

More Thermal Energy and Home Heating

Physics and Mathematics of Sustainable Energy

College of the Atlantic. October 12, 2023

1. A certain house in Maine uses 500 gallons of heating oil each winter. The furnace is 80% efficient.
 - (a) How much does this fuel cost?
 - (b) What is the heating load of the house? (I.e., how much of the thermal energy released by burning the fuel ends up in the home?) Express your answer in BTU and kWh.
 - (c) What are the emissions associated with burning this amount of fuel?
2. You want to generate the same amount of heat with a heat pump with a COP of 3:
 - (a) How much electricity would this require?
 - (b) How much would this cost in Maine?
 - (c) How much CO₂ would be released as a result if:
 - i. The carbon intensity of electricity generation is 700 grams/kWh.
 - ii. The carbon intensity of electricity generation is 350 grams/kWh.
 - iii. The carbon intensity of electricity generation is 50 grams/kWh.

- $1 \text{ kWh} = 3.6 \text{ MJ} = 3412 \text{ BTU}$
- $1 \text{ MMBTU} = 1,000,000 \text{ BTU}$
- Calorific value of heating oil: 12.8 kWh/kg, 37.3 MJ/L, 139,000 BTU/gallon
- Carbon intensity of heating oil: 260 g of CO₂ per kWh of thermal energy. 10.2 kg CO₂ per gallon of fuel.
- 1 gallon = 3.8 liters
- Current average cost of heating oil in Maine: \$4.10/gallon.
- btw, the cost of electricity in our part of Maine recently increased to 30.2 cents per kWh.