Zero Energy Project
EDSGN 100 Section 20
Team Name: iGalaxy
Submitted to: Bevin Etienne October 15th, 2013
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Abstract
Using basic environmental and geothermal studies the I-Galaxy team has developed an underground energy efficient home. This home will not need any form of heating or cooling because it utilizes the natural cooling and heating elements of nature to keep the house a stable crisp temperature. It also uses state of the art energy efficient equipment to keep energy consumption at the utmost minimum. It also powered by 30 solar panels which provide more than enough energy to power the house as well as sell electricity to energy companies.

Introduction
Over the past few weeks the I-Galaxy team has been developing a 0 energy home. This 0 energy home relies on extreme efficiency and modern technology in order to produce all the energy the house consumes. The premise of the plan was to develop a completely underground 1500 sq. ft. home. This is because at approximately 6 feet underground, the Earth’s temperature stays at a constant, cool temperature. The average US household wastes 56% of their energy bill on heating and cooling. The idea behind this is to avoid cooling and heating systems that contribute to high levels of energy consumption. In addition to this, on the surface of the house we will have have sufficient surface area to hold enough solar panels to sustain energy consumption of the entire house. All in all, this house has the capacity and systems to produce enough energy to sustain a family of 4 and sell back to energy companies. Simple math proves this house has the capacity to produce more than enough energy to sell to energy companies to
make money. In addition, it comes loaded with 3 bedrooms, 2 bathrooms, a living/dining room, kitchen and a utility room. In the utility room there is a water heater and 8 batteries to provide a backup energy system in case of a disaster. The appliances in this house are all energy star rated and extremely efficient. In addition the lighting uses LED bulbs which last an extremely long time and consume the least amount of energy. Overall this house has the potential to revolutionize the housing industry by utilizing natural forces of the Sun and Earth.

**Mission Statement**

The I-Galaxy team is determined to develop unique, long term, and practical 0 net energy homes using the latest in energy efficient appliances and solar power systems while maintaining an economical and fundable plan.

**Customer Needs Analysis**

In being with provided with a low-income family as customers, the I-Galaxy team developed details required for the family to live comfortably from their income and for them to live at a higher standard than previously. Of most importance to the family, is living affordably and to lead healthy lives. For those living with asthma or are frequently sick, it is best to live in a temperature controlled house and be provided with clean air. The house will need standard heating and air-conditioning units or an affordable alternative as to control the temperature and allow the family not to open the window to prevent asthma attacks for one of the children. The family is also in need of more space. As the children continue to grow they will need places to study as well as the correct electronics to be able to properly do their work. They will need a properly working kitchen as well as furniture that is not in disrepair. The family needs to be given a better living condition than what they previously had, however it is not necessary to provide them with extravagance that they will be overwhelmed with, or too far out of their own price range.

**External Research**

**Appliances**

With the concept of zero-energy, the team looked for energy-efficient appliances and to gain as many with energy-star ratings as possible, but at affordable prices. With the family being poor, we also looked for simple and non-extravagant appliances knowing that the family would not need nor miss expensive appliances with many more applications than necessary. We found that gas appliance used little electricity and that natural gas is a cheaper form of running said appliances. We also found that the biggest draws of energy in a household are the refrigerator and hot water heater. With that taken into mind, hot water heaters can be run on natural gas, eliminating the electricity used by the hot water heater. Second we found that microfridges run more efficiently than regular refrigerators as they do not have as much space to cool. As the family was a low-income
family, having an excess of food to store will be unlikely for them, so the microfridge would save them energy as well as space.

<table>
<thead>
<tr>
<th>LARGE APPLIANCES</th>
<th>Number of Units</th>
<th>Energy per Year</th>
<th>Cost of Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oven/Stove Range</td>
<td>1</td>
<td>290 kWh/yr</td>
<td>$600</td>
</tr>
<tr>
<td>Microfridge</td>
<td>1</td>
<td>212 kWh/yr</td>
<td>$600</td>
</tr>
<tr>
<td>Washer</td>
<td>1</td>
<td>30 therm, 108KWh/yr</td>
<td>$500</td>
</tr>
<tr>
<td>Dryer</td>
<td>1</td>
<td>260 therm, 10KWh/yr</td>
<td>$350</td>
</tr>
<tr>
<td>Hot Water Heater</td>
<td>1</td>
<td>703 therm, 5KWh/yr</td>
<td>$1,000</td>
</tr>
<tr>
<td>Lighting</td>
<td>35 LED Bulbs</td>
<td>6500 kWh/yr</td>
<td>$804</td>
</tr>
<tr>
<td>Small Appliance Total</td>
<td></td>
<td>1642.8 kWh/yr</td>
<td>$4,300</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>7126 kWh/yr</td>
<td>$8,754</td>
</tr>
</tbody>
</table>

**Lighting**

For the family to be able to function in the house after dark (or all day as later decisions influenced), they needed a light source. In our searches for the best ways to light rooms, we came across this chart which would become influential in our decisions. While LEDs may be more expensive to purchase, in the long run they are cheaper as they consume less electricity and last much longer.

<table>
<thead>
<tr>
<th></th>
<th>LEDs</th>
<th>CFLs</th>
<th>Incandescents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent On/Off Cycling</td>
<td>no effect</td>
<td>shortens lifespan</td>
<td>some effect</td>
</tr>
<tr>
<td>Turns on instantly</td>
<td>yes</td>
<td>slight delay</td>
<td>yes</td>
</tr>
<tr>
<td>Durability</td>
<td>durable</td>
<td>fragile</td>
<td>fragile</td>
</tr>
<tr>
<td>Heat Emitted</td>
<td>low (3 btu/s/hr)</td>
<td>medium (30 btu/s/hr)</td>
<td>high (85 btu/s/hr)</td>
</tr>
<tr>
<td>Sensitivity to temperature</td>
<td>no</td>
<td>yes</td>
<td>some</td>
</tr>
<tr>
<td>Sensitivity to humidity</td>
<td>no</td>
<td>yes</td>
<td>some</td>
</tr>
<tr>
<td>Hazardous Materials</td>
<td>none</td>
<td>5 mg mercury/bulb</td>
<td>none</td>
</tr>
<tr>
<td>Replacement frequency (over 50k hours)</td>
<td>1</td>
<td>5</td>
<td>40+</td>
</tr>
</tbody>
</table>

**Underground Housing**

While searching for the least expensive effective way to insulate a home, we happened upon the idea of underground homes. The combination of a thick layer of concrete and at least 3 feet of soil provide for the best insulation. We also found that at 6 feet underground, the air temperature stabilizes due to passive heating with the Earth. If the home is built correctly, the home will cool naturally in the summer months letting the heat leach into the Earth when outside air temperatures are hotter than the temperature of the earth. Passive heating works in the opposite direction in winter when the temperature of the Earth is greater than that of the outside
air and the heat will transfer into the home due to normal heat flow as shown in the graphs below.

Benchmarking
Our next step in the design process was to come up with a list of appliances that we need in the Zero Energy Home. The group members used clipart papers to write down the idea and then we stuck them in the table. A few minutes later, and after each of us did the brainstorming part, we looked at the ideas together and divided them into groups. The group came up with plenty of great ideas after using this process.

The group members have discussed how we want our house built. All members agreed on one essential aspect about the house, which is to be unique. We searched on the Internet and asked some experts about the best house that would meet our budget and requirements. We discussed several different designs, until we decided to build an underground house. We all agreed about this design, since we are the only group that has a unique and special design. Furthermore, we found out several advantages for the underground house compared to a normal house, such as that it is lower cost of construction, and it is more energy efficient. In addition,
underground houses are naturally insulated by the earth and soil. This makes heating and cooling inexpensive and more efficient.

**Concept Selection**

After finishing the concept generation part, we moved to the next step, which is “concept selection”. In this step, we had to narrow down our large list of concepts and ideas into one final list that works with our design and plan. Before narrowing the ideas list down, we decided how the house would look from the inside. Since we are dealing with a family that has 4 members, we decided to make a normal home design, which consists 1 master bedroom, 2 bedrooms, a living room connected to the kitchen, 2 bathrooms and utility room. Later, we narrowed the appliances list down, we picked up the appliances we need for the house carefully and put them in list with importance level. We then studied the efficiency and price of each appliance and figured out which would be the optimal choice for a limited budget. As a result, this step helped as deciding what to look for first since we have the priority list. In addition to selecting a different appliances we also had to make the most vital choice of whether we should chose an underground home or a normal aboveground home. This was a tough choice because we knew this would require a different perspective to constructing the house. In the end we decided that the most revolutionary and efficient design would be the best which ended up being the underground home.

**Embodiment Design and Final Design Description**

The final design of our zero energy house is a single floor home that is completely underground. The house is 1500 sq feet with 3 bedroom and 2 bathrooms. It has two entrances: a main door and staircase near the front of the property and a ladder situation towards the back of the property that leads down into the utilities room. The kitchen, dining room, and living room are in an open layout to utilize more space. Appliances either run on natural gas or are energy star certified. Lighting is supplied by LED lightbulbs throughout the house. The insulation of the house is a combination of concrete and a layer of soil at least 3 feet thick. The house is heated through passive heating with the natural temperatures of the Earth but is supplemented by a heater for temperature preferences. Thirty solar panels supply power to house averaging 12,500 kWh/yr, leaving around 4,000 kWh/yr for the family to sell to the power company for profit. While the solar panels take up room in the yard, there is still space for the kids to play. The overall design was intended to be replicable and affordable which is achieved in a simple space that provides for a four person family.

**Conclusion**

In conclusion the I-Galaxy team has carefully planned out the details of the proposed zero energy home project. This facility will be beneficial in future developments.
Zero Energy Homes is an economically efficient design that efficiently performs its function due to the integration of key features such as the house being underground and the effective solar panels. Our product has stable revenue, and is environmental friendly. Our Zero Energy Home includes sophisticated choices in appliances and basic infrastructure which help keep the house at a modest but efficient price. Less focus seems to be on the adequate inclusion of future primary energy consumption. Besides generating and saving energy, our zero energy home also contains necessary rooms to accommodate the 4 person family, and other rooms to make the visit of the patrons more enjoyable. Here we have planned out a home which possesses the power to revolutionize the housing and energy market.

References

Eagle Valley Green Homes. ""Thinking about Buying or Building an Underground Home?"


i-Galaxy Energy Home

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Mission Statement

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Introduction

- Underground Home
- Energy efficient appliances
- Solar energy
- Customer needs
Design Process

- Product Selection
  - appliances
- Final Specifications
ZEH Calculator

- Complicated
- Helpful
- Gave a direction to research
Energy

- Solar Panels
- Batteries
- Energy output
- Energy consumption

<table>
<thead>
<tr>
<th>SOLAR PANEL INFO</th>
<th>MOUNTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Grid-tie Battery backup</td>
</tr>
<tr>
<td>Quantity</td>
<td>30 solar panels</td>
</tr>
<tr>
<td>Array Size</td>
<td>7500 Watts</td>
</tr>
<tr>
<td>Monthly Output</td>
<td>up to 1,000 kWh</td>
</tr>
<tr>
<td>Yearly Output</td>
<td>up to 12,500 kWh</td>
</tr>
<tr>
<td>Price</td>
<td>$18,281</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MOUNTING</td>
</tr>
<tr>
<td></td>
<td>Price</td>
</tr>
<tr>
<td>USA Std VS Flush Racking</td>
<td>$67.00</td>
</tr>
<tr>
<td>Surrette AGM Battery Bank</td>
<td>54.100</td>
</tr>
<tr>
<td></td>
<td>Total</td>
</tr>
</tbody>
</table>

TOTAL PRICE: $24,391
Layout
Conclusion

- Underground House
- Zero energy input/ energy output
- Meeting Customer Needs
Lessons Learned

• Utilizing the Design Process
• Developing projects as a team
• How to deal with changing teams
Questions