

# Cogeneration 101: Key Points to Consider

On-site power generation can reduce electrical and steam costs, increase the reliability and availability of energy and protect the environment by saving energy and minimizing pollution. But how do you know when it's right for your project? Here are some key points to consider.

By Doug Post

Today, electricity largely contributes to an ethanol plant manager's financial burdens. However, small-scale cogeneration, or "combined heat and power (CHP) is often a cost-effective means of reducing a facility's utility bills and increasing the bottom line. Capturing and exploiting heat byproducts of on-site electrical generation can make cogeneration much more efficient and more reliable than using the power grid. Cogeneration offers tremendous economic and environmental benefits for the right ethanol facility. Ethanol plants can utilize on-site generation, and the resulting low-grade steam, to reduce electrical and steam

costs, to increase the reliability and availability of its supply of energy, and to protect the environment by saving energy and minimizing pollution. To determine whether or not cogeneration is the right decision for your plant, there are initial and secondary considerations to assess.

## Initial considerations

The major driving force behind deciding whether a plant can utilize cogeneration is comparing local power rates to the cost of natural gas. Natural gas, a clean source of fuel, is the most common resource of cogeneration applications. Gas utilities see cogeneration as beneficial; therefore, they often give discounted gas rates. Retail gas rates and electric rates vary from region to region. In most cases, if the electrical rate is 5 cents per kilowatt hour or higher, and the gas rate is less than \$3.50 per MMBtu, on-site generation should be considered.

The electric and thermal power profile of the facility is also critical to cogeneration economics. Cogeneration units should not be sized to meet the plant's peak electric load, but a fairly constant base load. By doing this, it would allow the plant to run at its most efficient rated load. When sizing a unit in this way, the amount of operation time increases, therefore maximizing the investment. As shown in Figure 1-1, systems or ethanol plants that operate at least 6000 hours per year and have constant heating and electrical loads can profit from the efficiency.

Figure 1-1

Parameter	Guideline
Purchased Electrical Cost	>\$0.05/kWh
Fuel Cost	<\$3.50/MMBtu
Operating Hours	>6000hours/year
Thermal Load Requirements	>8000 MBTu/hour
Electrical Load Requirements	>1MW

1-10, a gas turbine system should be considered while if from 3-20 a steam turbine should be considered. Ethanol plants with larger power and heat loads can generate proportionately greater savings and a shorter payback period.

While considering cogeneration potential, there are other key economic and technical topics to review. The rate structure between the ethanol plant and the utility provider should be analyzed. Because cogeneration units could supply more power than an ethanol plant can use, the option to sell back power to a utility could be available. For example, if a five megawatt cogeneration unit is installed, the ethanol plant may consume only 3 to 4 megawatts of that power. Depending upon the utility provider, the excess power could be sold back to the utility. Since the rate is based on the utility, it could be slightly below the electricity purchasing price paid by the plant. Various rate requirements should also be

expected from utility providers.

Along with rate requirements, a conservative review of likely costs for standby power must be assessed because there are times when the cogeneration unit will not be operating. Most utilities determine their standby charge using a formula that increases the charge as the unit outages increase. Interconnection regulations are also not standard throughout the country; therefore, it is necessary to keep in mind utility costs of standby power and metering.

Perhaps the most influential factor in system design is the thermal-to-electric load ratio. If the ratio is from

Integrating auxiliary systems such as feed-water treatment, steam distribution, and condensate systems of a cogeneration unit depends upon location and age of the systems. Thermal energy from the unit, usually in the form of steam, must be tied into the facility's piping. The ability to locate the cogeneration unit near the fermentation or other high steam use areas will keep capital costs down due to shorter piping and tie-in locations. Most cogeneration plants that sell power back to the utility are also centrally metered. If the facility is not currently centrally metered, costs to retrofit to a central meter can be expensive. A single meter will enable an ethanol facility to take best advantage of the facility's load profile to reduce demand charges from the utility.

## Secondary considerations

Secondary costs and benefits should also be kept in mind when considering cogeneration. Maintenance plays a considerable role in calculating the costs of a CHP system. Maintenance includes routine preventive measures such as lubrication and coolant maintenance, bearing maintenance and periodic overhauls. For most cogeneration units, maintenance costs average \$0.003 per kilowatt hour. Regular maintenance to the cogeneration unit creates downtime and will also determine the amount of standby charges the utility has for providing power during the maintenance

periods.

In regards to environmental concerns, overall emissions of carbon dioxide, oxides of nitrogen, and sulfur dioxide from grid-provided electrical production are reduced as more cogeneration systems are installed. Energy is lost due to traveling from a power plant through power lines over great distances. Power plants also lose heat as a result of burning fossil fuels. Because cogeneration units are more efficient than power plants (due to the fact that steam and electricity are generated simultaneously) the same amount of energy can be utilized with less input fuel and less output pollution.

**Conclusion**

After analyzing general cogeneration potential, costs, and benefits, experts in the technical and business aspects should be called upon to analyze gas types, possibilities of electric tariffs, maintenance, and operating costs. Variations in electric cost, gas cost, and maintenance cost should also be studied. Remembering to obtain proper quotes for equipment, engineering, construction and start-up will prevent project over-run. Implementing cogeneration will enable your plant to not only make power for today, but money for the future. EP

Doug Post is president of Interstates Engineering, a company that specializes in industrial power design and consulting for facilities in industries such as food & beverage and value-added agriculture. For more information, visit [www.interstates.com](http://www.interstates.com).

**Comparison Assumptions**

**Gogeneration Plant System Specs:**

- ▶ 5 megawatt unit / 4 megawatt average load
- ▶ 8,000 operation hours per year
- ▶ 75% boiler efficiency
- ▶ 80% cogen efficiency (30% electric, 50% heat)
- ▶ 30% electricity = 88 kilowatt hours per MMBtu fuel in
- ▶ 50% heat recovery = 500,000 Btu/MMBtu fuel in
- ▶ Natural gas = \$3.25/MMBtu
- ▶ Electricity = \$0.05 per kilowatt hour
- ▶ Maintenance = \$0.003 per kilowatt hour generated

**Conventional Power/Steam**

Current steam costs (\$3.25/ 75% boiler efficiency)	\$4.33/mmBtu
Steam usage/year (recovered by cogen)	181,818 mmBtu
Steam cost	\$787,879/year
Energy used per year (4000 kilowatt @ 8000 hours)	32,000,000 kWh
Current cost of Purchased electricity	\$0.05/ kWh
Electricity cost per year	\$1,600,000
<b>Total conventional cost</b>	<b>\$2,387,879</b>

**Cogeneration**

Total fuel cost 88 kilowatt hours / mmBtu	\$1,181,818
Total maintenance costs per year	\$96,000
Total cogeneration costs per year	\$1,277,818
mmBtu recovered	181,818 mmBtu
Steam costs	\$4.33/ mmBtu
Recovered steam savings	-\$787,878
<b>Total cogeneration costs (with steam recovery)</b>	<b>\$489,939</b>

**Pay Back**

Savings per year	\$1,897,939
Expected installed system cost	\$1,500 /generator kW
Unit size	5000 kW
Total system cost	\$7,500,000
Simple pay back	3.95 years

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