

## Voltage Power Optimisation (VPO)<sup>®</sup>

### CASE STUDY

## West Pharmaceutical Services

Installed: January 2011  
Report: July 2011



*"Being in such close proximity to our supply transformer meant we were seeing line voltages of around 247V at our plant. We decided to install a powerperfector unit with an optimisation setting of 8%, to reduce our voltage to around 230V. We were told to expect savings of around 6% (37.4 tonnes / year), but after the first 6 months, it has become apparent to us that we are actually making savings of 13.2% (82.3 tonnes / year) and therefore the payback for the project has been reduced from the predicted 4 years to 2 years. The project was delivered in a professional manner, with good communication, both from powerperfector and their nominated contractor throughout."*

**Jon Rundle**  
Control & Instrumentation Engineer  
West Pharmaceutical Services

## About West Pharmaceutical Services

West Pharmaceutical Services is a manufacturer of pharmaceutical packaging and delivery systems. Founded in 1923 by Herman O. West of Philadelphia, the company's European headquarters are in Eschweiler, Germany. The England branch of the company is based in Bodmin and St Austell, Cornwall. WPS makes a wide variety of products, including stoppers, vials, seals, injection systems, intravenous system components, plungers and syringes. They also offer pre-sterilization services in association with their products, and laboratory services relating to packaging design.

## How powerPerfactor were able to help West Pharmaceutical Services

After West Pharmaceutical Services sent its annual electricity consumption details, it was possible to give a provisional quote for the powerPerfactor unit and the energy savings that would be expected. A voltage logger was then sent to the site for one week which recorded the voltage level in the building via connection to a regular mains socket. The logger found that the average voltage at the site was 247 V, 17 volts higher than the nominal supply required in the UK. After a survey of the site by an approved installation partner, the installation of the powerPerfactor unit took place. After the installation the electricity consumption of West Pharmaceutical Services was analysed, finding a reduction attributable to the powerPerfactor installation of **13.2%**, corresponding to a projected annual carbon dioxide emissions saving of **82.3 tonnes**.

## Getting the source right

powerPerfector 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 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, 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 powerPerfector.

### Savings Summary for West Pharmaceutical Services:

- Reduction in average kWh consumption: **13.2 %**
- Projected annual carbon dioxide emissions savings: **82.3 tonnes**
- Projected annual financial savings: **£12,100**

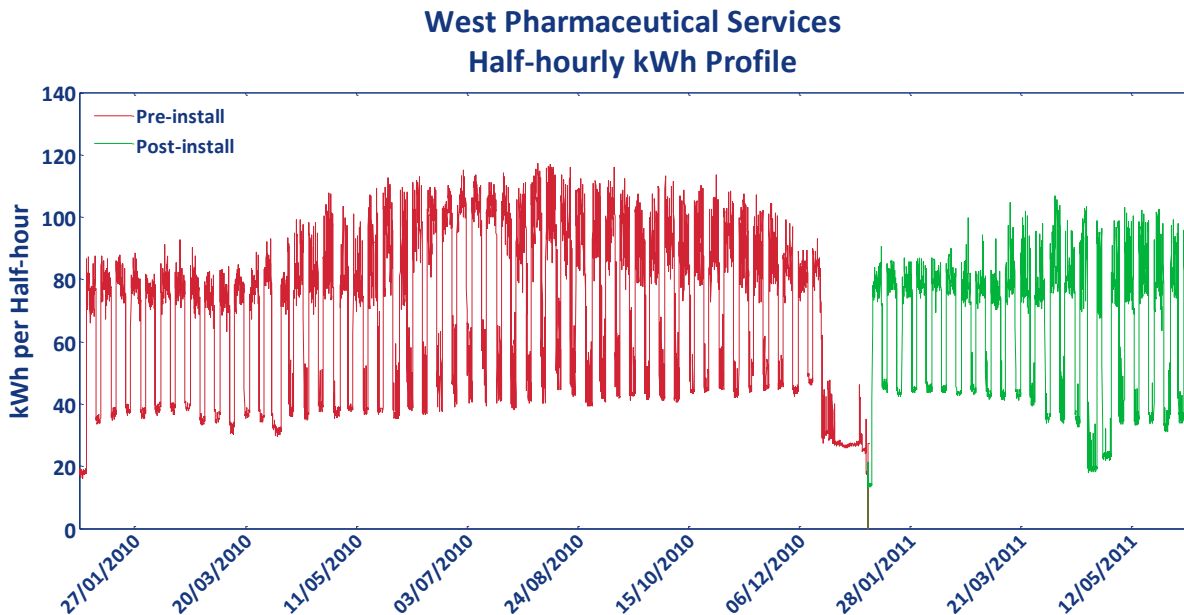
A 280kVA powerPerfector unit with an 8% optimisation setting was installed at West Pharmaceutical Services on 8<sup>th</sup> January 2011. A post-installation analysis was conducted. The analysis shows that the electricity consumption at West Pharmaceutical Services has been **13.2%** lower than the expected levels for temperature since the installation of the powerPerfector. This equates to a projected annual carbon dioxide emissions saving of approximately **82.3 tonnes** and an annual financial saving of **£12,100**. The method of analysis is detailed overleaf.



## Analysis

### Consumption Profile

The chart below shows all available kWh data for West Pharmaceutical Services from 1<sup>st</sup> January 2010 to 7<sup>th</sup> June 2011. Data before installation is shown in red and after installation in green.



Peaks in consumption are apparent in the summer in the consumption profile above, suggesting that there is some correlation with external temperatures. Therefore in the next section it has been assessed to what extent correlation with external temperatures can be used to model consumption and provide a baseline against which energy savings following the powerPerfector installation can be reported.

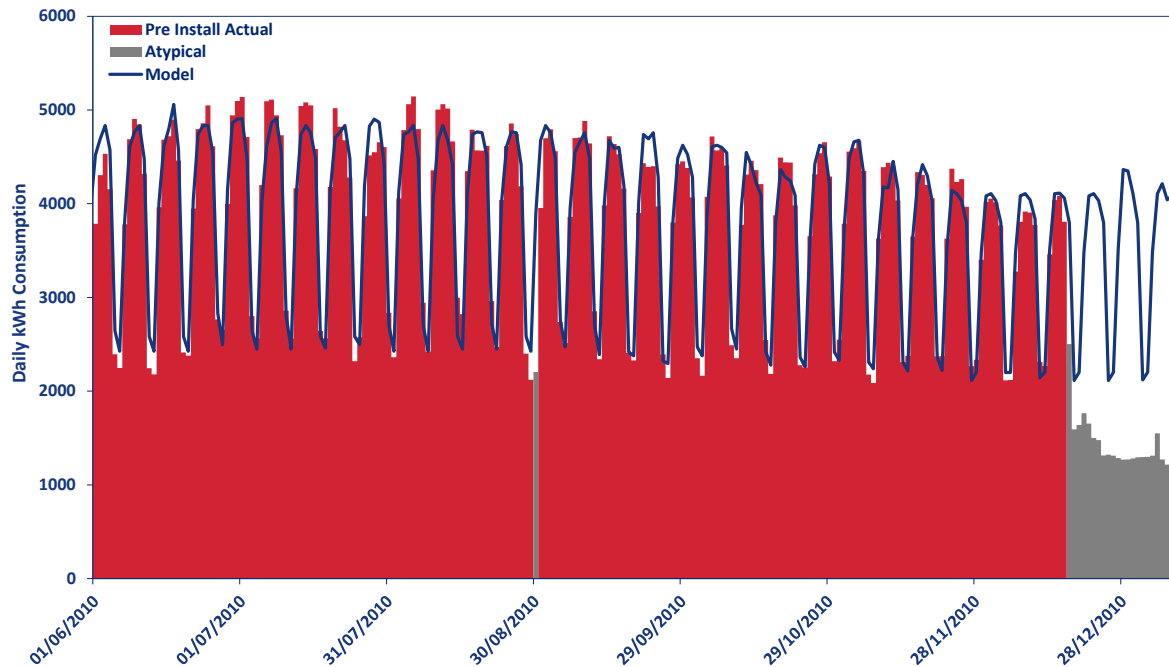
We have also been informed that the air-conditioning load was increased by 50% on 1<sup>st</sup> June 2010. Consequently all data prior to that date will be excluded from the analysis below as it is not comparable to the rest of the dataset, and in particular the post-installation data.

## Savings Analysis

An accurate and established method of quantifying the effect of external temperature on energy consumption is known as a 'Degree Days' analysis. Degree Days are based on Met Office temperature data for regions in the UK and represent the difference in external temperature and a base temperature for a given period of time. Since consumption has been higher in the summer, Cooling Degree Days (with a base temperature of 5°C) have been used to calculate the model below.

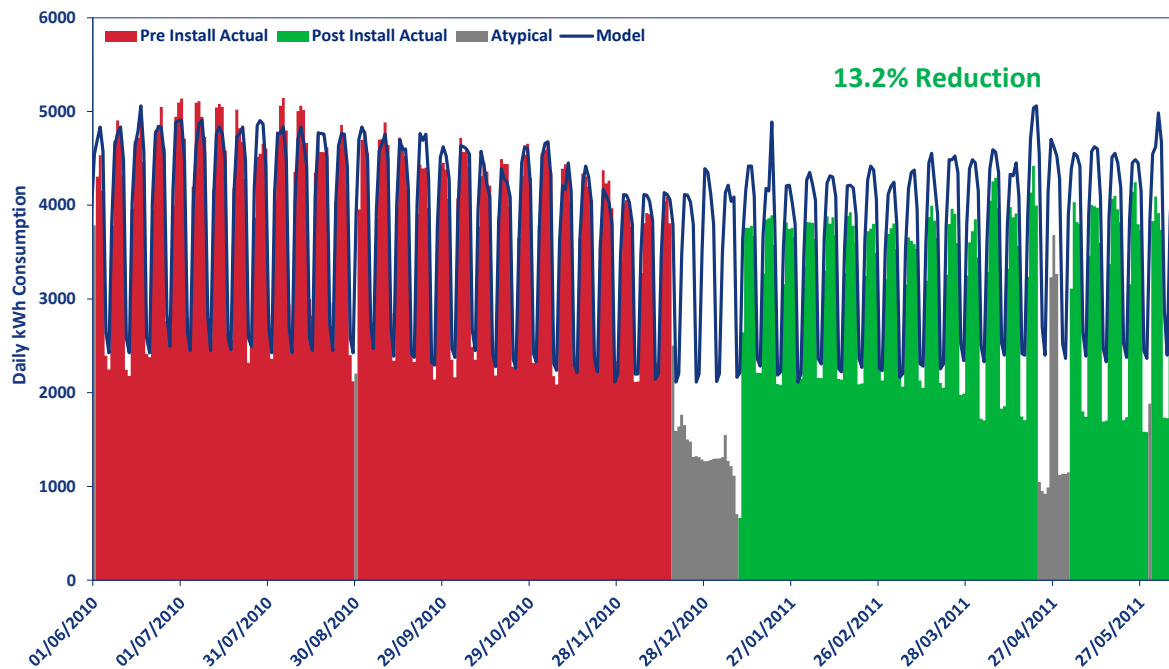
The next graph shows the model calculated using Cooling Degree Days along with the actual kWh consumption data. The red data represents the daily kWh consumption before installation. The blue line is the regression line of the pre-installation consumption data. All bank holidays as well as the installation date and the Christmas and New Year periods are shown in grey. These dates are excluded from the calculation of the model because the atypically low consumption on these dates is not representative of the site under normal loading conditions. The model starts on 1<sup>st</sup> June 2010 for the reasons explained in the previous section.

**West Pharmaceutical Services - Model Vs. Actual**



Having calculated the expected level of kWh consumption it is possible to compare the actual post-installation data to the level of kWh consumption that would have been expected if nothing had changed at the site. The green data is the daily kWh consumption after installation of the powerPerfector.

### West Pharmaceutical Services - Model Vs. Actual



The chart shows that, having taken into account the external temperature, the energy consumption at West Pharmaceutical Services has been, on average, 13.2% lower than would have been predicted had the powerPerfector unit not been installed.

### Conclusions

In conclusion, the analysis indicates that electricity consumption following the powerPerfector installation at West Pharmaceutical Services is **13.2%** lower than the expected levels for temperature. This equates to a projected annual carbon dioxide emissions saving of approximately **82.3 tonnes** and an annual financial saving of **£12,100**.

## Voltage Power Optimisation Additional Benefits

The ability of VPO<sup>®</sup> 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.