APPA Institute for Facilities Management

Energy & Utilities

Cooling Production (316)

Mark St. Onge, EFP

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Purpose of Today's Presentation

To provide a broad understanding of central cooling production systems

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Agenda

- **Introduction**
  - Central energy systems
  - Advantages and disadvantages of central energy systems
- **Chilled water system components**
- **Ways to reduce energy consumption**

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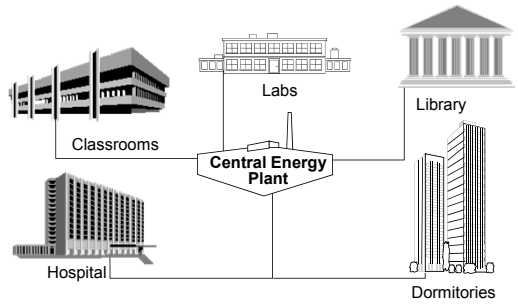
Central (District) Energy



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Central Energy Systems

Advantages

- **Integrated solutions**
- **Less equipment**
- **Lower service cost**
- **Better space utilization**
- **Alternate technological option**

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Central Energy Systems

Advantages (cont.)

- **Aesthetic options**
- **Lower operating costs**
- **Better management and energy control**
- **Higher overall efficiency**
- **Multiple fuel capabilities**

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Central Energy System

Disadvantages

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

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Why is this important?

As noted by Pérez-Lombard (2008):

- **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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Chilled Water System Components

- **Chillers**
- **Cooling Towers / Condensers**
- **Pumps & Piping**
- **Air Handlers**

IT IS ALL ABOUT MOVING BTU'S!

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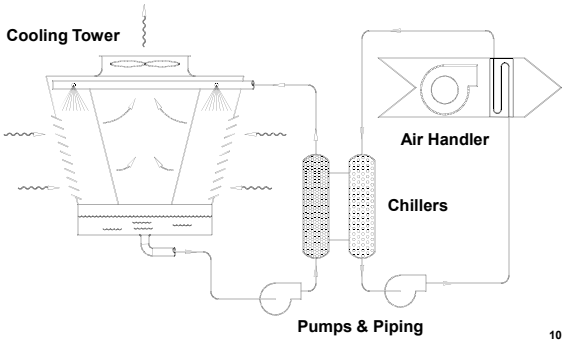
Chilled Water System



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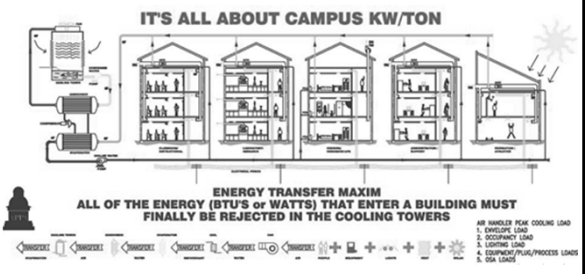
It's All About BTUs



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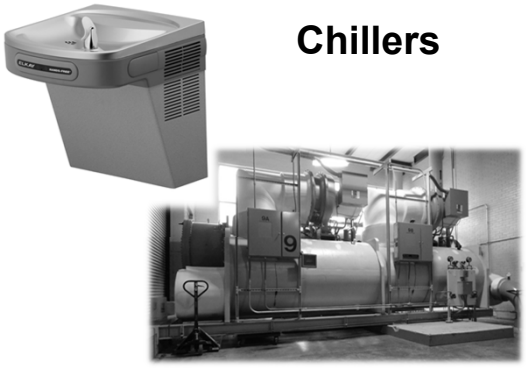
Chillers



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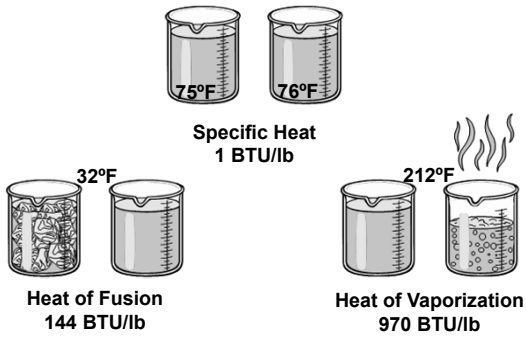
MSO1

Water - Ideal Heat Transfer Fluid



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Refrigeration Cycle

Primary Components:

- **Compressor**
- **Condenser**
- **Evaporator**
- **Throttling device**

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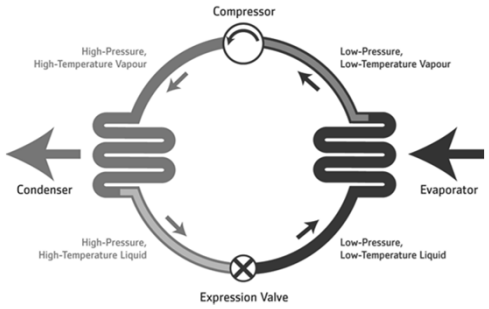
Refrigeration Cycle



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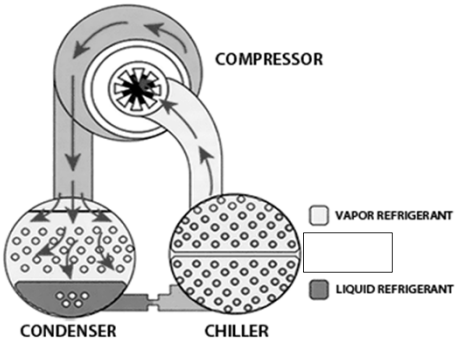
Refrigeration Cycle



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Refrigerants

Issues

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

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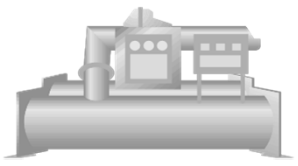
Chilled Water System Components

Chillers

3 Types:

- Centrifugal
- Rotary
- Absorption



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Types of Prime Movers Used for Modern "Pumps"

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

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Horsepower, Voltage, Tons of Refrigeration Correlation

Horsepower Range	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

Source: www.kylesconverter.com

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Horsepower Required for Common Chiller Sizes

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

Source: http://www.kylesconverter.com

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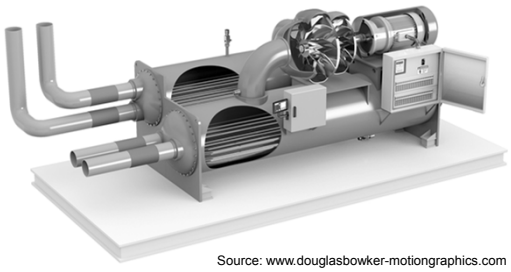
Chilled Water System Components: Chillers



Source: www.douglasbowker-motiongraphics.com

Centrifugal Chiller, Electric Motor-Driven

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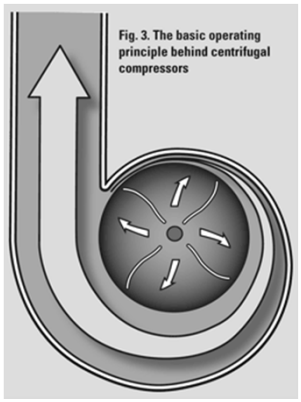

Source: www.maintenancetechnology.com

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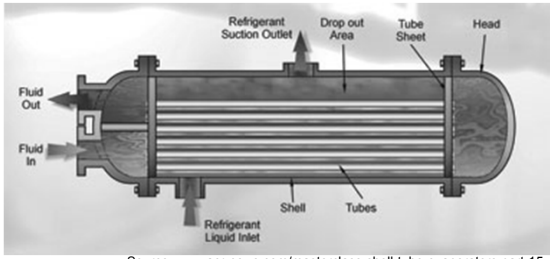
Chilled Water System Components: Chillers



Source: www.acr-news.com/masterclass-shell-tube-evaporators-part-15

Chiller Barrel (heat exchanger)

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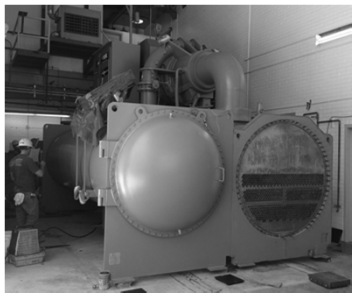
Chilled Water System Components: Chillers

Condenser



Evaporator

Chiller Barrels (heat exchangers)

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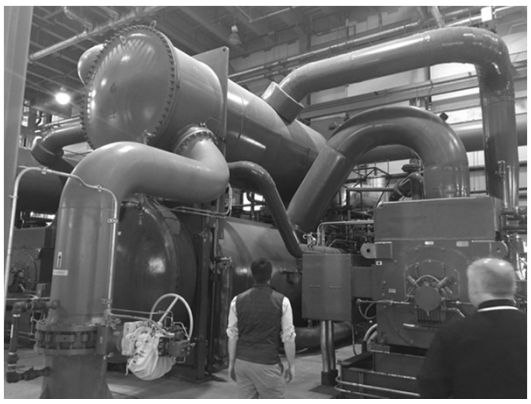

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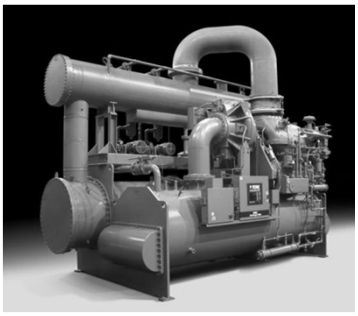
Chilled Water System Components: Chillers



Centrifugal Chiller, Steam-Driven

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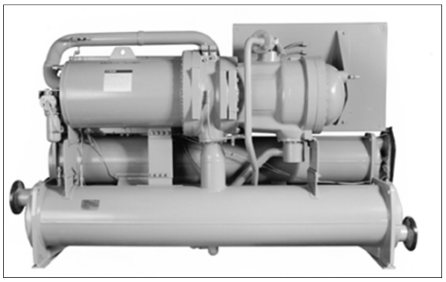
Chilled Water System Components: Chillers



Screw Chiller, Electric Motor-Driven

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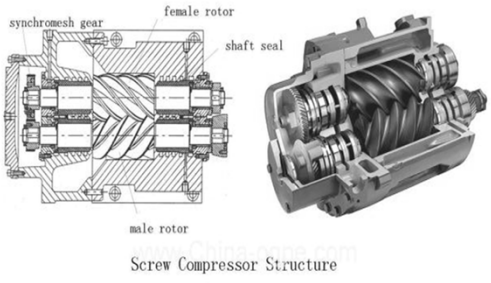
Chilled Water System Components: Chillers



Screw compressor cut-away

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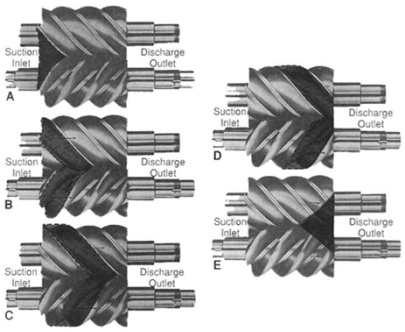
Screw Compressor



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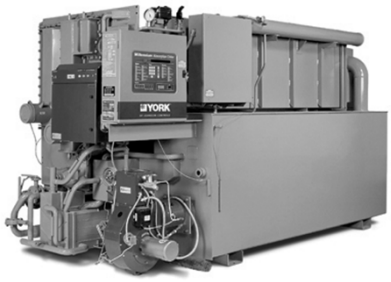
Chilled Water System Components: Chillers



Absorption Chiller, Steam Driven

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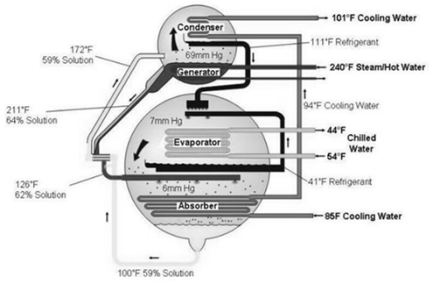
Chilled Water System Components: Chillers



Single Stage Steam-Fired Absorption Chiller

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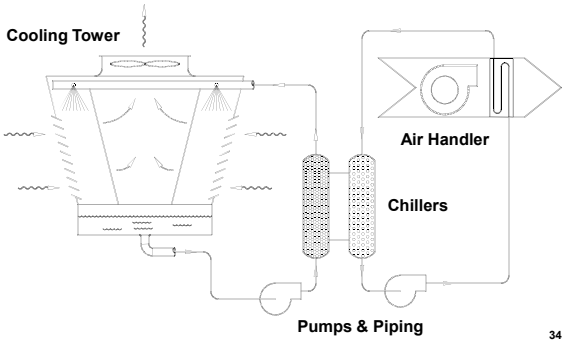
Chilled Water System



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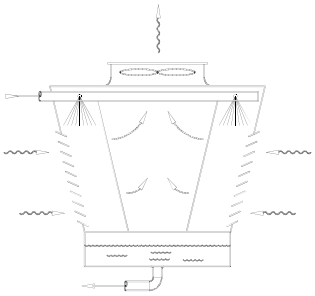
Chilled Water System Components

Condensers

- Air Cooled
- Water Cooled



Cooling Towers

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Refrigeration Condensers

Air Cooled

Water Cooled

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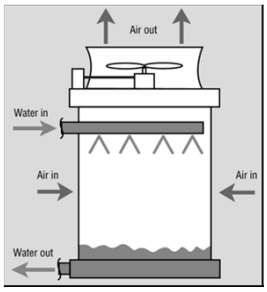
Chilled Water System Components: Cooling Towers



Rejects unwanted heat from campus

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What Makes a Cooling Tower Work?

WET BULB

RANGE

FILL

AIR FLOW

APPROACH

L/G RATIO

TRANSFER UNITS

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Induced Draft Crossflow (Double Air Entry)

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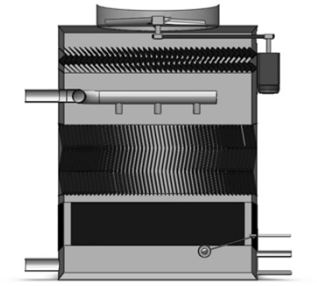
Cooling Tower



THE ENGINEERING MINDSET.com

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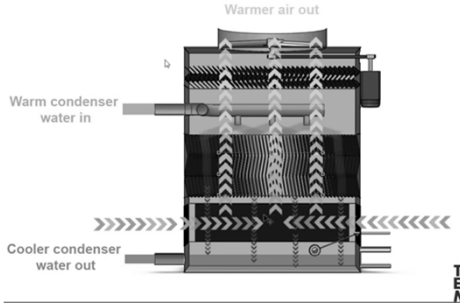
Cooling Tower



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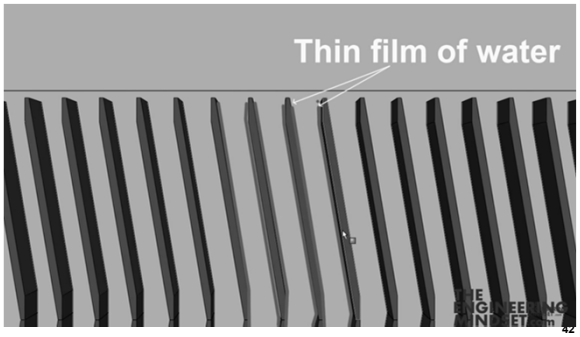
Cooling Tower



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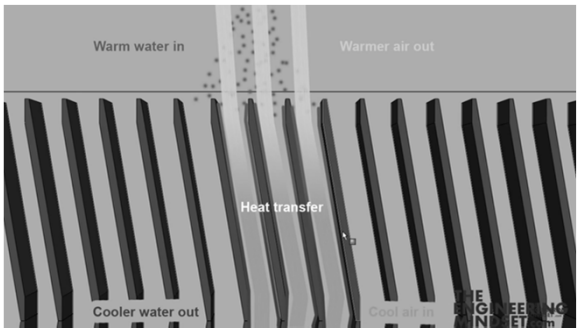
Cooling Tower



Chilled Water System Components: Cooling Towers

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Chilled Water System Components: Cooling Towers

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University of Illinois

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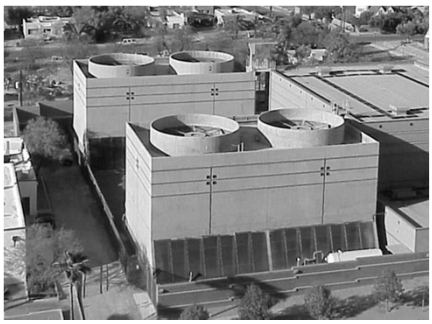
University of Arizona



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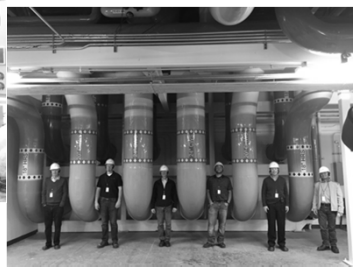
Pumps & Piping



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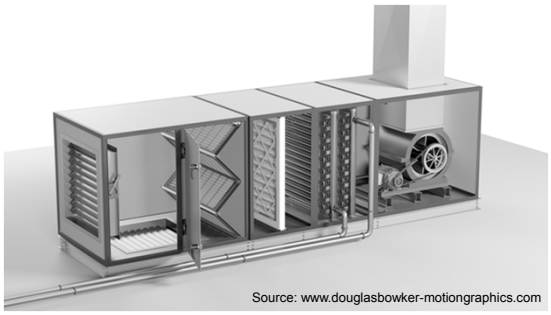
Air Handlers



Source: www.douglasbowker-motiongraphics.com

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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
- Metering / Analytics
- Thermal Energy Storage
- Free Cooling

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Free Cooling?

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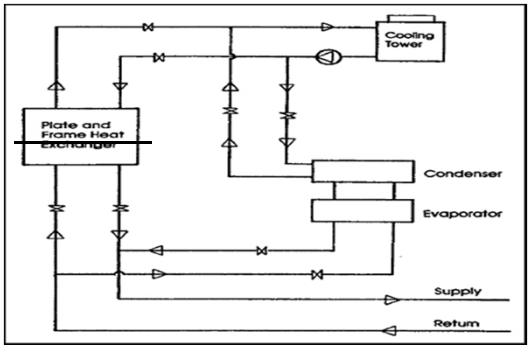
Free Cooling



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Thermal Energy Storage

Chilled water storage tank

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Thermal Energy Storage

Ice Storage Tanks

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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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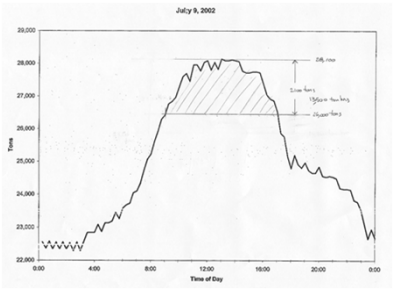
Cooling Load Profile Shaving the Peak with TES



Summer "On-Peak" Electrical Rate 2:00 pm – 8:00 pm

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Questions / Comments

Sign-in Sheet / Evaluation Form

Mark St. Onge
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