Gas Fired Chiller Replacements at UConn

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OVERVIEW | STORRS

Campus History

• Founded in 1881 as the Storrs Agricultural School
• Land, Sea & Space Grants
• Became the University of Connecticut in 1939
• Under UConn 2000, $3.7 billion in construction
• With Next Generation CT, $1.5 billion in infrastructure
OVERVIEW | STORRS

Campus Overview Today

• National leader among public research universities

• More than 19,000 undergraduate students at Storrs Campus

• Over 100 undergraduate majors

• Ranked among the top 25 public universities in the nation by U.S. News & World Report in 2014

• Storrs Campus ≈ 443 acres
**OVERVIEW | STORRS**

**Master Plan & Goals**

- Significant new building to meet rising student enrollment & increased research footprint
- Development capacity in conjunction with sustainability goals
- Prioritize increases in efficiency
- District, connected & looped SUPs

### Chilled Water Load Projections

<table>
<thead>
<tr>
<th>Business As Usual Approach</th>
<th>Demand</th>
<th>Near Term</th>
<th>Mid Term</th>
<th>Long Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>8,300</td>
<td>14,691</td>
<td>16,301</td>
<td>22,171</td>
</tr>
<tr>
<td>New Capacity</td>
<td>(1,700)</td>
<td>2,691</td>
<td>4,301</td>
<td>10,171</td>
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</table>

<table>
<thead>
<tr>
<th>10% Energy Reduction</th>
<th>Demand</th>
<th>Near Term</th>
<th>Mid Term</th>
<th>Long Term</th>
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<tbody>
<tr>
<td></td>
<td>13,222</td>
<td>14,671</td>
<td>19,954</td>
<td></td>
</tr>
<tr>
<td>New Capacity</td>
<td>1,222</td>
<td>2,671</td>
<td>7,954</td>
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<table>
<thead>
<tr>
<th>20% Energy Reduction</th>
<th>Demand</th>
<th>Near Term</th>
<th>Mid Term</th>
<th>Long Term</th>
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<tbody>
<tr>
<td></td>
<td>31,753</td>
<td>13,041</td>
<td>17,377</td>
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</tr>
<tr>
<td>New Capacity</td>
<td>(247)</td>
<td>1,041</td>
<td>5,737</td>
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<table>
<thead>
<tr>
<th>30% Energy Reduction</th>
<th>Demand</th>
<th>Near Term</th>
<th>Mid Term</th>
<th>Long Term</th>
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<tbody>
<tr>
<td></td>
<td>10,284</td>
<td>11,411</td>
<td>15,820</td>
<td></td>
</tr>
<tr>
<td>New Capacity</td>
<td>(1,796)</td>
<td>(589)</td>
<td>3,520</td>
<td></td>
</tr>
</tbody>
</table>

**Assumptions: (SF/TON)**
- New Buildings
- Demolition
- Renovation

- Academic / Teaching: 200, Demolition: 154, Renovation: -667
- Administration: 200, Demolition: 154, Renovation: -667
- Arts / Culture: 225, Demolition: 173, Renovation: -750
- Athletics + Recreation: 375, Demolition: 288, Renovation: -1,250
- Misc: 400, Demolition: 308, Renovation: -1,333
- Parking: 0, Demolition: 0, Renovation: 0
- Residence / Dining: 200, Demolition: 154, Renovation: -667
- Science: 175, Demolition: 135, Renovation: -583
- Student Services: 200, Demolition: 154, Renovation: -667
- Support / Utility: 400, Demolition: 308, Renovation: -1,333

*Renovated buildings are assumed to be approximately 30% more efficient following the renovation. Indicated value is relative energy savings.*

** Load projections based on new, removed, and renovated space by phase and use type, as outlined in the Campus Master Plan and the Load Calculations at the end of this report.**

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**Impact on Utility Systems**

- Existing Capacity: 6,100 tons
- New Capacity: 8,100 tons
- Required Demand Migration: 22,200 tons
- New Capacity or Remaining Capacity Update: 11,000 tons
<table>
<thead>
<tr>
<th>Category</th>
<th>Steam Generation</th>
<th>CHW Generation</th>
<th>Elec Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Demands</td>
<td>Steam = 250 KPPH</td>
<td>CHW = 9,000 Tons</td>
<td>Elec = 27.0 MW</td>
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<tr>
<td>Fuel Types</td>
<td>Generation Pressure: Inside CUP 600/125 PSI, 1 Backpressure Steam Turbine Generator</td>
<td>Distribution Pressure: 65 PSI</td>
<td>Feed Water Makeup Supplied by Reclaim Water backed up by Potable Water Vulnerability = Loss of Natural Gas</td>
</tr>
<tr>
<td>Steam Generation Reliability Criteria:</td>
<td>Primary Driver Types</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Chilled Water 1993</td>
<td>CUP Supplies CHW to 3M+ SF Building Space via North &amp; South Utility Tunnels</td>
<td>- Capacity 12k tons, 4 Steam Chillers, 2 Electric Chillers, 4 Gas Chillers, Free Cooling Heat Exchanger</td>
<td>- Capacity 1k tons, 500 ton electric driven, 500 ton gas driven</td>
</tr>
<tr>
<td></td>
<td>South Chilled Water 1993</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHP Description &amp; Performance</td>
<td>CUP Supplies CHW to 3M+ SF Building Space via North &amp; South Utility Tunnels</td>
<td>97 Building Stand Alone Systems</td>
<td></td>
</tr>
</tbody>
</table>
Critically Important Factors

• Plant was a primary/secondary chilled water pumping system on one side, primary variable on the other. The project reconfigured the header system and is now all variable primary, greatly improving operational DP control.

• The 3 gas turbine inlets were originally designed with a chilled water loop for summer use only. A glycol loop was installed for preheating turbine inlet air in the winter, which also improves NOx control during extreme cold conditions.
Problem Statement

• Verify size/age/capacity of system vs updated need projections

• Capacity shortfall assessment for redundancy & resiliency

• Coordination with Master Plan

• Critical timeline & scheduling
**ENGINEERING | DESIGN CHALLENGE**

**Chiller Plant & Pumping Station**

- Existing physical & operational conditions
- Mapping sub-zone capacity/distribution
- Evaluation of reuse, rerouting, replacement & new infrastructure
- Proposed plant & location factors
ENGINEERING | DESIGN CHALLENGE

Key Design Challenges

• Flexibility / diversity / resiliency

• Maintaining occupied, active campus

• Diversity through multiple fuel sources

• Electrically constrained

• Logistical considerations
Design Approach

• System evaluation & assessment process

• Laser scanning & point clouds of building & tunnels

• Detailed infrastructure routing options

• Modeling scenarios
## Approach

- Conceptual timelines
- Design options & alternatives
- Enabling projects
- Estimating & budgeting priorities
- Identify & order long lead items

### Conceptual Timeline

<table>
<thead>
<tr>
<th>Infrastructure Projects</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>NER - Underground Base - NSS3 (Delivery to Churches)</td>
<td>Design</td>
<td>Design</td>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NER - NSS Extension - NSS3 Air mp</td>
<td>Design</td>
<td>Design</td>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSS2</td>
<td>Design</td>
<td>Design</td>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>Building Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant West</td>
</tr>
<tr>
<td>Science One</td>
</tr>
<tr>
<td>SUP (NSS Built)</td>
</tr>
</tbody>
</table>

### Power Infrastructure Enabling Upgrades

- 14G
- 14G2
- 14G3
- SP2
- SP7
- SP8
- NSS1
- NSS2
- NSS3

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**CampusEnergy2020**
**The Power to Change**
February 10-14 - Sheraton Denver Downtown - Denver, CO
Final Design Solution

• After enabling projects, new SUP chiller plant at periphery of campus

• 4 x ton chillers

• Looped back to existing chiller CUP plant at center of campus

• Upgrades to pumping stations
Equipment in Place

UConn Chiller Plant: 4 new 400 ton gas-engine chillers were up and running this past summer. They were temporarily shut down as the new cooling towers were being replaced this fall/winter and will be back in operation this spring.
Impact on Capacity / Performance

• Ongoing projects kept on-track

• Provided the Storrs Campus with excess capacity during this past cooling season for first the time in years

• Resiliency enabling upgrades to proceed without service losses
Design Lessons Learned

• New drive technology surpassed
• Gas driven chiller public bidding
• Pre-qualifications
• Planning interim steps
MISSION CRITICAL PLANT WITH UNIQUE EQUIPMENT REQUIREMENTS

- Lack of space
- Complex sequencing
- Public procurement
- Multiple campus jobsites
- No laydown space
- Critical milestones
22 Month Project

**Phase A:** Pre-shutdown over summer/fall 2018 (@ 6 months)
- Initial demolition and prep
- Add temporary chiller capacity

**Phase B:** Entire chilled water system shutdown over Jan & Feb 2019 (@ 2 months)
- Reconfigure headers, new connections & valves
- New electrical gear

**Phase C:** CUP chiller plant shutdown early spring 2019 (@ 2 months)
- New gas engine driven chillers 3A & B

**Phase D:** CUP must be operational over summer 2019 (@ 5 months)
- New gas engine chillers 1A & B
- Clean up work and prep for upcoming outage

**Phase E:** CUP chiller plant shutdown over fall/winter 2019/2020 (@ 7 months)
- Replace all condenser water and towers
- Project close-out
START WITH THE END IN MIND

SOLUTIONS

QA/QC Requirements
- Provides Database of Checklists for Team’s Use
- Full Project Team has 24/7 Access to Live Project Data

Safety Management
- A major issue will ruin the most well executed project

Application of Technology
- Superintendent and Field Staff Inspect Installation in Progress / Take Photos / Document in BIM 360
- Subcontractors Use BIM 360 to Document Corrective Work
LASER SCANNING & MODELING

- Enhanced project planning
- Offsite prefabrication of piping sections
- Rig path analysis to avoid conflicts
- Clash detection on the desktop
- Review valve orientations with operations
- Accurate as-built conditions
A LEAN APPROACH – REDUCE WASTE, ADD VALUE

1. Identify Value
2. Organize Work Through A Value Stream
3. Create a Smooth and Continuous Work Flow
4. Pull Planning Sessions
5. Continuous Improvement
OPERATIONAL COORDINATION

- Shutdown planning
- Temporary chillers
- Work around academic calendar
- Daily plant staff coordination
- Safety inspections and JHA’s
- Deliveries logistics
- Neighboring projects
EQUIPMENT PROCUREMENT

RISK MANAGEMENT

- Costs
- Delivery
- FAT
- Start-up and Cx
- Warranty
LESSONS LEARNED

- Adaptive planning, we had a contingency scenario for every major phase
- Utility grade rental equipment is a good investment
- Public procurement and set-asides requires that we understand the system and players and how to best utilize them.
- “Incremental” commissioning requires a special approach
Proposed Chiller Plant Under Construction

- New campus construction will increase peak demand above 10,000 tons, exceeding existing distribution capacity
- New CHW source in North District will be cross connected & provide capacity for new NW Science Quad loads
- New SUP to augment capacity utilizing steam & electric chillers
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