

# Operational Impacts of Energy Management

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## **NJHEPS** **Energy Management Workshop**

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# Overview

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- Princeton Campus Energy Demands
- Energy System Components
- Energy Production Before & After Deregulation
- Cogeneration Efficiency & Power Cost
- Economic Dispatch System
- Impacts of Economic Dispatch
- Future Plans

# Energy Demands at Princeton



- > 150 Buildings
- Academic
- Research
- Administrative
- Residential
- Athletic





# Campus District Steam System



# Energy Equipment & Peak Demands

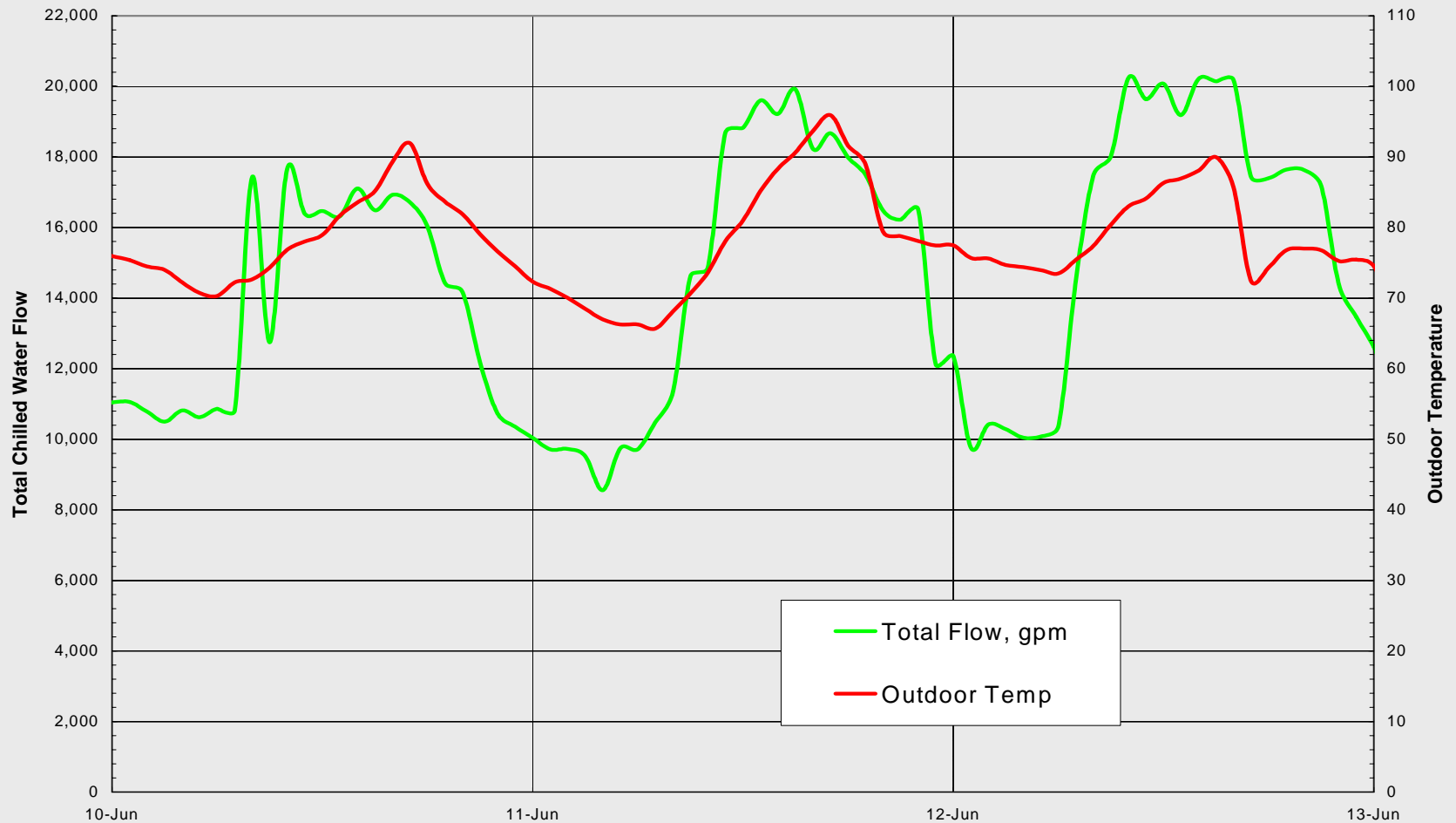


	<u>Rating</u>	<u>Peak</u>
<b>■ Electricity</b>		
■ (1) Gas Turbine Generator	15 MW	23 MW
<b>■ Steam</b>		
■ (1) HRSG	180,000 #/hr	
■ (2) Aux Boilers	<u>125,000 #/hr ea.</u>	
■ Auxiliaries	300,000 #/hr	244,000 #/hr
<b>■ Chilled Water</b>		
■ (3) Electric Chillers	10,100 Tons	
■ (3) Steam-Driven Chillers	5,700 Tons	11,000 Tons
■ (8) Primary CHW Pumps	23,000 GPM	21,000 GPM

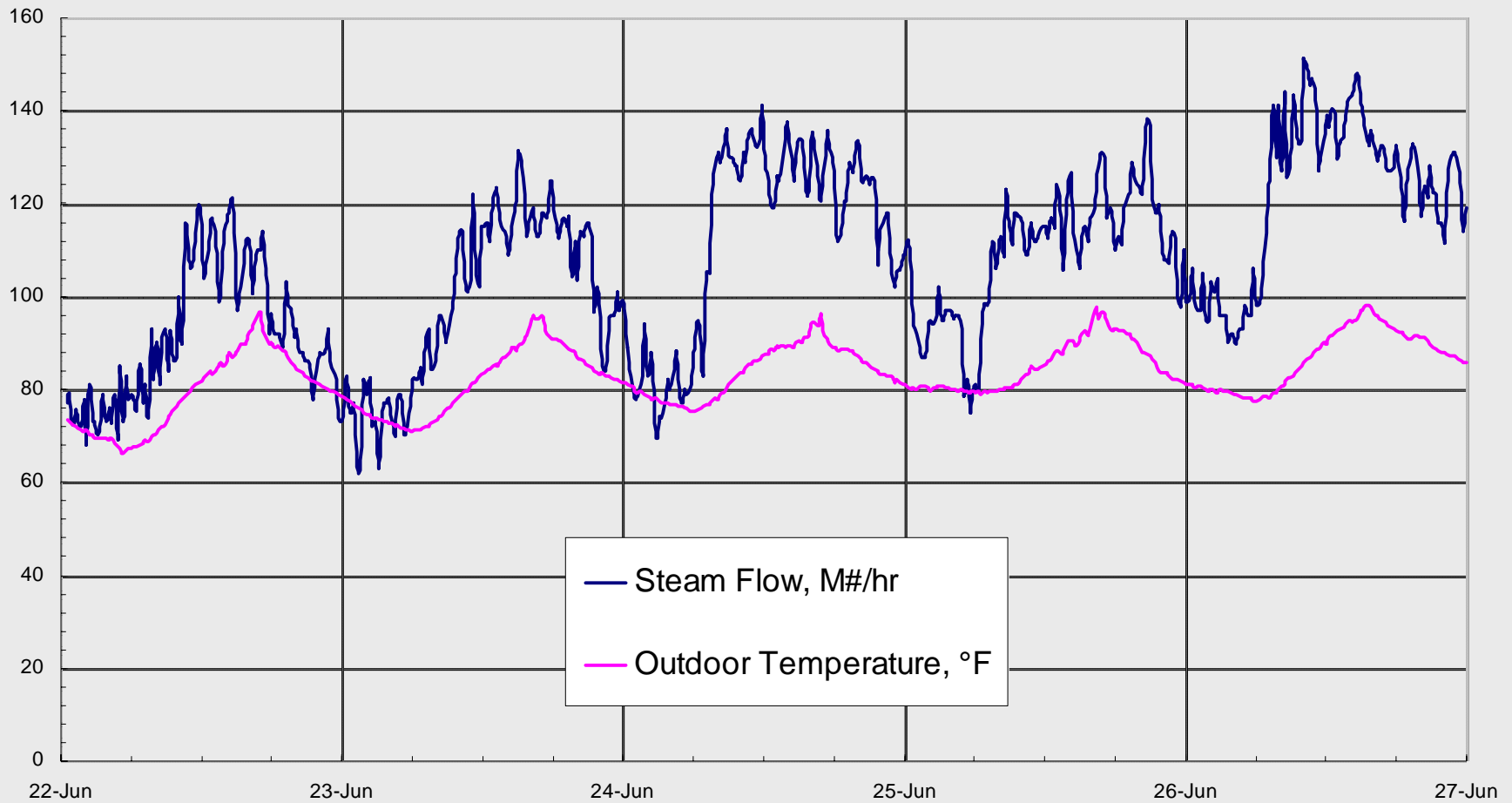


# Princeton Chilled Water Use

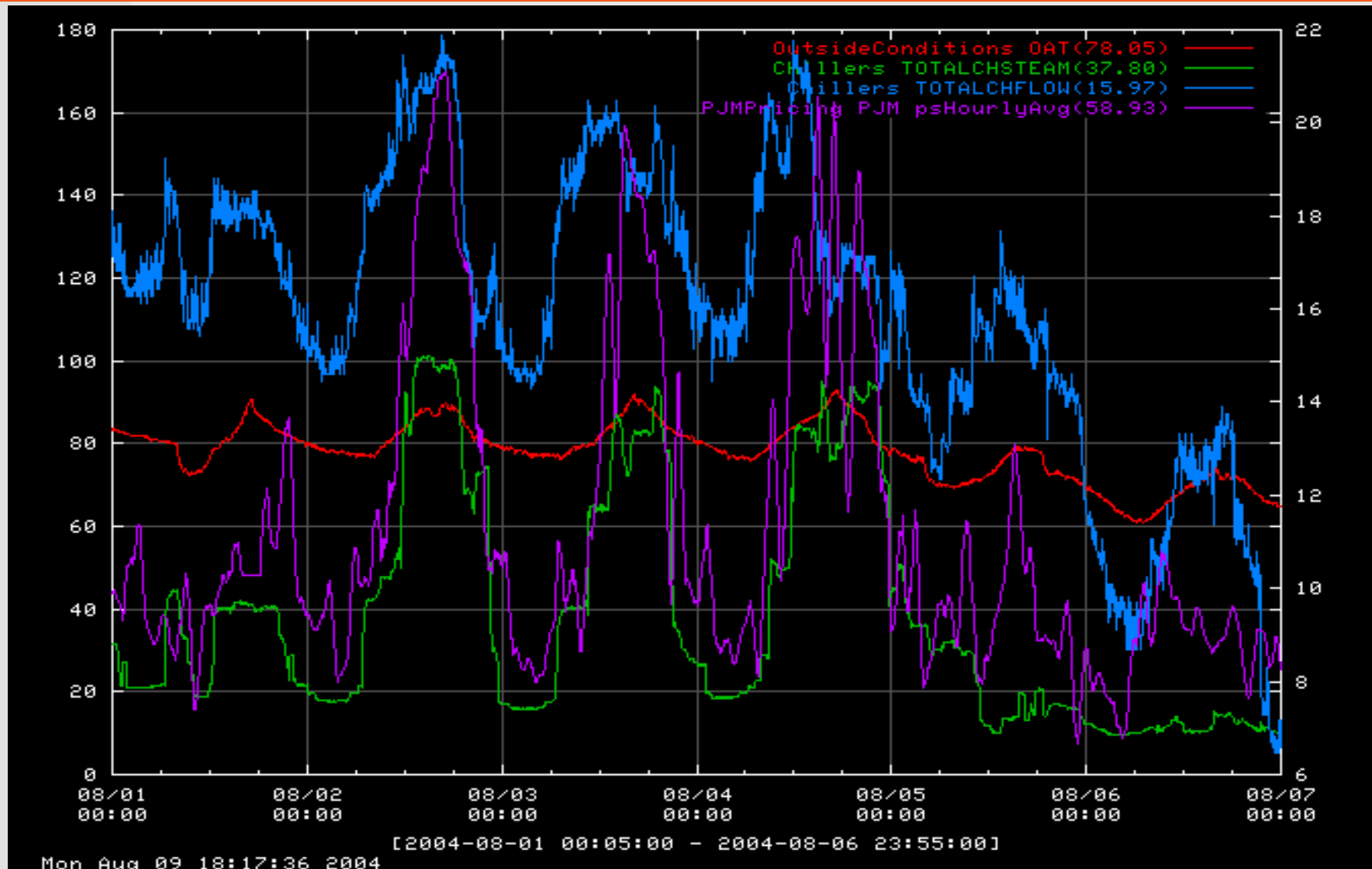
Campus Chilled Water Production, June 2002



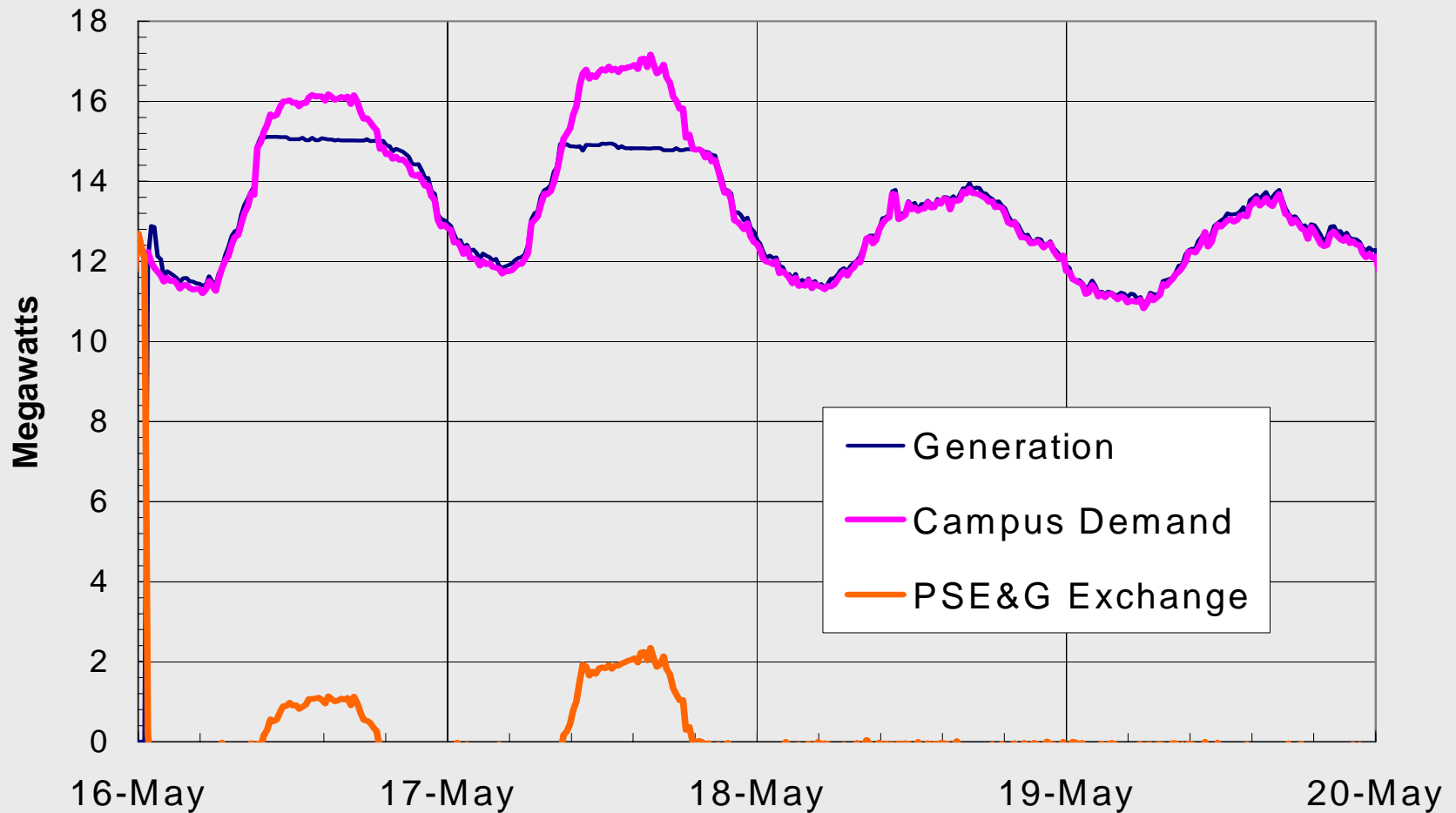
# Summer Steam Use – Before Deregulation



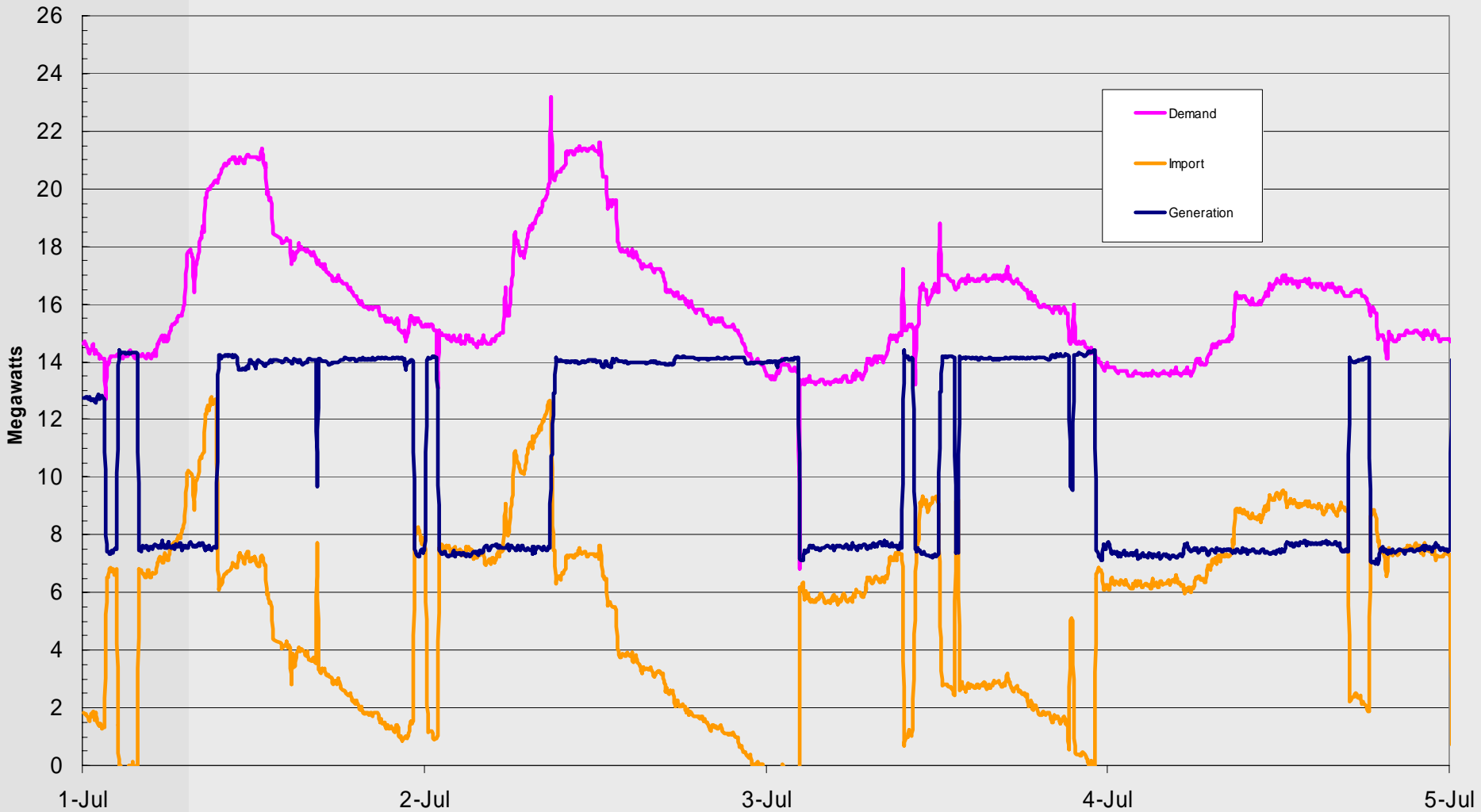
# Summer Steam Use - After Deregulation



# Electric Generation & Use Before Deregulation



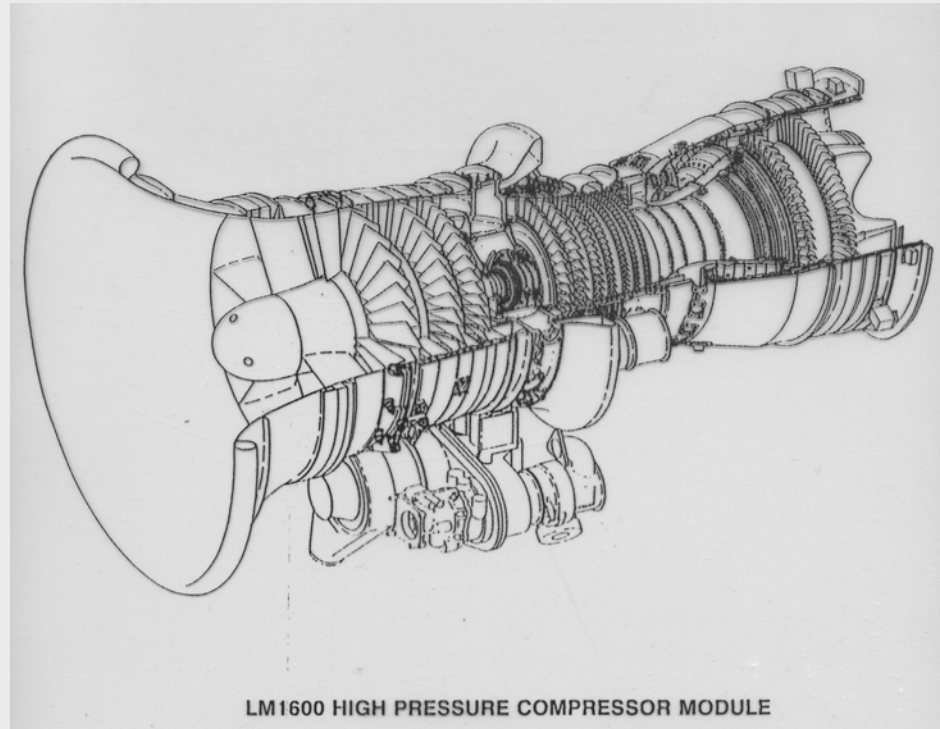
# Electric Generation & Use After Deregulation



# LM-1600 Efficiency



- Perfect energy conversion = 3412 Btu/kWh
- LM1600 Heat Rate = 10,000 Btu/kWh with 55F ambient air
- i.e. ~ 1/3 efficient.





# Cost to Generate Power

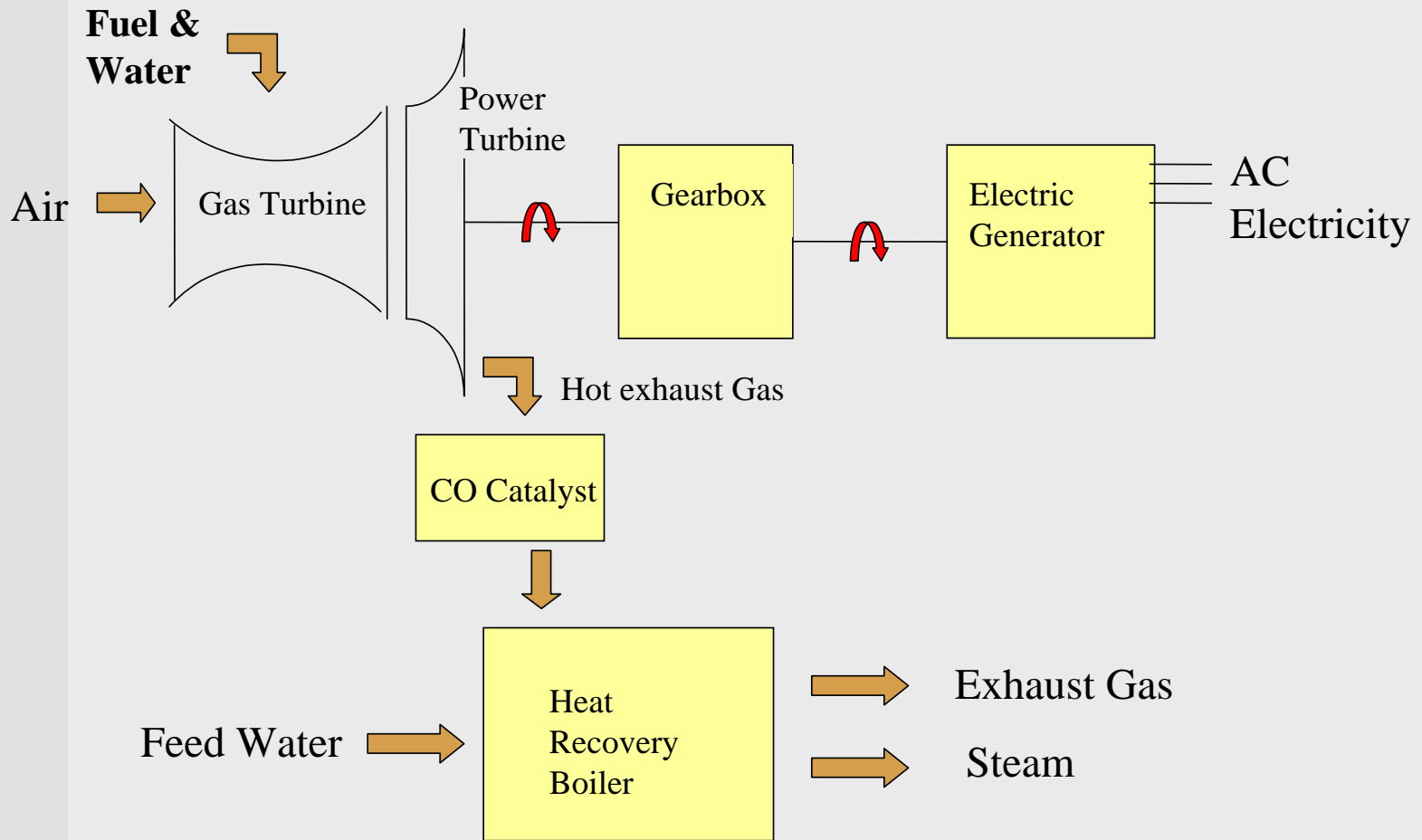
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- $1 \text{ kw} \times 10,000 \text{ Btu/hr} \times \$7.90/1,000,000 \text{ Btu}$   
= 7.9 cents/kwh + maintenance, insurance,  
financing...

so ~ 8-10 cents/kWh (simple cycle)



# Combined Cycle “Cogeneration”



# Reducing Energy Cost and Emissions

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- 1. Reduce Use
- 2. Optimize Production, Delivery, & Use Efficiency
- 3. Procure or Produce at Minimum Cost  
(often reduces emissions impact)

# Procure or Produce at Min. Cost

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- Generate/Purchase/Mix Electric Production
- Use min. cost fuel for electric and steam production
- Preferred Steam Generator Selection
- Preferred Chiller Selection
- Load Shed during “ICAP” Hours
- Load Shift Using Thermal Storage

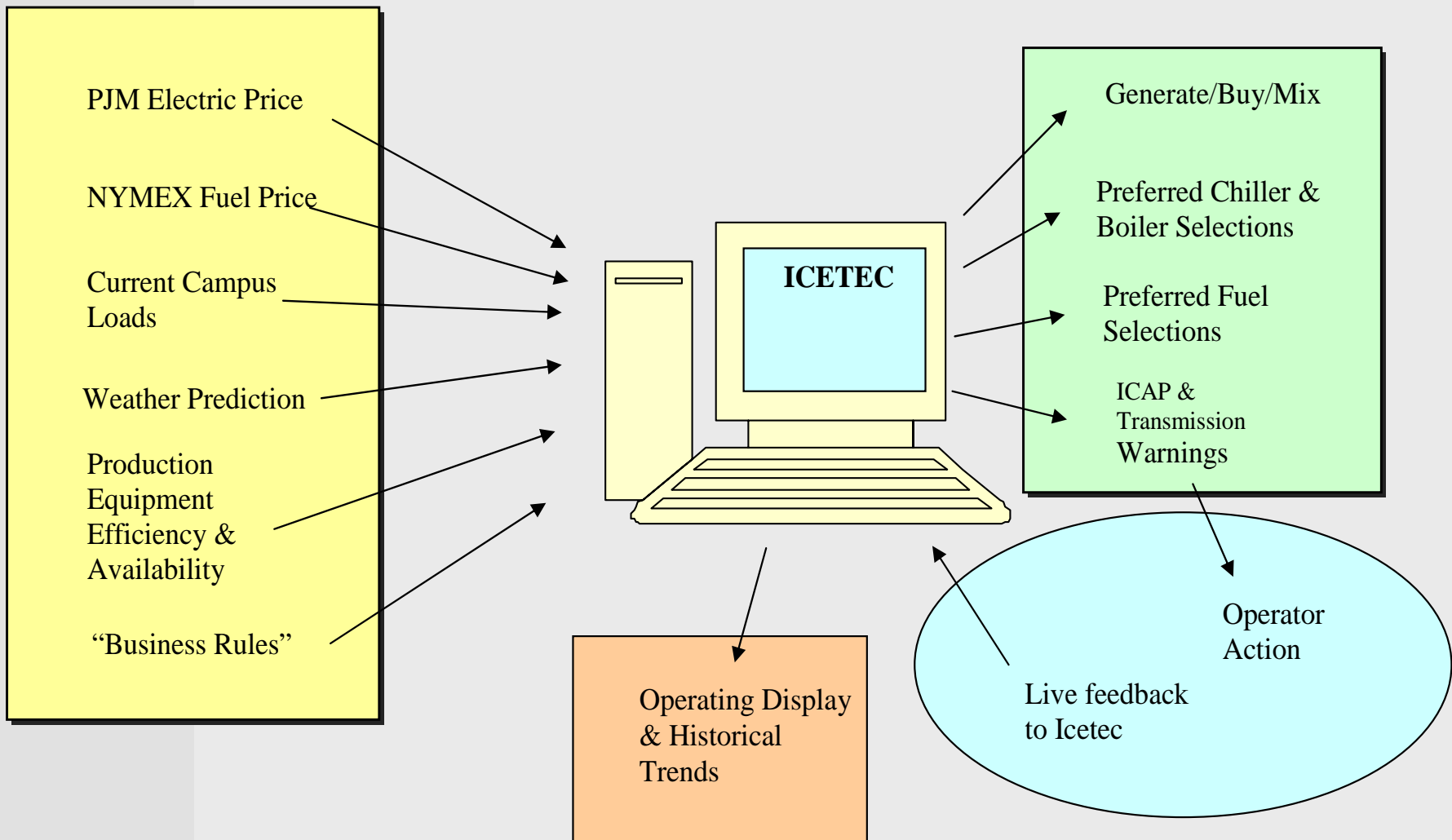
# Optimal Energy Management

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- Operate based on best predictive model, not “conventional wisdom.”

# Icetek Energy Management System



# Operating Strategy



- “With a range of options of utility purchasing and production equipment, the plant operator’s focus moves from simply meeting demand, to delivering energy in the most cost-effective manner.”
- Flexibility in fuel, purchasing, and production equipment is required.
- Reliability sometimes trumps economics!

# Energy Management Impacts



## ■ Plant Operations Personnel

- More guidance
- Better understanding of costs
- Better load prediction
- More machine changes
- “Pay For Performance” contract

## ■ Plant Equipment

- GT: More cycles, life cycle & noise issues
- Chillers: More electric use, less steam use.

## ■ Campus Building EMS Personnel

- More guidance
- More Load Changes
- Strategic Load Trimming

## ■ Management:

- \$ savings, Improved records, load prediction,
- Spot & futures market purchases
- Negotiated contracts with wholesale market

## ■ Other Campus Personnel: e.g., athletics



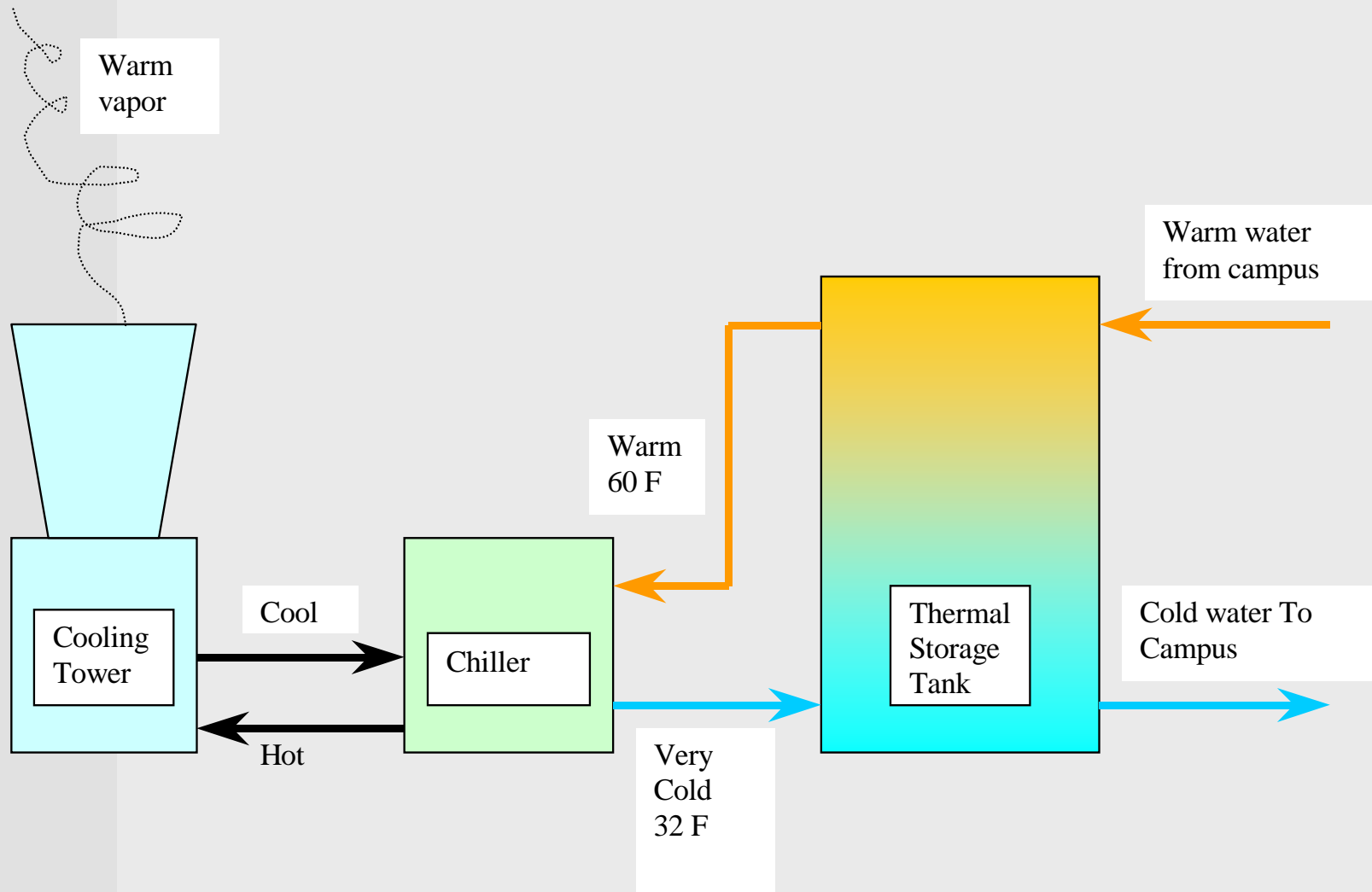
# Future Plans



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- Ongoing upgrades to Iccotec HMI – graphics, data archives, pagers...
  - Expand Iccotec system to include more detail in energy plants and buildings
  - Integration of utility plant controls systems
  - Add 2 chillers and Thermal Storage
  - Space for future chiller, boiler & auxiliaries



# Chilled Water Thermal Storage





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Thank you

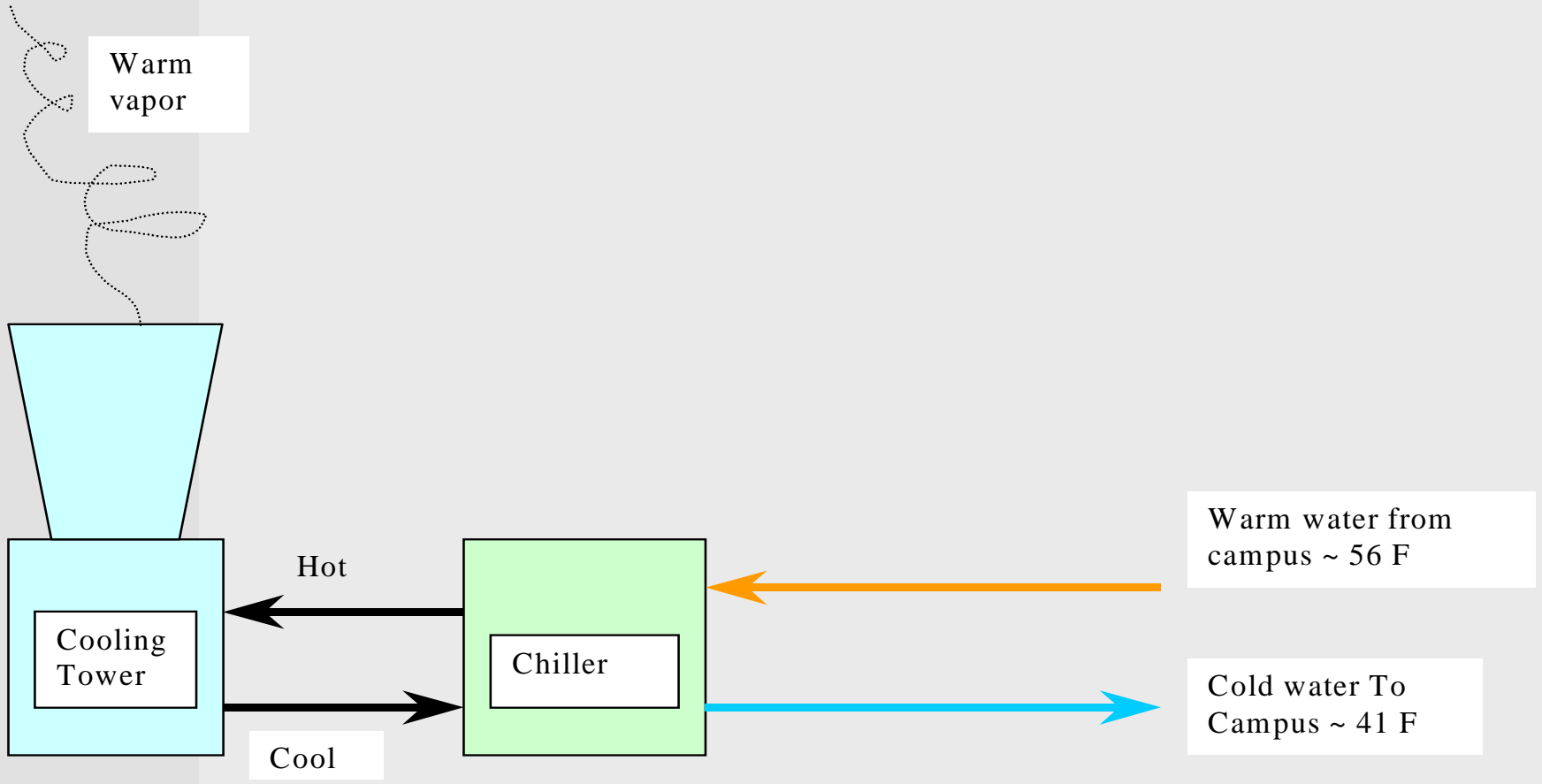


# Energy Plant Arrangement





# Chilled Water Campus Loop





# Gas Futures – Price Fluctuations





# Electric Price Fluctuations

