Should I Monitor Whole-Plant or Individual Equipment?

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Should I Monitor Power Use for the Whole-Plant or Individual Equipment?

A question often asked by our customers relates to the recommended strategy to save the most money on their electric bill. Specifically, the question most often asked is " ... to save the most money, would it be better to continuously monitor all the power coming into our plant to monitor individual pieces of equipment and smaller power distribution panels.

In many cases, monitoring individual equipment gives you better insights into saving money. As is usually the case with these types of decisions, there are lots of engineering trade-offs and no simple, always correct answer, but here are some guidelines that we used to reach our answer. Many of these issues may apply to your situation. Although these guidelines are not perfect, they may help you select the best approach for your needs.

Make measurements that provide actionable information to reduce power consumption.

Measurements of "whole-plant" power usage may mask the power use information of individual pieces of equipment or processes.

Whole-plant power measurements may not provide actionable data because the information is all-encompassing, individual processes may not be resolvable.

If your goal is to save money on your plant's electric bill, focus on electricity consumption or peak demand measurements. Power quality is a different issue that can be explored on a different project.

It is useful to measure the current used by a piece of equipment connected to your factory's power grid. But, from the perspective of "what do I need to do to save dollars on the electric bill", it may not be useful to measure the number of spikes coming into your facility from your electricity service provider or the exact frequency of your 60 Hz signal (Is it really 59.9985 Hz?).

If your boss wants to cut electricity expenses, focus on the cost goal of identifying big users of electricity and then exploring alternatives such as eliminating wasteful operations of equipment, acquisition of more modern energy efficient equipment, alternate production approaches, and other energy savings actions. There are reasons to make power quality measurements and that should be part of another project involved with power quality. Worry about summer-time "brown-outs" and equipment damage from voltage spikes with a different project. Don't confuse people (boss, co-workers, staff) with a mix of recommendations and conclusions about actions to both reduce electricity consumption and improve the quality of the power coming from your service provider. Typically, these are separate issues.

Make measurements with enough resolution in the power data so that individual pieces of equipment or processes can be identified.

Whole-plant power measurements force your scale factors to mask tiny changes in power consumption.

There may be so many, small and frequent changes to power measurements for an entire plant, the particular power change you are trying to measure in correlation with powering down a piece of equipment on the plant floor may be unidentifiable.

If you are focused on studying the power consumption of a single piece of equipment that consumes between 100 watts (0.1 kW) and 2,000 watts (2kW), make sure your monitoring equipment can measure and display changes below 50 watts and above 2 kW while measuring the total connected power. This is a reasonable requirement. Saving money on the electric bill is all about the aggregate of many smaller power drains.

For example, a 2 kW power drain during a 24-hr, 365 usage cycle will cost about $5/day or $1800/year. Make an impact on 10 or more of these size power drains and on-the-whole your impact can be significant. A 10% reduction in this modest power usage add up to significant dollars ($1,800/yr). A few modest sized projects like this can make an impact in the aggregate.

Your monitoring system should give you the ability to see small changes in power consumption (on the order of 50 watts) and larger changes in power consumption (on the order of 2 kW), while measuring a larger steady power consumption of 200 kW. If you connect your power monitoring sensors to a power distribution panel supplying 200 kW to various pieces of equipment but you want to initially study a single piece of equipment that consumes 0 watts when disconnected, 100 watts when set to an idle condition or 2 kW when operating at peak load. The same piece of equipment should be able to monitor a 200 hp air compressor consuming 150 kW.

Make measurements with enough time resolution to allow for meaningful feedback to the users.

Real-time or near real-time feedback from your monitoring system is important in order to understand your power-use data and derive actionable information from power-on/power-off/power-level tests. To be useful, the monitoring system that records changes in your power-use must deliver meaningful information to you within 15 seconds of the action that causes a change in power consumption. Specifically, when a piece of equipment is turned on or off, you must be able to see the impact of that change on your power consumption profile within a few seconds -- in order to make actionable conclusions from your test. If your power-use monitoring system collects and sends data to you only once every 15 minutes, you will not be able to resolve actions that test the power consumption of individual machines.

For example, in power-on/power-off tests, 15-minute measurement intervals will not allow you to determine if the power measurements that you are viewing were affected only by the target machine in your tests. It is possible that some other piece of equipment - elsewhere in your facility but supplied by the same power distribution panel - happens to turn on or off during the 15-minute data acquisition interval.

In addition, if you need to wait 15 minutes between each test, efforts to associate power consumption with different pieces of equipment become impractical. The long delay between even the simplest tests make these types of tests too inefficient and too time consuming. In addition, as described above, long time intervals increase the uncertainty in the data.

In summary, if too much time elapses between measurements or there is too much time delay before you can view the data, then the information is simply not useful.

Select a remote monitoring measurement system that allows you to view changes in power consumption near the work location where changes are being made.

Whole-plant power-use monitoring systems do not typically make it easy to view real-time power-consumption data on the plant floor -- where the action is. Making a change to the electricity consumption profile on a piece of equipment and then walking 350 feet to the main electrical service entrance panel to read an LCD display on the main breaker panel -- and then walk back to the equipment you are working with -- is impractical. Aside from the poor use of your valuable time, during your walk other pieces of equipment may turn on or off. Finally, real world limitations demand that if it is too time-intensive to check for changes in power consumption, you probably won't do it as often as is needed - if at all.

You should be able to see the effect of your changes instantly in close proximity to the physical location where the changes are being made. You should not have to walk 100 feet to a view a meter hanging on a power distribution panel. You also should not have to first download data from a memory device into a computer in order to see the results of your equipment power changes. You need to have measurement data that is easy to view, instantly available, and close to the action.

Select a monitoring system without too much "installation and setup" effort.

Monitoring systems for individual pieces of equipment can be easy to setup and install and easy to move from one piece of equipment to another.

For "whole-plant" monitoring, the installation and setup is frequently an involved process with conduit installation, power outages, and wiring modifications.

Beware of dangerous voltages that me be present during installation and setup as well as dangerous voltages that may be present at the monitoring instrumentation. There are some approaches, like Sensor Synergy's Watts Aware that minimizes exposure to dangerous voltages during installation and does not involve any exposure to high voltages after installation and setup.

Make and record measurements that will help you analyze prior events and possibly prior electric bills.

Electricity use monitoring solutions that monitor all of the electricity used by your facility often do not provide the time-resolution or the power-level resolution to identify specific actions that can be used to reduce your electric bill.

Although measurements on individual pieces of equipment may only be responsible for a fraction

of your on-going electric bill, in the aggregate you will be able to make a significant impact on your bill during a few months of focused, energy-cost reduction activities.

As in many situations, you may discover that 20% of your equipment is responsible for 80% of your electric bill. Making changes to electricity consumption profiles for the most power hungry equipment in your facility will have a noticeable impact on energy savings and help you get the most "bang for your buck" - or the most electric bill cost reduction per dollar invested in efficiency improvement projects.

There may be many ways to reduce electricity consumption in your facility. However, from a cost perspective, it may be best to focus on actions that are cost-justified by the expected returns.

To know the expected returns on an efficiency improvement project, you first need to know how much is being spent prior to the project. Sensor Synergy's Watts Aware 118 can help you make these cost of operation measurements. Information on the cost of electricity to operate a machine running under the conditions at your plant (throughput, mechanical load, etc.) will help you determine how much you can spend on an energy-efficiency/electricity-use-reduction project.

For example, to reduce the use of electricity in your plant, you may be able to add variable speed drive modules, replace old inefficient motors with more modern higher efficiency motors, replace improperly sized motors, and/or replace inefficient lighting fixtures with more efficient lights. All of these changes can reduce electricity consumptions. But, the question you must answer is - "which steps are most cost effective"? To answer this question, you must estimate the expected cost savings as a result of your energy efficiency project. This estimate must be based on your pre-project electricity cost usage study and the expected electricity-use reduction percentage.

Electricity-use monitoring solutions focused on equipment can identify which pieces of equipment are the most power-hungry and which equipment uses relatively little power. Projects to reduce electricity consumption should focus on the power-hungry users. If a smaller electricity consumers cannot cost justify an energy efficiency project, then it may be appropriate to leave those machines alone.