Thermal Energy

Physics and Mathematics of Sustainable Energy

College of the Atlantic. Fall 2019

1. Consider a house that is 2000 square feet. Assume that the ceilings are 8 ft. Let's say that it is 0 degrees C outside and you want the air inside your house to be 20 degrees.

   (a) Estimate how much energy it would take to raise the air in this house 20 degrees C. Express your answer in Joules, kWh, and BTU.
   (b) If the air in this house changes every two hours, what is the daily energy needed for heat? How much would this cost in Maine if this heat was electric?

2. A 1kW electric heater corresponds to how many BTU/hr?

3. Cottage House uses around 80 MMBTU per year of heating oil.

   (a) How many gallons of fuel is this?
   (b) Convert this to kWh.
   (c) How many tons of CO_2 does burning this oil release into the atmosphere?
   (d) How many tons is this per person? How many kWh of energy is used per person per day?

4. Your heating bill for January is 200 Euros. The average outside temperature is 10. If you turned you thermostat from 25 to 22, what would your heating bill be?

Some Conversions are below. This info, and so much more, is in Appendix D of the textbook.

- Specific Heat of Water $\approx$ 4200 J/L·K
- Specific Heat of Air $\approx$ 1200 J/m^3·K
- 1 kWh = 3412 BTU
- 1 BTU = 1055 J.
- 1 MBTU = 1000 BTU
- 1 MMBTU = 1,000,000 BTU

Calorific values of fuels:

- Gasoline: 13.0 kWh/kg, 34.7 MJ/L
- Coal: 8.0 kWh/kg
- Propane: 13.8 kWh/kg, 25.4 MJ/L
- Natural gas: 14.85 kWh/kg, 0.04 MJ/L
- Heating oil: 12.8 kWh/kg, 37.3 MJ/L
- Kerosene: 12.8 kWh/kg, 37 MJ/L
- Wood: $\sim$4–5 kWh/kg

Carbon intensity of fuels (gCO_2/kWh):

- Natural gas: 190
- Propane: 217
- Gasoline: 240
- Diesel: 250
- Fuel oil: 260
- Coal: 300