Power Factor, Ratchets and Your Electric Bill

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I spent this week in Hong Kong, where summer has already arrived and everyone is scrambling to reduce the peak electrical charges that hit during the hottest months. Due to the upward trend of global temperatures, I thought it would be worthwhile to describe your electric charges (before the Summer heat). *Note that April 2014 tied the record for hottest global April average temperature, and was also the 350th consecutive month where global average temperatures were above normal.* In addition, energy prices are going up, so this article may be timely for you as the "peak of summer" is on the horizon.

Getting Started: Bill Analysis

Whenever I do an energy audit, I ask for at least 2 years of energy bills, so that I can see the historical consumption and charges. From this data, I can normalize it to account for weather or other variances such as increased/decreased use of the buildings (more/less occupants, production, etc.). Once normalized, you often can compare the energy used per ft^2 against benchmarks and databases such as Energy Star. If you have multiple facilities, you may compare their energy consumption against each other and even have contests to see which facilities have the least "energy density".

Electric Bill Components

Most electric bills are composed of 5 to 6 primary components:

1. Customer Charge (fixed each month)
2. kW (Demand Charges)
3. kWh (Energy Charges)
4. Fuel Adjustment Charges
5. Environmental, Regulatory, etc. Surcharges
6. Sales Taxes (if applicable)

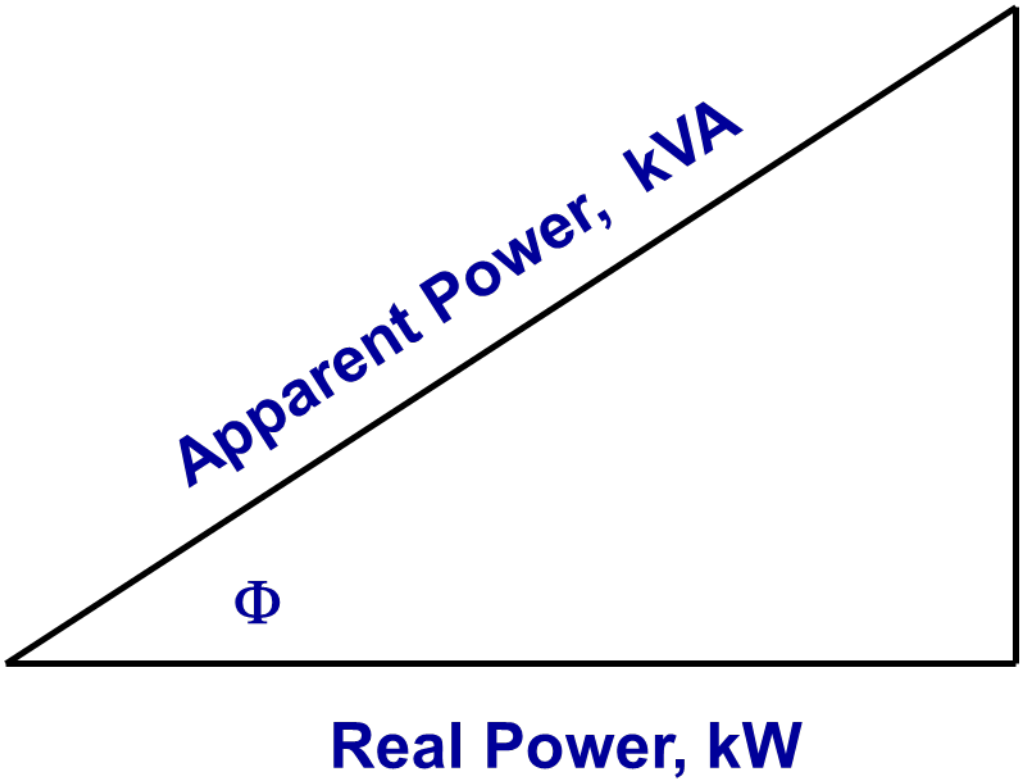
kW (Demand Charges)

After doing a peer comparison, I usually examine the demand charges (in both Summer and Winter months) to see if it is consistently more that 40% of the bill. If so, then there are often cost-saving opportunities by merely shifting the load or using energy scheduling to reduce the power consumed at during certain periods of the day. Many of my clients have electric rates that can be 2 to 5 times more expensive during certain hours of the day, as well as differential pricing for different seasons.

Here is how demand charges are typically assessed: Most utilities monitor demand (your power load) every second and then calculate an average kW load over 15 minutes, (much like how a car's computer may calculate "average speed" on a drive). The highest peak load for any fifteen-minute period is recorded each month and you will likely see this as your "demand charge" each month. *However, power factor and "ratchets" can influence the amount billed, so we will talk about those impacts next.*

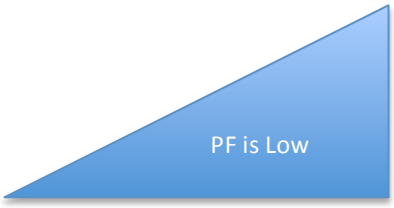
The Impact of Power Factor:

Power Factor is an expression of power quality and can range from 0 to 100%, and is usually measured by your utility. Power Factor is the ratio of kW divided by kVA (kiloVolts*Amps). Although you may not recognize KVA, it is basically what most electric utilities supply. Power Factor is influenced by inductive loads such as motors as well as other processes like welding. Because large motors are popular in many buildings, it is worth looking to see if you have a PF penalty on your bill. Below is a diagram of the relationship between kW, kVA and PF.



If you have a high PF, there will be a small angle between kW and kVA and the lengths of the hypotenuse and the base leg (kW) will be close to the same value. If PF is low, then this angle will be large and it is easy to see that the utility would then need to supply more kVA for the same about of work done (kW). The diagrams below show the relative angles when PF is high versus being low, while a fixed amount of work is being done (100kW). Often utilities will charge you an extra fee if your power factor is below 70% (or some number between 60% and 100%). If your PF is low, you can correct the problem by installing capacitors or other approaches. *Note that if you are billed on KVA, you should not see a PF charge, because it is already incorporated.*

100 kW



100 kW

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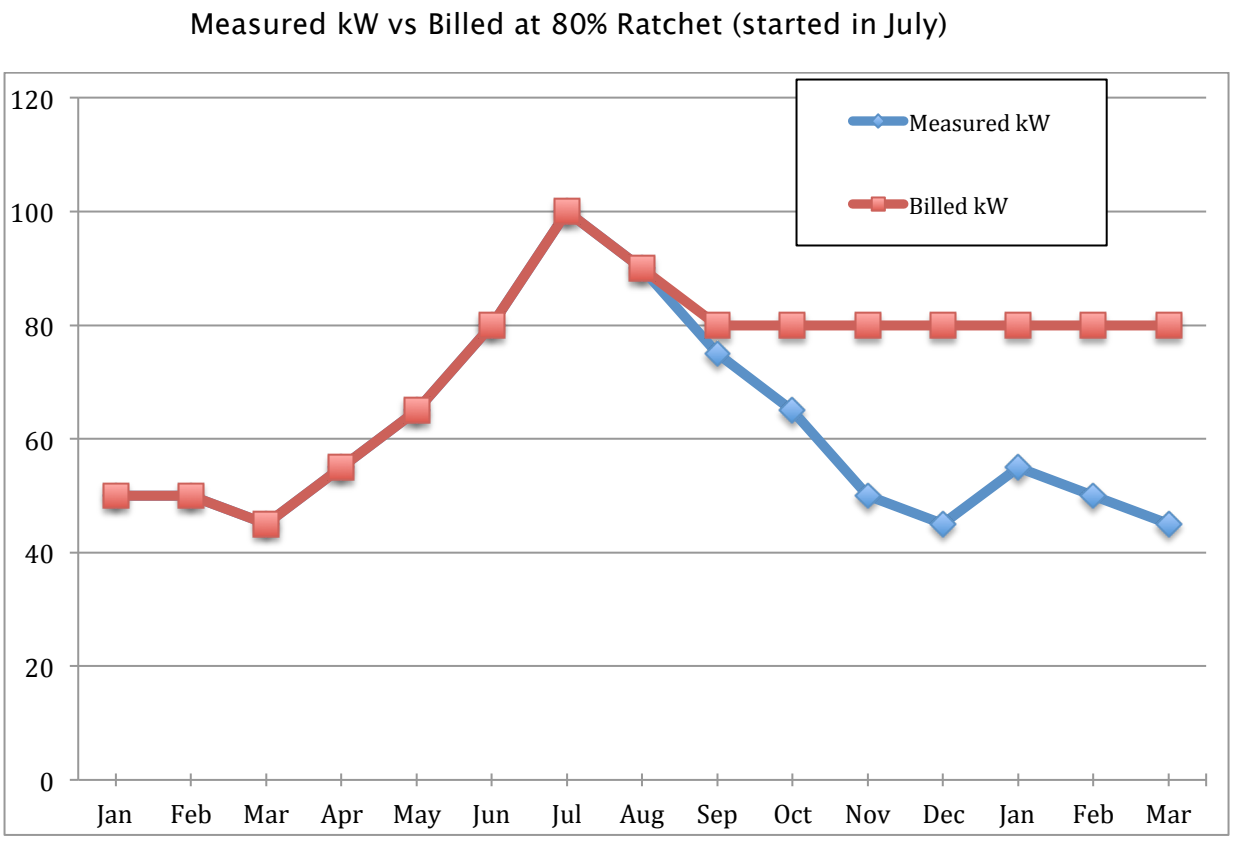
Look out for a "Ratchet" Clause

A "Ratchet Clause" is one common way for utilities to recoup the short term and extreme expenses they incur during the summer months when they have to supply more power due to air conditioning loads. Basically, a ratchet clause (or similar pricing strategy) can motivate clients to use power in a more consistent pattern throughout the year, which makes it easier for the utility to forecast and deliver energy based on more "level" loads. *If you notice that your "Billed Demand" doesn't change from month to month, it is highly likely that you are "ratcheted".*

Here is how ratcheted demand charges are calculated: Basically, the utility notices when you set a "new high" peak demand (any 15 minute period). If the ratchet is 80%, then going forward for the next 11 months, the utility sets a minimum billed demand for ~80% of the maximum recorded peak kW. Thus, as the figure below illustrates, even if you use a smaller amount of power during a succeeding month, you will be billed 80% of your previous peak. *Note that ratchets typically vary from 50% to 100%, so it is good to know the ratchet level!*



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Another Example:

Lets say that you turn on all your equipment during a 15 minute interval and you set a new peak demand that is 1 kW higher than normal. In this case, you would pay your typical demand cost, which might be ~$10/kW for that month, but you would also be obliged to the ratchet for the next 11 months. Assuming a 70% ratchet, then for each kW of new peak:

=(.7)*(1kW)*($10/kW-month)*(11 months/year)

=$77 per year

Conversely, if you shifted one megawatt of demand to "off peak", then you would save $77,000 in demand charges over a year's time. This can be accomplished via demand response or thermal energy storage strategies.

It is worth mentioning that some utilities may not assess demand charges, or ratchets. However, on every continent I have worked, the utility will find a way to recover their summer costs (or peak period costs). They can do this via the methods described above or by having a relatively high kWh cost during certain periods or by having extra fees if you exceed a predetermined "baseline", or by charging for larger transformers (needed for high kW loads).

kWh Charges

Compared to the previous calculations, kWh charges are relatively simple and represent the amount of energy you consume over a months' period. *Analogy: if you were filling up a swimming pool, the volume of water would be similar to the kWh charge, while the flow rate out of your hose would be analogous to kW charges.*

Note that Fuel Adjustment Charges are periodic "adjustments" to account for price variance of commodity fuels that are used to make the electricity. For example, if coal or natural gas prices go up, then the utility will pass those variable costs on to consumers. Because most utilities are highly regulated, fuel adjustment charges are easier to implement than adjusting the rate structure (tariff structure), which can be a lengthy process.

Environmental and Miscellaneous Charges

Many people don't realize that these charges can add 10% to your bill. There is not much you can do about this, but when calculating savings, be sure to count these charges as well as the Sales Taxes (which can be another 5%-9%) that you won't be paying when you reduce consumption.

Summary:

I hope this article has helped you understand the importance of demand charges and the potential impact on your bill. There are many ways to lower kW costs by using dimming controls or turning off “non-critical” electrical loads during the peak periods of a day. Huge savings can be accomplished with “load scheduling”, if your business can be a little flexible. Feel free to write me about your success stories: eric@ericwoodroof.com

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