Power Factor Correction – why is it important?

Our world is changing. With energy consumption set to double within 30 years and with growing concerns being voiced about climate change, how, with an ever-growing global population, are governments going to be able to sustain a power-hungry world? More than ever before, the need for energy efficient products and reliable grids continues to grow.

In this article, ABB's **Mike Thornton** describes what power factor is, why power factor correction (PFC) is important and gives practical examples of how PFC solutions have paid for themselves.

SO WHAT IS POWER FACTOR

Power factor (PF) is simply the relationship between the active and reactive power on an electricity distribution network and a measure of whether the system's voltage and current are 'in phase'. Take, for example, a frothy latte. The coffee body is the 'active power' that you can use to do work. The froth on the top is 'reactive power'; some is useful, but too much is simply a waste – the same as the foam you leave behind in your glass.

A perfect body = good PFC.

Latte glass = capacity = kVA. Coffee = useful energy = kW. Froth = waste capacity

A frothy latte = poor PFC

- If a network is 100% efficient (ie if no reactive power is present) its power factor (PF) is 1 or unity. This is the ideal for power transmission, but is practically impossible to attain. Variation in power factor is caused by different types of electrical devices connected to the grid that consume or generate reactive power. Unless this variation is corrected, higher currents are drawn from the grid, leading to grid instability, higher costs and reduced transmission capacity
- A poor PF results in additional costs for the electricity supplier
- These costs are passed on to the customer as a 'reactive power charge' or 'exceeded capacity charge'
- All UK electricity suppliers impose a reactive penalty charge when the average PF falls below 0.95 in a month.

The causes of poor PF include inductive loads on equipment such as AC motors, arc welders, furnaces, fluorescent lighting and air conditioning. The more inductive loads there are on the network, the greater the possibility there is of a poor PF.

Take the example of a typical industrial electricity bill breakdown. This shows kW and kVA maximum demand, the excess kVAh charges calculated from the total kWh and kVArh units, the authorized capacity charges (SAC) and the excess reactive charges, in this case £641 per month.

THE BENEFITS OF POWER FACTOR CORRECTION

The following are the main benefits of PFC

- Eliminating expensive utility penalties for a poor power factor
- Improved energy efficiency – reduced system currents and kW losses
- Security of supply – reduction in peak currents prevents fuse failure and loss of supply
- Release additional capacity – to take advantage of the full current capacity available in existing transformers, switchgear and supply cables
- Increase system load without the need to invest in additional infrastructure
- Environmentally friendly – reduced kWh losses mean that less power needs to be generated, so less CO_2 is produced
- Increased infrastructure service life – since the amount of heat generated within cables, switchgear, transformers and other equipment is reduced

Power factor correction equipment is not only fast and cost-effective to install but it starts paying back on your investment immediately, with typical payback times from 12 to 24 months. Take the following examples:

A CERAMICS MANUFACTURING COMPANY

- Max demand: 665 kW
- Power factor: 0.78
- Cost of PFC including installation: £8k
- Potential annual savings in reactive power charges and authorized supply capacity (ASC): £5.2K
- Payback: 1.6 years

A FOOD MANUFACTURING COMPANY

- Max demand: 637 kW
- Power factor: 0.85
- Cost of PFC including installation: £5.8k
- Potential annual savings in reactive power charges and authorized supply capacity (ASC): 1.3 years payback

Power factor is a key issue for UK industry that impacts on energy efficiency and electricity bills, as well as the reliability and availability of network infrastructure. PFC solutions, for example Vector from ABB based on the company's CLMD capacitor technology, offer network installers and panel builders a simple approach for PFC projects with a fast return on investment.

ENERGY & USE OF SYSTEM CHARGES BREAKDOWN

Total kWh	1414782.50	PF @ Peak kVa	0.900	Max kW 2583.0	at 1700 on 27/10/06
Total KVArh	734241.50	Average Lagging PF	0.888	Max kVa 2856.0	at 1830 on 16/10/06
Load Factor %	73.62	Chargeable Capacity kVa	3500	Max contract to date 2586.0 kW 2856.0 kVa	

Energy Description	Quantity	Unit of Charge	Rate	Period Charge (£)
Energy Consumption (billed in GMT)				
0406 All Year Mon-Sun 0700-2400	1130278.0	kWh	0.065740	74304.48
0795 All Nights 0000-0700	284504.5	kWh	0.043220	12296.28
		Energy Sub-total		86600.76
Distribution Use of System (charges based on metered volumes)				
Capacity Availability				
	3500.0	kVA	1.040000	3640.00
Consumption				
0405 All Year Mon-Sun 0000-0700	280852.5	kWh	0.000600	140.43
0406 All Year Mon-Sun 0700-2400	1135410.5	kWh	0.001700	1930.20
Fixed Charge		Annum	1401.36	116.78
Reactive Power Charge				641.67
		Distribution Sub-total		6469.08

PF Power Factor
- **Authorised Capacity Charges (ASC)**
- **Excess reactive charge**
- **Excess kVArh from total kWh & kVArh units**
- **kW & kVA maximum demand**

Extract of a typical industrial electricity bill

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