

Voltage Power Optimisation (VPO)[®]

CASE STUDY



DS Smith Plastics Worldwide Dispensers

Installed 29th December 2006
Report March 2007

"In the current economical and environmental climate, energy consumption is on everyone's agenda. It is an issue that nobody should ignore, whether in industry or private households. The continuous rising of electricity cost made it imperative for us to seek ways of reducing consumption.

Worldwide Dispensers, an established manufacturer of dispensing solution for the beverage and household products market and part of DS Smith Packaging Group, last year installed a powerPerfactor Voltage Power Optimiser with the aim of achieving cost savings by optimising voltage and at the same time improving the operation and life span of the site electrical infrastructure.

We are now averaging savings of 29,000kWh per week and believe that the operational performance of our equipment is improving too."

Enzo De Luca
Operations Director, Worldwide Dispensers

About DS Smith Plastics

DS Smith Plastics (a part of Worldwide Dispensers) is a successful and long-established manufacturer of high quality, plastic taps and related dispensing filaments.

powerPerfector unit details

An 830kVA/1200A unit was installed on the 25th September 2006 with a –7% Optimisation setting. Once the savings had been proved for this installation, a 560kVA/800A unit and a 420kVA unit were installed on 29th December 2006

- **22% reduction in daily average consumption**
- **£100,672 per year**
- **103 tonnes CO2 per year**



FULL REPORT

Contents

- **Introduction**
- **Overview**
- **The Savings Report**
 - Savings summary
 - Overall savings
 - Conclusions

Introduction

powerPerfector optimises the voltage and improves the power quality for a whole site more efficiently than any other technology available. Optimising the supply voltage allows equipment to use only the energy it requires to operate efficiently.

For example, providing a motor with its optimum voltage prevents excess heat and vibration, while delivering the required torque and speed. When these effects are aggregated across a whole site, substantial energy savings are delivered. The Maximum Demand of the site is also reduced — typically by as much as 10% — which will help keep the site within its Agreed Service Capacity and may reduce penalty charges.

Installing a powerPerfector improves power quality on a site considerably. The reactance of some electrical equipment is reduced when voltage is optimised, so there is an overall improvement in power factor. Equipment is protected as the powerPerfector eliminates transients up to 25,000V and harmonics are filtered from the mains, while the balancing of phase voltages maximises the efficiency of three-phase equipment. By optimising the power supply at source, the powerPerfector is able to extend the lifetime of all the electrical equipment on a site, substantially reducing maintenance overheads in addition to the energy savings.

Overview

Three powerPerfector Voltage Power Optimisation units have been installed at DS Smith Plastics – Worldwide Dispensers in Merton, London. The table below shows the installation programme:

Supply	powerPerfector Unit Size	Optimization Setting	Installation Date
SP3	830kVA	-7%	25/09/2006
SP2	560kVA	-8%	29/12/2006
SP1	420kVA	-8%	29/12/2006

A scheduled shut down of the site was required, with the work carried out over a weekend. Following installation all electrical equipment has operated normally and there have been no reports of any problems. With further observation over time, our clients tell us that equipment life can be noticeably extended.

THE SAVINGS REPORT

Savings summary

Reduction in daily average consumption	22.0%	£277 per day £100,672 annually
Projected annual carbon savings	103 tonnes	

Overall savings

Now that the installation programme is complete, the entire site is benefiting from optimised voltage, improved power quality and balancing of the three supply phases. Electrical equipment is operating at, or close, to its design-optimum voltage, and electricity consumption has been reduced substantially as a result. The projected savings of **11.5% – 13%** have been realised and exceeded by a considerable margin, with the overall kWh consumption across the site as a whole reduced by **22%**. From the time of the final installation up to 25th February – the date to which half-hourly kWh data is available – savings in carbon emissions of **12.4 tonnes** have been achieved.

Figure 1 Electricity consumption data for the period since the installation of powerPerfector units on supplies SP1 and SP2 is compared to data from earlier in the year in the chart below, illustrating the savings that have resulted from voltage optimisation. As shown, there has been a **21.8%** reduction in average weekly electricity consumption, from 132,521kWh to **103,625kWh**.

In cost terms, based on an electricity unit price of 6.7 pence/kWh, this is equivalent to a weekly saving of **£1,936**.

DS Smith Plastics - Worldwide Dispensers - Weekly Consumption

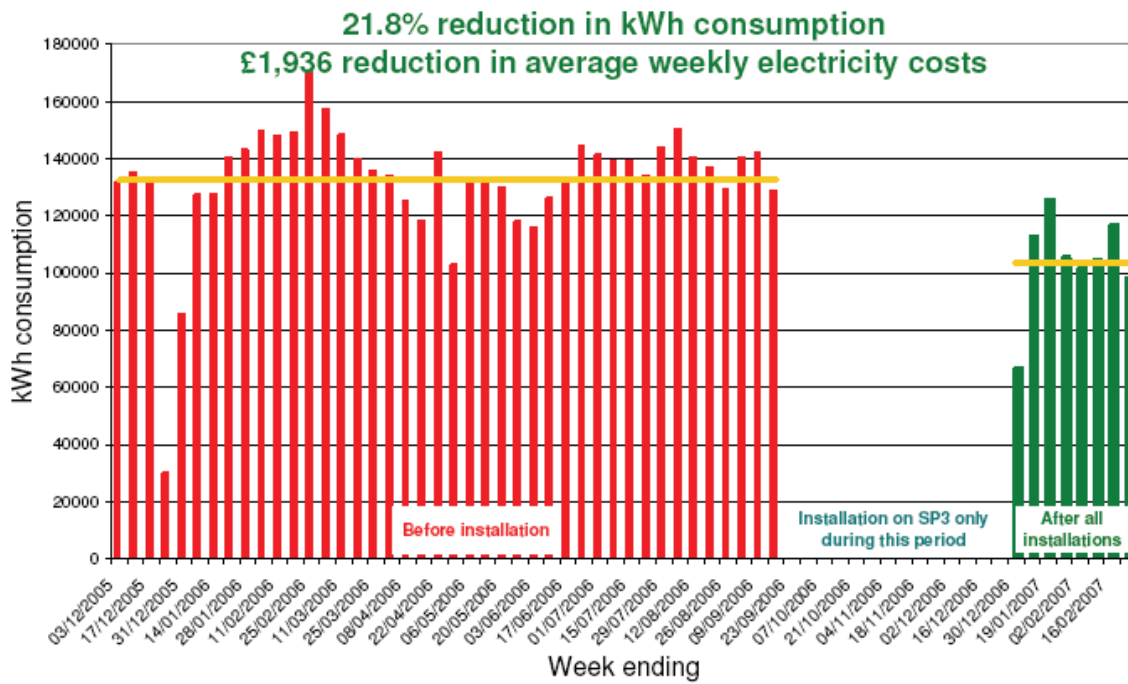


Figure 1

Figure 2 An analysis of daily electricity consumption on the site is shown below. Calculated on a daily basis, the average kWh consumption over the period since the final units were installed is **22.0%** lower than the average before optimisation – reduction from **1,262kWh** to **985kWh**. This is a daily saving of **£277**.

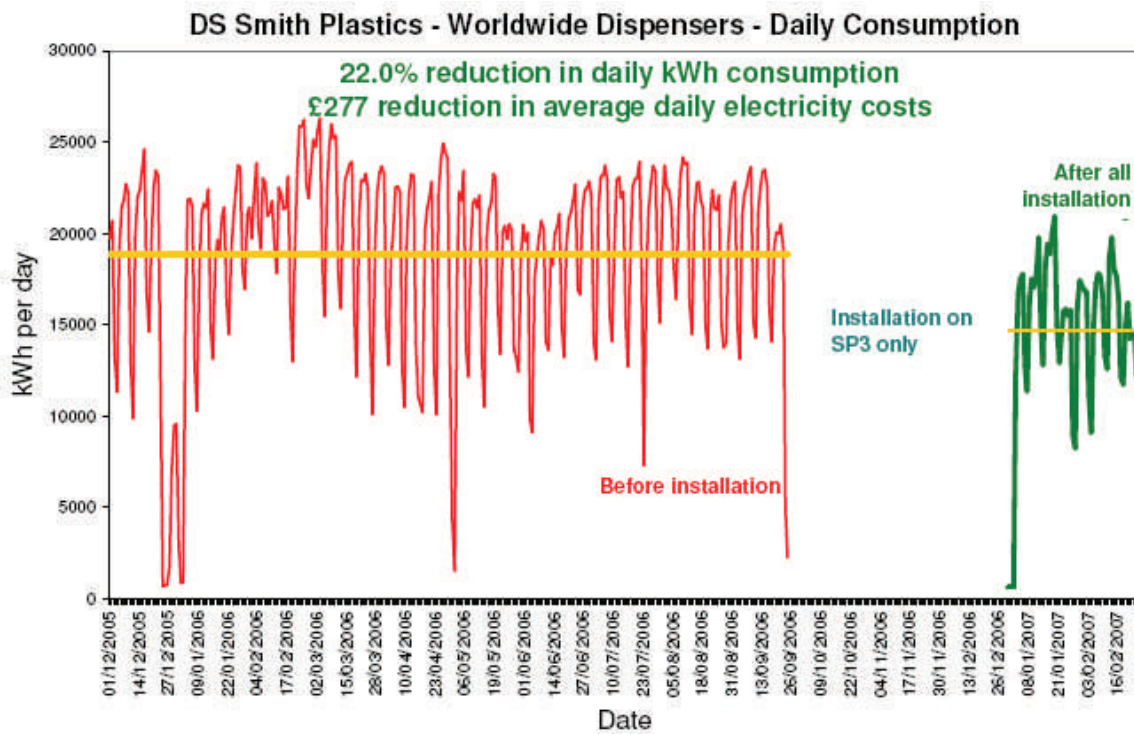


Figure 2

DS Smith Plastics - Worldwide Dispensers - Year-on-year comparison of daily kWh consumption

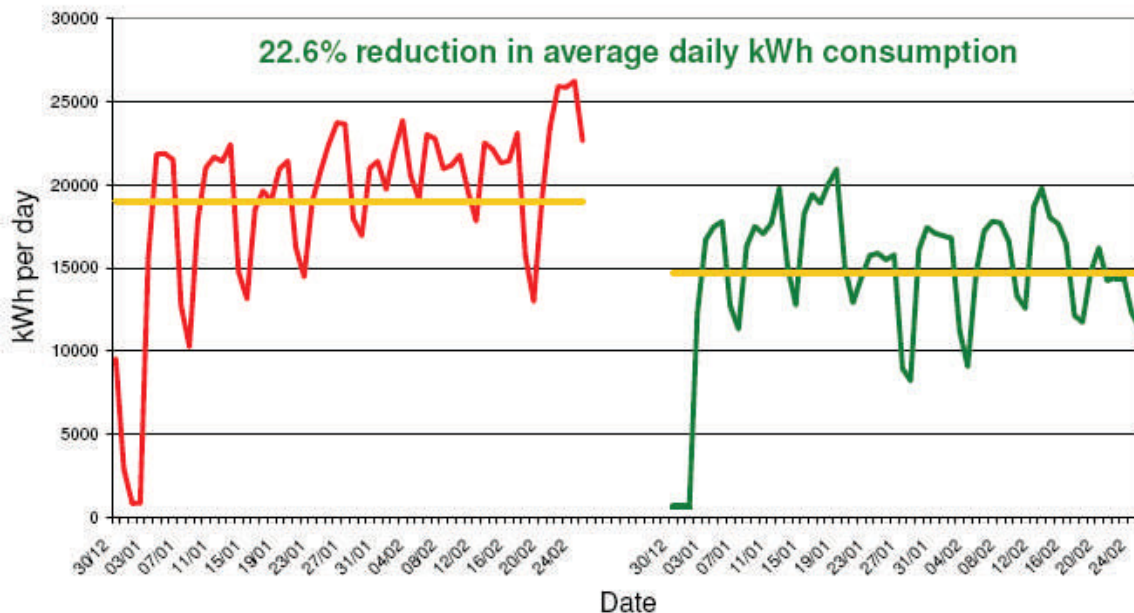
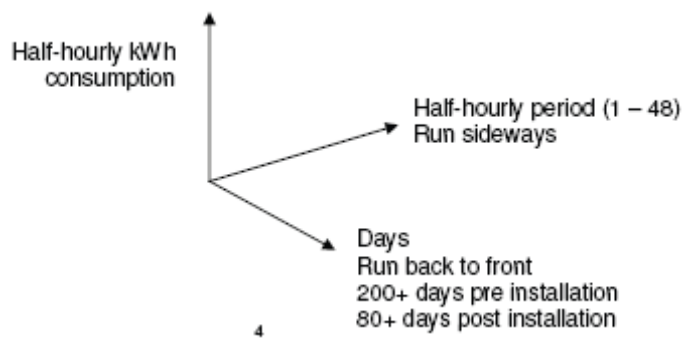


Figure 3

Figure 4 Electricity consumption on the site has a very flat characteristic, indicative of a high load factor. This means that there is little distinction between the base load (i.e. electricity consumed overnight) and the peak load, on days when the site is operating. As a result, the efficiency improvements brought about by the powerPerfector are saving energy throughout a large proportion of the time. On an average day, the site is consuming 22% less electricity than before the powerPerfector was installed, which is illustrated on the following page. The three-dimensional charts show daily profiles for each LV supply and for the site as a whole, for the period before installation and the period afterwards, in the format shown below.



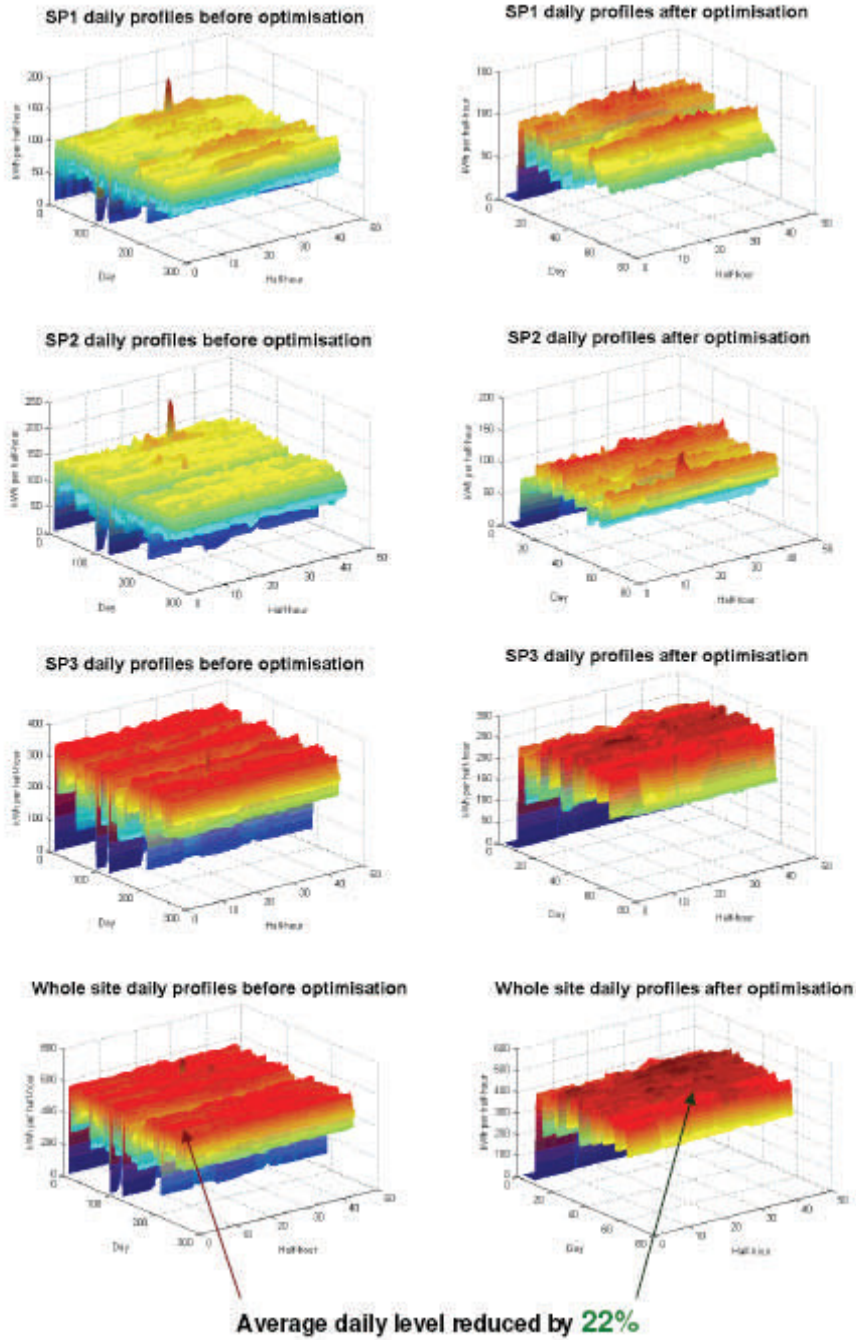


Figure 4

Figure 3 There has therefore been a marked reduction in the kWh consumption compared to previous data, well in excess of the estimated savings level of 11.5% - 13%. The chart below shows a direct comparison with the same period from the previous year, showing a reduction of **22.6%**.

The effect of the powerPerfector installation on an average day's electricity usage on the site is shown in **figure 4**, below.

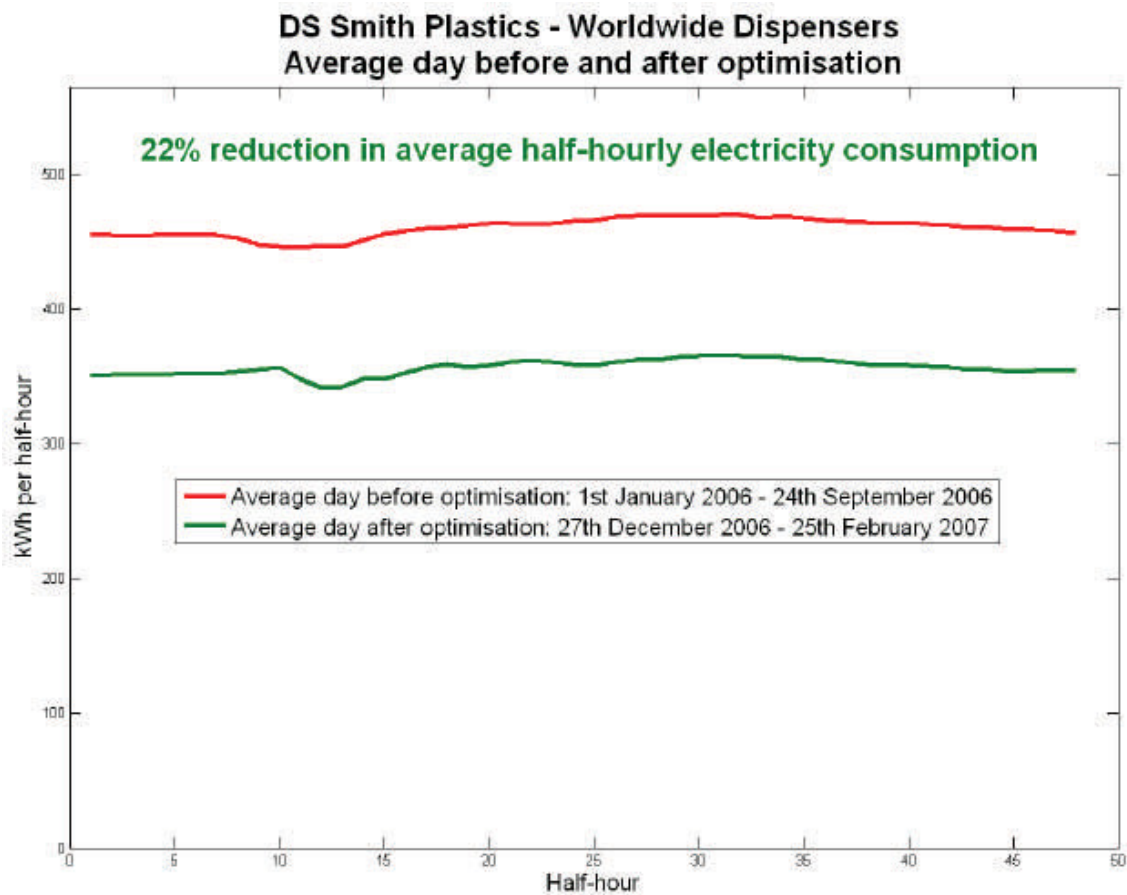


Figure 5

Conclusion

In conclusion, analysis of the electricity consumption since the installation of the **powerPerfector** indicates that savings have substantially exceeded predictions.

Additionally, the site's equipment is being driven more efficiently by the **powerPerfector's** higher quality power output, with improved phase balancing, reduced harmonics and optimised voltage. Equipment lifetimes will be extended as a result, giving further savings going forward that are not included in this analysis.

It should be noted that there were no reported problems upon switch over from normal supply to **powerPerfector** and there is no requirement for ongoing maintenance, beyond the standard 5 yearly electrical checks required for all electrical equipment.

Voltage Power Optimisation Additional Benefits

The ability of VPO[®] technology to reduce energy (kWh) consumption on a site is well documented, but the technology also provides a range of other benefits. These all contribute to creating a more efficient, robust and reliable electrical supply for your site, and provide further financial benefits on top of the reduced energy costs.

Reduced maintenance burden

- Optimising voltage with powerPerfector brings your supply voltage to the “higher efficiency” operating range of your equipment. Without this, the ‘raw’ supply voltage to your site is likely to be at the top end of the range of voltages your electrical equipment can tolerate. As well as reducing energy consumption, this reduces the **strain** on your equipment, and many of our clients tell us that this increases its lifespan.
- For example, a lightly-loaded **induction motor** operating at an optimum 380V instead of a ‘raw’ 415V experiences less heating and vibration, reducing wear on bearings and prolonging its life.
- The life of **incandescent light bulbs** is almost doubled by optimising their supply voltage.
- Most equipment benefits from the lower ‘**pressure**’ when voltages are optimised. Other examples include Variable Speed Drives – which are particularly sensitive to over-voltage – and the capacitor banks in Power Factor Correction systems.
- When these effects are **aggregated**, the benefit to your site of extended equipment lifetimes and reduced replacement costs will be substantial. The exact saving is difficult for powerPerfector to quantify, but we estimate it to give you a 10%+ reduction of your maintenance and capital replacement costs.

Improved power factor

- Optimising supply voltages reduces the **reactance** of electrical equipment, as it prevents over-excitation of magnetic components. The effect of this is to reduce the level of wasteful **reactive power** in the electrical system. Reducing reactive power improves **power factor**, and the powerPerfector typically improves power factor by 3-10%.
- The **maximum demand** of a site is expressed in kVA (incorporating both real and reactive power). So reducing reactive power reduces the maximum demand of a site, which will lead to reduced kVA demand charges, Agreed Service Capacity (ASC), and increase spare capacity for further growth. (8% optimisation = 6%-10% reduction in MD normally)

- Power factor **penalty charges** – which are now uncapped in the UK – can be avoided if your power factor is above 0.95. These may appear on your bill as ‘reactive power charge’, ‘kVAr charge’, ‘use of system charge’ or ‘availability charge’. If your power factor is at around 0.9 at the moment, the powerPerfector could remove your exposure to these charges.
- In general, the strain on your electrical infrastructure is reduced if power factor is good. If your system is carrying a high proportion of reactive power, impedances and voltage-drop will be excessive, and overall **efficiency** will be low. The powerPerfector improves the electrical efficiency of your site.
- The powerPerfector yields many of the same benefits as **Power Factor Correction**, but does not use capacitors, which can be prone to failure. Instead, it helps correct the underlying cause of poor power factor, while saving energy.

Lower harmonic distortion

- The powerPerfector is able to **filter harmonics** on the mains incomer. Harmonic distortion is on the increase, leading to apparently random failures of electronic equipment.
- As the site is protected from mains-borne harmonics, disruptions to the operation of sensitive **electronic equipment** that could otherwise result from intolerance to harmonic distortion are minimised.
- By preventing harmonics from entering the secondary side of the **HV supply transformer**, the powerPerfector is able to improve the transformer’s efficiency and increase its effective capacity. Customers whose utility meter is on the HV side of their transformer will see higher savings as a result.
- The threat from damaging **resonance** effects is reduced as harmonic distortion is lower, as is the risk of failure of Power Factor Correction capacitors.
- The **efficiency** of any equipment containing magnetic components is improved – contributing to energy savings – as the heating effect of harmonics is reduced. This in turn extends operating life by postponing the breakdown of insulating materials.

Reduced neutral currents

- As well as providing general harmonic filtration, the powerPerfector helps to reduce the level of **triplen harmonics** on a site, by balancing the three phase voltages.

- In addition to the benefits listed above, this leads to reduced **neutral currents** and temperatures – even though the neutral cable does not pass through the powerPerfector – as triplen harmonics accumulate on the neutral. Lower neutral currents are always desirable, and with an increasing proportion of non-linear loads generating more harmonics than ever before, undersized neutrals are a potential risk on many sites.

Improved phase voltage balance

- The operation of **three-phase equipment** – particularly induction motors – is much more efficient if the phase voltages are closely balanced. For large industrial sites that are heavily dependent upon such loads, balancing phase voltages at an optimum level with powerPerfector can yield energy savings of over 20% in motors.

Protection

- A powerPerfector makes an electrical supply more robust, and your site better protected. **Transients** – which are very brief surges in voltage from the grid – are eliminated by the powerPerfector, provided they are less than 25,000V.
- This level of protection is able to prevent transients from causing catastrophic damage to equipment, but it also prevents smaller, more common transient events that act to degrade equipment over time. This prolongs the expected life of electronic equipment.

