Brakey Consulting, Inc.
your key to energy

Power Factor Improvement

Two FirstEnergy Examples

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Executive Summary

Power factor is a measure of how effectively your equipment is converting electric current from the generation station to useful power output. Certain types of electrical equipment (transformers, motors, etc.) require power in excess of the kilowatts actually metered. In other words, this equipment requires a level of "apparent" power (kVA) greater than the "real" power (kW) consumed (incandescent lights, resistance heaters, etc). The utility must generate additional power to cover this excess, which is called "reactive" power, or kilovolt amps reactive (kVAR).

Power factor is the ratio of real power to apparent power, or kW / kVA. As your power factor approaches 100%, less current must pass through the wiring to operate the equipment. Only at 100% power factor is the real power (kW) and the apparent power (kVA) the same.

Many utilities charge a premium for low power factor because they must install larger equipment down the line to satisfy the requirements of these consumers. Some utilities penalize heavily for poor power factor (e.g., Ohio Edison) while others do not (e.g., the Illuminating Company). Ohio Edison bills peak demand directly in kVA (kW demand / power factor), which means that the customer is penalized for any power factor less than 100%. The Illuminating Company has an additional demand charge for kVAR.

There are solutions to reduce this inefficiency. However, the energy user needs to understand how poor power factor impacts the bottom line. When power factor penalties in themselves are low, it may not be worthwhile to take measures to improve power factor unless these measures can be justified by other benefits, such as a reduction in harmful harmonics and a reduced transformer loading.

This report provides an analysis of the results of power factor improvement measures that have been taken by two MICA member companies. One company is served by Ohio Edison, while the other is served by the Illuminating Company.

Additional details on the data and analysis are available upon request.

Michael W. Brakey, President

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Ohio Edison Example

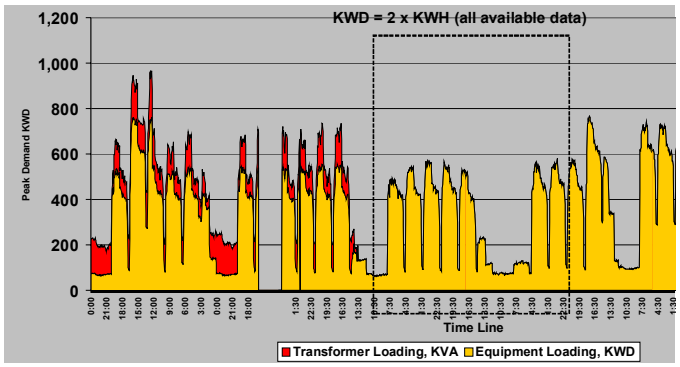
Company A has two facilities which are served by Ohio Edison, a FirstEnergy company. Both facilities are metered under the General Service Large rate schedule.

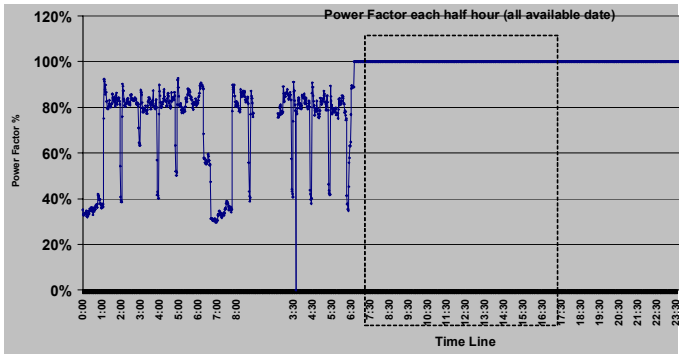
Company A installed power factor correction equipment from Correction Controls at the first facility in May, 2006. The results showed up in the electric bills for the billing period ending in June. Their power factor which, on average, hovered in the low to mid 70's, went to 100%. Because of the success of this installation, a few months later, the equipment was installed at the second facility.

The table below shows a history of the onpeak power factors[1] by facility.

Billing Month	first facility	second facility
February	74.613%	96.953%
March	71.897%	96.116%
April	75.524%	96.299%
May	78.690%	95.699%
June	100.000%	95.758%
November	100.000%	98.600%

The first graph illustrates the kVA (in red) being out of phase with the kW (in gold) when the power factor is less than 100%. The second graph below, with the blue line, shows the first facility's power factor for each half hour interval between May 15 and June 16, 2006.





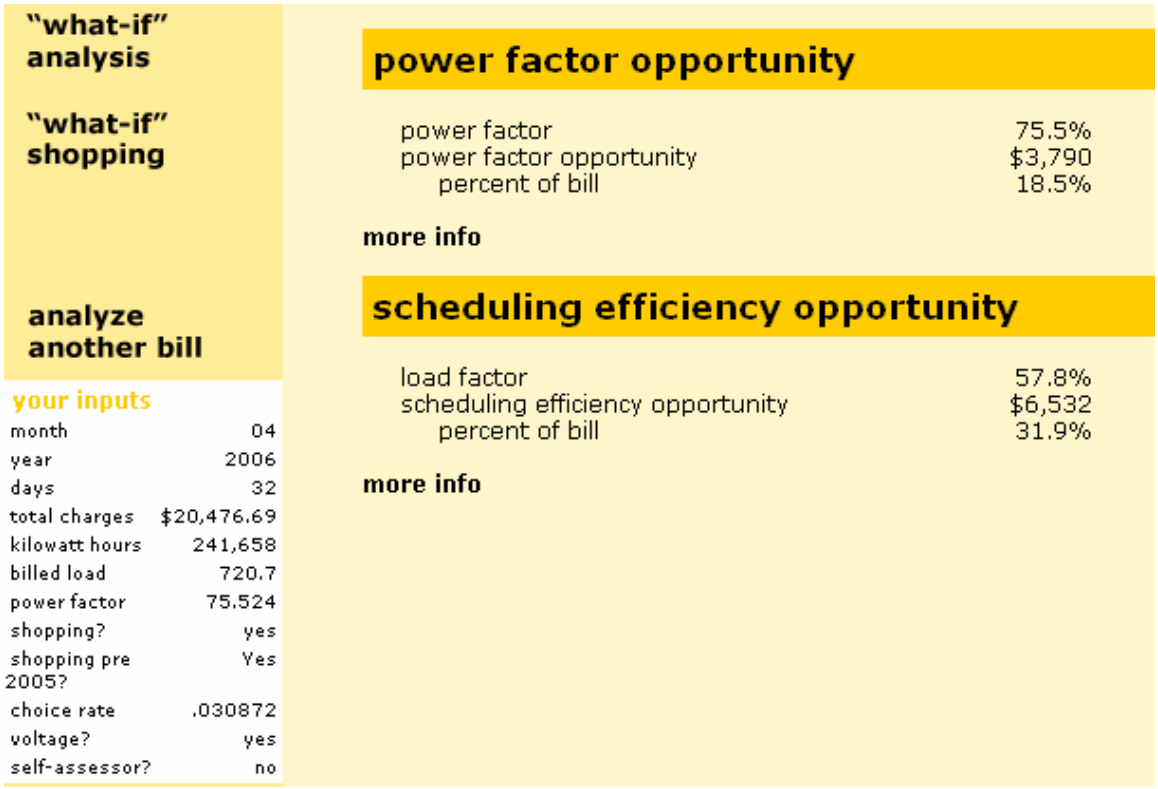
The power factor increased to 100% on May 20, after the installation of the Correction Controls' equipment. We see this represented graphically by no difference between the apparent power (kVA) and the real power (kW).

During some of the heavier loading periods, power factor fell as low as 38%, prior to the installation of the Correction Controls' equipment. However, the power factor was 100% at the highest peak load of 766.1 kVA on June 2, 2006.

[1] Ohio Edison defines "onpeak" as the period between 8:00 A.M and 9:00 P.M.

Cost Savings

Using *EnergyManager.com*[2], we estimated the potential savings opportunity from power factor improvement based on the April electrical profile for Company A's first facility. This was prior to the installation of the power factor improvement equipment. If they could have increased their power factor to the ideal of 100%, the savings would have been about $3,790, or 18.5% of the electric bill. (See results below.)



The actual charges for the first facility decreased from $25,934, or 10.4¢ per kilowatt hour, for the billing ending in May, to $22,533, or 7.8¢ per kilowatt hour for the billing period ending in June. With many different variables going into the calculation of an electric bill, this entire difference can not necessarily be attributed to power factor correction.

[2] *EnergyManager.com* is an easy-to-use website that provides Ohio business customers of FirstEnergy with the information they need to reduce their electric costs.

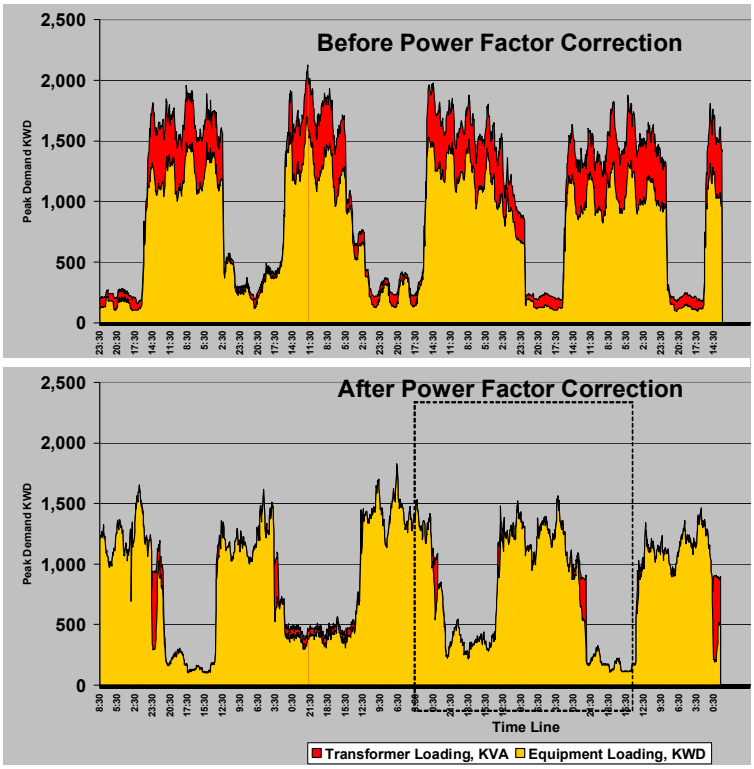
Illuminating Company Example

Company B has a facility which is served by the Illuminating Company, a FirstEnergy company. This facility is metered under the All Electric rate schedule.

Company B installed Correction Controls' equipment at its facility in March, 2006. The power factor correction began to show up in the electric bills for the billing period ending in April. Beginning in August, the power factor had increased to 100%.

Billing Month	Billed Reactive demand[3]	POwer factor
January	1,121.4	84.4%
February	1,187.3	83.9%
March	959.7	88.2%
April	510.7	94.6%
May	307.6	97.6%
June	461.1	94.8%
July	258.5	97.9%
August	N/A	100.0%
September	N/A	100.0%
October	N/A	100.0%
November	N/A	100.0%

The first graph at right illustrates the kVA (in red) being out of phase with the kW (in gold) when the power factor is less than 100%. This was from the billing period ending in April, 2005. The second graph, from the billing period ending in April 2007, shows that the kVA and kW are virtually the same because the power factor is close to 100%.



[3] The Illuminating Company does not show the power factor on its electric bills. Instead, they show billed reactive demand, which is a measure of the apparent power which does no real work in a system. It can be used to calculate the power factor. As billed reactive demand increases, power factor decreases.

Cost Savings

Using *EnergyManager.com,* we estimated the potential savings opportunity from power factor improvement based on the February 2006 electrical profile for Company B's facility. The Illuminating Company charges 48¢ per billed reactive demand (rkva). If Company B could increase the power factor to the ideal of 100%, the savings would be about $570, or 1% of the electric bill (see results on next page).

Even though the Illuminating Company's power factor penalties are low, Company B decided to invest in power factor improvement measures because Correction Controls claimed that their equipment would also:

- recapture magnetic motor losses
- reduce resistance losses
- lower consumption (kilowatt hours)
- lower demand

There was too much volatility in the day-to-day operations for a reliable test of these claims. In addition, FirstEnergy may change the rules for power factor rewards and penalties in the next few years.

Company B's Results from EnergyManager.com

"what-if" analysis

"what-if" shopping

compare rate schedules

analyze another bill

your inputs

month	02
year	2006
days	30
total charges	$51,837.17
kilowatt hours	788,999
billed load	1,874.9
bill react dmd	1,187.3
shopping?	yes
shopping pre 2005?	yes
choice rate	.029172
voltage?	yes
substation?	no
self-assessor?	no

power factor opportunity

power factor	83.9%
power factor opportunity	$570
percent of bill	1%

more info

scheduling efficiency opportunity

load factor	58.5%
scheduling efficiency opportunity	$5,472
percent of bill	9.7%

more info

Clearly, the power factor savings opportunities are far smaller than the previous example due to the difference in the rates.

Power Factor Charges

The power factor of the electrical energy a customer consumes affects how much it costs the utility to support an equivalent amount of customer load. Therefore, many utilities charge a premium for low power factor. It is prudent for commercial and industrial customers to understand how the utility charges for demand.

- Some utilities bill peak demand directly in kVa. Ohio Edison's General Service Large rate schedule works this way. In this case, the customer is effectively penalized for operating at any power factor less than 100%.
- Another way is for the utility to charge a power factor penalty when the power factor falls below a set level.
- Some utilities, such as the Illuminating Company, add an additional charge for the reactive demand (kVAR).

We have researched how 187 different utilities in major cities across the United States bill for power factor. We found that 78% of these utilities bill in some way for low power factor.

Summary

The "power factor" of the energy you consume may be one important factor in reducing your electric bill. Power factor is the ratio of "real" power actually consumed (kW) to the amount of "apparent" power being supplied by the utility (kVA). A power factor of 100% means that no power is being wasted.

In order to decide whether power factor improvement can economically reduce your electric bill, you must first understand your utility rate schedule and how your utility charges you for power factor. For example:

- Ohio Edison bills peak demand directly in kVA and, thus, penalizes for any power factor less than 100%.
- The Illuminating Company has an additional demand charge for the excess of the apparent power over the real power, or reactive power (kVAR).

Uncorrected power factor can also lead to overheating and premature failure of motors. Capacitors are one way to reduce the inefficiency associated with poor power factor.