

Design a Zero-Energy Building

Background

The client, a promising mid-size company, is committed to becoming a leader in the area of passive solar energy in residential buildings. According to the client, “all newly constructed buildings must consume nearly zero energy by the end of 2020.” The key to solving this challenge is finding a way to take advantage of the free and unlimited energy from the sun without compromising the thermal comfort of the buildings for the occupants.

Design Challenge

The client has submitted a request for proposals for a **zero-energy residential building**. They are looking for a design that consumes no net energy over a year.

Statement of Work

The client wants all energy-cost simulations to be performed using the Energy3D platform. This software is available for download at <http://energy.concord.org/energy3d>.

Criteria

A successful design must meet the following criteria:

- The total amount of energy that the building uses annually should be equal to or less than the total amount of renewable energy that it generates.
- Minimize total cost of the building (material cost)
- Should be easy to construct
- Should have an attractive exterior or “curb appeal”
- Comfortably fit a 4-person family (approximate building area 100-200 m² and height 6-10 meters) (default platform size is 12m x 16m)

Constraints

In addition there are geometric and budget limitations:

- The cost of building materials cannot exceed \$50,000
- Each side of the house must have at least one window on each floor.
- Tree trunks must be at least two meters away from the house.
- Solar panels cannot hang over roof edges.
- Roof overhang must be less than 50 centimeters wide (the default is 25 cm).
- A house is defined as a space enclosed by one and only one set of connected walls. Don't put multiple houses on the platform. Do not add entry porches, dormers, chimneys, garages, or driveways. Do not add additional buildings such as guest houses, dog houses, etc. **You can only build one house on the platform.**

Always document your work, especially your analyses about the energy performance, in the Note Area. Your notes will be automatically saved when you save your design.

ENGR 131 PROCESS

You will spend **four class periods** carefully planning, constructing, experimenting, analyzing, optimizing, and documenting your designs. You will develop a preliminary design developed individually and a final design developed in a team.

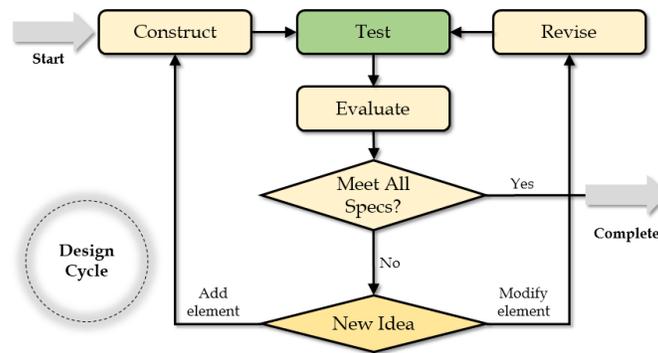
The Design Deliverables and the Statement of Work

- Preliminary design (completed individually, *see Design Specs Sheet*)
- Reflective design
- Final design (*see Design Specs Sheet*)
- Reflective design

Suggested Engineering Design Cycle Using Energy3D

At the beginning, you should explore a variety of design alternatives. Remember to compare the cost and energy performance data frequently. Energy3D can automatically calculate the annual energy usage for heating and cooling. Based on your evaluation of the results, you will decide how to improve the energy efficiency of the house. Meanwhile, your design must meet all the other specifications from the client.

There are a number of different design cycles you can use. Here is an example:



Evaluation of Design Process (30 points)

	WOW, this is expert-like behavior! ← 10 pts 0 pts → No evidence of informed design behavior	
Problem Scoping	<i>Asked questions, conducted investigations, interviews, observations and explored the real challenges early in the process and iterated when necessary</i>	<i>Did not engage in a deeper exploration of the problem</i>
Idea Generation	<i>Generated a large number of ideas. Used a variety of idea generations methods. Used multiple representations, built quick/simple prototypes to test ideas.</i>	<i>Fixated on a single idea</i>
Experimentation	<i>Gathered information, conducted experiments to evaluate alternative design solutions. Used graphics or other data to compare benefits and trade-offs of ideas.</i>	<i>Decisions are made in a haphazard way based on assumptions and no experimentation or information gathering</i>

Evaluation of How the FINAL Solution Meets Design Criteria (20 points)

Does the final solution meet the following criteria and constraints?

- There is only one house on the platform. (All calculations would be inaccurate if you have not met this constraint)
- The total amount of energy that the building uses annually should be equal to or less than the total amount of renewable energy that it generates. (x5)
- Total cost of the building is minimized and does not exceed \$50,000 in material cost (x5)
- Comfortably fit a 4-person family (approximate building area 100-200 m² and height 6-10 meters) (x2)
- Should be easy to construct (x2)
- Should have an attractive exterior or “curb appeal” (x2)
- Each side of the house must have at least one window on each floor.
- Tree trunks must be at least two meters away from the house.
- Solar panels cannot hang over roof edges.