Cooling Production (316)

Lalit Agarwal - EnergyCAP

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Purpose of Today's Presentation

To provide a broad understanding of central cooling production systems

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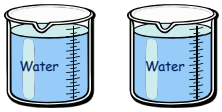
Water - Ideal Heat Transfer Fluid

Specific Heat of Water

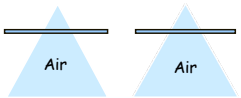
1 BTU/lb



75°F *Plus 1 BTU =* **76°F**

Specific Heat of Air

0.24 BTU/lb



75°F *Plus 4 BTUs =* **76°F**

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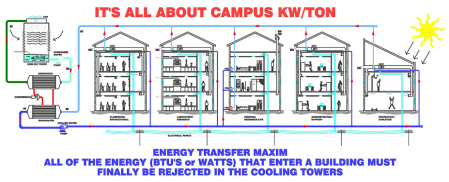
All heat rejected



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Why is this important?

Nearly 50% of the energy consumed in a building can be attributed to the HVAC system.

In the U.S., HVAC systems are estimated to account for 20% of the total energy used.

Source: Pérez-Lombard, L., Ortiz, J., & Pout, C. (2008). A review on buildings energy consumption information. *Energy and Buildings, 40*(3), 394-398.

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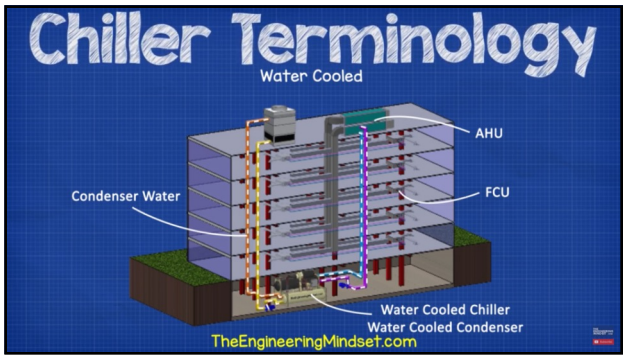

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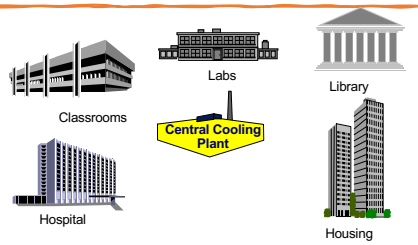
District Cooling



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Central Cooling Systems Advantages

- Integrated solutions
- Less equipment
- Lower service cost
- Better space utilization
- Alternate technological option
- Lower operating costs
- Better management and energy control
- Higher overall efficiency
- Multiple fuel capabilities
- Aesthetic

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Central Cooling System Disadvantages

- High first cost
- Inflexible once constructed
- Distribution losses
- Need for specialized technicians

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Chilled Water System Components

- Chillers
  - Vapor-compression (Variety of compressor designs
  - Absorption
- Condensers (air cooled or water cooled)
- Evaporators (the heat sponge)
- Pumps & Piping
- Air Handlers

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Chillers

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Chillers

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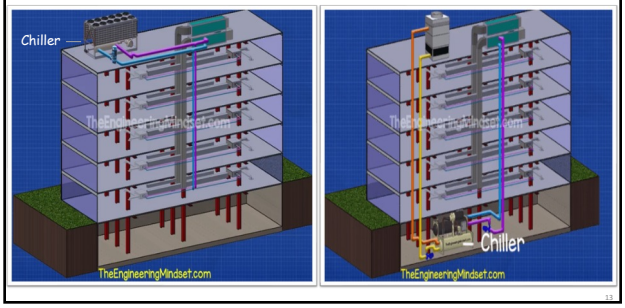
Air Cooled Chiller

Water Cooled Chiller



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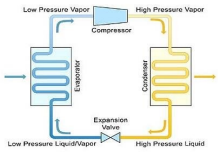
Refrigeration Cycle

- **Primary Components**
  - **Compressor**
  - **Condenser**
  - **Evaporator**
  - **Throttling device**



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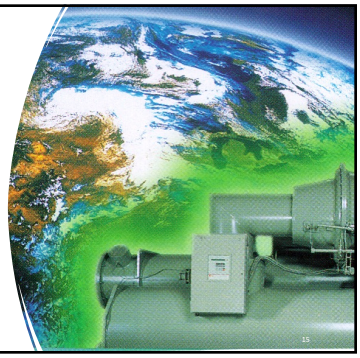
Refrigerants Issues

- Increasing cost of refrigerants
- Global warming vs. ozone depletion
- Alternative refrigerants
- Regulatory



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Types of Prime Movers (Modern Pumps)

- Electric motor
- Steam turbine
- Combustion turbine
- Combustion engine (diesel or gasoline)

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Chiller Types

- Centrifugal
- Rotary/Screw
- Absorption

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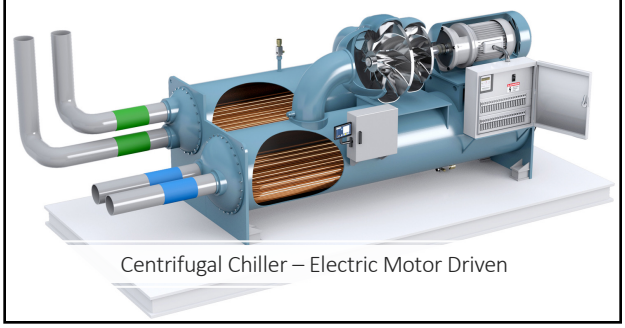

Centrifugal Chiller – Electric Motor Driven

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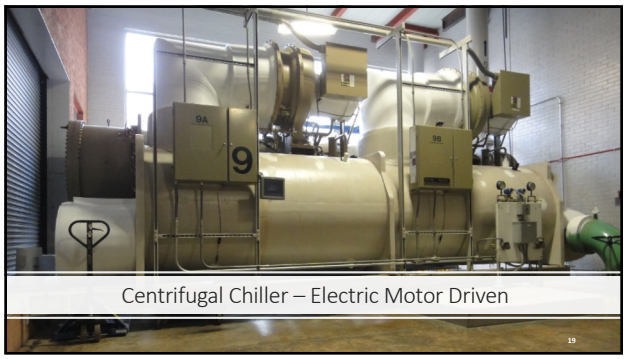

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Horsepower, Voltage, Tons of Refrigeration Correlation

Horsepower Range	Operating Voltage	Tons of Refrigeration
100 - 500	**480 - 2,400**	**21 - 106**
500 - 5,000	**2,400 - 5,000**	**106 - 1,060**
5,000 - 10,000	**5,000 - 12,000**	**1,060 - 2,120**

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Horsepower Required for Common Chiller Sizes

Common Chiller Sizes	Horsepower Required
600 Tons of Refrigeration	**2,830**
1,200 Tons of Refrigeration	**5,659**
2,000 Tons of Refrigeration	**9,432**
5,000 Tons of Refrigeration	**23,580**

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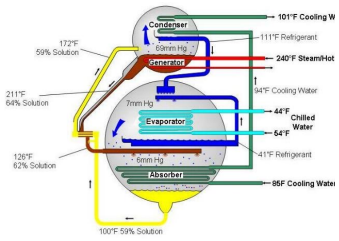
Absorption Chiller



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Absorption Chiller

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Condensors

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Condenser Types

- Air Cooled
- Water Cooled

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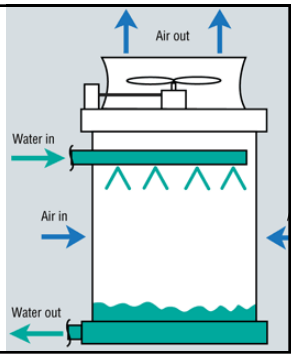
Cooling Towers

Rejects unwanted heat from campus



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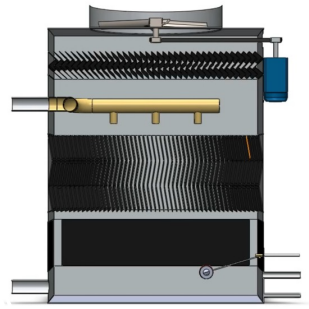
Cooling Tower



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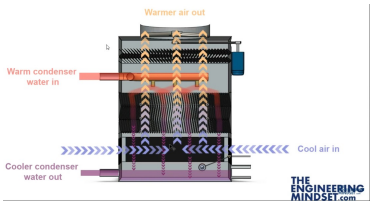
Cooling Tower



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Cooling Towers Examples

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Cooling Towers Examples

- Hidden in parking garage

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Cooling Tower Examples

University of Illinois

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Cooling Tower Examples

University of Arizona

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Other Components/Technologies

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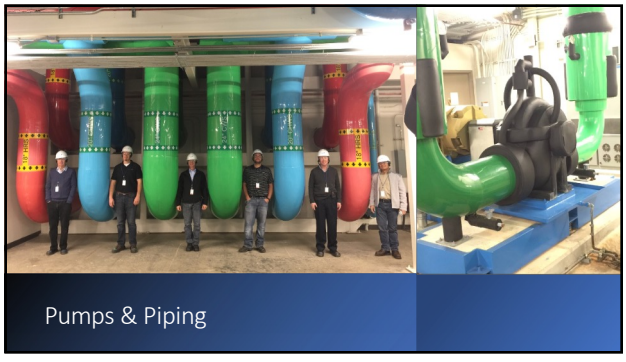

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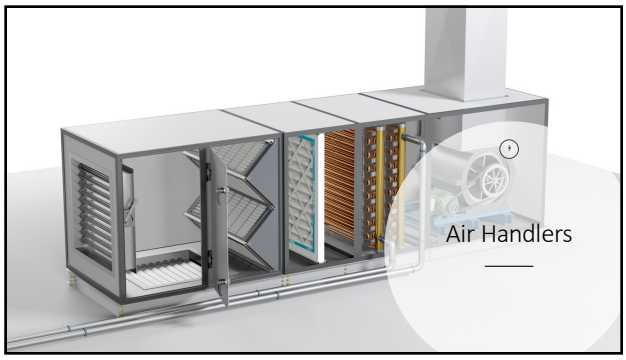

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Thermal Energy Storage

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Ice Storage

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Thermal Energy Storage

- Benefits
  - Shifting system load demand
  - Stability of cooling capacity
  - Dual-duty operation
  - Managing energy costs
  - Reduction in demand charges

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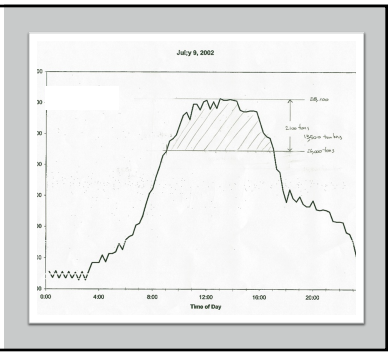
Cooling Load Profile Shaving the Peak with TES



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Control / Reduce Energy Costs

- Chillers
  - Variable speed drive
  - Mechanical unloading
- Towers
  - Variable speed drives on fans and pumps
- Distribution Pumps
  - Variable speed drives on pumps
- Good Maintenance
- Metering / Analytics
- Thermal Energy Storage
- Free Cooling

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Questions

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