

# Heat Pumps

## Physics and Mathematics of Sustainable Energy

College of the Atlantic.

- 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 traditional electric heater:
    - (a) How much CO<sub>2</sub> is released as a result? (Assume a carbon intensity for electricity generation of 400g/kWh.)
    - (b) How much would this cost in Maine?
  0. If you generate this heat with a furnace burning heating oil and the efficiency of the furnace is 80%:
    - (a) How much CO<sub>2</sub> would be released as a result?
    - (b) How much would this cost in Maine?
  1. Suppose you want to get 100 kWh of heat into your house by using a heat pump with a COP of 3.
    - (a) How much electrical energy you need to use to pump this much heat?
    - (b) How much would this cost in Maine?
    - (c) How much CO<sub>2</sub> would be released as a result?
  2. The EnergyGuide for a heat pump is shown in Figure. 1. Convert its HSPF into a COP.
  3. A resistive electric heater has a COP of 1. Convert this into an HSPF.
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- 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<sub>2</sub> per kWh of thermal energy
  - 1 gallon = 3.8 liters
  - Current average cost of heating oil in Maine: \$2.30/gallon.
  - Cost of electricity in Maine \$0.168/kWh.

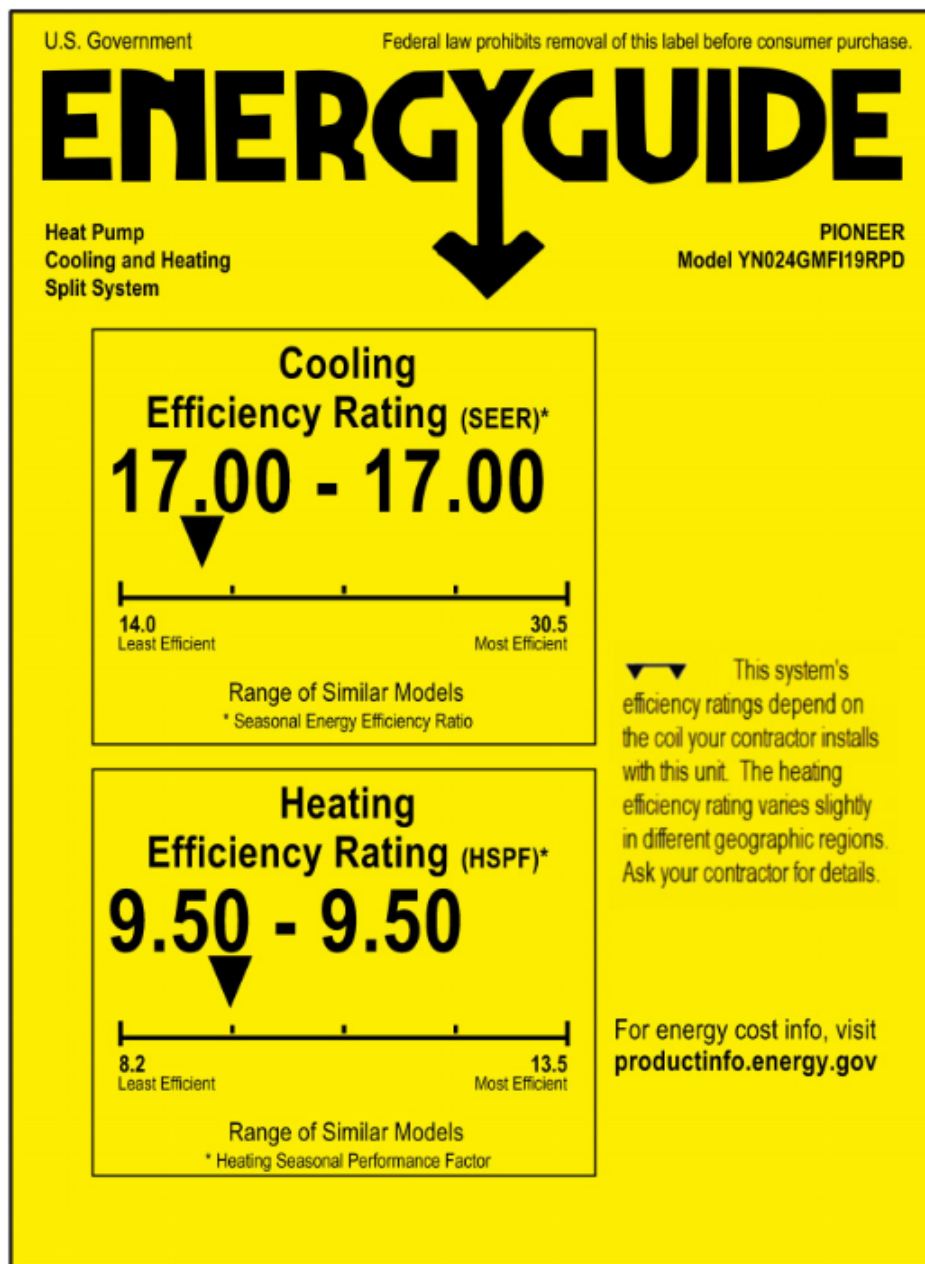


Figure 1: EnergyGuide for the Pioneer Model #WYS024GMFI19RL-16 24,000 BTU Heat pump.