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CASE STUDY OF CHALLENGES AND SOLUTIONS AT THE UTILITIES AND ENERGY MANAGEMENT OF THE UNIVERSITY OF TEXAS AT AUSTIN, USA

In September of 2007 a representative from 7-Technologies (7T) came on site to the University of Texas at Austin, USA (UTA) to install the initial 7T TERMIS software model of the UTA district cooling/chilled water system. This article – part 1 of 2 – describes the efforts of 7T and UTA over the next 30 months to take what was a very successful district heating (DH) operational energy management software and apply it successfully to one of the largest and most complex chilled water systems in the USA.

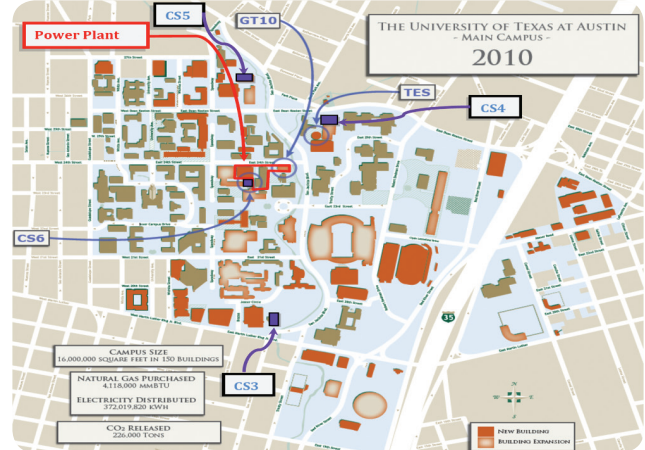
INTRODUCTION

“We needed to develop real-time models of our systems in order to design, operate and maintain them at their full potential” says Juan Ontiveros, and continues “Those of us who operate plants, distribution networks and buildings learned long ago that digital controls and historical data gathering are essential to successfully operate district energy (DE) systems to their full potential. I believe, however, that the ante has been upped to the point where this is not enough: We also need to develop real-time models of our systems that allow us to manage plant performance and distribution systems on a real-time basis. It is too costly to instrument everything to populate the energy models, so we need to take advantage of the state-of-the-art real-time modeling and operational tools available industry. This will allow us to use limited instrumentation and let the real-time model predict the rest of the system conditions. While this may sound futuristic, let me assure you they have been doing it for years in Denmark, and we at the University of Texas at Austin have also started to do this with very good results. The matter of the fact is it is much less costly to model information than measure it”

BACKGROUND

The University of Texas at Austin (UTA) was founded in 1883 and today it has grown to a 1.4 km²/350-acre main campus with 21,000 faculty and staff, 16 colleges and schools and 50,000 students – virtually like a super energy dense city of 75,000 people.

Today the UTA Utilities and Energy Management provide all the utility services to the 200 buildings at the campus and provide 100 % of the power, steam, chilled water, deionized laboratory water and compressed air for the campus.



UTA Utility and Energy Management Operations at a Glance

- Total Cooling Capacity – 161 MW/45,000 Tonnes
- Peak Load – 125 MW/35,000 Tonnes
- Peak Flow – 265 m³/minute/70,000 gpm
- Average Supply Temperature – 3.9°C/39°F
- Average Return Temperature – 9.5 °C/49°F
- Average Supply Pressure at Plants – 7 bar/100 psig
- Peak Supply Pressure at Plants – 8.6 bar/125 psig
- Average Return Pressure at Plants – 2.8 bar/40 psig
- Total Piping Length - 19.3 km/12 miles supply and return piping
- Total Annual Cooling Produced 146,000,000 Ton-Hours
- Total Annual Power Consumed by Chilling Plants - 108,000,000 kWh
- Average Plant Efficiency – 210 kW per MW/0.75 kW per Tonnes
- Average Campus Cooling Load – 59 MW/16,500 Tons
- The production of chilled water consumes approximately 1/3 of the energy produced by the CHP plant
- Cooling is required on campus 24 hours per day, 7 days per week, 52 weeks per year.
- The minimum cooling load for the campus is approximately 18 MW/5,000 tonnes.
- The campus cooling load has been increasing by about 3% annually for the past several years.

The 4 central chilling plants house 11 electric centrifugal chillers. A 15 million liters/4 million gallon, 36,000 tonnes hour Thermal Energy Storage (TES) tank is currently under construction, planned to be in operation September 2010, to provide capacity and back-up to ensure that the campus is never without cooling.

▶ CASE STUDY OF CHALLENGES AND SOLUTIONS...

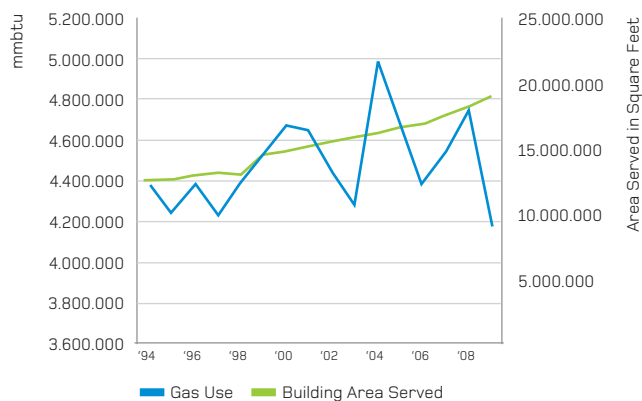
With some differences in equipment, systems, pressures, temperatures and distribution methods, the chilled water system at UTA is similar to hundreds of other utilities; found at universities, industries and elsewhere throughout the world. Therefore the challenges and solutions to these can be applied at many other utilities.

THE SYSTEM OPTIMIZATION CHALLENGE FOR UTA

In the year 2000 natural gas, UTA's primary fuel was about \$2.00/€1.50 per mmbtu. In September of 2006 the University paid over \$14.00/€10.40 per mmbtu for natural gas and since that time has paid an average of about \$8.00/€6.00 per mmbtu. The annual gas budget which 8 to 9 years ago was about \$9/€6.7 million has soared to approximately \$36/€26.7 million. Again, this is not a problem faced only by the UTA, this is a problem faced by everyone using natural gas or other fuels.

The operations in the central CHP plant are managed through a highly developed Supervisory Control and Data Acquisition (SCADA) system that integrates all of the systems and equipment in the central plant. Through this integration UTA has been able to optimize the systems and their operations to achieve significant efficiency gains while not compromising the safety or reliability of the plant.

University of Texas At Austin
Fuel Consumed and Building Area Served



UTA Campus Area Growth and Fuel Consumed by Utility Plants

Over the past 15 years the campus area served by the CHP DE system has grown from approximately 1.2 million m2/13 million square feet to nearly 1.8 million m2/20 million square feet. The energy consumption on campus has grown even more drastically as the new buildings being added are significant users of energy. While the CHP plants have reduced their fuel input from about 4.4 million mmbtu to less than 4.2 million mmbtu in the last fiscal year ending August 31st 2009. This has been made possible through changes in equipment, operations and in the ability to effectively use the information gathered during the day to day operation of plants, systems and equipment. Software applications such as TERMIS allow operators, engineers and

management to be presented with decision-ready information in a way that can be used successfully to improve plant, distribution and building efficiency. The sporadic up and down annual gas use is due to the construction projects that have been ongoing at the utility plant. Future use will be stable around the 4.0 million mmbtu mark as the University approaches gas use quantities as low as plant consumption during the 1970s.

In the 4 central chilling plants both new and old technologies exist to optimize the efficiency and operation of the individual plants. The new challenge became how to, as with the central CHP plant, integrate the operations of all four chilling stations and op-timize their operation as a whole. Several driving factors were behind the new challenge to effectively manage the entire chilled water distribution system as a whole rather than only managing the operation of the individual plants and providing only minimal operational management of the distribution system itself. These factors were:

- With a peak electrical load for producing chilled water of nearly 30,000 kW and an annual consumption of nearly 110,000,000 kWh there was a significant opportunity for cost savings.
- Attempts at trying to reduce chilled water pumping pressures to save energy had inadvertently resulted in other problems
 - Frequent "hot-call" from building occupants with the result that the chilled water operation was to blame.
 - Lower pressures in the distribution system required the building chilled water pumps to operate correctly for the first time in years, many did not.
 - Confusion from chiller plant operators as to how to operate the new chilled water system with 4 plants now that the old rules of thumb did not apply.
- In older areas of the campus existing buildings were being torn down and replaced with new or renovated buildings with resulting increases in cooling demand.
- Concern how to serve future buildings as the infrastructure became loaded to 100 % or beyond.
- Aging building mechanical systems were returning chilled water well below design leading to the "low delta T syndrome" that affects nearly every aging chilled water system.
- How would the newest chilling station and new Thermal Energy Storage (TES) be integrated into the system and their operation optimized?
- Typical hydraulic analysis tools could provide only limited answers and then typically only at peak conditions giving no insight on how to operate the remaining 98 % of the time.
- Many of the research facilities on campus required 100 % availability of chilled water. But aging distribution systems need maintenance. Finding the best combination of valve positions, chillers and pumps had become a necessity, but no solution existed for this.

MARKET RESEARCH TO FIND THE BEST SYSTEM
OPTIMIZATION SOLUTION

"UTA questioned other campuses throughout the US and industrial campuses all around Texas" says Kevin M. Kuretich and continues "No one else had found any solutions that covered the entire DC system, only certain parts. The closest solution was at a Toyota plant that had just been constructed. In that facility the plant SCADA system included data all the way down to the position of every air handler control valve in the entire facility. Using the position of the most open valves, they were able to control the pressure and temperatures output from their chiller plant.

Unfortunately, however elegant this solution, the cost to measure pressures, temperatures, flows and valve positions throughout 17 million square feet and bring all of that information in real time back to an operating system was not feasible at all. Although no actual cost estimate was done, the total cost of such a monitoring system, when only 15 % of the University had digital controls in the buildings would have been well into the millions of dollars and would have taken years to implement."



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In June of 2007 the members of the university's plant operations saw a presentation by the University of New Mexico on an Energy Management System based on Real Time Thermal Energy Modeling and Simulation for their chilled water and steam distribution systems. The System had been developed in Europe and had been in use for over 20 years providing operations management for DH systems. The product, TERMIS, had been developed by 7-Technologies (7T) in 1985.

"Several things about TERMIS appealed to the University" says Kevin M. Kuretich and continues "It showed significant potential for solving the challenges ahead, these were:

- Rather than having to measure every temperature, pressure and flow through-out the system TERMIS relies on a few selected real time measurements and then calculates results elsewhere.
- Using real time information provided a way to analyze the distribution system under all conditions not just peak design conditions.
- Provided a means to simulate the impact of new facilities at different loads and different tie in locations quickly.
- Provided a way to simulate distribution system outages, their potential impacts and the best combination of valves, chillers and pumping to provide uninterrupted cooling to critical areas.

- To the operator in the control room TERMIS looked just like the other SCADA screens that they were used to seeing. Unlike some potential applications TERMIS did not require an engineer to be on hand at all times to translate results.

The article will continue in the next edition of Hot|Cool 2/2010

- For further information please contact:

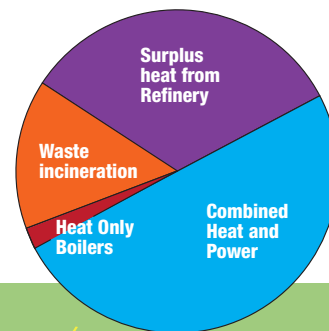
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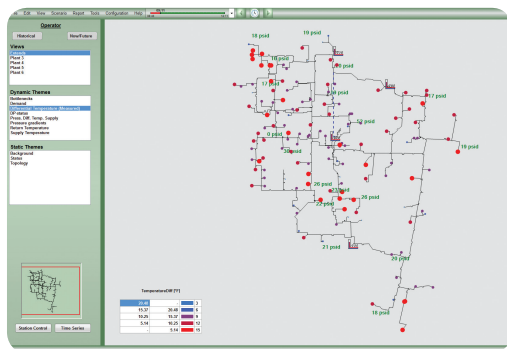
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Example of TERMIS OPERATION SCADA VIEW for operators in the control room and distribution engineers