Examples Where CHP Cuts Costs and Improves Reliability at Industrial Sites

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ABSTRACT

Combined Heat and Power (CHP – also known as cogeneration) has many benefits; its strategic operation can cut costs, and certain configurations of on-site generation can operate during grid outages and thereby improve reliability. Increasingly, industrial customers are seeking the benefits that CHP can deliver, especially cost-savings, reliability, and fuel diversification.

This paper will examine four examples of industrial-sited CHP systems (two have been installed and are currently operational, two are currently under contract for detailed engineering design, equipment procurement, and eventual installation) in New York State with funding support from the New York State Energy Research and Development Authority (NYSERDA). These projects include CHP systems based on microturbines installed at a facility that processes plastic film into bags and wrapping, a condensing steam turbine installed at a facility that produces formaldehyde for use by various adhesive manufacturers, backpressure steam turbines to be installed at a tech park which has a utility distribution system that serves numerous tenants in a campus setting, and internal combustion reciprocating engines to be installed at a frozen food warehouse.

Introduction

Combined Heat and Power (CHP – also known as cogeneration) has many benefits: modern equipment is environmentally friendly; use of available heat (thermal energy) increases fuel-use efficiency; a plethora of economically advantageous equipment is available and its strategic operation can cut costs; diversification of electrical supplies enhances energy security; certain configurations of on-site generation can operate during grid outages and thereby improve reliability; and on-site generation alleviates load pocket constraints which are attributable to transmission and distribution (T&D) congestion, and thus can reduce energy costs for all local consumers when sited in zones where localized demand exceeds localized supply.

The continued growth of CHP in New York State is occurring in numerous end-use sectors, including commercial, residential, institutional, and industrial customers. This growth is the result of a fortuitous intersection of an increased supply of practical and durable equipment, an expanded customer awareness and the resultant increased demand for the benefits that CHP can deliver, and the continued evolution of well-focused state and federal government policies and programs to nurture energy efficiency in general, and CHP in specific. Expanding customer awareness of the benefits of CHP is an important component of many government-sponsored CHP programs, and is best addressed through technology transfer that highlights measured and verified economic and performance data from actual CHP installations which can serve as role model examples for a large audience to replicate.

Increasingly, industrial customers are seeking the benefits that CHP can deliver, especially cost-savings, reliability, and fuel diversification (including the use of lower-cost fuels and "opportunity fuels" which would otherwise be handled as wastes). This paper will examine four examples of industrial-sited CHP systems (two have been installed and are currently operational, two are currently under contract for detailed engineering design, equipment procurement, and eventual installation) in New York State with funding support from the New York State Energy Research and Development Authority (NYSERDA). The motivating factors which influenced these facilities to install CHP, and the specific features of the CHP systems which were incorporated in order to address the sites' needs, will be discussed. Consistent with NYSERDA's mission to provide objective information to help solve some of New York's most challenging energy issues, this roundtable will serve as one of a series of steps aimed at achieving the timely technology transfer that is vital to the continued growth of CHP.

CHP Provides Benefits Such As Reduced Costs and Improved Reliability

Industrial facilities can reduce costs by implementing a variety of energy efficiency measures. Several generic infrastructure systems, which are commonly found in industrial settings, such as compressed air production and distribution, steam systems, lighting, and motors, can be retrofitted and/or upgraded with premium efficiency practices. Activities within the manufacturing process itself can also be the focus of energy efficiency upgrades, although the unique nature of many production processes may require custom measures and involve proprietary practices. As such, manufacturers have been slow to replicate examples where similar facilities have successfully capitalized on process-related energy efficiency opportunities, but they can be worth pursuit.

Making your facility as efficient as possible *before* adding CHP helps make your CHP system more efficient and cost-effective. This will ensure that your CHP system is not wastefully oversized. Thus, CHP can be an excellent money-saving improvement to supplement (not replace) aggressive energy efficiency upgrades. CHP can be a good fit for facilities that have elevated and prolonged electric and thermal loads, where the needs for both electric and thermal energy occur simultaneously (i.e., coincident demand). Cost-savings derive from displacing high-cost grid-supplied electricity with lower-cost self-generated electricity, and displacing thermal energy (from a furnace or boiler fired with purchased fuel) with recovered heat that would otherwise be rejected from the generator (often referred to as waste heat).

CHP systems can be compatible with a variety of gaseous and liquid fuels, and can often be configured to run on natural gas when available, with switchover to distillate fuel oil as needed. Such dual-fuel capability can provide opportunities for selecting the lowest-cost operating fuel, and/or for engaging in contracts for "interruptible" gas, which tends to be at a discount. Frequently, installation of a new, efficient CHP system operating on a clean-burning fuel will provide sufficient recovered heat to enable abandonment of an old, inefficient boiler or furnace – and occasionally such furnaces or boilers had operated on number 6 fuel oil. This transformation could result in a net reduction of on-site air emissions for which the site could apply to claim Emission Reduction Credits (ERCs) or Allowances. Certificates of ERCs or Allowances can be sold, with the proceeds helping to defray the cost of installing the CHP equipment. In one example being studied in New York State, a project at an apartment building costing approximately $1.4 million to install 550 kW of CHP is forecasted to yield 7.5 tons of

NOx ERCs that could be worth approximately $85,000 (this represents a savings of 6% off of the $1.4 million project cost).

CHP can offer industrial sites other benefits through improved reliability, and such improved reliability translates into reduced costs and greater productivity. Facilities that receive all of their electric power from the local utility grid are subject to an aging infrastructure that has seen minimal investment in Transmission and Distribution system (T&D) upgrades in recent years. Growing demand is not being met with commensurate upgrade of T&D or construction of new central station generators, resulting in further exacerbation of reliability concerns and possible price spikes, especially in constrained areas where local demand exceeds local supply. Land use patterns often conflict with the desire to create new corridors for transmission lines or the siting of new central station generators.

While all users are exposed to the variations in power quality, such as voltage sags or outages, which could occur more frequently and/or more severely as a stressed grid continues to age, industrial sites are particularly impacted as more and more manufacturing equipment becomes computer controlled or reliant on sensitive electronic components and therefore more susceptible to power quality upsets. Furthermore, unexpected power outages can wreak havoc at a manufacturing facility due to the disorderly shut down of process equipment. Losses ranging from spoilage of perishable materials or damage to a work-in-process are compounded with unexpected expenses for disposal of outage-event created waste. A power outage may also incur labor costs for workers who are sidelined from their primary functions, as in the case where workers are idled, and/or workers are reassigned to sort/separate spoiled/damaged goods or restart machinery upon the return of power. Occasionally, equipment can become damaged, as when molten materials such as metal at a foundry, plastics in an extruder, or glass in a melting furnace, cool and seize-up within the production vessel. If the production vessel becomes ruined, there could be significant costs and extended delays in acquiring replacement specialty equipment that might not be a routinely stocked item, and this could have serious repercussions for a facility's productivity.

In addition to helping a facility reduce costs, CHP can provide reliability benefits such as voltage/frequency stability, and stand-alone power. A CHP system that operates on a daily basis (and receive appropriate exercise and routine maintenance) may prove more reliable as stand-alone emergency power compared to a traditional standby generator that is typically idle. The use of modular CHP equipment provides redundancy. Reliability is further enhanced when redundant fuel supplies are available as in the case of dual-fuel CHP systems.

Nevertheless, there are still many challenges that affect the penetration rate of CHP in the industrial sector as well as other end-use sectors. Many of the larger-sized industrial sites have already installed CHP; in New York State, smaller-sized sites typify the remaining market potential. Since not all CHP project costs scale linearly with size, smaller-sized sites typically have a smaller margin for profit; therefore, the remaining candidate sites represent more-challenging CHP installations. The industrial sector is characterized by a wide variation of energy consumption within customer application/size class, thus limiting the ability of any particular site to serve as a role model example for others. Another hurdle that limits market penetration is that users can perceive CHP to be a high risk, non-core investment. Yet, as we will hear in the following four case studies, industrial sites are overcoming such challenges and implementing CHP in order to cut costs and improve reliability.

Representative Industrial Sites Installing CHP

Allied Converters of New Rochelle, New York, is a 30-employee plastic wrap assembly facility that processes plastic film into bags and wrapping. Two Capstone Microturbines, rated at 30 kW each, and two Yazaki Chillers, rated at 10 tons cooling each, have been operational since July 2003. Heat from the microturbines is used for comfort space heating during the winter months, and to activate the chillers for comfort space cooling during the summer months. Electricity produced on-site by the microturbines represents approximately 90 percent of the facility's needs; the remainder is consumed from the local electrical grid in the Con Edison territory. During normal operation, electricity is simultaneously self-generated on-site and consumed from the grid; during a grid outage, the microturbines shut down, the facility "islands" from the grid, and the microturbines automatically restart and run in "stand-alone" mode.

Borden Chemicals of South Glens Falls, New York, has capacity to produces two hundred million pounds per year of formaldehyde for use by various adhesive manufacturers. This chemical process is exothermic (i.e., it produces excess heat) – the excess heat is used to make steam that is traditionally vented to dump the heat to the outside ambient air. A condensing steam turbine rated at 450 kW has been operational using this opportunity steam since January 2004. The reclaimed condensate exiting the turbine is recirculated to the formaldehyde manufacturing process where it is converted back to steam. The site routinely consumes up to 750 kW from the local electrical grid in the Niagara Mohawk Power Corporation territory. During grid outages, the facility halts the formaldehyde production process, the opportunity steam supply is interrupted, and the on-site generation activity is suspended.

The 345-acre Rochester Tech Park of Rochester, New York, with over 4 million square feet of buildings, is currently 20-percent occupied. It has a central boilerhouse that produces steam, and an adjacent utility building that produces chilled water, and both systems operate year-round for distribution throughout the campus setting to numerous industrial and commercial tenants. A project to install two steam backpressure turbines, rated at 400 kW each, has been contracted to receive NYSERDA co-funding; detailed engineering design is currently underway. To further expand fuel diversity, the boilers, which operate on either natural gas or #6 fuel oil, will be reconfigured to also operate on a recycled fuel produced from reprocessed waste motor oil and marketed in accordance with New York State Department of Environmental Conservation (NYSDEC) regulations regarding Waste Fuel. The on-site generation will be able to operate with, or without RG&E's local electrical grid, and during a grid outage will be able to produce sufficient electricity to power the boilers, the chilled water plant, and all necessary appurtenant equipment such as pumps, fans, and controls, in order to heat and cool the entire campus.

Allied Frozen Foods Storage of Brockport, New York, is a fourteen million square foot commercial frozen food warehouse located next to, and primarily serving, a Birdseye Foods processing facility. Typically, more than $100 million dollars of perishable inventory is on hand. Two natural gas-fired internal combustion reciprocating engine generators, rated at 1,250 kW each, manufactured by Kraft Power, have been purchased. They will be installed in the Fall of 2005 and are forecasted to commence operation before the end of 2005. The facility will remain interconnected with Niagara Mohawk's local electrical grid; the facility will self-produce all of the required electrical power at all times (therefore, will not consume any electricity from the grid), but at times will export its surplus electricity to the grid. A 250-ton ammonia absorption low-temperature chiller will be installed and will be activated using the available heat from the engine generators; natural gas fueled duct firing in the exhaust stream from the generators will provide additional heat to activate the chiller, and will be able to operate the chiller during times when the generators are not in operation. A new diesel-fuel-fired emergency generator will be installed to provide redundancy that will further improve the reliability of the facility.

Conclusions

Increasingly, industrial customers are seeking the benefits that CHP can deliver, especially cost-savings, reliability, and fuel diversification. There are still many challenges that affect the penetration rate of CHP in the industrial sector, such as size (smaller-sized sites – which typify the remaining market potential in New York State - typically have a smaller margin for profit), the wide variation of energy consumption within customer application/size class (thus limiting the ability of any particular site to serve as a role model example for others), and users can perceive CHP to be a high risk, non-core investment. Yet, industrial sites are overcoming such challenges and implementing CHP in order to cut costs and improve reliability.

Cost-savings derive from displacing high-cost grid-supplied electricity with lower-cost self-generated electricity, and displacing thermal energy (from a furnace or boiler fired with purchased fuel) with recovered heat that would otherwise be rejected from the generator (often referred to as waste heat). Dual-fuel capability can provide opportunities for selecting the lowest-cost operating fuel, and/or for engaging in contracts for "interruptible" gas, which tends to be at a discount. Occasionally, installation of a clean and efficient CHP system could result in a net reduction of on-site air emissions for which the site could apply to claim Emission Reduction Credits (ERCs) or Allowances which could provide revenues to displace a portion of project implementation costs.

CHP can provide a site with improved reliability, such as protection against voltage sags or outages - industrial sites are particularly susceptible to the detrimental impacts of power quality upsets, as more and more manufacturing equipment becomes computer controlled or reliant on sensitive electronic components. Unexpected power outages at a manufacturing facility can cause disorderly shut down of process equipment, leading to losses from spoilage of perishable materials or damage to a work-in-process, and labor costs for workers who are sidelined from their primary functions. In certain configurations, CHP systems can provide a facility with stand-alone power - a CHP system that operates on a daily basis (and receive appropriate exercise and routine maintenance) may prove more reliable as stand-alone emergency power compared to a traditional standby generator that is typically idle.