Industrial Focus of NYSERDA's Combined Heat and Power Program

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ABSTRACT

Combined Heat and Power (CHP) 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; diversification of electrical supplies enhances energy security; and on-site generation alleviates load pocket constraints which are attributable to transmission and distribution (T&D) congestion.

Increasing the market penetration of CHP is a worthy goal and deserving of support through public-benefit programs. The New York State Energy Research and Development Authority (NYSERDA) has a development and demonstration program to encourage the deployment of clean and efficient combined heat and power systems in the State. This program provides co-funding for small, typically less than 5 MW, CHP installations and is intended to demonstrate the viability of this concept in various applications and end-use market segments. NYSERDA's current portfolio of projects includes internal combustion engines, microturbines, fuel cells, backpressure steam turbines, and combustion gas turbines from a variety of equipment manufacturers.

Extensive heat recovery is vital for CHP success. As the use of otherwise wasted heat increases, fuel-use efficiency improves, and economic gains increase. Conventional uses for recovered thermal energy to support the operation of a building include domestic hot water (DHW), comfort space heating, and comfort space cooling. Depending on the type of building and geographical location, these conventional uses can fluctuate significantly by time of day, day of week, and season of year. Industrial and commercial processes provide additional opportunities for recovery of thermal energy, and sometimes yield economic value related to improved power quality and reliability derived from the generation of electricity on-site.

Through co-funding of various CHP projects, NYSERDA observes the emergence of a range of opportunities for increasing the recovery of thermal energy at industrial sites (beyond basic DHW/comfort space heating/comfort space cooling), including but not limited to: intensive steam loads for drying operations in paper mills; continuous need for cooling of extruded-plastic parts in order to "freeze" their shape; and year-round warming of anaerobic digesters for treatment of farm animal wastes and drying of farm products. In addition, the economic value of reliable and stable electrical power can be achieved by preventing undesirable attributes which might otherwise occur at these and other industries during a power outage, such as: lost production time resulting in idle workers; potential damage to manufacturing machinery (e.g., seize-up of plastic within an extruder); or destruction of a batch of a product (e.g., spoilage of milk due to lack of refrigeration).

This paper will highlight NYSERDA's CHP programs and some identified themes specific to CHP at industrial settings through a few brief case studies addressing a system of microturbines (circa 100 kW) at a dairy farm, a system of engines (circa 1,000 kW) at a plastics processing facility, and a combustion gas turbine system (circa 1,000 kW) at a paper mill.

Introduction

The benefits associated with increased deployment of clean and efficient Combined Heat and Power (CHP) systems are well documented. New York State promotes the use of clean and efficient CHP through the identification of marketplace opportunities, demonstration of hardware at various end-use sector sites (including residential, commercial, institutional, and industrial), improvement of the design and manufacturing capabilities of CHP system components, and widespread dissemination of lessons learned to all CHP stakeholders.

The New York State Energy Research and Development Authority (NYSERDA) provides approximately $15 million per year for support of CHP. NYSERDA seeks to encourage end-use customers/early adopters of emerging CHP technologies to pursue the cleanest and most efficient systems and configurations, and to document the hurdles and lessons learned from conceptual design through implementation and operation. Based on operational data, successful "role model" systems will be identified; they will be promoted to encourage replication - so that follow-on sites can implement such proven designs faster, better, and cheaper.

Demonstrating successful CHP applications will minimize engineering costs by providing "role model" design templates, thereby reducing both financial and technical risks. Reducing risk is critical if marketplace participants are to invest in clean and efficient CHP. NYSERDA's funding for these role model sites is intended to support the detailed-design and associated learning curve for inclusion of premium-efficiency features/environmental controls, and to facilitate detailed data collection, documentation, and technology transfer tasks. NYSERDA selects CHP demonstration projects for funding through a competitive process; proposals are solicited, and those which offer the best combination of superior environmental performance, improved grid reliability, improved energy efficiency, increased utilization of renewable fuels, reduced energy costs and economic expansion, and effective technology transfer are preferred.

In contrast to central power stations which generate electricity for distribution to end users and reject the by-product heat to the environment in a wasteful manner, CHP systems, by virtue of being located at the end user's site, can make beneficial use of both the electrical and thermal energy. Maximizing the beneficial use of a CHP system's by-product heat will maximize its fuel use efficiency, but therein lies the challenge.

CHP is generally feasible at sites that have substantial, consistent, and prolonged demand for thermal energy. The extent of temporal coincidence of heat loads and electric loads determines the feasibility of a CHP installation. Surplus thermal energy generated at one point in time can sometimes be stored and beneficially used at a later time (e.g., domestic hot water storage tanks), this adds complexity (and cost) to a CHP system. Likewise, surplus electricity generated at a point in time can sometimes either be stored and beneficially used at a later time (e.g., batteries), or exported to the utility grid and sold to external customers; this too adds complexity (and cost) to a CHP system. For most sites, energy storage is not currently feasible due to high capital costs and technical issues.

Institutional buildings like those on a college campus, which provide year-round heating and cooling of occupied spaces via district steam and chilled water piping supplied by a central plant, are good candidates for CHP by virtue of their existing infrastructure. Conversely, "all-electric" buildings, often found at multifamily residential apartment buildings in metropolitan areas, cannot conveniently use a significant amount of thermal energy without costly (and often uneconomical) construction of a piping infrastructure.

While self-generation of electricity at an "all-electric" building may be economical for "peak shaving" purposes, NYSERDA's CHP Program promotes "role model" design templates which provide significant use of by-product heat. Occasionally these buildings can use some thermal energy to produce domestic hot water (DHW) - the daily cycle of demand for DHW in such settings has been shown to follow a weekday pattern with a morning and an evening peak and an overnight valley, and a weekend pattern of a noontime peak and an overnight valley (Goldner, Price & Karins1999). NYSERDA encourages developers to achieve maximum beneficial use of by-product heat from the CHP system (and thereby maximize the CHP system's fuel use efficiency) by designing thermally sized systems.

The industrial sector provides many opportunities for highly efficient, economic CHP applications. However, since each manufacturing process is unique, it is difficult to create a standard design template. In response, NYSERDA supports projects at industrial sectors with numerous facilities in New York State (such as the plastics processing sector), in order to expedite replication. NYSERDA also supports projects that service common processes within various industrial sectors (such as anaerobic digestion of wastes at dairy farms, food processors, pulp and paper mills, and municipal wastewater treatment plants).

Market Potential and NYSERDA Portfolio

NYSERDA commissioned a study (Hedman et al. 2002), which shows that as of 2002, New York State has approximately 5,000 MW of CHP installed capacity at 210 sites. The industrial sector accounts for 78% of the existing CHP capacity in the State. Over half (54%) of the capacity is concentrated in the metals, paper, and chemicals industries. The remaining capacity (46%) is divided equally between other industrial processes and the commercial/institutional sector. There is Technical Potential for approximately 8,500 MW of new CHP over the next decade aggregated at over 26,000 sites. [1] Modeling forecasts that in a Base Case scenario an estimated 764 MW of CHP could be installed by the year 2012, whereas in the Accelerated Case scenario market penetration reaches nearly 2,200 MW during the same time frame.

The industrial component of this technical potential represents 1,948 MW of new CHP aggregated over 4,828 sites. Nearly 99 percent of these sites could be candidates for

[1] "Technical Potential" as used herein refers to demand-sized settings that would allow a high-load factor, high-thermal utilization CHP system to operate. The technical potential for new CHP is an estimation of the remaining market size constrained only by technological limits - the ability of CHP technologies to fit existing customer energy needs. The technical potential for new CHP includes sites that have the energy consumption characteristics that could apply high-load factor, high-thermal utilization CHP. The technical potential for new CHP does not consider screening for other factors such as: ability to retrofit, owner interest in applying CHP, capital availability, natural gas availability, or variation of energy consumption within customer application/size class.

new CHP sized at 5 MW or smaller. NYSERDA's CHP Program focuses on systems sized 20 MW or less, and to date most systems in NYSERDA's portfolio are sized 2 MW or less - these smaller size systems represent the bulk of the technical potential. These smaller size candidates are at sites that are not expected to be as energy-sophisticated as large (circa 100 MW to 1,000 MW) candidates, and are not expected to have as ready access to capital.

Since September 1999, through eight solicitations which have received 372 proposals, NYSERDA has selected 154 projects and earmarked $52.5 million to support a combination of CHP site-specific feasibility studies, CHP demonstration projects, CHP technology transfer studies, and new product development of power system components that could be used in CHP systems. Our ninth solicitation has received 117 proposals; funding decisions are currently pending. In some cases, a candidate site has received NYSERDA support in one year to conduct a site-specific CHP feasibility study, and then received NYSERDA support in a subsequent year to implement a CHP demonstration project. The CHP demonstration projects selected are characterized in Table 1.

Table 1. Characterization of CHP Demonstration Projects Selected

Sector	# Selected	$ Earmarked	Aggregate kW
Industrial	34	$14,628,762	28,079
Institutional	29	$7,225,510	25,490
Residential	21	$7,659,345	7,498
Commercial	19	$6,856,802	8,146
Total	103	$36,370,419	69,213

Of these 34 industrial CHP demonstration projects selected, 23 are making good progress toward implementation. These 23 viable projects are identified in Table 2. Not every project selected to receive funds will go forward. This project attrition occurs for many reasons, such as changes in energy costs, standby tariff costs, ownership of the site, the national economy; greater scrutiny as provided through a site-specific feasibility analysis which may show that the CHP system is not as well suited as initially perceived; etc. This attrition is evidence of the technical and institutional hurdles faced by customers trying to implement CHP.

Agriculture

Agricultural production is an important economic sector for New York State, returning over $3 billion to the farm economy in New York State and accounting for approximately 25 percent of the state's land area in 2000 (NYS Ag & Markets & USDA 2001). NYSERDA provides support to the agricultural sector consisting of new technologies for controlled environment agriculture to "extend the State's growing season"; energy efficient variable speed drives on milking equipment, and dairy farm manure digesters, some of which are coupled with CHP systems.

Table 2. Viable Industrial CHP Demonstration Projects

Industrial Sector	Project Site Name
Agriculture	Allenwaite Farms
Agriculture	Auora Dairy Farms
Agriculture	Cooperstown Holstein Dairy
Agriculture	Microgy Cogen Systems
Agriculture	Sheland Farms
Agriculture	Twin Birch Dairy
Agriculture	Town of Perry (multiple dairy farms)
Chemical Processing	Borden Chemical, Inc.
Electroplating	General Superplating Co.
Food Processing	4C Foods Corp.
Food Processing	Blue Ridge Farms
Food Processing	Hermany Farms
Food Processing	LSG Skychefs
Food Processing	Rockland Bakery
Food Processing	Victoria Packaging
Lumber Mill	Double Aught Lumber
Lumber Mill	W.J. Cowee, Inc.
Plastic Manufacturing	Northern Development (Harbec Plastics)
Plastic Manufacturing	Paradise Plastics
Paper Mill	Southern Container Corp.
Soda Bottling plant	Pepsi Cola, Inc.
Textile Dyeing	Compudye, Inc.
Wastewater Treatment (POTW)	26th Ward, Redhook, Oakwood Beach plants

The biogas produced by the digesters can be used to fuel the CHP system, and the heat by-product of the CHP system can be used to warm the digesters. Additionally, the heat by-product can be used to dry the animal bedding and to produce hot water for frequent sanitary wash downs of the milking parlor equipment. Furthermore, manure management through digestion addresses environmental concerns for nutrient control and odor abatement, and can produce a marketable fertilizer product.

NYSERDA has selected 20 dairy farm digesters for support, including examples of the two leading design types consisting of plug flow and mixed tank reactor designs. NYSERDA's experience with anaerobic digesters extends to the winery industry and municipal wastewater treatment plants as well. Of these 20 dairy farm digesters, 90 percent will also use CHP. Experience shows that dairy farms with herd sizes of approximately 750 or more have the potential to produce a sufficient amount to manure to justify construction of a digester. If food wastes or other organic supplies can be used, such as aggregating the manure from neighboring farms, a digester might also be feasible on a smaller farm. In 1997 there were 109 farms in New York State with a milk-cow herd size inventory of at least 500 head of cattle and calves (USDA 1999). Furthermore, experience shows that dairy cows contribute manure to a digester to produce sufficient biogas to generate electricity at a rate of 0.1 kW per cow.

In general, the number of head of cattle will determine the size of a digester and the resultant production of biogas. A CHP system sized to exploit this opportunistic fuel supply is expected to generate more electricity than can be used on-site most of the time; dairy farm digester/CHP systems can be expected to routinely export electricity to the utility grid and periodically consume electricity from the utility grid. In New York State, these systems are facilitated by recently enacted on-farm net metering law (New York State Public Service Law 2002), which was drafted by NYSERDA and the New York State Department of Agriculture and Markets, and strongly supported in the legislative process by the NY Farm Bureau. Furthermore, to complement this support for supply, and in order to create a sustainable marketplace, New York State is encouraging demand for "green" electricity generated from renewable fuels, such as biogas. State agencies are taking a leadership role in establishing such demand, as coordinated through Executive Order 111, issued by Governor Pataki on June 10, 2001 (Pataki 2001), which requires that state agencies procure 10 percent of their electricity from renewable sources by 2005, and 20 percent by 2010. Also, the Renewable Portfolio Standard (RPS) under development by the New York State Public Service Commission (NYSPSC 2003) will ensure that within 10 years, at least 25% of the electricity purchased in New York State is generated from renewable resources.

Dairy farms, by virtue of being located in rural agricultural districts, tend to be located at or near the end of electric utility distribution infrastructure, and therefore can be prone to power quality upsets such as voltage sag (which can shorten the lifespan of electrical devices such as motors). In January 1998, a severe ice storm hit upstate New York, downing power lines and disrupting electric supply to 120,000 customers in 8 New York Counties.[2] Areas with dense populations were restored first, and as a result, many rural areas and dairy farms struggled for over a month before electric service was restored.

Case Study: Twin Birch Dairy

At Twin Birch Dairy, LLC, in Skaneateles (Onondaga County) New York, NYSERDA is supporting the construction of a CHP system to take advantage of biogas generated by an anaerobic digester sized for 2,000 head of cattle. The CHP system consists of four Capstone microturbines, rated at 30 kW each. A gas conditioning system has been provided to remove moisture from the biogas before it can be used in the microturbines, otherwise the moisture could damage the equipment.

Twin Birch Dairy is located in the watershed of two lakes used as public water supplies. Previous manure management on the farm, consisting of long-term storage in lagoons with capacity to hold 216,000 gallons, and seasonal spraying during warm-weather months, had been identified as an issue that needed to be addressed. The dairy is located

[2] The ice storm impacted a very large region, causing power outages for 229,000 customers in Maine, 40,000 customers in New Hampshire, and 36,000 customers in Vermont, and 2.5 million people in Canada - it strained response resources throughout the region.

next to a golf course, so odor and appearance are also issues. A team consisting of Twin Birch Dairy, AnAerobics, and the Cayuga County Soil and Water Conservation District, with financial assistance from the New York State Department of Environmental Conservation (NYSDEC), has constructed a manure management system including an anaerobic digester. The plug flow digester is currently in start-up mode and is expected to yield 40 million standard cubic feet (40 MM SCF) of biogas per year, with a heating value of approximately 600 Btu/SCF. The biogas is expected to contain 60 percent methane, 39 percent carbon dioxide, and impurities such as 0.5 percent hydrogen sulfide and moisture. Although the digester is currently yielding biogas with a lower methane content (and therefore lower Btu value) than expected, this will be rectified. At Twin Birch Dairy, newborn calves are medicated with antibiotics for a brief period of time. Residual antibiotics, expelled from the calves in their wastes and introduced into the digester, have been retarding the microbial action responsible for methane generation. Options under consideration include segregating the calve wastes (a minor fraction of the overall waste stream) for dedicated non-digester handling, pre-treating the calve wastes to de-activate the residual antibiotics prior to introduction into the digester, or changing/eliminating the medication.

Twin Birch Dairy has installed a series of Copeland Gas Booster/Compression units to boost the fuel supply to 60 psig, the required input to the microturbines. The microturbines have been installed; operation will be delayed until a vital safety requirement is addressed. The anaerobic digester, constructed of poured-in-place concrete floor and walls, and capped with pre-cast concrete spans, operates under slight elevated pressure due to the generation and evolution of the biogas. This pressure is sufficient to force the biogas through imperfections in the concrete seam seals, causing flammability concerns. Although the digester was initially leak-tested by flooding with water, the gas permeability issue was not detected. Since the digester has already been filled with manure, seam sealing from the inside of the vessel is no longer an option. External techniques for seam sealing are under review.

Heat from the CHP system will be used to warm the anaerobic digester. The system is expected to annually produce 940 MWh of electricity of which 648 MWh will be used on-site, and 293 MWh will be exported to the utility grid. The boosters will impose 12 kW of new electric load, and the digester will impose 19 kW of new load, resulting in a new peak electric demand for Twin Birch Dairy of 182 kW. Periodically, on-farm electric demand will exceed self-generation capabilities, and electricity will be consumed from the grid. This is forecasted to amount to 162 MWh per year. The CHP system is forecasted to achieve a net efficiency of approximately 65 percent. Surplus biogas will be produced beyond that which can be used in the four microturbines, and will be burned in a boiler when heat recovery has value, or otherwise flared (the project team anticipates flaring approximately 7,200 MM Btu of biogas per year based on current equipment). It is expected that the surplus biogas could be used to fuel two additional microturbines in the future, and would provide for greater export of electricity to the utility grid - this will be considered when the most economical export arrangements are resolved. Prolonged power failures at Twin Birch Dairy are unacceptable; milking must occur three times daily, and milk must be cooled for preservation to ensure a salable product.

Lessons learned from this project have been presented at a conference sponsored by NYSERDA in June 2002 in New York City.[3] Additional technology transfer will occur within 18 months following system startup and commissioning; Twin Birch Dairy will host an open house demonstration event to showcase the system.

Plastics Processing

Plastics processing, including injection molding, extrusion molding, and blow molding, create value-added shapes from plastic stock. Plastic stock, typically in the form of pellets, is fed into an extruder (a long metal tube housing a concentric auger). An electric-driven motor rotates the auger to transport the plastic through the tube, and electric-resistance heating elements installed along the length of the tube assist with melting of the plastic pellets - these features represent an energy-intensive aspect of plastics processing. Molten plastic emerging from the end of the tube is formed into a desired shape, and then rapidly cooled so the plastic will solidify. Plastics processing facilities characteristically display a temporal coincidence of thermal and electric demand that is well suited to CHP. In New York State, the Rubber and Miscellaneous Plastics Products Industry consisted of 690 facilities which collectively had 36,479 paid employees in 1997 and an annual payroll of over one billion dollars (US Census Bureau 2000).[4]

Plastics processing extruders require sophisticated operating schemes, typically directed by computer controls, in order to maintain proper temperature profiles along the length of the extruder tube. Reliable power supplies, and stable power quality, are critical for profitable operation of the business. Power failures at a plastics processing facility can damage an expensive extruder - if molten plastic cools and seizes-up inside the tube it could cause irreparable damage to expensive components. Power stability fluctuations can wreak havoc on computer controls and circuit components. In addition, even short power failures can result in significant production losses due to the need to clean and restart extruders and scrap any material being processed at the time of the outage.

Case Study: Paradise Plastics

Paradise Plastics, located in Brooklyn (Kings County) New York, manufactures plastic garbage bags from post-industrial plastic wastes. The facility operates 24 hours per day, five days per week, and 50 weeks per year. A sheet of low-density polyethylene (LDPE) plastic film exits the extruder as a continuous hollow tube - the tube is inflated with cool air to keep the sides from touching and sticking together until the plastic film solidifies. After it is cooled, the plastic tube is flattened, rolled, perforated, cut, and folded.

Electric load pockets are defined as locations where local electric demand on the utility grid occasionally exceeds local electric supply capabilities. The section of Brooklyn where Paradise Plastics is located is a load pocket where local electric demand *frequently* exceeds local electric supply capabilities. This manifests itself in the form of poor power quality and reliability for all electric customers in the area. Paradise Plastics has experienced

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[3] Copies of the PowerPoint presentations from the conference are available on CD by request at chpnys@nyserda.org.

[4] Standard Industry Classification (SIC) Code 30 represents the Rubber and Miscellaneous Plastics Products Industry.

frequent power interruptions and power quality voltage fluctuations, resulting in delays and loss of productivity. For stability reasons, Paradise Plastics has chosen to generate electricity to satisfy 100 percent of their needs (the facility is isolated from the electric grid). By self-generating electricity, Paradise Plastics reduces demand on the electric grid, thus improving power quality and reliability for its neighbors who remain grid-connected.

With NYSERDA support, a team consisting of Paradise Plastics and Energy Concepts, Inc., of Rochester, New York, has installed a CHP system consisting of one lean-burn natural gas fired internal combustion reciprocating engine generator as the prime mover, manufactured by Waukesha and rated at 1,000 kW; one diesel fuel fired internal combustion reciprocating engine generator as a back up, manufactured by Cummins and rated at 600 kW; and one heat-driven absorption chiller, manufactured by York and rated at 100 tons cooling capacity. By-product heat from the prime mover is directed to the York chiller - the chilled water thus produced is processed through a heat exchanger to create chilled air that is used to cool the plastic products. The absorption chiller operates continuously as part of the manufacturing process, and as such, year-round serves as a stable and constant reservoir to receive and beneficially-use approximately 50 percent of the by-product heat from the CHP. Additionally, a small amount of heat is used for DHW and comfort space heating of the occupied spaces. It is anticipated that 2,500 MWh per year will be self-generated, and that the CHP system will yield over $80,000 in net annual energy savings.

Lessons learned from this project will be presented to the Association of Post-Consumer Plastics Recyclers. Additional technology transfer will occur via open house demonstration event at Paradise Plastics to showcase the CHP system to various plastics industry groups, including manufacturers of plastics recycling equipment, plastics recycling associations, and publishers of plastics recycling journals. Furthermore, Paradise Plastics will establish a web-based database to store relevant process variables and monitoring data. Such a web-based system, to be maintained for a minimum period of five years, will be accessible to all plastics manufacturers located in New York State, and to NYSERDA.

Pulp and Paper Industry

Pulping is the process of converting wooden logs into small bundles of cellulose fibers. Pulp is a watery suspension of these small bundles of cellulose fibers. This “size reduction” activity is energy-intensive, requiring significant electrical energy to drive motors used in mechanical processes, and significant heat in the form of steam to operate chemical processes.

Papermaking involves uniformly distributing a thin layer of pulp onto a screen which allows the water to drain yet retains the fibrous particles in random overlapping and interlocking orientations to form a sheet. After some water drains, the moist sheet eventually becomes sturdy enough to be removed from the screen; it undergoes further drying by the application of heat in a drying stage. Paper and paperboard are similarly manufactured, with the distinction that in paperboard manufacturing the layer of pulp is thicker, and therefore the resultant dry sheet is thicker. Significant electrical energy is required to pump the pulp through conditioning stages that adjust the surface features of the fibers in order to increase their ability to overlap and interlock. The drying stage imparts a significant thermal demand.

Integrated mills perform both pulping and papermaking at a single site. The process of "converting" refers to value-added processing of paper materials, such as bonding various layers of paper products in the manufacture of corrugated cardboard.

Facilities in the pulp and paper industry characteristically display a temporal coincidence of thermal and electric demand that is well suited to CHP. In New York State, the Paper and Allied Products Industry consisted of 466 facilities in 1997, down from 541 facilities in 1992; in 1992, such facilities collectively had 33,847 paid employees and an annual payroll of almost one billion dollars (US Census Bureau 2000).[5] Most paper mills in New York State are older, smaller, and capital-constrained, when compared to "sister facilities" elsewhere in the United States, and often have a difficult time competing for workload assignments and/or improvement projects administered by their parent corporation. As a result, many New York paper mills have closed over the last decade.

Power stability fluctuations can wreak havoc on computer controls and circuit components that run a continuous process used in the pulp and paper industry. In addition, even short power failures can result in significant production losses due to the need to clean and restart the papermaking machinery and scrap any material being processed at the time of the outage.

Case Study: Southern Container Corporation

Southern Container Corporation, headquartered in Hauppauge (Suffolk County, Long Island) New York, is one of the nation's largest, independent full-service, privately owned manufacturers of corrugated paper materials. It was founded in 1946 as a small family-owned sheet plant in Jamaica, Queens (Queens County) New York, and currently operates eight strategically located converting facilities (six corrugating plants and two sheet plants) serving primarily the northeastern and southeastern markets of the United States. One such facility is their corrugating plant in Deer Park (Suffolk County, Long Island) New York.

The facility operates a corrugating machine that accounts for approximately one-third of the electric load and the entire steam load, with the exception of steam usage for comfort heating of occupied spaces. The corrugator operates 24 hours per day, and 5 days per week, except during periods of the year when production is slow.

A team consisting of Southern Container Corporation and KeySpan Business Solutions of Melville (Suffolk County, Long Island) New York, recently conducted a NYSERDA-sponsored feasibility study to determine if CHP is an economically and technically viable option for the Deer Park facility, and to address the possibility of duplicating the selected CHP system design at some of Southern Container's other manufacturing plants. The Deer Park facility operates 24 hours per day 5 days per week. The facility currently buys its electricity from the grid, and generates its own steam using its existing boilers. The site's existing boilers consist of two (2) 500 HP Cleaver Brooks firetube boilers (one in operation, one as standby, each approximately 10 years old) with an average usage of 9,000 pounds of steam per hour. These existing boilers are outfitted to run on natural gas and are presumed to have a fuel use efficiency of 82%.

As a result of the feasibility study, the CHP project was originally conceived as a grid-isolated (i.e., "islanded") design, to consist of one combustion gas turbine generator as the main prime mover (for use during weekday daytime production), manufactured by Solar

[5] Standard Industry Classification (SIC) Code 26 represents the Paper and Allied Products Industry.

Turbines Corporation (model Saturn 20-T1600) and rated at 1,200 kW; one natural gas fired internal combustion reciprocating engine generator as the alternate prime mover (for use during periods of low electricity demand - evenings and weekends), rated at 400 kW; and one diesel fuel fired internal combustion reciprocating engine generator as a back-up, rated at 600 kW.

After reconsideration, a grid-parallel system is now being pursued. Electricity will be self-generated in addition to being continuously imported from the grid. NYSERDA encourages grid-connected CHP projects because the equipment can serve as a valuable resource for the greater public benefit, and, on occasion, can help electric utilities delay/avoid transmission and distribution line upgrades by providing a lower cost option. The current grid-parallel design consists of one combustion gas turbine generator rated at approximately 800 kW as the prime mover for use continuously on weekdays in conjunction with continuous import of electricity from the utility grid (the utility grid will be used to satisfy the entire demand on weekends).[6]

The turbine will be fired on natural gas, when available. The facility will purchase natural gas under a lower-cost interruptible contract, and will fire the turbine on diesel fuel if necessary. The constant import of electricity from the grid will prevent backflow of power and will provide frequency stabilization for improved operation of the turbine. The turbine will utilize low NOx technologies (i.e., a back-end catalyst). High pressure, high temperature steam will be self-generated primarily using the turbine. Heat exhausted from the turbine will be routed to a new heat recovery steam boiler and result in beneficial use of approximately 90% of the by-product heat, and supplemented as needed on high demand by use of natural gas fired duct burners to be installed in the transition duct work between the turbine exhaust and the heat recovery steam boiler. The two existing boilers will remain for use during periods when steam is needed but the turbine is not operating. The CHP system will provide recovered heat for space and process heating. The CHP system is expected to have an overall annual fuel conversion efficiency of 65 percent, reduce annual electric consumption from the grid by over 3,250,000 kWh/year, and result in approximately $165,000 net annual energy savings.

Lessons learned from this project have been presented at a conference sponsored by NYSERDA in June 2002 in New York City.[7] Additional technology transfer will occur via postings to a website to promote the results of this project with real time access to system data along with trending information and narrative project results.[8] The website content will be updated monthly for a period of one year after start-up and quarterly for five years thereafter. Additionally, the project team will conduct a series of at least three on-site demonstrations of the CHP system in partnership with the Association of Facilities Engineers, the Association of Energy Engineers, and the New York Institute of Technology.

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[6] Selection of equipment has not been finalized. Leading candidates include a Solar Saturn T-1200, a Kawasaki S2A-01, and a Kawasaki S7A-01.

[7] Copies of the PowerPoint presentations from the conference are available on CD by request at chpnys@nyserda.org.

[8] See www.distributedgenerationonline.com

Conclusions

There are significant market opportunities for CHP in New York State. NYSERDA's CHP Demonstration Program encourages end-use customers/early adopters of emerging CHP technologies to pursue the cleanest and most efficient systems and configurations. Program objectives include reducing both financial and technical risks by providing "role model" design templates which: emphasize feasibility based on thermally sized design; expedite replicability; have validated documentation of project performance; and are amenable to technology transfer.

The extent of temporal coincidence of heat loads and electric loads determines the feasibility of a CHP installation. Review of historic energy consumption data for a site provides a basis for recommending an appropriately sized CHP system, and is an integral part of a site-specific CHP feasibility study. Often, as was the case with Southern Container Corporation, a CHP feasibility study is an important preliminary step toward implementing a CHP demonstration project.

Highly replicable CHP system design templates can result from projects at industrial sectors with numerous facilities (such as the plastics processing sector), and projects that service common processes within various industrial sectors (such as anaerobic digestion of wastes at dairy farms, food processors, pulp and paper mills, and municipal wastewater treatment plants). With assistance from the US Department of Energy, US Environmental Protection Agency's CHP Partnership Program, and US Combined Heat and Power Association, NYSERDA has selected projects for sponsorship that appear to be good candidates for such replication.

Each project sponsored by NYSERDA will produce a final report documenting the economics and operational performance of the commissioned CHP equipment, as well as other lessons learned (e.g., environmental permitting, interconnection with the electrical grid, financing mechanisms). Distribution of such reports, as well as technology transfer through open house showcase events, participation in conferences, publication of articles in journals, website postings, and other outreach mechanisms, will help end-use customers/early adopters of emerging CHP technologies make well-informed and timely decisions.

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