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# Unlocking the Promise of Advanced Metering

## Analyzing Interval Data

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## Advanced Metering

Advanced Metering is becoming the premier information tool of the electric power industry. Substantial benefits for the end user—lower energy costs, better monitoring of facility operations, accurate budgeting tools, etc.—are being promoted by the industry.

Firms that specialize in facility and energy management have found they can routinely save 15% of the total energy bill in any building that has not had an expert fine tune operation within the past year. For the commercial building sector, this implies a potential savings of $12 billion annually. Advanced Metering clearly has the potential to provide the information necessary to tap into this potential.

| Building Floor Space (square feet) | All Buildings | | Consumption | Energy Cost per Square Foot | | | |
|---|---|---|---|---|---|---|---|
| | Number of Buildings (thousands) | Floor Space (million square feet) | mBTU per Square Foot | North-east | Mid-west | South | West |
| 1,001 to 5,000 | 2,348 | 6,774 | 123 | $ 3.72 | $ 1.45 | $ 2.19 | $ 2.12 |
| 5,001 to 10,000 | 1,110 | 8,238 | 79 | $ 1.48 | $ 1.05 | $ 1.24 | $ 1.68 |
| 10,001 to 25,000 | 708 | 11,153 | 70 | $ 1.50 | $ 0.80 | $ 1.17 | $ 1.12 |
| 25,001 to 50,000 | 257 | 9,311 | 81 | $ 1.79 | $ 1.05 | $ 1.34 | $ 1.35 |
| 50,001 to 100,000 | 145 | 10,112 | 93 | $ 1.66 | $ 1.25 | $ 1.32 | $ 1.65 |
| 100,001 to 200,000 | 59 | 8,271 | 105 | $ 1.84 | $ 1.48 | $ 1.67 | $ 1.51 |
| 200,001 to 500,000 | 23 | 6,851 | 107 | $ 1.64 | $ 1.31 | $ 1.46 | $ 1.53 |
| Over 500,000 | 7 | 6,628 | 102 | $ 2.11 | $ 1.54 | $ 1.16 | $ 1.15 |

Data obtained from EIA's 1999 Commercial Buildings Energy Consumption Survey (CBECS). Square foot consumption and cost metrics have been adjusted to exclude warehouses.

Just as clearly, that $12 billion benefit rounds out to merely $15-20 per month per 1,000 square feet of floor space. This potential savings is not fat that can be trimmed, but marbling in the meat of operation. The opportunity exists because most people are unaware of the compounded implications of their actions. For whatever reason, they don't bother to shut off unnecessary lights. They turn down the thermostat on that really hot day and never bother to turn it back. There was late meeting, so they had the heating system run longer and the time clock was never reset. Pretty soon, the utility bills are up. Somebody calls it "load creep". It's not the main line of business in the company, so the bill gets paid and the cause is forgotten.

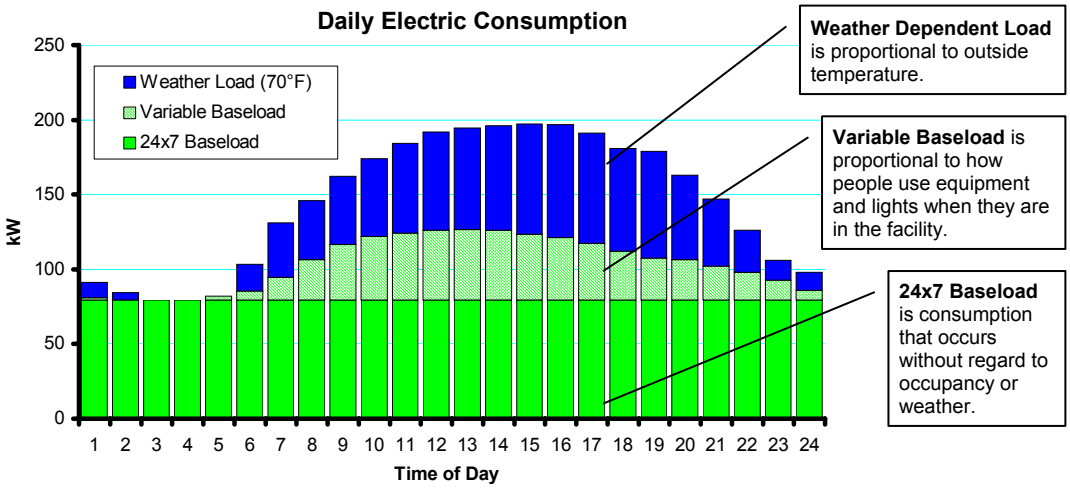
Capturing the savings potential will not be easy. There are two substantial hurdles to overcome, the first of which is cost. Advanced Metering is more than just the installation of a meter. The device needs a communications pathway, interface applications and operational strategies put in place in order for it to produce results. There is also a question of who should make the investment. All of these can and will be resolved. The more significant hurdle is that **the market needs to be educated about Advanced Metering and how to achieve its benefit.**

## Information: The Value in Advanced Metering

In the 1950's, electric utilities had a vision of power so cheap there would be no reason to meter. Economies of scale drove costs down to the point where even if you metered, at least you didn't have to actively manage consumption.

Different times, of course, lead to different strategies. The promise of Advanced Metering is the ability to resolve consumption according to time of day while the utility varies the time-of-day price according to market conditions. The expectation is that consumers will apply modern management techniques, change their habits, and extract new efficiencies for the industry – all so that the utilities can keep overall costs down while meeting their mandate for plentiful, reliable power. It promises to be the perfect, symbiotic relationship after the business owners, facility managers and end users have learned how they are expected to respond.

Interval data presentation is the most significant development since the invention of metering. The building owner now has the capability of seeing when power was used, in addition to the total amount. Raw data, of course, does not normally yield significant information. The ability to interpret the patterns of consumption is the ability the industry hopes its users will achieve.




The chart shown above is a typical daily consumption pattern for a building. Interval data, as supplied by the meter, only describes the height (kW) of each hour's consumption column. Looking closely, it is possible to see that there is a block of consumption

that occurs 24 hours per day (green). This minimum, unoccupied level of consumption normally occurs seven days per week. The next block of power identified in the chart is Variable Baseload (green stripe). This consumption is a result of equipment – lights, computers, office machines, etc. – that people use when at work. The final power block is weather dependent consumption. As will be seen, weather load can be extracted through statistical analysis.

The new level of information available as a result of Advanced Metering is both self-apparent and obscure in the facility management industry. Tools to take advantage of its value still need to be developed. And as they are developed they need to be integrated into the daily operation of operating a building.

## Analyzing Interval Data

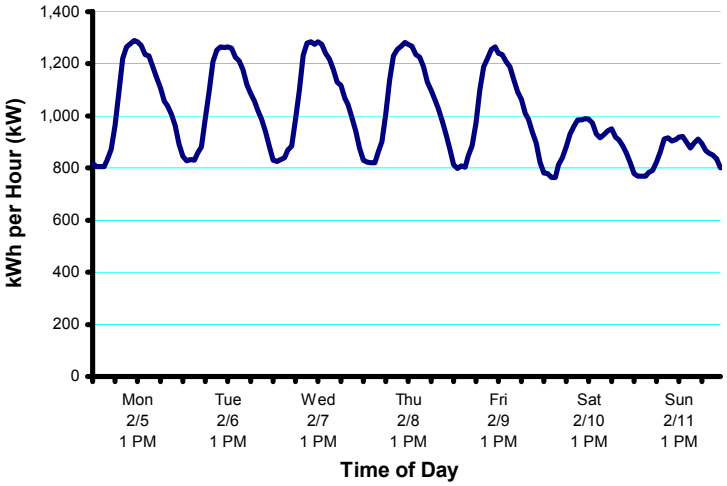
Analytics can be summarized as a process for identifying patterns within a given set of data. When considering utility metering data, these patterns are often hidden deep within the data. Pulling out the patterns requires an understanding of how buildings operate as well as the ability to perform complex statistical analyses. The benefits, however, are substantial. Analyzing Interval Data will explain a process that reduces the complexity of analyzing utility data.

Once the bills are modeled—whether they are gas, electric, etc.—they are reduced to that state which allows them to be scientifically managed. Past performance predicts future performance. Any deviation becomes a flag for management's attention, while consistency confirms good practice. And, because the bills predict future consumption on the most detailed levels, purchasing strategies can be maximized to obtain the best price.

### Controlling the View

Interval meter data provides a rich source of information for energy traders, service companies, and facility managers. Every decision regarding the construction and use of a building is locked within the bill. The key is to find a process that will unlock that information in a cost-effective way.

Looking at interval data in the manner that it is received, a time-stamped strip, alludes to a pattern. Monday through Friday appears to have the same peaks; Saturday and Sunday show the same saw tooth pattern, but with considerably lower peaks. Rearranging the data will provide better insight to the pattern.

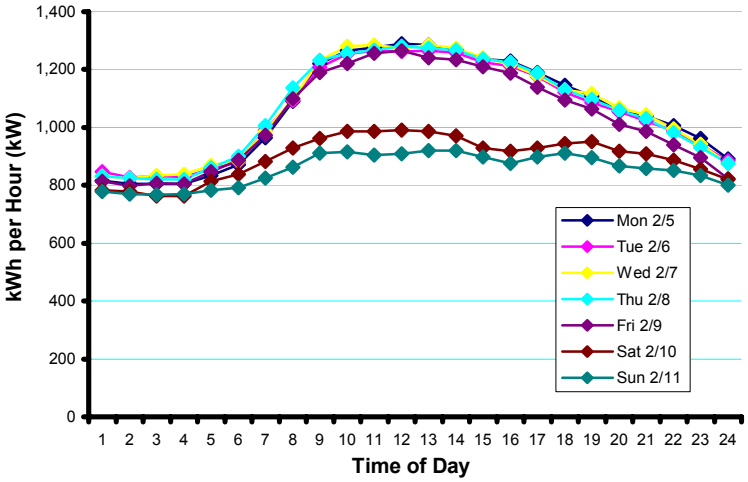



Spreading the time interval out over a single day, then overlaying each day upon the next, allows you to look into the pattern. (A little background information is in order. The sample data has been derived from a hospital, with 24x7 occupancy.) There is a standard workday pattern apparent. Occupancy begins to ramp up around 6 AM, levels off around 9 AM, begins to tail at 5 PM and everyone is asleep by midnight. Even though the building is occupied on the Weekend, consumption is far lower indicating that the doctors are responsible for driving consumption during their work hours.

Based upon this chart, it is easy to see that energy consumption is a function of process and schedule. A critical piece of information also recognized is that in a hospital – as well as most other business activities – process consumption varies in proportion to schedule (in this case the doctor's 9-5 M-F). This colinearity of factors that drive consumption will make it simpler to define a model.

### Minimizing Complexity

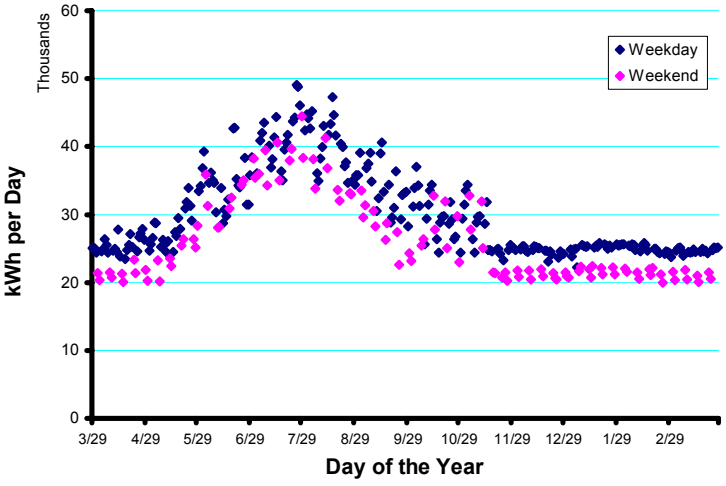
Weekdays versus Weekend consumption patterns were identified in the previous graphics. To see if this pattern holds together over an entire year, the simplest step is to summarize the data by day,




then look at the pattern that emerges.

There are two viable methods for looking at the annual pattern of consumption from interval data. As we have seen when each day of the week's pattern (24-hour) was overlaid, there is a consistency for day type according to the hour of the day. Therefore, the first method is to examine the annual pattern of each hour of the day. Eventually, this method will allow the load profile of the facility to be extracted.

Since we have already seen that the hourly consistency exists, a simpler method is to sum all twenty-four hours into a single day and examine the daily pattern. It is obvious that Weekend consumption trends lower than Weekday. That pattern holds true.

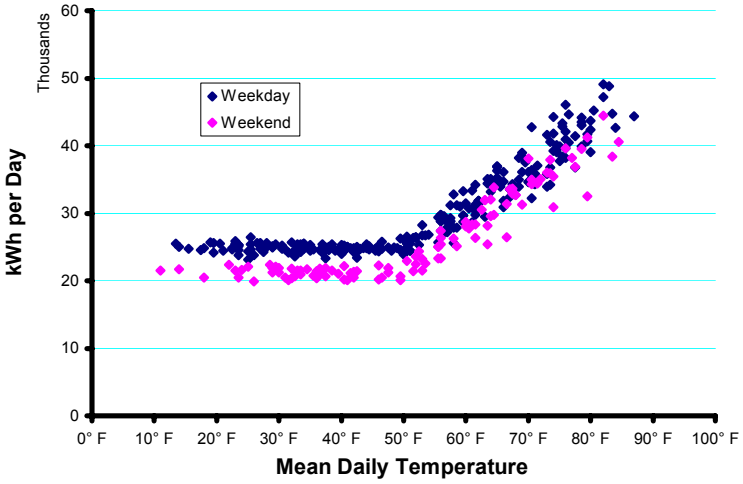


But there is another pattern overlaid on consumption that creates an increase during the summer months while blurring the Weekday/Weekend relationship.

The daily kWh is reorganized again to highlight its relationship to weather (as characterized by the most common metric, Mean Daily Temperature). At this point there is enough information about the patterns of energy consumption and the factors that describe it to build a model: consumption is a function of schedule, process and weather.

$$Q = f(s, p, w)$$

Since process is known to be colinear with schedule, a single factor will describe both.



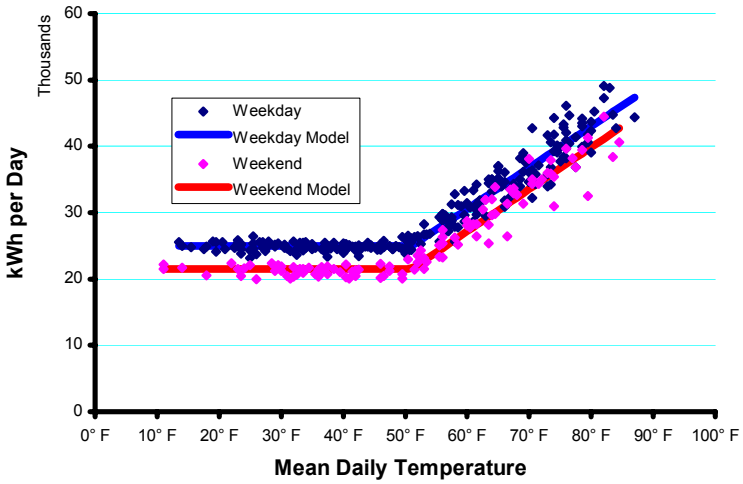

The colinearity of schedule and process is an extremely important insight into energy consumption patterns. The implication for commercial building energy consumption is somewhat obvious. A typical pattern of occupancy, e.g. Weekday/Weekend & Holiday, describes a majority of facilities.

Industrial facilities often exhibit this same pattern of colinearity among process and schedule. Even though there are particular processes that drive energy consumption differently, there is often a consistent schedule for those processes that can be extracted from the interval patterns of energy consumption. This means it is often possible to describe consumption patterns by an artificial variable (day type) as opposed to having to have access to the actual production data. For companies where the sharing of production information can be an issue, this is an extremely attractive benefit of the modeling process.

## Using Regression to Build a Model

Regression is used to develop the equations that describe consumption. Two curves are shown is this chart, one for Weekdays and the other for Weekends.

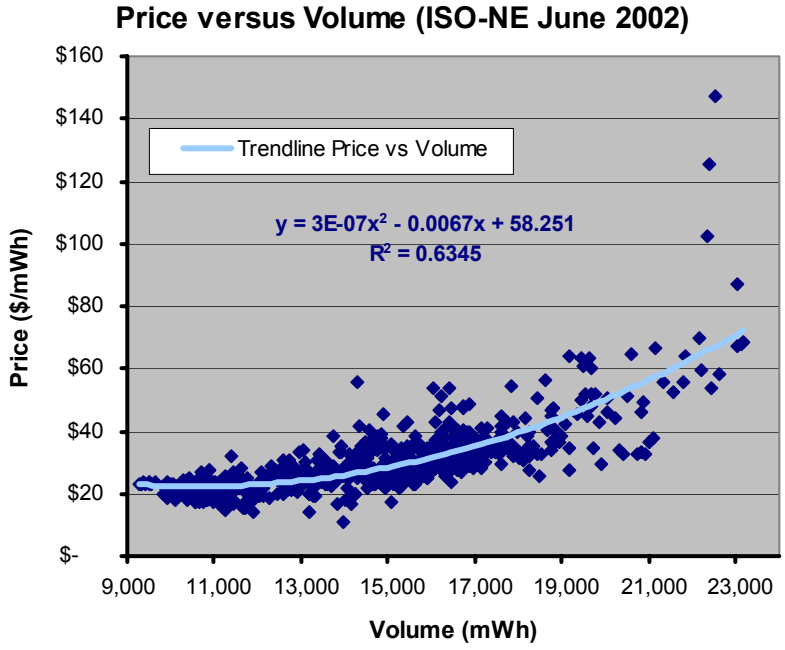
Mean Daily Temperature (MDT) was actually represented by calculating site-specific Cooling Degree Days (CDD). In this case, each CDD is equal to the MDT minus 51° F, whenever the MDT is greater than 51° F.




One benefit of regression analysis is that the standard deviation of the model versus actual use can be calculated for both baseload and weather dependent consumption (±3% and ±26%, respectively). The accuracy of the energy model has implications in both energy conservation potential and the cost of power.

## Deregulation: Putting Value on Risks in Energy Supply Contracts

We have seen that historical energy consumption for a facility can be modeled. The nature of facility operations is such that this model is also an accurate predictor of future consumption. As the market becomes more educated it will demand products that accurately match its risk profile with cost.



Historically, regulated public utilities have used a highly complex methodology to determine the cost of service and set the price for energy consumption. Deregulation, which split the price of energy from the price of the delivery system, has unequivocally shown that market system to be flawed. The price of energy has significantly greater bias toward time of use and seasonality than has been captured under rate structures. Recent trials with Price Responsive Load Management (PRLM) indicate that dramatic savings in system costs and increases in system reliability are achieved when demand management is included as part of the supply of energy.

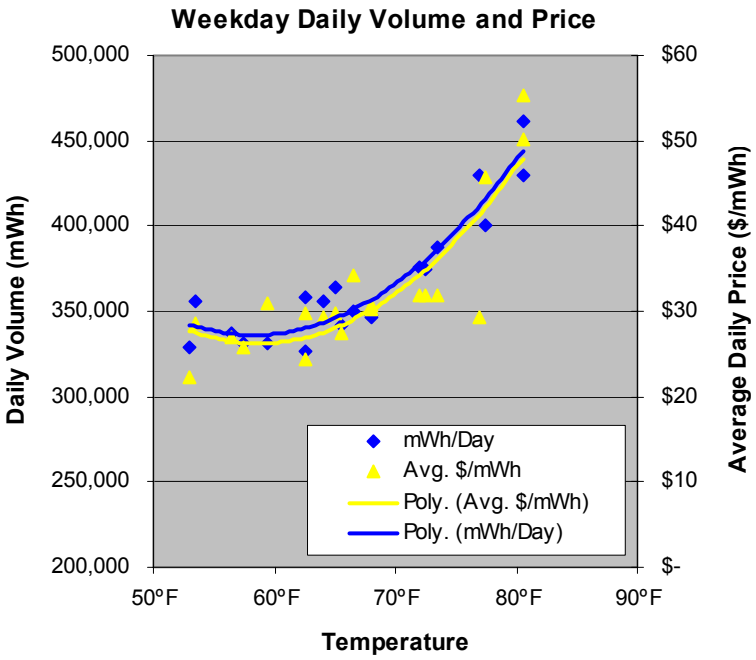
One way to look at electrical power and quantify its volatility is to compare the price of electricity at the Independent Systems Operator (ISO) with the volume of electricity being delivered. In the chart Price versus Volume, you can see that the hourly price of electricity varies with the amount (volume) being purchased. The variation from the mean price at any volume is clearly identified in the chart.

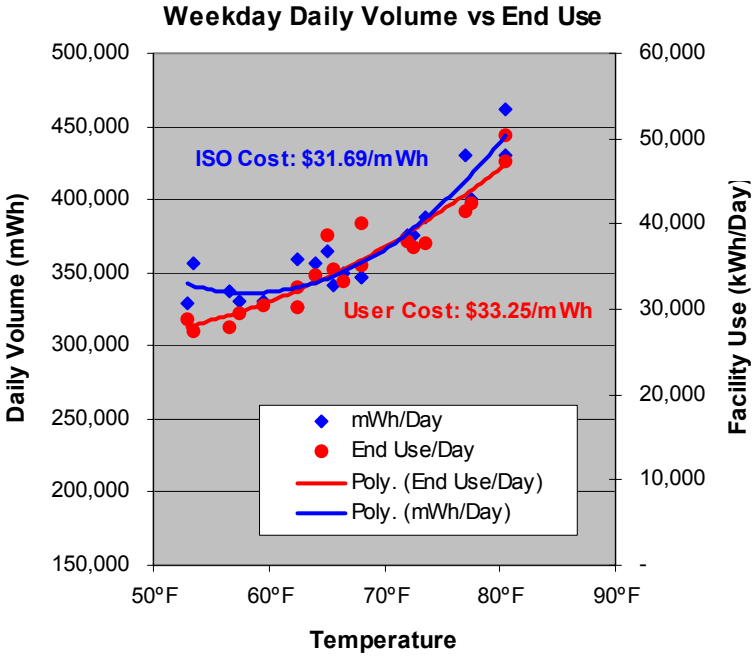
In order to quantify the risk associated with supplying power to a facility or group of facilities, it helps to view the variables in the same context. Consumption at the ISO is the same as an aggregation of facilities. Therefore it is possible to model the data as if it were a single interval meter.

The model on the right, Weekday Daily Volume and Price, redisplays the previous chart as a daily summary with separate plots for both the volume and average price for the day. As is shown, the correlation between volume and price remains.

The next chart, Weekday Daily Volume vs End Use, exposes an additional source of risk. If the facility consumption exactly tracked that at the ISO, its wholesale cost of power would be $31.69/mWh. However, just as the price of power has a risk component associated with its volatility, the model of consumption for the facility identifies an additional component of volatility. In the projection shown, the price of providing power for this facility can be nearly 5% greater, or $33.25/mWh.

Clearly, volatility associated with end use consumption is a significant risk in providing power. This volatility is unique, but quantifiable, for each facility. The fact is that **facilities that are managed better have less risk associated consumption volatility**.




## Conclusion

Advanced metering will continue to expand in the marketplace because significant value can be found within its data. Energy suppliers will push for its implementation because it allows a proper assessment of the risks within their portfolio. (Typically, traders hedge their position by balancing their portfolio against changes in the price of energy. By default this presumes that the risk associated the volatility of consumption is equal across all end users. Energy modeling shows that this is not true and that the process of deriving the variation is economic.)

As users become familiar with this tool they will appreciate its value to managing their facilities. They will also demand retail power products that recognize the value of their efforts. More importantly, they will demand better management of energy within their own organization.

There is a caveat – something that is often lost in the euphoria of advanced metering. Although industry wonks can identify tremendous value within the data, the average user cannot. Benefits from advanced metering comprise a mass market, which requires different tools than the industry is used to supplying.

This paper has shown one method that can be used for identifying and accessing value within advanced metering. By no means does it represent a tool for the mass market since the presentation is far too complex. The state-of-the-art with regards to Information Technology for advanced metering data is about to change or, …the promised market will fail to materialize. Which one will it be? These are exciting times.

## For more information:



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