POWER FACTOR, ITS IMPACT ON NET ENERGY SAVINGS AND OTHER TANGIBLE BENEFITS.

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The significance of the article is to evaluate and table the findings of my energy audit. It has been the responsibility of every electrical energy user to fix his PF nearer to unity. In the interest of those who are non technical, please be known that the PF in electrical terms is very much similar to blood pressure of a human being. Just as the deviation from the normal range is dangerous, so is the case of PF in the electrical system. A low PF or a Very high (leading) PF will cause heavy loss; in case of the human system it is the life loss.

To bring on table the energy scenario, let us consider the energy consumption pattern. While every urbanite blames the high power consumption by the agricultural sector for the huge power loss, it is more important to look at the facts and figures before we consider the main cause for power loss and the possible scope for savings.

The fact that, the power consumed by industry sector, accounts for 50.7% against the 3.5% of agricultural sector has been neglected by and large but the fact is that the huge power loss exists in this sector is very much a fact. This is mainly due to the length of the transmission cable laid for the agricultural sector.

If the industry sector is by & large educated the agricultural sector is largely uneducated. In both the cases we have the problem of power factor. The industry is not much concerned because the energy use pattern is unpredictable and or is advised by unskilled electrical contractors. The agriculturists are not to be blamed at all for the fact that they know not about Power Factor & its purpose, more important they get the power for free almost. Hence the point of concern is for those who wish to save on distribution loss either within or outside.

The power factor parameter has been discussed widely by eminent technicians and every one has a point to support there views.

Let me put my experience w.r.t. to the power factor, on the energy conservation/saving drive. It has been widely discussed that the improvement in power factor does not reduce active power or the units consumed. *This statement is true at some point and false at the other*. Let me discuss with few case studies, below.

First, all the technocrats know the power is combination of Active power, Reactive power and Apparent power. And the Power Factor is related to all the three powers in the system.

Secondly, what is it that constitutes the system? It is the device (motor, resistance heating coil or illuminating device etc.,) alone or it is in addition to the cable which interlinks the device and the power source, contactors, relays, measuring devices etc., and any other device which forms the part of the system as required on site.

If you consider the power drawn by the device alone then the impact of power drawn by it certainly is independent of power factor.

Is it just the device alone that constitutes the system? Can this device work with out the other integral components? Certainly not, it is the cable conductor, contactors and all other devices that constitute the system which drives the key device. Hence the total power drawn should be the power drawn by the complete system. Every piece of the system constitutes to active power drawn.

In this context importance of the power factor is highly relevant and should be a key parameter when the power loss is accounted for.

Let us consider a case.

The unit under discussion manufactures automobile components with good number of CNC machines and has a contract demand of 1300 KVA. The average power factor that was possible with APFC system was 0.87. The unit installed new APFC system and connected large sized capacitors and still the power factor showed no improvement (?).

Our energy audit showed that the operating method of the unit was much below the manufacturers assumed loading on the machines. In fact the load on the motors was never felt by it because there was no major change in no-load and on-load power.

The other findings were that the current in the cable was too high when compared to the active power. The table below gives the current drawn at different timings and the actual active power with power factor readings.

				Prior to PF Correction								
Sl. No.	Cell details	Cable used Al in Sqmm	Resistance per KM	Time of Reading	KW	KVAr	KVA	PF	voltage	current	Voltage Harmonics	Current Harmonics
1	UJ	400	0.086	12:00	38.82	78.82	88.00	0.45	414.00	115.00	0.80	2.70
2				13:55	34.72*	57.00	69.00	0.50	415.00	97.20	0.70	4.30
3				14:40	37.20	66.80	77.00	0.48	418.00	106.70	1.60	5.80
				Average	36.91	67.54	78.00	0.48	415.67	106.30	1.03	4.27

* These readings are during lunch break, the machines are running idle.

The power factor improvement was taken up and the **following readings were recorded.**

The pre & post power factor correction exercise showed that current in cable dropped substantially (as predicted), it was also found that the current harmonics increased five times.

Post PF Correction								
Time of Reading	KW	KVAr	KVA	PF	voltage	current	Voltage Harmonics	Current Harmonics
16:10	35.80	12.07	33.10	0.95	417.00	51.00	1.70	17.00
16:25	34.00	11.00	36.00	0.94	415.00	52.90	1.30	24.20
16:50	34.00	11.89	34.00	0.97	424.00	47.00	0.60	18.00
Average	34.60	11.65	34.37	0.95	418.67	50.30	1.20	19.73

The current reduction was also associated with the KWs (active power) reduction. The fact that the same job work was operated, before and after correction, a 10% plus, reduction in active power was seen. This was mainly attributed to the system loss.

As it is seen from the table 1 above the cable resistance and the current flow in the cable was measured to arrive at the cable & accessories loss.

Post PF Correction								
Average Reading	KW	Resistance per KM	KVA	PF	voltage	current	I2R loss	Other Losses

After correction	34.60	0.086	34.37	0.95	418.67	50.30	0.223	Assumed zero
Before correction	36.91		78.00	0.48	418.67	106.30	0.972	1.338

The loss due to accessories is reflecting beyond acceptance. However it is the reading on site and has to be accepted the way it occurs.

The point of discussion is just that the impact of Power Factor on the working system as a whole.

Extending the discussion further to the total energy consumption scenario the total energy savings by virtue of power factor consideration alone works out to be 5% of the total energy consumed in the industry sector and .35% in agricultural sector. The fact that the agricultural sector is spread over vast area the actual energy loss is much more than 0.35%. If we can generalize the energy loss in the agricultural sector is nearer if not less than industry sector.

Inference: it is to be considered by the large scale industries and the utilities and ascertain the actual loss rather than generalize the loss only on agricultural sector.

Conclusion:

1. It is now very prominent that the improvement in the power factor helps reduce power consumption both in terms of units and the contract demand.
2. The relation of power factor with active power drawn by the device should be extended to the system as whole and not the device alone.
3. The current in the cable reduced inversely.
4. The cable temperature was also less.
5. The loss due to drop in temperature will further add to our benefits.
6. The voltage level across the terminals improved marginally.
7. The impact of surge loads is not felt by the smaller motors/machines.

The other tangible benefits are.

Under the given cable size available on the site, more machines can be loaded, which implies reduced infrastructure cost.

The power consumption is reduced by around 10% which otherwise would have been lost as I^2R losses.

The other benefits of PF correction will also prevail over the entire industrial establishment.

PRECAUTION:

The point of concern or a critical factor is the RYB polarity that the industry has to follow. If the polarity is not followed then the result is that the PF would reduce and not increase in spite of any of the value connected in the network.

The sequencing of Capacitors is equally important when the connections are being made. The centre lead should always be connected to the Yellow phase when RYB polarity is maintained within the industry.

EXTENSION: the logic when extended to the utilities that are instrumental in power distribution will find that their losses can be substantially reduced. Considering the length of the distribution network the utility can achieve their distribution loss cutting in the first instance alone over 10%.

FURTHER STUDY:

The impact of current harmonics on the system has now to be carried out in depth and rectification measures implemented accordingly.