IDEA2015 | Inspiring the Next Generation

106th Annual Conference & Trade Show I Boston, MA I June 28 – July 1

Primary Heating/Cooling Plant Strategies & How to Maximize the Energy & Financial Savings

Mehdi Jalayerian, PE, LEED AP BD+C
Executive Vice President – Global Practice Leader
Environmental Systems Design, Inc.
Chicago, Illinois

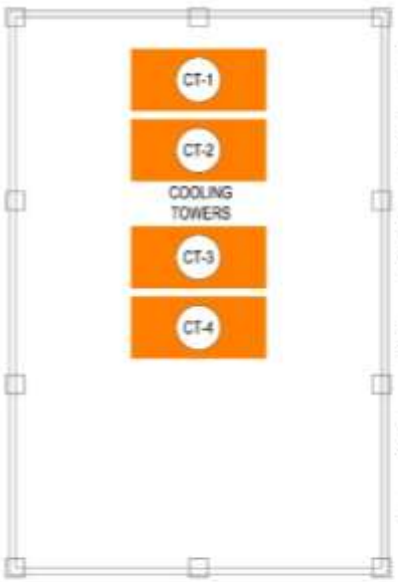
Summary - Abstract

Strategies to improve efficiency of central heating and cooling plants applicable to single building as well as multiple buildings in a campus setting include optimization of central plant's location, configuration, equipment, arrangement, operating parameters, primary utilities and piping distribution systems. Additionally, consideration given to critical commissioning (Cx) activity that focus on ensuring the proper operation is achieved either at time of turn over or through the life of the system. By focusing on large elements of your development like the central plant, the benefits of Cx can be huge! Cx can ensure that the central plant is capitalizing on all available economizer options, reset schedules and load following optimization which can translate up to 20% lower energy consumption or cost.

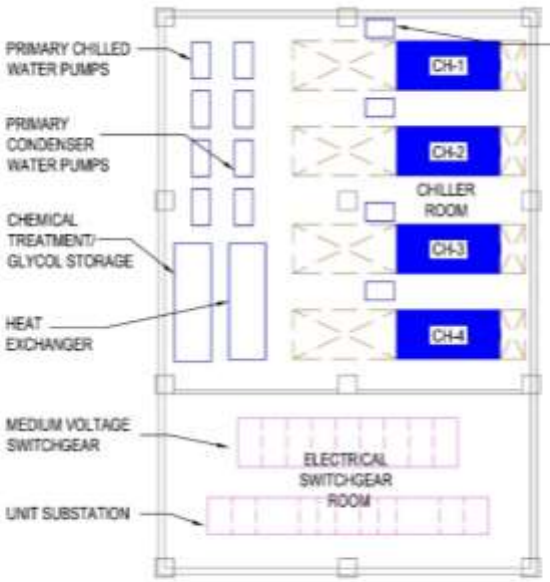
Agenda

- Central Plant Shell
- Heating Plant Strategies
- Cooling Plant Strategies
- System Parameters
- Central Plant Commissioning (Cx)
- Plant Case Review
- Q & A

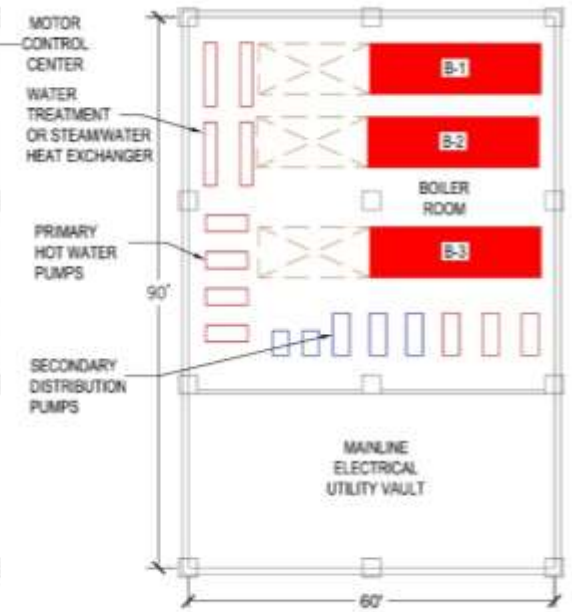
Typical Central Heating / Cooling Plant



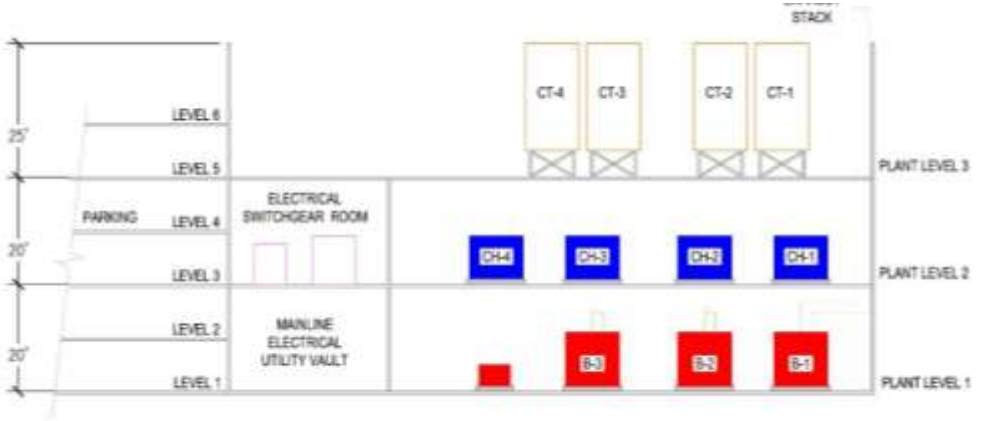
3 CENTRAL PLANT CONCEPT - LEVEL 3



2 CENTRAL PLANT CONCEPT - LEVEL 2



1 CENTRAL PLANT CONCEPT - LEVEL 1

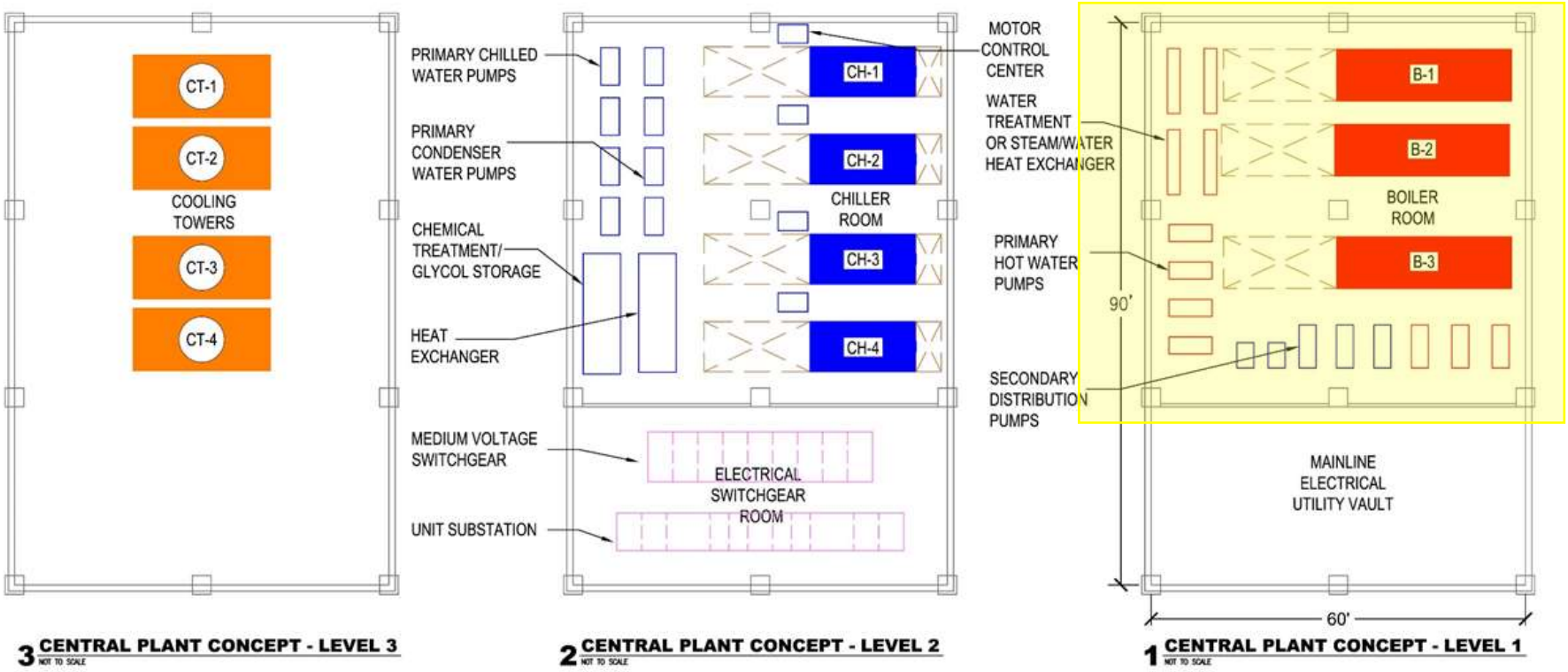


1 CENTRAL PLANT CONCEPT - LEVEL 1-3 ELEVATION

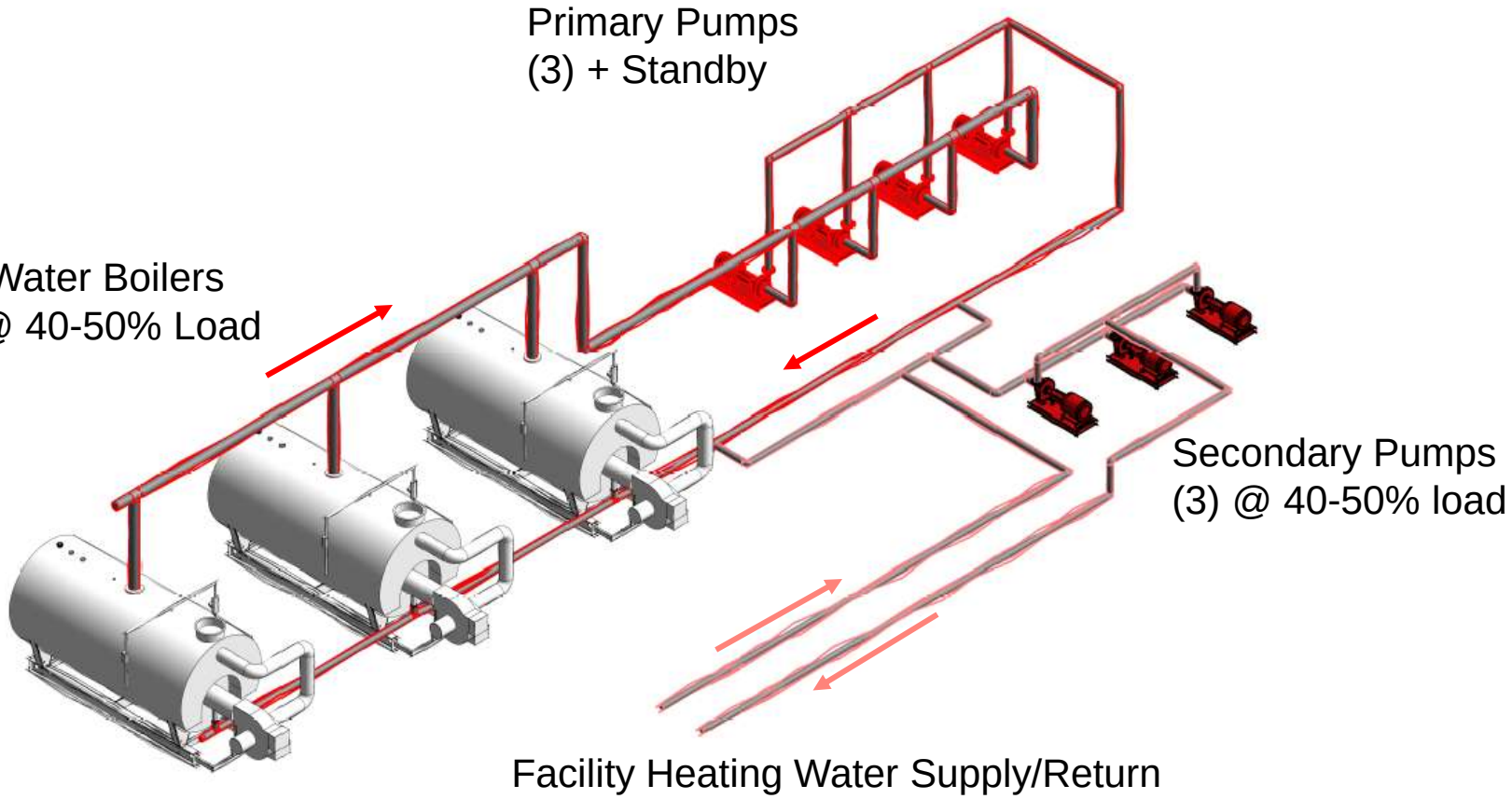
Heating Plant

Strategy 1: Central gas-fired hot water boiler plant

Strategy 2: Central gas-fired steam boiler plant with steam/water heat exchanger



Heating Plant Strategy 1
Gas Fired Hot Water



Heating Plant Strategy 1
Gas Fired Hot Water

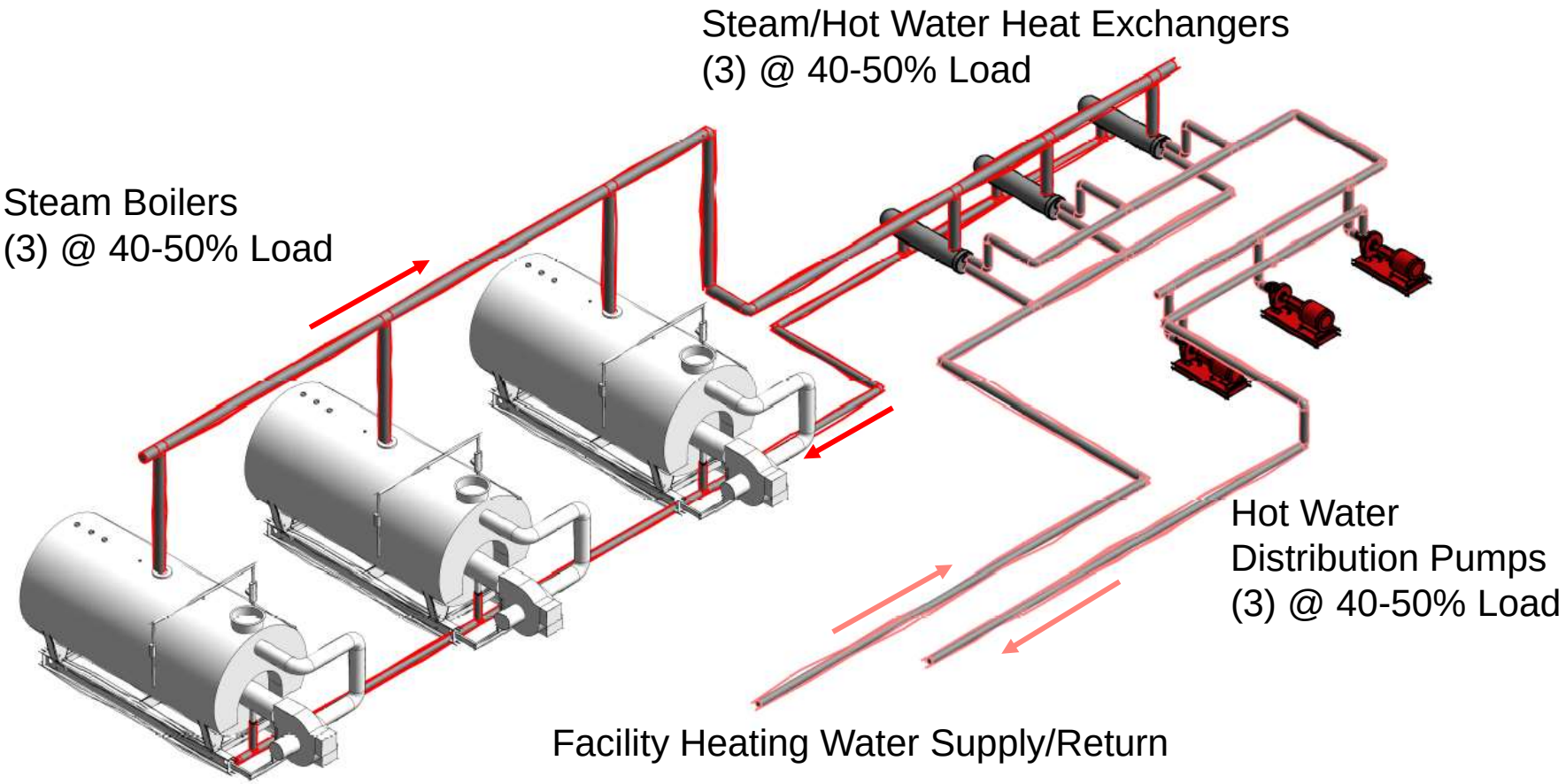
Pro's:

- Fuel source flexibility
- **Operational simplicity**
- **Good part-load efficiency**
- Reliability
- Operational safety
- Long life expectancy
- Centralized maintenance
- Standard application

Con's:

- Space requirement
- Integrate boiler flue with architecture
- Construction scheduling
- Piping distribution system

Heating Plant Strategy 2
Gas Fired Steam Boilers & Heat Exchange



Heating Plant Strategy 2
Gas Fired Steam Boilers & Heat Exchange

Pro's:

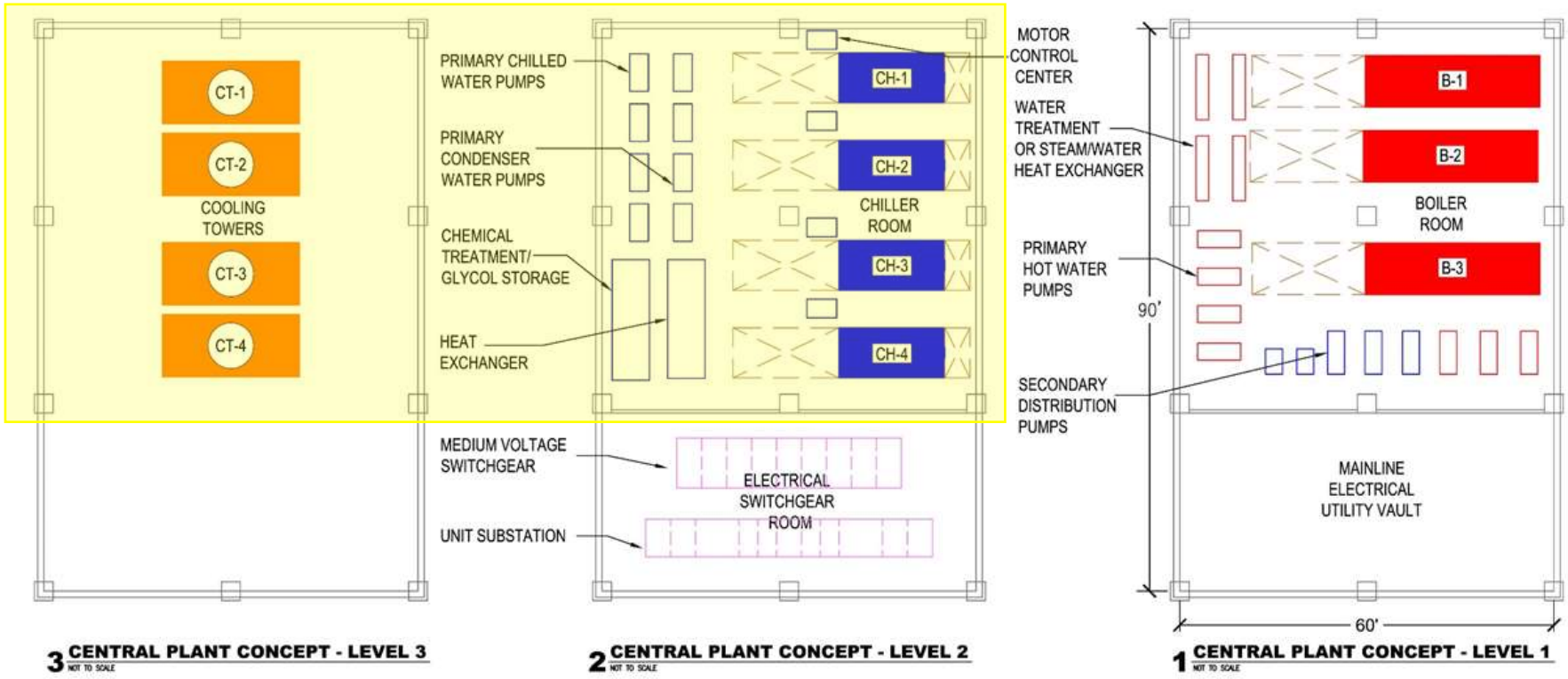
- Fuel source flexibility
- **Best part-load efficiency**
- **Expansion flexibility**
- **Can be integrated with heat recovery system**
- Reliability
- Long life expectancy
- Centralized maintenance
- Standard application

Con's:

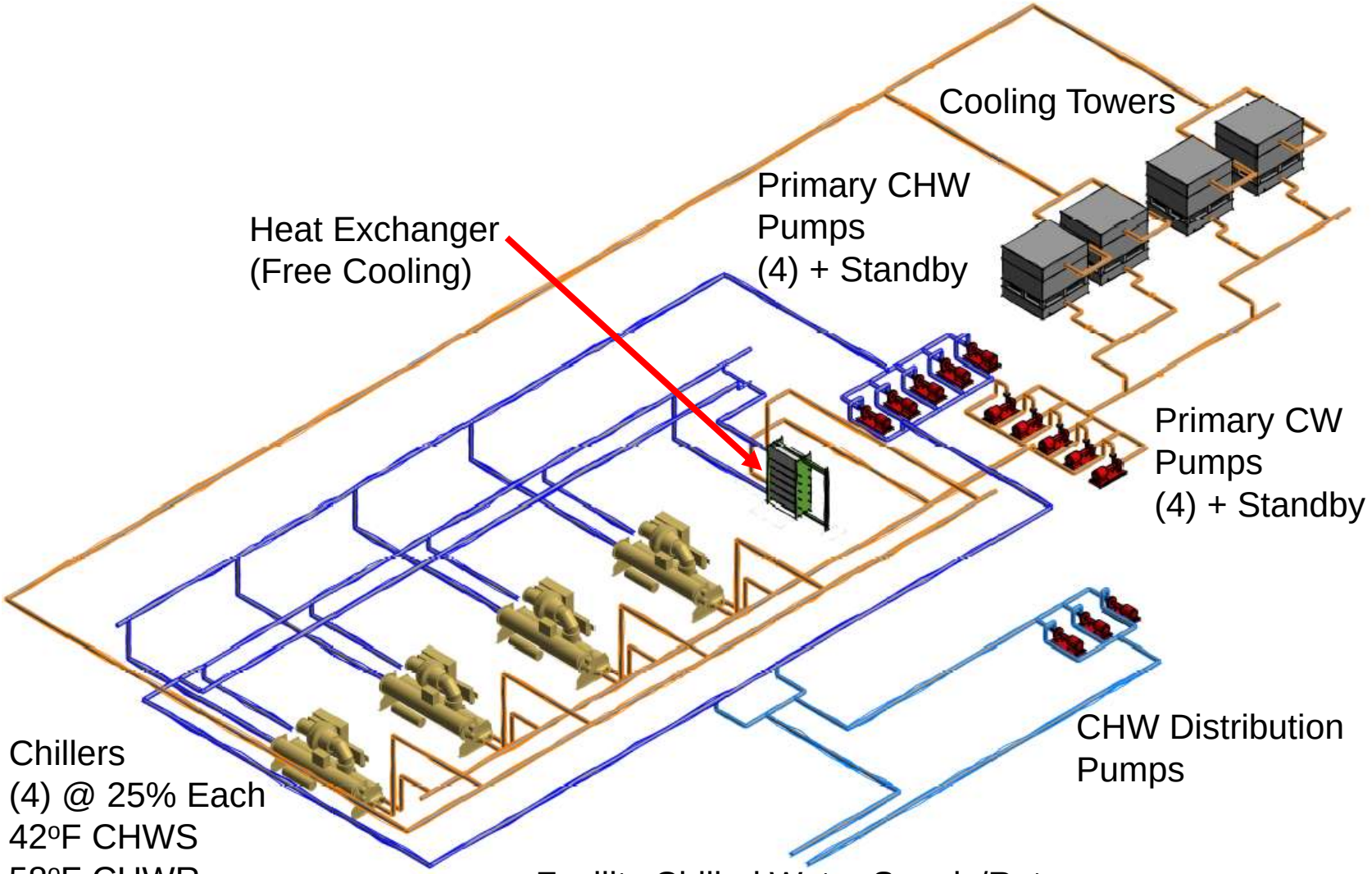
- Space requirement
- Integrate boiler flue with architecture
- Construction scheduling
- Piping distribution system
- **Additional operational complexity**
- **Increased safety requirements**

Cooling Plant

Strategy 1: Standard Chillers and Cooling Towers
Strategy 2: Low Temperature Chillers
Strategy 3: Heat Recovery Chillers
Strategy 4: Low Temperature chillers with Thermal Storage (Ice)



Cooling Plant Strategy 1
Standard Chillers and Cooling Towers



Base Scheme - Standard Chillers and Cooling Towers

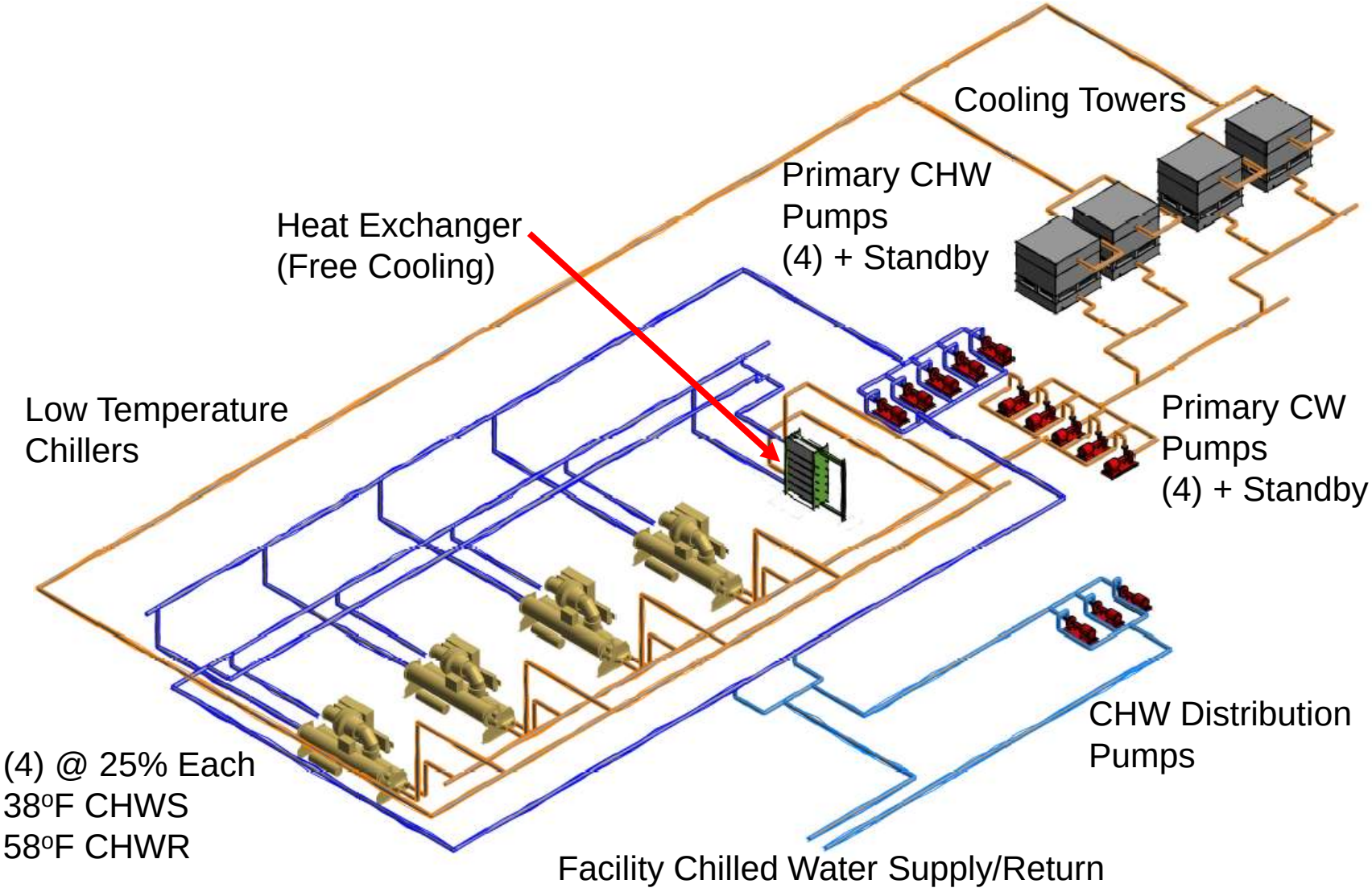
Pro's:

- **Operational simplicity**
- Good part-load efficiency
- Reliability
- Operational safety
- Long life expectancy
- Centralized maintenance
- Standard application

Con's:

- Space requirement
- **Large pipe distribution**
- **High pumping energy**

Cooling Plant Strategy 2
Low Temperature Chilled Water



Cooling Plant Strategy 2
Low Temperature Chilled Water

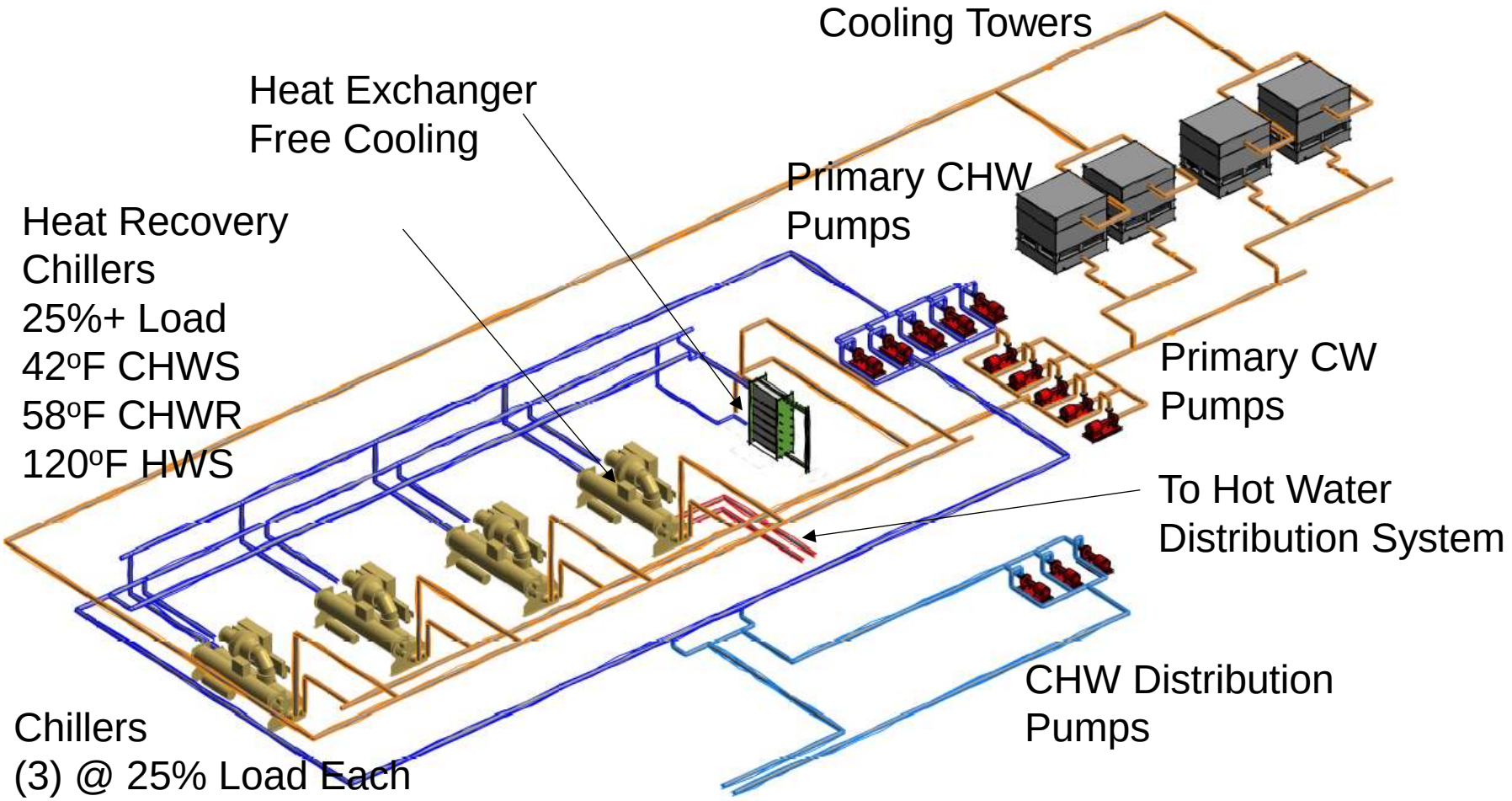
Pro's:

- **High overall system efficiency**
- **Low overall system cost**
- **Low chilled water pumping energy**
- **Better dehumidification capability**
- Good part-load efficiency
- Reliability
- Operational safety
- Long life expectancy
- Centralized maintenance

Con's:

- Space requirement
- **Higher chiller power**
- More complex operation

Cooling Plant Strategy 3
Heat Recovery Chiller



Cooling Plant Strategy 3
Heat Recovery Chiller

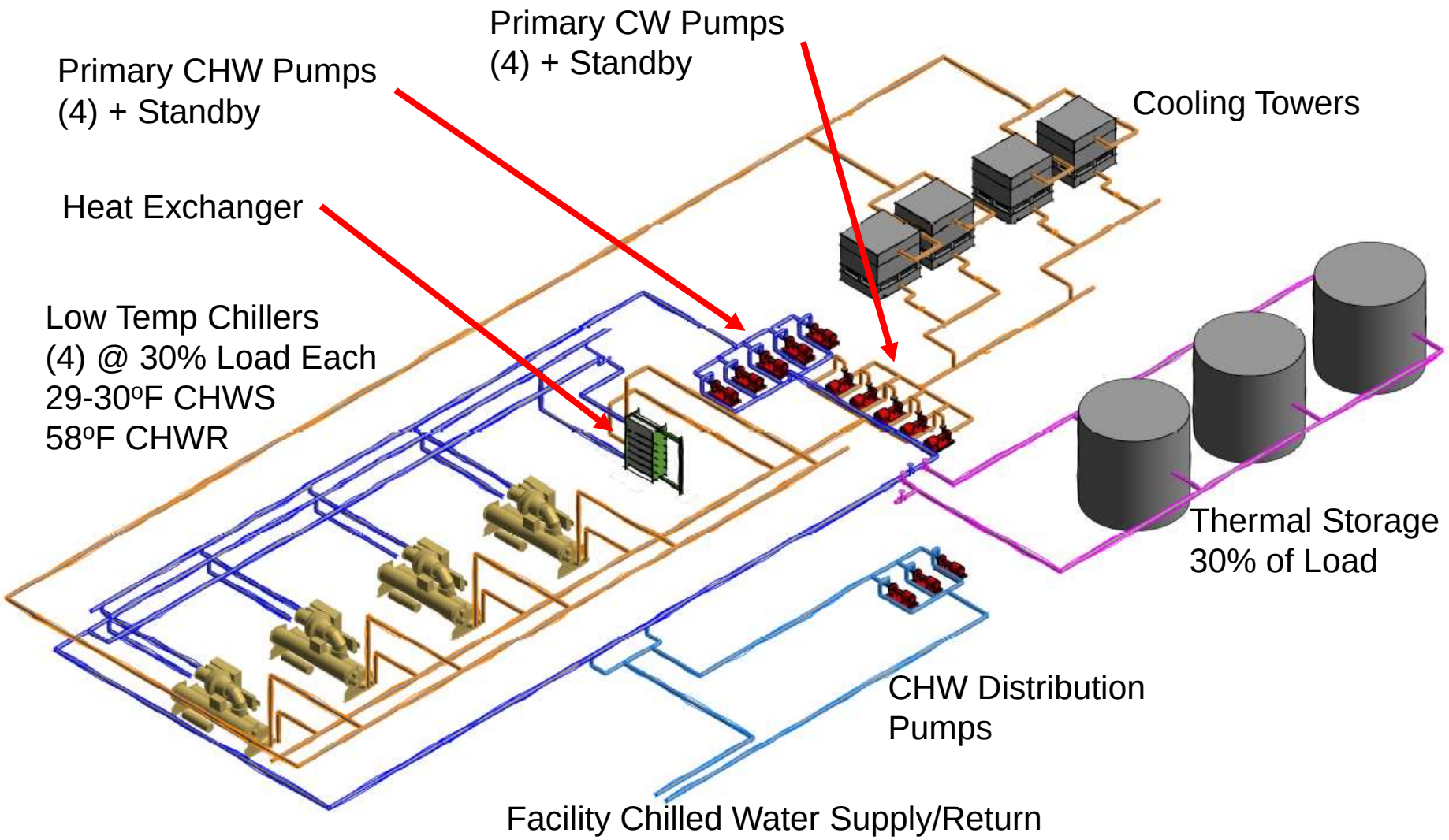
Pro's:

- **High system efficiency**
- **Energy recovery (from internal building heat gains)**
- Good part-load efficiency
- Reliability
- Operational safety
- Long life expectancy
- Centralized maintenance

Con's:

- High initial cost
- **Space requirement**
- Large pipe distribution
- Higher pumping energy

Cooling Plant Strategy 4
Low Temperature Chillers & Thermal Storage



Cooling Plant Strategy 4
Low Temperature Chiller & Thermal Storage

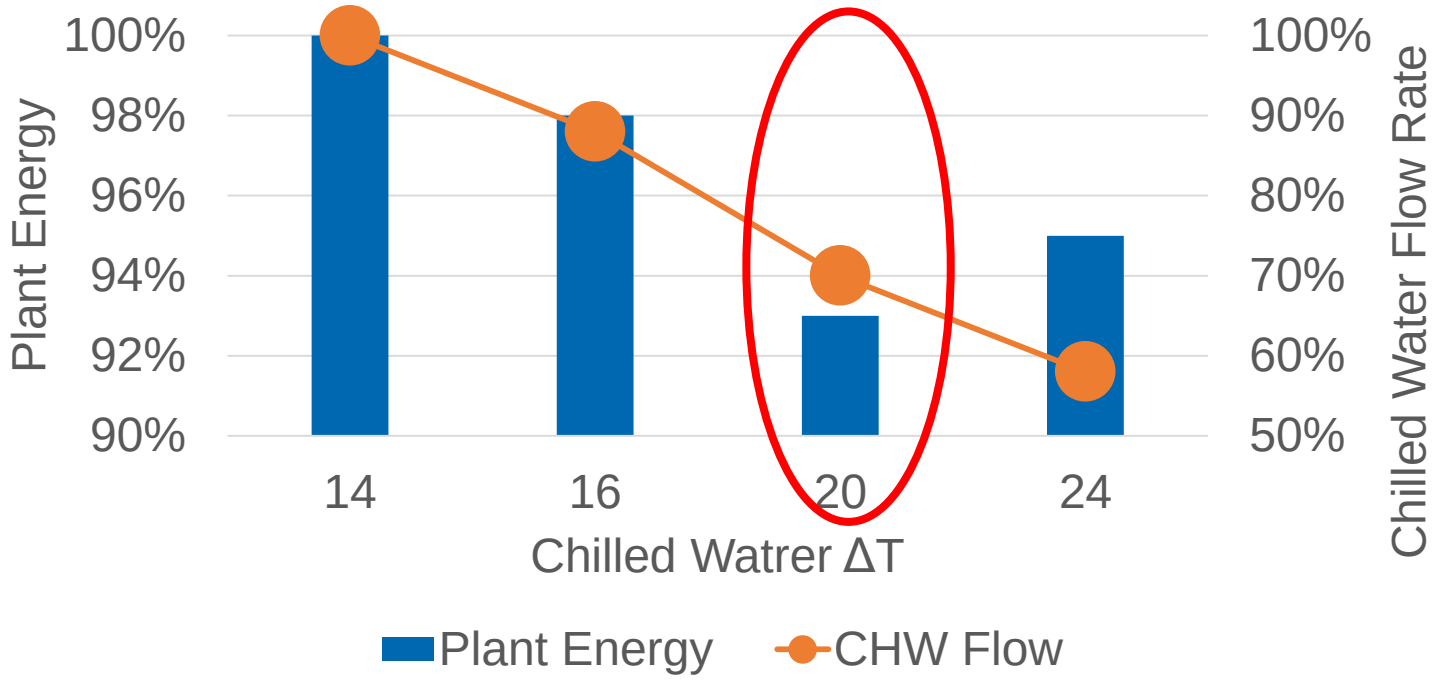
Pro's:

- **Reduces utility demand charge**
- Lower installed chiller capacity (storage)
- **Low chilled water pumping energy**
- **Better dehumidification capability**
- Good part-load efficiency
- Reliability
- Long life expectancy
- Centralized maintenance

Con's:

- Large space requirement
- **Higher chiller power**
- Higher maintenance
- Complex operation
- Savings based on utility structure that may change

Central Chilled Water Plant
Optimized Chilled Water Flow

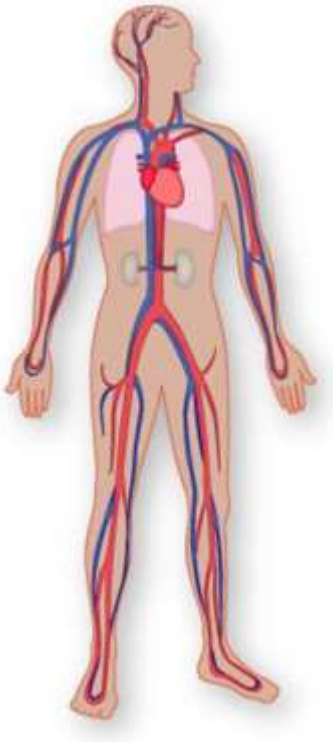


Beyond the Basics

- How to maximize the benefits from Cx
- Where to look and where not to look
- The role of Automation and Integration
- Challenges for your new buildings
- Different challenges for the existing building / campus

Central Plant Cx: The Best Bang for Your Buck

- Value for time and money spent
- The Central plant consumes as much as half of your HVAC energy
  - *Huge energy savings potential*
- The central plant often has only 20% of the points in a building wide automation system
- Largest core energy use for your building
  - *The heart of the living building*
- If central plant is failing no other system can help
- Easiest to commission ☺!



Why is the Central Plant Often Overlooked

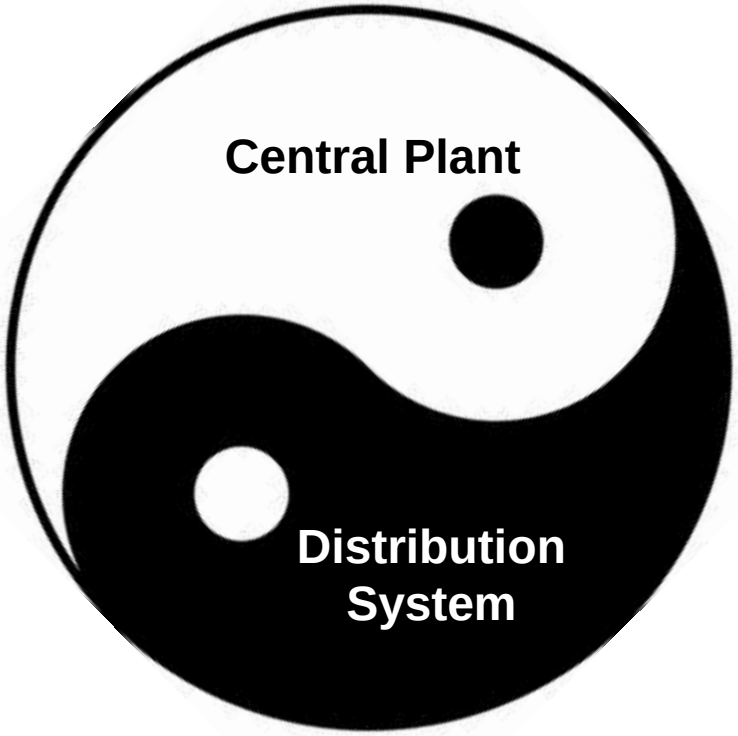
- The "**plant**" is not visible and can not be heard by occupants
- The larger pieces of equipment often come with start-up services
- How to test the central plant before the building is done

Tips & Tricks to Cx Central Plants Without Active Loads

- Maybe not the easiest to commission …
- How do you test a heart without a body
- Focus on modular approach
  - Logic simulations
  - Monitoring verification
  - Fake “body”
  - Fake “treadmill”
- Define future tests or observation
  - No surprises!!!!!

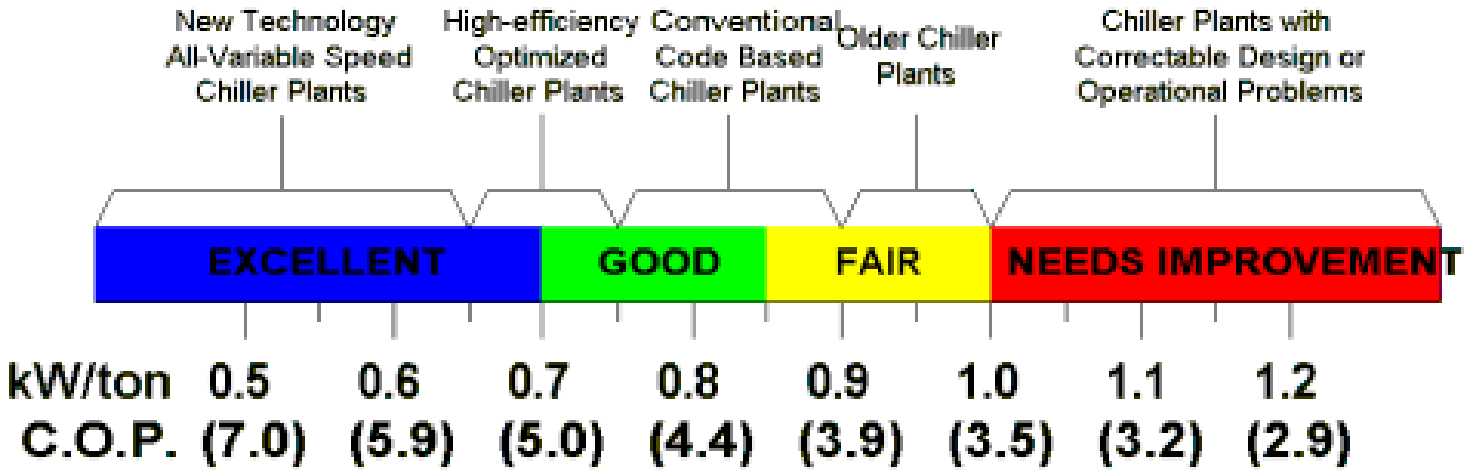
Central Plant Cx Overview & Benefits: Existing System

- Focus on all aspects of central plant
  - Pumping is 1st place to look
  - Part load operating strategy and control
  - Next look at the end use consumption
    - Delta T at each building – Anything stand out
    - Required supply condition at only one spot!
    - Steam: Check the return and traps



Central Plant Cx Overview & Benefits: Existing System

- Maybe your not adding anything but just want to be better?

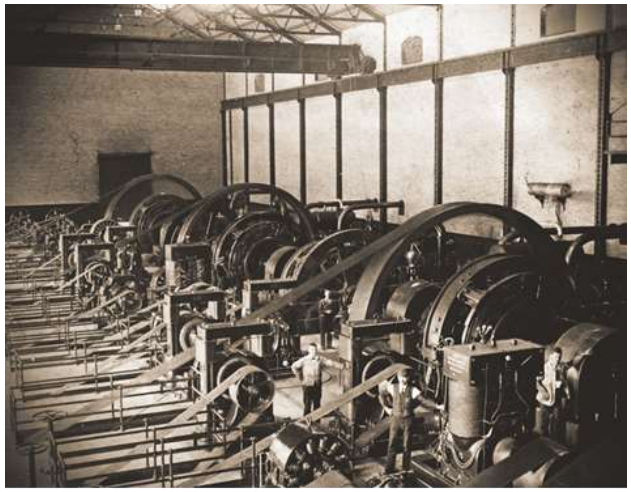


AVERAGE ANNUAL CHILLER PLANT EFFICIENCY IN KW/TON (C.O.P.)
(Input energy includes chillers, condenser pumps and tower fans)

Based on electrically driven centrifugal chiller plants in comfort conditioning applications with 42F (5.6C) nominal chilled water supply temperature and open cooling towers sized for 85F (29.4C) maximum entering condenser water temperature. Local Climate adjustment for North American climates is +/- 0.05 kW/ton

Central Plant Cx Overview & Benefits: Undergoing Expansion

- Expanding your plant – Free EBCx
  - Well almost free
- You must test the complete system
- Again, modular approach
  - Test all new pieces
  - Test interconnection point
  - Test load shed and ramp up
  - Failure scenarios
- TAB scope for old and new!
- Different generations of equipment?
  - Focus on:
    - Life Safety
    - Individual unit control
    - Downstream system feedback
    - Include for automation upgrade in the capital plan



Plant Case Review - McCormick Place Convention Center


300-4,500 person Theaters

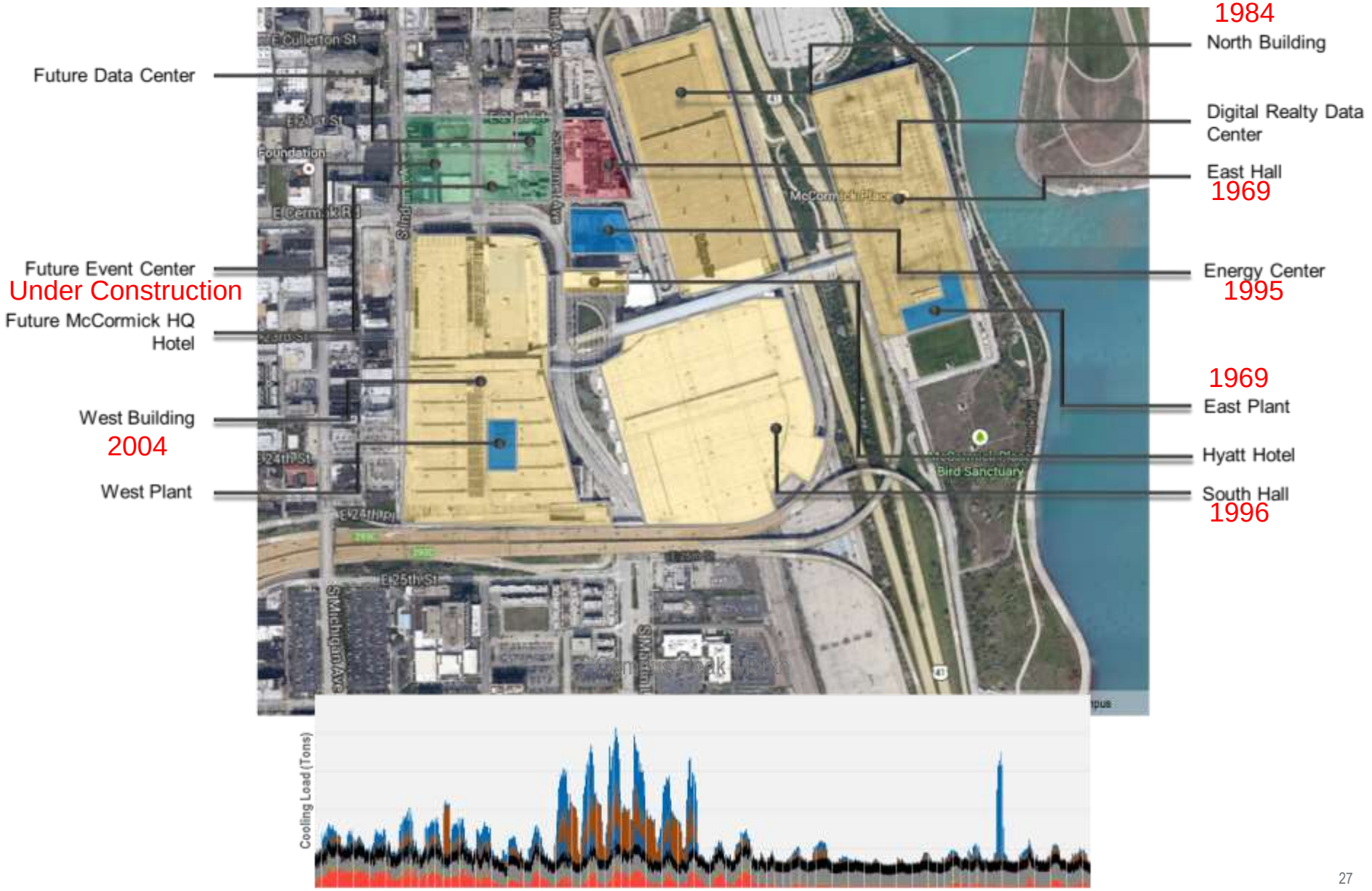

1,200 Room Hyatt Hotel


Multiple Ballrooms and 600,000 Meeting Rooms

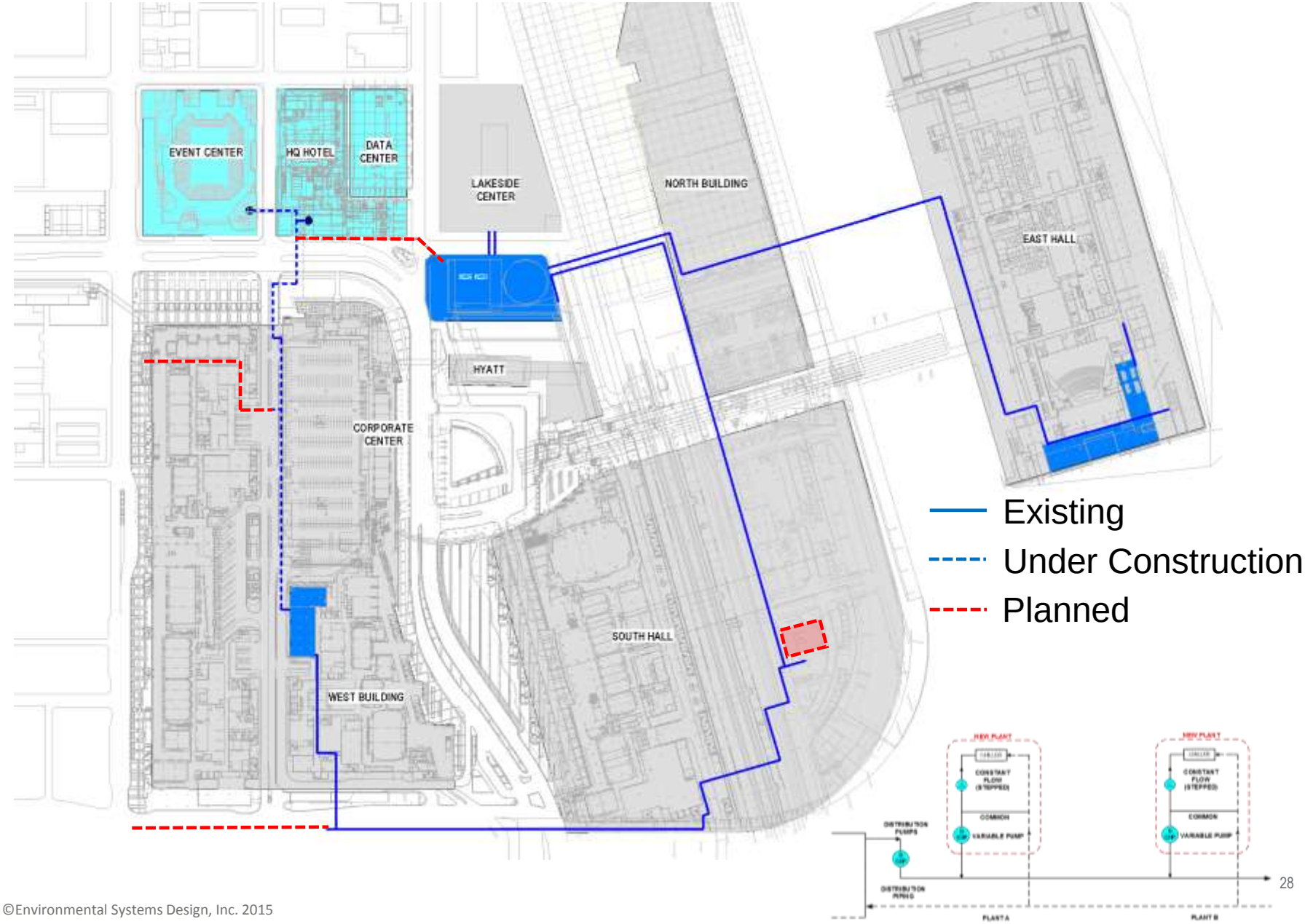

NEW -10,000 Seat Arena and 1,200 Room Hotel


40,000sf Grand Concourse

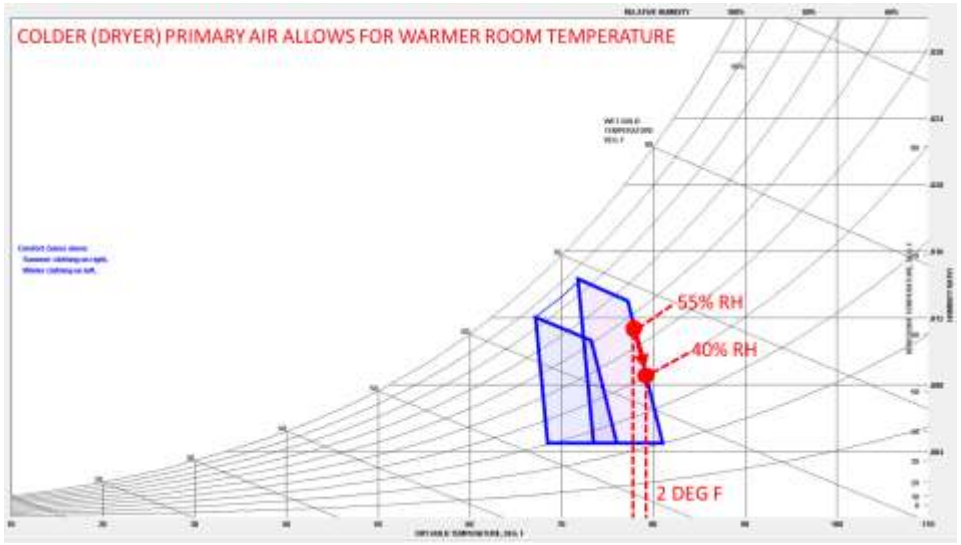
Explore the Campus



McCormick Place Convention Center - Campus



Overall System Impact



Primary Heating/Cooling Plant Strategies & How to Maximize the Energy & Financial Savings

Questions?

Thank you,

mjalayerian@esdglobal.com
312-456-2268

www.esdglobal.com