

Facility Dynamics

ENGINEERING

Absorptoin vs. Centrifugal Cooling

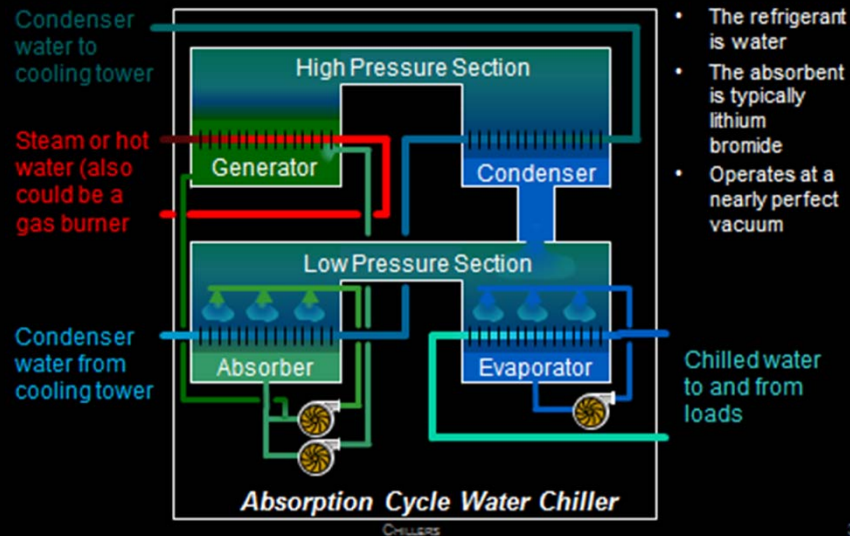
Presented By:

- David Sellers, Facility Dynamics Engineering
- Senior Engineer

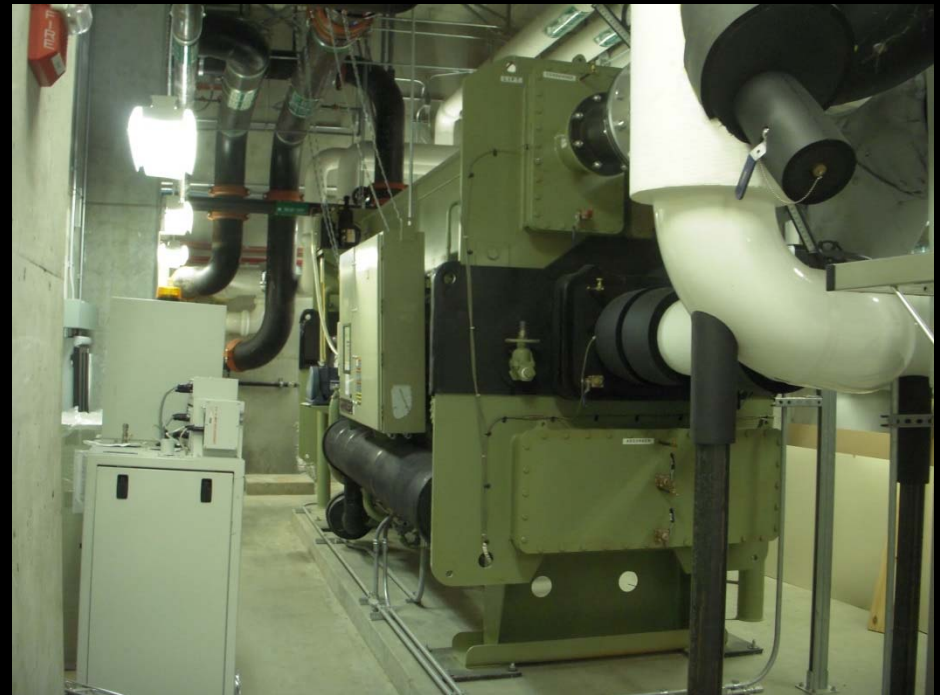
Cooling

A Process that can be Driven Directly by Thermal Energy

Absorption Chiller

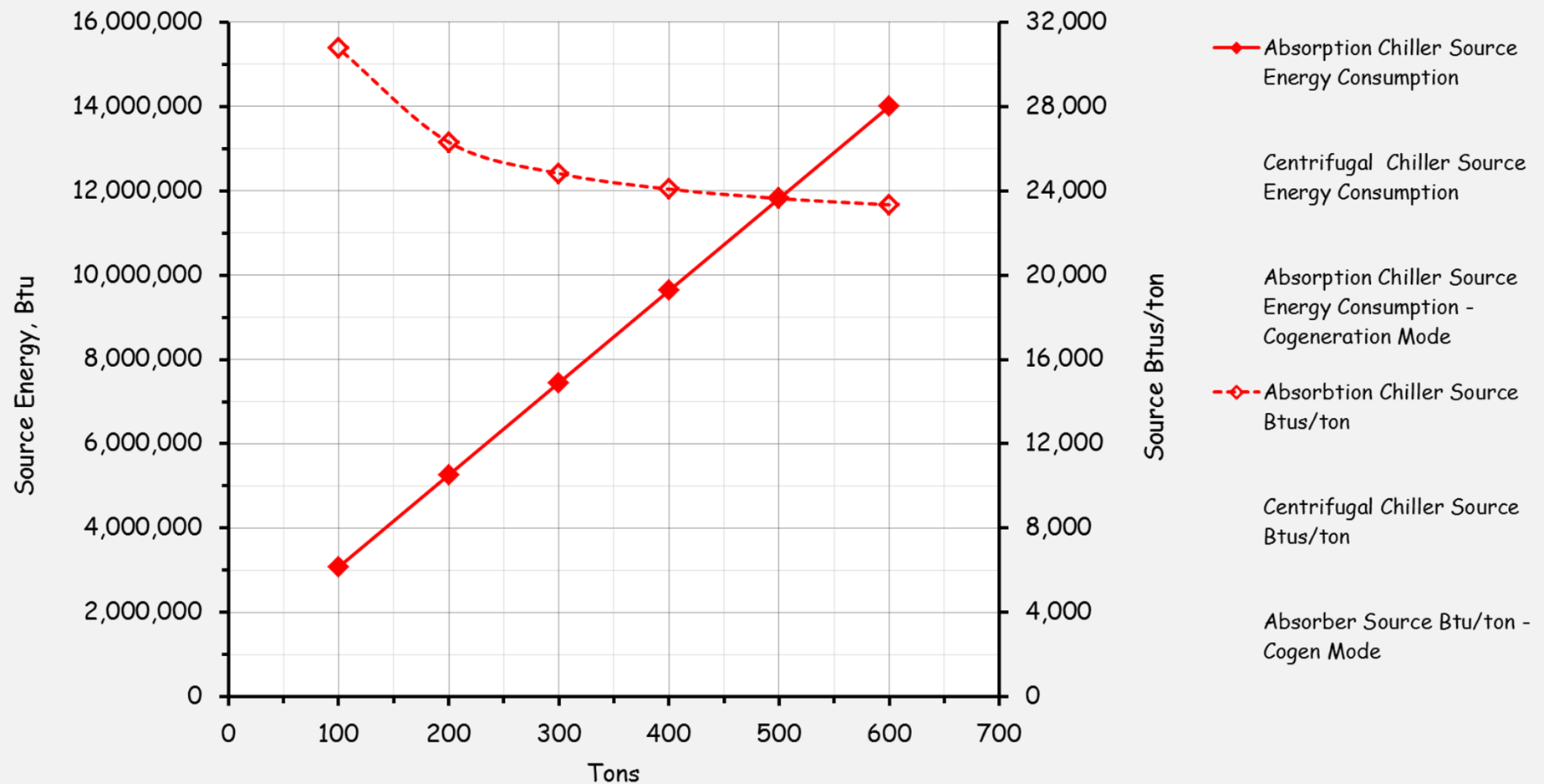


31



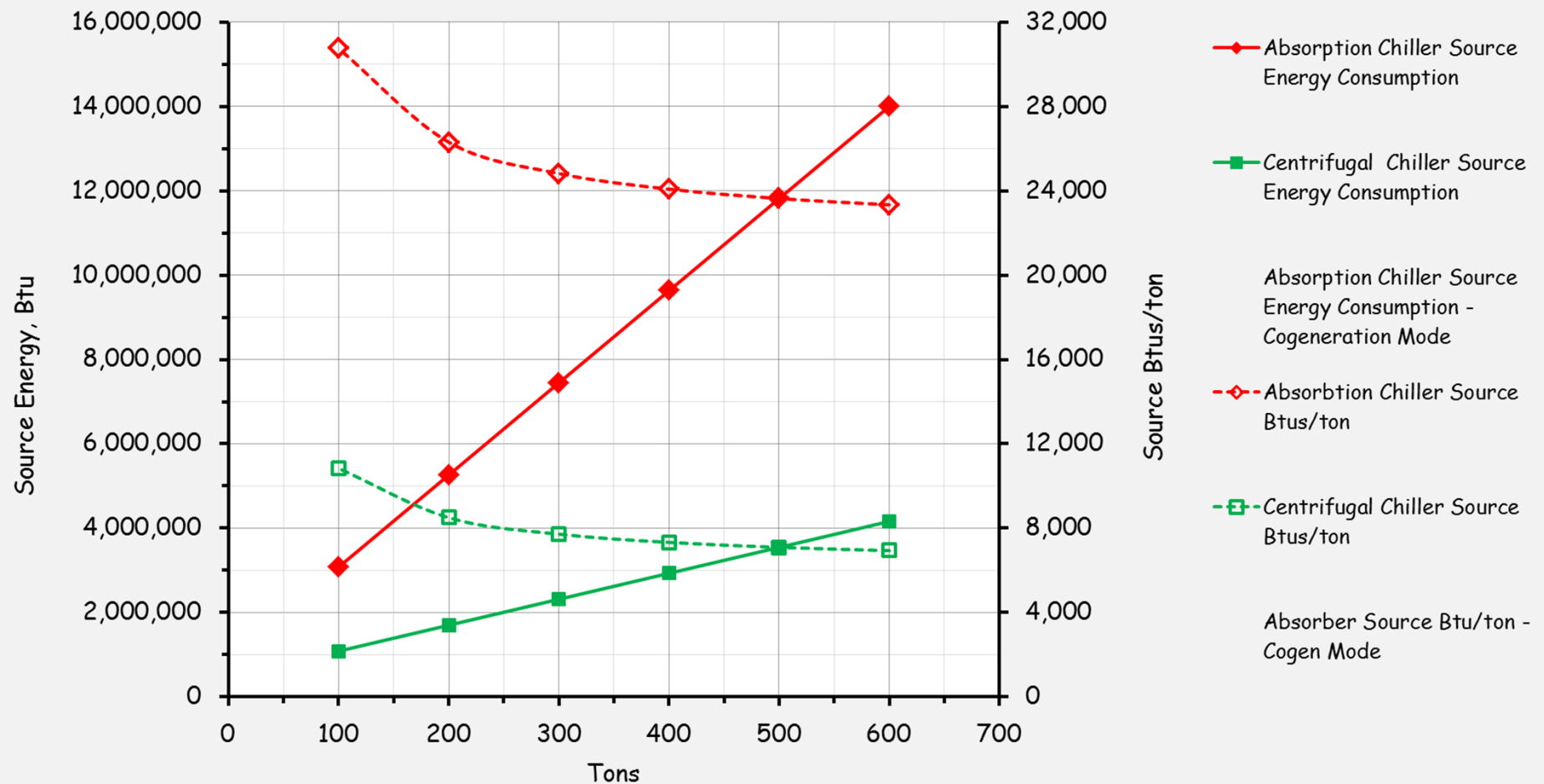
Chiller Source Energy Consumption for One Hour at Different Load Conditions

Includes all Auxiliary Energy Except Cooling Tower Fans



Chiller Source Energy Consumption for One Hour at Different Load Conditions

Includes all Auxiliary Energy Except Cooling Tower Fans



Source Energy Consumption and Site Cost to Produce 600 tons for One Hour				
Item	Absorption Chiller, Btu		Centrifugal Chiller, Btu	
	Source Btu	\$	Source Btu	\$
Refrigeration Process Source Energy	13,114,286	\$76.11	3,693,399	\$35.40
Chilled Water Pumping Energy	241,896	\$2.32	241,896	\$2.32
Condenser Water Pumping Energy	513,084	\$4.92	220,693	\$2.12
Absorber, Generator, and Evaporator Pump Energy	135,633	\$1.30	N/A	\$0.00
Oil Pump	N/A	\$0.00	5,837	\$0.06
TOTAL for 600 tons for One Hour	14,004,899	\$84.65	4,161,826	\$39.89
Heat to be Rejected at the Cooling Tower	17,485,714		8,408,202	

Power Generation

A Fundamental Way that we Use Heat in Buildings

Definitions

– Power Generation

A process that generates power by converting one form of energy into a different, more useful form for the task at hand



Cogeneration

Leveraging Power Generation to Serve Other Building Loads

Definitions

- Combined Heat and Power Cycle

A process that generates power by converting one form of energy into a different, more useful form for the task at hand and also use the waste heat from the generation process to provide heating and cooling for a facility

The Conventional Approach

Image Landsat / Copernicus

Google Earth

The Conventional Approach

Gas

Electrical
Generating
Plant

33-34% Efficient

6-8%
Losses

Loads that Use
Electrical
Power

Motor Efficiency – 74-95%
Machine Efficiency – 40-87%
Lighting Efficiency – 10 – 140 lumens per watt

Loads that Use
Electrical Power
to Cool

COP = 4 - 6

Loads that Use
Electrical Power
to Heat

Heat Transfer
Efficiency = 100%
(Conservation of
Mass and Energy)

75-85% Efficient

Steam
Generating
Plant

6-9%
Losses

Loads that Use
Thermal Energy
to Cool

COP = 0.7 - 0.9

Loads that Use
Thermal Energy
to Heat

Heat Transfer
Efficiency = 100%
(Conservation of
Mass and Energy)

The Cogen Approach

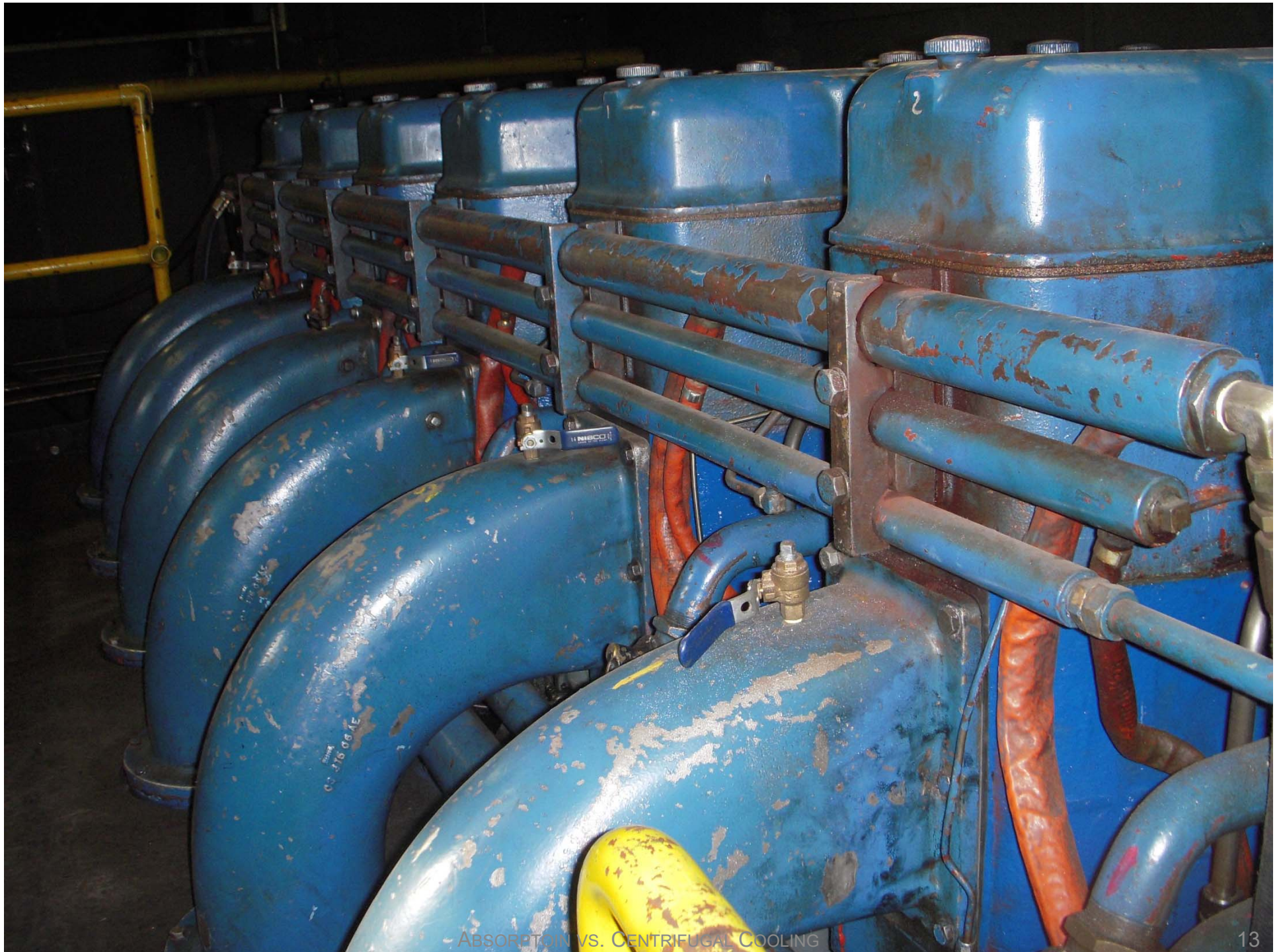


ABSORPTION & CENTRIFUGAL COOLING

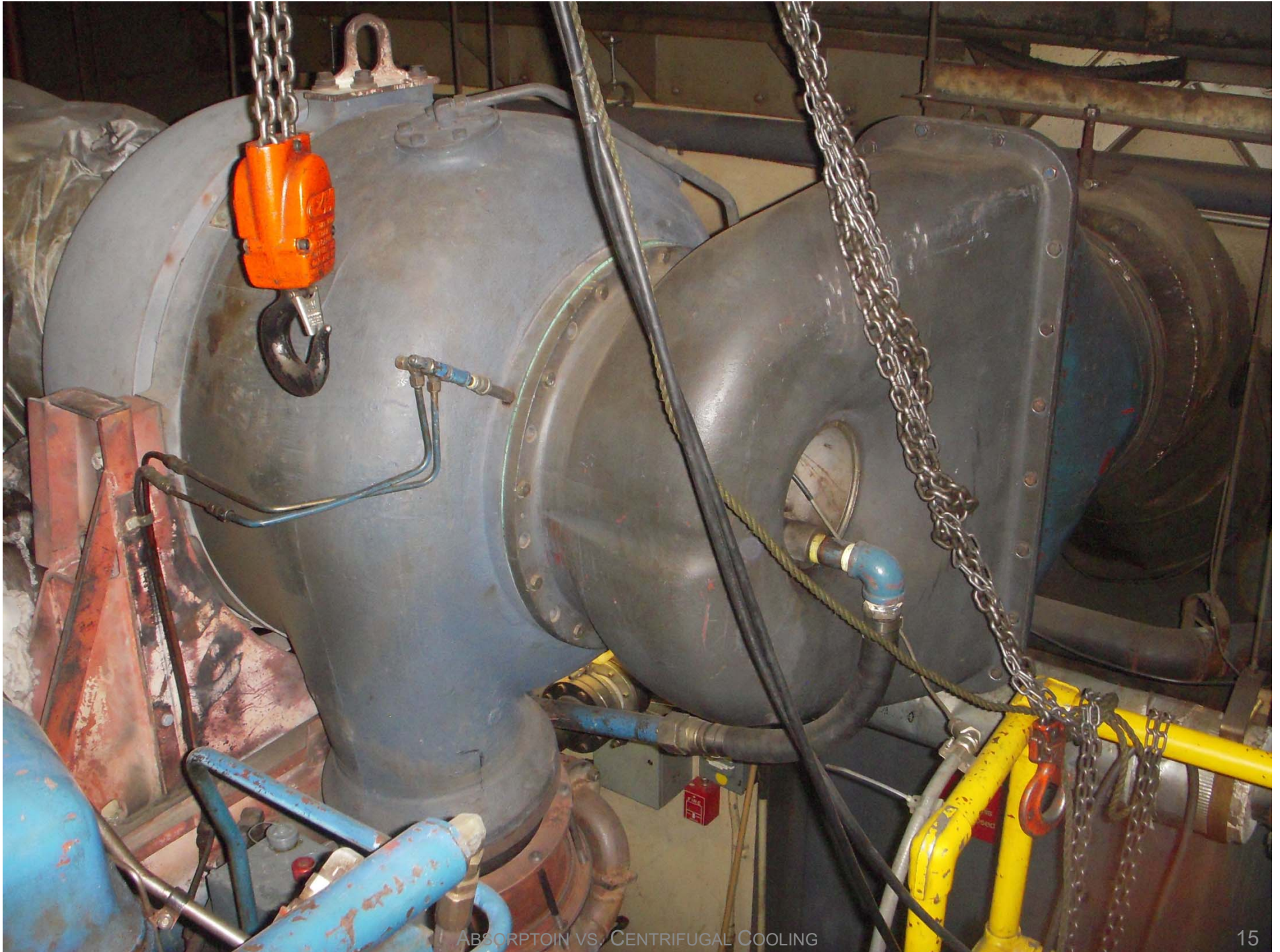
The Cogen Approach













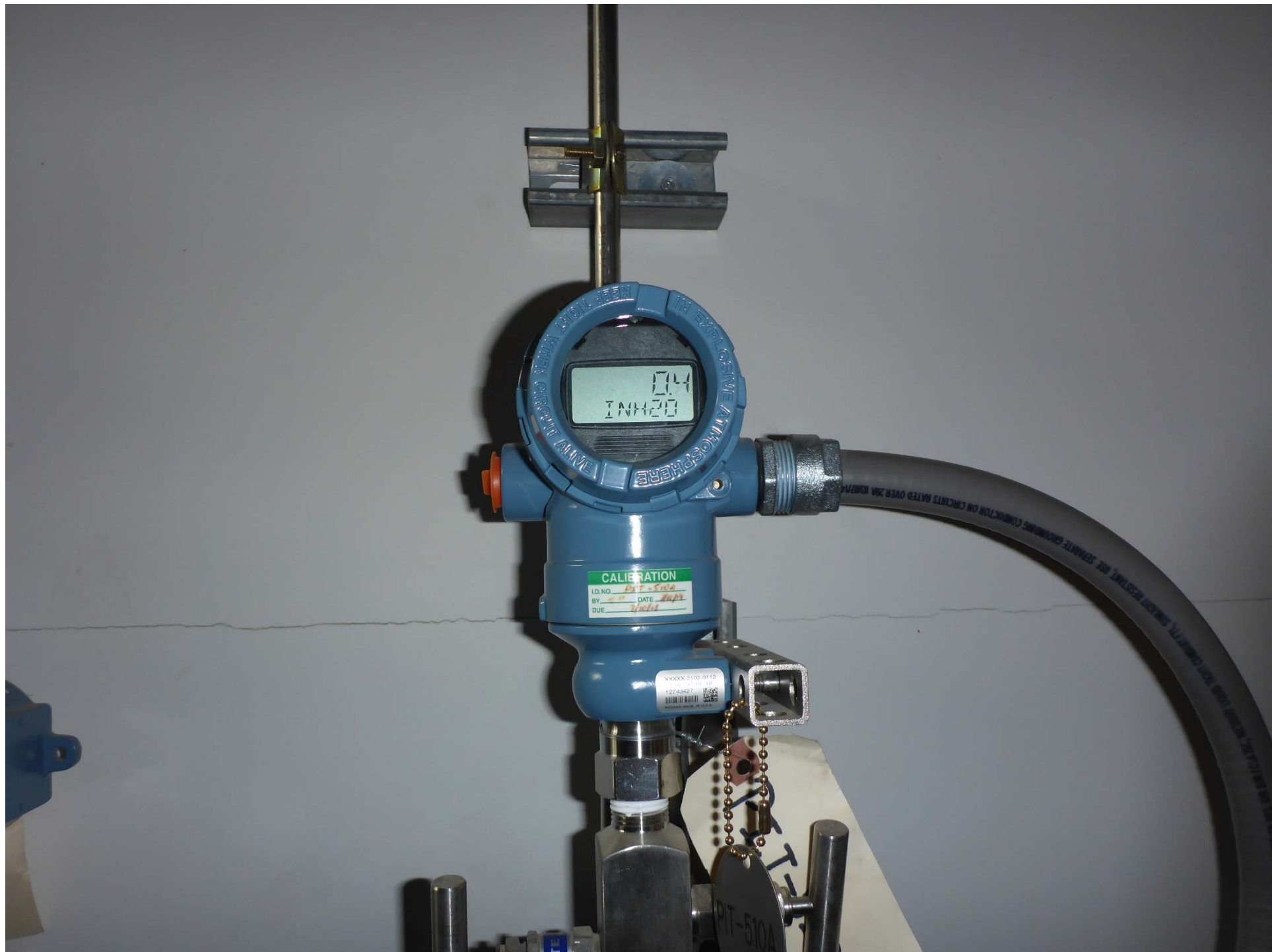


ABSORPTION VS. CENTRIFUGAL COOLING









CALIBRATION

ID. NO. PT-510A
BY [Signature] DATE [Signature]
DUE 1/2014

XXXXX 51100 0142

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

12743423

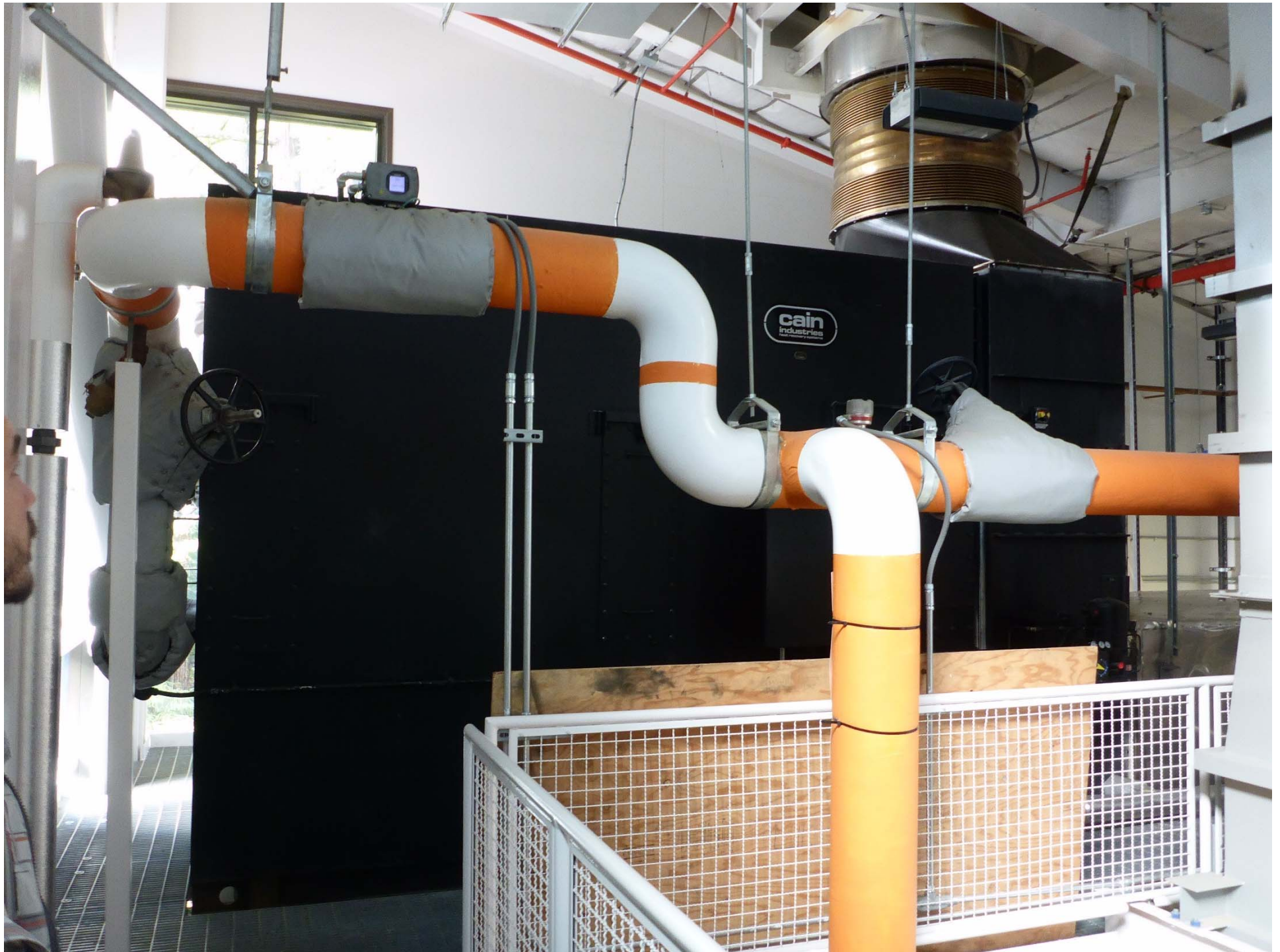
12743423

12743423

12743423

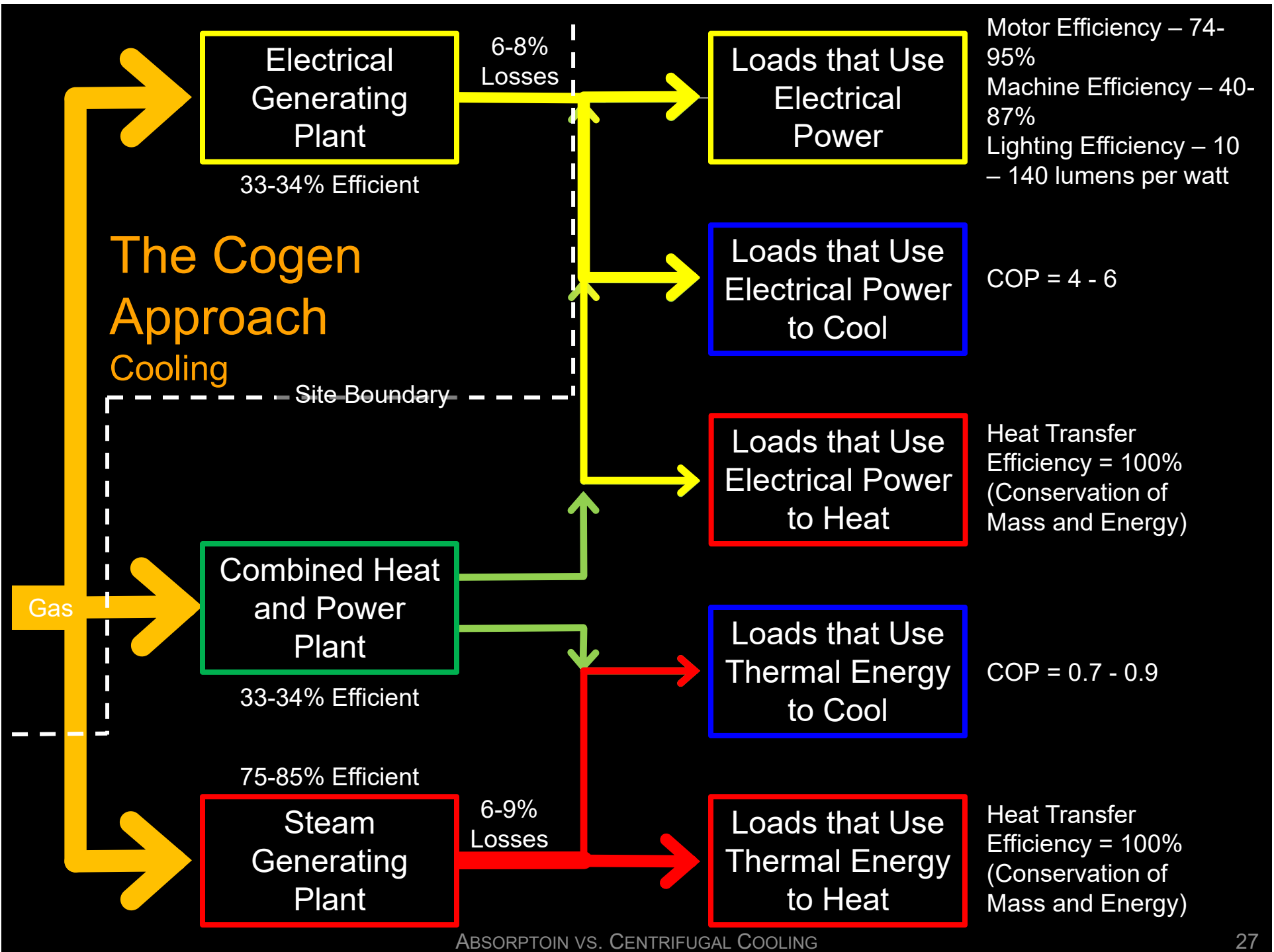








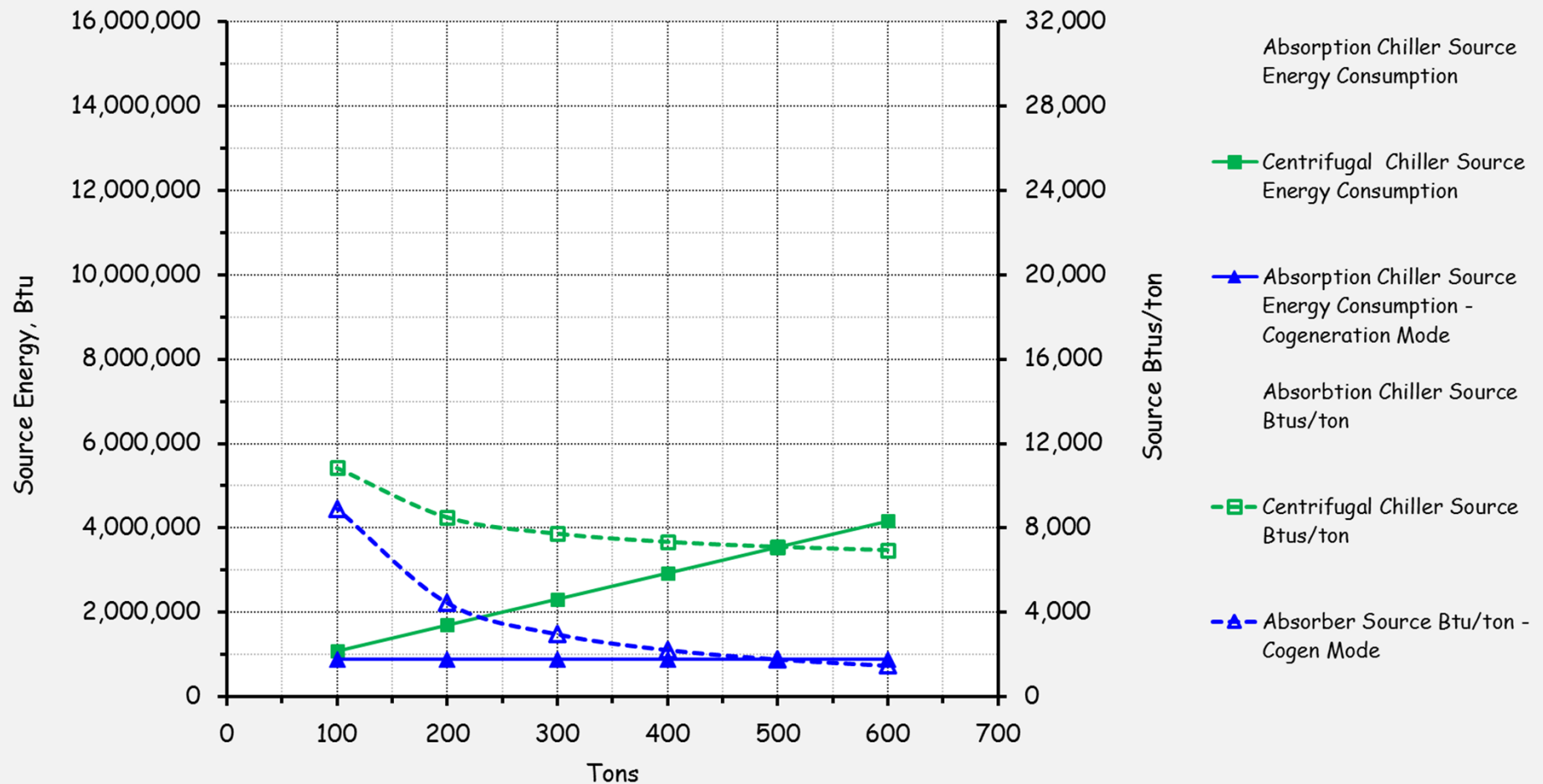




Waste Heat Makes Absorption Cooling Economically and Holistically Attractive

Chiller Source Energy Consumption for One Hour at Different Load Conditions

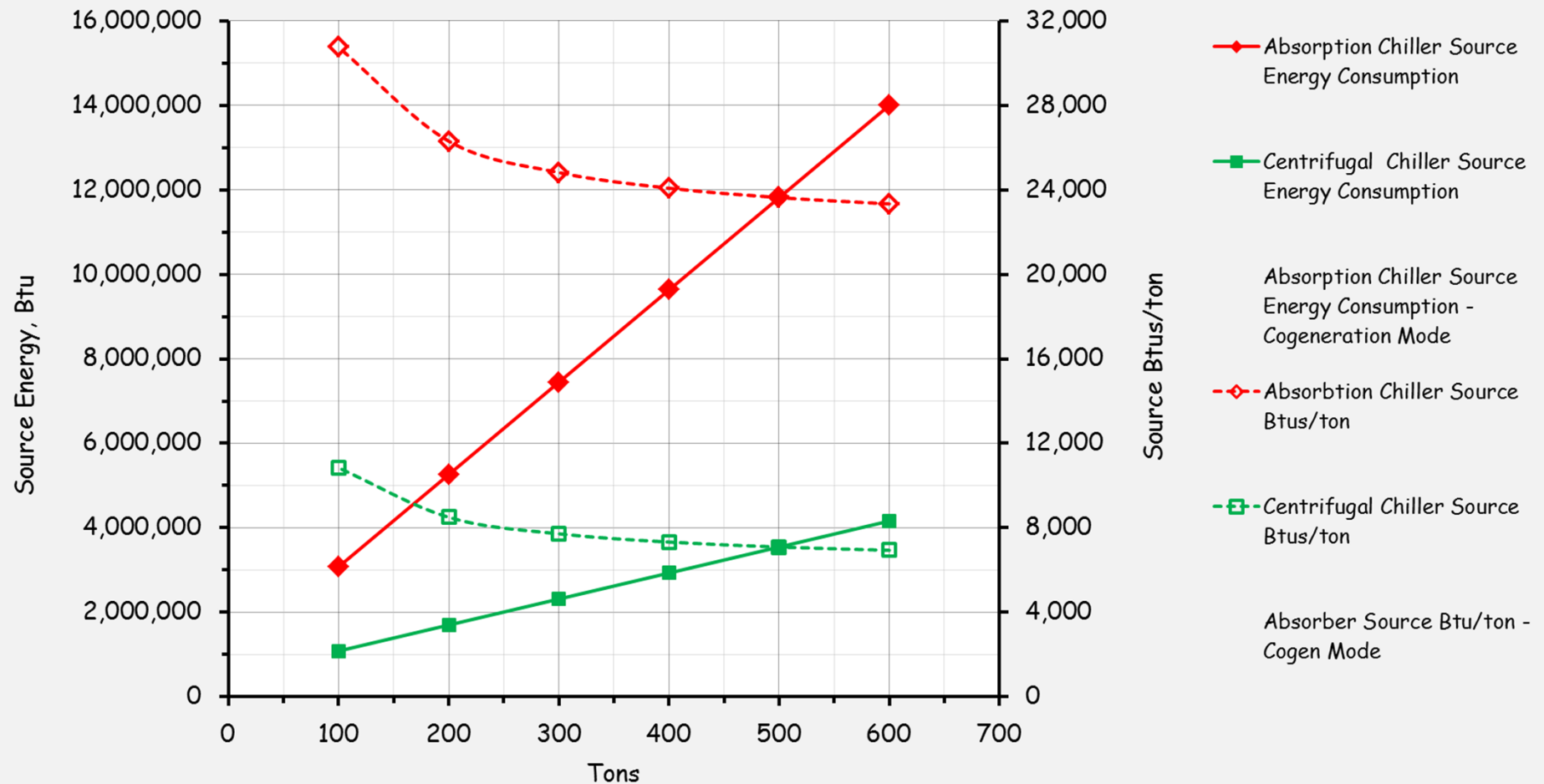
Includes all Auxiliary Energy Except Cooling Tower Fans

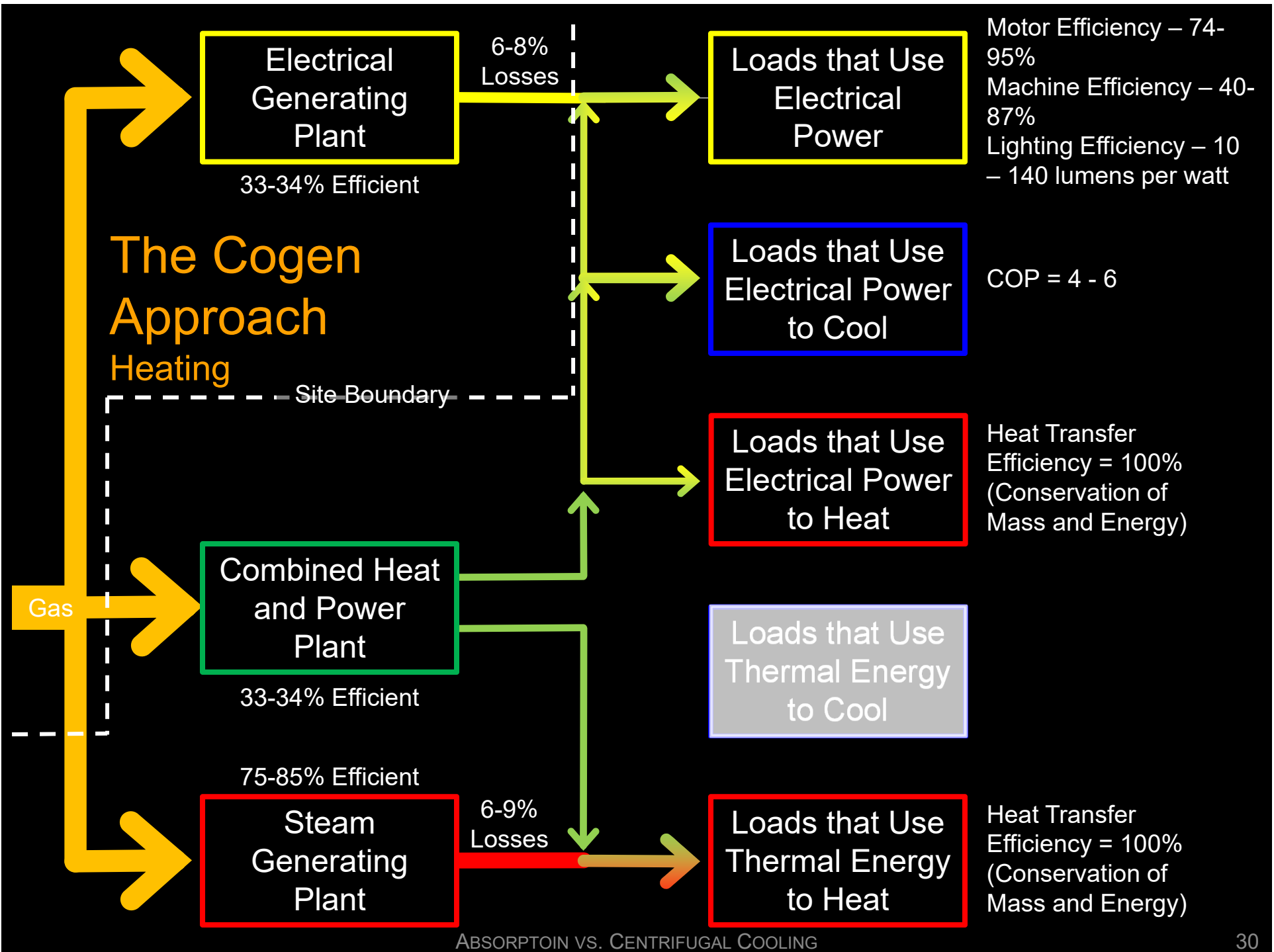


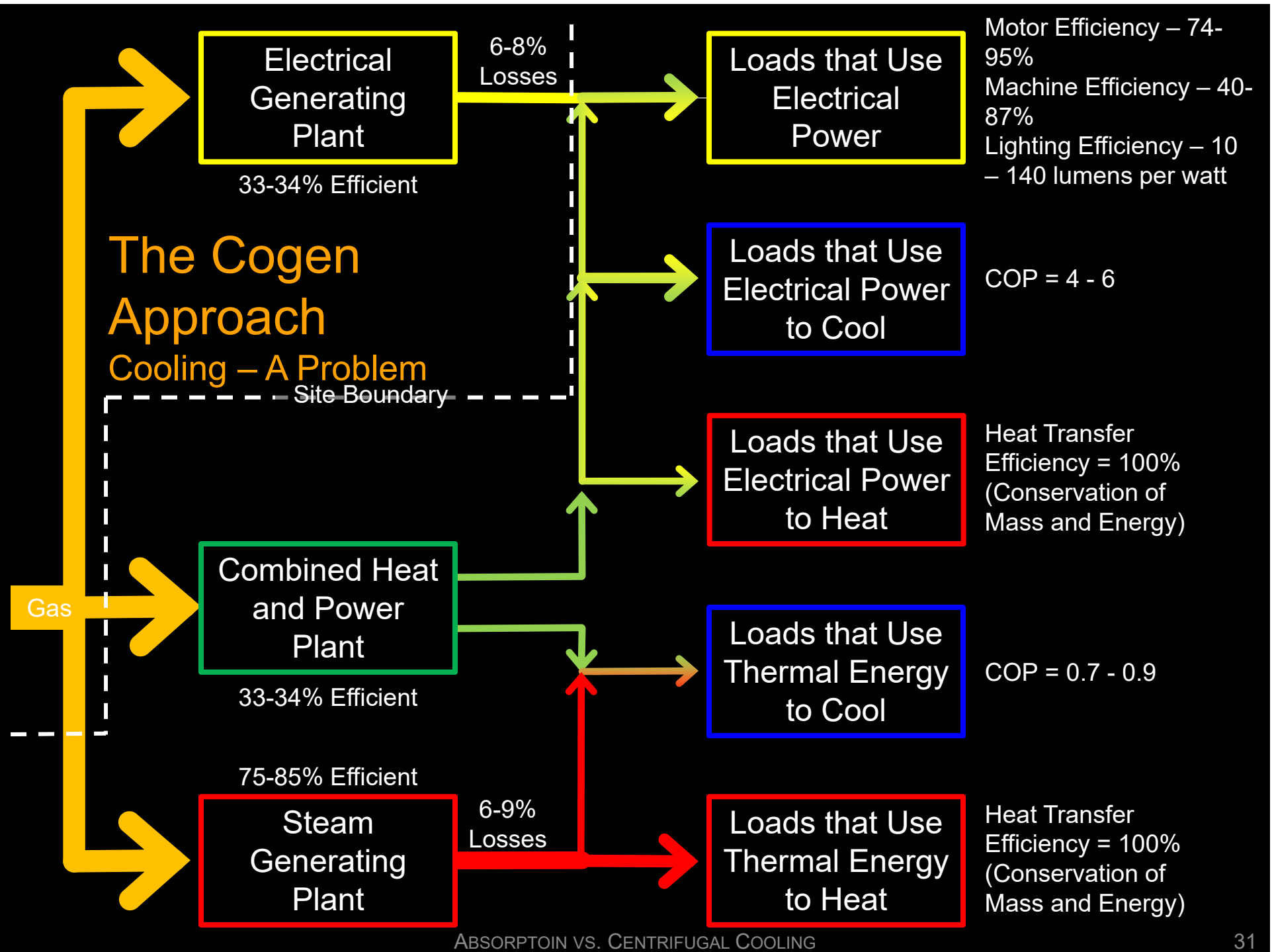
Without Waste Heat; Not So Much

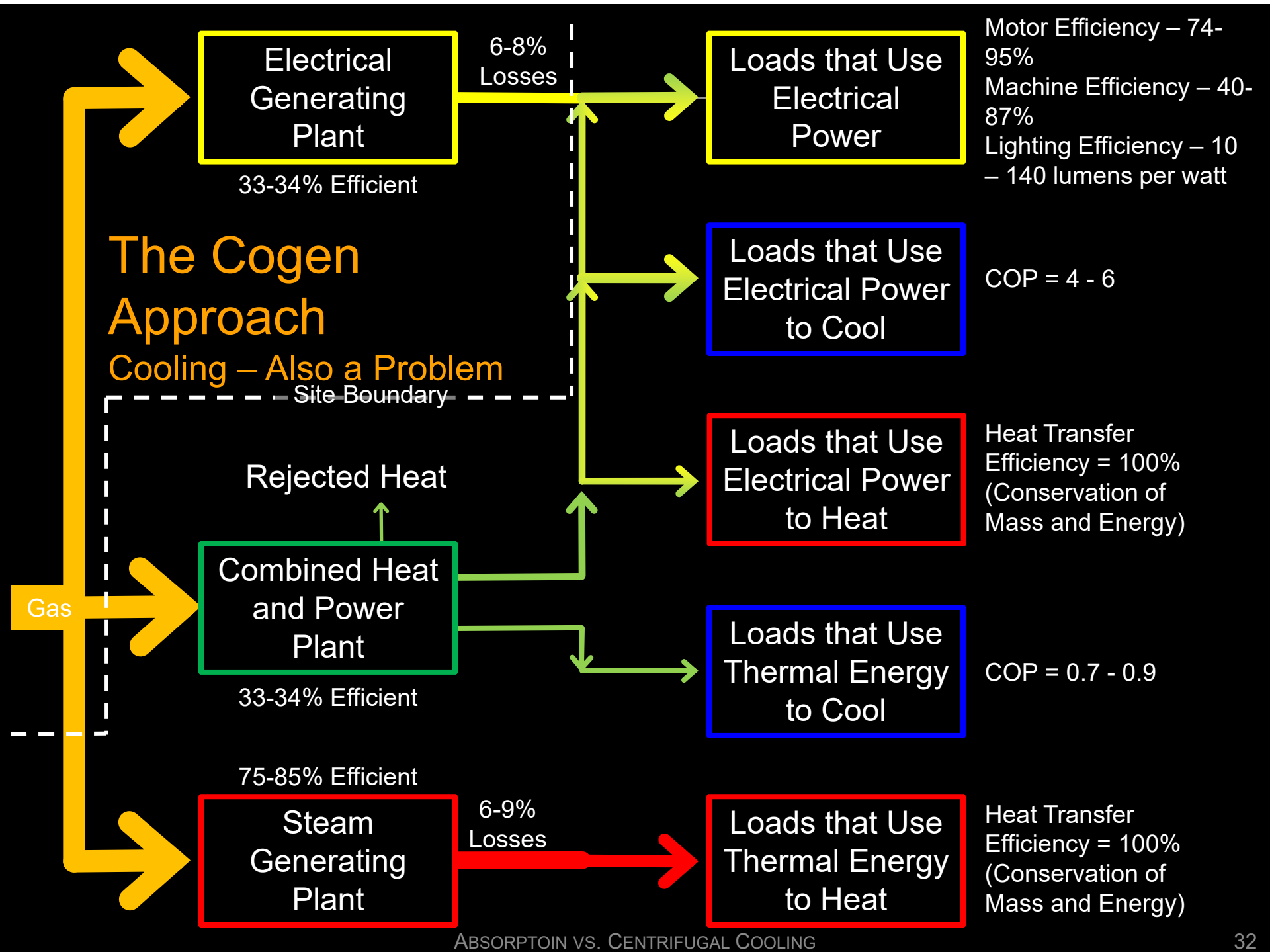
Chiller Source Energy Consumption for One Hour at Different Load Conditions

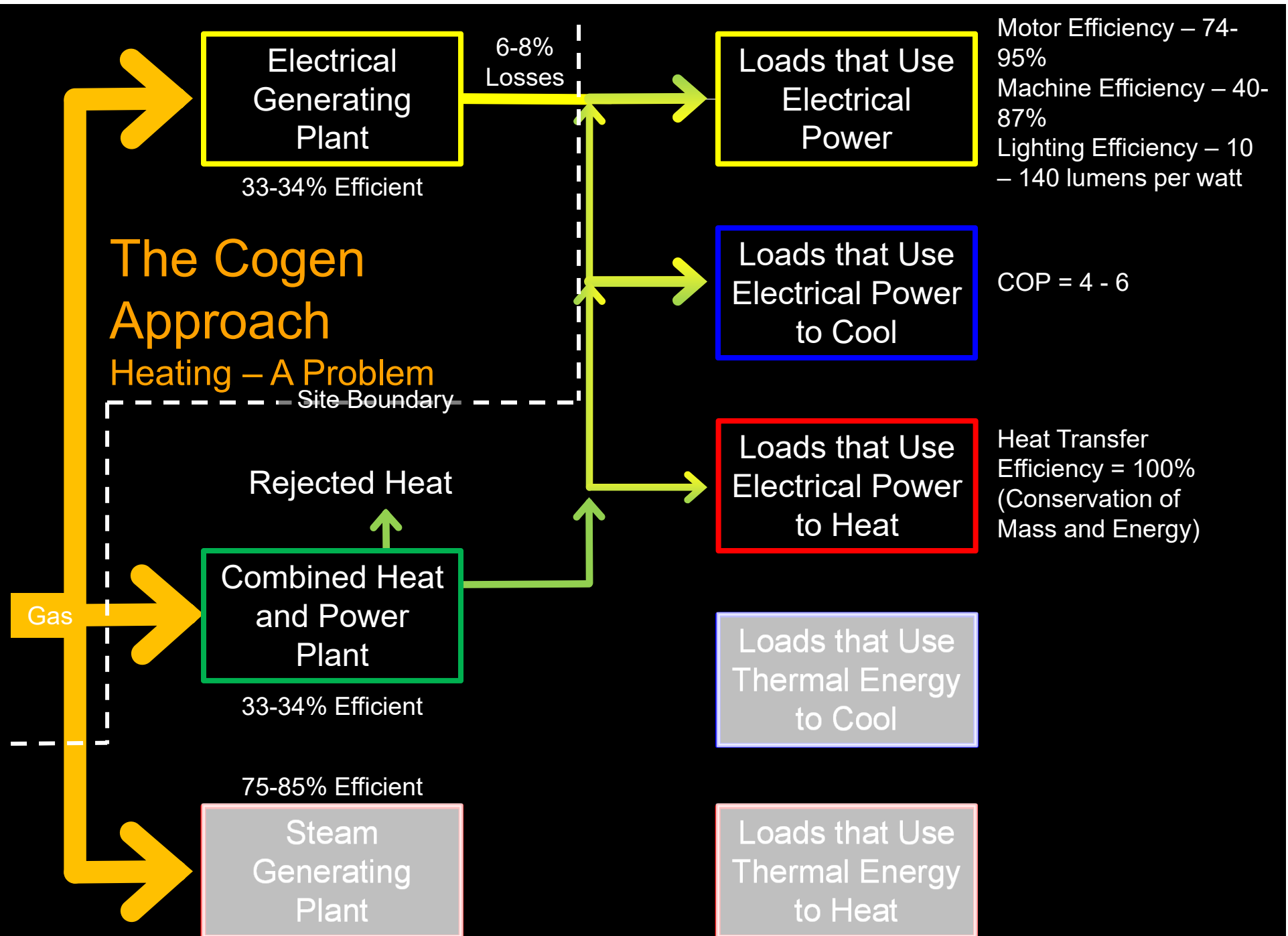
Includes all Auxiliary Energy Except Cooling Tower Fans











All of that aside, the fuel does not just naturally flow from somewhere in the earth to the pipeline

- For natural gas losses include

- Extraction losses
- Flaring
- Leakage
- Transportation
- Compressor Power

- See <http://www.eia.gov/pub/itg/ghgp9.htm> for more information

- The EnergyStar factor for these losses is 1.047 (http://www.energystar.gov/ia/business/evaluate_performance/site_source.pdf)

Gas

Electrical
Generating
Plant
33-34% Efficient

6-8%
Losses

Loads that Use
Electrical
Power

Motor Efficiency – 74-95%
Machine Efficiency – 40-87%
Lighting Efficiency – 10
= 140 lumens per watt

Loads that Use
Electrical Power
to Cool

COP = 4 - 6

Loads that Use
Electrical Power
to Heat

Heat Transfer
Efficiency = 100%
(Conservation of
Mass and Energy)

Loads that Use
Thermal Energy
to Cool

Loads that Use
Thermal Energy
to Heat

Steam
Generating
Plant
75-80% Efficient

Another Consideration; Grade or Quality of the Heat

In a system, a process that occurs will tend to increase the total entropy of the universe

2nd Law of Thermodynamics