



Argonne National Laboratory

6.3 MW CHP System



Project Overview

Argonne National Laboratory (ANL), the first national engineering and science laboratory in the United States, was established in 1946. ANL is located on 1,500 acres of wooded land 25 miles southwest of the City of Chicago and has over 1,250 scientists and engineers working at their facilities to further national interests in energy, environment, and national security.

In the fall of 2016, ANL completed the installation and start-up of a 6.3 MW Combined Heat and Power (CHP) system that featured a Solar Turbines (A Caterpillar Company) Taurus 65 Gas Turbine/Generator (GTG) module. The 6.3 MW (nominal) natural gas fueled turbine is equipped with dry low NOx combustion technology which limits NOx emissions to 15 ppm. During the first nine months of operation the CHP system produced > 31 million kWh of utility grade electricity, displacing the need for ANL to purchase both this electric capacity and its related demand charges.

The exhaust from the turbine is used as the primary source of energy into a Heat Recovery Steam Generator (HRSG). The HRSG also contains a bank of natural gas fired duct burners which allows the HRSG to operate up to 2,200°F, and produce 100,000 lb/hr of 190 psig steam. The system is capable of producing 80% of ANL's steam requirements throughout the year. In addition, the CHP system includes a fresh air fan to allow full steam output from the HRSG should the gas turbine be "off line" and a bypass damper and stack to allow the gas turbine to fully operate should the HRSG be "off line". Finally, the project included the construction of a 5,400 sq. ft. building to house the CHP system. The new facility is located adjacent to the old existing steam plant.

Project Drivers

The primary function of the ANL CHP system is to replace an aging (50+ years old) steam plant infrastructure. The CHP system provides the base load steam generation which is used primarily for temperature and humidity conditioning within Argonne facilities, including some laboratory process loads. The successful operation of the

"The investment in the CHP system has modernized and strengthened both our electric and thermal infrastructure, providing options should the laboratory experience electric power grid interruptions or unscheduled outages of any of the older existing boilers."

**Josh Koons – Manager, Utilities Group,
Argonne National Laboratory**

CHP system has resulted in one of the five existing aging boilers being decommissioned, leaving the remaining four boilers as backup and/or supplemental steam resources. This helps reduce the laboratory's carbon footprint, saving more than 24,000 metric tons of greenhouse gas emissions annually, the equivalent of about 5,000 cars removed from the road. Argonne's CHP plant has resulted in both energy and cost savings, reduced emissions, and increased operational reliability for the laboratory.

Quick Facts

- LOCATION:** Lemont, Illinois
- MARKET SECTOR:** Gov't Facility / National Laboratory
- CHP GENERATION CAPACITY:** 6.3 MW (nominal)
7.4 MW @ 0°F day; 4.8 MW @ 100°F day
- PRIME MOVER:** Solar Turbines 65 GTG Turbine - Generator Set
- HEAT RECOVERY STEAM GENERATOR (HRSG):**
Unfired capacity: 30,000 lb/hr 190 psig steam
Duct fired capacity: 100,000 lb/hr 190 psig steam
- CHP FUEL SOURCE:** 300 psig Natural Gas, provided by the local utility (no onsite gas compressors)
- PROJECT FINANCING:** A 15 year Energy Savings Performance Contract (ESPC) with annual energy savings paying for 100% of the project cost and operation. A \$2M energy grant was awarded by the Illinois Department of Commerce and Economic Opportunity (State Energy Office).
- EMISSION REDUCTIONS:** Eliminates 24,000 metric tons of greenhouse gas emissions annually
- SYSTEM START DATE:** Fall 2016



ANL CHP Plant

Since ANL considers the energy efficient steam generation as the major function of the CHP system, they refer to the electricity that is produced as a “byproduct” of the CHP process. This “byproduct” is significant, supplying 20% of the laboratory’s electric requirement, reducing ANL’s dependency on the local power company. The CHP system is designed to stay on-line in the event of a utility outage and is also equipped with “black start” capability which allows the CHP plant to be started and then operated isolated from the grid, if utility power is not available.

Project Financing

ANL entered into a 15 year Energy Savings Performance Contract (ESPC) with NORESKO, a federally approved energy savings company (ESCO). An ESPC is an innovative financing technique that, when applied to federal agencies, allows that agency to procure energy savings and facility improvements with no upfront capital costs or special appropriations from Congress. An ESPC is not limited to federal agencies, it is a financial tool that has been successfully used by both large commercial and industrial companies. The ANL ESPC with NORESKO included \$22.8M for the design, construction and installation of the CHP plant and an additional \$18.7M for the operation, maintenance, repair and replacement services for the system. The performance contract is based on the guarantee that the NORESKO effort will result in average annual energy savings of \$3.5M that ANL will utilize to pay back the project cost. After the first year of operation, the CHP project is on track to save more than \$50M within the first 15 years. After 15 years, the annual savings can be utilized by ANL to supplement their annual capital budget. In addition, since 100% of the costs are paid through the realized energy savings, ANL can utilize its annually allocated federal funds on other important facility projects.



Solar Turbines: Taurus 65 GTG Module

To assist in the financing of this project, ANL proposed and was awarded a one-time energy grant from the State of Illinois under its Energy Efficiency Combined Heat and Power Incentive Program. The grant award of \$2M was contingent on the CHP System meeting an agreed-upon set of performance requirements monitored over the first 12 months of operation; the CHP System met all the performance requirements.

Lessons Learned

The following are just a few of the comments, thoughts, and lessons learned expressed by the ANL team after 13 months of operation of the CHP system:

- Early discussions with the local electric and natural gas utilities on interconnecting with their systems is imperative. Understanding and integrating their requirements into the project design phase will definitely minimize costs and avoid unforeseen downstream delays in project implementation.
- The use of an Energy Savings Performance Contract (ESPC) provided ANL the financial tool necessary to move forward with a very significant investment in laboratory sustainability while not penalizing other needed shorter term capital improvement projects. Negotiating a fair and realistic ESPC required extensive analysis (both technical and financial).
- During the first year of operation, the CHP system has demonstrated its ability to provide increased reliability of both electric and thermal service for the laboratory, its ability to substantially reduce the laboratory’s carbon footprint, and its ability to realize the significant energy cost savings necessary to successfully meet the ESPC financial requirements.



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