Combined Heat & Power in University

University of Texas, Austin

137 MW (65 MW-peak) CHP Application

Project Profile

Quick Facts

Site location:
Austin, TX

Industry Type:
University

CHP equipment:

- 2 Gas Turbines-77 MW
- 4 Steam turbines-62 MW
- 4 chiller plants-48,000 Tons
- TES Tank – 4 million gallons

Fuel: Natural Gas

Generating Capacity: 137 MW (65 MW peak)

Steam Production (unfired):
474,000 lbs/hr

CO_2 reduction:
91,267 tons/yr

Site Overview

The University of Texas at Austin main campus is a dense urban campus with over 16 million square foot in 200 buildings serving 70,000 faculty, students and staff. The buildings are connected through a district energy system, with all utilities centrally generated on campus by The Utilities & Energy Management Department. Connections to the surrounding city electrical grid exist only for emergency backup, providing the University independence and versatility in generating the electricity, chilled water and heating steam required on campus. Eighty percent of the campus is research oriented, operating 24 hours a day, 7 days a week, and 365 days a year. The research facilities conduct around several hundred million dollars in contract and research grants annually, demanding a variable and uninterrupted supply of energy at all times.

Plant Description

The CHP plant consists of one combustion gas turbine each from General Electric (43 MW) and Westinghouse (34 MW), both of which have inlet air cooling. In addition the central plant is equipped with four steam turbines with a combined generating capacity of 62 MW. The system is operated in a combined cycle mode with each combustion turbine paired with a steam turbine. Maximum electrical generation efficiency is obtained by operating the combustion turbine as high as possible, using the inlet air cooler in hot weather, and matching the HRSG steam output to the steam turbine generator to match the exact campus electrical load requirement. Steam is extracted from the turbine to supply steam to the campus for heating and hot water generation in the facilities. The boilers are operated to provide peak steam needs above and beyond what can be produced by the HRSG’s and they provide a backup steam source in the event of a combustion turbine/HRSG upset. The campus electrical distribution system is configured as a looped system with 100% redundant high voltage switch gear on 12 switch gear systems and is connected to a 69 kV to 12,000 kV substation with four 50 MVA transformers connected via a ring bus. This entire system is managed using a digital SCADA system.

CHP Drivers

The CHP plant was first established in 1929 to meet its utility needs, before the electrical grid was available. As years passed, capacity expansions were needed to meet the increasing requirement. The matching electric and thermal loads made expanding the cogeneration system an efficient and economical solution for the University. UT Austin management see themselves as responsible environmental stewards by pursuing a committed energy conservation policy, demand side reductions, installing sophisticated measurement, verification and optimization systems and continual utility plant improvements, all leading to significant emissions reductions at the campus

Lessons Learned

- The plant has achieved a reliability of 99.9998% over the last 35 years for all delivered energy.
- Continuous efficiency gains, savings and greenhouse gas reductions are being achieved at the campus through plant enhancements. Key additions made since 2004, include the following:
  a. Chilling station providing inlet air cooling for the combustion turbine apart from space cooling in order to maximize output and efficiency.
  b. 4 million gallon chilled water thermal energy storage to augment peak cooling capacity thus avoiding purchase of costly “low run hour” chillers.
  c. New fiberglass cooling tower with variable frequency drives allows operational flexibility and the ability to operate at the highest efficiency, despite varying loads and ambient air conditions.
  d. Flue gas recirculation and use of VFD’s to regulate flue gas and combustion air in the boilers (used to augment steam needs) are a cheaper and more cost effective option than purchase of expensive low NOx burners.
  e. Real time and sophisticated modeling technology is essential to operate, optimize and sustain efficiencies. It is used to validate existing performance and continuously evaluate operating scenarios that can improve efficiency.

Project	Cost	Resulting Gas Savings (MMBTU/Year	Resulting Emissions Reduction (Tons/CO_2/Year)
Steam Turbine (25 MW)	$ 15,864,000	200,000	11,000
Cooling Tower	$ 8,500,238	50,000	2,750
Boiler FGR/NOx Retrofit	$ 3,000,000	200,000	11,000
Steam/Feed Water By-Pass	$ 900,000	500,000	27,500
Chilling Station 6	$ 35,200,000	71,500	3,933
Inlet Air Chilling	$ 4,000,000	120,000	6,600
Chilling Station Modernization	$ 3,780,000	20,000	1,100
Gas Turbine (34 MW)	$ 39,350,000	399,400	21,967
TOTAL	**$110,594,238**	**1,560,900**	**85,850**

The carbon abatement costs for this project over an assumed 20 year life cycle is **minus $58/ton of CO_2**, strongly indicating a synergy between favorable economics and the associated environmental benefits.

Management at UT Austin Central Plant through demand side projects, utility plant improvements and continuous monitoring have ensured that carbon emissions in 2009 have returned to 1977 levels, despite a 89% increase in campus growth in terms of area and load.

For more information –

Krishnan Umamaheswar, LEED AP, CEM, CDSM

U.S. DOE Gulf Coast Clean Energy Application Center

O: (281) 363-7906
Email: ukrishnan@harc.edu