

Renewable Energy Systems (ME 416/516)

Final Design Project

Analyze an existing small residential home to identify how to reduce the energy use from the baseline conditions. Document what improvements you would recommend by showing evidence of why the improvement is beneficial (energy savings, carbon savings, and/or cost savings). Evidence includes a written explanation and your calculations comparing the existing system to your proposed recommended improvement. You must include at least 1 RES in your recommended improvements.

Project Overview

Design a renewable energy system to achieve the following goals:

- 1) Achieve at least a 50% reduction in energy use compared to the baseline design - documented by BTU input required for both cases. (i.e. convert all energy use into Btu/yr AND show all calculations)
 - a. Detail the baseline energy use and energy cost
 - b. Detail your proposed system's energy use and energy cost
- 2) State why your system is an optimum investment. (i.e. - justify by your system costs and your return on investment)
- 3) Bonus
 - a. For energy reduction greater than 50%
 - b. For a better overall return on investment compared to the baseline case (note - you must document your cost estimates and include installation costs)

Building:

Single story, residential house
2"x12" roof construction - 11.25" Fiberglass Batt (R-38)
Wood, 2"x6" wall construction - 5.5" Fiberglass Batt (R-19)
Infiltration/ventilation = 0.45 Air Changes per Hour
Windows = 0.6 U-value, 0.4 SHGC

Base design:

Natural gas furnace, 78% efficiency
Electric air conditioning, COP = 2.5
70F temperature setpoint, 24/7

The minimum information required in your final report is outlined in the following table. All information must be documented by sample calculations, explanations of methods and appropriate documented sources for costs. Include detailed tables, charts, graphs, pictures, and other supporting information to fully document your analysis in order to achieve the maximum grade. Your analysis should be clear and well formatted.

Table of Required Information in Final Report

Parameter	Current	Proposed
Lighting Electrical Energy Use (kWh/yr)	720	
Cooling Electrical Energy Use (kWh/yr)	961	
Appliances & Plug Loads - Electrical Energy Use (kWh/yr)	2,650	
Other Electrical Load (if any)	0	
Total Electrical Energy Use (kWh/yr)	4,331	
Space Heating Fuel Energy Use (Therm/yr)	604	
Water Heating Fuel Energy Use (Therm/yr)	186	
Total Natural Gas Fuel Energy Use (Therm/yr)	790	
Other Energy (if any)	0	
Total Energy Use (MMBtu/yr)		
Pounds CO2 /yr Produced*		
Renewable Energy Generated (-MMBtu/yr)	0	
Total Net Energy Use (MMBtu/yr)		
% Conventional Energy Reduction		
CO2 Saved/yr* (total pounds & % savings)		
Total Return on Investment (simple payback period)		
Energy Savings/yr (total MMBtu/yr & % savings)		
Energy Cost Savings/yr (\$/yr)		

* use 1,380 lbs CO2 per megawatt-hour of delivered electricity

Table of Max Grade for Final Report

Parameter	Max Grade 416 / 516
50% Conventional Energy Reduction	70% / 0%
70% Conventional Energy Reduction	80% / 70%
80% Conventional Energy Reduction	90% / 80%
Net Zero	100% / 90%
100% RE (off-grid)	110% / 100%

Minimum: 1 RES added

**ME 416/516 Final Project
Base Assumptions for Current System**

Furnace efficiency	78%		
Furnace Natural Gas Use	604	Therm/yr	
Furnace - heat into house	47,112	MBtu/yr	30,000
Air conditioner SEER	13		
Air conditioner Elec. Use	961	kWh/yr	
Air conditioner - heat out of house	12,493	MBtu/yr	20,000
# of Lamps (60 W incandescent)	12		
Lighting (Average 'On time' per lamp)	1,000	hr/yr	
Total Lighting W	720		
Lighting Elec. Use	720	kWh/yr	
Water Heater Energy Factor (50 gal tank)	54%	EF*	
Water Heater Natural Gas Use	186	Therm/yr	
Hot Water - average use (125F)	44	gal/day	
Appliances & Plug Loads Elec. Use (Conventional Appliances)	2,650	kWh/yr	

*Energy Factor (EF) is an annual measure of the useful energy coming out of your water heater divided by the amount of energy going into the water heater to heat the water.

Table of Energy Costs

Parameter	Metric
Natural Gas	\$0.90/therm
Electricity	\$0.10/kWh
Electricity (sale price back to electric utility)	\$0.04/kWh
Diesel (off-road)	\$3.00/gal
Biomass / wood	\$225/cord