THE STANDARD FOR ENERGY & POWER MEASUREMENT

White Paper

How to Conduct an Energy Audit Using the Energy Platform EP1

Introduction

Sophisticated energy analyzers introduced in the 80s were able to trend and record energy usage and help identify when, where, and how much electrical energy was being used. However, due to limited user-interface capabilities, these analyzers printed to paper tape and tended to be complex to operate. At that time, the cost of an energy analyzer was approximately $5,000, which translates to well over $10,000 today. For these reasons energy audits and surveys were limited to medium to large industries that could justify the investment in the instruments as well as the time necessary to conduct the surveys and analyze the results.

Today's energy analyzers are more much more powerful and cost effective. Since even low-cost analyzers include all the accessories and software needed to conduct a complete and user-friendly energy audit, energy analyzers are now within reach of companies large and small who need to manage their ever rising energy costs.

The new Energy Platform EP1 from Dranetz offers a combination of benefits that balances the requirements of cost, functionality and ease of use. Starting at under $3,000, the EP1 enables users to conduct a full-featured energy survey and produce easy to understand reports that clearly present audit results.

Knowing What to Measure

Energy audits come in many forms and can range from simple applications that monitor a single device or machine, to complex monitoring of an entire campus – and anything in between. The typical objective is to measure the electrical usage at one or more point with the goal of understanding how much electricity is being used, and when and where it is being used. This comprehensive snapshot is necessary for taking action to reduce energy consumption, such as employing more efficient lighting and motors, etc., or finding simple solutions, such as turning off lights.

Regardless of a facility's energy load, most energy audits have much in common. The most important parameters to measure when analyzing electrical energy are typically voltage (V), current (I), watts (W), volt-amperes (VA), volt-amperes reactive (VAR) and power factor (PF). Recorded over time, these basic parameters can provide the necessary information of an energy profile.

Voltage and current measurements are used as the basis to compute the other parameters. The parameters can be viewed instantaneously by a variety of instruments, but the key benefit of using an energy analyzer is its ability to record and trend parameters over time. Energy analyzers also compute the demand and energy that utilities use for billing.

Energy, which is usually measured in Kilowatt-hours (kWh), is the accumulated usage of electricity over the time it is measured. (Comparing energy to water flow, measuring energy would be analogous to measuring gallons per hour.) Demand, which is usually measured in Kilowatts (kW), is the average power used during an interval that is typically set by the utility at 10 or 15 minutes. These very same parameters are measured by the electric utility as the basis for determining energy costs.

Selecting Energy Analyzers

What an energy-measuring instrument measures and computes is important -- but how it measures can be critical. For example, some low-resolution, low-cost instruments may measure the basic parameters mentioned, but they can miss data and thereby result in false and misleading measurements.

Effective energy analyzing instruments should provide a sampling rate that is appropriate for the application and take continuous readings. Power analyzers typically specify sampling rate as the number of samples per AC (60/50Hz) cycle. This is the digitization of the analog voltage and current being measured. In general, the more samples per cycle the better, which leads to more accurate measurements and a better digital representation of the measured data.

When choosing an energy analyzer, users must choose a unit that can measure more than just the basic power parameters. In addition to what's displayed in Figure 1, many more advanced parameters may be required to also help understand the quality of the electrical supply, including: voltage and current total harmonic distortion (THD), crest factor (CF), transformer derating factor (TDF), crest factor (CF). Additionally, with the advent of alternative energy applications, parameters such as forward and reverse energy that record the flow of power to and from the grid are often required.

The EP1 offers continuous measurements, which means every AC cycle is measured with no gaps. The EP1 is the only instrument on the market that can offer all key measurement parameters. The analyzer has the ability to provide currently needed measurements as well as additional features to meet your needs as requirements evolve. This analyzer is also the industry leader in sampling at 256 samples per cycle. In comparison, lower-priced energy analyzers have dead time between measurements, some in the order of seconds, which can lead to missed data and inaccurate measurements.

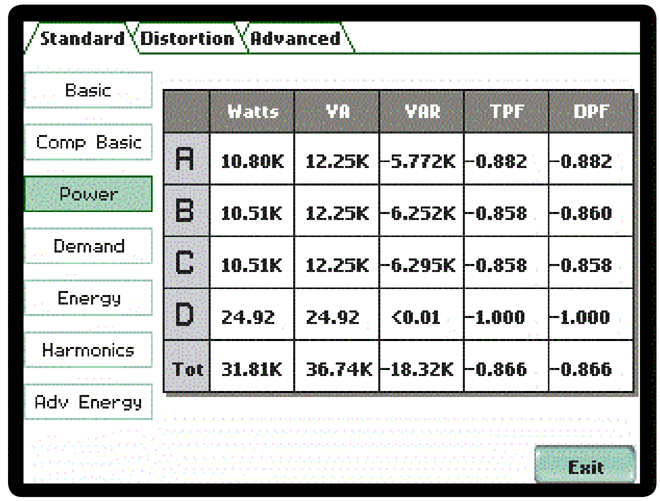

Figure 1. The EP1 can measure advanced parameters beyond the basic power parameters displayed above.

Making Instrument Connections

Properly connecting an energy analyzer is essential; especially with the complex three-phase circuits that are most common in industry. Proper voltage and current connections to the circuit are necessary for proper readings, so it is important to make the proper connections prior to taking the survey.

When making instrument connections it cannot be stressed enough to closely follow all appropriate safety procedures and manufacturer's instructions. Such circuit connections can pose a danger and only qualified personnel should make instrument connections.

To measure the total power of a circuit, the energy analyzer computes the power in each phase before it totalizes all of the phases. A wattmeter in the instrument measures each phase, although the total number of wattmeters required varies by circuit type. The industry norm for this procedure is based on Blondel's Theorem, which says that in order to measure the total power of a circuit, N-1 wattmeters are needed, with N being the total number of wires. A wattmeter requires both a voltage and current circuit connection and measurement. Voltage is the potential between two points and is always measured between a "hot" wire and a reference, with the most common reference, when available, being

Neutral. Voltage is usually connected directly to the circuit in Low Voltage (LV) systems without the use of potential transformers (PTs) or transducers. It is important to make sure the analyzer can safely measure the voltage levels in use.

Current is usually measured using transducers called current transformers (CTs). CTs are available in many types ranging from rigid clamps to very adaptable Flex CTs. Regardless of the type used, it is necessary that the CT is sized for the application and has a current range appropriate to the current flowing through the circuit. As a rule, Dranetz CTs are specified to operate in the range of 10% to 100% of their full scale. A 500A CT (TR2500) has a range from 50A to 500A. It is important to assure that the current being measured falls in this range, otherwise the measurements may be inaccurate. Each CT will have an arrow or other indicator showing the direction of current flow. All CT connections must have the arrow in the same direction and pointing towards the load.

Connecting the analyzer depends on the circuit type. A single-phase circuit has two wires (L, N), so according to the (N-1) approach, it requires one wattmeter. A split (2) phase has three wires (L1, L2, N) and requires two wattmeters. There are two common types of three-phase circuits, Wye and Delta with the difference being the reference used for measurements. A Wye circuit is the simplest using Neutral as the measurement reference. A Wye circuit has four wires (A, B, C, N) and requires three wattmeters. Delta, having only three wires (A, B, C) is more complex since there is no Neutral or other fixed measurement reference. Following the typical procedure, two wattmeters are required and one phase is chosen as the reference, with phase C being the most common choice, as shown in Figures 2a and 2b.

The EP1 can directly connect to any circuit operating at 600VAC/DC or less. Medium voltage (MV) or high voltage (HV) circuits will require a PT or other voltage transducer to safely step down the voltage below 600VAC and into the measurement range of the instrument.

The EP1 makes circuit connections easy for the user by providing on-screen diagrams showing how to properly connect the instrument. Buttons that allow the user to view Scope and Phasor displays are available to help determine connection problems or meter the circuit in real time. By simply following the diagram for proper voltage and current connections, the EP1 will provide the user with onscreen feedback to determine if the analyzer is connected properly.

It is also able to automatically detect the circuit type to simplify settings. For example, the EP1 screen shot in Figure 2a illustrates when it is connected to a Wye circuit. The image shows the circuit type automatically detected as "3 Phase Wye" and shows the voltage and current connections are "OK." The screen capture in Figure 2b shows that the circuit type manually changed to "3 Phase 2-Watt Delta" is incorrect, which is indicated by the "Mismatch" indicators in red.

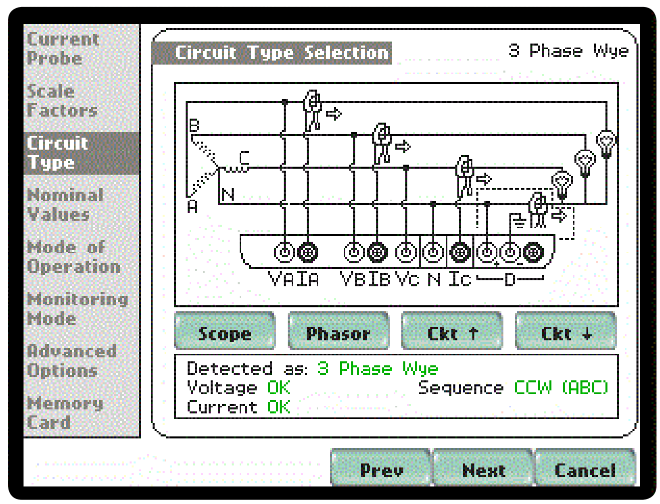

Figure 2a. Determining the connections for an energy analyzer. (3-phase WYE circuit shown)

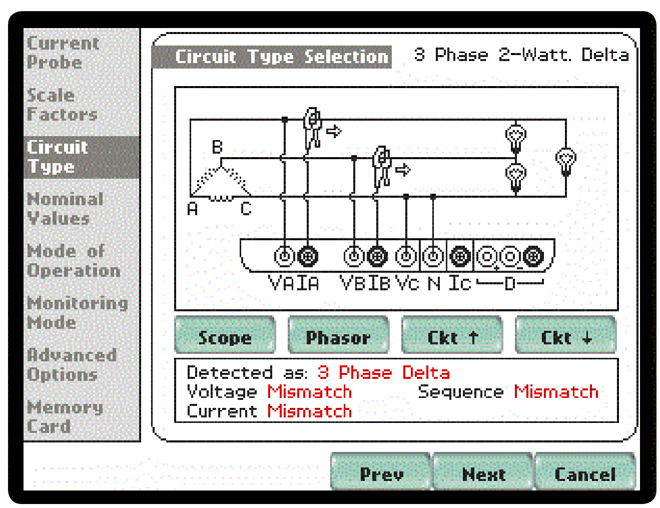

Figure 2b. Determining the connections for an energy analyzer. (3-phase DELTA circuit shown)

EP1 Setup and Configuration

Once the analyzer is connected it must be configured properly for the application. As mentioned previously, proper wiring configuration is essential since this information tells the analyzer how it is connected and how to totalize the power. Beyond wiring configuration, other required analyzer settings are usually dependant on the analyzer's capabilities, with each manufacturer having different requirements.

As shown in Figure 3a, the EP1 not only provides a rich feature set, it is also quick and easy to set up. First, is an automatic setup that requires virtually no user programming. The user simply selects "Automatic Setup" from the Start/ Setup button on the main page and the EP1 will sense the wiring configuration, nominal voltage and current, and set itself up using industry-standard settings. The user only has to select the CTs being used, which are easily chosen from an onscreen list. Once this is done and "OK" is pressed the analyzer is up and running. All parameters available in the EP1 will be recorded and trended automatically and will be monitoring correctly when unattended. The EP1's 4GB compact flash (CF) removable memory, the largest available, allows for ample storage for even the longest of surveys—even in situations with recurring triggers that would fill the memory of most other instruments and render them useless.

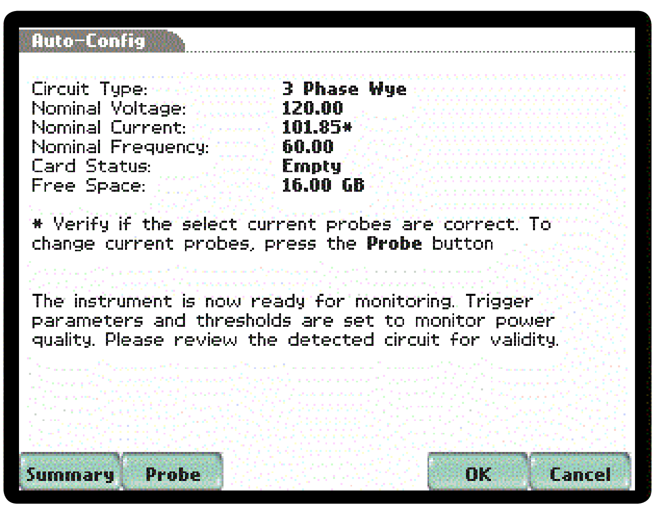

Figure 3a. The EP1 enables quick and easy set up.

For more advanced users, the EP1 has a Wizard setup that provides a step by step setup process for customized settings (Figure 3b). The wizard guides the user though all the steps necessary to configure the instrument, including: current probe selection, wiring configuration, trigger limits, demand/trending intervals, memory card formatting and file naming. It also allows the billing rate and carbon footprint constant from the utility to be entered. Onscreen prompts describe each setting and allows information to be entered using the color touch screen by simply touching the parameter of interest, selecting the enable box, and typing in the high, low and other limits. Once completed, the EP1 can save the settings as a template for future use.

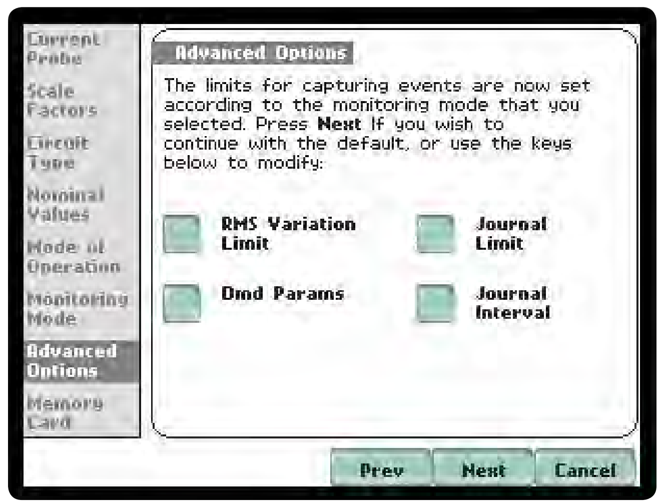

Figure 3b. The EP1 provides advanced set-up options that can be customized.

The Survey

Details of the survey can vary greatly according to the application. The goal of an energy audit is usually to determine the energy profile of the system being monitored. Regardless of application, it helps to know some of the information about what is being monitored, such as the type of load, process or facility. These details are essential for determining the duration of the energy survey.

To obtain a complete picture of the energy profile, it is recommended that several business cycles of the load being audited is monitored. For example, an industrial process that cycles (start to finish) every 15 minutes may only need monitoring for approximately an hour to capture multiple cycles and to find out what is usual or typical for that load. An office building cycling on a 24-hour basis may require a much longer survey, such as a week or more, to determine a typical energy profile. A survey replicating a utility bill may require monitoring for multiple utility billing cycles over several months.

Reporting and Results

All energy analyzers should provide the ability to summarize and report the result of an energy survey, but the range of capabilities and flexibility vary widely. Reporting requirements will vary greatly by application, with some requiring very little detail while others may require formal reports on a client's company letterhead.

The EP1 analyzer's color touch screen provides a user-friendly means of displaying energy information. Figure 4a depicts a two-week demand trend from a light manufacturing facility. As shown in this example, the user can choose any parameter to trend over time or review event lists with details of triggers that have occurred. Figure 4b shows the EP1's color-coded alarm panel indicating trigger conditions that have been recorded during the monitoring session. A green square mean no alarm or trigger conditions have been met for that parameter. Yellow means a trigger condition alarm has occurred while the red squares indicate a severe trigger has been met. The panel on the EP1 provides significant time savings and an easy-to-read visual interface as part of the survey database. Without this alarm panel, users would have to review trends and lists of events to determine what triggers have been recorded.

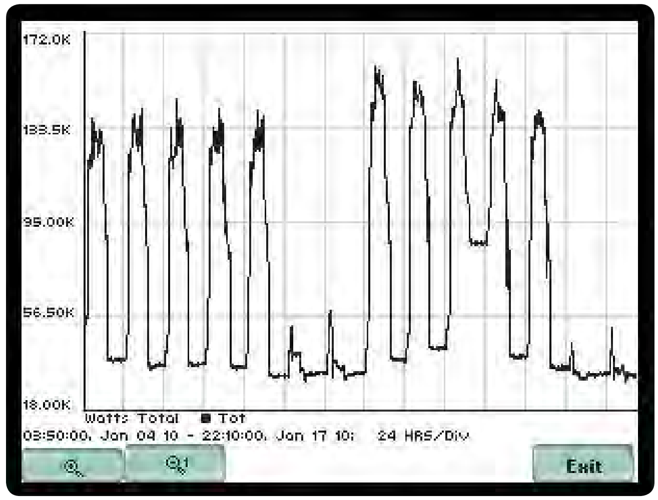

Figure 4a. EP1 can display the demand trend during desired period.

Figure 4b. The combination of the EP1 and its report writing software EPRW provides a powerful set of reporting tools.

Many applications require advanced PC-based reporting for email or printing. In addition making it easy to review data, the EP1 package includes Energy Platform Report Writer software (EPRW) that enables quick and easy reporting and includes a built-in energy audit report. EPRW's reports can be printed directly or saved in a standard (.rtf) format for simple annotating, editing and emailing.

 Dranetz 1000 New Durham Road Edison, New Jersey 08818-4019, USA 800.372.6832 (North America) 732.287.3680 (International) **www.dranetz.com**

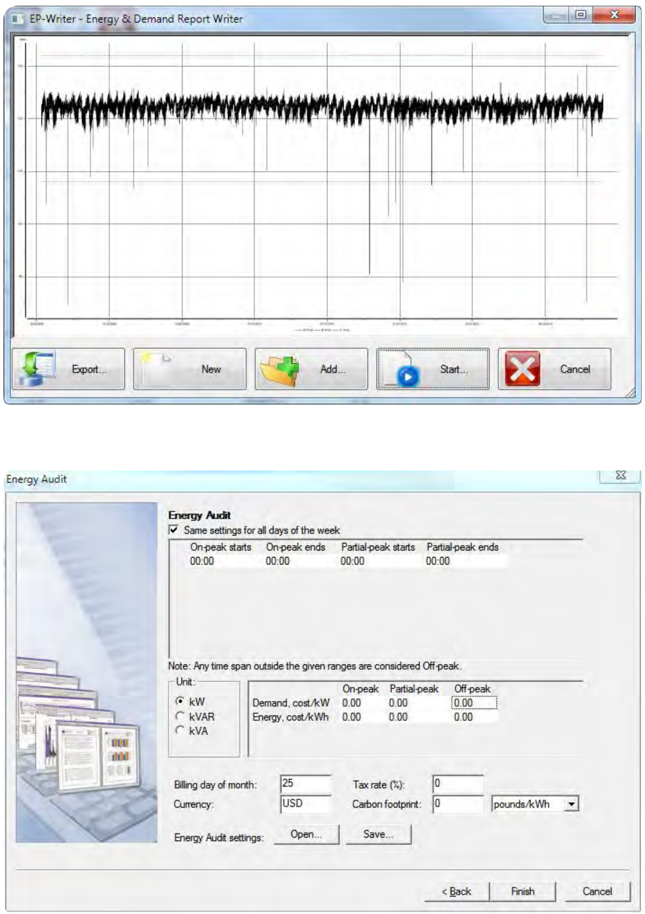

Figure 5. EPRW software enables printed or electronic reports.

The EP1's EPRW software significantly augments the capabilities of the EP1 by providing advanced reporting tools and the ability to export data to other software. EP1 data is recorded to a removable compact flash (CF) memory card. Once the CF card is brought to a computer, EPRW can read the data directly from the card or anywhere else it is stored and is accessible by the computer.

EPRW provides the ability to include or exclude trending of any parameter in the audit report. It also can take this data and produce an easy to read energy audit report. During reporting setup, the user simply enters the utility's time of use information (i.e., on peak, off peak, partial peak) and the associated costs for demand and energy charges. EPRW then produces an energy audit report showing the critical information needed in most energy surveys: how much energy has been used, when it has been used and the cost. A carbon footprint calculator is also included.

For more advanced requirements, the EP1 data can also be viewed using DranView PC software (optional). DranView provides advanced reporting and statistical analysis and allows EP1 data to be used in parallel with data taken with more costly power quality analyzers.

Time of Use Billing
Site: Breaker 32A-5
Measured from 07/14/2009 11:12:09.0 to 07/29/2009 02:37:01.0
BILLING DAY OF MONTH: 25

TIME OF USE COSTS

	DEMAND		
	ON-PEAK (USD)	PARTIAL-PEAK (USD)	OFF-PEAK (USD)
Jul (*)	0.0	0.0	82.4
Aug (*)	0.0	0.0	0.0
	ENERGY CONSUMPTION		
	ON-PEAK (USD)	PARTIAL-PEAK (USD)	OFF-PEAK (USD)
Jul (*)	0.0	0.0	138.2
Aug (*)	0.0	0.0	0.0
Total values	0.0	0.0	192.6

(*) Indicates partial month.

Conclusion

The Energy Platform EP1 package has many features derived from more advanced power quality analyzers from Dranetz. Even at a competitive price, the EP1 provides a color touch screen, automatic setups, large 4GB memory, and alarm reports, to name just a few. The EP1 is an affordable, yet powerful tool for any energy or power monitoring, large or small.