Thermal Energy: Home Heating

Physics and Mathematics of Sustainable Energy

College of the Atlantic. Fall 2019

1. Suppose that you set your thermostat at 22 degrees C and in January you used 15 MMBTU of heating oil to keep your house warm. The average outside temperature in January is -6 degrees C. The current average cost of heating oil in Maine is $2.61 per gallon.

   (a) How many gallons of fuel is this?
   (b) How much would this fuel cost?
   (c) How much CO2e would be emitted from burning this fuel?
   (d) If you turned your thermostat from 22 to 18, how much less fuel would you use? Express your answer as percent. I.e., N% less fuel.
   (e) How much would you save on your heating bill?
   (f) How much less CO2e would be emitted?

2. A modern gas turbine converts thermal energy (heat) to electricity with an efficiency of 60%.

   (a) If you burn gas in the turbine, and the gas produces 1000 kWh of thermal energy, how much electricity would be generated?
   (b) How much thermal energy from gas would you need to generate 1000 kWh of electricity?

3. Suppose you want 100 kWh of heat to keep your house warm on a cold Maine day. If you generate this heat with a traditional electric heater, how much CO_2 is released as a result?

4. If you generate this heat with a furnace burning heating oil and the efficiency of the furnace if 83%, how much CO_2 would be released?

5. If you generate this heat with a heat pump with a COP of 3, how much CO_2 would be released?

The calorific value of heating oil is: 12.8 kWh/kg or 37.3 MJ/L or 139,000 BTU/gallon.
Getting kWh of thermal energy from burning heating oil will produce 260 grams of CO2.