Better Buildings Summit
Space Conditioning:
Systems Approach to Central Plant HVAC Optimization

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NREL

Washington, DC

May 7, 2:30-3:45

Agenda

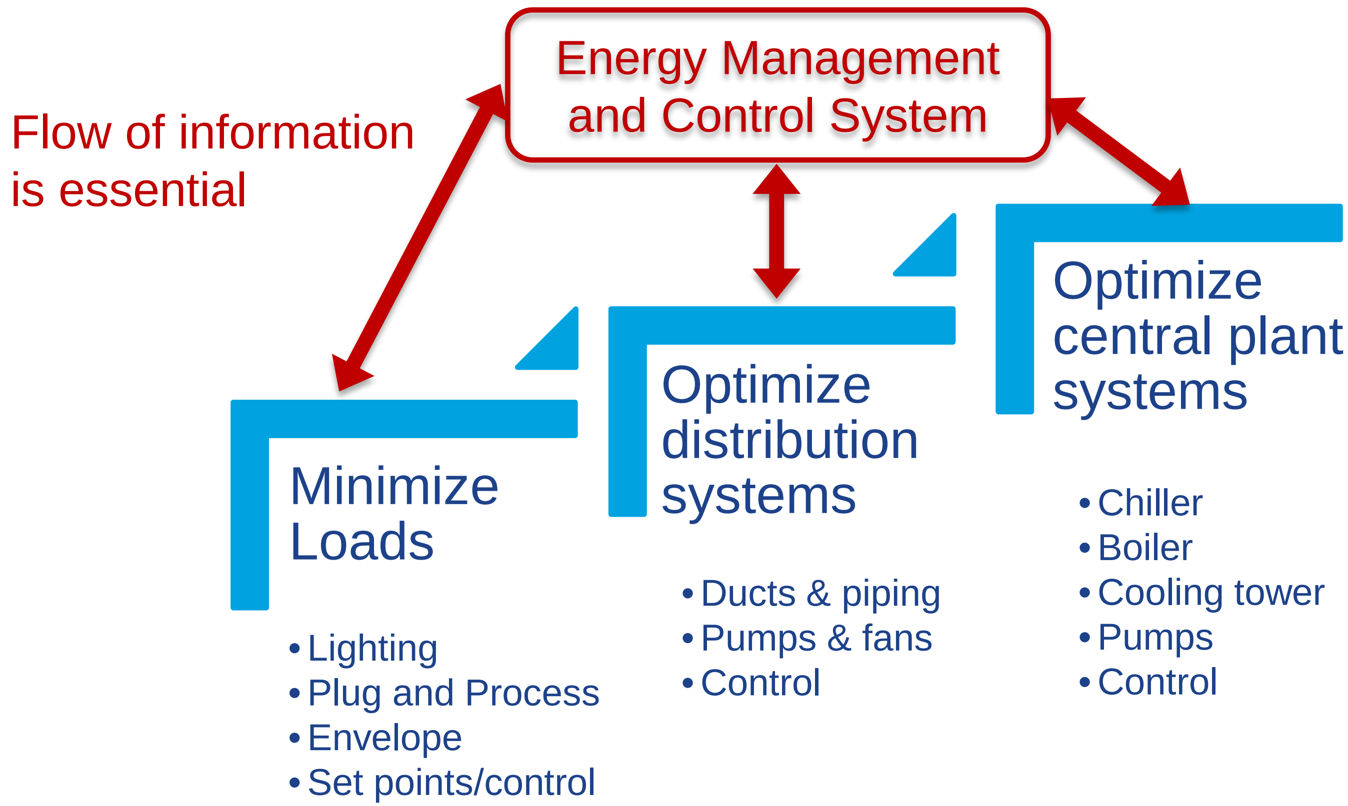
- Introductions
- System view of a central plant
  - Efficiency improvements by optimization of the parts
- Chiller Optimization at New York Presbyterian Hospital – Ed Hall,
- Opportunities with motors
- Open discussion
  - New challenges and opportunities

Central Plant Optimization – Know the "Why" first

Determine objectives and set goals

- Minimize energy consumption
- Maximize cost savings – demand, energy consumption, energy source, maintenance
- Minimize downtime
- Optimize comfort
- Maintain health, safety, and security

Systems Approach to Central Plants



Continuous process but automation is increasing

Keeping Track of Opportunities

	Component	Metrics	Benchmarks	Control	Standard Practice	Best Practice	EEMs	Tools	Gaps/Needs	References
Space Loads	Envelope	UA			90.1					
	Infiltration	cfm/ft2			90.1					
	Lighitng	W/ft2			90.1					
	Plug loads	W/ft2								
	Process loads	W								
	Ventilation	cfm/ft2, cfm/person			62.1					
	Setpoints									
	Domestic hot water	gal/person								
Distribution Systems	Diffuser									
	Ducting				90.1					
	Piping									
	Terminal units									
	VAV boxes									
	Fans									
	Pumps									
	Sensors/Controls									
Central Plant	Chiller, air cooled	kW/ton			90.1					
	Chiller, water cooled	kW/ton			90.1					
	Boiler				90.1					
	Cooling tower				90.1					
	Pumps				90.1					
	Fans				90.1					
	Sensors/Controls									

The New York-Presbyterian Columbia Campus Chiller Plant Optimization

Edward Hall,
Senior Project Manager

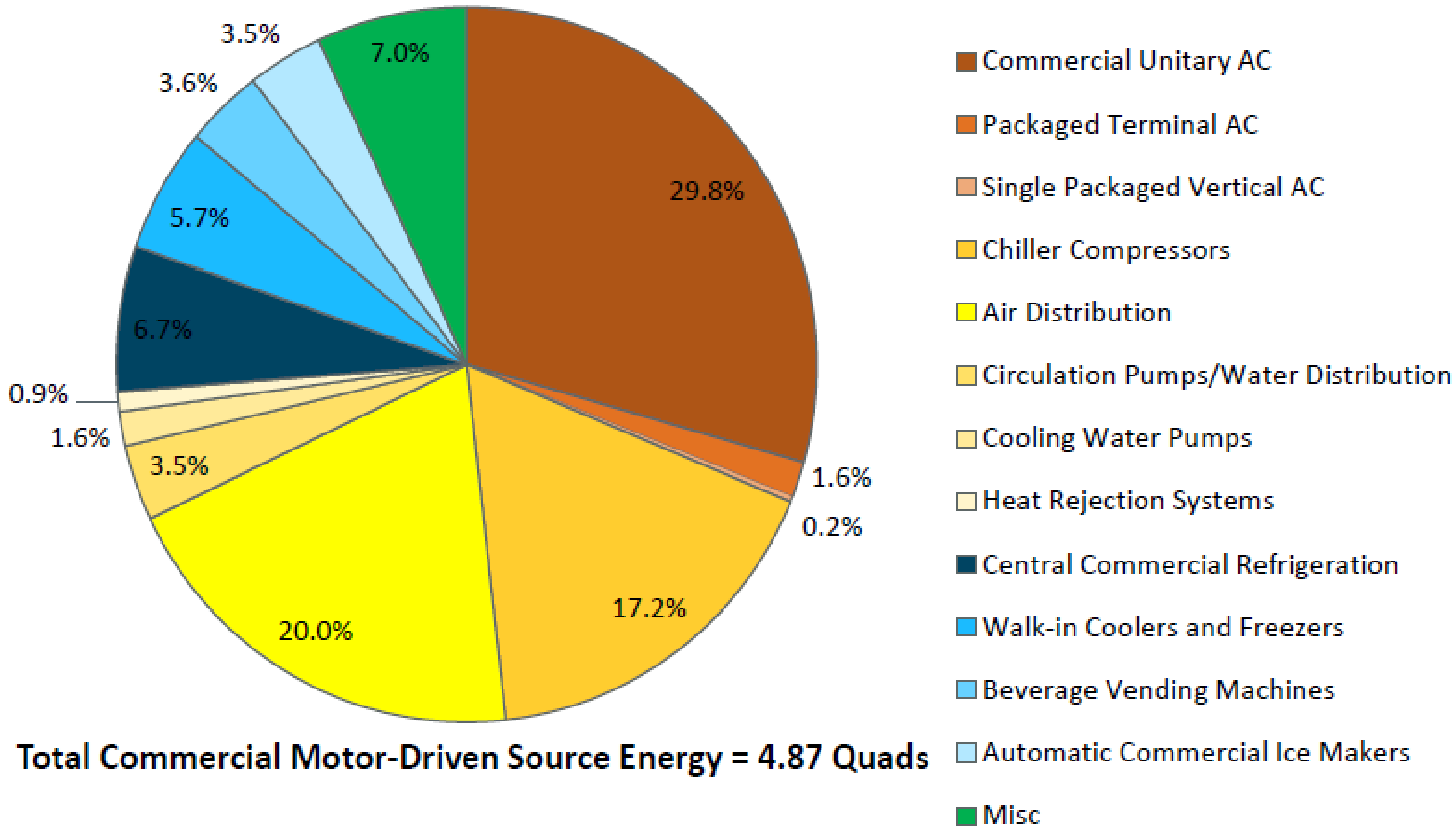
Switch Slides

U.S. DEPARTMENT OF ENERGY

Motors
What are the Opportunities?

U.S. DEPARTMENT OF
ENERGY

Motors in Commercial Buildings



Total Commercial Motor-Driven Source Energy = 4.87 Quads

4.87 Quads = 28% of Commercial Building Energy Consumption

DOE (2013) Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment

Motor Requirements in Standards

- EISA 2007
  - Only Premium Efficiency general purpose motors be imported or sold in the United States after December 19, 2010. Covered motors include low voltage 1 to 200 horsepower
- 90.1-2010
  - VFDs on motors > 5 HP
- 90.1-2013
  - Motors > 1/12 HP and < 1 HP shall be ECMs or efficiency ≥ 70% and variable speed
  - Cooling systems have multispeed or modulating fans

Types of Electric Motors

Many ways to classify motors

	Type	Maturity	Peak Eff.	Eff. Range	Cost	Examples	Comments
AC	Single Phase Induction	High	Low-Med	Low	$ - $$	Permanent split capacitor, Shaded pole	Most common
AC	Three-phase Induction	High	Low-Med	Low	$$		Common for large motors
DC	Permanent Magnet / Brushless DC	Med	Med-High	Med	$$$	Includes ECMs and Switched reluctance	Cost is coming down for some motors
DC	Electronically commutated	Med	Med-High	Med	$$$		Limited to 1 HP
DC	Switched Reluctance	Low	Med-High	High	$$		cost should reduce

Motor Efficiency Opportunities

- Turn it off
- Whole system efficiency (i.e. reduce load on motor)
- System and motor maintenance
- Turn it down – add variable speed capability
- Replace with high-efficiency motor
  - Select the right motor for the application
  - Consider
    - Permanent magnet motors – ECMs
    - variable speed or multi-speed motors

Motor Resources

- MotorMaster +, DOE Tool for selecting motors
- Motor Decisions Matter – motorsmatter.org
- DOE Motor Reports
  - Energy Savings Potential and Opportunities for High-Efficiency Electric Motors in Residential and Commercial Equipment, Dec 2013
  - Premium Efficiency Motor Selection and Application Guide, Feb 2014

Open Discussion

Open Discussion

- Recent Successes
- Challenges
- New opportunities

We Put Patients First

The NewYork-Presbyterian Columbia Campus Chiller Plant Optimization

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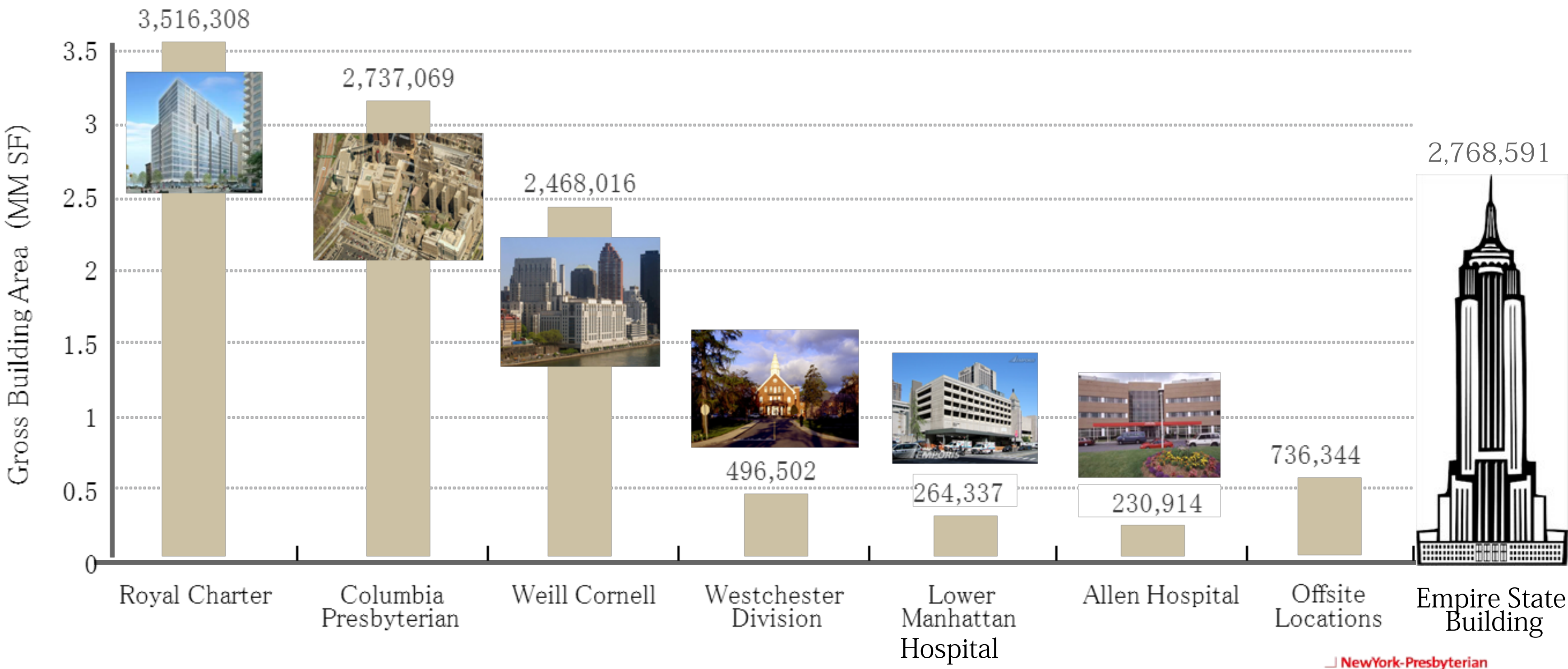
NewYork Presbyterian Facilities

Total NYP
10.4 million sq ft



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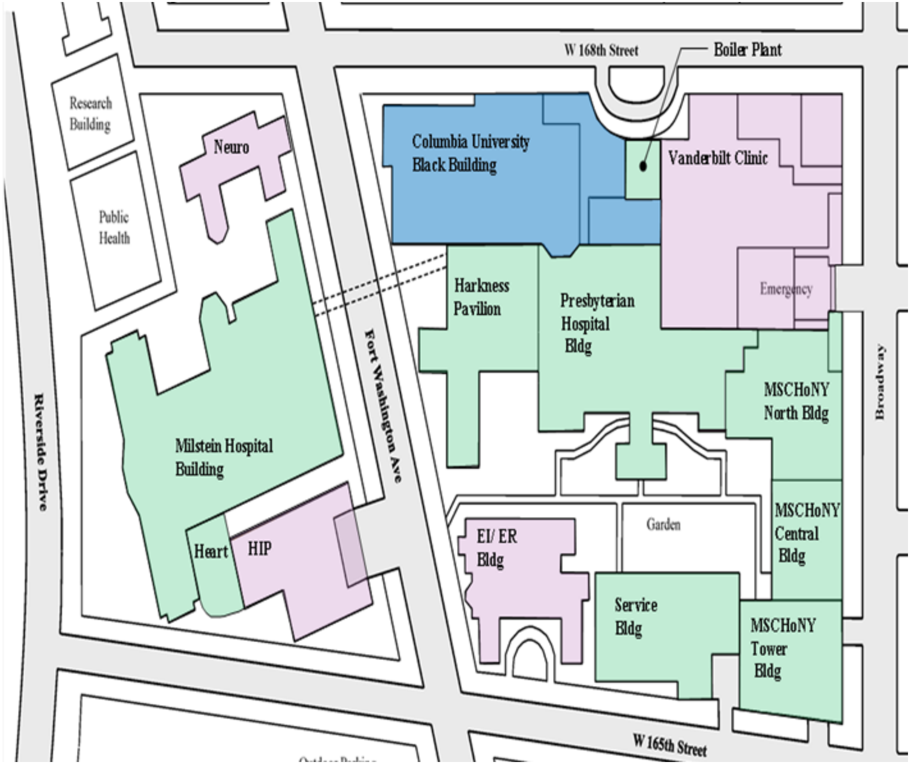
NYP/Columbia Presbyterian Campus

- Seven (7) Chillers (Hybrid)
  - (3) Electric (4) Steam
  - ~ 14,800 tons of CHW capacity
- Fourteen (14) Cooling Tower Cells
- Four (4) High Pressure Steam Boilers
  - 150 PSIG, 120k lbs/hr each
- Campus Chilled Water Max Load ~9,000 Tons
- Chiller Plant serves approximately ~3.5 M sq. ft. (including University facilities)



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Energy Efficiency /Capital Improvement Program

Chiller Plant Optimization and Monitoring (UtiliVisor) 2010 - Ongoing

Sequencing at various loads with different fuel sources.

Optimizing cooling tower sequencing.

Balance energy usage on auxiliary components.

Calibrate temperature sensors.

Lowering condenser temperatures and correcting flow to meet design tonnages.

Retro Commissioning/Energy Efficiency 2012

Upgrade controls/Adjust VFD Programming for CHW.

No automatic isolation on Cooling Tower.

Developed chiller plant design sequence of operations that would provide virtual/ manual modifications, reducing cost per tonnage.

Capital Improvement Program 2012-2013

Isolating Chilled water speeds/Cooling Tower Modulating Fans Speed and Sequencing.

N+1 York Steam Chiller 2800 Tons Installation.

Chiller Plant Control Upgrade: Siemens BMS controls and phase out of an obsolete CSI control system.

Future Modernization

Condensing Water Sand Filter

Cooling Tower Fill Replacement

Cooling Tower Control Valve Automation

Vibration Switch Upgrade

Complete Chiller Plant Automation

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Real Time Data and Continual Optimization

- The system is currently semi automatic and manually controlled with input from UtiliVisor.

- The standard mode of operation provides guidance to plant engineers with respect to current plant operations that may yield energy savings:
  - Without regulation of chillers and auxiliary pump motor speeds the hospital is unable to yield continual energy savings. Prior to control systems and real time energy management, equipment was operated at 100% full load.

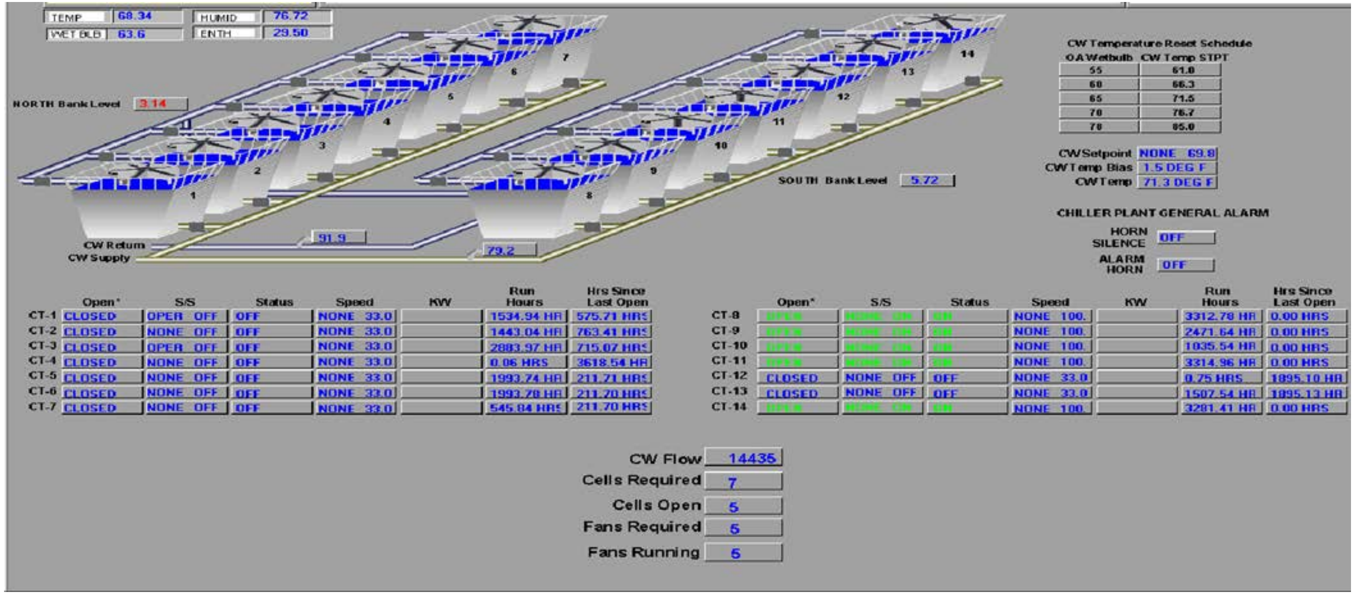
- Troubleshooting equipment and verifying the problem source has become easier with controls in place. Increasing corrective action by not having to physically inspect each equipment to troubleshoot.

- Annual calibration of all chiller plant points is established for data integrity.

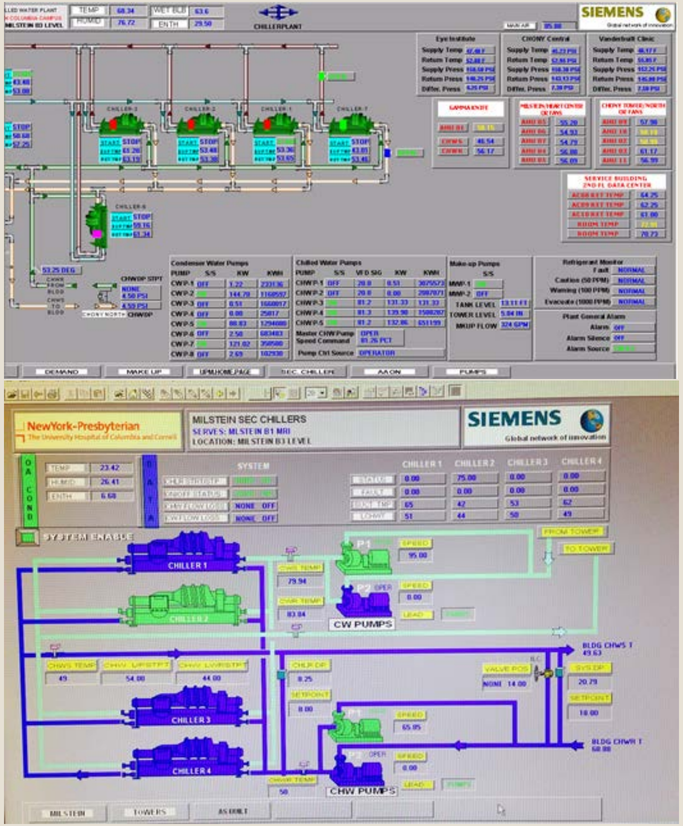
- Prior to isolating chilled water speeds and modulating fans on the cooling towers for sequencing. The operations team would need to troubleshoot (turn off/on) towers manually. This meant traveling from the chiller plant control room up to the 10th floor (approx. 30 minute travel time).

Siemens BMS Upgrade - CT and CHWP Optimization

- Cooling tower was designed to have a 7'F approach temperature based on the wet-bulb temperature.
- Program design would allow for individual selection of cooling tower cells for the correct amount of chillers in operation at any given time.
- Isolating CT supports maintenance, troubleshooting and and demand response peak demand curtailments.



Siemens – CHW Distribution Optimization



- Prior to UtiliVisor's optimization program, CHWPs were operated at 100% full load. With UtiliVisor's recommendation and lack of control, the CHWPs were reduced to operate at 85%.
- Automated controls allow operators to determine how many chillers to operate per differential pressure serving distribution points on the main chilled water loop.
- Control logics were revised to decrease CHWP run time to 81%, Increasing efficiency on pumps with VFD's.
- Water flow rate limits were implemented.
- Understanding differential pressure between supply and return.
- Cost savings on chilled water is holistically managed from production to distribution as opposed to saving on the cost to produce a ton and having unsatisfied customers (end users).

Project Benefits

- Since chiller plant optimization program and capital improvement initiatives the hospital saved $1M-1.5M annually in chiller plant operating costs.
- Saving 21,116,405 lbs of Co2 or the annual ghg emissions from approximately 2,000 passenger vehicles.
- New control system allows staff to monitor the chiller plant in its entirety which supports ease of troubleshooting operations and promotes continuous monitoring and optimization of the plant.

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NewYork-Presbyterian
The University Hospital of Columbia and Cornell