Determining Energy Savings with Micro-Loggers

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"**O**ur gadget will save you 20 percent to 40 percent of your energy bills!" How many times have we read or heard something like that? Most Resource Conservation Managers hear it all the time. Often the savings are "guaranteed." Suppose you bite and install the new product or technology – how do you tell whether the savings really happen?

While you can read your utility meter to measure how much energy you are using after making upgrades or installing a gadget, there are two barriers to determining the savings:

1. Savings are what you would have used minus what you are using. To determine what you would have used, you'll need to collect "before" data prior to the upgrade.
2. The upgrade may be on a small part of the systems served by your electric meter, so that even if you have good "before" and "after" meter data, you can't isolate the specific effect of the upgrade.

Addressing and defeating these barriers is made easier by using some new instruments that were far less diverse and capable a couple of years ago. Most did not exist at all ten years ago. These are micro-loggers. Micro-loggers are pocket-sized devices with energy-miser circuits that can operate for months or years on a small internal battery.

Micro-loggers are usually one of three types. Most manufacturers make all three. They are:

1. **Running-time meters** – These simply tell the number of operating hours a particular load has accumulated since the logger was installed and initiated. To detect operation, various models sense light, magnetic fields, voltage, vibration, or current. Use running-time meters to assess a product or technology that purports to reduce the operating time of something.
2. **Time-log meters** – These are a step beyond the running-time meter. They produce a data file that records the date and time of each change of state, e.g. ON/OFF. Use these if you need

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to know the schedule of operating time as well as the total operating time, for example to evaluate water heater time clocks intended to mitigate peak demand.

3. **Magnitude loggers** – These record the actual magnitude of a parameter like temperature, current, or power with respect to date and time. Use these when the product or technology is expected to reduce power during operation, rather than just shorten or reschedule operating times.

Time-log and magnitude loggers represent the real technological advances, and the following discussion will focus on them. With data management software provided by the manufacturers, the data you collect can be downloaded to a computer for display and analysis. In some applications you can use loggers with no electrical connections. They work by detecting light, vibration, temperature or magnetic fields from the systems being logged. Some micro-loggers are strictly for plug loads and others can attach in an electrical panel to measure single-phase or three-phase power or current.

Diversity is certainly an apt characterization of today's micro-logger products. Some are single channel. Others are multi channel and can record multiple things like temperature and relative humidity. Some are flexible multi-channel devices into which you can plug different kinds of sensors to suit your unique data needs.

Battery life usually exceeds the time span of the desired data retrieval interval. Some micro-loggers have internal modems or network cards so they can be read remotely. At least one manufacturer sells a data-fetching device barely larger than a book of matches that you can take into the field to download the data and then reset the loggers. It lets you avoid dragging around a laptop or removing the loggers to take them to a desktop computer.

Micro-loggers help bypass the barriers to measuring energy use and savings by directly metering the specific load or subsystems that are affected. This has long been possible with larger data loggers, but they are often not used because they present at least some of the following difficulties:

- High cost.
- Require 120 volt alternating current (AC) power to drive the instruments.
- Multiple loads distributed too widely to be wired into a single multi-channel data logger.
- Too bulky to be completely closed up in an electrical panel, resulting in open panel doors with leads running out. People can trip over the leads and dislodge them, tamper with the instruments, or even steal the instruments (which are usually worth several thousand dollars).

Measuring Power Versus Measuring Current

Directly measuring electrical consumption is one of the most important applications for micro-loggers. You can get by with cheaper and simpler loggers if you just measure current, but beware. Current loggers can suffice when energy reductions are being accomplished by changing the loading on individual components, such as fixing compressed air leaks; you can establish the kilowatt (kW) versus kilovolt-ampere (kVA) relationship with a portable power meter before installing a current logger. If a single load is monitored and that load is driven by an induction motor, the motor can be entered into MotorMaster+ software's "Inventory" module, and a range of currents plugged into the "Field Measurements" tab to generate a kW versus current curve.

Carefully consider whether you need direct power monitoring rather than just current monitoring. The issue is that utilities bill in kW-hours, not kVA-hours. When loads are reduced, and especially when power conditioners are installed, kW often does not drop in proportion to kVA. Some power conditioners are mostly capacitors and can dramatically reduce kVA with almost no reduction in kW. When a power conditioner is implemented as the energy saving device, the logger must be attached on the line side of the conditioner

and there is no reliable way to convert current data to kW.

Some energy-saving products introduce a high level of harmonic distortion and others claim to cure high levels of harmonic distortion. Examples are motor voltage and speed controllers and black box power conditioners. If you install one of these products, look for a micro-logger with the ability to read kW accurately when voltage or current waves are badly distorted. Otherwise forego the micro-logger in favor of a larger recording power analyzer.

Choosing a Micro-Logger

Product lines and individual models vary considerably. Read the specifications carefully and talk to manufacturers' sales staff to be sure you select a model with sufficient accuracy, weather protection, memory capacity, and connection features for your own situation.

The Dent Instruments Elite Pro is shown in Figure 1. This logger sells for under $1,000, including voltage leads but not current transducers. A variety of current transducers are available from the manufacturer for various current levels and conductor access situations. The Elite Pro is Underwriters Laboratories (UL) listed and rated for 600 volt exposure. It is completely self contained and can run for weeks on battery power. If single phase power is to be measured, it can be programmed to record three load circuits simultaneously. The unit is a fast scan device and can

read accurate true power even in the presence of severe voltage and current harmonics.

Figure 1.

Two sources of tiny battery-powered current loggers are the ACR Systems Owl line and the Onset Hobo H8 line. A current transducer (CT) can be plugged into either to obtain electrical current data. ACR offers four-channel and one-channel loggers. Figure 2 shows an ACR Owl that accepts standard 4-20 milliamp input from any sensor that communicates on that standard. A logger and one CT sell for under $450.

Figure 2.

Onset offers many products including the four-channel logger shown in Figure 3. A logger and one CT sell for under $150. Onset has a modular

brick-sized battery powered logger that can monitor up to six separate three-phase loads.

Figure 3.

Resource

MotorMaster+ software, U.S. Department of Energy. Software can be downloaded at *http://www1.eere.energy.gov/ industry/bestpractices/software. html#mm*

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More information

For more information, see the WSU Resource Conservation Management web page at *www.energy.wsu.edu/projects/rem/rcm.cfm.*

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