

Physics and Mathematics of Sustainable Energy

Homework Four

College of the Atlantic

Due April 25, 2014

- Suppose it is -10 C outside and your thermostat is set at 15 C . By what fraction would your heating bill decrease for that day if you set your thermostat to 13 C instead?
- These questions concern the figures on pages 148–50 of McKay.
 - Suppose you have 100 units (kWh) of natural gas and you want to use 60 of those units for electricity and 40 for heat. Assume that you are using a condensing gas boiler and that electricity is generated in a power plant that is 49% efficient. What amount of electricity and what amount of heat would you get?
 - What if you used a traditional electric heater to generate the heat instead of your gas furnace? (I.e., you use all 100 units to make electricity, and then you take 40% of that and use it to make heat in an electric heater in your house.) What amount of electricity and what amount of heat would you get?
 - Now suppose that you use a heat pump to generate the heat. What amount of electricity and what amount of heat would you get? Assume that the heat pump has a COP of 4, and that there is an 8% loss due to transmission in the grid.
- Optional.** (Do this if you want to get a feel for some of the numbers behind the heat loss formulas I presented in class. I don't think these problems are essential to understanding heating issues.) Consider a two-story house that is 50 feet by 20 feet. Assume the air in the house changes once every hour, and that the overall R value for the house is 15. The house is in Bar Harbor, where the degree days per year are around 7500.
 - Determine an approximate value for the average power needed to heat this house. This is a multi-part question—be sure to make your steps clear and state any assumptions that you make. Express your answer in BTU/h and kWh/d.
 - Assume that you provide heat for this house by burning fuel oil in a furnace that is 70% efficient. How many gallons of fuel would you need to use in one year. (There is a chart on page 199 of MacKay that will be useful.)
 - How much would this fuel oil cost in Maine?
 - How much greenhouse gas would be emitted as a result of burning this fuel? (There is a chart on page 335 of MacKay that has some useful info.)