powerPerfector

VoltagePowerOptimisation®

energy world

energy INSTITUTE

Article written at the request of the Energy Institute, for Energy World's January 2006 edition, explaining Voltage Power Optimisation.

Voltage optimisation arrives to generate electricity cost savings

It is not widely known that the statutory band for UK electricity supplies was reduced towards lower, European levels, in 1995, and is due to reduce again in 2007/08. Now, most electrical equipment is designed to operate at a significantly lower voltage than the old 415 V (three phase) supply that persists in the UK. This has opened-up the possibility for 'voltage power optimisation', writes Angus Robertson *of powerPerfector.*

To date, the majority of savings in electricity have come from new technologies and control systems downstream of the switch room: with the use of low energy light bulbs, management control systems, energy saving initiatives to remind people to turn off power, upgrading of equipment that costs less to run, lighting control systems, motor controllers and more. But nobody has focused on the raw power quality as it enters the building. Nobody questions power quality until there is some unexplainable occurrence in their electronic or mechanical infra-structure – then they call in experts to solve the problem.

If you have an expensive car you choose higher octane fuel to get a more efficient and better performance from your asset. However nobody has questioned the electricity supply, or have they?

Fortunately the Japanese have, because they had the same pressures on fuel and energy prices ten years ago that we have today, as they have to import all of their fuel requirements and electricity. As a result attention was focused on the incoming supply to a building, on its voltage level and quality. Technology was invented specifically to save energy and optimise supply quality – 'perfected physics' – you might say. The obvious benefit is that an entire site would only require the technology to be installed on each of its incoming supplies, between the meter and the main distribution board, so downstream disruption was minimised.

In the UK, when we plug into the electricity mains, most of us don't give a second thought about how the voltage level might affect the efficiency of the electrical equipment we connect. We know that in the extreme, when the voltage is far too high, light bulbs glow brightly and blow with alarming regularity; whilst with very low voltages, TVs flicker and motors overheat. But there is a broad band in between these extremes where the effects are more subtle, though very significant in terms of energy efficiency.

Falling voltage limits

The statutory voltage band, within which the UK electricity distribution companies had to deliver three phase electricity, was changed in 1995 from 390–440 V (three phase) to 376–440 V. The Europeans increased their supply band from 360–400 V to 360–440 V. The next stage of European harmonisation in 2007/8 will see the UK paralleling Europe on a 360–440 V statutory range.

This whole harmonisation was really a fudge so that suppliers did not have to move supply levels – however manufacturers of electrical equipment had to broaden the voltage parameters of their product so they would run at 360–440 V. Equipment also had to take into account 'volt drop' of 4%, so equipment in Europe operates at 345 V and above. Logic dictates that the UK Government cannot reduce our minimum statutory range of supply to European levels (360 V minimum) in 2007/8 unless everything works – yet most of it will and does.

Currently the average level of voltage supply, according to the Electricity Association (trade association for the electricity supply, transmission and distribution industry) remains around 415 V, equivalent to 240 V single phase. This is because it is most common for electricity companies to set voltages towards the high end of the statutory band. They do this for two main reasons:

- the old 415 V (240 Vv single phase) figure sits within the statutory band and so no change in the level of supply was required; and
- high voltage transmission produces lower losses on the electricity companies' transmission systems, so it saves them money to keep the voltage high.

An extract from the *Electrician's Guide to the IEE Wiring Regulations*, published by EPA Press, states that: "Since the present supply voltages lie within the acceptable spread of values, supply companies are not intending to reduce their voltages in the near future. This is hardly surprising, because the action would immediately reduce the energy used by consumers (and the income of the companies) by more than 8%."

However, in fairness to the supply companies there is little they can do about the voltage change, and putting any pressure on them to reduce voltage levels would be pointless because of historical design and physics. The fact is that the British grid was designed to deliver a 415 V supply level to consumers and, as physics dictate that as you move away from the power supply point (an high voltage 11,000 V to 415 V transformer), the voltage supply level reduces (this is called volt drop). So as it is today, if you are a farmer, or in certain parts of cities, you may well be running your business with voltages as low as 350 V (three phase), 200 V (single phase) at times – and amazingly, in most cases, it still all works. So, if power generators reduced their voltage unilaterally by 5–10%, approximately 15% of the country would probably stop working.

This means that the supply industry hands are tied unless they redesign the whole supply network – which would cost billions, so we will continue to have current high voltage supply levels.

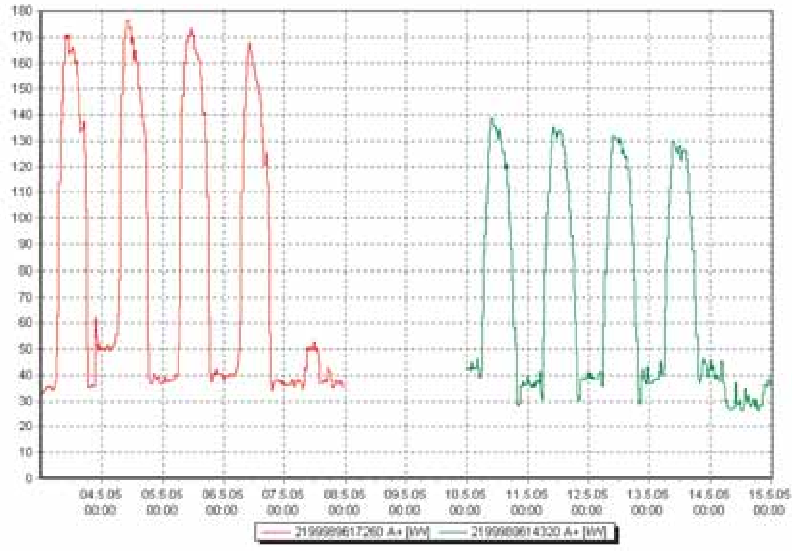
Power optimisation

As the average supply in the UK is 415 V, (240 V single phase) the opportunity is born to optimise it. In fact the opportunity is greater here than in Japan because the voltage supply parameters in Japan are 90–110 V and they are optimising their voltage by minus 2%, minus 4%, and minus 6% and saving millions.

The technology that does this is called 'voltage power optimisation' (VPO) and has now been introduced into this country under the name powerPerfector. Over 300,000 premises in Japan have installations and the Japanese government give 30% grants to businesses to install it.

Let's look at he figures – the average supply is around 415 V (240 V single phase), so there is an opportunity to reduce this by 9% to 380 V (218 V single phase) and still be inside current statutory supply levels in the UK even before the next stage of harmonisation where it drops to 360 V.

From the voltage logging that powerPerfector has done across the country, the company estimates that just over



80% of premises have a voltage supply that can be optimised by minus 8% and produce kWh savings of 13% as a result.

For example, Land Registry, which registers all land transactions in the UK, has installed VPOs at 20 sites, not just to save energy but also to protect their electronic infrastructure from transients (spikes) and Figure 1 shows one site's performance comparing five days before and after installation.

Buckingham County Council has installed a 560 kVA unit in its New County Offices and report 13% savings. The Council is now rolling out the technology to its other sites. Buxton Press has installed an 830 kVA unit and has also reported 13% savings. Tesco has installed over 70 units and both Woolworths and BP have installations that they are now assessing.

How does voltage optimisation work?

Having seen the results of optimising LV supply (as opposed to HV) you may think that, by reducing the voltage level on the high voltage transformer, you would save substantial amounts on money. I am afraid you would be wrong, judging by results from the implementation of just this by two major supermarket chains in the UK. Remember this was before the introduction of the new Japanese technology but it was a bold move when both Tesco and Sainsbury reduced their supply levels on over 300 transformers they owned by an average of 5% and gained savings of approximately 3.5% and 4%. Savings that are three to four times lower than if they had simply installed VPO technology downstream of their HV transformers.

Why are the results so much better than if they had reduced voltage on the HV transformer? First, it is rare to find an HV transformer with more than 5% reduction capacity so the extra 3% to 5% that would be left has not been taken advantage of. Secondly, powerPerfector has losses of just 0.1% through its entire operating range as it is a completely different design to any transformer technology we have in Europe. Here are some basics.

Normal transformer coils are wound from copper conductors, typically in the form of round wire and rectangular strip. VPO, however, utilises wide copper sheet rather than wire, of the highest possible purity. Sheet production is a demanding process, requiring large, very accurate machines to roll sheet up to 800 mm wide, between 0.05 and 3 mm thick; this is then insulated and wrapped around a uniquely designed flaked silicon iron core. Separate star and delta windings act to generate a strong internal magnetic field that assists in balancing the incoming three phase supply, suppressing harmonics and stopping any transients (spikes) from entering a building. This technology also improves power factor in a building, as proven in readings taken pre and post installation by Nottingham University's Environmental Technology Centre, which has tested the technology and confirmed savings of 11.5% on minus 7% optimisation.

Technically, most savings are realised in induction motors and lighting equipment. When you optimise voltage to motors, within their normal operating range, core and winding losses are reduced, so they run more efficiently, with less stress, and live longer.

Lighting benefits by being returned to its 'design' voltage and brightness, so both current and power is reduced and lamp life is increased substantially.

Economic justification

Economics are of course key to the success of any energy saving technology and, whilst some of the greener companies may show support for wind and solar technologies with paybacks of 10 years or more, many companies have to look more closely at the shorter term returns on investment. Here the news is good as typical offices are returning 50% on investment (savings versus cost) and supermarkets, which have high load factors return 75% ROIs. As a rule-of-thumb, the electrical load factor of a building is close to the return on investment possible.

The Carbon Trust has already taken a lead by stepping in to offer smaller companies up to £100,000 in interest free loans for four years on installations.

However, it is important to make the point that focusing on your supply does not preclude the need to implement the installation of some of the highly efficient products and technologies on the market today – like motor controllers and lighting control systems. These technologies are, and will continue to make substantial reductions to your energy costs and therefore carbon emissions downstream of your supply. •

Contact powerPerfector via tel: 0845 6014723, or visit **powerperfector.com**

powerPerfector guarantees to reduce your kWh consumption by 10% / 20%

A selection of the clients we are working with:

Let us show you the benefits. The next steps:

If you would like to see how *powerPerfector* will benefit your company as it has our existing clients, the next step is simple.

Please send us the following data, on any sites that you would like to have financially assessed, we will send you a very close estimate of the installation value for ***powerPerfector*** – i.e. the savings in financial terms, carbon saving, the payback and the ROI.

1. The highest maximum demand in the last year for each of the incoming supplies to your building (from this we size the unit required and the capital cost)
2. The total kwh consumption for the last 12 months on each incomer.
3. The cost of supply for the last 12 months including CCL if you are not buying “Green”.
4. Your next contract negotiation date and expected percentage increase from “3”.

Please don’t hesitate to contact us with any queries. We look forward to hearing from you.

Tel: 0845 601 4723 - Email: info@powerPerfector.com - Web: www.powerPerfector.com

powerPerfector is accredited by the Carbon Trust’s 4 year interest free loan scheme, for which you may qualify if you have less than 250 employees. We will assist you in applying for a loan up to £100,000. With typical payback between 12 and 24 months powerPerfector will have paid for itself long before you have to.