

Enhancing Grid Reliability and Access to Electricity in the Aftermath of Hurricanes

Introduction

Recent hurricanes affecting Texas and the greater Gulf Coast states have shown repeatedly the devastation caused by these storms. The most dramatic impacts are the physical damage caused by wind damage and storm surge close to the point of landfall. While physical damage can be acute, the bulk of the economic impact from hurricanes arises from the long-term loss of electricity. Again and again, we have seen that hurricanes will destroy the electrical grid throughout the affected area with the impacts felt for days, weeks, and even months following landfall. Hurricane Ike knocked out power for over 2.5 million businesses and households in the greater Houston region and caused “catastrophic damage” to the grid in the Entergy Texas service territory. Restoration of electrical service across affected Texas communities is expected to take a month or more.

While common wisdom holds that electricity is essential for the conveniences of modern life, anyone who’s lived through a hurricane and its aftermath will tell you that loss of electricity is more than an inconvenience -- access to electricity is vital for our physical and economic survival. Due to the ongoing march of technology, we are now utterly dependent on electricity for cell phone and email communications, healthcare, water, traffic lights, air conditioning, lighting, refrigeration, food preparation, and to engage in general commerce to secure needed goods and services.

While loss of electricity impedes the physical recovery of the community, it also grinds economic activity to a halt. Individuals and businesses are unable to deliver products and services or to manufacture goods. Government closes courts and offices providing vital information and permits necessary for commerce. Organizations relocate employees outside of the affected areas to allow continued services, as do individuals seeking services. A full accounting of hurricane damages includes both the physical damage and the lost economic activity encountered from long-term loss of electrical service.

Recent Hurricanes Highlight Systemic Weaknesses

The hurricanes affecting the Gulf Coast in recent years have all impacted the electrical grid in a consistent and predictable manner. The observed impacts highlight systemic weaknesses in how we generate and distribute electricity today. The devastation to the electrical grid that occurs each and every time we encounter a hurricane demonstrates that the current paradigm is fundamentally broken. We can have a robust and resilient electricity system. However, spending even more money to rebuild

the network back again and again is not a solution. If we are to change the outcome to obtain better results, we must introduce new methods and new technologies to the electricity sector.

In Texas today, electricity generation is provided predominantly by large (> 500 MW), remotely-located power plants – the so called “central station utility model.” The model relies on long transmission lines and an extensive network of distribution wires to connect these remote power plants to load centers requiring electricity. The model allows for economies-of-scale in construction, fuel procurement, and operations and maintenance, and has resulted in low electricity prices historically. However, the central station model has two problems relative to hurricanes. First, it concentrates electricity production at a small number of sites where large power plants are located. Damage to one of these large power plants can impact millions of customers. Second, and most important, the model relies on an above ground transmission and distribution infrastructure to deliver electricity. Thus, the overall reliability of the electrical system rests on the ability of wires on wood poles to survive the hurricane intact.

In the aftermath of recent hurricanes along the Gulf Coast from Florida to Texas, including our recent experiences with Hurricanes Katrina, Rita, Gustav, and now Ike, we can draw the following conclusions:

- Electricity supplies can be lost for weeks or months – extensive damage to the transmission and distribution system has impacted millions of people across large areas
- Those with electricity in the immediate aftermath were capable of self-generating electricity – on-site diesel generators are widely available to a broad cross-section of the population and provided the only electricity until utility power is restored
- Many diesel-fueled back-up generators failed within hours or days – many generators were unfit for continuous, long-term duty and failed quickly, while others simply ran out of fuel
- Natural gas supplies were generally available in affected areas – the underground network of pipelines survived intact and remained pressurized for service

Electricity supplies are vital for life, public safety, and to begin the recovery process. The worst impacts of the hurricane can be avoided if some electricity can be restored quickly. Even if the availability of electricity is limited to specific facilities in each community, the availability of power allows critical services to be offered, provides a base for first responders, and connects the community to the outside world. This is especially true for small towns that can become isolated in the aftermath of a major storm.

We Must Do a Better Job Maintaining Electricity Service

Living with a weak and vulnerable electricity supply is not a requirement. Technologies and engineering solutions are available that can increase the resiliency of the electricity supply. More reliable service will help avoid the human tragedy, property damage, and economic losses caused by hurricanes. We must do a better job maintaining electricity service during and after hurricanes.

Building a robust and resilient electricity sector requires us to use more smarts in how we build our electricity supply infrastructure. Certainly we should wind “harden” our transmission and distribution infrastructure with stronger, metal towers and use underground solutions in neighborhoods and developments. However, to create a resilient energy system, we need to integrate a broad array of distributed generating technologies into the existing system. Distributed energy technologies include a variety of technologies like reciprocating engines, natural gas turbines, fuel cells, solar panels, and energy storage technologies that are located at industrial and commercial sites, including critical facilities like hospitals, schools, airports, prisons, shopping malls, and hotels.

Because distributed generating equipment does not rely on the utility’s vulnerable transmission and distribution system, these technologies can keep facilities wholly operational and functional during the critical days and weeks following landfall. Properly engineered and integrated into the network, these facilities can be combined onto “micro-grids” that can provide power to the larger community external to the host facility.

Combined Heat and Power

Combined heat and power (CHP) technologies represent one distributed generation approach that is readily available and cost effective today. CHP is cost effective because the naturally occurring thermal energy produced as electricity is generated is captured and used productively for heating and cooling needs. By using the thermal energy available from the power generating process, CHP plants can have overall energy efficiency between 60-90%, which is at least double the efficiency attained using the central station model. As a result, CHP systems provide impressive environmental benefits and enhance the wise utilization of our energy resources. Because CHP systems are located at the point of energy use, they do not require additional transmission and distribution infrastructure to support broad implementation. Due to the ability to “island” the CHP system during grid outages, CHP systems improve the security of energy supplies of their site hosts. For many adopters, CHP will reduce their overall energy costs. A number of CHP equipment suppliers operate in Texas today, providing thousands of jobs in the process.

CHP can be used any place that heating or cooling is needed. The systems can be very large to serve a petrochemical complex, or small to match the heat load of a building, hospital, university campus, or school. In most cases, CHP uses conventional power generating equipment, but that equipment is sized consistent with the scale of the host facility’s energy needs. The primary goal of CHP is to meet the energy needs of a specific host building or facility, rather than to provide electricity to the wholesale market.

Texas has a long and successful history of CHP implementation, but more can be done. Between 1980 and 2005, more than 16,000 MW of CHP electrical generating capacity has been built in Texas fueled by Texas natural gas. The vast majority of CHP in Texas, which represents roughly 20% of the total generating capacity in the entire state, is operating at industrial sites along the Gulf Coast. Because

these host facilities have large thermal energy needs, these CHP plants are also extremely large. Even with that great success story, CHP still represents a substantial opportunity to bring clean, cost-effective generating resources online in the state, especially at critical infrastructure facilities needed during hurricanes. An estimated 20 GW of additional potential is believed to exist in Texas at:

- Industrial plant sites
- Commercial buildings
- Institutional facilities and campuses
- Agricultural operations

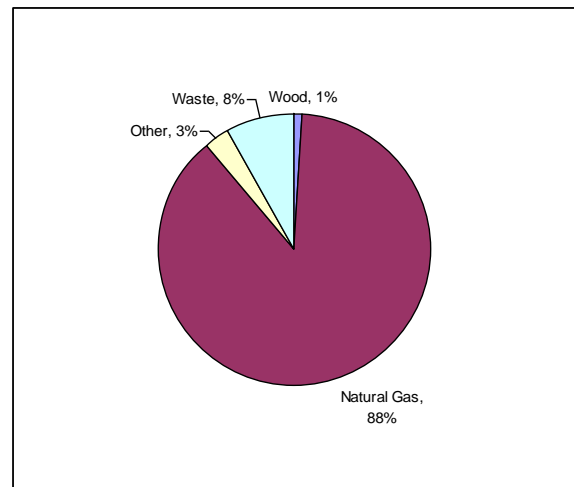
While many of the larger opportunities for CHP have been developed, a tremendous opportunity exists for small to medium sized CHP facilities. Project opportunities also include the recovery of wasted heat at industrial plants. The commercial and institutional facility market is virtually untapped for CHP projects. An estimated 9 GW of new CHP could be developed at Texas universities and schools, food processing plants, hotels, office buildings, data centers, refrigerated warehouses, and wastewater treatment facilities. A number of recent and developing projects in the commercial sector illustrate the types of projects possible in the state. These projects include:

- Thermal Energy Cooperative at the Texas Medical Center– Houston, Texas
- BP Rodeo and Helios Plaza – Houston, Texas
- Methodist Hospital – Houston, Texas
- The Domain – Austin, Texas
- Dell Children’s Hospital – Austin, Texas

CHP Fuels

About 90% of all CHP systems in Texas are fueled with natural gas. The breakdown of existing CHP systems by fuel type is shown in the figure. As prices for all forms of energy are expected to continue rising, the high energy efficiency of CHP systems increases the economic value of natural gas. CHP stimulates demand for natural gas, which benefits the Texas natural gas industry and the state.

A small fraction of CHP in Texas is powered by renewable fuels such as wood wastes and landfill gas, although the potential exists for much more.



Renewable fuels can be converted in biogas through the use of anaerobic digesters or gasification, or simply combusted to generate high pressure steam. Untapped sources of biomass fuel include urban wood waste, land clearing wastes, agriculture wastes, forestry wastes, and wastes from lumber mills and paper mills. A recent study by HARC concluded that up to 1.0 GW of CHP could be fueled with Texas agricultural wastes alone.

Benefits of CHP

Substantial amounts of electrical capacity can be implemented all across Texas and the Gulf Coast region to lessen the vulnerability of the electricity supply. This capacity can be developed cost-effectively today. CHP will stimulate demand for Texas natural gas and create high paying jobs throughout the state to manufacturer the technologies and to operate the systems. CHP technologies are twice as efficient as central station power plants operated by electric utilities and produce energy with a fraction of the pollution. By using clean burning natural gas, CHP produces no mercury and uses almost no water. The technologies can be dispatched at will, so they can provide firm capacity during summer peak conditions. Highly efficient and highly reliable CHP can help fill a vital need in the state for a molre resilient electricity supply strategy.

The following three benefits represent important reasons for adopting CHP.

ENHANCED POWER RELIABILITY

CHP systems provide an on-site power source capable of keeping critical facilities operating during grid outages. Whether power outages are brought by an event such as a hurricane, tornado, or ice storm, or from a systemic or grid operating condition resulting in a black out, CHP plants can be “islanded” from the grid and continue running. Because they rely on secure natural gas supplies, CHP systems have been documented to continue operations during natural disasters like Hurricanes Katrina and Rita. CHP plants offer an excellent solution to ensure power continuity to the state’s critical infrastructure including hospitals, schools, airports, military bases, and other critical government offices. In addition, CHP plants can improve the power quality during grid imbalances, when minor events can cause major consequences to emissions controls, lost production, and loss of life. CHP plants help ensure that computers and other sensitive equipment are not affected by momentary voltage sags, surges, and harmonics.

ECONOMIC BENEFITS

CHP dramatically reduces fuel consumption, which can result in an energy cost savings for Texas businesses working to compete in global markets. Added electricity reliability can create a competitive advantage for Texas manufacturers. In addition, CHP plants can provide operational flexibility to the host facility. By providing several options to meet energy supply needs, adopters can better manage energy costs under changing conditions and prices.

The development of CHP can also provide economic benefits to communities across the state. Installation of CHP systems creates high paying jobs for Texans who design, construct, manufacture, and operate them. Because of the CHP potential in Texas and our leadership in the energy industry, our businesses are already leaders in the supply of equipment and services for CHP systems. There are numerous facilities in Texas that supply and service turbo machinery, engines, and heat recovery systems. In addition, Texas has a large number of consultants, engineers, and developers with experience in CHP. CHP also benefits the natural gas industry because it provides a way for natural gas to be competitive as a base load power resource.

ENVIRONMENTAL BENEFITS

CHP conserves fuel and represents an important energy conservation technique. CHP has been documented to reduce toxic air emissions, water consumption, and greenhouse gas emissions. The United States DOE and EPA compared the environmental benefits from a mix of small to medium sized natural gas CHP applications (anticipated to be typical of many commercial and small industrial applications) to the average emission produced from Texas power plants and concluded the following:

- Mercury emissions are reduced by 100%
- Sulfur oxides are reduced by 100%
- Water use is reduced by 90%
- NOx emissions are reduced by 84%
- Carbon dioxide emissions are reduced by 51%

Combined Heat & Power Technologies

The existing CHP plants in Texas use conventional natural gas combustion turbines for over 90% of the capacity, with the balance of the plants using steam turbines and reciprocating engines. CHP technologies expected for new projects, including small projects in the commercial and institutional sector, would also utilize conventional power equipment, albeit sized consistent with the needs of building and facilities that they would serve. "Packaged" CHP systems are becoming more readily available to serve many applications with shorter design and construction times at lower costs. Most technologies are readily available in the marketplace at competitive prices. In many cases, equipment manufacturers have well established operations and offer maintenance programs. The primary CHP technologies include natural gas combustion turbines, steam turbines, natural gas reciprocating engines, and fuel cells. Heat recovery units, absorption chillers, and thermal energy storage systems are also common components in CHP plants.

Implementation Barriers

Distributed generation technologies such as CHP have seen excellent adoption rates in the industrial sector, but the uptake has been uneven and the pace of adoption has slowed recently. In addition, Texas industrial facility managers have not aggressively pursued small to medium sized CHP projects, nor have many commercial and institutional facility managers implemented projects. The reasons for the untapped potential is that significant barriers exist that inhibit the development of many CHP projects. The following barriers illustrate important barriers to CHP, but are not the only obstacles.

Electric Utilities Have a Historic Bias Against Distributed Generation

Decades of rate of return regulation in the electric utility industry institutionalized a bias toward large capital projects capable of generating large returns on investments. Small projects including many CHP projects, especially those not requiring significant capacity on the transmission and distribution infrastructure, were less attractive to utility decision makers, due to their lower capital costs and higher incremental development costs. Non-utility CHP developers were seen as competition within the utility's monopoly service territory, which led some utilities to adopt punitive "standby" or "cogen killer" rates. While deregulation of ERCOT has helped, some transmission and distribution service providers (TDSP) oppose CHP because their revenues are adversely impacted by projects that decrease their energy deliveries. Outside of ERCOT, traditional regulated utilities having a monopoly in their service territories remain staunchly opposed to CHP.

Energy Production is Not the Core Business of Facility Owners & Operators

The development of small projects at individual facilities is hindered by a lack of knowledge of the benefits of CHP projects. Facility managers and owners often do not have the capital, the skill set, or the risk profile to invest in CHP projects. Management often requires a financial return unsuited for a long term capital asset like the power equipment used in CHP projects. The requirement to enter into long-term contracts of up to 20 years to secure third party financing can be a barrier for companies wishing to outsource project development.

Building Developers Are Incentivized for Lowest Cost

Building developers are often not the long term owners of the buildings they construct, nor are they often tenants. As a result, they are rarely interested in the operating cost benefit or energy security enhancement that can arise from CHP. Competition in the building market is based upon cost per square foot metrics, which tend to penalize developers that add non-standard value enhancing features like CHP. While the LEED system is having a positive impact, a general lack of awareness and understanding of the benefits of on-site CHP systems by building owners and tenants results in a failure to set high standards for energy performance sufficiently early in the building design process.

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