WHAT YOU DON’T KNOW MAY BE HURTING YOUR BOTTOM LINE

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ABOUT THE AUTHOR

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All buildings, large and small, all have at least one thing in common, they consume energy. In these tough economic times, cost-saving measures are actively being sought by building owners. When trying to identify cost-saving measures for commercial buildings, many facility managers face the same issue: they do not have the required energy data records to accurately determine where the energy is being consumed. The lack of energy measurement and tracking makes it difficult for facility managers to prioritize operational changes for energy savings. In addition, not monitoring energy consumption can allow easily corrected operation and maintenance issues in HVAC systems to go undetected, costing the facility money.

Measuring and Verifying Energy Use

So what can be done? A number of approaches can be taken to monitor and verify energy use: utility bill analysis, sub-metering, and using the trending capabilities of a building automation system (BAS).

The most basic approach is to review utility bills. Utility bills provide usage information and can include information such as on-peak, intermediate-peak and off-peak energy usage, and demand charges. By recording this information for an extended period of time, a facility manager is able to gain an understanding of their building’s energy use throughout the year.

Utility bill information is normally stated in terms of kilowatt hours (kWh) used and therms of natural gas used. This allows the user to determine the energy utilization index (EUI). Simply put, the EUI is the energy consumed over the course of a year per square foot of space (IFMA Foundation, 2009). It is expressed in terms of thousands of BTU’s per square foot per year (kBTU/(SF*yr)). Monthly consumption can be graphed to identify trends in energy usage for the analyzed year. Spikes or unusual consumption patterns may indicate that the building is not being operated optimally for the season, or that issues with building systems are present.

Demand charges are also important to consider. Demand charges are typically applied to the quarter-hour or half-hour period with the highest power consumption peak during the billing month. Demand charges can account for a significant portion of the energy bill and provide opportunities for savings, both monetary and energy. It is tough to pin-point peaks by reviewing with the utility bills alone; however, some utility companies will provide time-of-use data if requested. A facility manager, with an understanding of their building’s demand usage, may choose to reduce demand charges by incorporating strategies such as an optimized start of air-handling units (AHU) in the morning to prevent them from starting simultaneously.

Figure 1: Example Consumption Analysis over a Year
There are other forms of analysis that can be performed through analyzing the utility bills, but these become increasingly complicated. Examples include degree-day analysis, regression analysis, load factor calculations, and building modeling. These can be very insightful for facility managers and are included in most ASHRAE Energy Audit specifications. A qualified building energy modeler can be of assistance with these forms of analyses.

If using the utility bills alone do not provide adequate information, a facility manager may opt to install building sub-meters on high energy consuming systems such as chiller plants, data centers, etc. The initial cost of sub-meter installation may seem high, but they can more effectively identify correlations between the building operations and energy usage allowing for better energy optimization. Sub-meters are recommended to be installed in locations of the building known to have a high energy density. They provide information regarding the energy efficiency and performance of the equipment specific to that area.

A common location for sub-meters is computer data centers. Computer data centers are notorious for consuming large amounts of energy. Because of their high energy density, there is a potential for significant increase in efficiency. Not only will a sub-meter precisely pinpoint actual energy use of the space, but will also quantify energy savings of implemented energy conservation measures.

Installing sub-meters is not always easy and takes careful thought and planning. Data centers often must operate continuously without interruption, making it difficult to install sub-meters. Many times when installing a sub-meter, the area will need to be shut down temporarily while the work is performed. It is important to consider the downtime of the data center if a sub-meter is going to be installed and determine if the downtime is possible.

If a more detailed level of analysis is desired and the technology is present, many building automation systems (BAS) have trending capabilities that allow a facility manager to track and record energy usage. For example, Johnson Control’s Metasys system offers a Sustainability Manager™ that allows facility managers to track energy use, greenhouse gas emissions, maintenance costs and savings (Johnson Controls, 2009). The trending capabilities of modern BAS systems have taken energy monitoring to a whole new level because they are capable of easily tracking parameters that would otherwise require extensive sub-metering such as monitoring at the equipment level.

Each of the three aforementioned options is ordered by increasing levels of sophistication. A regularly read and recorded building meter may not cost much, if anything, but will only provide information relevant to the building as a whole. Conversely, a BAS can provide very detailed and specific information, but can be prohibitively costly to install as a retrofit.

**Importance of Measurement and Verification**

Buildings waste a tremendous amount of energy. Wasted energy puts an unnecessary burden on the electrical grid, increases pollution, and wastes money. A well monitored building can lead a facility manager into identification of failed or failing equipment or it could identify energy saving changes to a building’s operation and maintenance procedures. Additionally, monitoring a building’s energy use will allow a facility manager to gauge the effectiveness of implemented energy saving changes.

Another important aspect of metering is that it enables a building to be benchmarked against similar buildings. Benchmarking is an exercise in comparison from which a building owner/operator can gauge their building’s performance in relation to similar buildings. The predominant method of benchmarking energy use is the ENERGY STAR® Portfolio Manager.
ENERGY STAR® is a well known application developed by the United States’ Environmental Protection Agency (EPA). It allows for a facility manager to model their building and obtain an ENERGY STAR rating. Not all buildings can be rated, however, the Commercial Building Energy Consumption Survey (CBECS), largely the basis for the ENERGY STAR rating, can be used for benchmarking should the building not qualify for an ENERGY STAR. CBECS is a survey performed by the United States’ Energy Information Administration (EIA) and collects information on US commercial buildings, including their energy related building characteristics and their energy consumption and expenditures (US Energy Information Administration).

An added benefit of sub-metering is that prospective tenants are becoming more and more interested in spaces that allow for sub-metering and energy efficient design. (Austin Business Jounal, 2009) Sub-metering allows for a more appealing space for tenants wishing to pursue a sustainable workplace.

**Justification of Measurement and Verification Costs**

As with anything, justification of the cost of measurement and verification needs to occur. Arguably, the biggest selling point is that measurement and verification can save the building money by pin-pointing areas of waste. For example, monitoring energy use and performing some of the previously stated analyses may lead a facility manager to recognize that a building’s outside air economizer’s are not operating optimally during the shoulder months of the year, thus providing the opportunity for energy and cost savings.

If a sophisticated BAS is used for measurement and verification, the rewards can be even larger due to the high level of building control the system offers. The Pittsburgh Airport updated their BAS in 2002 and now has the capability of centrally monitoring and controlling the facility providing exceptional efficiency and energy savings (Matt, 2009).

The sustainable building aspect also can indirectly pay dividends. Unoccupied space within a commercial building is undesirable and revenue is lost. In these tough economic times where real estate demand has been devastated, any benefit that a building can provide over its competition is a justification for energy measurement and verification.

**Avoiding Pitfalls of Measurement and Verification**

When installing additional meters, it is important to ensure that valuable information will be received in return. It may be beneficial for a qualified energy manager to perform an assessment to determine which systems and spaces use the most energy. An energy manager can then develop a computer model of the building and calculate and energy use breakdown by systems and sub-systems. Figure 2 is a graphical representation of an energy use breakdown.

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![Figure 2: Example Breakdown of HVAC Energy Use](image_url)
It makes sense to monitor energy use in spaces with a high energy density because there may be a higher potential for energy savings. Using the energy use breakdown as an example, it is logical to monitor the cooling system since it consists of approximately 26% of the buildings energy. In addition, the cooling system lends itself to a number of low cost operational and maintenance (O&M) changes that can reduce energy usage.

Monitoring building energy use is a key step in reducing the overall energy use of a building, whether it is simply looking at utility bills or using more sophisticated techniques. Measuring and verifying energy use will quantify a building’s energy use and provides actual savings data of implemented energy conservation measures. Facility manager’s can choose the appropriate method of monitoring the energy use of their building knowing that they are taking positive steps towards reducing their energy usage and associated costs.
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