The Energy Crunch
University Business, August 2005

Rising energy prices are spurring university and college administrators to take steps to cut costs, ensure adequate power, and implement energy-saving initiatives in an increasingly technological-dependent campus environment.

These issues have recently become more relevant due to the impact of rising energy costs, coupled with such major events as the California energy crisis of 2000 and the Northeast blackout of 2003. Moreover, since oil and gas supplies--and prices--appear to be in a roller coaster mode due to unstable Middle East conditions and, in general, more global energy consumption, IHEs need to examine their power infrastructure to ensure a steady flow of power at a reasonable cost.

The upside is that IHEs can recoup hundreds of thousands of dollars, if not more, by implementing a comprehensive energy management plan. In order to realize such savings, however, both energy production and consumption must be addressed.

Power 101

Power is provided to a campus either through an external grid, such as a local utility, or an internal grid by generating electricity onsite. Institutions with important scientific or medical facilities likely already have some type of backup power available. The California energy crisis of 2000, the blackout of 2003, and other recent events reinforce the need for colleges and universities to consider upgrading their power generating capabilities from backup supplies for certain buildings to a dedicated power plant capable of providing part or all of on-campus power requirements.

Even with its own power plant, a college or university may sometimes need to draw from the external grid to supplement its own needs. The rate structure under which the university purchases power from the local utility determines that cost. Under some rate structures there may be times when temporarily drawing power from the external grid is more cost efficient. Having the ability to switch from campus-supplied power to the external grid allows a university to maximize its savings potential rather than be locked into the rate structure of the local energy provider.

Some universities have the resources to own and operate their own power plants, while for others this is not always a necessary or realistic option. Consider the differences in how **Princeton University** (NJ), **Texas Tech University**, and the **University of Florida at Gainesville** provide for their own power requirements.

Princeton University has a daytime population of approximately 10,000 people: half students and the remainder a combination of researchers, faculty, and staff. The university has been providing power since 1996 to its 500-acre campus with one General Electric (GE) LM1600 gas turbine (www.ge.com/en). The turbine's technology, which is based on the jet engine that powers the F18 fighter aircraft, produces 70 to 85 percent of the electric power required by the campus all year. The LM1600 is designed so that in addition to the power produced by running the turbine, the hot air of the exhaust is harnessed to produce steam in a process called cogeneration (cogen). On moderate days, just one LM1600 online is sufficient to provide heat and power for the campus. The energy plant manager for Princeton, Ted Borer, estimates that the university roughly saves about $3 million a year by producing its own power through cogeneration.

Texas Tech University, located on 1,839 acres in Lubbock, does not own or operate a power plant; instead, local energy provider Lubbock Power and Light (LP&L) (www.lpandl.com) supplies its energy needs. Usually, the facility providing that energy is LP&L's Brandon Station, located near the Texas Tech campus, which is powered by GE's 21 MW LM2500 gas turbine. When in operation, the turbine's output is roughly equal to the university's demand, according to David Goode, interim production superintendent for LP&L at Brandon Station.

Rising gas prices, however, resulted in LP&L temporarily reducing operations at Brandon Station for several months in 2003 and 2004, during which time the company drew power from other sources to supply Texas Tech. The ability to switch power sources depending on economic conditions provides the opportunity to take advantage of the lowest price available in the marketplace.

The University of Florida at Gainesville is situated on a 2,000-acre campus with more than 900 buildings. UF's cogen plant is owned by Progress Energy (www.progress-energy.com) and is operated as a baseload plant supplying electric power to an external power grid (a baseload plant can handle all or part of the minimum load of a system, produces electricity at a generally constant rate, and runs continuously). Three 69KV feeders enter the university from various directions, forming the grid from which the university buys its power. The plant's LM6000 gas turbine, provided by GE, when operating at maximum output only meets approximately two-thirds of the university's peak power requirements. UF owns a pair of boilers, also operated by Progress Energy, which are used to supply steam to its campus during shutdown and maintenance of the LM6000. In case of extreme weather conditions, the boilers can also be used in conjunction with the LM6000 when demand exceeds the 220 KPPH maximum generating capability of the cogen plant. Thus, a sufficient supply of energy can be maintained during short duration peak spikes, according to Nick Florentine, utilities planning engineer for UF Gainesville.

Supply and demand

Power demands, along with fuel prices, are increasing. According to Princeton's energy plant manager, Ted Borer, between now and 2015 the university expects to see an increase from 11,000 tons peak cooling demand to about 20,000 tons peak demand (cooling water is used primarily for air conditioning, but also for some specialized research equipment such as lasers and CAT scan equipment). Additionally, over the same time period, campus electric demand is expected to increase from 21MW to nearly 30MW and steam demand will increase from a peak of 244,000 pounds of steam per hour to approximately 280,000 pounds per hour.

UF's Nick Florentine reports that despite a decrease in lighting costs with the shift from incandescent to high reflectivity fluorescent fixtures, the university's electric power demand had grown from three to four watts per square-foot to 17 to 18 watts per square foot in some cases.

"The design team has estimated our latest research building at 20 to 25 watts per square foot," says Florentine. "Whether it's because of students, professors, or support staff, the number of personal computers, cell phone chargers, and Palm Pilots had added significantly to the electrical and heat loads."

The academic departments that constitute the largest consumers of electricity and steam on UF's Gainesville campus include the Health Science Center, the Institute of Food & Agricultural Sciences, and the Chemistry, Engineering, and Physics departments.

"We see increases in medical research, cancer/genetics, biomedical engineering, basic engineering, and food production research," continues Florentine. "The analytical tools and diagnostic imaging units put big loads on our electrical distribution system. We expect this to increase dramatically in the near future."

Rating rates

While Princeton supplies most of its own electricity, the university relies on the Public Service Electric and Gas Company (PSE&G) (www.pseg.com) for about 15 percent of the annual power needs.

When drawing power from the external power grid, a college or university may either be locked into a fixed rate (predictable tariff) or a rate that changes depending on when the power is drawn (time-of-day tariff). Princeton at one time purchased its external grid power from PSE&G at a predictable tariff rate; however, as of August 1, 2003, the rate switched to a time-of-day tariff. Although the fixed-rate, predictable tariff is easier to work with, the market-based pricing of a time-of-day tariff allows those with operating flexibility an opportunity to save a significant amount of money compared to a fixed-rate tariff, according to Borer.

"The change in the rate structure more accurately reflects the value of electricity at any given time," says Borer.

UF's electric rate is a general service time-of-use tariff. Demand is based on the maximum 30-minute average demand for the month with no ratchet clauses. A ratchet clause is a contractual mechanism wherein a utility company determines the billing demand for the billing cycle based on a comparison of the actual demand, historical demand, and possibly the contractual demand. Without the ratchet clause, only the current month's average is considered in determining the cost.

Whether locked into a predictable fixed rate or time-of-use tariff, a university is beholden to the local utilities and the market forces that affect their businesses. The more power a university can generate for itself, the more effectively it can meet growing power demands and control costs. For this reason, as well as ensuring a reliable source of electricity, having an on-campus power plant becomes an attractive option.

Under the time-of-day tariff, it is likely that there will be times during the night or weekends when operating Princeton's LM1600 will not be the lowest cost option. So, while there may be more accounting involved with a time-of-day tariff, the savings could be quite appreciable due to the flexibility it offers. Because Princeton generates much of its own power, costs incurred by purchasing power off the grid are mitigated.

Time to upgrade?

Upgrades are an important component of an overall energy management plan. Upgrading power generation equipment on a periodic basis maintains efficiency and keeps costs down. The fiscally conscious university or college may decide to defer the cost of replacement equipment in a tight economy, but can it really afford not to? As many homeowners have experienced, even though the old furnace in the basement still works, a new furnace would more efficiently provide heat at a lower monthly cost.

Upgrades to Princeton's power plant, built in 1996, have enabled it to keep pace with demand and provide for more efficient power production. Boilers are being upgraded to increase peak steam output, and chilled water production capability is also being increased to keep up with expected heat and air conditioning demands. To take advantage of the large cost difference between daytime and nighttime electric rates, Princeton is adding "thermal storage" in the form of 2.5 million gallons of chilled water. The chillers will be run at full load to cool off the stored water during the night when they operate more efficiently and power costs are lower. The campus can then be cooled during the day using the stored chilled water.

In addition to expanding capacity, upgrades can also improve the performance of older turbines nearer to the standard of the current production models, keeping costs down, efficiency up, and keeping pace with technology, demand, and environmental regulations. Upgrade packages to achieve the same results between similar model turbines may vary due to factors such as age, location, and operating cycle.

As one would not expect a 21st-century university or college to operate with a 20-year-old computer system, neither should the campus power plant. Turbine control systems, also known as a Human Machine Interface (HMI), maintain and monitor performance. Older control systems, however, can be expensive to maintain as replacement parts become scarcer. To help keep maintenance costs down while taking advantage of the latest technology, LP&L's Brandon Station replaced its old and obsolescent Woodward 501 digital control system with a new Atlas control system, which has an improved diagnostic capability. HMIs can be upgraded to a Windows-based system with either a desktop or panel-mounted PC.

By incorporating steam injection and/or a process such as General Electric's SPRay INTercooling (SPRINT) system, the power, heat rate, and overall efficiency of a turbine can be improved. Other upgrades may include rebuilt/refurbished uprated engines, flow enhancers, liquid fuel treatments, and fuel system upgrades. Additionally, water and steam injection systems reduce emissions, and may be an important consideration as turbines get older.

Scheduling a turbine overhaul can be a lengthy process. The longer the unit is offline the more costly it becomes, since power has to be drawn from the external power grid to make up for the lost generating capacity.

In order to avoid costly downtimes during overhauls, leasing a gas turbine is a possibility users may consider to keep the plant operating while their own engine is being repaired. An alternative is to exchange an older gas turbine for a newer model, essentially "swapping out" an older engine with a new or rebuilt one for improved performance and reliability.

When selecting a turbine for an on-campus power production facility, take into consideration how difficult or easy it will be to upgrade the unit. Purchasing the right service package from the manufacturer can also help manage the costs of maintenance, repairs, and upgrades.

Waste not, save a lot

As the old saying goes, if you take care of the little things, the big things take care of themselves. Consider, for example, those two ubiquitous inhabitants of all colleges and universities, computers and vending machines. Both are alternately abused and ignored.

Can small efforts, such as turning off unused equipment, add up to significant savings? **Michigan State University** could save a approximately $300,000 a year if its faculty and staff would turn off their computers at night, according to one media report. That's enough money saved to provide power to nearly three average-sized college residence halls for a year.

"In the mid-'80s, groups of people shared computers and a few had Internet access," says Borer, referring to Princeton University. "Today, including central servers, there are probably more than 10,000 computers on campus. If each one draws 150 watts, we need 1.5 MW just for computers. That's more than 10 percent of our average campus demand."

According to University of Florida records, there are at least 26,836 computers on campus, reports Jeff Johnson, UF's energy management coordinator. Although campus administration requests that users shut off their computers at night, if, for the sake of argument, all computers are left running 24 hours a day, seven days a week, costs quickly add up.

If, noted Johnson, on average each UF computer consumes 400 watts (including monitors and other peripherals), with all 26,836 computers running at least 720 hours a month, the monthly energy consumption would total 7,728,768 KWh. At current local rates for the University of Florida, that would cost around $458,316. The annual energy consumption cost for the computers would total $5,499,792.

"If we cut the runtime of these computers to 220 hours (each) a month, we could see a significant reduction in electrical consumption," said Johnson. "If all 26,836 computers were only operated when needed this would result in a monthly cost of $140,041, saving an estimated $318,275 each month. The annual savings would come out to $3,819,300."

Vending machines, which can number in the dozens, if not hundreds, on a large university campus, provide service 24 hours a day, seven days a week, yet are only used a fraction of that time. Devices that reduce the amount of electricity drawn from vending machines when not in use have been available for some time now. Princeton, after a yearlong test, installed USA Technologies Vending Miser (www.usatech.com) throughout campus. As a result, the university reduced vending machine energy consumption by 40-percent, saving about 20 KW continuously.

The University of Florida's Gainesville campus has 582 soft drink vending machines. With an average consumption rate of 10.3 KWh for each machine, at current electrical rates it costs $129,750 a year to operate the machines.

"By adding a Vending Miser to each machine we can achieve savings between 24 percent to 51 percent," reported UF's Johnson. "Thus, we could expect savings ranging from $31,140 to $66,172 annually. We are working towards placing Vending Misers on all drink vending machines."

A full range of these devices are available from several companies to regulate the power consumption not only of vending machines, but also for many types of power hungry office equipment, monitors, and laser printers.

Michigan State University, in addition to installing Vending Misers in the more than 300 vending machines on campus, has an ongoing $4 million relighting program to change over old-style fluorescent lighting to more energy-efficient fluorescents as well as replacing all incandescent bulbs with compact fluorescent lighting where possible. According to MSU's Campus Sustainability Report in September 2003, upgrading fluorescent light fixtures and bulbs will save the university $250,000 a year while replacing 162,000 light bulbs.

Plugged-in savings

Realizing any potential savings by implementing an energy management plan requires a committed staff and support from the university or college administration. Positions such as an energy management coordinator are vital to the overall success of a comprehensive program. The plan needs to take into account not only how energy is being consumed in buildings and by power-hungry scientific research equipment, but also by students, instructors and staff, and yes, even vending machines and personal computers.

Back the plan up with incentives. For example, campus recycling programs often encourage participation by returning a percentage of the savings to the college community. Administrators could provide similar incentives for energy conservation by reinvesting a percentage of the savings realized from lowered consumption back to the departments that contributed the most towards conserving energy or supporting a high profile project or expansion of academic facilities. Alternatively, the savings could be used to reduce or supplement some student fees.

Universities that provide their own power can keep costs down through upgrades that allow older turbines to continue operating at peak efficiency or by harnessing a turbine's exhaust to provide steam for heating (cogeneration), turning a resource that would otherwise be wasted into a commodity. **Wellesley College** (MA) installed its first cogeneration plant in 1994 with four JMS 616 natural gas engines manufactured by Jenbacher AG of Austria (www.jenbacher.com), which was recently acquired by General Electric. After adding a fifth JMS 616 engine in 1998, Wellesley now receives 97 percent of its total power needs from the Jenbacher power plant. According to Jenbacher, as of 2002, Wellesley College estimated a savings of approximately $1 million annually in energy costs with its own dedicated, on-campus power plant.

Acquisition costs can be managed by participating in engine exchange programs that allow a university to purchase an affordable, recently overhauled turbine. Consumption can be dramatically reduced with such devices as Vending Misers and simply by having staff turn off their computers at night.

Despite rising energy costs, colleges and universities can see significant savings by curtailing the cost of power. Short-term goals can be realized with a proactive energy conservation program while long-term goals, such as providing low-cost electricity to a growing power-hungry campus, can be met by the construction of a dedicated campus power plant. A comprehensive energy management program can potentially recoup thousands of dollars annually for even a small campus, while a large university could save hundreds of thousands, if not millions, of dollars. Even modest savings can help retain teaching positions, purchase needed equipment, or fund threatened extracurricular programs.

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