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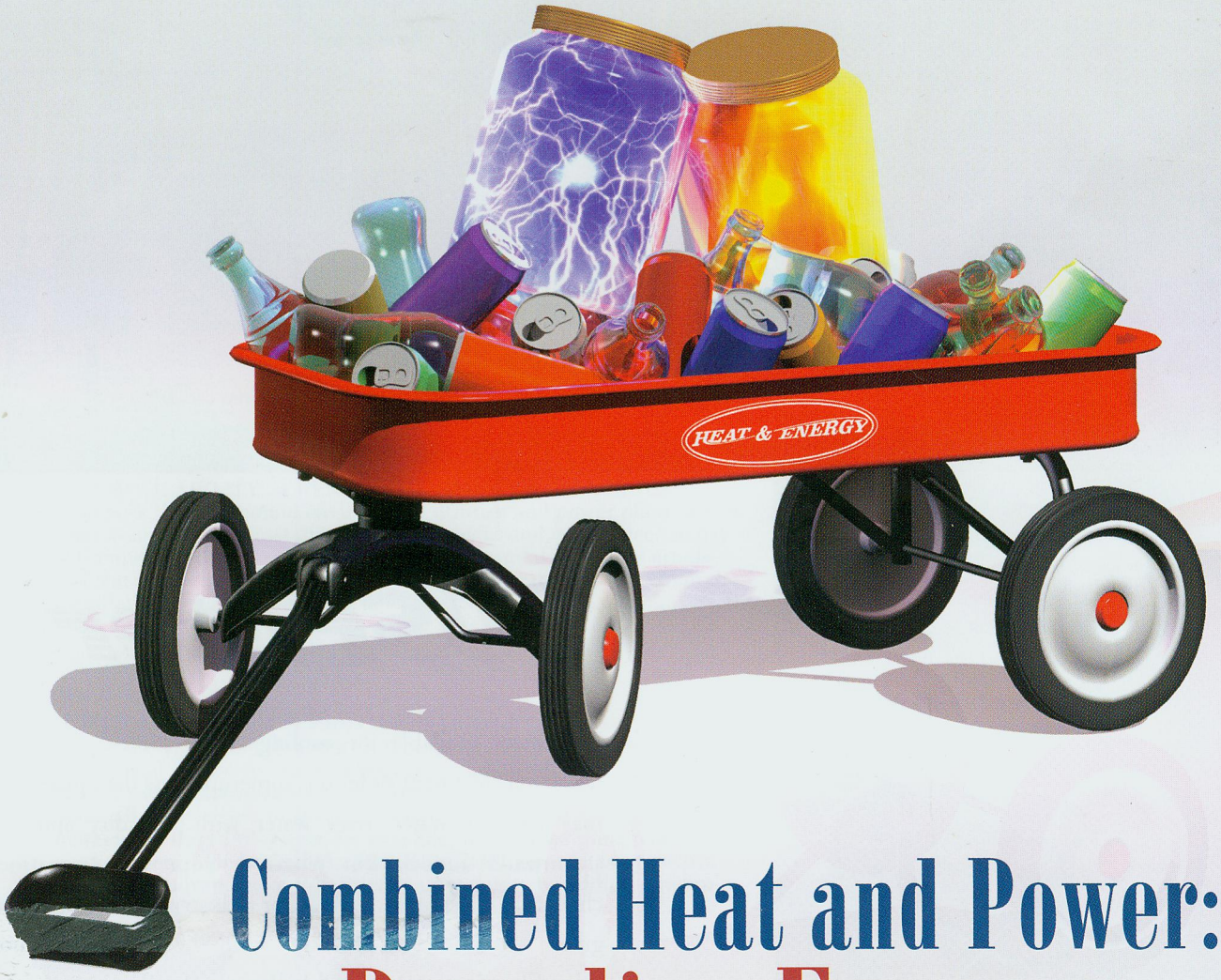

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Steve Blankinship,
Associate Editor

Chicago Museum Goes Green With Cogen System

"The system operates from 8:45 a.m. to 6:00 p.m. over Commonwealth Edison's peak times," says Bill Vanderbilt, the museum's facilities manager.

"In the winter months before we turn the air conditioning on, the system is carrying about 90 percent of the building's total electrical load. We had hoped to use some of the waste heat from the engine to supplement our domestic hot water, but we found that it actually supplies all of our domestic hot water needs when it is operating. When the air conditioning is on during the summer months, the main use of the waste heat output is to run a desiccant dehumidifier, but the conversion boiler puts out so much steam that we routed it into the existing boiler header to heat much of the building in so-called 'shoulder' months of the spring and fall. It pleases me how well it works."

Key organizations behind the project were the U.S. Department of Energy (DOE) and the Gas Technology Institute (GTI). In November, 2000, GTI was awarded a grant from DOE to test and demonstrate a hybrid building cooling, heating and power (BCHP) system that would utilize a natural gas powered generator set (250 - 300 kW) and a desiccant system. An initial site for the demonstration project was one of the new Chicago police stations, but an economic analysis determined the building had inadequate thermal loads and would have required too long of a payback period to be practical.

Cummins and GTI approached the museum to discuss the project. After completion of an economic analysis by GTI, the museum agreed to be the host site for the demonstration. Since the scope of the project increased from a 300 kW system to a 1.75 MW system, GTI secured additional funding from the Illinois Department of Commerce and Community Affairs, the City of Chicago's Department of Environment, and the Illinois Clean Energy Community Foundation. The museum also contributed significant funding to the project.

Ballard Engineering of Rockford, Ill. provided overall design and installation of the cogeneration system. Primera of Chicago provided the engineering for the installation and integration of the desiccant unit to the museum's HVAC system.

The system consists of a Cummins 1.75 MW lean-burn natural gas engine generator and associated controls, a Cain ESG1 heat recovery boiler producing 4,000 lb/hr of steam at 40 psi, and a Munters AM30N-S desiccant wheel dehumidifier that supplements the building's heating and air conditioning system. The steam heat also assists in space heating during the winter and helps supply domestic hot water in the building's restrooms and cafeteria's kitchen.

"The system operates from 8:45 a.m. to 6:00 p.m. over Commonwealth Edison's peak times," says Bill Vanderbilt, the museum's facilities manager. Instead of just supplementing the domestic hot water system, the waste heat from the cogen plant provides all the domestic hot water needs during that time, he says.

"In the winter months before we turn the air conditioning on, the system is carrying about 90 percent of the building's total electrical load. We also use the waste heat from the engine to heat domestic hot water between 9:00 a.m. and 6:00 p.m. When the air conditioning is on during the summer months, the main use of the waste heat output is to run a desiccant dehumidifier, but the conversion boiler puts out so much steam that we routed it into the existing boiler header to heat much of the building in the spring and fall. I am pleased with how well it works."

The heat recovery boiler uses the waste heat from the engine exhaust to flash water into steam at 40 psi. The Cummins lean-burn gas engine has a particularly high specific heat output compared to other gas engines of its size, which makes it ideal for a wide variety of medium size cogeneration applications, according to Tom Easterday, Director of Energy Solutions Americas for Cummins Power Generation. Additional low-quality heat from the engine may be obtained from the engine coolant jacket, but in this installation, a roof-mounted radiator is used to reject the coolant system's heat to the atmosphere.

Chicago's Museum of Science and Industry now has an example of both — a 1.75 MW cogen gen-set that is the basis for both a scientific exhibit and an energy frugal power system. Photo courtesy of Cummins Power Generation.

The 10,000 CFM Munters desiccant dehumidifier treats about 15 percent of the makeup air coming into an air handler serving a portion of the building. The dehumidifier's function is to remove moisture from intake air in the summer months so that low humidity air is passing over the air conditioning cooling coils. This reduces the load on the air conditioning compressor because dry air cools down more quickly. In the dehumidifier, a large enthalpy wheel coated with a desiccant material is alternately saturated with moisture in the air stream and then rotated into another chamber where it is dried using 480 pounds of steam per hour from the heat-recovery boiler. In the winter months, the enthalpy wheel can be used to preheat a similar portion of incoming air, thus saving on heating costs.

Annual savings for the cogeneration installation were initially projected by GTI to be about $200,000 based on natural gas priced at 50 cents per therm. While the cogen plant was being installed, natural gas prices increased significantly,

reducing potential savings. However, heat from the cogen plant for heating domestic hot water was a late revision to the design, and savings from water heating have added to the system's economic performance.

"When we installed the museum's food court last year, the domestic hot water system was converted to electric," says Vanderbilt. "Today, if we were to run the food court's hot water system on electricity alone it would cost us $32,000 a year for the energy. Realistically, we now save about half of that by fully utilizing heat energy from the cogen plant."

According to Mike Connolly, an instrumentation and control engineer with GTI, and the demonstration project's manager, the Cummins lean-burn engine-generator eventually installed at the museum was the first gas generator set to be tested in GTI's new Distributed Energy Test Center in Des Plaines, Ill. "Based on the original performance parameters for fuel consumption, exhaust emissions, horsepower and heat output, everything on the Cummins lean-burn generator set performed at or above specifications," says Connolly.

In order to be centrally located, the cogen plant was installed on the second floor of the building directly over two important meeting rooms — the Columbian Room conference room and the Founder's Room. "Everybody was expecting some noise and vibration, but with sound-proofing and special vibration damping mounts under the engine-generator, you can't hear or feel anything in the rooms below while the unit is running," says Vanderbilt.

If the cogeneration plant becomes an exhibit at the museum, the public will have a rare opportunity to learn about the energy-saving benefits of cogeneration, says Vanderbilt. "Everybody hears about small generating plants that get put in to reduce peak demand, but here they can actually see our cogeneration plant running and understand what it takes to make electricity and heat. Most likely, observation windows will be installed, and the public will be able to actually see things running. Plus, we're thinking about installing some real-time metering as part of the display so visitors can see how much energy is being produced and how much energy is being saved." PE

Alliant Energy Converting Waste to kW

Alliant Energy-Wisconsin Power and Light and the Sauk County Landfill have placed into service a project that captures methane gas produced by decomposing waste at the landfill and burns it to generate electricity with microturbines. Eight 30 kW Capstone microturbines generate enough electricity to power about 100 average homes. Within the next year, an additional four microturbines will be added, increasing the electrical capacity to 360 kW. Photo courtesy of Alliant Energy.