white paper Commercial Offices

Leading Techniques for Energy Savings in Commercial Office Buildings

Learn how building automation products and services can reduce energy costs in owner-occupied and tenant-occupied commercial office buildings. This paper outlines proven techniques, effective in achieving energy conservation results with an attractive return on investment.

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I. Executive Overview

Owners of commercial office buildings today face energy costs that continue to rise, creating very difficult challenges managing the facility budget. Ancillary costs of building maintenance products and services are also rising proportional to energy as vendors pass on high fuel costs to the consumer. Hence, executives of owner-occupied and tenant-occupied buildings must take new and creative steps that put energy costs in check to maintain a healthy and sustainable business.

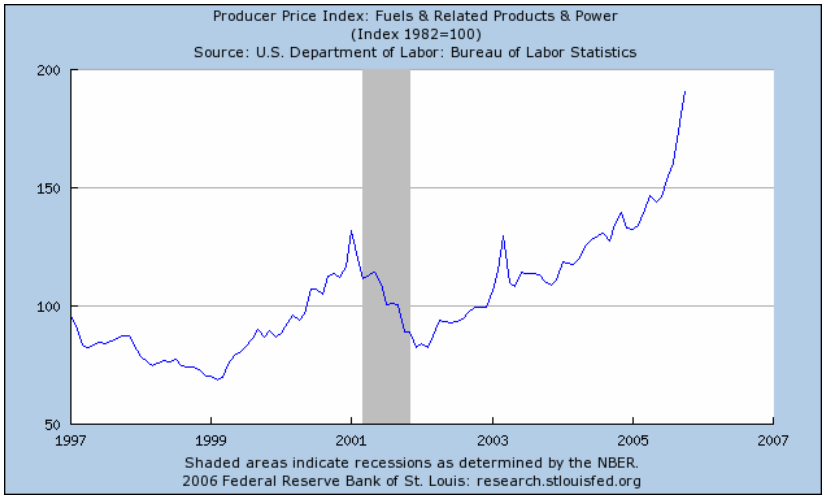
This paper is intended to raise awareness of the many areas of potential savings that relate to energy consumption at commercial office properties. Cost-effective recommendations and best practices will be outlined, demonstrating how owners can take action to address their energy inefficiencies and implement energy programs. The reader will also learn some of the often overlooked techniques that comprehensively address energy conservation and increase 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 Commercial Offices 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.

Add to this scenario the fact that 70 percent of these buildings are at least 20 years old[1], and the average building uses 20% more energy than necessary[2].



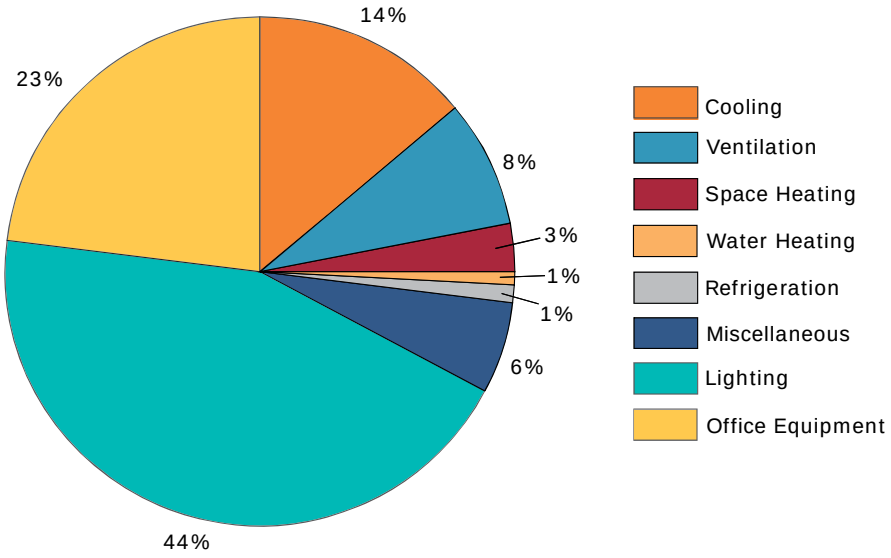
Furthermore, TAC has found a remarkable number of commercial office buildings that run heating, cooling, and lighting 24 hours a day, and with equipment that is poorly maintained. It then becomes clear that commercial property owners must make renewed efforts to address energy costs through energy conservation measures and energy programs.

[1] Frost & Sullivan, *North American BAS Controls Market,* 2004

[2] American Council for an Energy Efficient Economy, *2005 Study*

PROFILE OF ENERGY DEMAND IN COMMERCIAL OFFICES

Energy use in offices has risen in recent years because of the growth in information technology, air-conditioning, density of use, and a competitive market where tenants see high value in a comfortable workplace. Two-thirds of all energy consumed in an average office building is electricity. Lighting, office equipment and HVAC account for 90 percent of this expenditure. Certainly, the trend of high energy demand is offset by the considerable improvements over time in design, construction, insulation, lighting, and controls. Yet as energy costs continue to climb, improvements and innovation on the consumption side will not be able to keep pace.



Commercial Office Electric Demand

ENERGY CONSERVATION MAKES SENSE

Despite perceptions to the contrary, energy-efficient offices are not expensive, difficult to manage or inflexible. They don't hamper productivity or comfort either. Energy conservation measures which work well are reliable, straightforward, and compatible with both management and user needs. Further opportunities to improve energy efficiency can be sought during refurbishment, renovation, or office reconfiguration, when it can be planned in the budget. Investments at the time of renovation often carry handsome paybacks and improvements to the business.

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

III. Unique Concerns of Both Owner & Tenant-Occupied Property

There are generally two types of commercial offices. Those where the owner also occupies the building, such as company headquarters and local businesses, and others where the owner holds the property for investment and income, using the space to lease out to tenants.

OWNER-OCCUPIED BUILDINGS

If an owner also occupies the space, lowest operating cost is always a primary concern. Investment in the property is usually difficult due to limited financial resources and uncertainty about return-on-investment.

What the owner needs is a clear justification for investment in energy-related products and services to alleviate these concerns. The owner needs to know what to do, why it should be done, and how soon the investment will create positive returns. Work with an energy service provider capable of projecting these returns for clear decision-making criteria.

Management Concerns

- High energy expenses.
- Keeping the facility secure and safe for liability concerns.
- Keeping employees productive in a comfortable and healthy environment.
- There is little or no measurement of trends in energy demand.
- The facility manager is a jack-of-all-trades with too much to do and little time to learn new skills.

So why invest in energy efficiency? The answer is not simply to reduce energy costs. Other benefits specifically related to *owner-occupied* buildings are evident.

Benefits Realized Due To Energy Efficiency in Owner-Occupied Buildings

- ✓ An energy efficient building has greater market value.
- ✓ Regaining 1% to 2% in employee productivity could offset a significant amount of the energy budget for the year.
- ✓ Energy costs become more predictable in the budget, because demand trends are measured over time through reporting.
- ✓ Maintenance staff receive alarm notification of facility problems, often before more costly events occur. Staff can also proactively address issues before they result in tenant complaints.
- ✓ Frequent or after-hours maintenance costs are reduced.
- ✓ Equipment life is extended, deferring replacement cost for years to come.
- ✓ Changes in building use can be monitored for significant impacts on energy demand.
- ✓ Facility staff can enhance their skills in energy management, which increases job satisfaction and employee retention.
- ✓ The building will be seen as an energy leader in the community, attracting interest and promoting the business.

Each of these points must be evaluated for their merits as they apply to a given building. Section IV describes specific energy conservation techniques and services that can be implemented to achieve these results.

TENANT-OCCUPIED BUILDINGS

Whether it's a high-rise tower or an office complex, today's tenant-occupied office buildings exist in a very competitive market with multiple stakeholders who have different building demands.

Tenant Concerns
Tenants want a comfortable and secure working environment.
Tenants need the ability to adjust temperature and control lights.
Tenants themselves desire a stake in energy efficiency, so they can be rewarded for reducing demand.

Management Concerns
High energy expenses.
Maximizing property income at the least cost.
Billing tenants for their appropriate share of utility costs.
Keeping the facility secure and safe for liability concerns.
Offering attractive space in a competitive market, with differentiating features.
There is little or no measurement of trends in energy demand.
Tenant complaints about climate, lighting, security, and other facility conditions.
Burdening maintenance staff and increasing costs.
Retaining good facility management staff.

The owner of tenant-occupied commercial space will invest in the building if it means clear returns in terms of tenant retention or improved prospects of leasing all available space. Let's examine again the additional reasons to invest beyond the need to just save energy, specifically for *tenant-occupied* properties.

Benefits Realized Due To Energy Efficiency in Tenant-Occupied Buildings

- ✓ An energy efficient building has greater market value.
- ✓ Energy costs become more predictable in the budget, because demand trends are measured over time through reporting.
- ✓ The same system that produces trend reports can issue utility bills to tenants. This properly allocates costs and enables tenants to control their own expenses. The result can be lower lease rates, helping the property to compete better locally.
- ✓ After-hours access, climate, and lighting can be controlled and billed to tenants. This permits large sections of the building to economize on energy.
- ✓ Maintenance staff receive alarm notification of facility problems, often before more costly events occur. Staff can also proactively address issues before they result in tenant complaints.
- ✓ Frequent or after-hours maintenance costs are reduced.
- ✓ Equipment life is extended, deferring replacement cost for years to come.
- ✓ Changes in building use can be monitored for significant impacts on energy demand.
- ✓ Facility staff can enhance their skills in energy management, which increases job satisfaction and employee retention.
- ✓ The building will be seen as an energy leader in the community, attracting interest and new tenants.

IV. Moving Beyond Basic Energy Control

Many commercial buildings today have the original building automation system (BAS) system in operation. It is also not uncommon for facilities to have no controls or automation at all, and instead use simple programmable thermostats installed by the HVAC equipment provider. Of course, there are many variations of control depending on the building size, design, configuration, and use factors.

So what kind of control is necessary for optimal energy performance and reasonable return-on-investment? The answer depends largely on the building, how it is currently used and planned for use, and the desired cost-savings timeframe.

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

It is inexpensive to implement basic controls. However, while initial costs are lowest, the building owner's ability to more aggressively manage energy is compromised by these low-cost, fixed-function solutions. This means there is limited or no capacity 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.

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 building owner's options for taking greater control of energy demand increase dramatically. Well designed building automation can save a property owner 5% to 20% annually[3] in energy costs; more if the office currently runs climate and lighting around the clock.

The following are a few best practice control strategies commonly implemented by BASs and proven financially justifiable by commercial property owners.

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

Fundamental Control Applications

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

Best Practices - Fundamental

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 occupants are in the facility.

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 the entire building 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 an entire calendar year, saving staff time implementing special schedules and ensuring holiday weekdays do not run in occupied mode.

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:

Best Practices - Advanced

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 Harvesting[4] – 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 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.

[4] 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.

Best Practices – Advanced (cont.)

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 – CO_2 levels in the occupied space are used as an indicator of the number of occupants in a room. Calculations are then performed that relate the CO_2 level to the fresh air intake damper, indicating when more outdoor air is needed. CO_2 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 tenant 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 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 office 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 commercial office. Integrated control provides a high level of potential business benefits, plus the flexibility to expand control, at least cost, for future energy savings objectives.

Best Practices - Integrated

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. 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. Lights turn off on a schedule or based on occupancy sensors. This is especially useful to save energy at properties with multiple tenants and unpredictable occupancy periods.

Reporting and Billing – The BAS logs data from HVAC operation, utility meters, indoor and outdoor temperature trends, and other devices. This data is then used to view weekly, monthly, or annual trends in energy consumption. Proper reporting provides early warning when energy efficiency begins to "drift." 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 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 commercial office in a design-to-suit offer. No matter what level of automation or control is present, a building owner should be inquiring with their supplier about whether any of these techniques can be achieved with modifications to an installed BAS.

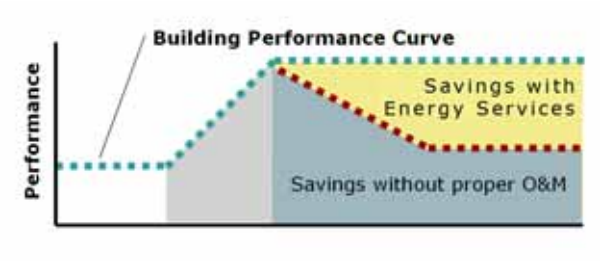
V. Energy Services

We have discussed the business motivators around energy relating to owner-occupied and tenant-occupied commercial buildings. 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 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:

- Outsourced remote monitoring and reporting
- Outsourced operations & maintenance, including controls
- 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 office 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 help commercial building owners maximize savings, not just once, but on an annual basis.

VI. Examples of TAC Customer Solutions

Union Pacific Headquarters (owner-occupied)

Union Pacific Corporation chose TAC to provide energy management automation for its headquarters building in Omaha, Nebraska. Union Pacific wanted to provide a safe and comfortable environment for its 4,000 employees, but also needed to consider the energy costs associated with a 1.3 million square foot facility.

Solution
A TAC partner installed an integrated automation system that provided precise indoor climate control of 12 mechanical and electrical subsystems. Union Pacific implemented a system that also controls a series of automatic shades in offices and common areas that open or close based on whether solar radiant heat is required. A unique system of sensors also detect glare that can affect the productivity of workers using computer screens, and reduce the glare using automatic or user-activated shades. The TAC energy management system also activates centrally controlled storm shutters in the event of a tornado warning.

Gains
Today, Union Pacific's headquarters facility provides a sustainable, safe, and energy-efficient work environment for employees that is comfortable, and has innovative qualities to maximize worker productivity.

1718 Argyle St, Halifax, Nova Scotia (tenant-occupied)

Sonco Group, a real estate firm in Halifax, Nova Scotia chose TAC as their partner in energy efficiency during renovation of its 60,000 square foot tenant office building at 1718 Argyle Street. Sonco Group needed to make the property more competitive in its local market to attract and retain tenants, and to increase revenue from the property.

Solution
Energy efficiency and security were primary considerations during planning. A TAC partner integrated the new BAS with 55 existing heat pumps, optimizing the morning startup time based on the season. In the summer, the pumps on the east-facing zone come on first to pre-cool that part of the building during off-peak utility hours, offsetting the heat of the strong summer sun on the building's face. In the winter, the west-side pumps come on first, while the east-facing parts of the building take advantage of solar warmth. The TAC system is also integrated with digital security cameras and a card access system that assures tenants' safety around the property, and also controls off-hours lighting and HVAC in an occupant's part of the building.

Gains
1718 Argyle Street provides comfort, security, and peace of mind to tenants, which makes it very attractive for new lease opportunities and client retention for Sonco Group. The same system also helps Sonco Group keep energy costs at a minimum, leading to greater profits for their business.

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.

TAC is a leading expert in energy services, with customers in 75 countries and more than 500 offices around the world. As a company of Schneider-Electric, TAC brings the resources of a $14 billion parent company with 92,000 employees to help meet the requirements of any power or control need. To learn more about how TAC can help you achieve your business goals in the commercial office market, visit www.tac.com or call 1-866-TAC-INFO.

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