Optimizing Cogeneration Performance

Cogeneration System
Cogeneration, or combined heat and power (CHP), systems use heat engines to simultaneously generate electricity and useful heat. Power plants produce electricity but reject waste heat to the environment and have grid losses. By using on-site cogeneration instead of buying electricity from the utilities, efficiency is increased from around 40% to 80%.

Energy Efficiency
Buildings have two major energy demands: electrical and thermal. In conventional generation, electrical demands are met by purchasing electricity from a utility grid and thermal demands are met by purchasing natural gas and running boilers.

Conventional Generation
- Waste Heat: 75 Units
- Grid Loss: 5 Units
- Fuel: 115 Units
- Electrical Demand: 35 Units
- Heat: 45 Units
- Boilers

Cogeneration (Combined Heat and Power)
- Electrical Demand: 35 Units
- Heat: 45 Units
- Cogeneration Plant

*Units in this figure represent units of useful energy.

Project Goals
A study of the 150kW cogeneration plant at Cooper Union’s Foundation Building (FB) reveals that optimizing cogeneration plant operation could save an additional $64,000 annually. The goal is to work with facilities and vendors to implement changes in order to increase electricity production and heat recovery.

Foundation Building Cogeneration
Overview
Cooper Union’s historic Foundation Building, built in 1859, underwent major HVAC renovations in 2010 including the installation of a 150kW cogeneration system. To minimize installation costs, the cogen system was connected in parallel with the boilers with common pumping and water treatment. Heat was originally dumped to the cooling towers. Subsequent water treatment and control issues caused multiple engine failures so the water loop was reconfigured in Spring 2016.

Data Analysis
Building Management System
The Building Management System (BMS) is a computer-based control system that monitors and controls the operation of the HVAC system.

New Cogeneration System Flow Diagram
To improve operation, a dry cooler was installed to isolate the cogen coolant water from the building’s hot water. The original heat exchanger, plumbing and pump were repurposed but ultimately the pump failed. It was also observed in April 2016 that the boilers were firing while the cogen system was dumping heat.

Future Work
- Analyze pumping and heat recovery performance with newly installed higher capacity pump
- Update BMS to reflect new system flow schematic and set up automated trending of data
- Develop analysis tools to track electrical and thermal performance

$64k in potential annual savings identified:
1. Increase run load to 150 kW by installing current transformer to track building electrical load
2. Analyze hot water loop and determine boiler set points to optimize heat recovery

Assumed utility rates and maintenance:
- Electric: $0.2/kWh
- Gas: $0.85/therm
- Maintenance: $0.0375/kWh

Source: BMS Real Time Data (10/10/2016)

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