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APPLICATIONS BULLETIN

PRACTICAL APPLICATION INFORMATION FOR THE MCQUAY SALES FORCE

We hear about deregulation everywhere we go both for our homes and for our work places. This article is written to provide you with the basics, expose you to the problems and direct you to the opportunities it provides.

More than anything else, energy will be the main issue for McQuay and its sales force for the next 10 years. Almost a third of all energy used in North America is used in buildings. Not only is Deregulation important, we also have the Kyoto Protocol and Climate Change, ASHRAE Standard 90.1-1999 and the upcoming Guideline 19.

Like the CFC issues of the 1980s, energy issues provide our industry with an opportunity to meet the changing needs of our customers as they try to deal with it. The informed sale office REP will be a great asset to their customers.

Prior to joining McQuay, I worked for a consulting firm that specialized in energy issues including deregulation. While I will be involved in all aspects of the Applications Group, I will be focusing my efforts on all issues pertaining to energy. Feel free to contact me.

Regards,
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B.E.Sc., B.A. Economics

Electricity Deregulation 101

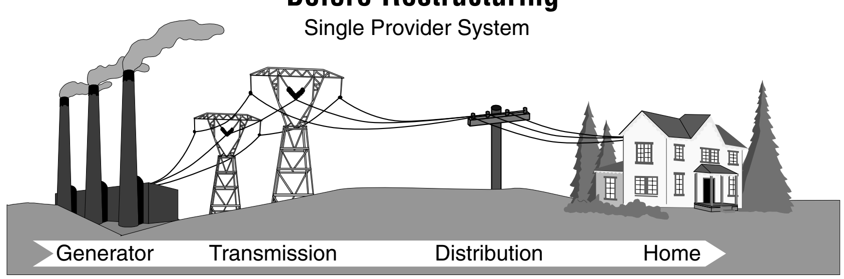
The electrical generation industry is being deregulated. Like the airline and telephone industry deregulation the ultimate goal is fair competition and fair pricing for all consumers. Like the airline and telephone industry we cannot be sure **how** things will change, but we can be sure things **will** change.

Deregulation – What does it mean?
Deregulation in the electricity market means that there will be increased competition between companies that generate electricity. What will not change? The flow of electricity will remain the same. Electricity will continue to flow from a generator through the transmission lines, to the local utility and then to the consumer.

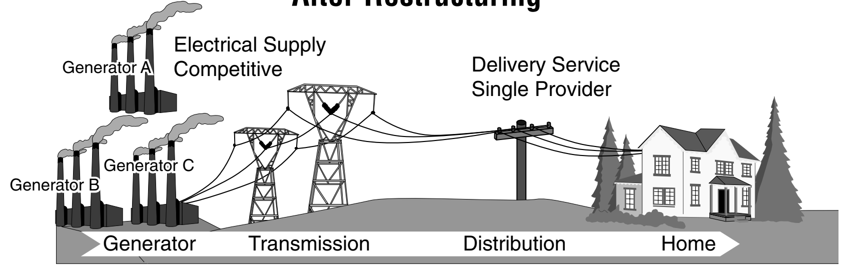
What will change?
Those that prefer to do so, may buy their electricity from any electric generation company (or supplier). Some consumers will also buy electricity from an energy broker who will buy electricity from an assortment of generators on their behalf. When choosing an electricity supplier there will be choices as to the source the electricity is derived

Before Restructuring

Single Provider System



After Restructuring



McQuay® Air Conditioning

from. Some customers can buy electricity that is produced by hydro electric or perhaps by wind and solar. Other suppliers may offer different pricing for electricity generated from coal, gas and nuclear sources. It may also be possible to buy electricity from a generator in Maine and have it delivered to a customer in California. Those that do not want to change suppliers will automatically remain with the default supplier (usually the local utility). The default supplier is also referred to as a *standard* offer. In this scenario the local utility will buy electricity from a generator (if they themselves do not own one) and sell it to the consumer.

How does this affect electricity billing?
Currently local utilities combine generation, transmission and distribution charges into one rate. This will change with deregulation. Deregulation means that these charges involved from generation to delivery to service and miscellaneous charges will appear as individual items on the electricity billing statement. This is called *unbundling.* However only the generation portion of the electricity bill is deregulated, transmission, distribution will continue to be regulated and miscellaneous charges such as stranded costs will vary from state to state. Depending on the location, two electricity bills may be produced, one by the generator for the commodity cost, and one by the local utility to cover delivery service. In some states, the local utility will combine these two bills.

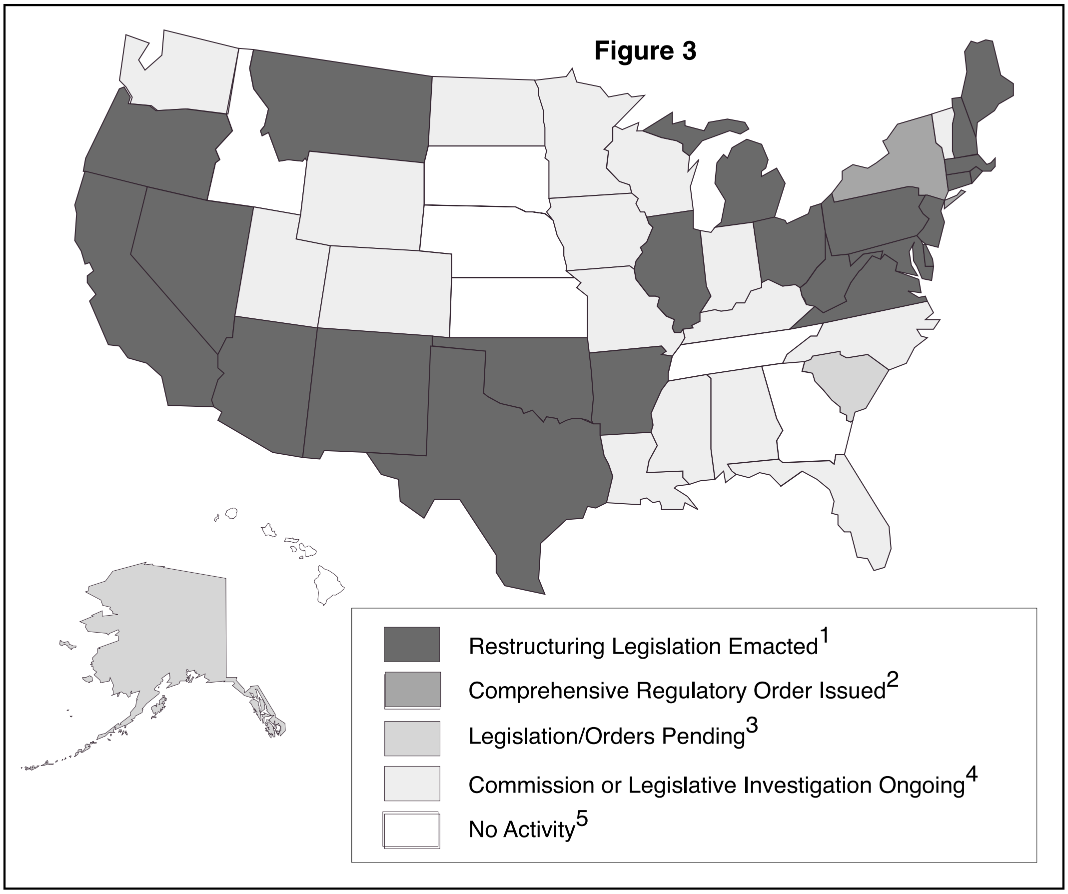


Figure 3

How will price be determined?
The old way to pay for electricity was one charge for on peak and another charge for off peak. There were two periods/prices during the day in which electricity was charged. The amount of electricity consumed during each period was charged according to the price during that period. That will no longer be the case with deregulation.

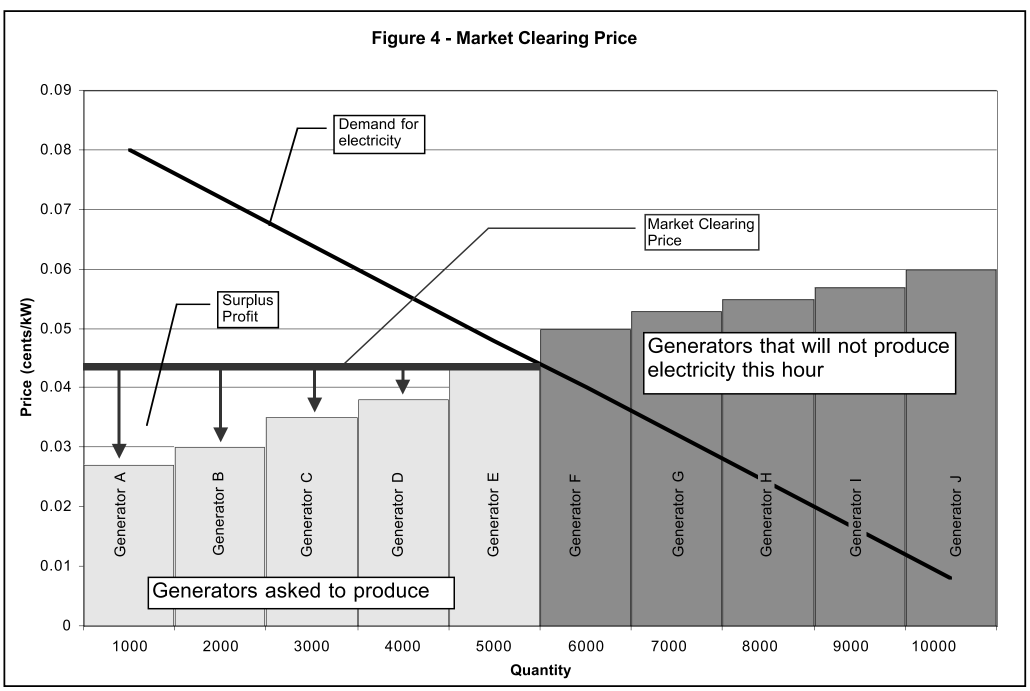


Figure 4 - Market Clearing Price

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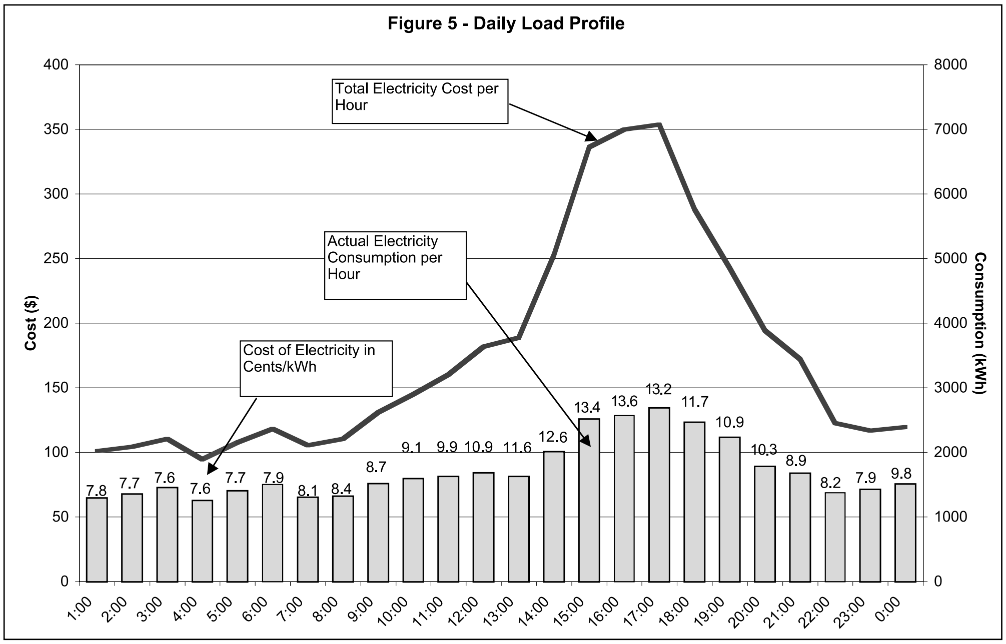

Figure 5 - Daily Load Profile

The price of electricity will change every hour of every day with deregulation based on the market value of electricity for that hour. This means that there will be a total of 8760 different prices of electricity annually. On peak pricing will still be referred to since the hours during the day are more likely to be higher in price while off peak pricing will refer to the night time when pricing is likely to be lower. The hourly price for electricity will be determined by the *market clearing price.* Every hour the independent system operator (ISO) will ask each generator to determine their generation price. The ISO will then determine the demand and ask utilities to produce power at the price where generation supply meets the market demand for electricity. This price is called the market clearing price. The generators above the market clearing price will not be asked to produce power. The highest price at that level will be the market clearing price and will be the price for all generators.

For example the hourly load of a hospital in California consumes from 1250 kW at 4 AM to 2684 kW at 5 PM in one day. When the hourly pricing is combined with the hourly load, the load and cost profile would look like figure 5. Costs indicated are consumption costs only. Demand costs are not integrated since demand is charged on a monthly rate not hourly.

What About Rebate Programs?

Since the local utility will be passing through the costs of generation to their consumers, they no longer have an interest in reducing electricity consumption for their customers. Reduced consumption means less revenue for the utility and the generator! This means that current utility rebates may cease to exist for those consumers who reduce consumption. New rebate mechanisms may be put in place, or reduced consumption will result in reduced or avoided electricity costs.

What about reliability?

When electricity supply cannot meet demand, the ISO begins to turn off service for those customers who are on an interruptible rate. The ISO also asks all other consumers to reduce energy consumption in order to meet demand. Price can become very large as those customers who really need electricity will be willing to pay an even higher amount in order to stay on, while others are willing to accept energy reduction by switching over to another system. For example, our hospital in California might be on an interruptible rate that allows them to switch over to another source of electricity, such as cogeneration, during peak hours.

What is Peak Shaving?

Peak shaving is a demand management method where an energy management system regulates the use of certain devices

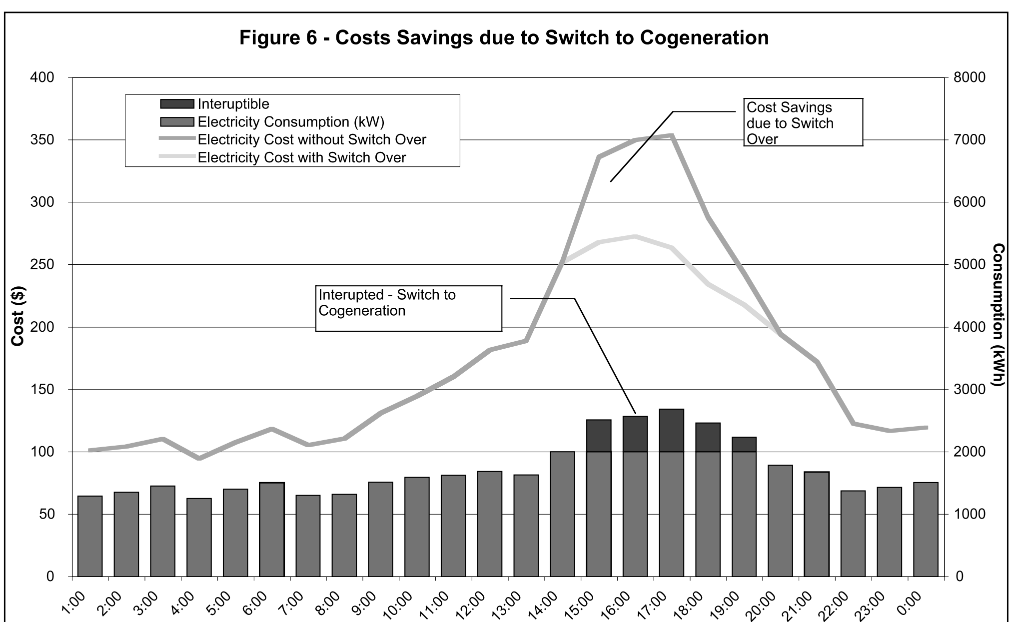

Figure 6 - Costs Savings due to Switch to Cogeneration

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so that peak demands are not set too high. Cogeneration can be used to help shave off the peaks.

What is Cogeneration?

Cogeneration is the ability to simultaneously produce ones own electricity and use the byproduct (usually heat) to drive other energy using systems. For example cogeneration can use natural gas with a gas turbine to produce electricity. The excess heat from the turbine process can be used to produce high or low pressure steam. This steam combined with a single or double effect absorption unit, can produce cooling for air conditioning needs instead of electricity. For example, our hospital in California could shave off its peak demand requirements with a cogeneration plant. The hospital has a maximum annual peak of about 2700 kW. A cogeneration plant could be designed to shave 25% off the peak load, by sizing the cogeneration plant at 675 kW. There is also the possibility of producing power and selling it back to the grid through the ISO, although this is not usually economically feasible. The hospital would not be as susceptible to the price spikes that occur during the day with a cogeneration plant installed. Cogeneration could be used by the hospital to even out their demand profile to avoid ratchets by the utility as well.

What is a Ratchet?

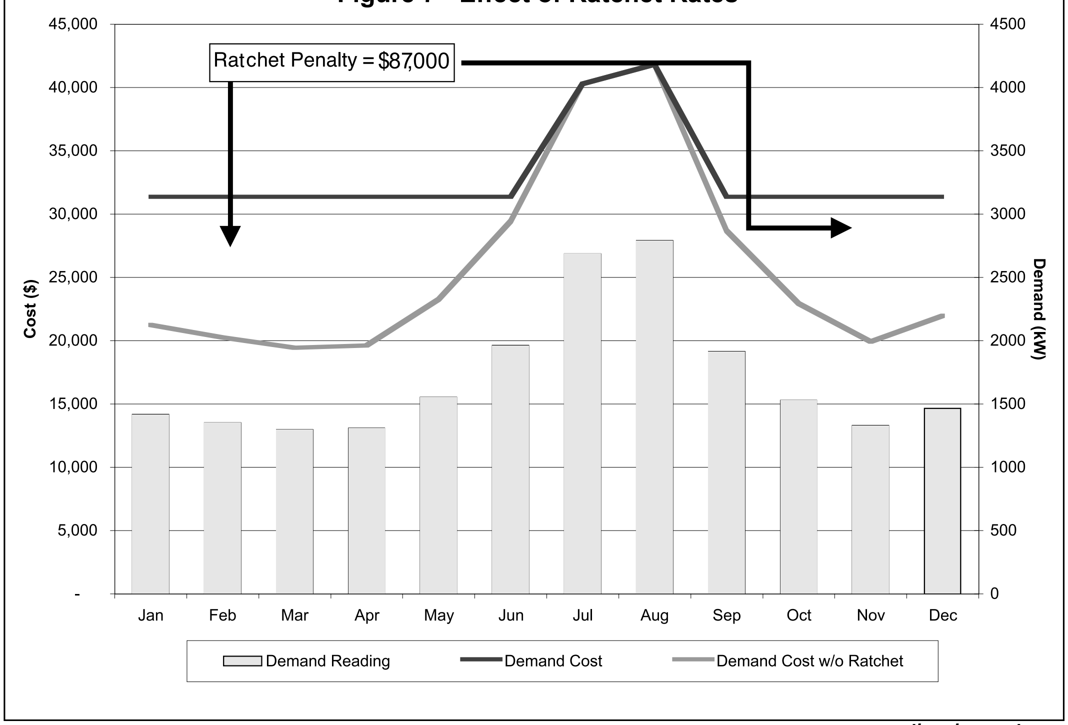
There are two different types of charges on an electricity bill that will also be present on a deregulated bill. There are charges for consumption and demand. Consumption is the amount of electricity used during the billing period while demand charges are based on the peak amount of electricity used during any given one hour period. By turning on a light bulb (0.1 kW) for 10 hours, one kWh of energy will be consumed and the peak (demand) will be 0.1 kW. By turning on two light bulbs for five hours one kWh will still be consumed but the demand reading (or peak) will increase to 0.2 kW. Assuming a demand price of $5 and a consumption rate of 7 cents per kWh, the difference in price is about 90% higher with the greater demand. Demand charges can be as little as $5/kW or as much as $50/kW, depending on the location and utility.

Since the utility wants a load as flat or level as possible they set penalties for those consumers who have irregularities in their load profile. One type of rate that encourages flat profile behavior is called a ratchet. A ratchet is a set minimum demand amount that will be charged. The ratchet amount is usually set at 75% of the maximum demand in any given 12 month period. For example if the hospital sets its annual peak at 2,788 kW, then the minimum billable demand is (0.75 x 2788 kW) or 2,091 kW. If the real peak demand falls below the billable demand in any given billing period, the consumer will automatically be charged demand at 2,091 kW even though the actual reading may only be 1,500 kW. The ratchet resulted in an $87,000 extra annual billing for the hospital. The amount of the penalty varies depending on the rates. It may be cost effective to lower these peak amounts to reduce the ratchet penalty. This is why it is so important to know and understand load profiles.

How does this apply to HVAC Systems?

HVAC systems are a major energy user. Because HVAC systems are often weather dependent, the HVAC load profiles match those of the utility profile. Price curves follow the utility profile, meaning an increase in demand results in an increase in price of electricity. This makes improving the HVAC profile very important. Any opportunities seized in

Figure 7 - Effect of Ratchet Rates



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this area will positively affect the annual electricity budget for any commercial or industrial operation.

Seize Those Opportunities!

Cogeneration

Cogeneration is the ability to simultaneously produce ones own electricity and use the byproduct (usually heat) to drive other energy using systems. Natural gas is used to fuel a gas turbine. The off gases contain a large amount of heat which can generate high and low pressure steam. Low pressure steam (15 psi) can be used for heating and for process loads such as laundry, domestic hot water and autoclaves. Single effect absorption chillers can also use low pressure steam to produce chilled water. Double effect absorption chillers are almost twice as efficient as single effect with COP's as high as 1.2. By using a cogeneration plant with a double effect absorption chiller during peak loads, the total building demand can be reduced by first generating some of the electricity on site and then shifting cooling from electrically operated chillers to absorption chillers. This further reduces the amount of electricity purchased from the utility and flattens the annual demand curves. Ratchet penalties can be avoided with flat load profiles.

Hybrid Chiller Plants

Hybrid chiller plants are another solution to lowering peak demand charges. Hybrid chiller plants use a combination of electrically driven and gas driven chillers to reduce the peak demand of the load profile. A combination of electric centrifugal and absorption chillers are most common. A double effect absorption chiller can operate directly on natural gas or high pressure steam from the boiler plant. Steam driven absorption chillers can provide a base load for boiler plants that need to operate in the summer such as hospitals. Locations with access to a steam utility can use the steam for absorption and negotiate good rates during the summer.

Steam turbine and gas engine driven chillers are also available however they have very high maintenance costs. Electricity is still required for a hybrid plant and thus they should be sized accordingly if a 25% reduction in demand is required to prevent ratcheting.

Chilled Water and Ice Storage

Another method to reduce electricity cost is load shifting by using chilled water or ice storage. Ice or chilled water could be produced during the off peak hours when electricity prices are likely to be lower and then used during the day to produce cooling. By using ice storage, on peak demand is lowered, and the off peak demand is raised slightly, producing a more uniform load profile. This will help the consumer negotiate a better rate for electricity and will prevent ratcheting. The issue is space for the tanks and the first cost of the equipment.

Demand Limiting

Peak shaving can also be accomplished by using a Building Automation System (BAS) for demand limiting. Demand limitations can be set by the controls preventing the demand from setting a ratchet too high. McQuay's Protocol Selectablity™ allows a BAS to easily communicate with the chiller and reduce power consumption. For instance the chiller can be asked to run at 80% until the proper demand conditions permit the chiller to resume to full capacity. With dual compressor chillers, one compressor can be commanded off and the other compressor will provide 60% capacity with 50% of the chiller's rated power input.

Enthalpy Wheels

Outdoor air requirements add significantly to the building cooling load; this can be offset with enthalpy wheels. Enthalpy wheels transfer sensible and latent heat between exhaust and outdoor air. This results in drier, cooler supply air. Typically enthalpy wheels can supply outdoor air to the building at 80°F dry bulb and 67°F wet bulb without the use of any mechanical cooling. Using an enthalpy wheel in the hospital example resulted in an $55,000 annual savings from ratchet rates. In addition, there will be more savings in reduced mechanical cooling and gas heating. Enthalpy wheels also work well in heating environments. McQuay Vision™ units can be supplied with enthalpy wheels and shortly, McQuay Applied Rooftop Units will also offer enthalpy wheels.

Generator Sets

Peak shaving can also be accomplished by using on site generator sets (gensets). Many locations require an emergency genset such as health care facilities and internet hotels. By running a chiller off the genset during peak loads, the peak demand can be minimized.

The traditional problem with chillers is the high inrush current required for the compressor. This requires an oversized genset to be in place to overcome this problem. Variable Frequency Drives (VFDs) can lower inrush current to almost the rated load current. This would enable the genset to be sized according to the size of the compressor. Better yet, a VFD dual chiller could reduce the size of the genset even more. A McQuay VFD dual chiller has 2 compressors, 2 motors, 2 VFDs. With one of the compressors operating, the chiller can produce 60% of its load. For example a hospital with two 500 ton chillers can produce 800 tons

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of cooling with 275 kW of electricity or 0.344 kW/ton.

How is that possible?

With one of the chillers running off the electric utility and the other chiller running off a 140 kW genset. A 500 ton VFD single compressor chiller at 0.55 kW/ton requires a 275 kW genset to operate the chiller. With a VFD dual chiller, that genset can be resized to 140 kW in order to run one of the compressors. With one of the compressors operating, 300 tons of cooling is available through that chiller without using any outside produced electricity. This in combination with Demand Limiting is quite useful to avoid ratchets and price spikes in electricity during the day. Annual savings from the VFD dual chiller were $40,000 for our hospital example.

In summary the electrical costs for all building equipment, especially HVAC, will come under increased scrutiny as electricity is deregulated. Understanding your HVAC equipment options as well as how and when your equipment uses electricity will become even more important in the future.

Glossary

Ancillary services: Services provided by a utility in conjunction with transmission service that ensures generation services are delivered in a safe and effective manner.

Avoided cost: Costs that an electric utility avoids by purchasing power from an independent producer rather than building a new generation facility itself. Under PUHCA and subsequent statutes and regulations, federal officials required monopolistic utilities to purchase power from qualifying independent generators for no more than the avoided cost it would cost them.

Baseload capacity: The minimum amount of electric generating capacity required for the steady, around-the-clock provision of power.

Bundling: The combination of generation, transmission, and distribution services into a packaged whole that is sold at a single rate to customers. (Also see “Unbundling.”)

Cherry Picking: A generation utility would come into a distribution territory and approach all the large industrial accounts with low bids for electricity. The industrial consumers would accept these offers and stop buying power from their home utility. With the loss of all its large industrial consumers, the cost per kiloWatt-hour to the home utility increases and so their rates go up and making them less competitive.

Cogeneration: The simultaneous production of electricity and thermal energy. Cogenerators are considered qualifying facilities under the PURPA and thereby are able to sell their power at avoided cost to investor-owned utilities.

Demand side management (DSM): Entails efforts of utilities to encourage conservation of electricity usage, including demand and consumption patterns. Many of these demand/load management measures have been required, or strongly encouraged, by regulators.

Distribution facilities: Equipment used to deliver electric power at lower voltages from the transmission system to the final user. Although considered a distinct segment of the market, distribution facilities generally can be grouped with transmission facilities because these assets perform a similar function that is wholly distinct from generating facilities.

Divestiture: The process of requiring monopolistic utilities to spin off one segment of their business; this is done to ensure that uncompetitive advantages created by former government actions are removed so that competition can develop. Divestiture, or vertical disaggregation, serves as a viable alternative to open access to de-monopolize the industry.

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Energy brokers: Companies that act as middlemen in an electronic marketplace in which electric power is priced, purchased, and traded. Energy brokerage works like other commodities that are traded in major markets, such as commodity futures markets.

ESP: Electric Service Provider Customers can choose to purchase electricity directly from an Electric Service Provider (ESP). ESP's may produce power themselves or purchase power from the PX or directly from generators. The local utility will continue to transmit and distribute the electricity sold by ESPs to the electric grid on behalf of their customers.

Generation facilities: The equipment and assets used to convert various forms of energy input into electrical power. Generating facilities are wholly distinct from transmission and distribution facilities and are considered highly competitive in their own right.

Grid: Industry jargon referring to the interconnected power lines that constitute the transmission/distribution networks of the United States.

IPP: An independent power producer; a generating company that produces electric power but does not operate as an integrated utility because it has no transmission or distribution facilities. IPPs proliferated rapidly after the passage of the PURPA because the statute required monopolistic utilities to purchase IPP-producer power. IPPs are also commonly referred to as non-utility generators (NUGs).

IOU: Investor-owned utilities are shareholder-owned, publicly traded corporations that are taxed like other private businesses but regulated strictly by both state and federal officials. IOUs were granted regional monopolies via express government actions that simultaneously protected their service territory from competition while guaranteeing their profits and ensuring them against any market or financial risk. IOUs are collectively represented by the Edison Electric Institute.

Load: The aggregate amount of power demanded by electricity consumers at any given time and then placed on the grid by generating companies to fulfill that demand.

Off Peak: Time during which utility rates tend to be lower. Different for every utility but usually from 11 PM to 7 AM on weekdays plus weekends and holidays.

On Peak: Time during which utility rates tend to be higher. Different for every utility but usually from 7 AM to 11 PM Monday through Friday.

Open access: A deregulatory model that requires monopolistic utilities to allow rivals access to the transmission and distribution facilities they possess on non-discriminatory terms at cost-based rates. Many legislators and regulators view open access as the preferred method of de-monopolizing the industry and ensuring greater competition in the electric market.

Power pools/PoolCo: Centralized, independent organizations that would be responsible for purchasing all wholesale electric power in a given service region and then reselling power to final customers. Power pools would act as a short-term spot market where buyers and sellers could conduct electricity transactions. Many regulators argue PoolCo solutions represent the optimal method of coordinating operations and improving system reliability in the future. PoolCo critics argue the system would interfere with many existing and future contractual obligations and require too much on-going, centralized regulatory oversight.

Power marketer: Any middleman firm that buys and resells power but does not own its own generating or transmission facilities. Power marketers must file with the FERC to conduct business because they resell power across state boundaries.

Regulatory compact: Theory advocated by most regulators and electric utility companies that argues that in exchange for the construction and operation of a monopolistic, regional electrical system, utilities would have their profitability and overall financial viability guaranteed. The theory will be referred to often in the upcoming deregulatory debates; utilities will argue that because they have been guaranteed traditionally a fair return on any investment they made, assets or facilities that become uneconomic or "stranded" due to the rise of competition should be compensated for by competitors or captive ratepayers.

Retail wheeling: Non-utility generating companies that do not own transmission facilities sell the electricity they produce directly to residential, industrial, and commercial consumers. Currently wholesale wheeling is mandated under federal law.

Slamming: Slamming refers to being switched from one supplier to another supplier without consent. Slamming is illegal in all/most states.

S**tandard Service Offer:** Failure to sign up with another ESP, electricity

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will still continue to be supplied by the local utility by default (also called Default Service Provider)

Stranded benefits: Benefits many regulators and environmental groups argue will be lost with the move to competition in electricity: namely, mandated environmental conservation programs or those on the overall network integrity and reliability. Proponents of competition argue such benefits would be augmented in new ways if competition were allowed.

Stranded costs: Assets owned by utilities that supposedly would become uneconomical in a competitive marketplace: for example, non-depreciated generating facilities or pre-established long-term contractual obligations. Also called stranded debt.

Transco: Industry jargon for transmission facilities, or a company engaged almost exclusively in the provision of transmission service.

Transmission facilities: Equipment used to deliver electric power at higher voltages in bulk quantity, from generating facilities to local distribution facilities, for final retail use. Industry officials often include distribution facilities with transmission facilities, however, when discussing transmission services relative to generation services.

Unbundling: The separation of the various components of electricity production, shipment, and service in order to introduce greater elements of competition to these segments of the industry. "Functional unbundling" would require monopolistic utilities to provide access to their transmission and distribution network in exchange for an access fee. "Structural unbundling" would require complete vertical disaggregation such that monopolistic utilities would be required to divest either their generation assets or their transmission/distribution assets.

Wheeling: The transmission of electric power by a utility that does not own or directly use the power it is transmitting.

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