Thermal Energy: Different Forms of Home Heating

Physics and Mathematics of Sustainable Energy

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1. Suppose you want 100 kWh of heat to keep your house warm on a cold Maine day. If you generate this heat with a resistive electric heater:
   (a) How much electricity would you need?
   (b) How much CO_2 is released as a result?
   (c) How much would this cost in Maine?

2. If you generate this heat with a propane furnace and the efficiency of the furnace is 80%:
   (a) How many gallons of propane would you need?
   (b) How much CO_2 would be released as a result?
   (c) How much would this cost in Maine?

3. If you generate this heat with a heat pump with a COP of 3.5:
   (a) How much electricity would be required to generate this heat?
   (b) How much CO_2 would be released as a result?
   (c) 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
- Calorific value of propane: 91,600 BTU/gal.
- Carbon intensity of propane: 5.75kg/gal or 215g/kWh.
- Carbon intensity of heating oil: 260 g of CO_2 per kWh of thermal energy. 10.2 kg CO_2 per gallon of fuel.
- Carbon intensity for electricity in Maine: approx 320g/kWh.
- Current average cost of heating oil in Maine: \$3.34/gallon.
- Cost of electricity in Maine \$0.32/kWh.
- Current cost of propane in Maine: \$2.88/gal.