MIDWEST CHP Technical Assistance Partnerships

PROJECT PROFILE

Adkins Energy LLC

Adds 1.8 MW Waste Heat-to-Power Turbine Brings Total CHP Installed to 6.8 MW

Background

In 2002, Adkins Energy LLC, a 38 million gallon per year producer of corn based fuel grade ethanol, invested in a 5 MW natural gas fired turbine CHP system capable of providing 100% of the facility's electric needs and producing 25,700 lbs/hr steam satisfying approximately 30% of the facility's thermal load. Today, 17 years later, after proper maintenance and periodic system upgrades, the CHP system continues to provide reliable economic service 24 hours a day 7 days a week. Over the years, as the plant has increased production to 60 million gallons per year, the CHP system is providing 95% of the facility's electric requirement.

In 2018, an additional large distiller's grain dryer was installed to further increase the efficiency of the ethanol production process. The new equipment required approximately 1 MW of electric power to operate. To meet the new electric demand, Adkins Energy decided to expand its CHP capacity by adding a 1.8 MW waste heat-to-power backpressure steam turbine/generator set.

Quick Facts

Location: Lena, Illinois
Market Sector: Corn Based Ethanol Plant
CHP Capacity:

- 5.0 MW Solar Turbines natural gas turbine/generator set installed in 2002
- 1.8 MW Dresser Rand backpressure steam turbine installed in 2018

2018 Waste Heat-to-Power Project:
Prime Mover: Dresser Rand 4 Stage Model K Backpressure Steam Turbine/Generator Set
Steam Turbine Capacity: 1.8 MW – presently operating at 1.1 MW
Pressure Drop: 110 psig
Steam Flow: 37,000lbs/hr
Project Cost: Approximately $4.0 M – includes construction of new building
Est. EEPS Incentive (ComEd): $674,528 (year 1)
Est. Annual Savings: $674,000 based on $0.07/kWh
Project Payback: Estimated at 5.1 years
Began Operation: March, 2019

Waste Heat-to-Power CHP Project

The Adkins plant ethanol producing process utilizes a pressure reducing valve (PRV) to reduce the 110 psi steam used throughout the plant to slightly negative pressure for use in several process evaporators. This situation provided an opportunity to place a backpressure steam turbine/generator set in parallel with the PRV, allowing the pressure drop to occur through the turbine rather than the PRV.

Since the turbine is driven solely by the energy in the existing steam line, and no additional fuel is utilized, the turbine is classified as a Waste Heat-to-Power CHP system. The system utilizes a Dresser Rand 4 stage Model K steam turbine with an inlet steam flow of approximately 37,000 lbs/hr at 110 psi. The turbine shaft drives an electric generator that produces 1.1 MW of electric power. With the turbine/generator set operating 24 hours a day 7 days a week, the system produces over 9,600,000 kWh annually, sufficient to operate the new distiller's grain dryer.

Adkins Plant, Backpressure Steam Turbo-Generator Set

To ensure plant process reliability, should the turbine be inoperative, the steam flow is automatically diverted through the PRV, allowing the pressure drop to occur and the slightly negative pressure steam to advance to the evaporators.

Project Economics

Adkins Energy based its decision to purchase and install the 1.8 MW backpressure steam turbine/generator CHP system in part on a projected simple payback on the total installed cost of less than 6 years. The total installed cost of the system was $4,000,000, which included engineering and analysis, the construction of a new building to house the turbine/generator set, replacing and updating the 5kV synchronizing switchgear, installing substantial low pressure process/steam piping, as well as the cost of the turbine/generator and its installation.

Adkins Energy submitted an application to Commonwealth Edison (Com Ed), their local electric utility, for a financial incentive under the Illinois Energy Efficiency Resource Standard (EERS) program.[1] Com Ed offers an incentive for qualified CHP projects of $0.07/kWh produced over the first 12 months of operation. The project was approved by Com Ed, and they have established a Measurement and Verification (M&V) program to monitor and measure the energy produced. It is estimated that the incentive will be in the amount of $674,528. Therefore, the cost of the project to Adkins Energy is reduced to $3,325,472.

To calculate the simple payback on their investment, the estimated annual cost savings associated with generating the electricity on-site must be calculated. For a bottoming cycle CHP system using waste heat, the cost savings is the annual kWhs produced by the system times the price per kWh the plant would have paid for the electricity if it were purchased from Com Ed, minus the operation and maintenance (O&M) cost associated with the CHP system. The estimated O&M cost utilized for the CHP system is $0.0020/kWh and the avoided cost of the electricity produced on-site is $0.07/kWh.

How Does the Backpressure CHP Turbine/Generator Work?

In a backpressure steam turbine-generator, shaft power is produced when a nozzle directs jets of high-pressure steam against the blades of the turbine's rotor. The rotor is attached to a shaft that is coupled to an electrical generator.

The steam turbine does not consume steam. It simply reduces the pressure of the steam that is subsequently exhausted into the process header.

By paralleling the turbine/generator with the PRV where the exhaust steam is provided to the plant process, energy in the inlet steam can be effectively removed and converted to electricity

At 100% availability of the CHP system, the annual savings are $674,528 and the simple payback is 5.1 years. At 90% availability of the CHP system, the annual savings are $589,723 and the simple payback is 5.6 years.

Lessons Learned

The following are a few of the lessons learned expressed by the Adkins Energy team regarding their over 17 years of experience with CHP:

- One of the biggest concerns with the latest CHP project was the successful integration of both CHP systems into the utility grid. Working closely with the engineering partners, equipment representatives, and the Com Ed engineers, the integration went smoothly and the two turbines are operating well together.
- Adherence to scheduled maintenance and proper operation has resulted in the 17 year old 5 MW CHP system continuing to provide reliable and cost effective operation. This positive experience was instrumental in Adkin's decision to expand their CHP capacity.
- Maintaining a strong relationship with our local utility (Com Ed) has been and will continue to be a key element in Adkin's successful on-site generation capability.

"The CHP installations provide us economic stability and reliability for our electricity supply regardless of unforeseen electricity grid outages"
Jason Townsend – Plant Manager, Adkins Energy LLC

For More Information

U.S. DOE Midwest CHP Technical Assistance Partnership
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[1] ComEd CHP Incentive Program:
www.comed.com/WaysToSave/ForYourBusiness/Pages/FactSheets/CHPFactSheet.aspx