

Reading and Understanding Your Electric Bill

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For large electrical users such as water and wastewater utilities, saving money on electrical bills is a matter of: using less electricity, using it at a more even rate, using it more efficiently and making sure that all contracts and agreements match what is actually happening within the facility. These are simple items to say or write and in some facilities large and easy monetary savings have been achieved, but in most cases careful and diligent evaluations of the details from billing to operations must be performed in order to achieve savings without disrupting service delivery. This guide is to assist facility operators in the interpretation of the electric billing statement and give guidance on how operations may be adjusted to lower the charges.

Commercial Electric Meters

The commercial electric meter is far more complex than a residential meter. The basic residential meter will record the amount of electrical energy used in units of kilowatt hours (kWh). The bill is then calculated from the usage in kWh and the rate per kWh. A commercial meter will not only record the amount of energy used in kWh, but it will also record the peak rate that the energy is used. This rate of usage is called “demand” and will take the form of two different readings. One is kW (the “active” or average power in kilowatts) and the other is kVA (the “apparent” power in kilovolt amperes), and sometimes another value will be noted kVAR (the “reactive” power in kilovolt amperes reactive). These three demand values are mathematically and electrically related and are very important in the process of generation and distribution of large amounts of electrical power.

$$\text{kVA}^2 = \text{kW}^2 + \text{KVAR}^2$$

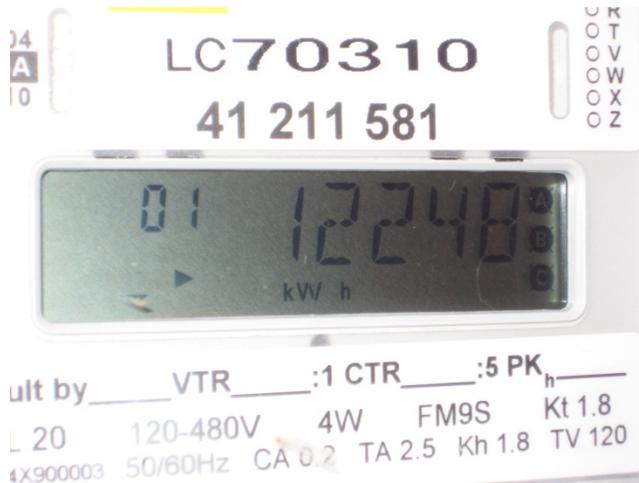
Because commercial meters record large volumes, the numbers seen on the dials or screens often have multipliers that are used to calculate the total usage. From the demand measurements a “power factor” is calculated.

$$\text{Pf} = \text{KW} / \text{kVA}$$

Generally power factors less than 85% will be penalized through a higher rate. Power factors change and charges vary depending on the way the electricity is used. It is the reactive power that causes the power factor to be poor. It is power that TVA must generate, but because of the type of equipment does not provide useful work. Ideally reactive power is zero and power factor is 1.0.

Example Meter Readings

Below are a series of photos of an actual electric meter at a municipal wastewater plant. In this case the multiplier is 120. These raw meter readings will be multiplied by that mathematical constant to give the actual usage value. The first photo shows the total energy usage in kWh, the second shows the real power demand in kW and the third shows apparent power demand in kVA.

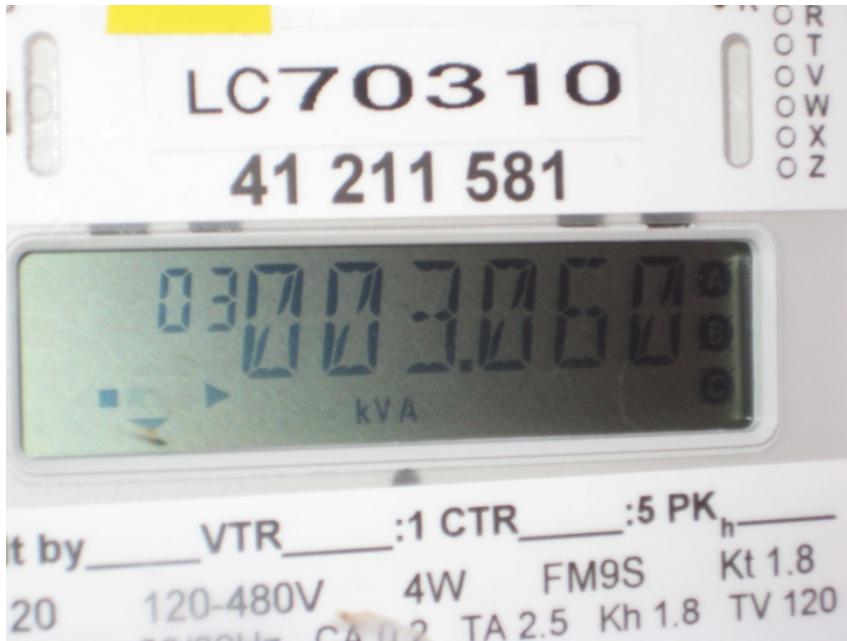


A commercial meter showing kilowatt hour or energy reading. This is similar to the totalizer on a water flow meter.



This is a commercial meter showing the kilowatt demand reading. The peak kilowatt demand is $2.155 * 120 = 258.6$ kW. Demand measurements are returned to zero each month. The readings are in 30 minute blocks of time and represent the peak 30 minute rate of electrical usage during

the month. This demand reading determines the rate paid for the full month and may factor in longer term peak demand rates.



The same meter with the kVA demand reading.

If these meter readings were used to calculate a bill, this user would face a power factor penalty because the power factor is 70%. $2.155 \text{ kW}/3.06\text{kVA} * 100 = 70\%$

A commercial electric bill can provide an electricity user with a lot of information if the bill is detailed and if the user knows how to interpret the statement. Though some bills are quite simple and only have a few details beyond the amount owed, a detailed billing statement will give the customer information about the amount of electricity used, the rate in which it was used and how it was used. There may also be other charges such as customer charges, outdoor lighting and contract minimum payments.

Billing Statement Evaluation

A key first step in evaluating how electric energy is used in your facility is to closely look at a detailed billing statement from your distributor. In addition to the monetary charges there should be a detailed listing of the total energy usage reported in kilowatt hours (kWh), the rate of that energy usage reported as demand or kilowatts (kW) along with kilovolt amperes (kVA) or perhaps kVAR (kilovolt amperes reactive), which gives an indication of how the energy is used and will show in the power factor value. A low power factor is common where a lot of induction motors are used and can be corrected by installing power factor correction capacitors.

If your billing statement does not show these details, request a detailed statement from your distributor. You may also want to schedule an appointment with a representative of the distributor who can clearly explain the statement. This may be a difficult task because much of the billing process is computerized and the customer service personnel may not fully understand the details behind all the line items on the statement. Pursue clarification until someone can fully explain each line item, how it impacts your charges, and advise you on improving that charge. Also adding to the confusion there are numerous acronyms and technical terms specific to the electrical industry, and sometimes slightly different terms used for the same item.

Example Electric Bill

SERVICE	KW DEMAND	KVA DEMAND	MULT	POWER FACTOR	PRESENT READING	PREVIOUS READING	AMOUNT USED	AMOUNT
CUSTOMER CHARGE	231.360	249.60	960	0.9270	25464	25319	139200	\$ 25.00
BILLED DEMAND						50.000 @	0.000000	0.00
BILLED DEMAND						181.360 @	12.730000	2308.71
ELECTRIC (KILOWATT HOURS)						15000 @	0.086480	1297.20
ELECTRIC (KILOWATT HOURS)						124200 @	0.045600	5663.52
TVA FUEL COST ADJUSTMENT						15000 @	0.007300	109.50
TVA FUEL COST ADJUSTMENT						124200 @	0.007150	888.03
SUBTOTAL								10291.96
TOTAL CURRENT CHARGES								10291.96

Activity Since Last Bill	Project #	Account #	\$ Amount
Previous Balance	Project #	Account #	10898.67
Payment	Approval:		-10898.67
Late Charge			0.00
Other Adjustments			0.00
Balance Prior to this Billing			0.00
TOTAL DUE			\$ 10291.96

A detailed billing statement should give a clear and itemized listing of raw or calculated meter readings, including the various charges and how the charges were calculated. There may also be an itemized fuel cost adjustments or these may simply be included in the various rates.

See the example billing statement. The first row includes headings for the calculated meter data from which the bill will be generated. The second row is the calculated meter data. For example under the heading of KW DEMAND, commonly called active power, is listed the number 231.36, and this was the kilowatts of demand that was calculated from the meter. Actually the meter read 2.41, and this was multiplied by 960, which is listed two columns to the right, to get actual kilowatts of demand.

The next number is KVA DEMAND. This reading is kilovolt amperes demand or apparent power. After the actual meter reading was multiplied by 960 the value is 249.6 kVA.

To the right of the multiplier is the POWER FACTOR calculation. This number is a result of dividing the KW by KVA or in this case $231.36/249.60 = 0.9270$. When the power factor is lower than 85%, additional charges are incurred because the bills are based on the higher kVA demand instead of the lower kW demand. Low power factors occur when current and voltage are out of phase which occurs with heavy inductive loads such as motors and other equipment that creates magnetic fields.

The next readings are PRESENT and PREVIOUS READINGS of kilowatt hours giving a USED reading of 139,200 kWh for the month. Again the raw readings were multiplied by 960 to give 139,000 kWh.

Below these values on the billing statement are the itemized charges. The first listed is a “customer charge” and will be in the \$25 range depending upon the distributor. In the example bill the next two lines are demand charges. Generally within the TVA system the first 50 kW of demand does not have an additional charge. The total demand of 231.36 kW less the first 50kW resulted in a billed demand of 181.36 kW at a rate of \$12.73 per kW. If the power factor had been under 85%, this user would have been billed on the kVA demand reading which is generally higher. For economy, you want the demand charges to be based on the kW demand not the higher kVA demand. Most distributors will assist users in correcting low power factor conditions because they also face power factor penalties from TVA. Capacitors are installed to correct low power factor conditions.

Next on the example statement are listed the energy charges in units of Kilowatt Hours. In the statement there are two levels with different rates. The energy charges for usage up to 15,000 kWh are at a rate of \$0.08648 per kWh. If you used more than 15,000 kWh there will be a second line of energy charges, and these are at a reduced rate. Below these values are the fuel cost adjustments for each energy usage tier.

There may also be contract minimum amounts associated with particular electric meter location. If these charges apply, request that your distributor carefully explain the details of those charges.

Saving money on a commercial electric bill.

There are three major ways to save money on electrical charges; use less energy as measured in kWh, reduce power factor charges, and reduce demand charges.

Everyone understands the first item. If you use less electricity, your bill goes down. Steps should be taken to reduce wasted kilowatts. Careful evaluation of all equipment and facilities can identify areas where better efficiency can be achieved. These details are beyond the scope of this guide.

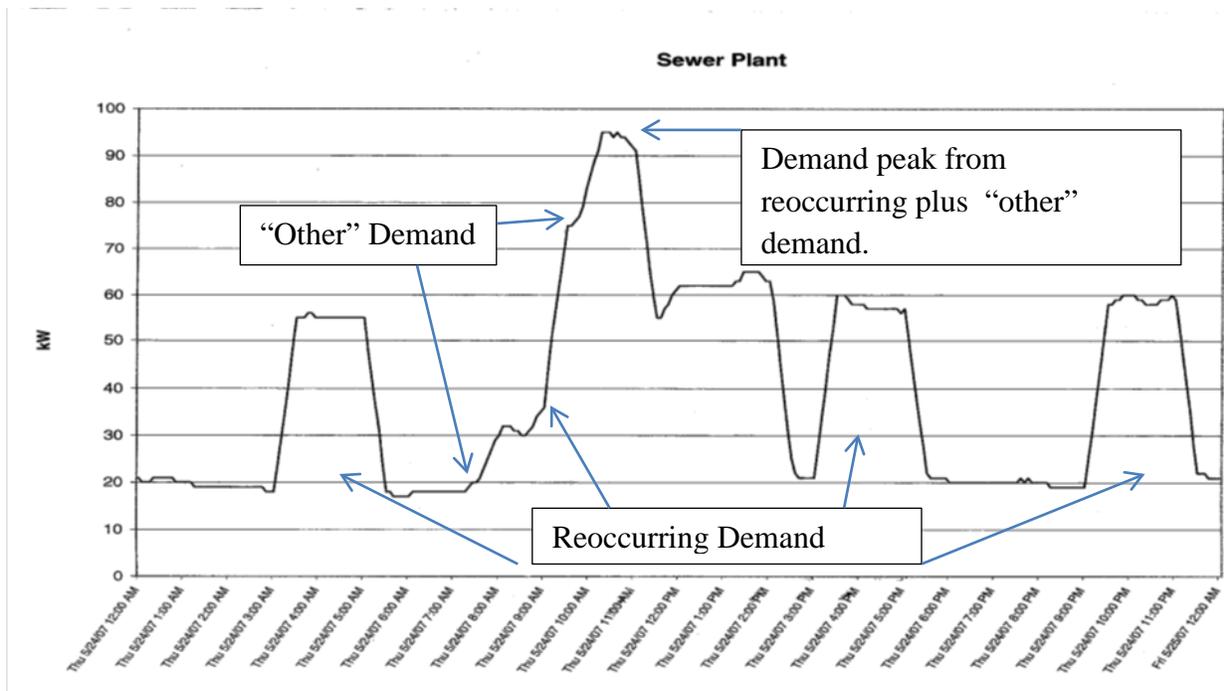
As mentioned above if the power factor falls below 85%, there will be additional charges. Contact your distributor or electrician about ways to improve the power factor.

To save money on demand charges either avoid the charges or minimize them. If the facility is small, demand charges can be avoided if demand in kW is less than 50kW. If the usage is on this edge with some months over and others under this 50kW threshold, charges may be avoided by carefully watching equipment usage. Many distributors participate with TVA in doing energy audits. When these include a week-long continuous graph of demand, it is easy to determine the times of day where demand was the highest. By carefully logging equipment usage during the time that the demand graph is being recorded, it is easy to determine which pieces of equipment were in use when the demand peaks occurred.

With the demand graph in hand and an equipment usage log, carefully determine what was running when the demand peaks occurred. If all the normal equipment is running and a single large piece of equipment is started only intermittently, operational personnel may be able to stop other equipment for the duration of that intermittent run and then return to normal operations when the intermittent equipment stops.

The simple process of starting motors creates an instantaneous very high demand. This high but very short spike in demand does not cause higher demand charges. Demand meters record the kW demand in 30 minute blocks of time. The high demand must extend for the full 30 minutes before it is recorded as a peak demand. If large power using equipment such as a motor is operated only once per month for 30 minutes while all the other normally operated equipment is operating, the cost of a single 30 minute operation can be quite high. If it is absolutely necessary, the price must be paid, but if other equipment can be turned off for the duration of the intermittent operation, the high peak can be prevented. Perhaps that intermittent load can be changed to a different day or different time of day when base demand is lower. Large electricity users cannot avoid all demand charges, but they can often, through improved process management avoid high peaks in demand by managing intermittent operation of large pieces of electrical powered equipment.

Example Demand Graph



The Example Demand Graph is an actual graph generated during normal operations of a municipal sewer plant. They have a base demand of about 20kW. There is a regular off/on aeration cycle of three hours "ON" and three hours "OFF." This cycle gives a reoccurring demand peak of 60kW. Beginning at 8:00 am some "other" piece of equipment was started that began to increase the demand. At 9:00 am the regular aeration cycle began resulting in a demand peak over 90 kW for about 90 minutes. It is this type of intermittent peak in demand that can increase costs significantly and may be preventable. If starting that "other" piece of equipment was necessary for service delivery or regulatory compliance, it is simply a cost-of-business; but if the operation of the "other" equipment could have been timed during the "OFF" cycles in aeration, that peak could have been reduced and the added cost avoided.

Demand control is a process of knowing and managing electrical demands. Workers must know what levels are normal and necessary for proper operation. They should know what equipment is

in operation and what equipment may be needed sporadically. They should also understand how total demand is impacted by the use of this equipment. Then compare all the operational knowledge to the demand charges that are incurred. It will take time and effort to collect the information and develop the knowledge to better manage the processes involved. In some facilities the effort may not be worth the savings, in others there may be significant savings for only a modest amount of effort.

Contracts and Minimum Bills

When a distributor installs a commercial electrical entrance, there is often a substantial investment. All power lines, transformers and measuring equipment must be sized according to the expected demand. In order to recover this investment in a reasonable time the contract with the user may specify a minimum charge. Some detailed billing statements may actually show those calculations, though they rarely apply at a location with heavy electrical usage. If a facility has several electric meters, some of those may not have heavy usage and should be checked for the possibility of contract minimum payments becoming applicable. Recently a Tennessee municipal wastewater plant with several meters throughout the plant discovered a meter with a \$2000/month minimum payment though very little electricity was being used. The distributor was gracious enough to adjust the contract. This discovery was not made until the plant operator began to ask the detailed questions about the various electric bills that have been discussed in this paper. This small usage meter was eliminated by connecting the load to another meter.

Energy saving measures are a hot topic throughout the nation. There are numerous consultants, vendors, and web sites promoting energy savings strategies and products. Before investing in these, you should have a clear understanding of your electrical usage and the costs associated with the service. The process described in this paper will cost very little, only some time and effort. Some municipal water and wastewater operators have achieved substantial savings in money and electricity by following these steps. It all begins by asking questions and pursuing the answers until you have a clear understanding of your electrical usage and the charges generated by that usage.

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