Utility-Ethanol Partnerships:

Emerging trend in district energy/CHP

www.districtenergy.org/weblink.htm

Ted Bronson, President, Power Equipment Associates; Kim Crossman, Team Leader, U.S. Environmental Protection Agency Combined Heat and Power Partnership; Bruce Hedman, Vice President, Energy Systems and Technology, Energy and Environmental Analysis Inc.

***Editor's Note:** : WebLink is an abstract of an article that appears in full on IDEA's Web site. After reading the abstract, visit www.districtenergy.org/weblink.htm for the complete article.*

Concerns about energy security and climate change are driving the federal government to focus on biofuels such as ethanol as a key solution for the nation's oil dependence. Much of the current biofuel industry growth is in dry mill ethanol production, which uses corn to produce ethanol. Energy is the second-largest cost of production for dry mill ethanol plants, surpassed only by the cost of the corn itself.

Driven by rising energy prices, the dry mill industry has increased its energy-efficiency profile in recent years. Analyses performed by the U.S. Environmental Protection Agency's Combined Heat and Power Partnership show that CHP can be an important energy-efficiency option for these facilities by reducing ethanol production's energy intensity.

Given the sector's new construction, the timing is right to integrate CHP into new and expanding dry mill ethanol facilities. However, low electricity prices in the Midwest and the need to expedite construction of new ethanol facilities have stifled widespread adoption of CHP in the industry. One approach to overcoming these barriers to CHP integration is the formation of utility-biorefinery partnerships.

Partnerships between electric utilities and new biofuel production facilities are a growing trend in the CHP market. They can take various forms, including joint ownership of generating and heat recovery assets and joint purchase of fuel. Successful partnership examples include utility and ethanol plant-owned CHP systems in Missouri and North Dakota.

Two main business approaches are apparent within these new co-location projects. Under one model, municipal utilities needing additional capacity are partnering with ethanol plants to sell steam to the facility while placing new generating assets on the customer site. In Laddonia, Mo., Missouri Ethanol and the Missouri Joint Municipal Electric Utility Commission are jointly building a new gas turbine-fired CHP system at Missouri Ethanol's 45 million-gal/year ethanol plant expected to start up in spring 2007.

The second model sees rural utilities attracting new ethanol and biodiesel facilities to co-locate in power parks as they try to enhance the efficiency of their existing coal-based generating assets while promoting economic development in their service areas. One example is Great River Energy (GRE) based in Elk River, Minn. The company has a generating capacity of 2,500 MW, comprised of both baseload and peaking power plants. GRE has two coal-fired CHP projects with ethanol thermal hosts under way in North Dakota. In both projects, CHP-produced electricity is delivered to the grid and sold to customers in Minnesota, while steam is sold to the ethanol facility.

By making CHP part of their business models, electric utilities are bringing CHP's efficiencies to their own operations, their customers, the thermal host site and the local rural economy – and planting seeds for a cleaner energy future.

For more on utility-ethanol partnerships and the authors, please read the full article at www.districtenergy.org/weblink.htm.

Ted Bronson, Power Equipment Associates, may be reached at TLBronsonPEA@aol.com. **Kim Crossman,** U.S. EPA Combined Heat and Power Partnership, is at crossman.kim@epa.gov. **Bruce Hedman, Ph.D.,** Energy and Environmental Analysis Inc., may be contacted at bhedman@icfi.com.

WebLink

Utility-Ethanol Partnerships: Emerging trend in district energy/CHP

***Ted Bronson*, President, Power Equipment Associates; *Kim Crossman*, Team Leader, U. S. Environmental Protection Agency Combined Heat and Power Partnership; *Bruce Hedman*, Vice President, Energy Systems and Technology, Energy and Environmental Analysis Inc.**

Second Quarter 2007, District Energy Magazine

***Editor's Note*:** *WebLink connects readers between District Energy magazine and IDEA's Web site. In each magazine, IDEA includes an abstract of an article that appears in full here online. To receive District Energy magazine, become an IDEA member or subscribe to the publication.*

Concerns about energy security and climate change are driving the federal government to focus on biofuels such as ethanol as a key solution for the nation's oil dependence. Much of the current biofuel industry growth is in dry mill ethanol production, which uses corn to produce ethanol. Energy is the second-largest cost of production for dry mill ethanol plants, surpassed only by the cost of the corn itself. (Read more about ethanol development.)

Copyright Maks Dezman

Driven by rising energy prices, the dry mill industry has increased its energy-efficiency profile in recent years. Analyses performed by the U.S.

Environmental Protection Agency's Combined Heat and Power Partnership show that CHP can be an important energy-efficiency option for these facilities. With CHP, ethanol plants can reduce the energy intensity of ethanol production by about 12 percent.

Given the new construction in this sector, the timing is right to integrate CHP into new and expanding dry mill ethanol facilities – and to ensure that CHP is part of the base design for the cellulosic biorefineries that will be constructed over the next 20 years. However, low electricity prices in the Midwest and the need to expedite construction of new ethanol facilities have stifled widespread adoption of CHP in the industry. One approach to overcoming these barriers to CHP integration is the formation of utility-biorefinery partnerships.

Partnerships between electric utilities and new biofuel production facilities are a growing trend in the CHP market. Partnerships can take various forms, including joint ownership of generating and heat recovery assets and joint purchase of fuel. Successful partnership examples include utility and ethanol plant-owned CHP systems in Missouri and North Dakota. Although these states have not been active markets for CHP due to their relatively low electricity rates, the growth of a rural biofuels industry with its substantial steam loads, combined with the pressure for utilities to produce cost-effective clean or renewable power, are driving these new CHP projects forward.

According to Tom Dorr, U.S. Department of Agriculture undersecretary for rural development, "Development of new, efficient rural energy sources not only has the potential of reducing our dependence on imported oil, the jobs created through the construction and operation of the renewable energy industry will spin off economic opportunities, sparking a rural renaissance in America. Through research, we are on the cusp of deploying systems that will greatly increase energy output from new technologies. We are also encouraging the construction of new infrastructure and promoting efficiencies through initiatives including co-location of ethanol production and electric generation facilities." (Read about federal resources promoting CHP and rural business development.)

Two main business approaches are apparent within these new co-location projects. Under one model, municipal utilities in need of additional capacity are partnering with ethanol plants to sell steam to the facility while placing new generating assets on the customer site. The second model sees rural utilities attracting new ethanol and biodiesel facilities to co-locate in power parks as they try to enhance the efficiency of their existing coal-based generating assets while promoting economic development in their service areas.

Model One: Municipal Utility Partnerships

Missouri Ethanol LLC in Laddonia, Mo., is a 45 million-gal/yr ethanol plant that began operation in September 2006. The plant uses approximately 5 MW of power and 100,000 lb/hr of steam. It is Missouri's fourth ethanol plant and one of two ethanol plants in the state that will employ gas turbine-based CHP through a utility-ethanol plant partnership. The CHP system at the Laddonia plant is now under construction, with startup expected in spring 2007. It will utilize a 14.4 MW Solar Titan gas turbine and an unfired heat recovery steam generator (HRSG).

The CHP system is jointly owned by Missouri Ethanol and the Missouri Joint Municipal Electric Utility Commission (MJMEUC) – a statewide joint action agency that supplies power and capacity services to 56 municipal

Missouri utilities. MJMEUC is expanding its portfolio of supply resources to include partial ownership of large coal generation and high-efficiency natural gas-fueled CHP.

The Missouri Ethanol project is patterned after an earlier successful CHP partnership between the City of Macon, Mo., and the Northeast Missouri Grain LLC ethanol plant in Macon. In both Macon and Laddonia, the utilities own and are responsible for gas turbine operation. However, the ethanol plants own and are responsible for the heat recovery equipment, including the HRSGs and downstream steam systems. Natural gas costs are shared between the utilities and ethanol plants in both cases; in Laddonia, MJMEUC and Missouri Ethanol share the costs at roughly a 50/50 split. This division is based on a number of factors including the avoided costs of steam for the ethanol plant.

The Missouri Public Utility Alliance (MPUA) is an umbrella organization representing three legal entities: the MJMEUC; the Missouri Association of Public Utilities, a trade association; and the Municipal Gas Commission of Missouri. MPUA views the Laddonia project as a 'win-win-win' effort, as it provides a cost-competitive power supply for MJMEUC, reduced steam costs for the ethanol plant and additional baseload gas demand for the Missouri Municipal Gas Commission. In addition to these benefits, the project directly supports a number of MPUA goals, including increasing the diversity of its supply portfolio, increasing local control of supply assets and promoting economic development for rural Missouri. The project also supports MPUA's commitment to the environment. MPUA is looking for opportunities to expand the model used in Laddonia and Macon to other new ethanol and biodiesel plants.

John Grotzinger, executive director of engineering and operations for MPUA, sees joint ventures like Laddonia and Macon as a way of getting "combined-cycle performance at simple- cycle prices," and as a way of adding efficient, competitive natural gas electricity generation to their system in capacity increments that match their load growth – 15 to 20 MW rather than the 500 MW of a typical combined-cycle investment.

Model Two: Rural Cooperative Partnerships

Great River Energy (GRE), based in Elk River, Minn., is the fastest-growing generation and transmission cooperative in North America. Its 2,500 MW generation system is comprised of both baseload and peaking power plants using coal, refuse-derived fuel, natural gas, oil and wind generation. GRE provides wholesale electric service to 28 distribution cooperatives that serve approximately 600,000 members. Much of GRE's power is produced in North Dakota and delivered to Minnesota.

GRE's goal is to reduce its carbon footprint to 2000 levels and improve generation efficiencies. Part of its strategy will involve capitalizing on CHP's superior efficiencies and carbon reduction benefits by installing 450 MW of CHP in the next few years. GRE has two coal-fired CHP projects with ethanol thermal hosts under way in North Dakota: One is an innovative new project with an ethanol facility and malting plant in Jamestown; the second is an expansion/modification of an existing facility in Underwood. In both projects, CHP-produced electricity is delivered to the grid and sold to GRE's customers in Minnesota, while steam is sold to the co-located ethanol facility.

"We think CHP is the wave of the future," notes Al Christianson, business developer for GRE. "Smaller, baseloaded plants at high efficiencies make sense to mitigate risk."

New Jamestown System

Located at the Spiritwood Industrial Park in Jamestown, the new CHP plant will be a 50 MW coal-fired system that will generate 800,000 lb/hr of steam at an expected overall efficiency of 83 percent to 87 percent. The system will use a circulating fluidized-bed boiler and a back-pressure steam turbine/generator to produce electricity and process steam. The project is being sited in conjunction with both a new 100 million-gallon-per-year ethanol plant, owned by The Newman Group, and a 30 percent expansion of the world's largest existing malting plant, owned by Cargill.

The CHP project is moving into the final detailed design and procurement phase. It has a projected startup date of 2010, due primarily to the long lead time needed to obtain the fluidized-bed boilers from Europe. The ethanol plant is scheduled to start operating using a natural gas backup boiler in 2008.

All three operations will profit from the co-location. The CHP plant will provide steam to both the ethanol plant and the malting plant. Each plant will share ownership of the CHP equipment that produces the steam. The steam generation will be run as a nonprofit operation, with true costs determining steam costs – resulting in the lowest-cost operation for all partners. In addition to the steam arrangement between the facilities, water from the malting operations will be used at the CHP and ethanol plants.

The effects of the partnership extend into the local rural community and the state, where the governor's office played an active role in bringing the project partners together. "The Spiritwood Industrial Park, a $350 million project, embodies our ongoing efforts to develop North Dakota's energy resources in tandem with other industries," says North Dakota Gov. John Hoeven. "Ethanol, lignite, value-added agricultural processing, farming and ranching – all of these industries are working together to create jobs and spur economic activity in other fields as well, like trucking, retail and services. The venture will benefit not only Jamestown, but the whole region."

Coal Creek Station Project

GRE's second utility-ethanol partnership is located at an existing power plant – the Coal Creek Station – in Underwood. The 1.16 GW plant has two dried-lignite-fired 605 MW units. Blue Flint Ethanol, a new 50 million-gallon-per-year ethanol production facility, has been built next to the power plant and uses its steam. Blue Flint, a joint venture between GRE (49 percent owner) and Headwaters Inc., began operating in February 2007. The ethanol facility will provide 37 jobs and $2 million in wages and benefits with an impact on the local economy of $160 million per year, according to the North Dakota Department of Commerce.

Blue Flint does not have a boiler to produce its process heat; instead, it solely uses steam piped from the power plant. The steam is valued on a cost-plus basis. To determine the quantity and cost of the steam to the ethanol plant, the power plant calculates the difference in the value of enthalpy between steam dispatched and condensate returned to determine the British thermal units and the cost of makeup water required. The steam price charged to Blue Flint is based on this cost plus a small profit markup, increasing the economic viability and competitiveness of the ethanol production facility by decreasing operating costs.

CHP plants are proven to be highly efficient, reducing the fuel use and the environmental impacts of power generation when compared with conventional separate heat and purchased power. By making CHP part of their business model, electric utilities are bringing these benefits to their own operations, their customers, the thermal host site and the local rural economy. These 'win-win-win' partnerships are emerging at a time when national and state public policy is calling for cleaner and more secure energy sources. By engaging in innovative CHP partnerships, these rural cooperatives and public power utilities are planting the seeds for a cleaner energy future.
(Read about how Oglethorpe Power analyzed biomass and CHP feasibility with the help of the U.S. EPA Combined Heat and Power Partnership.)

Ted Bronson *is president of Power Equipment Associates, a consulting firm dedicated to the advancement of clean energy technologies and markets. He has more than 25 years' power generation industry and project management experience. Bronson presently supports U. S. Department of Energy and Oak Ridge National Laboratory with as coordinator of the eight CHP Regional Application Centers and is a senior consultant to the U. S. Environmental Protection Agency CHP Partnership (CHPP). A member of the U. S. Combined Heat and Power Association's (USHPA's) Executive Committee, he currently chairs and manages the Midwest CHP Initiative. Bronson received USCHPA's CHP Champion Award in 2003. His email is TLBronsonPEA@aol.com.*

Kim Crossman *is the team leader for EPA's CHP Partnership. Her primary role within the Partnership is as lead strategist in decreasing the environmental impact of power production by facilitating the deployment of highly efficient CHP and other clean distributed generation projects. She has worked for more than 10 years in energy services including energy engineering and sales, construction project management and utility demand-side management programs. Prior to coming to EPA, Crossman worked as a CHP project developer for commercial, industrial and institutional facilities in California. She can be reached at crossman.kim@epa.gov.*

Bruce Hedman, Ph.D.*, is vice president of energy systems and technology at Energy and Environmental Analysis (EEA), an ICF International company located in Arlington, Va. He leads EEA services in distributed generation and CHP, including the firm's efforts to promote CHP within the ethanol industry. He has more than 25 years' experience in energy and environmental technologies and market development. Prior to joining EEA, he served as executive director of the Industrial Center Inc. and was director of industrial research programs at the Gas Research Institute. A past chairman of USCHPA, Dr. Hedman is an inductee into the American Gas Association's Commercial and Industrial Marketing Hall of Flame. He can be contacted at bhedman@icfi.com.*

More About Ethanol Development

Much of the current federal research and development on biofuels is focused on developing the next generation of biofuels, which will be produced from multiple cellulose feedstocks. These include woody biomass, energy crops and residuals including agricultural and other wastes. Although breakthroughs in cellulosic conversion to fuel are expected within the next five years, much of the current biofuel industry growth is in dry mill ethanol production, which uses corn to produce ethanol. In 2005, the industry's 90 operating dry mill plants produced almost 4 billion gallons of ethanol. Latest projections have the industry more than doubling production by 2010, outpacing the provisions in the Energy Policy Act of 2005, which mandated a market for 7.5 billion gallons of ethanol by 2012. The industry is poised to invest an estimated $6 billion in new plants and expansions by 2010 to build capacity to meet market demand.

The dry mill ethanol industry is comprised of dedicated ethanol facilities producing 20 million to 150 million gallons per year. The plants use significant amounts of steam for mash cooking, distillation and evaporation, and electricity for process motors, grain preparation and other plant loads. A typical 50 million-gallon-per-year dry mill plant will have steam loads of 100,000 to 150,000 lb/hr and power demands of 4 to 6 MW depending on its vintage and mix of operations.

Rising energy prices have driven the dry mill industry to become more energy-efficient. Average electricity use per gallon of ethanol produced is down almost 25 percent for current state-of-the-art plants compared to industry averages in 2000. Further efficiencies in the ethanol production process are being pursued, and the industry has expanded its fuel options as well: Where almost all dry mill plants were natural gas-based five years ago, a number of plants based on coal and biomass fuels are now under construction.

With their large, constant and coincident electric and thermal loads, dry mill ethanol plants are a strong technical fit for CHP to efficiently provide both steam and power for these facilities. With CHP, ethanol plants can reduce the energy intensity of ethanol production by about 12 percent, and these benefits can be obtained using a variety of fuels, from natural gas to coal to biomass.

Back to WebLink

Resources

- The U.S. Department of Agriculture Rural Development and Rural Utilities programs have loans, grants and bonds available to help rural businesses and power producers participate in the rapidly growing rural energy renaissance. Interested individuals can learn more about USDA's rural development programs at www.rurdev.usda.gov/rd/energy/.
- The U.S. Environmental Protection Agency Combined Heat and Power Partnership (CHPP) provides technical assistance to those considering implementation of CHP projects and has been encouraging the integration of CHP into ethanol plant designs within the dry mill ethanol industry. For more information, visit the CHPP's Web site at www.epa.gov/chp.

Back to WebLink

Oglethorpe Power Considers Biomass and CHP

Oglethorpe Power Corp. (OPC) is a nonprofit power supply cooperative serving 38 of Georgia's 42 customer-owned electric membership corporations (EMCs). These EMCs provide service to more than 3.7 million of the state's 8 million residents. OPC's members are the principal suppliers for rural Georgia's power needs. The corporation draws on a diverse portfolio of owned and leased power-supply resources including nuclear, coal, gas and hydroelectric facilities totaling 4,744 MW, in addition to long-term power supply contracts.

OPC is currently studying the use of renewable resources for power generation. The corporation is aware of the availability of ample local supplies of forestry residues and agricultural wastes and is considering the feasibility of using biomass fuel. In association with this conceptual review, OPC asked the U.S. Environmental Protection Agency Combined Heat and Power Partnership (CHPP) to analyze if integrating CHP into biomass power generation plants could make biomass power more economical.

The analysis was undertaken by the EPA CHPP for OPC as part of a preliminary, non-site-specific feasibility analysis. The CHPP considered three different conversion technology scenarios and determined the net cost to generate power for a 60 MW biomass power system (fig. 1). (The net cost to generate power consists of fuel costs, plus operations and maintenance costs, minus revenues from steam sales.) The CHPP then evaluated the impact of selling steam on the net cost to generate power. The analysis showed that steam sales can have a significant positive effect on reducing the net operating costs of generating power. With 200,000 lb/hr steam export capabilities at a 60 MW plant, power could be produced at less than 3.5 cents per kilowatt-hour.

Figure 1. Net Costs to Generate Power Using 60 MWe Fluidized-Bed Boiler/Steam Turbine CHP System.

Plant Input and Output Requirements	No Steam Export	100,000 lb/hr Export	200,000 lb/hr Export
Plant Profile			
Net Output, MWe	60	60	60
Total Steam Flow, Mlb/hr	500	540	585
Boiler Fuel, MMBtu/hr	853	921	998
Steam Sales, Mlb/hr	0	100	200
Fuel Price Assumptions			
Biomass Fuel Price* ($/MMBtu)	$2.76	$2.76	$2.76
Natural Gas Price ($/MMBtu)	$7.00	$7.00	$7.00
Steam Sales Price^ ($/Mlb)	$10.02	$10.02	$10.02
Net Operating Costs			
Biomass Fuel Costs* ($/kWh)	$0.0388	$0.0422	$0.0458
Nonfuel O&M ($/kWh)	$0.0205	$0.0211	$0.0216
Steam Credit^ ($/kWh)	$0.0000	($0.0166)	($0.0333)
Cost to Generate ($/kWh)	*$0 0593*	*$0.0466*	*$0.0341*

Source: U.S. EPA Combined Heat and Power Partnership, 2006.

Note: Power plant capacity factor was assumed to be 90 percent.

*****Biomass fuel prices reflect the delivered cost of wood residue in Georgia ($2.76/MMBtu), as estimated by Curtis et al. , 2003, "The Feasibility of Generating Electricity From Biomass Fuel Sources in Georgia," University of Georgia, Center for Agribusiness and Economic Development, College of Agricultural and Environmental Sciences, University of Georgia.

^Steam sales price is conservatively assumed as avoided natural gas price ($7.00/MMBtu firing an 80 percent efficient boiler) plus avoided boiler operations and maintenance costs (at $1.27/MMBtu).

Back to WebLink