COGENERATION: ITS PLACE IN THE FUTURE OF ELECTRICITY IN LOUISIANA

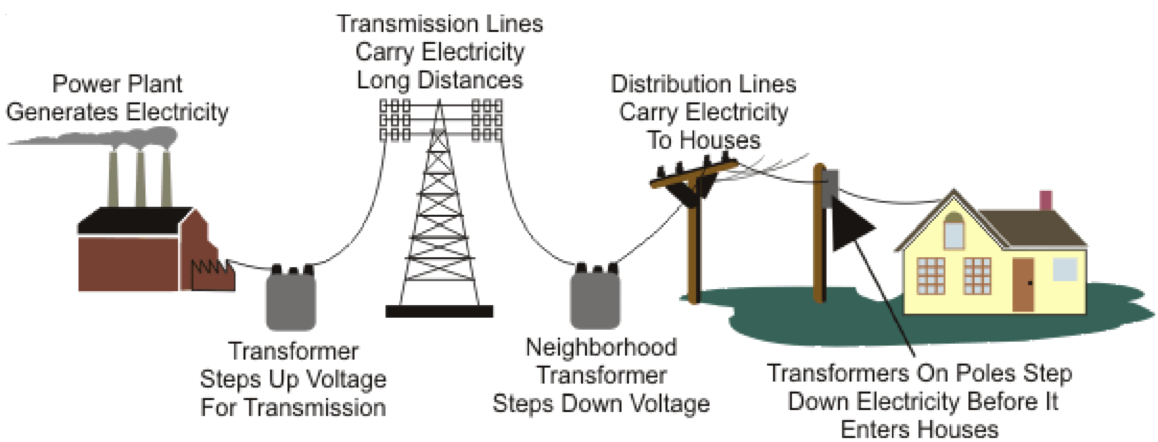
by
David McGee, Engineer
Patricia Nussbaum, Engineer

In the early days of electricity the generation and distribution were located close to each other. This is the concept called distributed generation, putting generators close to the loads they serve. As this new phenomenon of electricity grew into a business, transmission was born to take advantage of the economies of scale in the power generation industry. Electricity was generated in large, centrally located facilities and transmitted over miles of high voltage transmission lines to its final destination, the homes and businesses that consume it.

The U.S.-Canada Power System Outage Task Force had this to say about the electrical infrastructure:

> The North American electricity system is one of the great engineering achievements of the past 100 years. This electricity infrastructure represents more than $1 Trillion (U.S.) in asset value, more than 200,000 miles—or 320,000 kilometers (km) of transmission lines operating at 230,000 volts and greater, 950,000 megawatts of generating capability, and nearly 3,500 utility organizations serving well over 100 million customers and 283 million people.

Figure 1. Electric Power System Components



SOURCE: http://www.eia.doe.gov/basics/electricity_basics.html/28 March 2006

Today we use electricity in every facet of life, business as well as personal, and we expect reliable electricity. Power is essential to our way of life – reliability has become paramount in the delivery of electricity. When the power goes out every class of customer is affected. The American view of electricity reliability has been shaped by recent events. Since September 11, 2001, securing the electric power infrastructure against terrorism has become a focus. Then, on August 14, 2003, a massive outage occurred on a calm, warm day. Portions of the Midwest and Northeast United States and Ontario, Canada lost power. The blackout brought attention to the country's ageing transmission grid. Louisiana was forever changed on August 29, 2005 when Hurricane Katrina impacted many utilities and caused major damage to both the generating plants and the transmission infrastructure. When the power went out, basic services for health, communications, finance, cooling and water supply were no longer available. In addition, the flooding that accompanied the storm further worsened conditions by impeding access needed for recovery and restoration, and damaging equipment that was sitting in water. According to the situation reports from the Office of Electricity Delivery and Energy Reliability, U. S. Department of Energy (DOE), August 29, 2005 (10:00 PM EDT), Louisiana had 966,085 (42%) customers without power. The final gulf coast hurricanes situation report dated January 26, 2006 stated that power had not been restored to the Lake Catherine area, the Lower Ninth Ward and portions of Lakeview "due to severe destruction to delivery systems."

Figure 2. Classification of Electricity Consumers

The **residential sector** includes private households and apartment buildings where energy is consumed primarily for: • space heating, • water heating, • air conditioning, • lighting, • refrigeration, • cooking, and • clothes drying.	The **commercial sector** includes non-manufacturing business establishments such as: • hotels, • motels, • restaurants, • wholesale businesses, • retail stores, and • health, social, and educational institutions. Sometimes the commercial sector includes small manufacturing facilities as well.
The **industrial sector** includes: • manufacturing, • construction, • mining, • agriculture, • fishing, and • forestry establishments. An electric utility may classify commercial and industrial consumers based on either NAICS (North American Industry Classification System) codes or demand and/or usage falling within specified limits, set by the electric utility based on different rate schedules.	The **other sector** includes: • public street and highway lighting, • railroads and railways, • municipalities, • divisions or agencies of State and Federal Governments under special contracts or agreements, and other utility departments, as defined by the pertinent regulatory agency and/or electric utility

SOURCE: http://www.eia.doe.gov/cneaf/electricity/page/prim2/toc2.html/28 March 2006

Distributed generation is now being looked at as a hedge against power outages. Traditional users of distributed generation were operations which required absolute reliability of service. Today's dependency on electricity for our "way of life" broadens the scope of distributed generation.

Cogeneration, or combined heat and power (CHP), is a type of distributed generation that uses the waste heat produced by electricity generation for industrial processes or heating/cooling applications. Cogeneration, unlike some of the other distributed generation technologies, is not experimental. Cogeneration in the form of turbines, micro-turbines, reciprocating engines, and steam-turbine systems has operated successfully for decades. Combined heat and power is not the quick fix for high energy costs, but it can lower energy costs and increase electric reliability. One of the reasons for installing combined heat and power is independence from the grid; another is reliability. Some of the systems are connected to the utility's power grid and others are used only for internal use and are stand alone systems.

The ideal co-generation application uses the same ratio of electricity and heat all the time. Many plants only 'co-gen' enough electricity to produce the required heat for their process and buy the rest. Quite often they can not start the plant with their own power, but they provide a very stable base load for the utility as they generate most of the varying load for the process.

Other plants require much more heat than electricity. If the local laws permit, they can generate extra power and sell it into the grid. This provides the lowest heat value electricity available – sometimes below 4,000 British thermal units (Btu)/kilowatt hour (kWh) (1 kWh = 3,412 Btu). They must be prepared to do something else with the extra heat if the grid does not need the power. This adds capital cost to their operation.

Some utilities invite industry to locate near their generation station so they can sell heat to them. Generally, this is mutually beneficial, but the utility has to consider that the plant may close temporarily or permanently. If it is a merchant power plant then it is obligated to supply heat at times it may not be able to sell the power. This has given rise to the concept of 'power parks' – industrial parks that solicit industries on the basis of keeping their heat and electricity in balance and not being dependent on a utility. Generally speaking, all the businesses will have lower energy costs than if they were out on their own supplying their own steam and buying electricity. Specialization and economies of scale can be had in smaller packages than ever before from a few dozen kilowatts up.

In Louisiana, cogeneration has been largely confined to industrial users who needed process heat. Any time fuel is converted to electricity, extra heat will be left for disposal. The new reality created by the recent hurricane season opens the door for more applications of cogeneration at the agricultural, industrial and commercial customer levels. CHP systems may just be the mechanism to allow continued safe operations when the utility is out of service at hospitals, nursing homes, multifamily housing, and food storage or preparation businesses. All projects have to be justified technically and financially, but in some applications reliability, which was an elusive quality in the past, may have become a quantifiable service.

Hospitals are excellent candidates for CHP systems because they have high electrical and thermal energy needs that generally follow each other and have significant energy demands 24 hours per day/7 days per week/365 days per year. More than 200 hospitals and healthcare facilities nationwide are using CHP to lower energy costs by up to 50% and decrease power outages and interruptions by up to 95%.

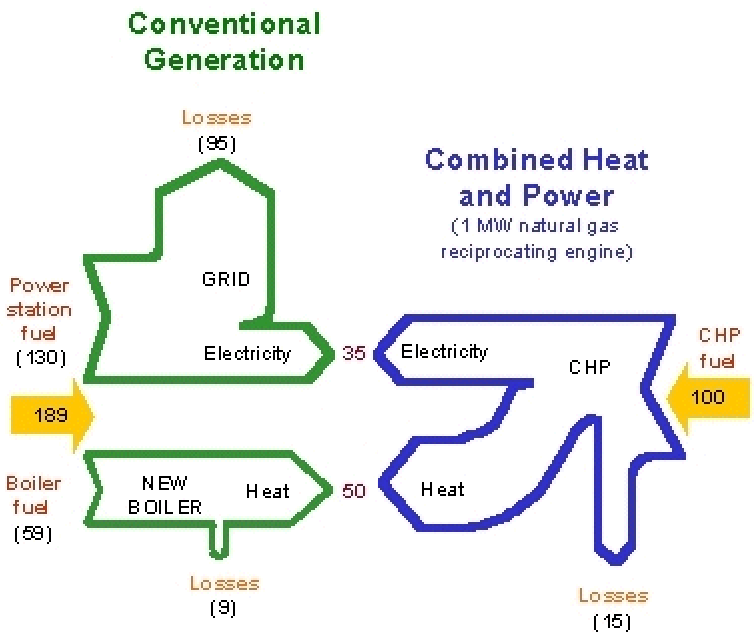
CHP can provide clean power and improved comfort for buildings from a single reliable source of both power and heat. Systems can provide winter space heating and utilize proven absorption chiller technology for summer cooling, while reducing overall electrical consumption and reducing NOx (nitrogen oxide (air quality)) emissions. The overall efficiency of CHP can easily be related to the reduction of total energy use and can be correlated to reduced operating costs for the building owner. Using energy more efficiently always has a positive effect on the air and water. Figure 3 compares the typical fuel input needed to produce 35 units of electricity and 50 units of heat using conventional separate heat and power. Centralized generation of electricity is, approximately, 30% thermally efficient. Typical installed boilers are about 80% to 85% efficient. CHP technologies range from 70% to 90% efficient, depending on the technology and degree of heat energy utilization.

The agricultural sector has significant CHP opportunities through waste management and opportunity fuels. Crop wastes, or "energy crops," can be co-fired in existing generators. Animal and agricultural wastes can be converted to biogas through the process of anaerobic digestion. The biogas can then be used in conventional engines or micro-turbines to produce electricity and heat for the farm. The following agricultural sites could make excellent hosts for CHP installations: diary farms and feedlots; pulp mills, paper mills, sawmills, timber harvest operations; rice, cotton and sugar cane processing operations.

The U.S. DOE has established and funded regional centers to encourage adoption of Combined Heat and Power. Louisiana is affiliated with the **Gulf Coast CHP Application Center** (http://www.gulfcoastchp.org) located in Houston. Over 214 CHP installations are operating in Texas, Louisiana, and Oklahoma, providing over 23 GW (gigawatts) of electrical capacity. The center's purpose is to help companies evaluate whether CHP would enhance their operations.

Figure 3. Comparison of Conventional Generation and Combined Heat and Power

Figure 3. and Power



SOURCE: http://uschpa.admgt.com/CHPbasics.htm /28 March 2006

<u>Selected Bibliography</u>:

Richard Munson, *From Edison to Enron* (Westport, Connecticut: Praeger 2005)

U.S.-Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations," April 2004.

Ed Ritchie, "The Energy Policy Act: It's All About the Incentives," *Distributed Energy,* September/October 2005.

Lynn Merrill, "Big-Time Blackout Banishment," *Distributed Energy*, July/August 2004.

Siobhan Bennett, "A Barometer Reading on Distributed Energy," *Distributed Energy*, July/August 2004.

National Council on Electricity Policy, "Electricity Transmission A Primer," June 2004.

David Engle, "Is Cogen Right for You," *Distributed Energy*, July/August 2004.

Anne Carlson and Bruce Hedman, Energy and Environmental Analysis, Inc., "Assessing the Benefits of On-Site Combined Heat and Power during the August 14, 2003 Blackout," June 2004.