PROJECT PROFILE

Eastern Michigan University

7.8 MW CHP Upgrade

Background

Eastern Michigan University (EMU) is located in Ypsilanti, Michigan, approximately 35 miles west of Detroit and 8 miles east of Ann Arbor. It was founded in 1849 as a small teachers college and today has grown into a major public learning and research institution with over 21,000 students. EMU historically has been a leader in energy efficiency and sustainability. In 1987, the University invested in a 4.5 MW natural gas turbine CHP system with a heat recovery steam generator (HRSG) capable of providing 56,000 lbs/hr steam for use in the University's central heating system. In 2009 the University entered into a multi-year partnership with ENGIE Services U.S. to renovate four residence halls and two dining halls, making the facilities more energy efficient. Upon completion of these facility upgrades, the University again partnered with ENGIE in 2016 to improve the operation, reliability and efficiency of its Central Heating Plant. This meant the replacement of a 64 year old boiler and a 28 year old CHP system with a new 7.8 MW gas combustion turbine CHP system.

Installing Taurus 70 – Central Heating Plant
(Source: Eastern Michigan Univ.)

Technology Options

Before EMU made the decision to invest in their new CHP system, a number of different technology options were analyzed. One option was to replace the aging CHP system with energy efficient steam boilers and return to purchasing all required electricity from DTE Electric, the local electric utility. This option was rejected on an economic basis, based on a minimal return-on-investment (ROI) calculation.

A second option included the design and installation of a fuel cell system. Although the electric conversion efficiency of the fuel cell system was relatively high, the system had limited thermal heat recovery and required a large physical footprint. In addition the system had both a high first cost and high estimated maintenance cost.

The third and eventually selected option explored the use of a natural gas turbine/generator set with heat recovery. EMU and ENGIE evaluated several turbine and heat recovery system combinations. The winning design most suitable to the University's needs, was a single Solar Taurus 70 turbine/generator set with a heat recovery steam generator (HRSG). The system is capable of providing 7.8 MW of utility grade electricity along with 90,000 lbs/hr steam for use in the university's central heating system. The system provides 93% of the annual electric requirements and 98% of the annual thermal requirements for the 800 acre campus. Any shortfall in electric requirements is provided by DTE Electric, and any shortage in heating requirements is provided by the existing backup steam boilers.

Quick Facts

Location: Ypsilanti, Michigan
Market Sector: Colleges and Universities
CHP Generation Capacity: 7.8 MW
Prime Mover: Solar Turbines Taurus 70 combustion turbine with SoLoNOx low NOx combustor
CHP Fuel Source: Natural gas
CHP Heat Recovery: HRSG that produces up to 90 MMBtu steam with duct firing (135psi steam)
Gas Compression: Includes two reciprocating compressors (redundancy) that boosts natural gas to the required 225psi turbine inlet pressure.
Est. Annual Cost Savings: $2.8M
Project Payback: Estimated at 7 years
Began Operation: February, 2018
Est. Annual CO_2 Global Emission Reduction: Offsets approx. 48,800 metric tons, equivalent to 10,700 passenger vehicles removed from the road

System Reliability / Sustainability

The CHP system is electrically interconnected to the DTE Electric grid. Should the CHP system become inoperative, DTE Electric provides all needed electricity to the campus; conversely, should the utility grid go off-line, the CHP system can both cold start and/or continue to operate independent of the grid, providing both the electric and thermal requirements of the campus. The HRSG is designed with natural gas duct burners and an exhaust by-pass duct that allows the HRSG to

operate as a 90+% efficient stand-alone steam boiler should the gas turbine/generator be inoperable for scheduled or unscheduled outages.

Taurus 70 Combustion Turbine/Generator with Heat Recovery

In addition, the project included the installation of two new natural gas compression stations used to boost the natural gas pressure provided to the campus to the 225 psi required to operate the turbines. The two compression stations share the natural gas load to the CHP system, ensuring the reliability and longevity of the gas compressors. These features (black start capability, electric islanding, HRSG with by-pass duct, and dual gas compressors) provide increased energy resiliency and reliability to the EMU campus, helping to ensure that the campus is able to weather an energy emergency. In the event of an extended electrical outage at the local utility, the University is now capable of providing a fully functional safe haven for its students and the surrounding community.

Project Economics

Environmental Impact

The new CHP system has increased the total level of CO_2 annual savings at EMU to approximately 48,800 metric tons. This is the equivalent of removing more than 10,700 passenger vehicles from the road or planting 48,155 acres of US forest.

The total cost of the upgrade to the central heating plant was $19.6 million. Initial analysis estimated a simple payback of approximately 9 years. However in 2016, the University negotiated a five-year natural gas contract reducing the cost of natural gas by approximately 30%. **In** 2018, the EMU Board of Regents approved the University to sign an additional five-year natural gas purchase agreement set to offer savings of more than 46%. The natural gas forward purchase agreements have resulted in lowering the estimated simple payback from 9 years to 7 years. These analyses are based on CHP annual electric production of 47,533,031 kWh and annual steam production of 339,156 lbs. Annual cost savings are estimated at $2.8 million.

Lessons Learned

- Early communication with the local electric and natural gas utilities regarding the intended project is essential. The distribution systems (gas pipelines and electric grid) are owned by the utilities and the site must abide by their rules, regulations, and fees. Forming a partnership with the utilities enhances the potential for technical and financial success of the project.
- Implementing energy efficiency improvements to the facilities prior to designing the CHP system will ensure the optimal size and configuration of the CHP system, resulting in the lowest overall project and operating costs.
- Negotiating long term natural gas contracts can positively affect the economic justification for the CHP project.

"This project has allowed the University to become nearly fully self-sufficient in meeting both the electric and heating requirements of our campus, while significantly reducing our carbon footprint and annual energy costs."

– John Donegan, VP Operations /Facilities at the Eastern Michigan University

- The upgrades inside the Central Heating Plant represented a unique learning opportunity for students attending EMU's College of Technology. An internship program was established to allow two to four students per eight week cycle to shadow engineers and construction managers on the project site to gain practical knowledge through direct, hands-on experience.
- After one year of operation, the system is operating as planned and the University has met its first year's energy, emission and cost savings goals.

For More Information

U.S. DOE MIDWEST CHP Technical Assistance Partnership
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