

Voltage Power Optimisation (VPO)[®]

CASE STUDY

University of Surrey

The Surrey Clinical Research Centre

Installation 21st December 2008

Report March 2009



"The integration of the powerPerfector, into what is a complex and demanding facility, went absolutely seamlessly. We've experienced no problems with any electrical or electronic system following the reduction in voltage and we are reporting significant savings in-line with predicted levels. This was our first voltage optimisation project, the intention now is to roll this equipment out into the nine substations on the main University campus. An 11% saving across our main campus consumption profile would represent a saving of around £250,000 per annum."

Dale Meadows, Energy Engineer

Estates & Facilities Management - University of Surrey



About the Surrey Clinical Research Centre

The Surrey Clinical Research Centre (SCRC) of the University of Surrey has a proven formula for success in clinical research, with a particular emphasis on sleep and human psychopharmacology. To date they have undertaken over 250 clinical trials including both volunteer and patient populations. SCRC is a purpose built facility bringing together everything needed to deliver full service clinical trial solutions and sleep research. They are ideally situated adjacent to The Royal Surrey County Hospital and the University's Postgraduate Medical School, which enables the close collaborative working with clinical colleagues and ensures the safe delivery of high quality trials. Furthermore, they are integral to the University with direct access to leading sleep and psychopharmacology academic experts.

Their facilities include:

- A 12 bedded ward
- 12 individual sleep laboratories
- A laboratory for sample preparation
- A secure pharmacy

powerPerfector unit details

A pP105kVA/150A unit with a 9% optimisation was installed at SCRC on 21st December 2008. Through installation the following results were achieved:

- **10% reduction in daily kWh consumption**
- **£2,600 projected annual financial savings**
- **15,000kg projected annual CO₂ savings**

FULL REPORT

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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

Following a process of evaluation to confirm the level of optimisation and suitability of SCRC for a powerPerfector unit, a pP105kVA / 150A unit was installed on 21st December 2008.

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	15,000 kg	£5.20 per day £2600 annually
Projected annual carbon savings	15,000 kg	

Introduction

A 105kVA powerPerfector unit with a 9% optimisation setting was installed at SCRC on 21st December 2008. The following report is an analysis of the half hourly kWh consumption data for the site up to 7th July 2009. Our analysis indicates that savings of at least **10%** having been achieved. The method of analysis is outlined in the report.

Figure 1 shows the full consumption profile throughout the period 25th October 2007 until 7th July 2009. The period before the installation of the powerPerfector is in red and the period after in green.

Surrey Clinical Research Centre - all available data

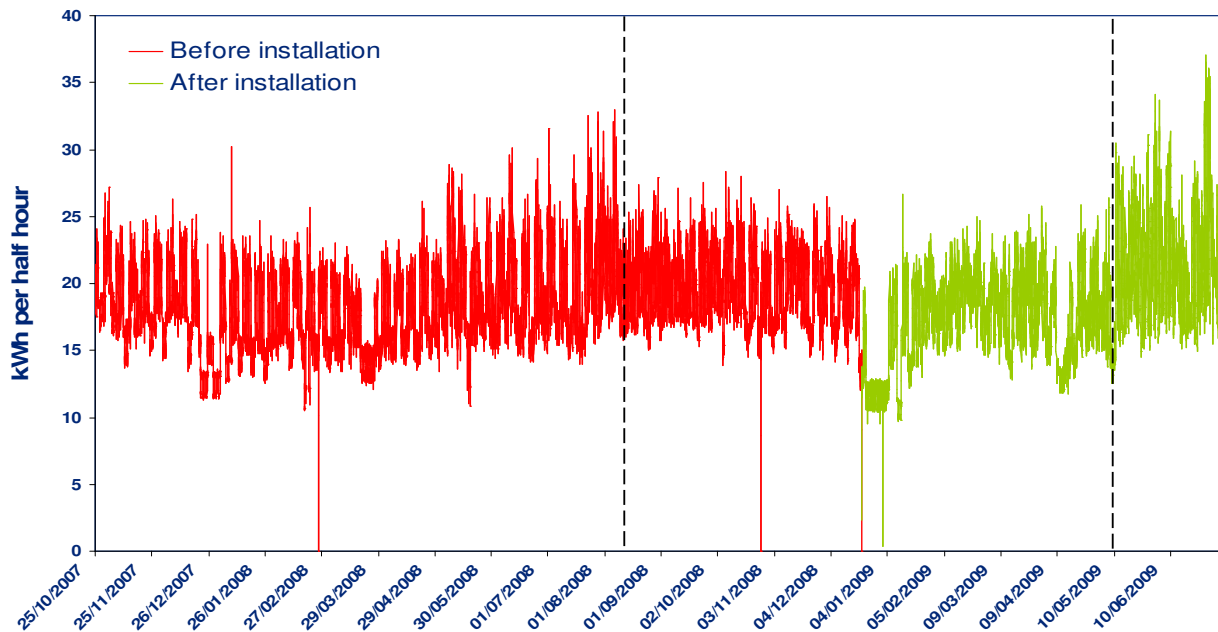


Figure 1. Electricity consumption per half hour of the Surrey Clinical Research Centre, between 25-10-2007 and 28-02-2009

Figure 1 (on the previous page) indicates that there is some variation in consumption, which is presumably related to use of the building at any given time. The two weeks immediately following the powerPerfector installation have an atypically low energy usage coinciding with the Christmas and New Year holiday period, as do the weeks coinciding with Easter. These weeks have been excluded from our analysis.

Having excluded this data, there is a reduction in consumption immediately following installation, so we have first compared the three weeks before installation with the three weeks after the holiday period when normal patterns have been resumed. We have noted that there is some variation in whether the building is largely in use at the weekends or not.

In **Figure 2**, we have only compared data for the weekdays, since weekend usage in the post data indicated that the building was not in full use, whereas data over some weekends in the pre install period was relatively high. Such changes can distort the savings figure with a comparison over a short period of time. On this basis of comparison, there is a 14.3% reduction in average kWh consumption.

Surrey Clinical Research Centre - three weeks before and after

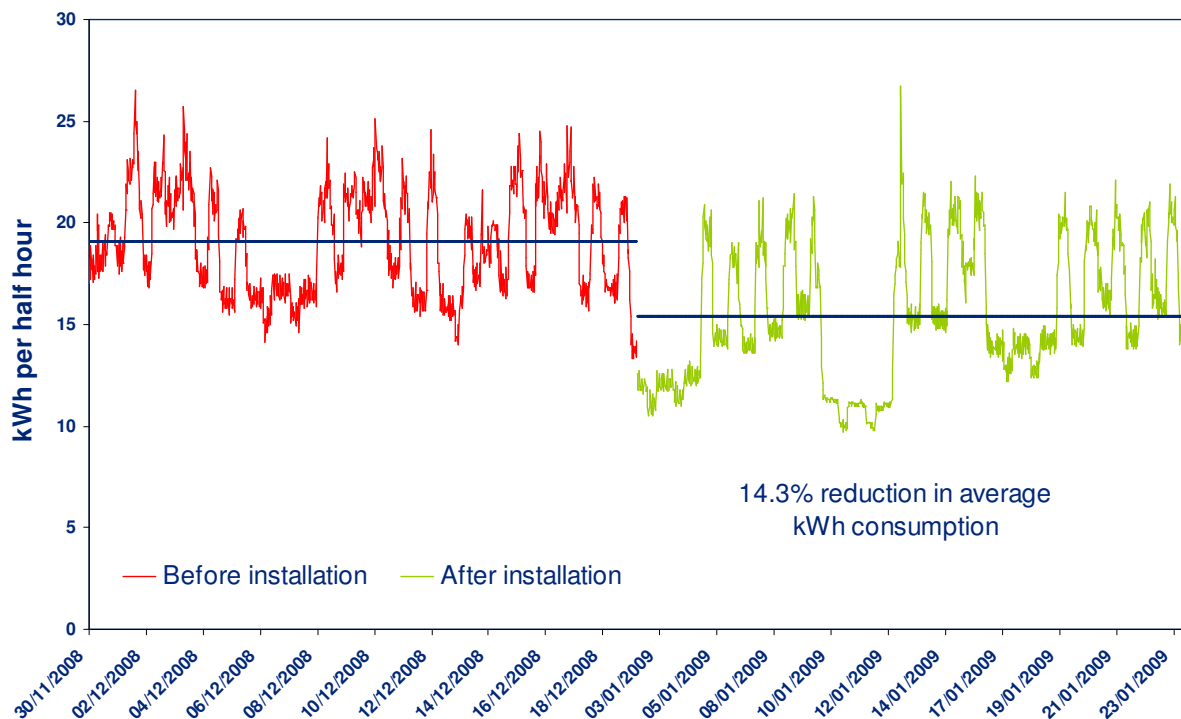


Figure 2. Electricity consumption three weeks before and after powerPerfector installation

Whilst it is useful to show the immediate effect, we have also considered the change in kWh consumption over a longer period of time having established the extent to which pre



installation data is consistent and therefore comparable to the post installation data.

From **Figure 1** showing all the available data, there is a peak in the maximum demand around the beginning of August. Following this, consumption is broadly consistent, so we have used this period as a benchmark for the post installation data. In the post installation period, consumption is also broadly consistent until the beginning of May 2009. The periods of comparison compared are indicated by the dashed lines in **Figure 1**. From this time, there is a steady increase in consumption, which is presumably attributable to the use of cooling loads in the building.

Since average consumption may be different for each day of the week, particularly the weekends, we have used an average weekly profile to illustrate the reduction in consumption following powerPerfector installation. The weekly profiles have been established by calculating the average kWh for each half hourly reading of the week. This is shown in **Figure 3**. The profile before installation is for weeks from the beginning of September and the profile after installation is for all of the data available (excluding the weeks with low consumption as discussed) up to the beginning of May 2009. On this basis of comparison, there is a 10% reduction in average kWh consumption.

Surrey Clinical Research Centre - average weekly profiles

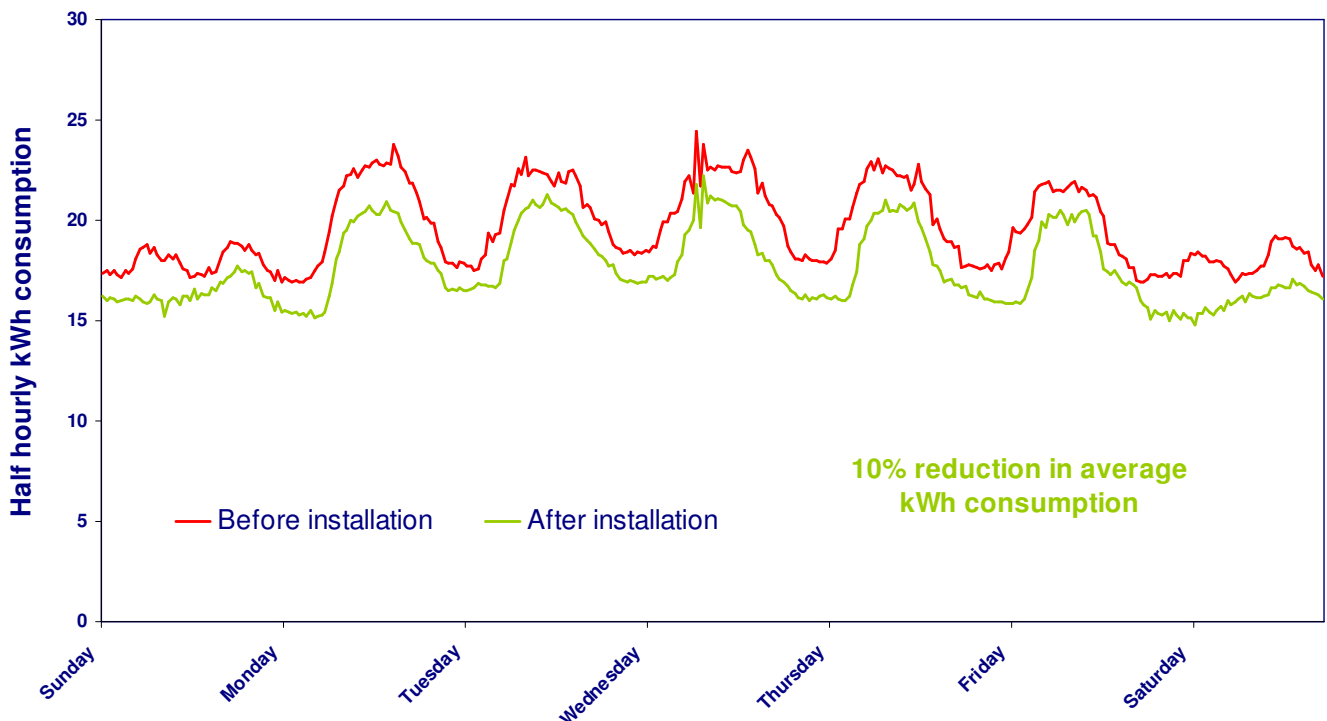


Figure 3. A average weekly consumption profiles before and after powerPerfector installation.

Conclusion

In conclusion, analysis of the electricity consumption since the installation of the **powerPerfector** indicates that average consumption has been reduced by **10%**. Additionally, the site's equipment is being driven more efficiently by the **powerPerfector**'s higher-quality power output, with improved phase balancing, reduced harmonics, optimised voltage and protection of transients of up to 25,000V. Many of our clients tell us 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 powerPerfactor 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 powerPerfactor improves the electrical efficiency of your site.
- The powerPerfactor 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 powerPerfactor 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 powerPerfactor 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 powerPerfactor 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.

