More Thermal Energy

Physics and Mathematics of Sustainable Energy

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1. In 2015–16 the Seafox Dormitory used 3185 gallons of heating oil.
   (a) How much would this fuel cost?
   (b) How much energy thermal energy is this? Answer in BTUs, MMBTUs, and kWh. Put this number into context.
   (c) How much carbon dioxide is released into the atmosphere as a result of burning this fuel? Put this number into context.
2. Suppose the Seafox furnace is 70% efficient. In that case, how much of the thermal energy from burning the oil ends up inside Seafox? This quantity is known as the *heating load*.
3. Suppose we replaced the Seafox furnace with one that is 90% efficient.
   (a) How much fuel would we need to heat Seafox with this more efficient furnace?
   (b) How much money would you save in one year?
   (c) How much less CO_2 would be emitted in one year?
4. 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:
   (a) How much CO_2 is released as a result? (Assume a carbon intensity for electricity generation of 350g/kWh.)
   (b) How much would this cost in Maine?
5. If you generate this heat with a furnace burning heating oil and the efficiency of the furnace is 80%:
   (a) How much CO_2 would be released as a result?
   (b) How much would this cost in Maine?
6. If you generate this heat with a heat pump with a COP of 3:
   (a) How much CO_2 would be released as a result?
   (b) How much would this cost in Maine?

- 1 kWh = 3.6 MJ = 3412 BTU
- 1 MMBTU = 1,000,000 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 CO_2 per kWh of thermal energy. 10.2 kg CO_2 per gallon of fuel.
- 1 gallon = 3.8 liters
- Current average cost of heating oil in Maine: $2.80/gallon.