

Voltage Power Optimisation (VPO)[®]

CASE STUDY

UNIVERSITY OF WINCHESTER

West Downs Centre &
West Downs Student Village

Installed: September 2009

Report: January 2010



**THE UNIVERSITY OF
WINCHESTER**



About the University of Winchester

The University of Winchester is located close to the centre of the ancient cathedral city of Winchester, an hour away from London. Established in 1840, it is home today to under 6,000 students studying a broad range of programmes at both undergraduate and postgraduate level.

The University core values - Intellectual Freedom, Social justice, Diversity, Spirituality, Individuals Matter and Creativity underpin everything that it does, for example its commitment to environmental sustainability where it aims to become an exemplar of good practice.

The West Downs Student Village is located just a few hundred metres away from the King Alfred Campus. It welcomes over 700 students in residences made up of houses and flats. It is equipped with a shop, a laundrette and spacious green areas.

The West Downs Centre is a Grade II listed building renovated by the University in 2001. Available there are 14 syndicate and plenary rooms, 65 en-suite bedrooms, dining and bar facilities as well as a reception space.



How powerPerfactor was able to help the University of Winchester

After receiving the annual electricity consumption details for West Downs Centre and West Downs Student Village, it was possible to give a provisional quote for two powerPerfactor units and to outline the potential for energy savings. Two voltage loggers were then sent to record the voltage level at the sites by connecting them to a regular mains socket. After ten days of logging for both sites, it was found that the average voltage level was 235V at the Student Village and 237V at the Centre, respectively 5 and 7 Volts above the nominal supply voltage in the UK.

After a survey of the sites by a powerPerfactor Approved Contractor, the installation took place. Analysis following the installation showed that there was an average reduction in kWh consumption of **9%** at the Centre and **9.6%** at the Student Village attributable to the powerPerfactor installations, equating to annual carbon dioxide emissions saving of respectively **13,100** and **36,300 kg**.

Getting the source right

powerPerfactor is the world's only Voltage Power Optimiser, giving energy, carbon and cost savings by efficiently optimising a site's supply voltage. By optimising the voltage, electrical equipment runs more efficiently and consumes less energy. The declared electricity supply in the United Kingdom is now, as a result of European Harmonisation, 230V with a tolerance of +10% to -10%. This means that effective voltage can be anywhere between 207V and 253V depending on local conditions. Most electrical equipment manufactured for Europe and the UK is rated at 220V and operates more efficiently at this level. Forcing appliances to operate at a higher voltage in the UK (242V is the average supply level) leads to significantly higher energy consumption, increased heat losses and a reduced life span. Optimising voltage with powerPerfactor 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, extending its lifespan according to many of our clients. It is estimated that 90% of sites in the UK are operating at too high a voltage and could therefore benefit from installing a powerPerfactor.

Savings Summary for West Downs Centre:

- Reduction in average kWh consumption: **9%**
- Projected annual carbon dioxide emissions savings: **13,100kg**
- Projected annual financial savings: **£2,450**



A 105kVA powerPerfector unit with a 6% optimisation setting was installed at West Downs Centre on 14th September 2009. The following report is an analysis of the half hourly kWh consumption data for the site using data up to 1st January 2010. The analysis indicates that electricity consumption has been reduced by **9%** since the powerPerfector was installed. This equates to a projected annual carbon dioxide emissions saving of approximately **13,100kg** and an annual financial saving of **£2,450**. The method of analysis is outlined in the following report.

The figure below charts half-hourly consumption from 1st January 2007 to 1st January 2010; post-installation data is shown in green.

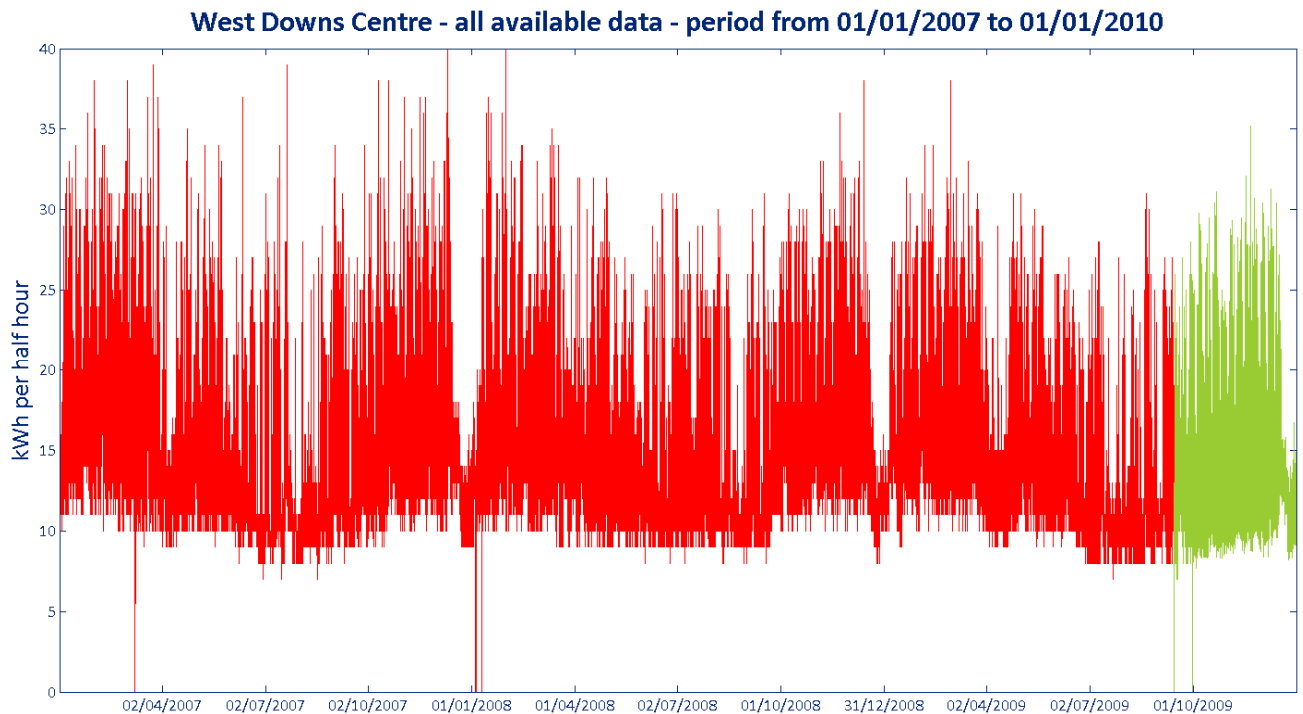


Figure 1. A chart showing consumption data between 01/01/07 – 01/01/10

To gauge the immediate effect of the powerPerfector, a Pre-Post comparison is made: periods of equal time are considered directly before, and directly after, installation. A straightforward comparison of the average consumption is made. This gives an immediate picture of consumption surrounding the installation period. This is meaningful when the consumption patterns are similar in the two periods, allowing a like-for-like comparison to be made. The results are shown in **Figure 2** below; a 5.9% reduction in consumption is seen.

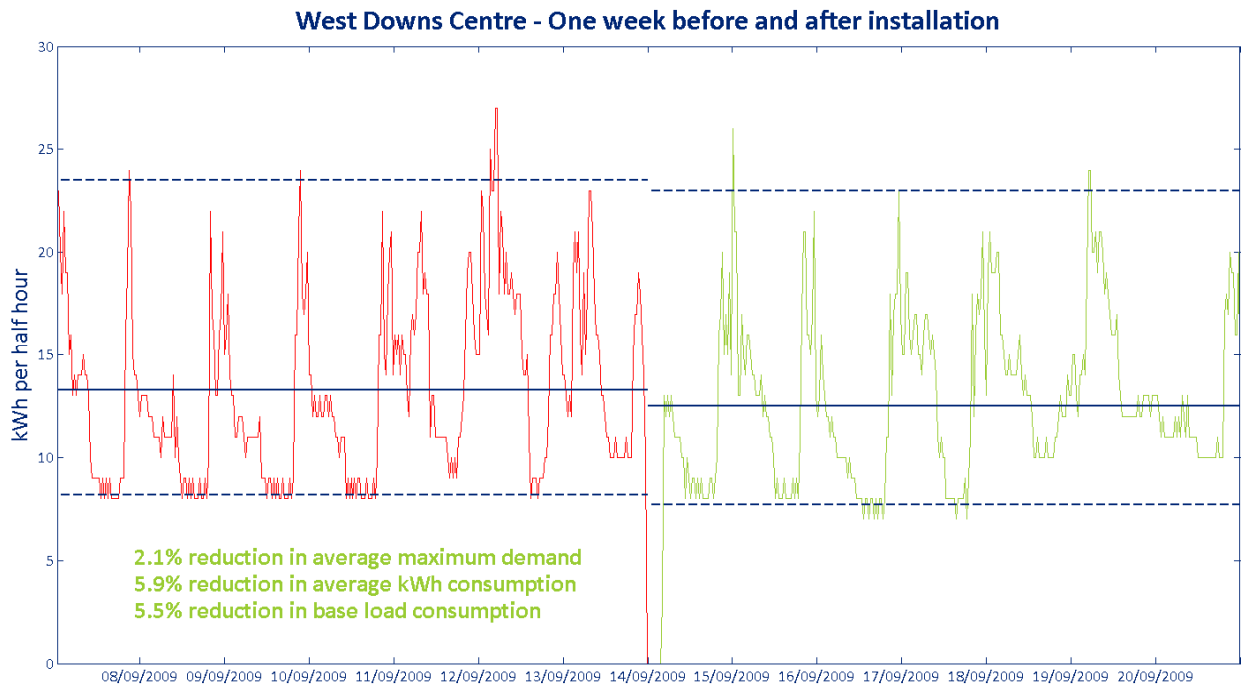


Figure 2. A chart comparing consumption directly before and after installation.

It is clear from **Figure 1** that consumption varies seasonally. By visually comparing consumption at the time of the powerPerfector installation with the same period 12 months earlier, one notices that consumption was set to increase, hence consumption is likely to have been reduced from a higher level than **Figure 2** suggests. In light of this a Year-on-Year comparison would yield a better estimate of the savings the powerPerfector unit is achieving. In this analysis post-installation consumption is compared to pre-installation consumption during corresponding months the year before. The figure below indicates a reduction of 9% in average electricity consumption.

Savings Summary for West Downs Student Village:

- Reduction in average kWh consumption: **9.6%**
- Projected annual carbon dioxide emissions savings: **36,300kg**
- Projected annual financial savings: **£6,770**



A 350kVA powerPerfector unit with a 6% optimisation setting was installed at West Downs Student Village on 14th September 2009. The following report is an analysis of the half hourly kWh consumption data for the site using data up to 1st January 2010. The analysis indicates that electricity consumption has been reduced by **9.6%** since the powerPerfector was installed. This equates to a projected annual carbon dioxide emissions saving of approximately **36,300kg** and an annual financial saving of **£6,770**. The method of analysis is outlined in the following report.

The figure below charts half-hourly consumption from 1st January 2007 to 1st January 2010; post-installation data is shown in green.

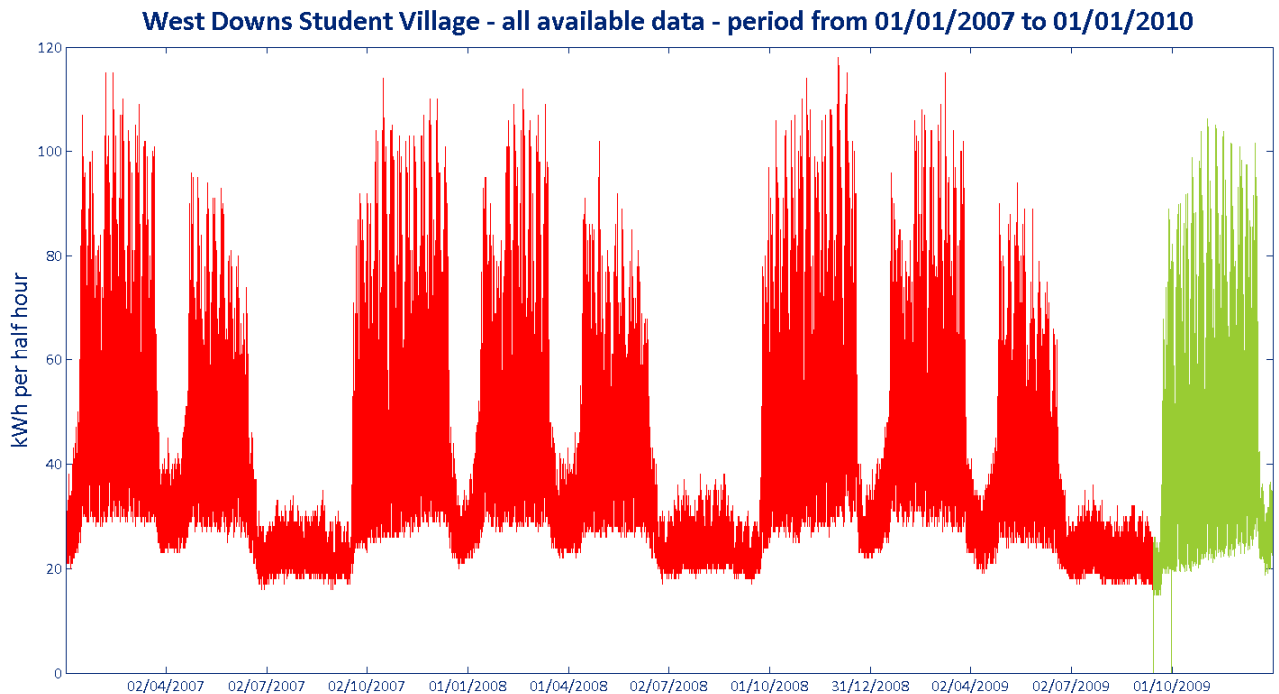


Figure 1. A chart showing consumption data between 01/01/07 – 01/01/10

To gauge the immediate effect of the powerPerfector, a Pre-Post comparison is made: periods of equal time are considered directly before, and directly after, installation. A straightforward comparison of the average consumption is made. This gives an immediate picture of consumption surrounding the installation period. This is meaningful when the consumption patterns are similar in the two periods, allowing a like-for-like comparison to be made. The results are shown in Figure 2 below; an 11.8% reduction in consumption is seen.

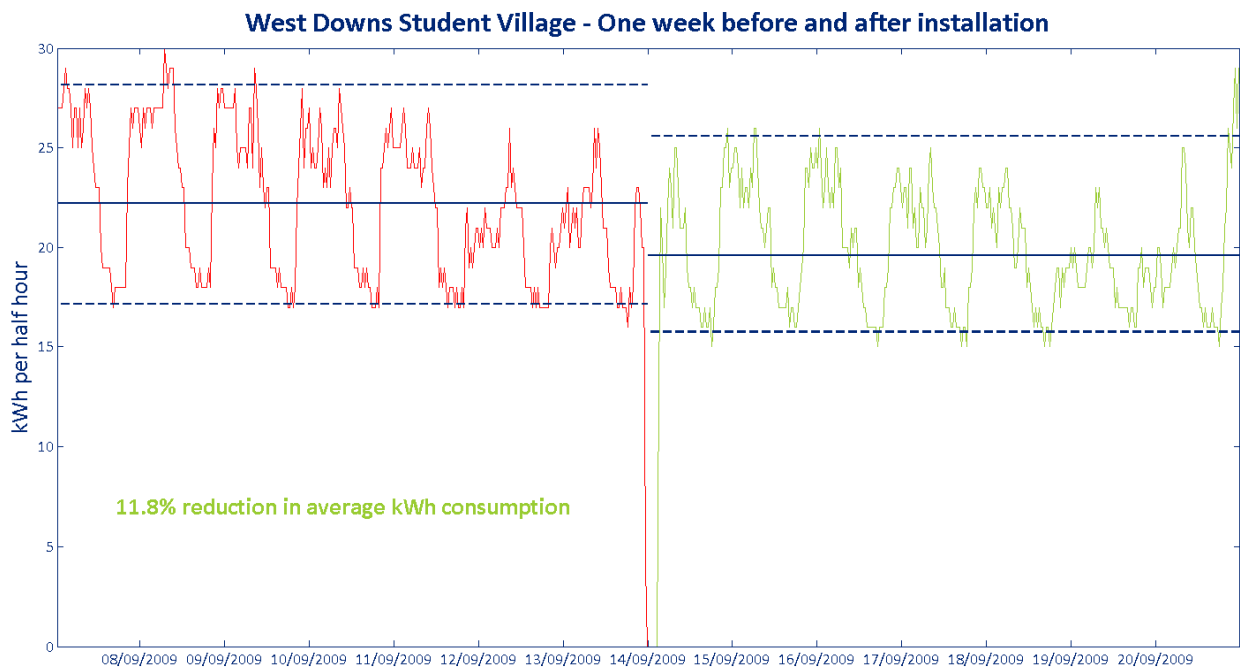


Figure 2. A chart comparing consumption directly before and after installation.

It is clear from **Figure 1** that consumption varies seasonally – due partly to temperature variation and partly due to terms/holidays of the University’s students. A Year-on-Year comparison would yield a better estimate of the savings the powerPerfector unit is achieving as it would isolate these factors affecting consumption. In this analysis post-installation consumption is compared to pre-installation consumption during corresponding months the year before. The figure below indicates a reduction of 9.6% in average electricity consumption.

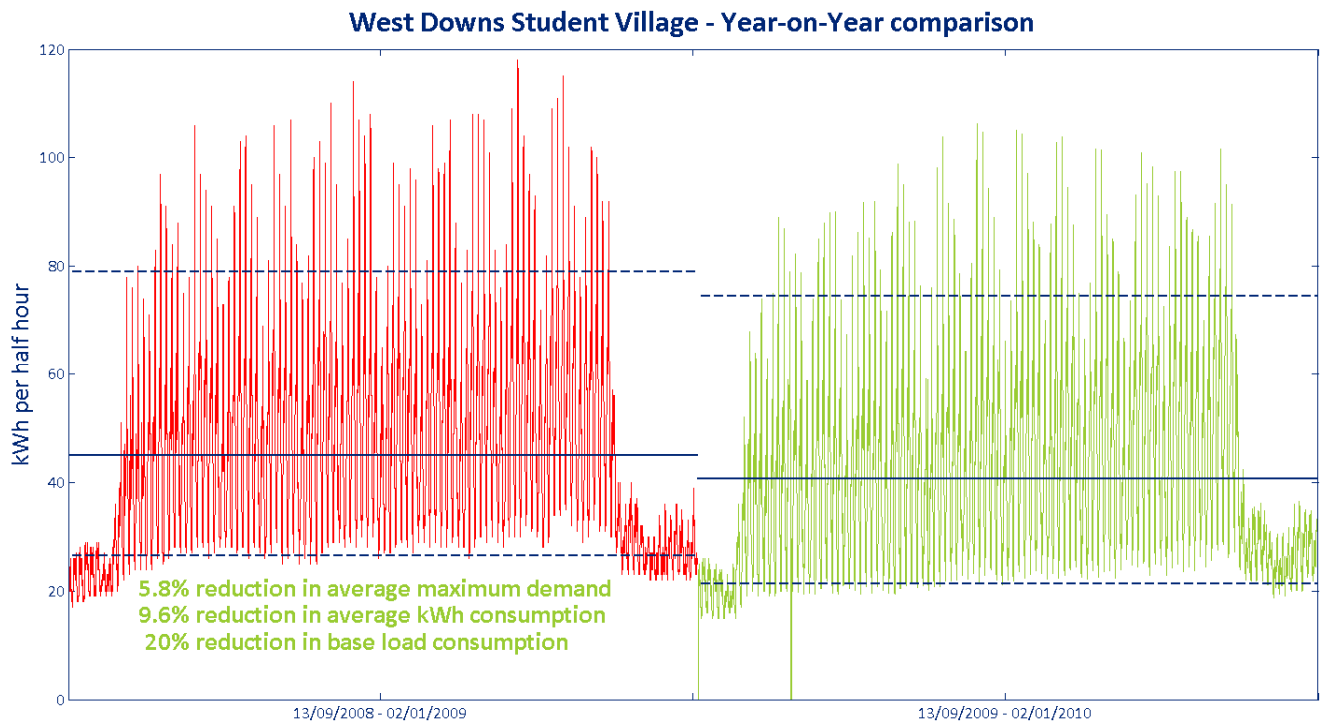


Figure 3. A chart illustrating the temperature dependence of consumption.

In conclusion, analysis of the half hourly kWh data shows that since the powerPerfector installation the average consumption is **9.6%** lower than a similar period during the year before, equating to a projected annual emissions saving of **36,300 kg** of carbon dioxide.

The powerPerfector is also ensuring that the site operates at a higher level of efficiency, as well as benefiting from improved power quality and protection from transients of up to 25,000V. Further details about the benefits of voltage power optimisation are appended to this report.

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.

