comfort and energy efficiency.
R-value of ceiling insulation	R-410-A

Ventilation air heat recovery (yes or no)	Yes
Predicted or measured annual energy use	0
Any other pertinent info	The First Zero Energy Home of the Nation

Sources:

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- ✓ http://www.sahomesblog.com/2010/07/sa-homes-launches-nation%E2%80%99s-first-zero-energy-home/
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External Research

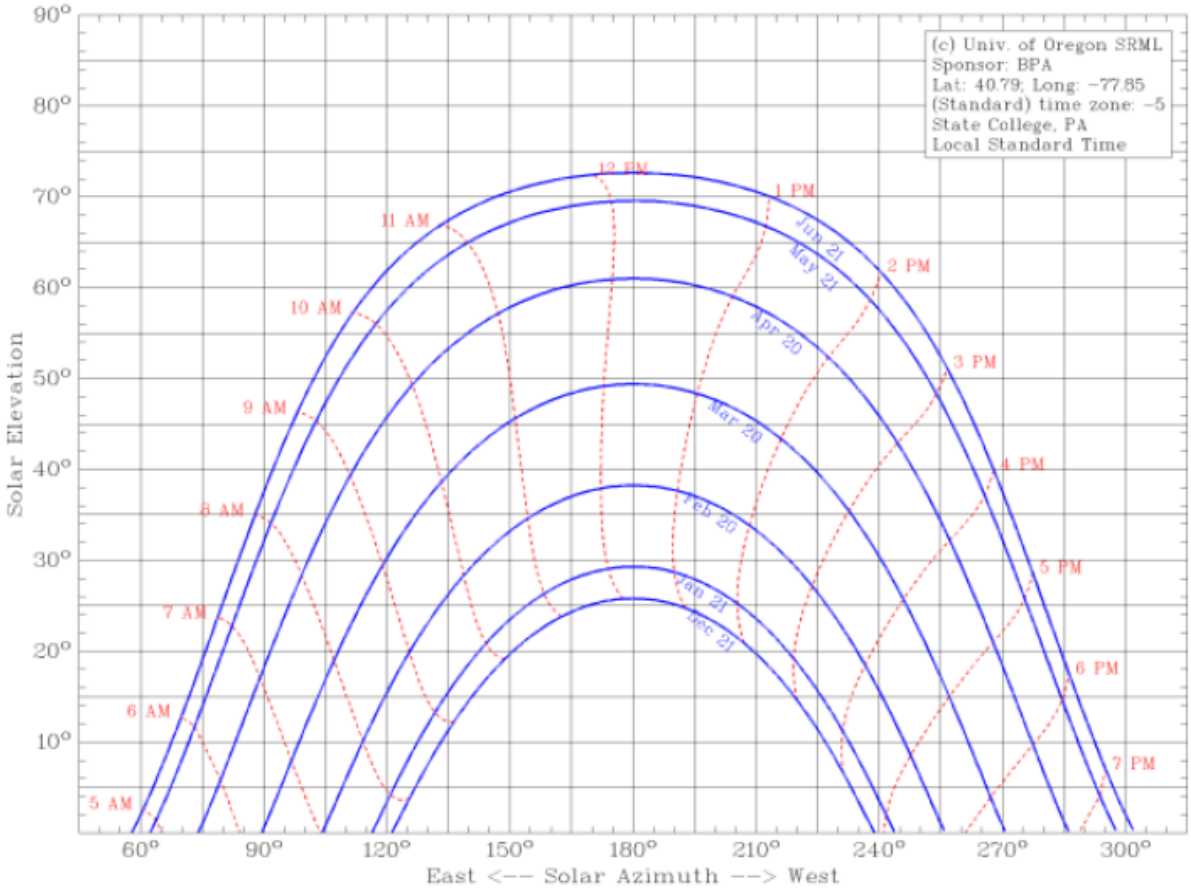
State College, Pennsylvania

Average temperature January: 25.4

Average temperature July: 71.2

Average rainfall: 40 inches

Average snowfall: 46.3 inches


(c) Univ. of Oregon SRML
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(Standard) time zone: −5
State College, PA
Local Standard Time
Solar Elevation
East <-- Solar Azimuth --> West
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80°
70°
60°
50°
40°
30°
20°
10°
60°
90°
120°
150°
180°
210°
240°
270°
300°
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
Jun 21
May 21
Apr 20
Mar 20
Feb 20
Jan 21
Dec 21

Concept Generation

	Metrics	Geothermal	Solar Panels	Water Reservoir	Floor to ceiling windows	Layered Roof	Energy Star Appliances	Large Open Rooms	Thick Interior/Exterior Walls
Needs									
The house will produce all the needed energy.		X	X	X					X
The windows will be large and open.					X				
The house will be a 21st century designed.		X	X		X	X			
The appliances will save on energy costs.							X		
There will be open spaced rooms.								X	
The materials used will be of high quality.		X	X						X

Concept Selection

Concept Matrix					
Geothermal H-Vac System	1 (worst)	2	3	4	5 (best)
Price over time					x
Efficiency			x		
Installation		x			
E-Impact					x

Concept Matrix					
Forced Air	1 (worst)	2	3	4	5 (best)
Price over time		x			
Efficiency				x	
Installation					x
E-Impact	x				

Concept Matrix					
Radiator	1 (worst)	2	3	4	5 (best)
Price over time				x	
Efficiency		x			
Installation					x
E-Impact			x		

Concept Matrix					
Batt and Roll Insulation	1 (worst)	2	3	4	5 (best)
R-Value			x		
Efficency			x		
Quality			x		
Price		x			
instalation	x				

Concept Matrix					
Concrete Block Insulation	1 (worst)	2	3	4	5 (best)
R-Value	x				
Efficency		x			
Quality					x
Price					x
instalation		x			

Concept Matrix					
Foam Board/Rigid Foam	1 (worst)	2	3	4	5 (best)
R-Value			x		
Efficency				x	
Quality		x			
Price		x			
instalation		x			

Concept Matrix					
Spray Polyurethane Foam	1 (worst)	2	3	4	5 (best)
R-Value					x
Efficency				x	
Quality				x	
Price	x				
instalation					x

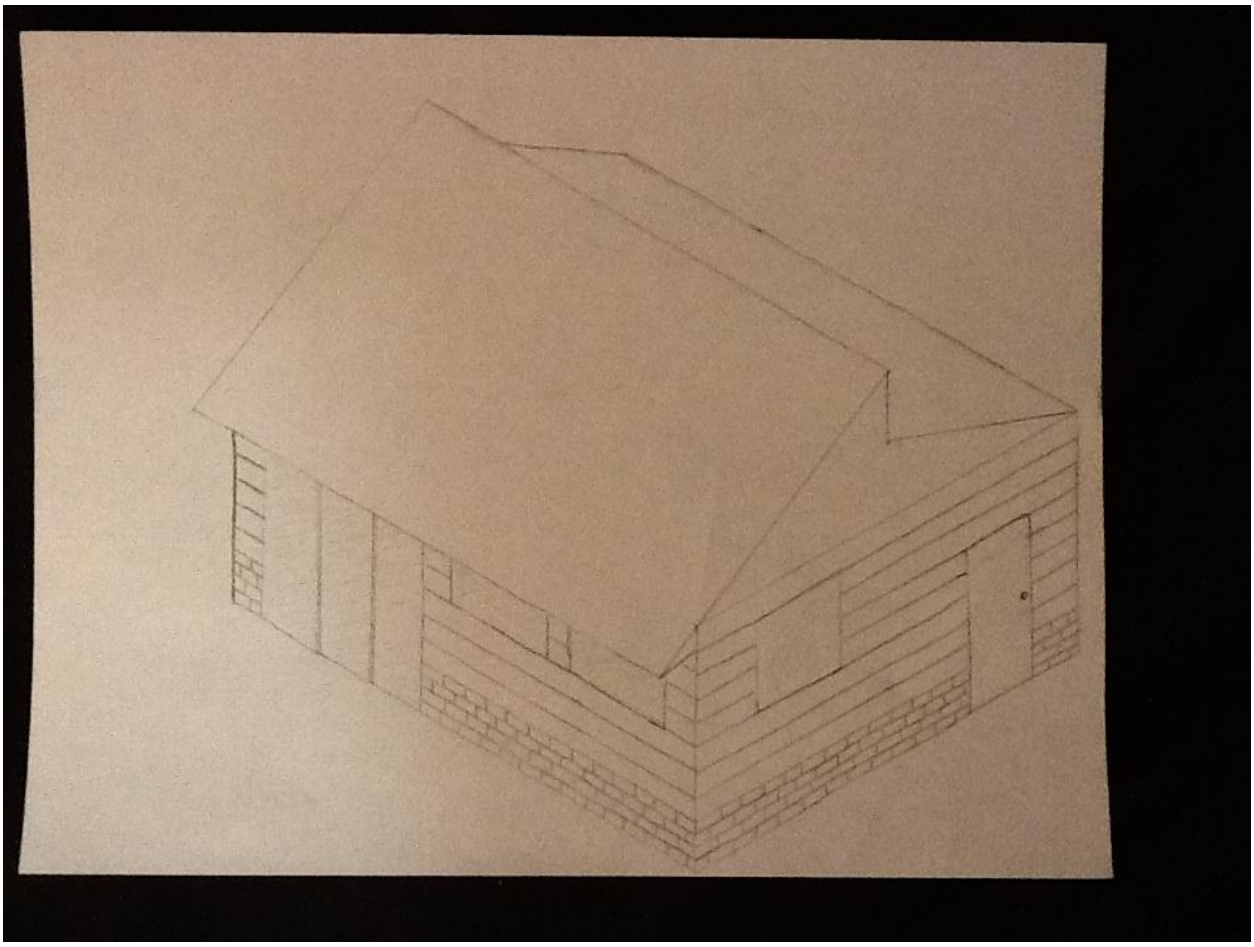
Concept Matrix					
Bamboo Flooring	1 (worst)	2	3	4	5 (best)
R-Value			x		
Efficency			x		
Quality		x			
Price	x				
instalation	x				

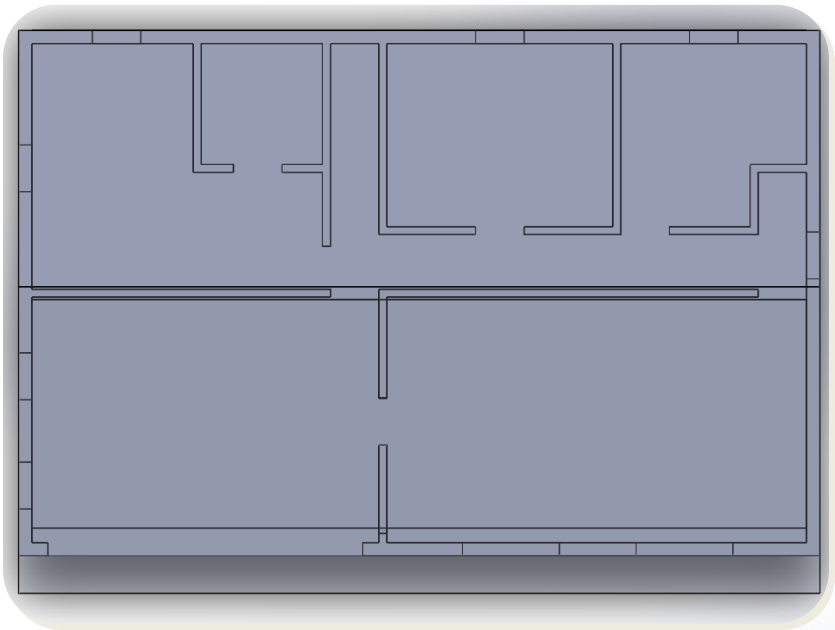
Concept Matrix					
Cork Flooring	1 (worst)	2	3	4	5 (best)
R-Value			x		
Efficency			x		
Quality		x			
Price			x		
instalation		x			

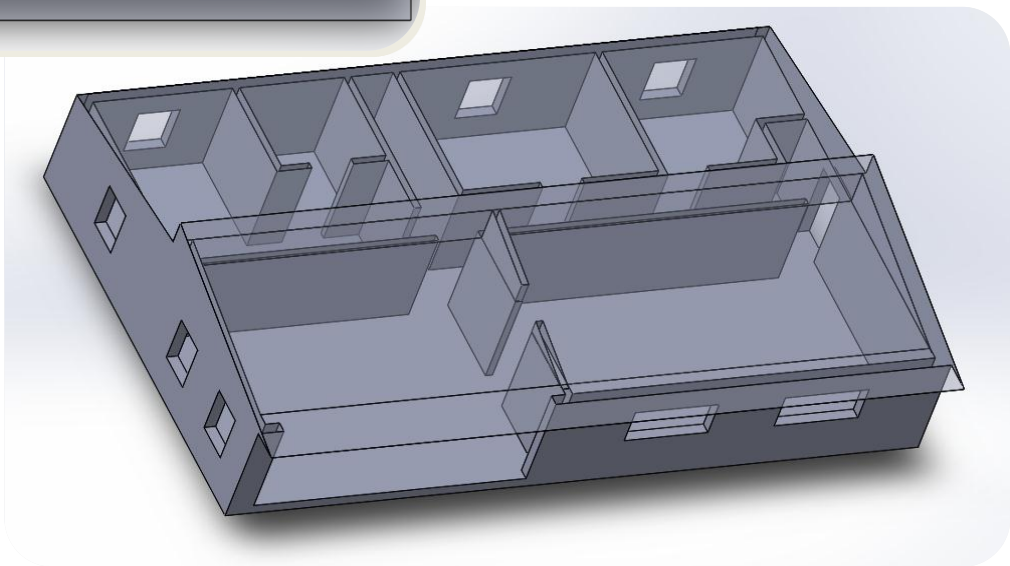
Concept Matrix					
Hardwood Flooring	1 (worst)	2	3	4	5 (best)
R-Value	x				
Efficency			x		
Quality				x	
Price			x		
instalation				x	

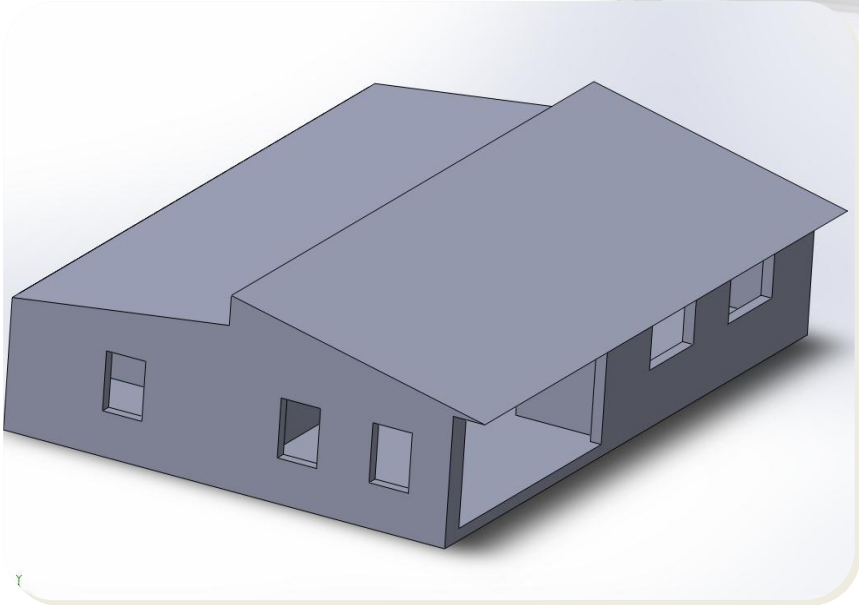
Concept Matrix					
Concrete Slab w/ radiant heating	1 (worst)	2	3	4	5 (best)
R-Value					x
Efficency					x
Quality				x	
Price	x				
instalation	x				

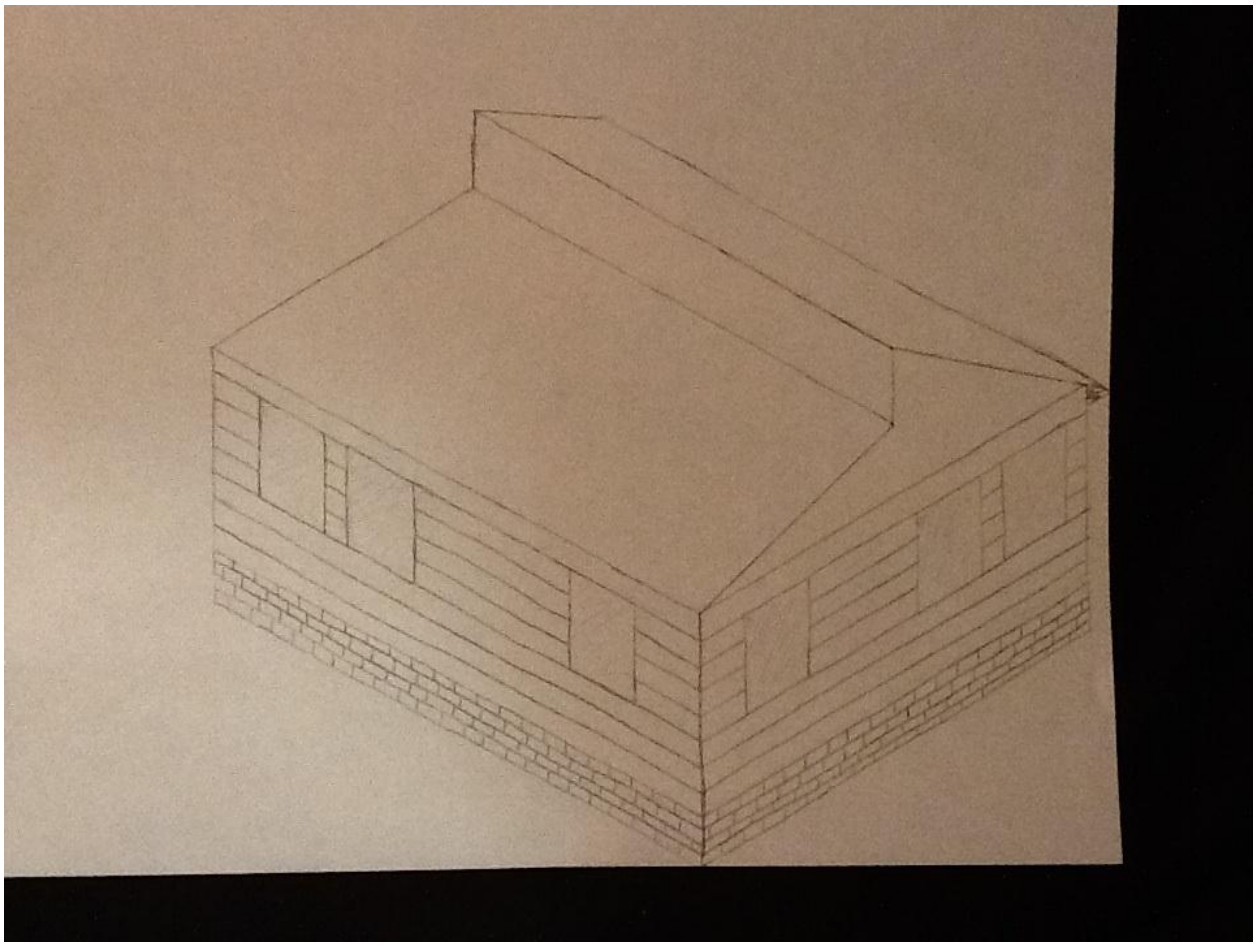
Design Sketches

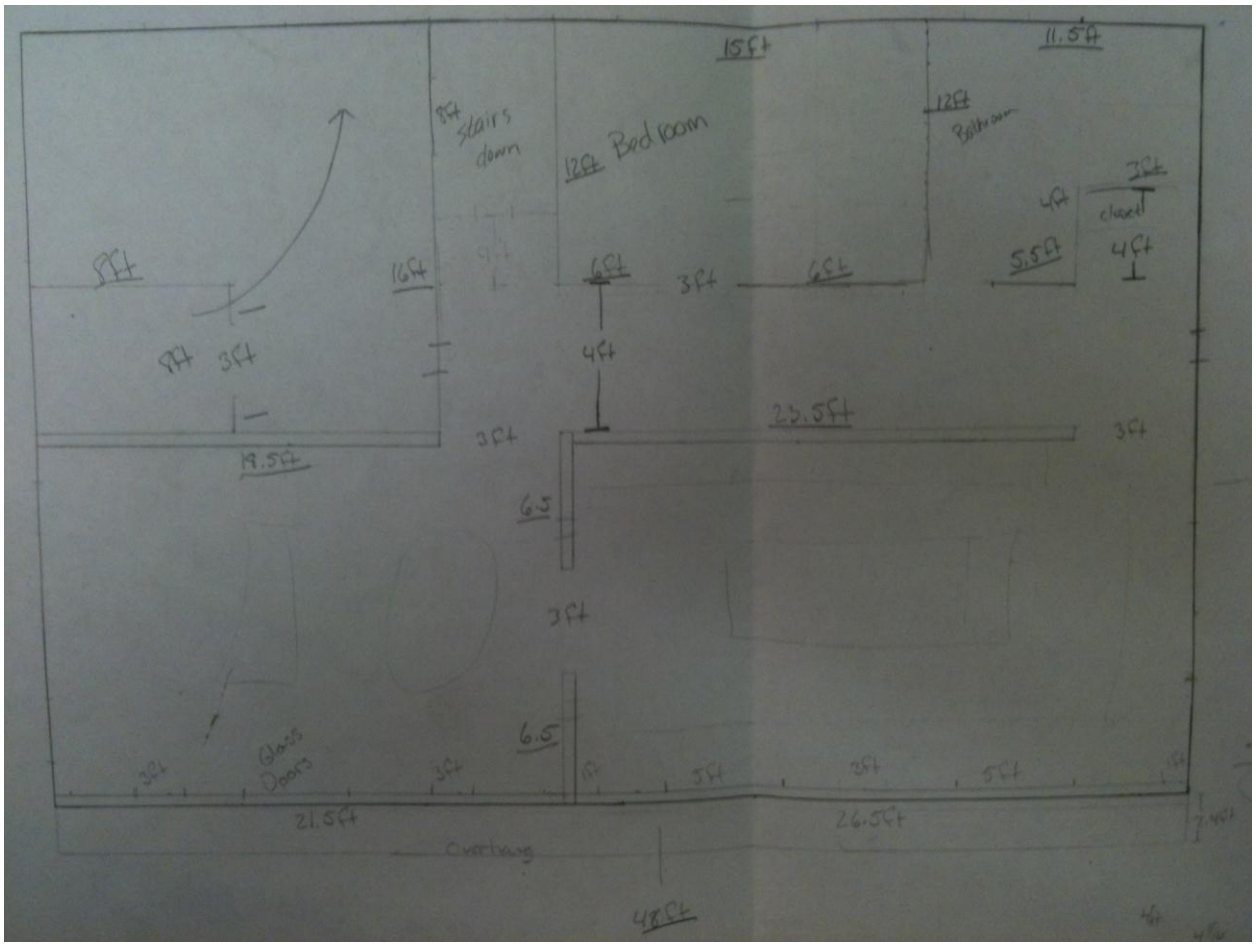











15ft
11.5ft
8ft
Stairs
down
12ft
Bed room
12ft
Bathroom
3ft
4ft
closet
4ft
5.5ft
8ft
16ft
6ft
3ft
6ft
8ft
3ft
4ft
23.5ft
3ft
3ft
19.5ft
6.5
3ft
6.5
Glass
Doors
3ft
3ft
3ft
5ft
3ft
5ft
21.5ft
26.5ft
Overhang
48ft

Conclusion

The conclusions we came to through our research in designing a zero energy home are that creating a ZEH is not easy. We had to find efficient ways to heat the house, power the house, and keep the house that way. Through our research we found the most energy efficient way to power a home is through geothermal heat. We installed a geothermal HVAC unit for this. We discovered that the best way to power a zero energy home is to harness solar power. Finally the best way to keep your house warm and cozy, while not using too much energy, is through good insulation and good floors. For this we decided that the closed cell polyurethane foam and the concrete slab flooring would suit our needs well. It wasn't easy to design a zero energy home, but through our research we found a way to make it possible and learned some useful information for the future in the process.

References

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