

Thermal Heat Pumps – A New Paradigm For Water Heating



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**ENERGY CONCEPTS
COMPANY**

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Heat Pump Classification



- Motive Power
 - Electricity: Electric Heat Pump (EHP)
 - ✦ *Reverse Rankine cycle*
 - ✦ Reverse Brayton cycle
 - ✦ Magnetic
 - ✦ Acoustic
 - Thermal energy (low grade heat): Thermal Heat Pump (THP)
 - ✦ *Absorption Heat Pump (Type I, Type II, AHP)*
 - ✦ Adsorption Heat Pump
 - ✦ Rankine – Reverse Rankine
 - ✦ Steam Jet Ejector
- Function
 - Heat pumping only
 - Heat pumping plus chilling (EHP/C, THP/C)

Sources of Thermal Power for THPs



- **Fossil fuel**
 - Natural gas
 - Oil
 - Coal
- **Waste heat**
 - Exhaust heat
 - Process heat
 - Jacket water
- **Solar thermal**
- **Biomass**
- **Geothermal**

Prime Energy Efficiency of Fossil Fuel Powered Heat Pumps



- EHP plus grid power
 - COP of EHP: 4
 - Efficiency (average) of grid: 33%
 - Overall COP (fuel to heat): **1.32**
- THP
 - COP of THP: 1.6
 - Efficiency of burner: 85%
 - Overall COP: **1.36**

Heat Pump System Components



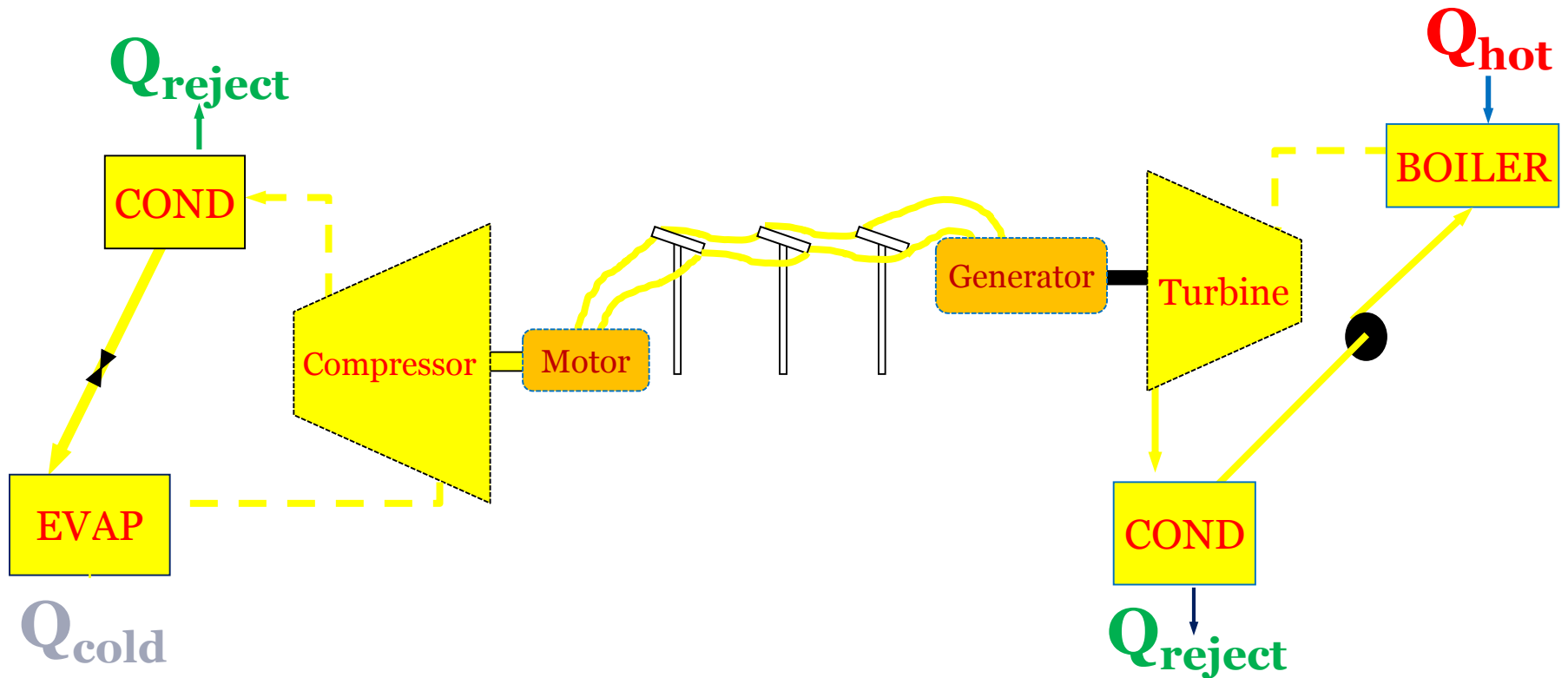
○ EHP

- ✦ Compressor & Motor
- ✦ Heat exchangers
- ✦ Electricity for motor
 - Turbine & Generator
 - Switch Gear
 - Heat Exchangers (intercooler, after cooler)

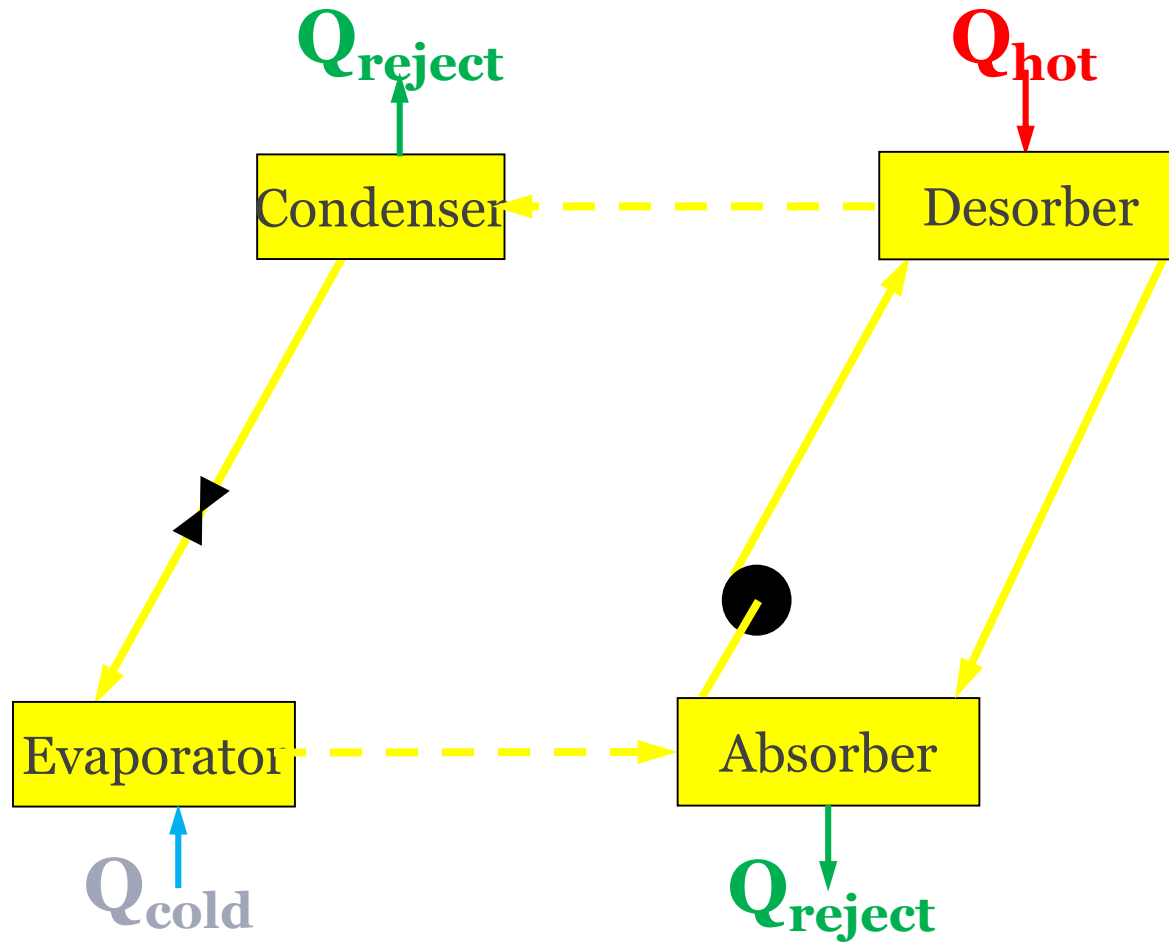
○ THP

- ✦ Absorption Refrigeration Unit
 - Heat Exchangers
 - Pumps

Heat Pumping from Electricity: motive fuel at power plant



Heat Pumping from Fuel or Heat: a Better Way



THP COMPARISON TO EHP



- Comparable Source COP
- Usually lowest operating cost
- Reduces peak electric load
- Lower cold end temperatures –cold climate benefit
- Better match for ground source coupling
- More durable hardware – no large rotating components with lubricated bearings
- Less noise
- Diverse fuels and motive heat sources possible:
 - Natural gas, oil, coal, biomass
 - Waste heat
 - Solar thermal heat
 - Geothermal heat (motive or cold end)
- Not fuel switching – no spark spread susceptibility

ECONOMIC COMPARISON OF THP TO EHP



- **Two Therm/hour THP (270,000 BTU/hour output)**
 - COP 1.6
 - Saves 1.2 therm/hour
 - @ \$1 per therm, saves \$1.20/hour (\$1.12 after parasitics)
 - @ 4000 hours/year of use, saves **\$4,500/year**

- **270,000 BTU/hour EHP**
 - COP 4
 - Saves 3.2 therm/hour; consumes 19.9 kW
 - @ \$.15 per kWh, operating cost \$2.99/hour
 - @ \$1 per therm, saves \$0.21/hour
 - @ 4000 hours/year of use, saves **\$840/year**

THP/C ECONOMIC PROSPECT

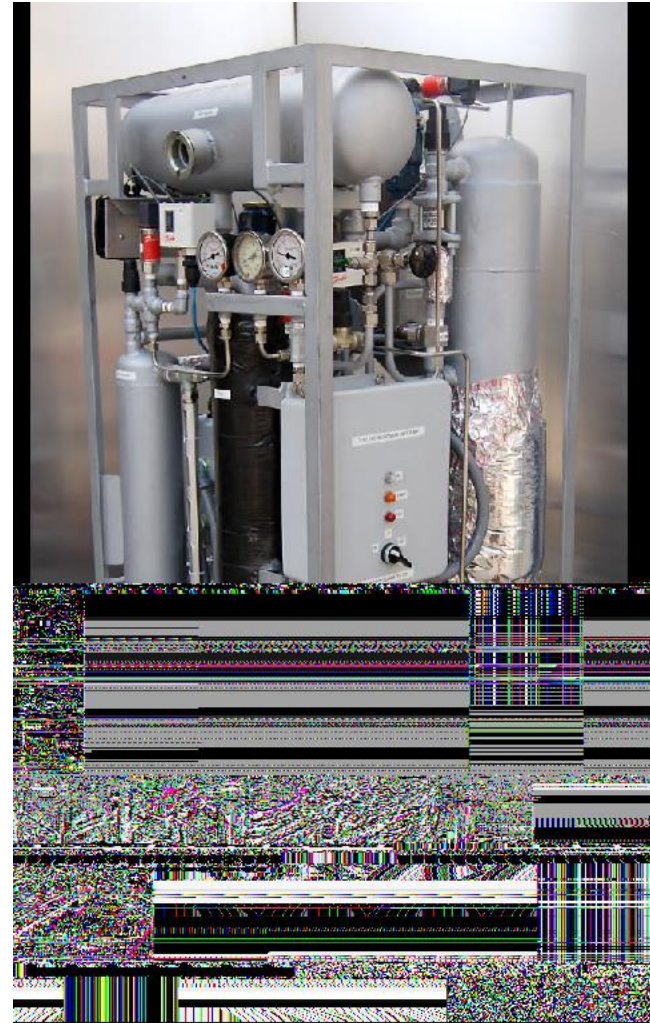


- **Product: Two therm/hour THP/C**
 - Delivers 3.2 therm/hour performance (270,000 BTU/hour heating)
 - Chilling dividend 8.5 tons
- **Energy Savings**
 - Natural gas – 1.2 therm/hour (\$1.20/hour)
 - Electricity – $8.5 \times 0.7 \text{ kW/ton} \times \$0.15/\text{kWh} = \$0.89/\text{hour}$
 - @ 4000 hours/year utilization, **\$8360** savings per year
- **Capital Cost projection**
 - Cost of manufacture - \$12K
 - Selling price - \$22K
 - Installed price - \$34K
 - Capacity offset - \$-12K
 - Net installed cost - \$22K
- **Payback: 2.6 years** (before incentives)

Seven Ton Thermal Heat Pump



- Produces 220,000 BTU/hour hot water at 136°F plus seven tons chilling at 44°F
- Saves 6 kW plus one therm/hour

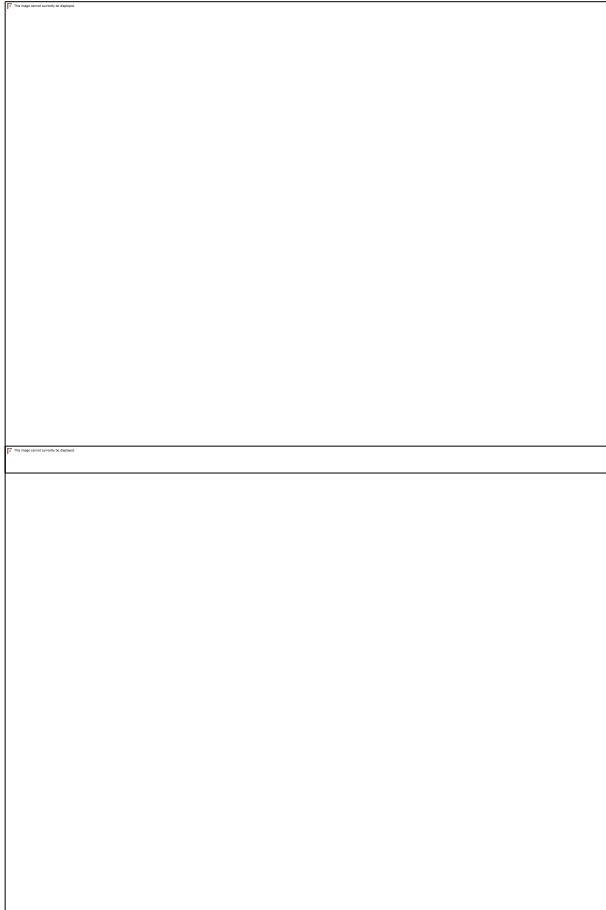


150 TON THP AT A PAPER MILL

- 4.8 million BTU/hour of 130°F hot water
- 150 tons of 35°F chilled water
- Powered by 3000 lb/hour 40 psig steam
- Saves 21 therms/hour and 145 kW



300 Ton Thermal Heat Pump at a Meat Packing Plant



- 300 tons chilling @ 38°F
- 9.6 MBH water heating @ 132°F
- powered by 6 MBH of 95 psig steam
- footprint: 7 ft x 11 ft
- NH3 charge: 800 pounds
- Saves 285 kW plus 40 therms/hour

CONCLUSIONS – THERMAL HEAT PUMPS



- Fossil energy efficiency of THP comparable to that of state-of-art EHP
- Operating savings of THP markedly higher than EHP
- THP/C has even higher efficiency and savings
- THP/C supplies 2.2 units of utilities from one unit of heat input (NG, waste heat or solar)
- Saves both gas and electricity – not fuel switching
- A long-overlooked technology with major energy-saving potential