SOUTHEAST

U.S. DOE

CHP Technical Assistance Partnerships

PROJECT PROFILE

Vanderbilt University

17 MW Natural Gas CHP System

Project Overview

Vanderbilt University is a private research university of about 6,500 undergraduate and 5,300 graduate and professional students located in Nashville Tennessee. The campus has 252 buildings across 330 acres and includes both university and medical facilities. To support this large campus, electric, heating and cooling utilities are provided and maintained by the plant operations department of Vanderbilt.

Aerial Photo of Vanderbilt University *photo from vanderbilt.edu*

The plant operations department serves 18 million square feet of conditioned space on campus providing steam and chilled water for heating and cooling. The Vanderbilt CHP power plant, located in the center of the university campus, produces 90 percent of campus heating and 40 percent of the campus cooling while providing 23 percent of the campus electricity. The power plant has undergone many renovations over the years, and in the summer of 2015 another major renovation was completed. This renovation included the elimination of coal-fired equipment in favor of natural gas combustion units including a new combined heat and power (CHP) unit. This project has increased the efficiency of Vanderbilt's energy system and is expected to save the university $3 million dollars annually while reducing campus greenhouse gas emissions by 30%.

Quick Facts

LOCATION: Nashville, TN
MARKET SECTOR: University, Hospital
FUEL: Natural Gas
GENERATING CAPACITY: 17 MW
THERMAL OUTPUT: 460,000 lb/hr @125 psig
IN OPERATION: 1925
LATEST RENNOVATION: 2015
EQUIPMENT:

- 7 MW Combustion Turbine with HRSG
- (2) 5 MW Combustion Turbines with two HRSGs
- (2) Packaged Boilers

USE OF ELECTRIC ENERGY: On-site
USE OF THERMAL ENERGY: Heating and Cooling
EXPANSION INSTALLED COSTS: $29 million
ESTIMATED ANNUAL SAVINGS: $3 million
SIMPLE PAYBACK: ~10 years
ENVIRONMENTAL BENEFITS:

- 75% reduction in NOx
- 99% reduction of SO_2,
- 50% reduction of Particulate Matter,
- 30% reduction of campus greenhouse gas emissions

Reasons for Installing Combined Heat & Power

Several factors led to the decision to upgrade Vanderbilt University's power plant:

- The coal boilers were near the end of their expected useful life.
- To meet the higher emissions standards of the Boiler MACT rule would have required Vanderbilt to install additional air emission controls, resulting in a large capital expenditure and increasing operational and maintenance cost
- The new CHP system and natural gas boilers will increase operational and fuel efficiency.

- The new CHP system and natural gas boilers will reduce greenhouse gas emissions and significantly reduce other air pollutants such as nitrogen oxides, particulate matter and sulfur dioxide.

The 2015 upgrades to the power plant included the installation of a 7 MW natural gas combustion turbine with a heat recovery steam generator (HRSG) and two packaged natural gas boilers. Prior to the current upgrade, the plant consisted of two 5MW combustion turbines, multiple boilers, two steam turbines and a dual pressure steam system. Three of the boilers were fueled from both coal and natural gas, operating at a high pressure which allowed electricity production through the steam turbines. The latest renovation included the decommissioning of the high pressure steam system and the coal equipment including the coal boilers, a coal storage silo, the tall coal boiler stack, and the two steam turbines. The new system is a single pressure delivery steam system.

Equipment , Configuration & Operation

Equipment

- One 7 MW Combustion Turbine – Solar Turbines Taurus 70
  - Rentech 100,000 lb/hr HRSG
- Two 5 MW Combustion Turbines – Murray Turbomachinery
  - Two Rentech 100,000 lb/hr HRSG
- Seven 900 ton and One 600 ton absorption chillers
- Two Babcock and Wilcox Packaged Boilers

7 MW Combustion Turbine

Operation

The three combustion turbines are fueled from natural gas and operate 24/7 base loaded. The exhaust gas from these turbines is ducted to three heat recovery steam generators to produce 125 psig saturated steam for the campus district steam system. During the summer, the steam is used by absorption chillers to provide baseload cooling for the campus. Packaged boilers provide steam for peak demands.

Construction

The biggest challenge for the project was to maintain the ability to produce steam for the campus with no interruptions while major construction was completed on and around the steam system. Temporary boilers were brought in to provide steam during construction.

Smokestack teardown in 2014

Campus Sustainability

Vanderbilt operated coal boilers from 1888 to 2014. Through decommissioning of the coal boiler system and the installation of a new natural gas CHP system, the campus greenhouse gas emissions will be reduced by 30%, the sulfur dioxide emissions will virtually be eliminated, the nitrogen oxides will be reduced by 75% and the particulate emissions will be reduced by more than 50%.

For More Information

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More Case Studies: http://www.southeastchptap.org or http://www.energy.gov/chp

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