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Energy Efficiency: The Wrong Way and the Right Way

Increasingly, "Energy Efficiency!" is the corporate cry heard across the U.S.

Why?

Our buildings consume 39% of the country's total annual energy supply. U.S. office space is responsible for *70%* of the entire country's electricity usage.

Companies recognize that energy efficiency can significantly lower their operating expenses, which strengthens the bottom line and makes them more competitive. Energy efficiency is also a key element of green buildings, and the market, regulatory jurisdictions, workers, and the public are increasingly demanding green buildings. Energy efficiency is also a vital means of combating global climate change, because it reduces greenhouse gas emissions.

Finally, while we'll continue to see fluctuations in oil prices, the reality is that oil is going to become more expensive, and perhaps a good deal more scarce as turmoil in the Middle East continues to grow. For companies, that means higher energy costs at all of their workplaces.

The best way for companies to protect themselves is to become more energy efficient. The question, of course, is: How?

With new construction comprising just 1% of our built environment, energy efficient retrofits of existing buildings is the smart choice.

A Series of Unfortunate Events

When it comes to energy efficiency, however, many building owners and tenants don't know which strategies and technologies to adopt, and when. The urgency to become energy efficient is so pervasive—and it has been driving such rapid changes—that building owners and tenants are overwhelmed by the deluge of information, regulations, advice, and products. That environment can lead to impulsive actions that often back-fire.

A major West Coast city, for example, wanted to make its City Hall more energy efficient. First, it decided that light levels could be reduced to save energy, so one fluorescent tube in each three-tube light fixture was removed. That single action reduced staff productivity, shortened the life of the light ballasts, and generated negligible energy savings which were eaten up the labor costs involved in removing and periodically replacing the tubes.

Nevertheless, this effort was received so enthusiastically that the city decided to do more. It then purchased an older generation building automation system for the City Hall at a "bargain" price. Making changes to this system and adding set-points was problematic and expensive, because of the system's limited functionality and because the manufacturer no longer supported the software.

Further, the system was installed incorrectly, without professional engineering. Nor was it commissioned which would have found that sensors, for example, were out of calibration or missing. Not only did this system *not* generate the expected energy savings, it caused the HVAC system to build up negative pressure and pull rain water into the building, creating higher humidity and the threat of mold growth.

This "bargain" building automation system led to a substantial *increase* in the City Hall's energy consumption.

Having wasted both time and money, the city finally engaged energy management experts to provide the strategies and technologies that would generate the energy efficiency and cost savings it wanted.

To avoid such pitfalls and to get the highest possible return on investment from their retrofits, companies must think and plan first before taking the energy efficiency leap.

There's a wrong way to do this, and a right way.

The Wrong Ways

Many companies have good intentions when it comes to energy efficiency, and they're eager to reap its many benefits, but promises of quick paybacks or the threat of disappearing incentives can easily lead them off track.

Lighting the Wrong Way: Removing lamps and replacing dimmable lamps with compact fluorescent lamps to supposedly save energy often lowers light below optimal levels and changes the color and quality of light, negatively impacting productivity and creating security and safety risks. Improperly engineered high-bay retrofits create similar problems. Putting lighting systems on timers leaves empty rooms flooded with light. Installing capacitor or resistor-based adapters on lighting fixtures generates minimal energy savings and enough heat to damage the fixtures.

HVAC the Wrong Way: Installing a cut-off outside air intake system to reduce energy consumption degrades indoor air quality and increases the likelihood of mold growth, which can make people sick and hurt workplace productivity. Shutting off return air or exhaust air fans, as well as overly aggressive HVAC set-point reset and start/stop settings, unbalances the system's air flow, leading to over- and under-conditioning. It also cultivates mold *and* it increases energy consumption. Installing variable speed drives on constant load prime movers like constant volume fans actually increases electricity consumption, along with noise levels, and it shortens the life of the motor.

Automation the Wrong Way: When electronic control systems are installed, but aren't integrated or commissioned, they can actually increase energy consumption, shorten the affected equipment's lifespan, and even harm productivity. Overly aggressive use of automatic triggers causes excessive bypassing, which negate the triggers' benefits and degrade performance. Installing tenant accessible thermostats without lockout guards guarantees mis-use of the climate system, an uncomfortable indoor environment, and increased energy consumption. Overly easy access to a technical system bypass may lead to short-cuts for maintenance and repairs that could increase energy consumption. Automatic systems with no real time control will light and heat or cool unoccupied spaces.

The Right Ways

According to the International Energy Agency, light industries like retail and the food sector can reduce their energy consumption by up to 50% using current best practices and technologies. According to the U.S. Green Building Council, most companies can reduce their energy consumption by 30% to 50%.

How?

Lighting the Right Way: Basic lighting design and maintenance principles can have a significant impact on energy efficiency.

More is not necessarily better when it comes to lighting. Human eyesight does not improve just because there is more light. Visual performance depends on a combination of light quality and quantity. In an energy efficiency retrofit, create a good lighting design that matches light levels and light quality to the tasks that will be performed in specific locations. Put light where it's needed, like at workstations, and lower the ambient light levels elsewhere, like in corridors and break areas.

Daylighting is a particularly important component of any energy-saving lighting system. A single three-by-five-foot window in direct sunlight brings in more light than is generated by 100 standard 60-watt incandescent bulbs. Adding large windows, clerestories, and skylights during a retrofit are just some ways to bring daylighting inside. Light-shelves, daylight monitors, louvers, mirrors, and other strategies help to direct that light throughout the building interior. Proper daylight harvesting controls and equipment coupled with a well conceived control strategy can reduce lighting energy consumption by more than 50%.

A lighting retrofit of Toyota Motor Sales USA Inc.'s 750,000-square-foot warehouse in Ontario, California integrated high performance high-bay fluorescent fixtures with occupancy sensors and daylight harvesting controls that maximized the daylighting from existing skylights. The retrofit generated a 65% reduction in lighting energy consumption and a 20-month return on the company's $850,000 investment, four months sooner than had been projected.

HVAC the Right Way: A company can replace inefficient centrifugal or screw compressors with small, very efficient oil-less centrifugal compressors with magnetic bearings which consume 50% less energy and can be modularized to better match part-load conditions. New Variable Air Volume terminals with electronic controls more accurately control the amount of air delivered to a space, reducing the energy required to condition a building.

In many cases, a workplace will have an energy-efficient HVAC system that can be retrofitted and maintained to improve performance significantly for much less cost than a new system. The key to maximizing savings it to engineer the HVAC retrofit based on the company's current space configuration and conditions.

Implement temperature reset strategies on both chilled water and hot water heating systems based on space conditions rather than outside air temperatures, which can reduce energy consumption by 20% to 30%. A "voting" reset strategy, for example, avoids choosing the hottest zone, the coldest zone, or the average of several zones. This system gives more "votes," i.e., more importance, to a west-facing conference room, which has solar heat gain issues, than to a north-facing office. Those "votes" determine what the cooling system set point temperature should be on a hot July afternoon.

Coupling motion sensors to both the HVAC and lighting systems will assure that energy isn't being wasted on unoccupied rooms.

The Irvine Company retrofitted the HVAC system in its 17-story Newport Beach, California office building. The company replaced two 20-year-old centrifugal chillers with a high-efficiency CFC-free chiller and a direct-fired absorption chiller. The new control strategy determines when it is more economical to run the absorption chiller based on day-ahead natural gas prices and time-of-use electric rates throughout the day.

This HVAC retrofit reduced the chillers' energy consumption by more than 40%, with a return on investment of under 30 months.

Remember that regular and proper equipment maintenance will assure that building systems continue to perform at optimum levels.

Automation the Right Way: Initial programming and commissioning, regular maintenance, and re-commissioning are the keys to doing energy-efficient automation the right way. For the HVAC system, the programming should establish set points for supply air temperature, volume, and static pressure. For the lighting system, the programming should deliver light only where and when it is needed. Motion/occupancy sensors should be integrated with an automated system to prevent energy waste. Equipment on-off schedules should be specified during the automated system's installation or initial commissioning.

Initial commissioning of every set point and component of the automation system's operations is crucial. HVAC set points that are not commissioned can cause inaccurate temperature, humidity, static pressure, and air velocity or water flow readings, which can significantly impair operating efficiency. Commissioning will assure, for example, proper air flow balancing in the Variable Air Volume boxes, which reduces the risk of overheating, over-cooling, or simultaneous heating *and* cooling a space.

Over time, operators will invariably make changes to the programming and input overrides to address everything from holiday schedules to operational changes. These changes can lead to less than optimum system performance and decreased energy efficiency. Re-commissioning (which should be implemented every three to five years, depending on how often a building is reconfigured or remodeled, or how often tenants make improvements) will catch and correct any mistakes, assuring that energy efficiency goals are met.

In 2006, Toyota Financial Services re-commissioned the building automation system in its 120,000-square-foot Cedar Rapids, Iowa call center. The re-commissioning reduced electricity consumption by 18% and natural gas consumption by 73%. These savings paid for the cost of the re-commissioning within one year.

Energy Efficiency the Right Way: The piecemeal energy reduction efforts that currently dominate the business world are actually hurting companies, because they aren't generating the depth and breadth of energy efficiency they need.

All of the strategies and technologies discussed above are important, but to derive their full benefits they must be incorporated into a comprehensive long-term energy efficiency strategic plan. That plan will integrate different systems, technologies, and actions so that they work together and perform at optimum levels, generating significant energy efficiency savings (and reduced greenhouse gas emissions) over the long-term.
Roy Jorgensen Associates' strategic tool FIRM (Facilities Integrated Resource Management), for example, has reduced Toyota Motor Sales and Financial Services USA's energy consumption by 24.5% since 2001, saving the company millions of dollars annually.

Incentives and Regulations

Energy efficiency isn't just a corporate focus. Many local, regional, state, and Federal agencies and utility companies are providing a variety of incentives, from tax credits to rebates, to encourage greater energy efficiency, including the installation of

energy-generating equipment that reduces a company's dependency on the power grid.

Austin (Texas) Energy, for example, gives rebates of up to $100,000 to companies that install energy efficient and energy-generating equipment, including solar electric power systems.

More and more jurisdictions in the U.S. and in many countries where U.S. companies operate are beginning to *demand* energy efficiency through new regulations. New York State is requiring major reductions in building energy consumption within five years. California's AB-32: Global Warming Solutions Act will impose renewable energy and efficiency requirements throughout the state.

Increasingly, if companies want to do business in the U.S. and around the world, they have to be energy efficient.

A comprehensive long-term energy efficiency strategic plan will help them do just that.

***Author Bio**: Al Pipkin, National Energy Manager with Roy Jorgensen Associates, Inc.—which provides facility and highway infrastructure, consulting, maintenance, and management services—has been involved in energy efficiency and energy-related issues for over 30 years, including development of an energy efficiency program for Toyota Motor Sales USA, Inc.'s facilities.*