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A New, Dirt-Cheap Way to View Interval Meter Data and Cut Electricity Costs

Lindsay Audin, CEM, CLEP, CEP, IES
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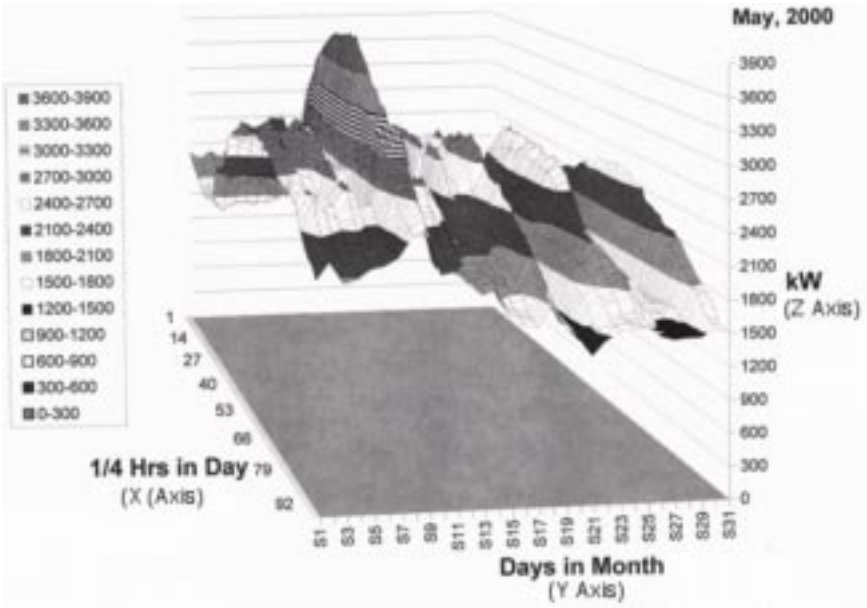

Figure 1. A monthly load shape for a New England college building in May.

EDITOR'S NOTE: Visualize, if you can, the three-dimensional monthly load shape profile pictured above, in 13 different colors. (Not easy, is it?) It gives electricity use at a New England college, for the month of May. In the article which follows, author Lindsay Audin shows you, step-by-step, how to set up a monthly load shape profile like this for your own facility(ies.) Putting the information thus gathered to work—a task that's

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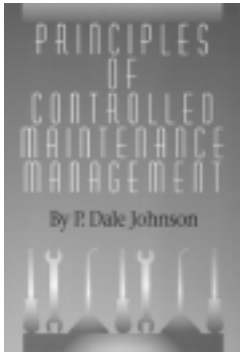

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up to you—will let you reduce your electricity costs.

(If you want to see the profile above in full color, check Lindsay's "Tip of the Month" for December 2001 at *www.EnergyBuyer.org*).

This "Tip of the Month" contains excerpts from Mr. Audin's seminar, "Profiting from Deregulation: Power Techniques for Power Purchasing," which focuses on training customers and consultants to handle retail power procurement. See *www.energyseminars.com.*

ABSTRACT

Trying to use monthly electric bills to understand power usage is a bit like trying to read a book held 50 feet from your face: at best, all you can make out is the shape. Interval meters give a clearer picture by providing 1/4-hourly consumption readings, but sifting through 3,000 readings a month is not a practical use of your time. What if you could visually scan your monthly (or even annual) load shape in a single color-coded three-dimensional picture? If you know Microsoft Excel, doing so may be easier than you think.

PUTTING INTERVAL DATA TO WORK FOR YOU

Most commercial/industrial electric accounts of 1 MW or higher are billed using a utility-owned interval meter that reads usage in 15- or 30-minute increments and reports that data (typically through a phone line) back to a utility computer. The customer is then charged for peak demand based on the highest consumption seen in one or two consecutive increments. A 300 kilowatt-hour (kWhr) usage in a 1/4 hour, for example, would translate into an average demand of 1200 kW for that period. For further information on this technology, see the August 2001 Tip of the Month at www.energybuyer.org.

Some customers (with permission from the utility) tap into those meters and send the interval data to their building management system (BMS) computer for conversion and analysis. A few others install meters designed to format this data directly into PC-compatible files and download the data through their firm's intranet. Some customers (or their

consultants) buy the monthly (or annual) data from the utility in .xls or .csv format so that it may be easily loaded into a spreadsheet, or "energy enterprise" software (see list under the heading "How To Get Started" in the *Sept. 2000 Tip of the Month* for later analysis). Files are received as e-mail attachments at a cost ranging from free to $100 a month, depending on the utility.

When converted into spreadsheet format, the readings may be analyzed to spot trends or operating problems (e.g., controls failures, incorrect fan schedules). While it takes a keen eye and a good engineering sense to translate perceived anomalies into corrective actions, that effort is eased considerably when the data is available in a graphic format. When graphed in 3D, the magnitude, duration, and relative impacts of such anomalies practically leap off the page.

VIRTUAL LANDSCAPING

Using Excel's chart features for creating a 3-D surface, those 3,000 monthly points are transformed into a landscape of mountains, valleys, plateaus, and peaks. The key to this trick is to use Excel's **SURFACE** function to graph each day's 1/4-hour readings on the X-axis, the days of a month on the Y-axis, and power demand on the **Z-AXIS** (*see Figure 1*). A typical building's power usage then appears as a series of parallel weekday mountains each 24 hours long, separated by weekend valleys. If nighttime usage is the same on weekdays and weekends, a plateau (i.e., a common time period in which usage is relatively low and constant) may be visible at each end of the mountain range. When a mountain's slope or height changes significantly relative to that of the others, we are seeing greater power demand and/or longer usage. When we see a sharp peak, a brief jump in demand becomes obvious. Such spires usually mean hefty peak demand charges.

In Figure 1, we see a monthly load shape for a New England college building in May. That's when its air conditioning season may begin, with one or two hot days setting the peak demand level for the month. The lines in the graph connect each interval's level of consumption with those that preceded and followed it on a given day, and to those occurring at the same time on days preceding and following it. The graphed surface then simultaneously shows how power usage varied from hour to hour and day to day.

MAKING THE MAGIC HAPPEN

To create and manipulate these charts, you need interval meter data (preferably in 1/4-hourly periods for a month), a 400 MHz Pentium II PC (or better), and Microsoft Excel (version 97 or 2000, though some older versions also work). When developing a shape for an entire year, it's best to use at least a 700 MHz Pentium III machine to avoid the long regeneration times required each time a change is made (e.g., orientation, title, etc.). A 400 MHz Pentium II machine should regenerate a monthly chart in 1-3 seconds, but annual charts may take 20-30 seconds (or longer). Older machines may simply crash when asked to digest such large files, so shut off other system-intensive programs when performing this task.

To make the chart come out right, here are a few tips.

- Be sure the first day's worth of data is complete. Interval data may start in the middle of a day, which confuses Excel. If such is the case, delete cells until you have a starting row that is completely filled. Highlight only the data cells, not the times, dates, or other information that may be provided in the file.
- Use Excel's Chart Wizard to create the initial version of your graph. At its Step I (**CHART TYPE**), choose **SURFACE**. Under **CHART SUB-TYPE** on that same screen, choose **3-D SURFACE**.
- When it comes time to enter names for the axes, enter **1/4 HOURS OF A DAY** for the X-axis, **DAYS** for the Y-axis, and **kW/4** for the Z-axis. Since interval data is actually given in kWh per 1/4 hour, the demand readings on the graph should be viewed as 1/4 of the average demands seen in each interval. If you want the Z-axis to show true kW, ask your information technology (IT) people to help you make that correction. That fix does not change the shape of the surface, so it's easier at this point to just remember to multiply any demand numbers by 4 to determine their true values.
- Once your chart is completed, the numbers for the days will appear with the letter S in front of them (e.g., S1, S7, etc.). That is an artifact of Excel; don't worry about it.
- At Step 4 (Chart Location), choose **AS NEW SHEET** so the chart appears under a separate Excel file tab. If you choose **AS OBJECT IN**, you may have longer regeneration delays and other difficulties.

- To best see the surface's shape and any anomalies, maximize the size of the **PLOT AREA**. Do so by moving the **LEGEND** to an empty corner, reducing the size of its text font, or just deleting it. Place your cursor near (but outside) the bounds of the graph so the words **PLOT AREA** appear. Click on that spot and see a rectangular boundary appear. Drag its corner until the graph fills most of the available chart space. You may also wish to reduce the size of your titles.

If you don't have a month of interval data to play with, e-mail us at energywiz@aol.com and we'll send you the file (in Excel 2000 format) used to make Figure 1.

SOARING ACROSS YOUR DATA

Now comes the fun part. On your toolbar, click on the **CHART** tool to see a drop-down box. Click on **3-D VIEW** to see fields for **ELEVATION**, **ROTATION**, **PERSPECTIVE**, and **HEIGHT**. To best view the surface's shape, first stretch the **DAYS** axis by reducing the **HEIGHT** percentage to 50 and clicking on **APPLY**. The impact will be immediately visible. Next, click on the various arrows in the box to maneuver the **WIRE-FRAME** sketch. When it's oriented the way you want to view your 3-D surface, click on **APPLY** to see the chart move into that orientation. The same result will occur by placing your cursor on one of the corners of the base of the graph. When the word **CORNERS** appears, press and hold your left mouse button. The instant you move your mouse, your chart will turn into a wire-frame diagram showing you how its orientation is changing. Go slowly at first as this technique takes a little practice. Release the mouse button when you achieve your desired orientation. Use the **ZOOM** command and your scroll bars to "fly" in for a closer look. You will begin to see variations that challenge your mind to consider how and why they occurred.

In our example, we see a two-day period where the power demand is significantly higher than the others due to unseasonable temperatures. The chillers had to run full tilt for just two days, raising the peak demand from the next highest point (3036 kW) to 3900 kW. A hybrid chiller plant (i.e., employing both electric and gas-fired chillers) or a thermal storage system might have avoided that costly bump. Through this process, you may find operational problems, controls failures, meter errors,

and other opportunities that could save your firm a bundle. Smoothing out your demand curve may also cut your cost for contracted power.

CONCLUSION

A graph by itself tells you little, except that there's an anomaly worth investigating. The challenge starts when you try to figure out what caused it. The end result may be a realization that submetering of some loads is needed to control demand spikes, that operating staff is not following shutdown rules, or that somebody screwed around with the BMS. As always, it's up to you to determine how to find and fix the problem.

ABOUT THE AUTHOR

Lindsay Audin (CEM, CLEP, CEP, IES), is the president of Energywiz, Inc., an energy consulting firm serving the competitive energy market, government agencies, large end users, and other consultants.

Audin has been named Energy Manager of the Year by three different national or regional organizations, most recently by the Association of Professional Energy Managers in 1995. In 1993, the Association of Energy Engineers (AEE) named him their International Energy Manager of the Year, and in 1996 inducted him into its Energy Manager's Hall of Fame, the highest recognition in that field.

He served on the board of the New York Designer's Lighting Forum, the *Energy User News* Technical Advisory Board, and an ASHRAE 90.1 technical committee. His column on lighting and energy issues has appeared quarterly, in *Architectural Record* magazine since 1991, and his work appears frequently in energy-related publications.

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