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Where is your facility's energy going?

Use an infrared thermometer and digital multimeter to save energy and money

Application Note

By Ron Auvil

Years ago I had arranged a meeting with a client to discuss his need for an energy savings effort in his facility. Just as our meeting started, an administrative assistant came in with checks that needed his signature. When we began talking, I asked him approximately what his energy bill was per month. It turned out that he had just signed a check for tens of thousands of dollars for facility utilities that month, without looking at the amount! While this may seem extreme, I believe it is more common than people may think. In this case, after a careful analysis, we found that the energy costs had increased 40 percent in the previous five years. Many facility managers are so buried in problems that must be solved that they don't realize the status of the energy patterns of their facility. So let's sit down over a cup of coffee and look at some ways to analyze your facility's energy usage.

How does my facility stack up?

A really good question for facility decision makers is "How does our facility stack up regarding energy and cost?" A very common measurement used to evaluate facilities is the energy utilization index (EUI). To calculate EUI, take the amount of energy consumed—measured in thousands of British Thermal Units (MBTUs)—and divide by the gross conditioned area in square feet. This value, when used as a comparison between functionally similar structures, will show the structures with higher EUIs to be less efficient than those with lower EUIs. In this format, hospitals are one type of commercial building while schools are another. Consider the type of commercial building to make an "apples to apples" evaluation of one facility versus another. Please keep in mind that EUI is a general measurement and many factors, such as location and weather, play a large role. Many facilities will use an additional consideration of "degree days" in addition to the basic EUI measurement. Both heating and cooling degree days may be used. In general, a degree day is the amount of variation between an average daily temperature and a base temperature, usually 65 °F (-8.9 °C). In this case, the EUI would be MBTU/Sq Ft/ Degree Day.

Another common measurement used for energy in facilities is the Energy Cost Index (ECI). In some ways it is similar to the EUI mentioned above. The ECI is the utility bills in dollars divided by the gross conditioned area in square feet. As before, comparisons can then be derived between similar facilities, such as office buildings, schools, or hospitals. Be sure to allow for the variance in energy costs by geographical region.

The bottom line is that the EUI and ECI can be used together or separately to get an objective ranking of the energy and associated costs of your facility.

Energy breakdown by equipment

The next step after the analysis by EUI and ECI is to identify the energy used by the mechanical system. For most facilities, that includes heating, cooling, and lighting. Some facilities could have another category, such as an industrial process, that may need to be evaluated as well. The number of, and energy use of, these individual devices and systems is important. Each device will use a percentage of the whole for that particular utility.

Heating systems

Most facilities are heated with natural gas, fuel oil, or electricity. Many facilities use steam or hot water boilers for heating purposes. Each individual boiler can be individually metered for natural gas or fuel oil consumption. Many facilities today add new utility meters in order to accomplish these measurements. This is a great idea. Today, these new meters are able to be integrated onto the building's Ethernet network. These meters can provide extensive information regarding time, date, and amount of energy use over time. In addition, the boiler nameplate energy consumption can be recorded and then compared for energy efficiency purposes.

Each system's consumption can then be related to the whole amount, and the effect of that particular device evaluated. Another advantage to this type of evaluation is that more efficient devices can be operated in lieu of inefficient ones, improving overall efficiency.

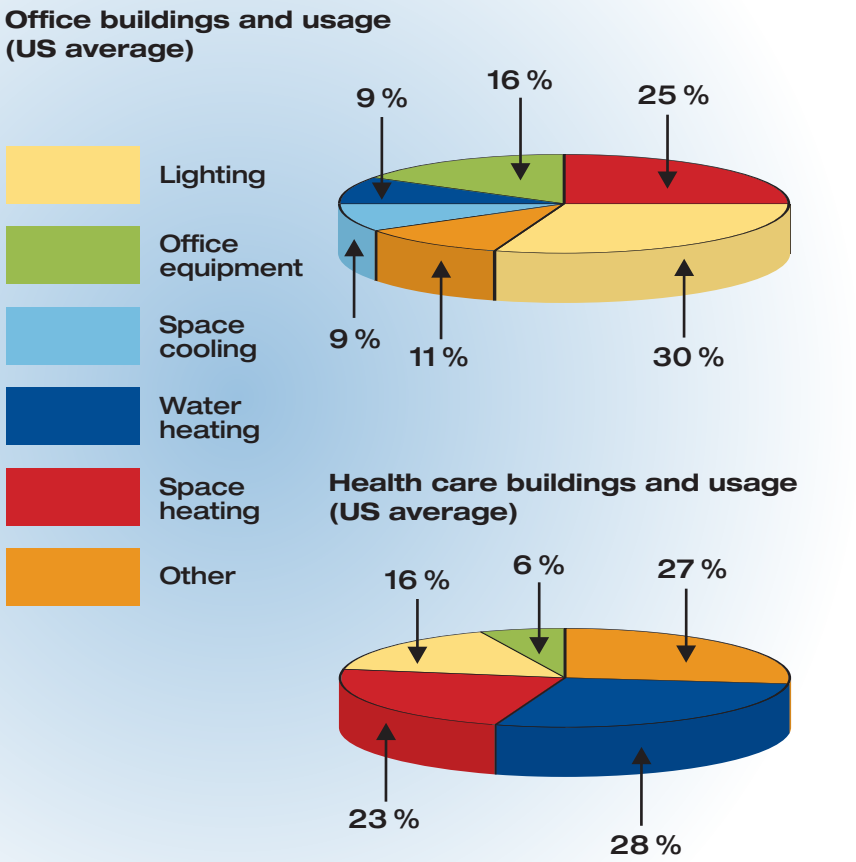
Cooling systems

The evaluation of cooling systems is somewhat similar. The majority of larger facilities utilize some form of chilled water cooling system. This system usually consists of a number of water chillers and chilled water pumps, and heat rejection through cooling towers. In most of my customers' facilities, the chillers are the largest energy-using systems in the entire building, often accounting for 50 to 70 percent of total electricity costs.

Again, individual monitoring of energy use by equipment type is extremely valuable. It is not uncommon that newer chiller equipment uses half of the energy in kW/ton of the older equipment. This should be considered when chiller sequencing and rotation schemes are created.

Fortunately, most newer pieces of equipment, such as chillers, already have a microprocessor control panel (MCP) installed. Most MCPs will provide real-time energy monitoring. When you perform this energy evaluation you cannot ignore the plant auxiliaries. The plant auxiliaries consist of the cooling towers and water pumps. These should be evaluated as well for their energy impact. This may be anywhere from roughly 10 to 30 percent of the total plant energy consumption. Most plant auxiliaries today have variable speed drives (VSDs) installed. These VSDs can supply energy data, such as kilowatt hours (kWh), that help in their evaluation.

Some facilities use smaller, packaged HVAC systems, such as rooftop units. In general, these units do not provide



A functionally distinct building, such as a hospital, has a different pattern of energy usage than another type of building, such as an office. Be sure to consider the type of building when making comparisons.

Data Source: US Energy Information Administration

the sophisticated control and monitoring schemes available for the large central chiller plant systems. These systems can be evaluated by using the manufacturer-supplied literature or by taking field measurements with a digital multimeter/ammeter combination to derive energy use.

Lighting

Another large energy consumer in commercial buildings is lighting. A general estimate is that 30 percent of the energy used is consumed in lighting. You can check the lighting circuits by using permanent meters installed in the circuit or by using portable test equipment. It is very important to add this to the energy profile.

A client of mine in a production facility recently performed an energy analysis and discovered that a high percentage of energy was being used in building lighting. On his recommendation, the production facility switched to a new high-intensity lighting system in their production areas.

Due to the lower amount of heat generated by the new lighting, approximately 100 tons of cooling was removed from their chiller plant in the summertime. Normally in the summer at peak outside temperature and humidity conditions the facility would have needed three chillers. This summer they mostly ran two, with only a rare need for three. This saved a very large amount of energy and money, with a very short payback.

Use of test instruments

Once you create an overall energy profile "pie chart" for the facility, you can use test instruments to identify energy waste areas and to identify specific energy loss areas. These test instruments include infrared (IR) thermometers and digital multimeters (DMMs).

Infrared thermometer

A basic, recommended test instrument is an infrared thermometer. You can use an infrared to walk through the facility and identify many places of energy waste, such as:

1. **Insulation problems.** In many cases, insulation has been removed for maintenance or repair. It may also have been used in small quantities where more was needed. You can use the IR thermometer to identify where more insulation is needed.
2. **Steam trap failure.** You can use the IR thermometer to find steam traps that have failed. Note that one failed steam trap that has been repaired will pay for the thermometer.
3. **Heat losses.** Any heat that is being lost through doors, windows, or other building openings will be identified by the IR thermometer.
4. **Stack losses.** Along with other instruments, such as a combustion analyzer, you can use the IR thermometer to identify abnormal amounts of heat proceeding from the stack of a natural gas or oil fired boiler system. This can identify waste and high heat loss.

Digital multimeter

You can use a good true-rms digital multimeter with a current clamp attachment to measure the VA or kVA (volt ampere or kilovolt ampere) and estimate the power used by a particular piece of equipment or lighting circuit. The digital multimeter is especially useful with smaller equipment, such as rooftop units. A good high-quality power quality meter is preferable. A high-quality true-rms meter will provide years of service, and some meters can be connected to a personal computer to store the data for future analysis.

Understanding the energy patterns

The methods listed above are a good start to understanding the energy patterns of your facility. They can help show a "path" of energy coming into the building and then being consumed by the building systems. You can then use this data to recommend specific energy savings strategies and estimate payback. These methods can help answer the question, "Do you know where your energy is going?"

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