Texas State University
Utility Analysis

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Texas State University - San Marcos

The rising STAR of Texas

- 1st in Texas State University System
- 6th in Texas
- 46th in the United States
- Fall 2012: 34,225 total students with an 5% enrollment growth per year

Campus

- 457 acres main San Marcos campus
- 5,038 acres of farm, ranch, residential and recreational areas
- 218 main campus buildings (oldest 1903; 4.5 million sq. ft.)
Campus Setting in Central Texas

• Unique Attributes
  – Long east-west orientation
  – Geography/topography
    • Hilly with 220 ft. elevation change
  – Waterways
    • Located at the headwaters for the San Marcos River
    • Situated over the Edwards Aquifer recharge zone
“Texas State University-San Marcos intends to ensure environmentally responsible practices and the efficient use of energy and water resources.”

Dr. Denise M. Trauth, President
Director Utilities Operations

- District Energy operations and maintenance:
  - Four thermal plants and distribution system for steam, hot water, and chilled water;
  - Public potable water supply production;
  - Life safety and backup generators;
  - 15kV electric distribution system;
  - Automated control systems for thermal plants and campus buildings, fire systems;
  - Campus energy management/conservation.
Sustainable Stewardship

The *continuous* process to meet the campus energy and water demands in a safe, efficient, effective, reliable, and sustainable manner. Be exemplary stewards for and with the community.
Texas State University divides energy and water sustainable conservation into three key areas:

- **Buildings**: HVAC/Envelope/Water/Lighting/Equipment (40%)
- **Plants**: Chillers/Boilers/Pumps/Motors/Distribution (30%)
- **People**: Students/Faculty/Staff/Visitors (30%)
Why Thermal Modeling?

- Growth of campus utilities evolved over time.
- Reality vs. design with verification of pipe sizes, pipe configurations, pumps, valves, etc.
- Identify current thermal system vulnerabilities and strengths.
- Maximize thermal operational efficiencies and meet growth planning through existing infrastructure capacity.
Twenty Miles of Distribution Piping
Thermal Plants

- Four thermal plants with combined design capacity of 19,000 tons cooling and 140,000 lb./hr. steam
  - 16 chillers
  - 11 cooling towers
  - 4 steam boilers
  - Multiple heat exchangers
  - 60 buildings (4.5 Million s.f.)
Campus Thermal Utility Study

- Purpose: Analyze current chilled water and steam generation and distribution capacity
  - Establish a baseline for future master planning of campus thermal utilities
  - Generate hydraulic models for “what-if” scenarios
- Two main components:
  - Generating capacity (chillers, boilers)
  - Distribution capacity (distribution piping, pumps)
Campus Thermal Utility Study

• Generating Capacity vs. Current Load:
  – Establish chilled water & steam generating capacity (site visits, submittals, etc.)
  – Establish connected load on each system (sum of all coils, etc.)
  – Establish peak load on each plant’s system (BAS data, manual logs)
  – Peak / Connected = System “Diversity” (%)
    • Cogen: 3,500 tons / 6,400 = 55%
### Campus Thermal Utility Study

- **Future capacity planning:**

<table>
<thead>
<tr>
<th>Building</th>
<th>Area (sq.ft.)</th>
<th>Sq.Ft./Ton</th>
<th>Design Tons</th>
<th>Diversity</th>
<th>Div. Tons</th>
<th>Div. GPM @ 14°F dT</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Campus Housing Complex</td>
<td>190,047</td>
<td>350</td>
<td>540</td>
<td>70%</td>
<td>378</td>
<td>648</td>
</tr>
<tr>
<td>Undergraduate Academic Center</td>
<td>130,455</td>
<td>285</td>
<td>460</td>
<td>70%</td>
<td>322</td>
<td>552</td>
</tr>
<tr>
<td>Recital Hall &amp; Theatre (PAC)</td>
<td>57,800</td>
<td>400</td>
<td>140</td>
<td>70%</td>
<td>98</td>
<td>168</td>
</tr>
<tr>
<td>Music (PAC)</td>
<td>109,600</td>
<td>425</td>
<td>260</td>
<td>70%</td>
<td>182</td>
<td>312</td>
</tr>
<tr>
<td>Engineering &amp; Science Building</td>
<td>94,300</td>
<td>250</td>
<td>380</td>
<td>70%</td>
<td>266</td>
<td>456</td>
</tr>
<tr>
<td>West Campus Housing Complex</td>
<td>180,000</td>
<td>400</td>
<td>450</td>
<td>70%</td>
<td>315</td>
<td>540</td>
</tr>
<tr>
<td>Large Theatre</td>
<td>146,100</td>
<td>425</td>
<td>340</td>
<td>70%</td>
<td>238</td>
<td>408</td>
</tr>
<tr>
<td>West Campus Additions</td>
<td>750,000</td>
<td>425</td>
<td>1,760</td>
<td>70%</td>
<td>1,232</td>
<td>2,112</td>
</tr>
</tbody>
</table>

**1.7 million sq. ft.; 3,000 Tons; 5,200 gpm**
Campus Thermal Utility Study

Cogen Plant Chiller Capacity

Year

- Design Load
- CH-1
- CH-2 (Absorp.)
- CH-3
- CH-4 (Absorp.)
- CH-5

Tons

- N+1
- Diversified Load

Campus Thermal Utility Study

- Distribution Capacity:
  - Generating capacity is useless if it can’t be distributed
  - Hydraulic models of the campus systems were built
    - Existing campus drawings and site work used to generate models
    - “Baseline” model developed using actual measured data from a specific time
Campus Thermal Utility Study

- Distribution Capacity:
  - Determine operating conditions for “Baseline” model
    - **Good:** Site survey to obtain gauge and thermometer data from plants and building (hot afternoon)
    - **Better:** Manual logs of plant and building data
    - **Best:** Building Automation Systems (BAS) data, metered and logged data trending for plants AND buildings
      - Temperatures, pressures, flowrates
  - A combination of all these methods was used
Distribution Capacity:
- Model is then calibrated to match reality
- This often points to installation or operational issues in the existing system
- Calibrated model can then be used to test future scenarios
- Can existing piping handle future loads? Can existing pumps distribute chilled water?
Campus Thermal Utility Study
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• Key Findings
  - Harris Plant Piping Bottleneck
  - Over pumping at Cogen Plant
  - Low Campus CHW Temperature Differential
Information Use – Reality Check

• Verification of pipe sizes, pipe configurations, pumps, valves, etc.
• Modeling provided real limits and possibilities:
  – Harris plant shut down for expansion but thermal services continue for the first time from Cogen Plant (no temporary chillers or boilers).
  – Started new South Chill Plant with building loads that were not previously considered.
Information Use - Reliability

• Developing redundancy within the distribution system instead of adding equipment.
• Failure analysis: certain plants may not meet peak loads if one boiler fails
• Identified high-priority distribution piping sections for repair/replacement annual budget
• Critical science/research buildings have alternate thermal service
Information Use – Energy

- Condensate return improvements
  - Steam trap maintenance program revisited
  - Piping and pumping improved
- Reinsulation of PRVs and manhole components
- Additional metering recommended – phase 1 completed, phase 2 underway
- Increase campus differential temperature (dT)
- Convert Cogen Plant to variable flow system (VFDs) – completed in July 2012
Information Use - Growth

- Incorporated data into expansion of utility service for new buildings:
  - Undergraduate Academic Center (UAC)
  - Two 600 bed residence halls on west campus
  - One future building on west campus
  - West Plant expansion
  - Engineering and Sciences building
  - Jones Dining Hall replacement
  - University Performing Arts Center
Information Use - Planning

- Utilities Master Plan project input:
  - Chilled water capacity will be needed in future
  - Identify priority areas to improve flows, temperatures, dT, dP and inlet pressure.
- Alternate operations strategies for seasons and disruptions.
Information Use - Confirmation

- Flexibility of operations for maintenance, upgrades and efficiencies without impacting customer service.
- Model refinement after major changes for continuous improvement to capacity analyses.
- Better capital investment evaluation, justification, and sequential planning to support a safe, efficient, effective, reliable and sustainable district energy system.
Questions?