THERMAL PRODUCTION

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AIA Continuing Education Provider

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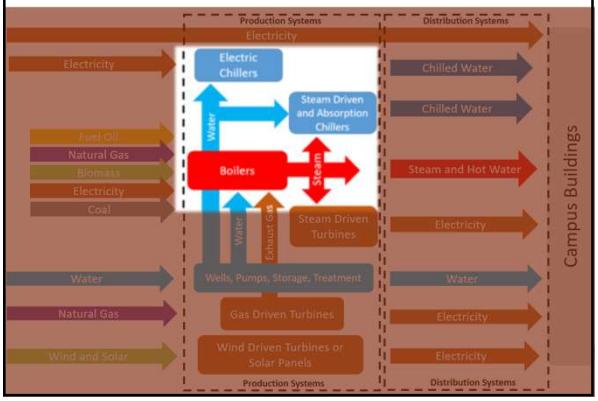
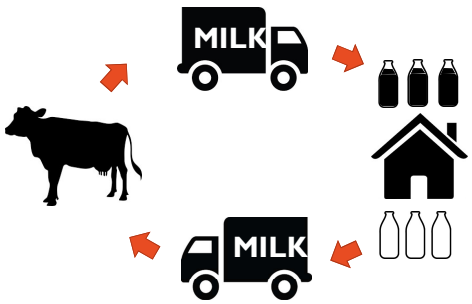
HEATING/COOLING PRODUCTION



CAMPUS HEATING/COOLING



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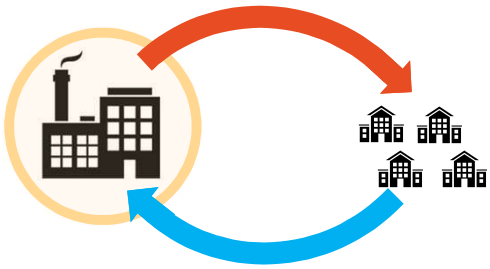
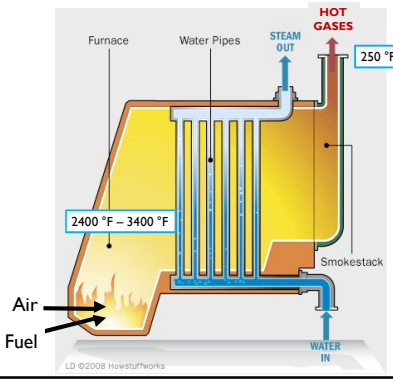


HEATING OVERVIEW

Boilers
Steam
Hot Water
Costs

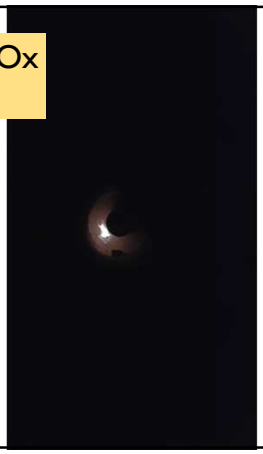
WATER TUBE BOILER



WATER TUBE BOILER

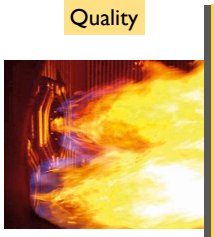
BURNER

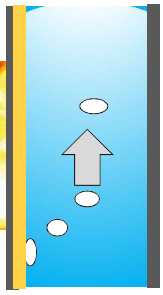
Low NOx Burner



BOILER TUBE

Water Quality

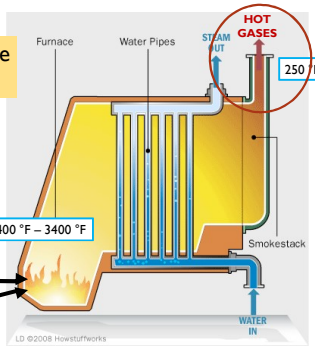




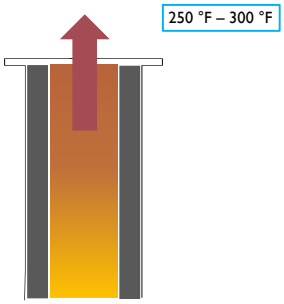
2400 °F – 3400 °F

STACK TEMPERATURE

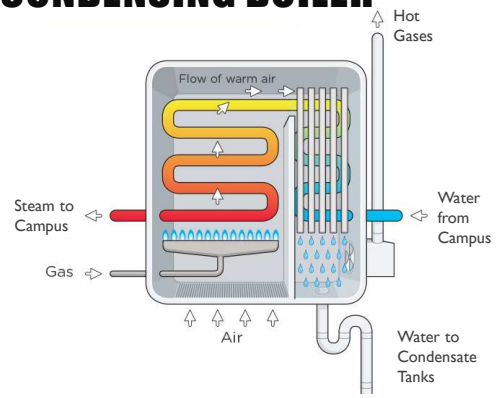
Water Tube Boiler



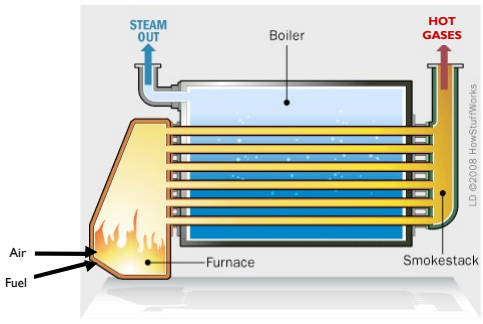
EXHAUST STACK



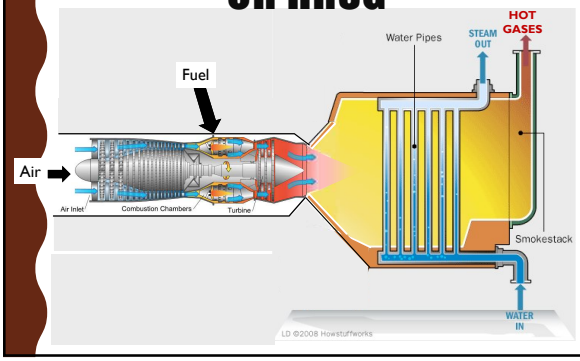
CONDENSING BOILER



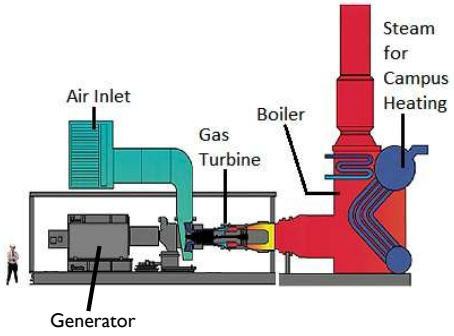
FIRE TUBE BOILER



HEAT RECOVERY BOILER OR HRSG



COMBINED HEAT AND POWER OR CHP



EQUIPMENT - RISKS

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WHAT HAPPENS IF YOU DEFEAT PRESSURE SAFETIES?

BOILER REGULATIONS

Construction
Repair
Operation

- ASME Boiler and Pressure Vessel Code
- Air Permit
- Operator Licensing
- Insurance Companies

HEATING COSTS

	Kentucky	New Mexico
Fuel	48%	55%
Labor & Maintenance	29%	34%
Chemicals	6%	2%
Electricity	4%	5%
Water	3%	1%
Other	10%	3%

CENTRAL OR DISTRIBUTED

Central

Distributed

CENTRAL VS. DISTRIBUTED

Pros
- Consolidation of operations/maintenance
- Backup fuel capability
- Can last over 50 years
- Combined Heat & Power
- Safer

Cons
- Requires pipe distribution
- Complex systems

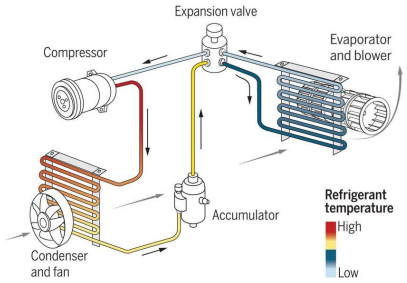
Pros
- Lower first cost
- Less complex
- Reduced exposure to catastrophic failure

Cons
- Less reliable
- Less flexibility
  - Fuel
  - CHP
  - Emissions

COOLING OVERVIEW

Chillers
Refrigerants
Water

VAPOR COMPRESSION CYCLE



- Evaporation (or boiling)
- Pressure manipulation

https://en.wikipedia.org/wiki/List_of_refrigerants

REFRIGERANTS

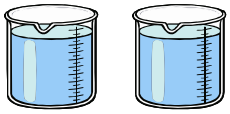
- Chlorofluorocarbons (CFCs)
- Hydrochlorofluorocarbons (HCFCs)
- Hydrofluorocarbons (HFCs)
- Natural Refrigerants

RISKS WITH REFRIGERANTS

REFRIGERANT TYPE	CLASS	OZONE DEPLETION POTENTIAL	GLOBAL WARMING POTENTIAL
CFC	Synthetic	High	Very High
HCFC	Synthetic	Very Low	Very High
HFC	Synthetic	Zero	High
HC	Natural	Zero	Negligible
CO2	Natural	Zero	Negligible

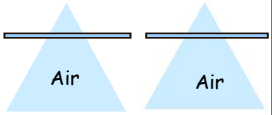
WATER – IDEAL HEAT TRANSFER FLUID

Specific Heat of Water
1 BTU/lb



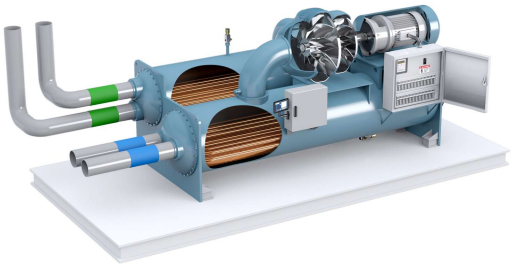
75°F ***Plus 1 BTU*** **= 76°F**

Specific Heat of Air
0.24 BTU/lb



75°F ***Plus 4 BTUs*** **= 76°F**

CENTRIFUGAL CHILLER



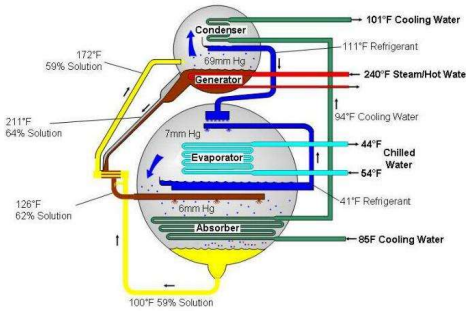
- Electric motor driven
- Also steam driven chillers

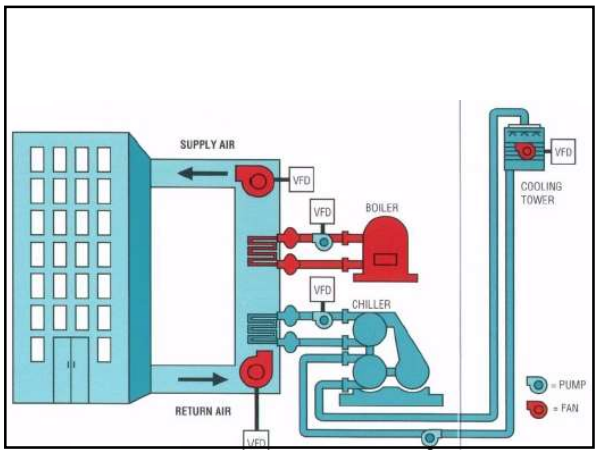
CENTRIFUGAL CHILLER

- 5,000 ton chiller

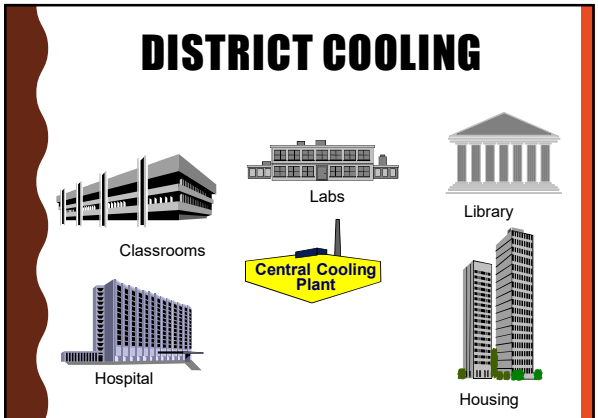
ABSORPTION CHILLER

ABSORPTION CHILLER





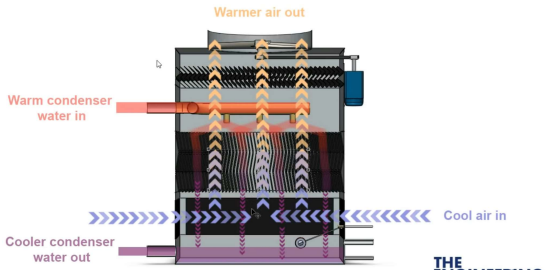
DISTRICT COOLING



DISTRICT COOLING - PROS AND CONS

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

COOLING TOWERS

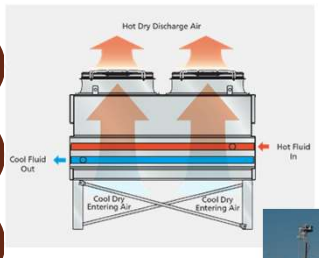


UNIVERSITY OF ILLINOIS

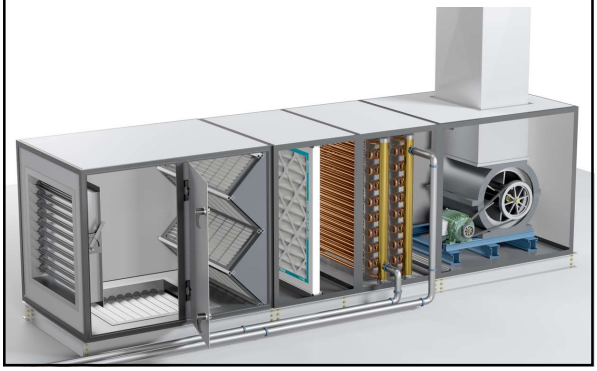
UNIVERSITY OF ARIZONA

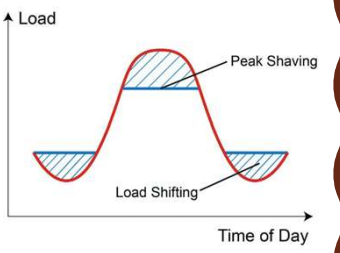
HIDDEN IN PARKING GARAGE

AIR COOLED COOLING TOWER



AIR HANDLERS





COOLING LOAD PROFILE

SHAVING THE PEAK WITH TES

THERMAL ENERGY STORAGE

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

DUKE UNIVERSITY - WATER

ICE TES

EFFICIENT CHILLER OPERATION

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

QUESTIONS?

THIS CONCLUDES THE AMERICAN INSTITUTE OF ARCHITECTS CONTINUING EDUCATION SYSTEMS COURSE

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