


Leading Techniques for Energy Savings in Healthcare Facilities

Learn how building automation products and services can reduce energy costs at healthcare facilities. This paper outlines proven techniques, effective in achieving energy conservation results with an attractive return on investment.

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I. Executive Summary

Healthcare executives today face energy costs that continue to rise, creating very difficult challenges managing the facility operating budget. Hospitals and clinics have high energy demands due to 24x7 availability, medical imaging equipment, and special requirements for clean air and disease control. Acute and extended care facilities must manage energy consumption to achieve optimal patient care, comfort and safety as efficiently as possible. Hence, healthcare managers must take new and creative steps that put energy costs in check, both for regulatory compliance and sustainable business goals.

This paper is intended to raise awareness of the many areas of potential savings that relate to energy consumption at healthcare facilities. Cost-effective recommendations and best practices will be outlined, demonstrating how management can take action to address their energy inefficiencies and implement energy programs. The reader will also learn some of the often overlooked techniques that comprehensively address energy conservation and increased building operating efficiency.

Finally, this paper will discuss several examples where TAC has effectively applied building automation products and related services to provide optimal facility operations at the lowest possible energy costs.

II. Energy Facts in Healthcare Facilities Today

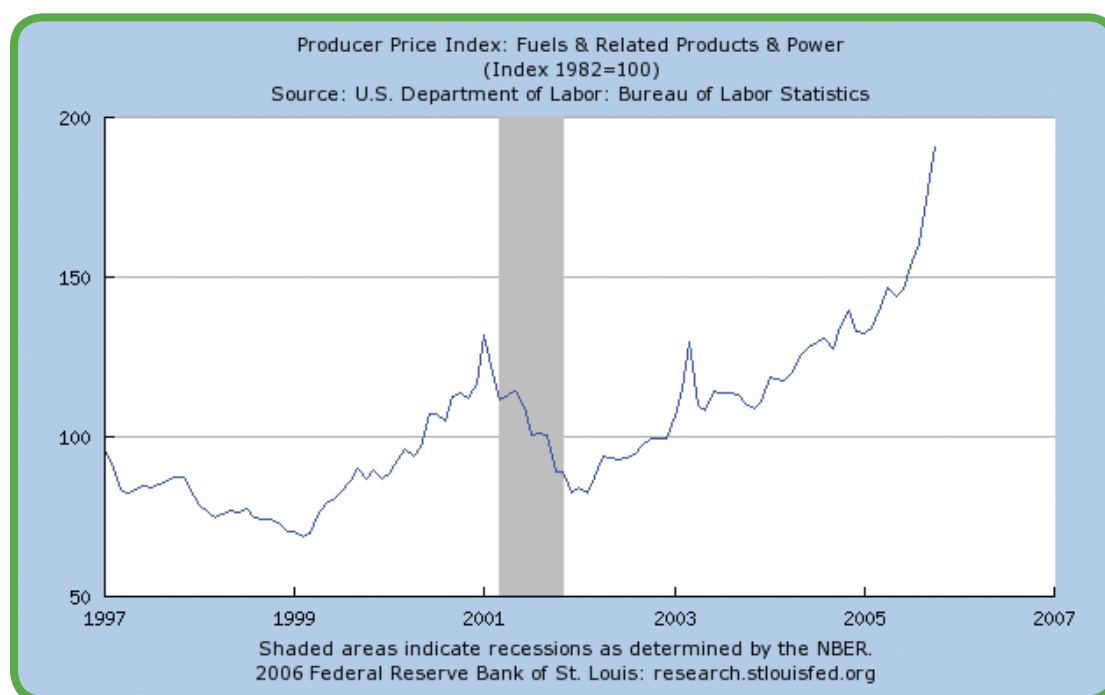
The U.S. Energy Information Administration's (EIA) Annual Energy Outlook for 2006 shows that energy costs rose 31 percent from 2003 to 2005. Using another source to corroborate the EIA figures, *The Producer Price Index for Fuels, Related Products, and Power* clearly illustrates the trend for increasing prices. And high energy prices are forecast to continue due to limited supply and refining capacity, a tense global political climate, and brisk worldwide demand for fossil fuel.

Healthcare-related research figures from the EPA's ENERGY STAR® program indicate that energy consumption per square foot in hospitals is much higher than many other types of buildings, primarily due to 24x7 hours of operation and demanding requirements for air filtration and air exchange. However, just because hospitals run 24x7 it does not mean there are fewer opportunities to save energy. This paper will explore these opportunities in detail, and how specific techniques for energy conservation can be applied to the unique industry requirements facing healthcare executives.

Healthcare energy demand is expected to grow significantly in the coming years. According to the American Hospital Association, over the last 5 years hospital construction projects have increased 47%, reaching \$23.5 billion in 2005. New construction, renovation, and expansion is expected to continue until at least 2010 as the industry responds to increasing health concerns from aging baby-boomers, and shifting demographics that require new healthcare facilities be built closer to patients.

Business concerns facing healthcare executives

Even though there is brisk demand for healthcare services today, the executive manager faces competition and significant challenges running a successful healthcare business. Hospitals, for example, must serve the uninsured public and spend money implementing systems and procedures that help them conform to government regulations such as the Health Insurance



Portability and Accountability Act of 1996 (HIPAA) and the requirements of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). In a competitive market, hospitals also face the private healthcare practices of nearby clinics and independent doctor consortiums, which can siphon away high-margin services such as minor surgeries, ultrasound, MRI and CT scan. And on the revenue side there is additional pressure from the Diagnosis Related Group (DRG) reimbursement schedule, which regulates how healthcare providers can charge for services.

Therefore, it is essential that healthcare businesses seek to proactively and continually reduce operating costs. Finding all possible areas that can contribute to energy conservation can help the healthcare provider maximize profits and uncover investment sources for new services.

Section IV gives examples of specific energy conservation measures that can be implemented by the healthcare provider's energy service vendor. Techniques that progress from fundamental control to more advanced and integrated applications are outlined for the reader.

Energy conservation contributes directly to operating income

What does rising healthcare demand mean to the executive who is managing facility expansion? It means there are excellent opportunities for the latest techniques in energy conservation to be designed into the facility, leading to the lowest possible energy costs in the annual budget.

Research by the EPA shows that facilities that implement energy conservation measures outperform their competitors by as much as 10 percent in net operating income¹. Regardless of age or technology, high performing hospitals use as little as one-fourth the energy used by like facilities at the bottom of the performance scale.

The EPA estimates that for not-for-profit healthcare organizations, \$100,000 saved in energy performance is the same as the margin earned from \$2,000,000 in new revenues. For a for-profit healthcare company, a 5 percent reduction in energy use is effectively a one-cent increase in earnings per share.

And healthcare businesses should not only be motivated by budget, but also by the desire to be seen as an energy leader in the community, and environmentally responsible.

Know where you stand compared to national energy averages

Independent research figures can help determine what steps to take for energy efficiency, and how much investment is necessary to achieve energy efficiency goals. The data below represent averages across all regions of the United States. Facility energy cost per square foot will vary based on factors such as local climate, hospital services provided, facility age, local utility rates, and energy conservation measures already being implemented.

A Platts Research & Consulting report from 2002 shows that hospitals in the U.S. spend an average of \$1.67 on electricity and 48 cents on natural gas per square foot (sf), for a total of \$2.15/sf annually. Adjusted for 2006 energy costs, this figure is \$2.81/sf.

Another source, a study conducted by Grumman Butkus Associates reveals a slightly lower figure.

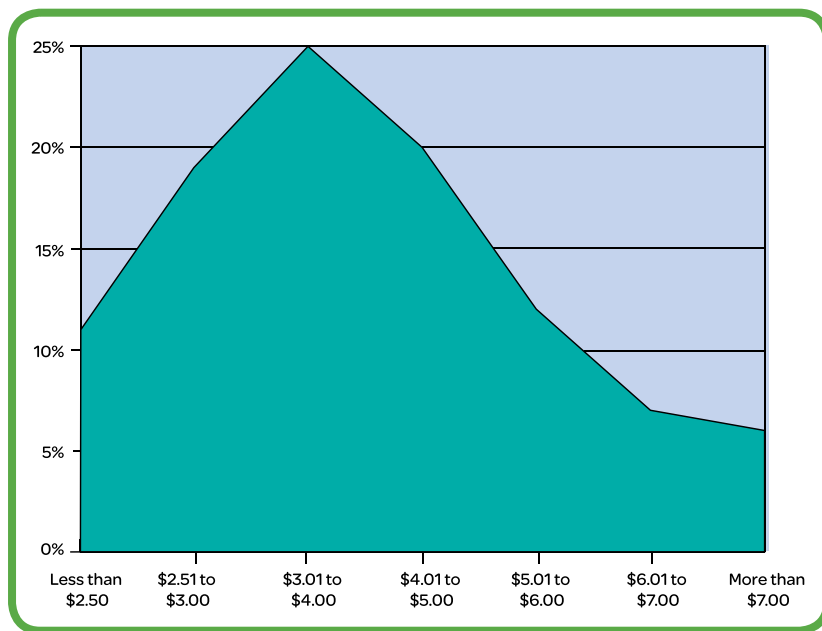
¹EPA Study, *Boosting Your Bottom Line through Improved Energy Use*, June 2005

A 2004 survey of 100 hospitals in the U.S. found the average energy expenses per square foot to be \$2.31 annually. Adjusted for 2006 energy costs, this figure is \$2.72/sf. The Grumman Butkus study was used in a profile on Great River Medical Center in Iowa, whose energy expenses are a mere \$0.81/sf each year. To frame that statistic, it should be noted that The Great River Medical Center, a geothermal project, is the most energy efficient hospital in the U.S.

The figures above are consistent with a *Health Facilities Management* magazine and American Society for Healthcare Engineering (ASHE) *Hospital Energy Survey*, conducted in 2006. The results of that survey appear in the figure below.

By comparing your facility's annual energy cost per square foot with this chart, you can assess where you stand on the curve of U.S. averages.

If your facility uses \$3.00/sf or more, there are excellent opportunities for energy conservation measures and additional savings in the energy budget. Even if your facility consumes less than \$3.00/sf annually, there is still room to examine where greater energy efficiencies can be found, weighing the savings gained against the investment required for those gains.



Acute Care Hospitals' Annual Energy Costs per Square Foot, 2006
(Costs include electrical, natural gas, steam, oil, cogeneration, and solar)

III. Unique Energy Demands at Hospitals and Clinics

Healthcare facilities provide acute care and extended care for patients. Buildings are typically located in cities or dense centers of population, often growing into campus-style developments as neighboring properties are acquired so the business can offer additional services. Regardless of whether a property is acquired or newly constructed, the patient environment must be strictly regulated for both health concerns and comfort.

There are many aspects of a healthcare building environment that have unique energy demands

compared to other types of buildings². Optimal control of this demand can contribute significantly to reducing energy expenses.

These energy demands are unique to hospitals, clinics, and extended care operations. Next we will examine steps that can be taken to conserve energy through building automation techniques that have been applied and proven effective at lowering energy costs.

What Drives High Energy Use at Healthcare Facilities?

- High Efficiency Particulate Air (HEPA) filtration is required to prevent the spread of disease (also known as *nosocomial infection*) in the ventilation system. HEPA filters that achieve 99.7% efficiency³ place greater electric demand on fans for proper air circulation.
- Stringent indoor air quality (IAQ) levels must be maintained, especially in operating rooms (OR), emergency rooms (ER), intensive care units (ICU), and laboratories. These rooms require 20 to 30 air changes per hour.
- Certain types of rooms have special HVAC pressurization requirements. ORs, ERs, and ICUs generally run over-pressure for protective isolation from airborne infection. Quarantine rooms require negative pressure (and UV lights) for infectious isolation and the control of diseases.
- IAQ must be strictly regulated for temperature, humidity, and quality. This increases the need for proper heating, cooling, and fresh air intake.
- Domestic hot water must be heated to 130°F to kill *Legionella* bacteria. But then the water temperature has to be lowered to 105°F before use.
- Some rooms require climate control set at 60°F to accommodate the adhesive cement used for orthopedics, which tend to set too quickly in warmer temperatures.
- Laundry facilities and kitchens can consume 10-15% of the building's energy, increasing the need to more closely monitor hours of peak demand from these sources.
- Hospitals require that power be provided at 100% uptime for patient care and liability concerns. Backup generators contribute to increased operating costs, or cogeneration (also known as *combined heat and power*, or CHP) investment may be necessary.

² EPA Article, *ERs, ORs, and PEs*, April 2002

³ The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommend 90% HEPA filtration, but this is often over-specified at 99.7% as a further precaution.

IV. Moving Beyond Basic Energy Control

It is not uncommon for a healthcare facility to have an underutilized building automation system (BAS), or use simple programmable thermostats and controls dedicated to mechanical equipment installed by the contractor. Best practices used for control of heating, cooling, lighting, and other uses of energy need to be optimized for patient comfort and the medical priorities of a 24x7 facility.

It is inexpensive to implement basic controls. However, while initial costs are lowest, the ability to more aggressively manage energy is compromised by these low-cost, fixed-function solutions. This means there is limited or no ability to do more with the system. Hence, when energy costs rise, there is no easy or cost-effective way to respond because all of the systems' energy saving features are already being applied. Additional costs must then be incurred to implement control strategies that could have been designed from the start in a more scalable BAS.

So what kind of control is necessary for optimal energy performance and reasonable return-on-investment? The answer depends on how the building is currently used and planned for use, and the desired cost-savings timeframe. In the healthcare environment, climate control needs can change from room to room, or even patient

to patient depending on the medical treatment or service being rendered.

Today's BASs can be expanded to control every piece of equipment in the building, including pumps, fans, valves, dampers, compressors, lighting, and more. Integrated systems can link disparate functions such as card access to lighting and climate control in any number of divided zones of a building. If a new application of control is necessary, choosing a good BAS results in a flexible and scalable system that protects the building owner's initial investment in controls. This makes it possible for the system to be expanded in the future should the need arise. Where existing controls are already in place, the building owner should evaluate whether software can be modified or upgraded to achieve the desired results.

Best practice control strategies

If a BAS is either being considered or already in place, the options for taking greater control of energy demand increase dramatically. Well designed building automation can save 5% to 20% annually⁴ in energy costs; more if advanced and integrated control techniques are applied throughout the facility.

While the initial costs of basic controls are lowest, the ability to more aggressively manage energy is compromised by these low-cost, fixed-function solutions

⁴ Portland Energy Conservation, Inc. (PECI) study for the U.S. Department of Energy, Fifteen O&M Best Practices for Energy-Efficient Buildings, September 1999.

The following are a few best practice control strategies commonly implemented by BASs and proven financially justifiable by healthcare facility managers.

Fundamental Control Applications

This is the starting point for the facility manager who wants to move beyond programmable thermostats or sensor-activated lighting controls. Techniques for fundamental control include:

Zone Scheduling – Permits defined sections of a building to have HVAC and lighting reduced or shut down on a schedule. Zone scheduling means that a whole building does not need to run at a 100% comfort setting if on only a few patients are in a given area.

Night/Unoccupied Setback – Changes the comfort settings (setpoints) of HVAC so that space temperature decreases in winter and increases in summer, thereby reducing demand for heating and cooling during unoccupied hours. This feature can also be done using a programmable thermostat, but with only a few schedules and no flexibility to more aggressively change setback temperatures.

After-Hours Override – Allows temporary changes to comfort settings after-hours. This eliminates the need to modify schedules, which can sometimes become permanent by accident. This also avoids having an entire wing run in occupied mode to meet the needs of a small group.

Occupancy Sensors – Detect motion or infrared signatures in the space, and trigger lights or HVAC accordingly. The BAS also enables scheduled overrides or triggers based on card access to an area of the building.

Holiday Scheduling – A calendar defines HVAC and lighting control for offices, clinics, or labs for an entire calendar year, saving staff time implementing special schedules and ensuring holiday weekdays do not run in occupied mode.



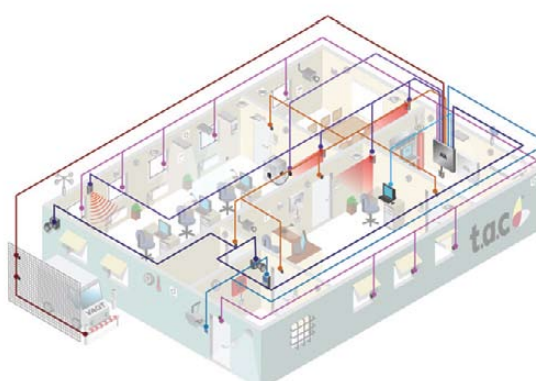
Best Practices –
Fundamental

Advanced Control Applications

In most cases, the same BAS put in place for fundamental controls is also capable of more advanced control applications, often with only software changes. Techniques for advanced control include:

Follow Sunrise & Sunset – Permits lighting schedules (such as parking lots, signs, and outdoor access lighting) to vary throughout the year as the length of daylight changes. This prevents lights from being on during the daytime. The BAS automatically computes sunrise and sunset based on the latitude and longitude of the building's location.

Daylight Harvesting⁵ – In zones of the building near exterior walls and windows, lighting can be dimmed or shut off based on specified minimum lighting levels detected by photocells. Controlled use of motorized shades can also optimize the



Best Practices –
Advanced

⁵ According to the California Institute for Energy Efficiency and the U.S. Department of Energy, 77,000,000 MWh of electricity are consumed in the United States each year for lighting buildings' perimeter zones where daylight is already present.

availability of natural light without compromising energy efficiency.

Optimum Start – Starts HVAC equipment only as early as required to bring the building setpoints to comfort levels for occupancy. Control routines take into account outside air temperature and inside space temperatures when initiating the morning warm-up or cool-down cycles. Optimum start takes the guess-work out of scheduled startup.

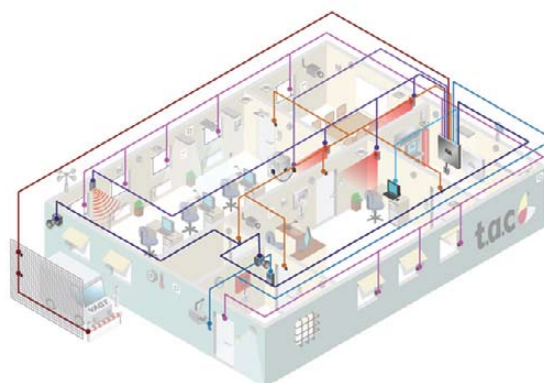
Optimum Stop – Determines the earliest possible time to initiate setback temperatures before unoccupied periods while still maintaining occupant comfort. Also known as “coasting.” Space temperature drifts gradually beyond comfort levels in anticipation of the unoccupied period.

Ventilation On Demand – CO₂ levels in the occupied space are used as an indicator of the number of occupants in a larger room, such as a theatre or lecture hall. Calculations are then performed that relate the CO₂ level to the fresh air intake damper, indicating when more outdoor air is needed. CO₂ levels also assist heating and cooling anticipation in thermostatic control to optimize comfort and air circulation.

Variable Air Volume (VAV) Supply Air

Temperature Reset – The supply air temperature (SAT) of variable volume air handlers can be reset upwards when full cooling is not required. The SAT setpoint is increased on cooler days based upon the actual building load. Then when terminal boxes reach 100% open, the SAT is decreased. This minimizes the need for mechanical cooling, optimizes the use of economizers, and improves comfort by reducing drafts due to the movement of excessively cold air.

Demand Limiting or Load Shedding – Monitors electric meters and current draw on high-demand equipment, then relaxes setpoints to immediately reduce demand. This technique can, for example, prevent a chiller from further loading, but can also



Best Practices –
Advanced (cont.)

globally change setpoints throughout the building to shed electric load to avoid peak utility charges. Non-critical equipment and lighting loads can also be shut off. Discussion and planning usually occur with the customer in advance so the right strategies are implemented that fit the business.

Chiller Optimization – The chilled water loop temperature can be raised as the cooling requirements for the building are reduced, increasing chiller efficiency. A technique known as “load reset” raises the chilled water temperature setpoint until one of the chilled water valves is 100% open.

Cooling Tower Optimization – The condenser water supply to the chiller can be decreased to a minimum setpoint, as defined by the manufacturer. Then an optimal water supply setpoint can be calculated using a combination of the outside air wet-bulb temperature and the cooling tower approach temperature. The reduced water temperature improves the chiller’s partial load efficiency and also optimizes the cooling tower’s operation.

Hot Water Reset – Hot water system temperatures can be reset based on outside air temperature, decreasing heat losses in supply piping. This saves energy and also makes the patient space more comfortable because it reduces localized heating caused by excessively hot pipes.

Integrated Control Applications

The concept of integrated control is an extension of fundamental and advanced control, but with links to more diverse parts of the healthcare facility. Integrated control provides a high level of potential business benefits, plus the flexibility to expand control, at least cost, for future energy savings objectives.

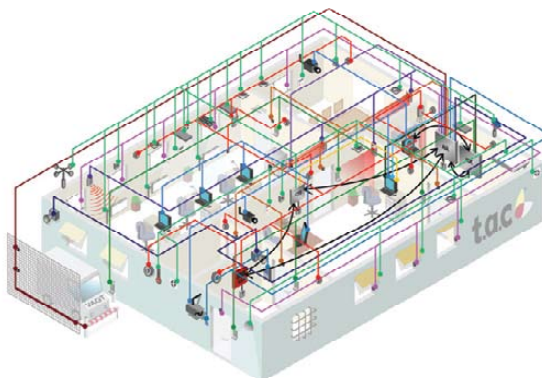
Variable Frequency Drives (VFDs) – VFDs optimize the power consumed by HVAC fans, speeding up or slowing down the fan based on climate demands of the space under control. Using VFDs, a 20% reduction in fan speed (and air flow) results in a 49% decrease in electrical consumption. Integrated control of VFDs can also be part of a load shedding strategy.

Card Access Triggers HVAC and Lighting – Card readers used for entry into the building trigger lighting and climate control for the specific area where the card-holder works. This is especially useful to save energy in medical areas that may not serve patient needs 24x7, or areas that have unpredictable occupancy periods.

Reporting and Billing – The BAS produces weekly, monthly, or annual trends in energy consumption. These can include custom reports that verify operating room air exchange rates meet, but do not exceed requirements, as well as reports that show drug or tissue storage temperatures are correct. Leased space can also be billed for actual energy consumption.

Smart Circuit Breakers – The BAS runs software that can switch on and off electrical circuit breakers (known as “smart breakers”). This enables integrated control of lighting and electrical consumption, which reduces the need for a separate lighting control system installation, training, and maintenance.

Third-party Equipment – Systems such as HVAC equipment, fire detection systems, alarm systems, smoke evacuation systems, and elevators



Best Practices -
Integrated

are integrated into a single BAS. This type of integration brings total control of the facility to a single graphical interface.

Central Monitoring and Control – Maintenance staff or the energy manager can monitor and control the whole building from a single console, either on-site or remotely over the Internet. Alarms defined by the user can appear at the console, or be sent to an email address or cell phone. The energy service provider can also perform remote monitoring.

These are examples of best practices in control operations, though not an exhaustive list. There are many techniques that apply to the specific equipment of a healthcare facility in a design-to-suit offer. No matter what level of automation or control is present, a healthcare executive should be inquiring with their supplier about whether any of these techniques can be achieved with modifications to an installed BAS.

A 250,000 square foot healthcare facility in Houston, Texas implemented integrated control applications in 2003. The work involved upgraded chilled water pumps and VFDs under control of the BAS. Management also balanced the air and water systems, installed lighting controls, and scheduled the air handlers and lighting to match operational hours. After implementing these changes, the facility moved to the top quartile of energy performers in its category in the U.S., achieving 24% savings in energy consumption annually.

Source: EPA

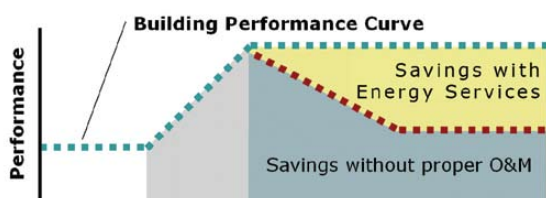
V. Energy Services

We have discussed the business motivators around energy relating to healthcare facilities. And we have outlined best practice techniques that apply a BAS toward solving the costs related to energy demand. This section now discusses energy services, and how ongoing review of energy practices can ensure energy management objectives are continuously being met.

The complete building envelope

Unless a BAS is maintained and upgraded regularly, it is likely there are energy inefficiencies. Buildings are known to “drift” out of control over time due to reconfiguration, changes in use, staffing changes, lack of training, and relaxed operations and maintenance (O&M) practices.

Energy conservation measures should not be looked at individually without considering how they interact and impact other planned steps toward energy efficiency. So an important aspect of energy conservation is to manage demand with control systems *combined with* energy services that apply to the complete building envelope, including the windows, walls, foundation, basement slab, ceiling, roof, and insulation. Looking at the building envelope broadens energy management beyond just smart BAS techniques. It considers non-control facets of the building that can affect energy demand. Energy services, usually part of an energy program, are designed to *maintain* optimum energy efficiency after initial efforts to establish energy conservation are put in place.



Types of energy services

Experience tells us that early identification of excessive energy expenses can often be corrected for very little cost with regular service to controller software, schedules, and economizer operation, and by practicing simple and inexpensive maintenance procedures. Ignoring, or not even seeing spikes in energy costs can consume many times what the remedy would have cost had it been implemented in a timely manner.

Energy services that look at the complete building envelope include:

- JCAHO compliance inspection & monitoring
- Outsourced remote monitoring and reporting
- Outsourced operations & maintenance
- Alarm notification and mechanical service response
- Building automation system fine-tuning
- Periodic energy audits and reports of recommendations
- Evaluations of infrastructure that relate to energy consumption, such as roofing, glass, airlocks, insulation, etc.
- Assistance finding government rebates and financing
- Comprehensive energy efficiency programs, like TAC EnergyEdge

Once initial steps are taken to maximize energy efficiency, periodic reviews ensure building configuration, equipment, controls, or other systems have not been altered by users or maintenance staff. Energy efficiency “drift” can defeat the best intended energy program.

A trained and qualified energy specialist understands the complete building envelope. Expert services, combined with effective knowledge of controls helps healthcare providers maximize savings, not just once, but on an annual basis.

VI. Examples of TAC Customer Solutions



Martin Army Community Hospital

Martin Army Community Hospital at Fort Benning, Georgia is one of the U.S. Army's largest and most comprehensive community hospitals. The Army Medcom group signed a performance contract with TAC for a total of five hospitals, earmarking funds from the resulting energy savings for hospital renovations and improvements.

Solution

To help cut costs, a TAC partner installed variable speed drives for supply fans, chilled water pumps, condenser water pumps and cooling tower fans. These measures enabled the hospital to schedule reduced supply fan speed as needed. Implementing a chiller optimization program also reduced the speed of pumps and cooling tower fans during non-peak periods of demand. Both the hospital and TAC partner monitor energy use remotely to ensure that demand trends are in line with the performance contract.

Gains

The ability to schedule zones within the hospital and to implement a chiller optimization program has helped Martin Army Community Hospital significantly reduce its energy costs.



Memorial Hospital of Carbondale, Illinois

Memorial Hospital of Carbondale, Illinois is an EPA ENERGY STAR® award winner; one of only three hospitals in America to earn this distinction. The hospital chose TAC as its energy service provider many years ago, and has continually improved on energy conservation using the system.

Solution

The hospital was recognized by the EPA primarily for its ongoing energy conservation measures, which have become a normal part of both new expansion and daily facility operation. The TAC building automation system has improved the efficiency of the central chilled water plant, helped to recover heat from internal spaces for use elsewhere in the hospital, and provided precise control for heating and cooling. These measures provide comfort and safety for both patients and healthcare workers, while at the same time holding energy costs to a minimum.

Gains

Although Memorial Hospital has doubled in size since 1979, the total energy used has increased by only a few percentage points.

VII. Conclusion

An effective building control system is not a commodity, nor is it a cost. A well engineered and maintained building automation system can provide a return on investment over many years. Ensure that the automation system you install or modify is fully programmable to take advantage of the control strategies outlined in this paper.

Make sure the energy conservation measures you put in place today are sustained over time. The best way to do this is to use energy services from a provider that understands the complete building envelope and the interrelated aspects of the building that affect energy demand.

Finally, require your energy services provider reduce your building's energy costs immediately, provide a sensible return-on-investment timeframe, and convey confidence that they are proposing products or services that are necessary and effective to achieve your energy savings goals.

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On October 1st, 2009, TAC became the Buildings Business of its parent company Schneider Electric. This document reflects the visual identity of Schneider Electric, however there remains references to TAC as a corporate brand in the body copy. As each document is updated, the body copy will be changed to reflect appropriate corporate brand changes.