Plant Power Efficiency
White Paper

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Abstract: A method for monitoring improvements in electrical energy usage that filters out the effect of changing energy usage.

This paper is intended for facilities that are paying a demand rate for *power* on top of the utility charge for electrical *energy*. Some plant operators and owners may be looking for a way to be certain that the plant is being as efficient with its power as is physically possible. This is over and above programs aimed at optimizing plant energy efficiency.

Some types of industry have a very flat power curve. That is, at any time of day or night, for any day of the month, the instantaneous power is at a constant level. This would be typical of a constant chemical process, such as a sulphur separator for a petroleum facility. In a facility of this type the energy is used at a nearly constant rate. The power curve for the entire month is quite flat. By comparison, a factory that operates two shifts a would have a power curve that has lots of hills and valleys. A facility with a flat power curve is already paying the lowest possible price for electrical demand. Those facilities with power curves that look more like a roller-coaster may save on demand charges through *increased plant power efficiency*.

If monthly energy usage were always the same for each month, measuring *power efficiency* would be a simple matter of comparing a month's metered demand with that of another month. Since constant energy usage is far from typical, a different method of measuring *power efficiency* is required.

Measuring power efficiency in a way that filters out variations in energy usage is done by comparing *metered demand* with *flat demand*: what the demand would have been if the facility were hypothetically able to operate with an absolutely flat monthly power curve.

The following simple equation shows how to calulate the demand for a flat power curve for any type of facility:

$$Efficiency\% = (Pavg / Demand) \times 100$$

$$Pavg = KWH / H$$

Where:

Pavg is the month's flat curve equivalent power.

KWH is the month's metered energy

H is the number of hours in the billing period.

Demand is the metered demand for the billing period.

Attaining 100% efficiency is not a reasonable goal. It is simply not possible. A calculated efficiency of 100% or more could mean that the utility meter is in need of calibration. Either the metered *energy* is being exaggerated, or the *demand* is being understated. It could also mean that the value for *hours* was incorrectly estimated.

Fictional Examples

These are fictional companies. The power and energy numbers used are based on actual facilities where power trend management is being used.

ABC Chemical Manufacturing:

Continuous process manufacturing of polypropylene fiber products; uses slightly more energy during summer for extrusion process cooling. The slight improvement in efficiency for Demember is due to having fewer switched loads than in July.

July Power Efficiency:

Billed hours	= 744
Metered demand	= 767kw
Metered energy	= 588,000kwh
Efficiency%	= ((558,000 / 744) / 767) x 100
	= 97.8%

December Power Efficiency:

Billed hours	= 744
Metered demand	= 692kw
Metered energy	= 505,920kwh
Efficiency%	= ((558,000 / 744) / 767) x 100
	= 98.2%

Crosstown Shopping Centre:

Electrical energy usage during summer months almost doubles with air conditioning demand. Winter heating uses natural gas. Display coolers and meat lockers are still operating on electrical refrigeration during winter months.

June Power Efficiency:

Billed hours	= 720
Metered demand	= 690kw
Metered energy	= 312,100kwh
Efficiency%	= ((312,100 / 720) / 690) x 100
	= 62.8%

January Power Efficiency:	
Billed hours	= 744
Metered demand	= 392kw
Metered energy	= 189,571kwh
Efficiency%	= ((312,100 / 720) / 690) x 100
	= 65%

Notice how there is only a slight difference in power efficiency, even though the metered demand for June is almost double that of January. This is why it is important to filter out differences in energy usage when measuring plant power efficiency.

Author's commentary:

Facilities like ABC Chemical Manufacturing with flat power curves have nothing to gain by applying *power trend management* techniques. They really do not have a problem to begin with, even though they may not be happy with their monthly demand charges.

It has been proven that a retail mall can raise its power efficiency from 65% to 73% by applying *power trend management* techniques. The difference in efficiency pays for the *power trend management* system. The resulting lower *billed demand* for the peak summer month is locked in by the electrical utility and the savings carry on for the next twelve months.

The average monthly return on investment is 30%. Although this is relatively small dollars in comparison with the total cash flow for such a facility, it enables the facility to get the asset monitoring and protection benefits of the *power trend management* system for free. There are actual cases in which these protection features have prevented huge energy cost overruns by revealing that a large power load was stuck on, and by revealing improper duty cycling of large loads by technicians doing repairs and adjustments. If not for the PTM system these costs could have continued indefinitely. This resulting in preventive savings roughly equal to the retail price of the *power trend management* system.

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