District Chilled Water Optimization at Penn State Health Milton S. Hershey Medical Center

Kevin Kanoff, C.E.M. - Campus Energy Engineer, Penn State Health Hershey Medical Center
Jonathan Kosobucki, P.E. – Director of Project Development, Optimum Energy
Milton S Hershey Medical Center

- Founded in 1963 through a $50 Million gift from The Milton S Hershey Foundation.
Medical Center Overview

- 24 Academic Departments
- 6 Major Institutes
- 4 Hospitals
- 17 Hospital Affiliates
- 10,000 employees
- 35 ORs

Accredited as both adult and pediatric Level 1 Trauma Center
College of Medicine

- First Students enrolled 1967; First Graduate degrees 1969; First Doctors of Medicine 1971
- Portfolio of $109M in funded research annually
- Research Equipment
- 400 Ultra Low Freezers
- Ultra Low Freezers (-80 C)
Milton S Hershey Medical Center

- 4.5M square feet of buildings
- 3.6M square feet of conditioned space
- 112,000,000 kWh annually
- 573,000 MMBtu natural gas annually
Infrastructure

• Central Plant provides steam and chilled water to central campus:
  – 3 Cleaver Brooks, dual fuel, water tube boilers (1967)
  – 7 chillers (1999-2017); 8,500 tons of cooling

• 2 Satellite Plants (2008, 2012)
  – 4 chillers; 4,800 tons of cooling

• 1.4 Million gallon Chilled water storage tank

• 155 air handling units across campus
Preventive Maintenance

• Over time the ability of the facility to meet chilled water needs of the facility become difficult.
  – Winter of 2010-11 an aggressive chilled water distribution PM program was instituted.
    • Strainer Cleaning/Replacement
    • Valve Replacement
    • Analog Thermometers added at Air Handler Coils
Hydraulic Study of Chilled Water Distribution System

• Hydraulic Modeling and Analysis
  – Central Plant - Chilled Water
  – Central Plant - Condenser (Tower) Water
  – Satellite Chiller Plants 1 & 2 – Chilled Water
Chilled Water Optimization

• Intelligent Energy Solution
  – Lowering Energy Consumption
  – Reducing Chiller Plant Operating and Maintenance Costs
  – Contributing to Milton S. Hershey’s Corporate Energy and Sustainability Goals

• Convert three chiller plants to variable-flow plants

• Implement optimization system powered by OptimumLOOP
Plant Layout - Site
Plant Layout – Satellite Plant 1
Plant Layout – Satellite Plant 2
Plant Layout – CUP (Commissioned mid-June 2016)
Optimization Foundation – Scope of Work

- VFDs added to 375 HP of primary chilled water pumps
- VFDs added to 1000 HP of secondary chilled water pumps
- VFDs added to 750 HP of condenser water pumps
- Power Monitoring for all chillers and auxiliary equipment
- Distribution Flow Meter and Temperature Sensors
- Deploy Optimum Energy Optimization Control Algorithms and Monitoring Platform
All Variable-Speed HVAC System

- Cooling Tower Fan Speed
- Condenser Pump Speed
- Chiller Vane & Speed
- Chilled Water Pump Speed
- Air Handler Fan Speed

Total System Schematic

VFD's

Total System Cooling Output

Total System Energy Input

PennState Health
Milton S. Hershey Medical Center

PennState College of Medicine
Additional Operational Requirements

- TES Must Remain available for Demand Response
- SAT plants elevation created negative return pressure conditions at high SAT plant flows.
  - Resolved through adjusting TES transition sequence changes and limiting SAT plant range
- Changing the Mindset
  - Shift from constant primary flow to variable primary flow
  - Variable chilled water temperatures
  - Variable distributions pressures
  - Variable condenser water flow through chillers
  - Wide range of tower water temperatures
# Chilled Water Optimization

## Table 1: Optimization Utility Savings

<table>
<thead>
<tr>
<th>Optimization Utility Savings</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Energy Savings</td>
<td>3,406,337 kWh/year</td>
</tr>
<tr>
<td>Electrical Demand Reduction</td>
<td>183.7 kW</td>
</tr>
<tr>
<td>Cooling Tower Water Savings</td>
<td>1,444,831 gal/year</td>
</tr>
<tr>
<td>CO₂ Emission Reduction</td>
<td>6,101,087 lbs/year</td>
</tr>
</tbody>
</table>

## Table 2: Optimization Financial Savings

<table>
<thead>
<tr>
<th>Optimization Financial Savings</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility Rebates and Incentives</td>
<td>$340,634</td>
</tr>
<tr>
<td>Annual Operations Cost Reduction</td>
<td>$260,656</td>
</tr>
</tbody>
</table>
Efficiency – Simulation during Analysis Phase

Performance Trends

- Post kW/Ton
- Pre kW/Ton
Efficiency – Prior to Optimization (2014)
Efficiency – Post Optimization (2016) - 0.709 kW/Ton

- Total annual savings of 4,156,991 kWh (2016)
Efficiency – Post Optimization (2017) - 0.675 kW/Ton
Site Efficiency – Post Optimization

2017 (black) 2016 (Blue) Total Plant Efficiency vs. Load

Campus Load (Tons)
Utility Efficiency Analysis – Pre/Post (2016)

- Utility verified savings of 4,156,991 kWh ($310,000) for 2016
  - $415,699 Utility Incentive
Chilled Water Optimization – Phase 2
Chilled Water Optimization – Phase 2

• Replace oldest 2 chillers with Magnetic Bearing Chillers

• Projected additional Savings
  – 1,624,040 kWh
  – $124,000/yr
  – One-Time Additional Incentive $94,000 (approx.)
Questions?