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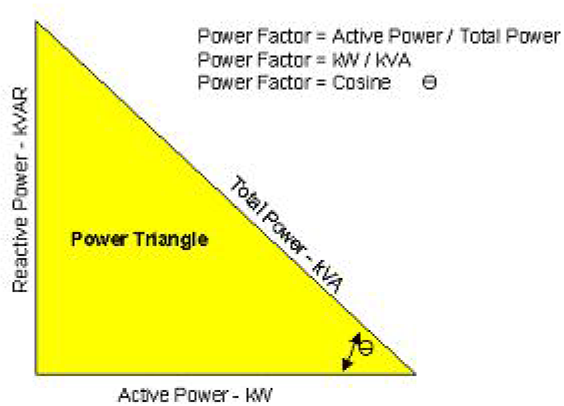
Power Factor – Cost/Benefit Analysis Example



If you are like most people, you probably view electricity as a commodity. You perceive the electricity you use as the same as your neighbor. You turn a switch; press a button and the power you need is either present or it's not. Well in this month's newsletter we want to help shed some light on why not all electricity is the same, and as commercial or industrial customers you are certainly not billed the same. Your utility company considers a number of factors in determining what it costs to serve your needs and bills you accordingly. This month we will explain Power Factor (PF) and examine how it can impact your operations and cost.

Power Factor is a measure of how efficiently power is consumed. It is expressed numerically in a range of 0-100 percent. A hypothetical facility with a 70% PF would mean that 70% of the electrical power purchased was being converted to useful work, and 30% of the power purchased was wasted. Useful formulas to calculate PF are shown above and are illustrated by the Power Triangle. As utility customers we pay for the total power (kVA) component of the power triangle. If we dust off our high school math memories, we will recall the relationships that apply to right triangles. If we are able to reduce our Reactive (kVAR) power, the Total power is reduced, our PF increases, and our bill is lowered.

Many electrical components and machinery require both active and reactive power. The reactive power is often used to create a magnetic (inductive) field in motors, transformers, fluorescent lighting, etc. The magnetic field is necessary for proper operation but produces no useful work. The utility companies charge for both active and reactive power delivered through your electric meter. The good news is there are ways to avoid paying for some or all that reactive power. Usually, PF correction capacitors are installed to restore site PF to desired levels. The capacitors capture the reactive power, store it, and share it with equipment as needed. By installing PF correction capacitors, we provide the reactive power ourselves and eliminate the utility charges. We will discuss the considerations that go into the capacitor selection process in an upcoming newsletter. If you care to learn more now, contact Independent Energy Consultants.
Power Factor Penalties

Since utility companies provide both the active power and the reactive power to meet your needs, they charge you for both. To determine if you are paying a charge for the

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reactive power you will need to examine your bill. If you see readings with units of kVAR or kVA you are likely paying a penalty if your site power factor is low. Often the penalty applies as soon as your power factor drops below 0.95.

Let's take a look at an example of a small industrial customer. The table below shows typical monthly billing information we can use to calculate the penalty imposed by the utility, and a cost analysis of improving the site power factor to 0.95. We are provided the site power factor, actual metered demand (kW) and the adjusted billing demand (kW). Armed with this information we can calculate the amount of corrective kVAR needed to achieve a PF of 0.95 and eliminate the penalty. For this example, the kVAR calculation was performed elsewhere. Other values were calculated as follows:

Bill demand = Actual demand x (0.95 / PF)
Demand charge = $4.25 / kW of Bill demand

Month	Power Factor	Actual kW Demand	kVAR Required	kW Billing Demand		Demand Charge		Demand Savings
				Before Correction	After Correction	Before Correction	After Correction	
Jan	0.74	228	132	293	228	$1,244	$969	$275
Feb	0.70	241	167	327	241	$1,390	$1,024	$366
Mar	0.72	233	148	307	233	$1,307	$990	$316
Apr	0.71	256	170	343	256	$1,456	$1,088	$368
May	0.70	219	151	297	219	$1,263	$931	$332
Jun	0.69	274	197	377	274	$1,603	$1,165	$439
Jul	0.68	281	211	393	281	$1,668	$1,194	$474
Aug	0.67	261	203	370	261	$1,573	$1,109	$464
Sep	0.72	238	151	314	238	$1,335	$1,012	$323
Oct	0.74	232	135	298	232	$1,266	$986	$280
Nov	0.72	245	156	323	245	$1,374	$1,041	$333
Dec	0.71	247	164	330	247	$1,405	$1,050	$355
					Total	$16,883	$12,559	$4,324

Let's review the month of January to make sure we understand the table. We see the facility operated with a PF of 0.74 and had an actual metered demand of 228 kW. However, since the PF was below 0.95 the amount of billed demand is adjusted to 293 kW. The increased bill demand results in a $275 penalty. Finally, 132 kVAR is the amount needed to correct the site PF to 0.95.

Now that we know the severity of the PF penalty, and the amount of kVAR needed to remedy the situation, we can determine if it is a problem worth fixing. By restoring the monthly PF to 0.95 we see that we can eliminate $4,324 in annual utility charges. The table shows that we need the maximum amount of correction in July. By knowing that at least 211 kVAR is needed, and 220 kVAR is the closest available capacitor bank rating, we can proceed with our financial analysis. The equipment and installation costs will vary depending on the individual application. In our example we will use a value of $40 / kVAR.

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Payback period = $ cost / $ savings / year
Payback period = ($40 x 220) / $4,324
=2.03 years

Power factor correction projects usually provide rapid paybacks, with many less than 2 years.

Hidden Cost of Poor Power Factor

We have just discussed the cost of operating with a poor PF. Those costs can be determined by understanding how the utility company calculates your electric bill. The story, however, doesn't end there. The reactive power that flows through your site's electrical distribution system creates other problems as well.

- Reduces distribution system capacity
- Reduces terminal voltage at equipment
- Increases heat loading in facility
- Shortens equipment life
- Creates kWh distribution losses that you pay for

Let's take a look at how a poor factor robs you of capacity needed to supply additional loads.

System Capacity Released = 100 x (1 - PFo / PFf)
where: PFo = original power factor
PFf = final power factor after correction

By way of example, let's assume our small industrial customer shown above wants to improve his average PF of 0.71 to 0.95.

% System Capacity Released = 100 x (1 - .71/.95) = 25.3%

That freed up capacity could allow him to add equipment, use smaller less expensive conductors, or avoid a costly capacity expansion project. Please contact us if you would like to discuss how you can eliminate your power factor penalties and these "hidden" costs.