



The University of Minnesota Minneapolis/St. Paul, Minnesota

22.8 MW CHP System

Site Overview

In 2009, the University of Minnesota developed a Utility Master Plan to evaluate all utility systems on campus, taking into account the University's 20-year growth projections. The Master Plan concluded that "without action, the ability to reliably provide steam energy to University facilities would be at substantial risk". That study initiated the effort which resulted in the reinvestment in and reconstruction of the Old Main Heating Plant; a facility constructed in 1912 and retired by the University in 2000. The old facility had fallen into disrepair with all the installed equipment (6 large coal-fired boilers) abandoned in place. The newly reconstructed Main Energy Plant, opened in November, 2017 and shown to the right, houses a new 22.8 MW Combined Heat and Power (CHP) system that provides both steam and electricity to the Minneapolis campus, reducing the University's dependence on the electric utility grid and greatly reducing greenhouse gas emissions.



University of Minnesota CHP Plant Aerial View
(Source: University of Minnesota)

Project Overview

After releasing the Utility Master Plan, the University evaluated several solutions to address the future potential steam shortage using **Reliability, Sustainability, and Cost-Effectiveness** as the selection criteria. The winning option was to rehabilitate the Old Main Heating Plant, incorporating a CHP system.

In June 2011, the University teamed with Jacobs Engineering Group to proceed with detailed engineering design, construction, installation, and commissioning of the CHP system, including the reconstruction of the Old Main Heating Plant building and surrounding grounds.

The final design consists of a GE LM 2500 dual fueled combustion turbine rated at 22.8 MW. The unit includes a dry-low NOx combustor with exhaust clean up catalysts resulting in NOx levels less than 4 ppm. In addition, the system includes a duct fired HRSG that can produce up to 272,000 lb/hr steam at 200 psi (fully fired). A 900 HP reciprocating compressor boosts the natural gas provided by the local utility at 90 psi, to the required 450 psi input to the turbine. The CHP system also has black start capability allowing the University to start the system should the electric grid be inoperative.

Quick Facts

Location: Minneapolis, Minnesota

Market Sector: University

CHP Generation Capacity: 22.8 MW

Prime Mover: General Electric LM 2500 dual fuel combustion turbine with dry-low NOx combustion

CHP Fuel Source: Natural gas and #2 fuel oil

CHP Heat Recovery Rate: HRSG that produces 92,000 lbs/hr unfired and up to 272,000 lbs/hr with duct firing (200psi steam)

Gas Compression: System includes a 900 HP reciprocating compressor that boosts natural gas from 90 psi to the required 450 psi turbine input.

Est. Annual Gross Cost Savings: \$8M – \$9M

Project Payback: Estimated at 8.8 years

Began Operation: November, 2017

Est. Annual CO₂ Global Emission Reduction: 32,000 metric tons

System Reliability / Sustainability

Until 2017, all the steam provided to the Minneapolis campus was generated from the Southeast Steam Plant (SE Plant) which underwent a major upgrade in 2000. As a result of the upgrade, the SE Plant includes 2 packaged boilers as well as a new solid fuel circulating fluidized bed boiler. These three boilers have a combined steam capacity of 650,000 lbs/hr. The SE Plant also houses a backpressure steam turbine CHP system that is used to reduce the 900 psi steam from the circulating fluidized bed boiler to the required 200 psi for the University steam system. On average, this system produces between 4 and 7 MW of utility grade electricity when the boiler is operating. The SE Plant boilers are used to supplement

the steam from the CHP system and to provide back-up should the CHP system be inoperative. This provides the steam reliability and sustainability desired by the University and together the two plants provide the firm steam capacity needed to meet the projected 20-year load growth.

Project Economics

Following the completion of the Utility Master Plan, the University investigated many potential options to address the projected long term steam shortage. Three options were identified in the final analysis including adding packaged boiler capacity to the SE Plant, rehabilitating the Old Main Heating Plant, or constructing a new steam plant facility on campus. Since the University identified having a single source of steam (single facility) for the campus as unacceptable, it was decided that rehabilitating the Old Main Heating Plant was more economically desirable with less permitting restrictions than embarking on the construction of a new steam plant facility.

Once this decision was made, the University then analyzed the cost versus benefits of using the Old Main Heating Plant to house either a packaged steam boiler system (250,000 lb/hr capacity) or a comparable CHP system. The final CHP design of a 22.8 MW system offered up to 272,000 lb/hr steam along with 190,000,000 kWh of utility grade electricity annually (95% availability). The life cycle cost analysis estimated that the incremental cost of installing the CHP system (\$49 M) would result in the University realizing a reduction in the total cost of utilities and O&M by \$167 M over the 20 year life of the equipment. The incremental cost included the need to modify the physical infrastructure and operation of the campus power distribution network. The analysis projects an estimated payback of 8.8 years on the incremental cost of the project.



22.8 MW CHP Combustion Turbine
(Source: University of Minnesota)

"The CHP system allows the University to operate as an energy island so that critical University services at our hospitals, clinics and research facilities can be maintained if there are external outage events."

- Jerome Malmquist, Director of Energy Management at the University of Minnesota

Lessons Learned

- The air permitting process for this type and size project is complex and costly. Early initiation and close attention to the process is essential. The air permitting process for this project took 27 months.
- Early communication with the local electric and natural gas utilities regarding the intended project is mandatory. The distribution systems (gas pipelines and electric grid) are owned by the utilities and the site must abide by their rules, regulations, and fees.
- Be flexible to ensure that the optimal solution (not necessarily the least expensive solution) is pursued. This takes detailed technical and financial analyses and championing the project through the approval process.
- After approximately 12 months of operation, the system is operating as planned and the University is on track to realize the expected first year energy, emission, and cost savings.

For More Information

U.S. DOE MIDWEST CHP Technical Assistance Partnership
Phone: (312) 996-4490
www.MidwestCHPTAP.org

A public project of this size and complexity requires support from many entities to be successful. Contributors included:

- Minnesota State Legislature: provided \$10M
- CenterPoint Energy (gas provider): Very supportive from day 1 including a \$2M rebate under their Energy Efficiency Program
- Xcel Energy (electric utility): Initially opposed the project, quickly changed and provided complete support.
- The Minnesota Energy Office, along with neighborhood communities, provided significant open support that may have helped in the permitting process.
- The Midwest CHP TAP provided technical and educational support to the Minnesota Department of Commerce, Division of Energy Resources with activities to provide education on the concepts of CHP in the State Energy Efficiency Program and to the University in its effort to develop and support this project.