Team 02 – High Efficiency Housing H.E.H.

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Introduction

In this project, our group sought to create a set of recommendations for the design of a high efficiency house to be built as a renovated house for our clients, Professor Renard Tubergen and his wife, Cheri.

We considered a variety of systems in our analysis and design, including the structure and design of the house, the insulation and wall construction, water systems, electrical systems, and appliances. These options were analyzed based on total cost over ten-, twenty-, and thirty-year lifespans.

High efficiency housing is a subject that has seen great improvements over the last few decades, with new products and techniques becoming well researched and common among green builders. A highly efficient house is not only cheaper to heat and cool, but also offers a more comfortable living environment for residents.

Objectives

- Create a sample house design to use in our analysis
- Create a scale model layout of the house for clarity
- Create a list of recommendations from our analysis for thermal systems, water systems, and electrical systems
- Create a sample of the chosen wall cross section to demonstrate advanced framing techniques

Methods

House Layout

Investigate existing house layouts and talk with our clients about their preferences.

Thermal Analysis

Calculate the R-value of the house to analyze the energy flow between inside and outside.

Water Systems

Evaluated water appliances and a water recirculation system based on energy and required by the appliance and the cost of water used.

Electrical Systems

Evaluated clothes dryers, refrigerators and lighting options based on initial cost and cost of electricity used.

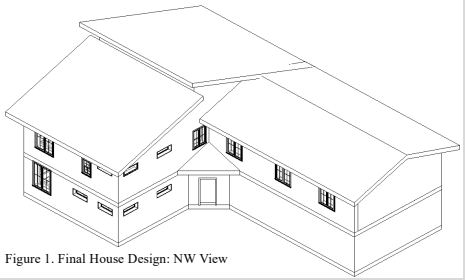


Figure 1. Final House Design: NW View

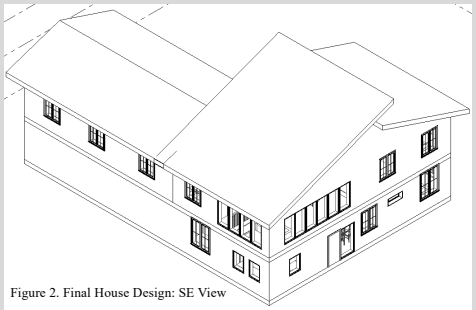


Figure 2. Final House Design: SE View

Results

The final house layout design is a four bed, four bath, 2400 square foot house shown in Figures 1 and 2 below.

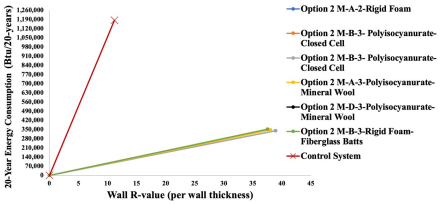


Figure 3. 20-year energy consumption comparison.

The thermal analysis shows that the optimal wall assembly results in an R-value of 38 for the walls, R-60 for the roof and R-47 for the first floor.

The analysis of water systems demonstrates that in this specific case, high-efficiency water appliances result in a lower cost over a 20-year period. However, the water recirculation system was not cost effective over any span of time.

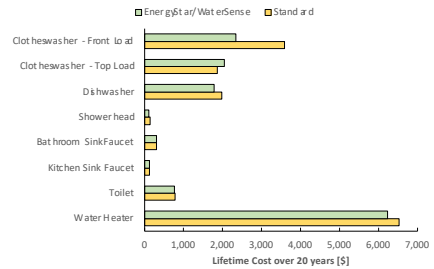
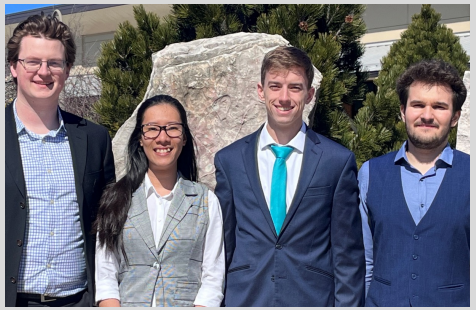


Figure 4. 20-year water appliance cost comparison.

The analysis of the electrical systems shows that high efficiency dryers (specifically heat pump dryers) are cost effective, that refrigerator cost is more dependent on door style than claimed efficiency, and that the best lighting style is high wattage LED light bulbs.



From Left: Aidan Bakker, Gia Mien Le, Nicholas Paternoster, Alin Stoica

Conclusions

Throughout our analysis in this project, we determined that higher efficiency building techniques and materials make a large impact on the efficiency of a house. A highly efficient design can achieve 70% energy savings over a 20-year lifespan for the same initial cost as a basic 2x4 framed walls house with fiberglass batting. High efficiency appliances also offer $10,145 in savings over a 20-year lifespan.

This project gave us the opportunity to learn more about how high efficiency housing works and implement it into a real-world scenario. We are also excited to carry this knowledge with us as we look towards eventually choosing our own housing.

Acknowledgements

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