Zero Energy Home Project

EDSGN 100 Sect 29
Group # 6

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Submitted to: Smita Bharti
The Zero Energy Home Project was started with research. The members of our group each researched a few different zero energy homes that were either located in Pennsylvania or in places of similar climates. We then each generated a concept that we thought would work best. Following after that we did concept selection and selected a design for our project. Once a design was selected we were able to start to model the design. The model was then tested for how well its passive abilities were able to retain heat.

The Zero Energy Home Project was an interesting challenge. We were given the task of designing and modeling a house that had to use zero energy and be able to support a family of four. The house also had to do so while using only passive solar techniques. Passive solar means that all the work is done by the sun and elements of the house there are no electronic parts in it. Passive solar is not as hard as it sounds. It has a lot to do with windows, materials, and the orientation of your house. It is a simple adjustment that can make your home much more energy efficient.

Our challenge was to design a home for a family of four that would use passive techniques to heat the house up as much as possible and sustain the temperature as long as possible. Our house had to be greater than seventy square inches in floor space and the roof had to be greater or equal to four in tall.

Many of the zero energy houses we researched followed the same criteria. In general zero energy houses follow small floor plans and limit themselves to two stories max, with majority following a one store plan. In our research we came across ZE Houses ranging from 3400 square feet all the way down to 1700 square feet, averaging out to between 1900-2400.
Another characteristic that all the houses followed was high insolation in the walls and roof. On average using R-values between 26-34 for the walls and R-values 40-73 on the roof. This is important to note because it shows the builders want to house to be as passively heated as possible with capabilities of maintaining that heat. The house did divert from each other when it came to the actual heating of the house. Some used geothermal heat to warm the house where others used electricity to generate heat. It seemed to depend on the accessibility of power source in the particular area that the particular house used. For heating the water most of the houses we researched had tank less water heaters, which cut down on wasted electricity. Most importantly the houses tried to manufacture their own power, each one did so through the use of solar panels mounted on the roof precisely to acquire to most sun as possible. Some resulted in putting power back into the grid, will others came up even with their power generated and power consumed. All took much less power from the grid as compared to an average American household.

After our research we had to each generate our own concept of a zero energy house. Each of us did this and then we compared them all together as a group. After comparing our houses as a group we came up with a concept selection matrix. We used Austin’s house as a base line. We then rated the other two ideas with a plus or minus depending on if it had a better feature than it or a worse. What we came up with was that Nick’s design scored the highest. However we took ideas from both Andrew and Austin’s designs to come up with a final version of Nick’s design. The conception selection matrix and original sketches are on the next page.
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<thead>
<tr>
<th></th>
<th>Austin</th>
<th>Andrew</th>
<th>Nick</th>
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<tbody>
<tr>
<td>Ease of building</td>
<td>0</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Does it look good</td>
<td>0</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Price</td>
<td>0</td>
<td>-</td>
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<td>+</td>
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<tr>
<td>Score</td>
<td>0</td>
<td>+1</td>
<td>+4</td>
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In our model we tried to incorporate as many passive solar features as possible while maintaining the plausibility of the build. Most noticeable is the large window on the south facing wall. This window was purposely put on the south wall to be able to capture as much sun light as possible to passively heat the house during the day. The window is slanted at a ~ 60 degree angle to capture the high summer sun as related to its position in the sky. The inside of the house is lined with aluminum to capture the heat and rubber to absorb the heat. We also placed a smaller window...
on the south facing side for the winter. Since the sun is lower in the winter, this window is angled closer to a horizontal face. During the summer this window is covered by the roof’s overhang so that the house doesn’t get too heated up. This also acts as a vent for the summer months to release rising hot air. Along with that this high window acts as passive solar lighting for the house. We tried to have windows in each room to passively light each area and take advantage of the cross breeze which could also cool of the house during hot months.

For part of the project we had to plug our house into a zero energy calculator. To do this we had to change our dimension using a scale of 1 in. to 16.66667 ft. This calculator told me that our house would cost about $132,000 for just the house. Then it would cost about another $54,000 for the upgrades to the house in order to make it a zero energy house. These upgrades included the best refrigerator, dishwasher, and clothes washer. As well as double 2x4 walls with 10” foam insulation, R60 ceiling insulation, and triple low-e windows. In order to keep our
energy usage down we decided that we were going to have an air tight recovery system that recovers a majority of the heat and we are going to try to conserve water. According to this calculator, we would spend $1,073 on heating, cooling, lights, appliances, and other electrical needs annually. This price is calculated when electricity costs $0.1 per kWh. Using a PV system of, at minimum, 8.75 kW our house with is able to cover all of electricity charges. Increasing the PV will give us even more money back, because we will not have to rely on the city electricity as much. If we lowered the insulation quality or the grade of windows we had then we would need to increase the size of our PV system in order to stay independent from the city electricity. Overall we feel that we picked the best components for our house; because we became a zero energy home, help the environment by using the least amount of electricity possible, and have the possibility to turn a profit, after a certain number of years.

After our house was completed we had to test its passive solar features. To do this we put our house through 2 back to back trials. The first of these was an 8 minute heat gain test. During this test our house was placed under a lamp. We placed a thermometer into the house and measure its temperature every thirty seconds. After the 8 minutes our house had raised 16 degrees, which gave us an average heat gain rate of 2 degrees per minute. Once the first test was completed, we took our house over to the next table for the heat retention test. During this test our house was placed in front of a fan that was blowing ice cold air at it for 7 minutes. After this test our house had lost 9 degrees, which gave a heat loss rate of -1.28. So between the two tests our house had raised its temperature by one degree. That may not sound too impressive, but when the rates are compared to the class a new story appears. Our heat gain rate was the second lowest in the class, but on the other hand our heat loss rate was the
second lowest in class. We feel that our house was successful, even though we only retained one degree of heat.

Our group learned valuable lessons throughout this project about zero energy design and passive/active solar capabilities. It was interesting to think in these terms and be able to incorporate them into our final model. We all divided up the tasks of the project evenly, between the purchase of materials to the actual report. We were side tracked by the departure of one of our teammates which set us back a little. Yet we succeeded since we already had planned times to finish our project each finishing our deadline in a reasonable amount of time with little stress.