THE EVOLUTION OF THE UT AUSTIN UTILITY PLANTS

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Presentation Objectives

• UT Austin’s Philosophy for Cooling
• UT’s Actual Historical Performance
• Impact to Power Generation
• UAE Plant Operation vs UT Plant Operation
• VFD vs Constant Speed
Holistic Approach to Total Energy
Evolution of Optimization

2007
45K Tons - Eliminate Steam Turbine Chillers, Add 15K Electric Chillers w/VFD’s but no Optimization

2008
45k Tons - Start Optimizing 15K ton plant

2009
Evaluate Distribution DP control and VFD Pumps at CS3

2013
Optimize Multiple Plant Dispatch, Reduce DP to 10 to 4 psi (summer vs rest of year) (4 plants)

2014 – 2017
Start Using 4 MG TES

2018 - 60k Tons
Add 15k All VFD Plant, Add VFD to 5k ton OM Chiller, Start Using 6 MG TES

Annual Average kW/ton = 0.84
15 million GSF
MW = 59, Tons = 29.3k, Steam 200k

Annual Average kW/ton = 0.80
15.9 million GSF
MW = 60, Tons = 33.1k, Steam = 190k

Annual Average kW/ton = 0.77
15.9 million GSF
MW = 62, Tons = 34k, Steam = 191k

Annual Average kW/ton = 0.66
17.9 million GSF
MW = 61, Tons = 33.4k, Steam = 188k

4-year Average kW/ton = 0.66
18.3 million GSF
MW = 61, Tons = 33.6k, Steam = 203k

Annual Average kW/ton = 0.615
19.6 million GSF
MW = 65, Tons = 38.3k, Steam = 240k

Total Cumulative Saved: 509.6K MWh
$21.3 Million
Peak MW Adjusted for Space Growth

- Actual Peak MW
- PEAK MW at 2007 Power Efficiency


Values: 59.40, 60, 62, 64, 64, 64, 61, 61, 61, 61, 78, 78, 59

55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67

80
Persistent Monitoring
Performance To Date vs Last Year

• Using Both TES for First Time (80,000 ton-hrs)
• Started TES & Chilling Station Optimization
  • Working through transitions:
    • Charging to Discharging & Vice Versa
    • Multiple Chilling Station Dispatch
  • Optimize Power Generation vs Chilled Water Production
    • Shift load to Nighttime – Increase Electrical Generation Efficiency (~3% Better)

• Peak Electrical Load and Cooling Load is August to September
  • Peak Power = 59 MW vs last year at 65 MW
  • Peak Cooling Demand = 34,118 vs last year at 38,300 (includes TES Dispatch)
  • 30,000 tons are Spare (CS3, CS4 & 5-2500 ton Chillers at CS7)

Goal is to Absorb Campus Growth With No New Plants
Auxiliary Energy Performance

UAE District Energy Plant

- Condenser water pump efficiency decreases as load decreases
- Primary pumps behave exactly the same
- This is the result of constant speed pumping and lack of VFDs
- Pumps cannot adjust with load so efficiency is a step function based on the number of pumps running
- \# Pumps On = \# Chillers On
- Chiller staging becomes a critical factor in overall efficiency
Variable Speed Condenser Water Pumps

UT Austin

- Condenser water pump efficiency increases as load decreases
- Variable CHW primary-only plant (no primary secondary)
- Pumps adjust with load
- # Pumps on does not equal # Chillers On
- Chiller staging becomes less of a factor in overall efficiency
Variable Speed Chillers vs. Constant Speed Chillers

• Chiller efficiency is linearly proportional to lift

• Variable speed chillers are more efficient at all loading due to redundant equipment.

• Constant speed chillers use constant speed condenser water pumps

• Variable speed chillers are operating at variable condenser water flow

• > 20% savings even at high wet bulbs
## Cooling Tower Selection

<table>
<thead>
<tr>
<th>Site</th>
<th>Entering (deg F)</th>
<th>Leaving (deg F)</th>
<th>Wet bulb (deg F)</th>
<th>Approach (deg F)</th>
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</thead>
<tbody>
<tr>
<td>UT Austin CS7</td>
<td>93</td>
<td>83</td>
<td>78</td>
<td>5</td>
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<tr>
<td>UAE site 1</td>
<td>103.1</td>
<td>93</td>
<td>86</td>
<td>7</td>
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<td><strong>Recommended design for UAE</strong></td>
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</table>
Cooling Tower Selection

- Approach gets worse as wet bulb decreases
- Approach improves significantly at part flow conditions
- It is possible at 33% flow to operate at less than a 1 deg F approach
- Towers at UT Austin are consistently operating at 1.5 to 2.5 deg F approaches year round.
All Variable Speed Chilled Water Plant
Thermal Energy Storage (Total UT CHW Plant Electric kW)
Questions?

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