The University of Texas at Austin Combined Heat and Power Plant

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ABSTRACT

The University of Texas at Austin's combined heat and power (CHP) plant has provided reliable, efficient, and cost effective utilities since its inception in 1928. This natural-gas-fired plant currently can produce up to 110 MW of electricity at 12-kV and 4.16-kV, 1.1 million lbs/hr of steam at 425 psi, 700°F, and 40,800 tons of chilled water using electric and steam turbine driven chillers. The system also provides the campus compressed air and about 9 million gallons per year of demineralized water for building and laboratory use. The system supports a campus of about 16 million square feet via underground tunnels and electrical duct banks.

COMBINED HEAT AND POWER SYSTEM

Figure 1 below is a graphical representation of the campus CHP system. The current peak campus load is 56 MW but is projected to grow to over 70 MW by 2008. The campus is a major research institution that cannot tolerate unreliable electric, steam, or chilled water service. The implications to lost research would be devastating. The capacity, prior to the addition of the new 25 MW steam turbine was 49 MW, which could not support campus growth. The new capacity of 74 MW has allowed the campus to retain its customary high margin of reliability.

Figure 1 shows the high and a low-pressure steam system. All steam from heat recovery steam generators and fired boilers is produced at 415 psi and 700°F, which is delivered to extraction steam generators. Steam is extracted at 165 psi and 500°F for delivery to the campus and chilling stations.

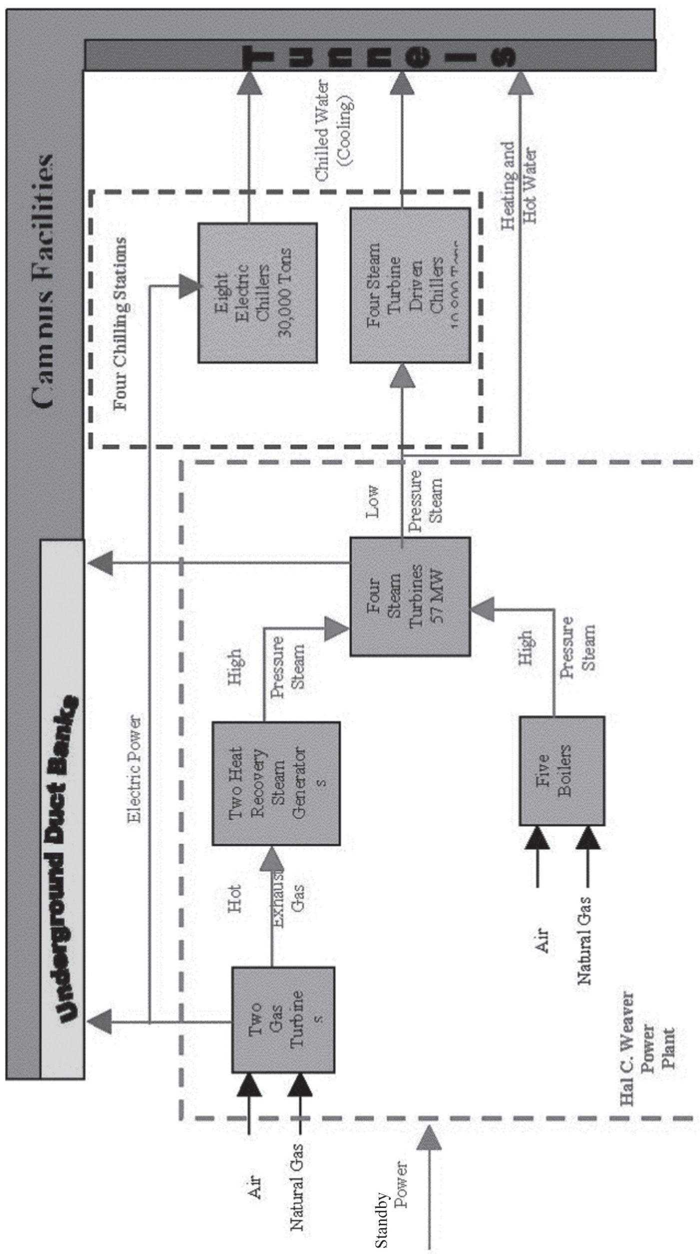

Figure 1. University of Texas Combined Heat and Power System

An integral economic component of the system is the design and operation of the chilling stations. A chiller capacity of 10,800 tons of can be delivered using steam-turbine-driven chillers and 30,000 tons using electric chillers. During the summer, when the chilling load is at its peak of 28,000 tons and electric load is at peak of 56 MW, the heat recovery steam generator (HRSG) delivered steam supports the steam chillers. The balance of the steam is delivered to the campus for building heating, sterilization, cooking and hot water production. This total system approach makes for an effective CHP system.

The chilled water system consists of four plants located around the campus that feed one common chilled water loop that is distributed via approximately 6 miles of easily accessible underground tunnels.

This chilled water distribution system provides complete redundancy because any one or more of the stations can support the campus hydraulically and thermally. Hydraulically, each station is sized to handle the total gallon per minute (gpm) flow needs of its station and then secondary pumps are located at the buildings to support the building needs.

RELIABILITY

Reliability is a product of the system design that consists of an interconnected system. The HRSG and boiler plant are a part of one contiguous steam system. If a gas turbine and/or HRSG were to fail, a standby electricity agreement for 25 MW from the municipal supplier is used to support the electrical system and one or more of the fired boilers is used to support the steam distribution system.

The chilled water, electrical and steam distribution system is also designed and operated with the same core principle of reliability. Most of the 160 campus facilities are designed with double-ended electrical substations and double main feeds for chilled water, steam, and domestic water. If problems develop utilities can be quickly rerouted.

The electrical distribution system is designed, as a switched multiple bus system that allows for alternate feed to the bus should one fail. Electrical system reliability is even carried out to the main campus 100 MVA substation through the use of four 50-MVA transformers connected via a ring bus arrangement managed and controlled by a SCADA system.

EFFICIENCY

The campus has invested over $8 million in digital controls over the last six years to automate the previously manually operated power plant and chilling stations. This PLC based system has improved reliability and efficiency from an overall thermal efficiency of 62% to 78% next year over the six-year period. Two new 5,000 chillers were also added about 6 six years ago that significantly improved the Btu/ton efficiency ratio. Tripped boilers and upsets occurred prior to the automation effort. Although these never affected campus service, it was stressful to plant operations and maintenance, which had maintained a standard of only one campus-wide electrical outage in 35 years.

The centralized automation system has allowed the campus to consolidate power plant and chilling station operations. This consolidation was a significant contributor to efficiency gains because the plants are now operated as one system. The campus is also expecting an increase in efficiency with projects such as a new 25 MW steam turbine, a plan to activate duct burners to fire assist an existing HRSG, and plans to install a steam dump condenser.

A dispatch model has also been developed that will be used as a tool to recommend optimum dispatch of all boilers, generators, chillers, and cooling towers on a real time basis. This model will help the campus factor in generation versus purchase decisions in a climate of unstable fuel costs. Full implementation of this model is scheduled for next year.

COST EFFECTIVENESS

Talks of efficiency should have a direct relationship to cost savings. The campus has grown by 2 million square feet since 1998 and consumed a peak amount of about 4.7 trillion Btus of natural gas.

For 2005, the projected fuel consumption is about 4.2 trillion Btus. At the current cost of natural gas, this is a significant reduction in prior budgeted fuel cost. The strategy of purchasing a fixed price of natural gas for 80% of the total volume and purchasing the swing amount on a monthly basis at market cost, along with the efficiency gains, has saved the campus about $4 million this year. The savings from the efficiency gain is about $2.5 million this year and has resulted in an effective payback of investments.

Figure 2 below describes the relationship of purchased natural gas, campus energy use and overall thermal efficiency. The data shows the relationships from 1997 to 2005 projected on an million Btu per square foot basis. The area in question is the campus area directly supported by the CHP system.

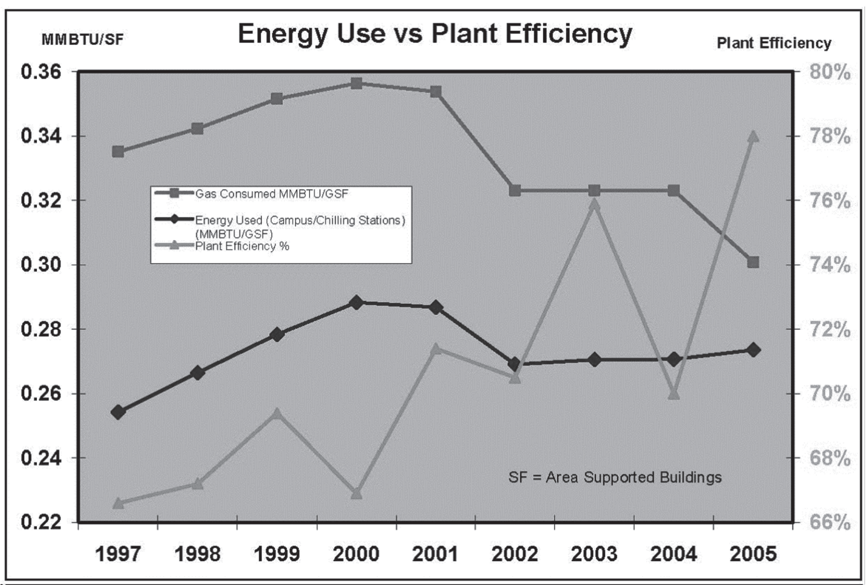

Figure 2. Energy Use versus Plant Efficiency

ABOUT THE AUTHOR

Juan Ontiveros, P.E., is the Director of Utilities and Energy Management at the University of Texas at Austin. The Mission of the Utilities and Energy Management Department is to use innovation and technology to provide reliable and cost effective electricity, chilled water, steam, deionized water, compressed air, emergency power and elevators to support the tradition of teaching and research excellence at the University. Juan Ontiveros may be contacted at juano@mail.utexas.edu.