

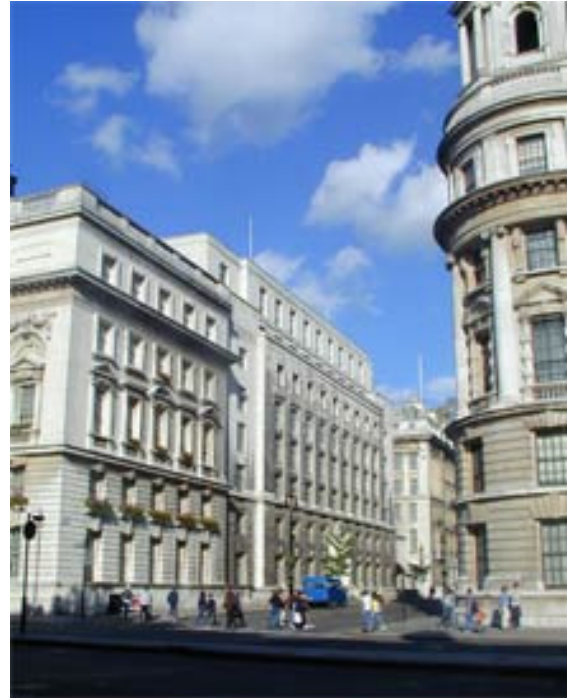
Voltage Power Optimisation (VPO)[®]

CASE STUDY

DEPARTMENT OF ENERGY AND CLIMATE CHANGE WHITEHALL PLACE

Installed: March 2008

Report: July 2009



“The powerPerfector at 3 Whitehall Place is a critical part of our energy reduction strategy, and has helped us to maximise our efficiency and reduce our carbon emissions.”

Jenny McInnes - Building DECC Team

DEPARTMENT OF
ENERGY
& CLIMATE CHANGE



About the Department of Energy and Climate Change

The Department of Energy and Climate Change (DECC) is responsible for all aspects of UK energy policy, and for tackling global climate change. Its objective is to bring about the transition to a low carbon Britain while making energy secure, affordable and efficient.

For Government to inspire action on climate change, it must lead by example - a challenge for the newly created Department of Energy and Climate Change (DECC) in October 2008 when it moved into its G energy efficiency-rated London HQ. Like many of Britain's homes and offices, DECC's HQ is a heritage building, designed well before today's energy efficiency standards.

In 'greening' its operations, DECC wants to show that it is possible to be more sustainable in an older building with planning restrictions. The Department is making essential changes to the way in which the building is used (including optimising lighting, heating and cooling controls). The Department has set itself an ambitious target to reduce its carbon emissions from 3 Whitehall Place by 10% in financial year 09/10, despite practically doubling its occupancy, and increasing its hours of operation.

Future plans may also include micro-generation of energy on-site and using renewable technologies. Engaging staff is key to making lasting changes, and DECC is rolling out internal 'Act on CO2' campaigns across the Department. The Department is the perfect test site for its plans for a low carbon UK by 2050.

Extract taken from Sustainable Development Unit – Issue 19

How powerPerfector were able to help the DECC

At the time of assessment for the powerPerfector installation, 3 Whitehall Place was occupied by Defra, and DECC has occupied the building since October 2008. The assessment process used the annual electricity consumption details to establish a provisional quote for a powerPerfector unit and the energy savings that would be expected. A voltage logger was then sent for one week, which recorded the voltage level in the building by connecting to it in to a regular mains socket. It was found that the average voltage at Whitehall Place was 245 volts (V), 25V higher than the nominal supply required in the UK. After a survey of the site by a powerPerfector Approved Contractor, the installation took place. The installation was completed on a weekend when there would be no disturbance to the building. There was no noticeable change to the operation of the building, although continuous carbon savings were instantly being made every day at Whitehall Place. Analysis after the installation showed that there was an average reduction in kWh consumption of **11.0%**, equating to annual carbon dioxide emissions saving of **136,500kg**.

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.

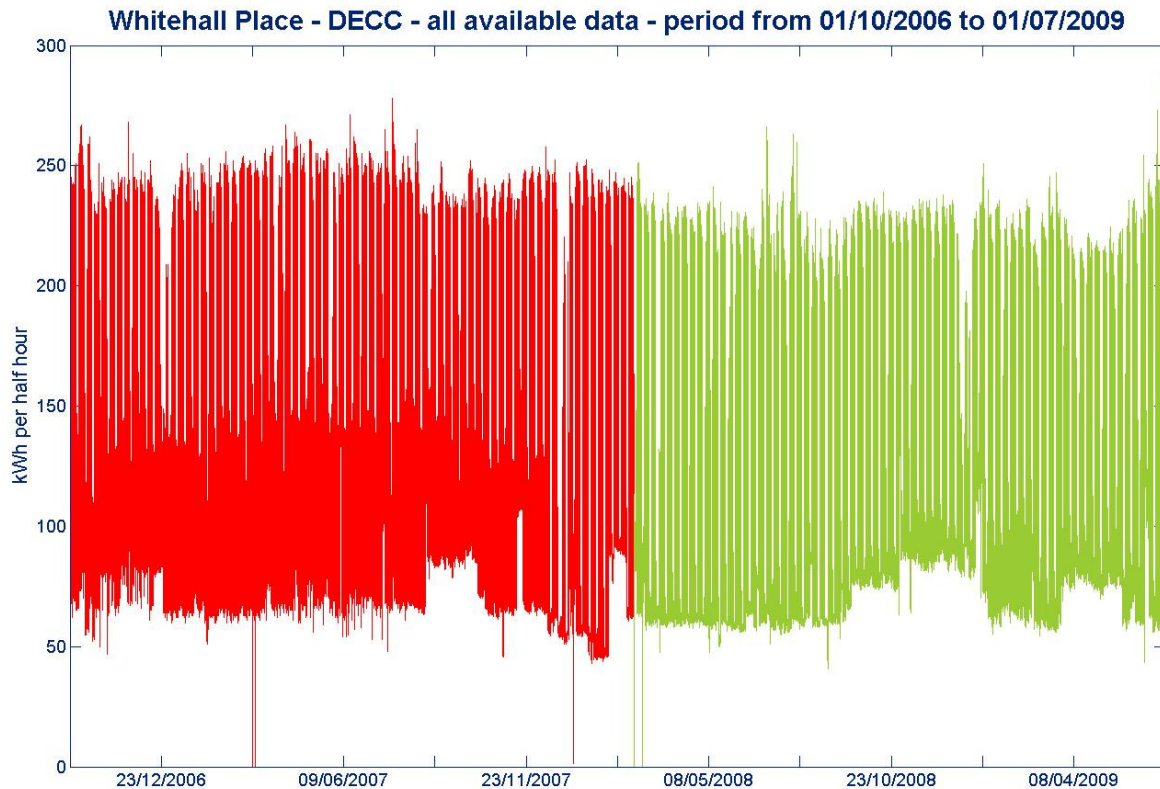
Savings Summary for 3 - 8 Whitehall Place:

- Reduction in average kWh consumption: **11.0%**
- Projected annual carbon dioxide emissions savings: **136,500 kg**
- Projected annual financial savings: **£19,000**

A 1MVA powerPerfactor unit with an 8% optimisation setting was installed at 3 Whitehall Place on 8th March 2008 to improve the sustainability of the building still further. Based on a comparison of the electricity consumption directly before and after the installation, the consumption since the powerPerfactor unit was installed is 11.0% lower than before installation, equating to an annual projected carbon saving of 136,500 kg. The method of analysis is outlined in the following report.

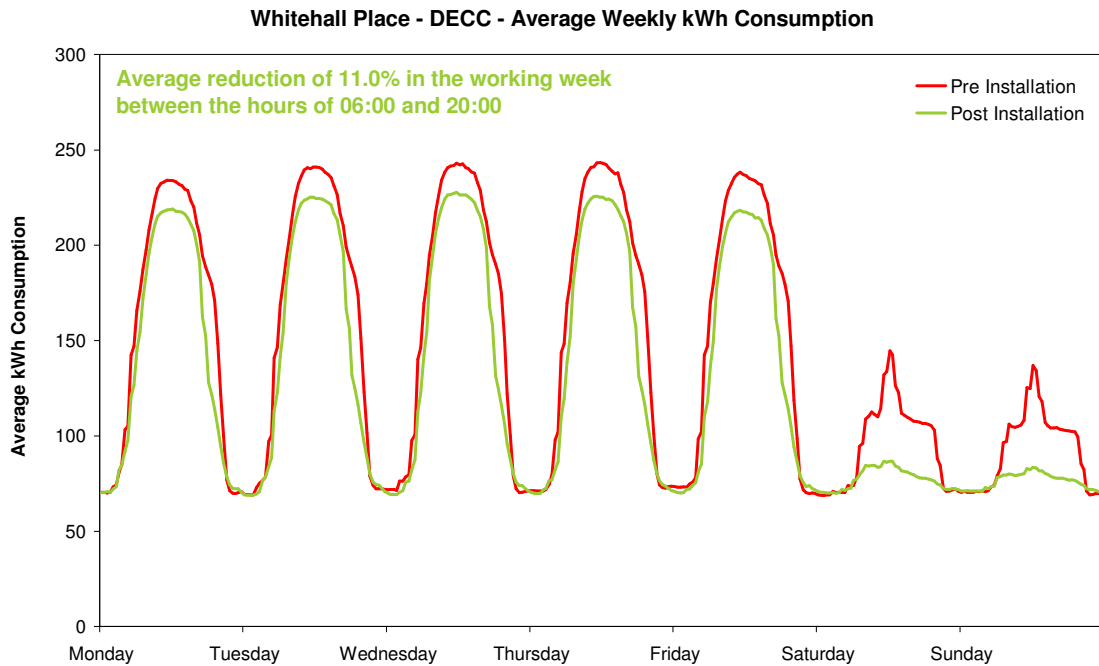


The total half hourly kWh consumption from October 2006 to June 2009 is shown below. The kWh consumption before the installation is shown in red and the post installation kWh consumption is shown in green.



There is some considerable variation in the baseload (overnight and weekend consumption) over time, which may be indicative of changes to the electrical loading or use of the site. These variations in baseload do not appear to coincide with increases in maximum demand, so we have therefore established it is reasonable to restrict the comparison to consumption during the site's normal operating hours and limit the effect of the variations in baseload consumption is observed.

The following graph shows the average weekly consumption profiles before and after installation using all of the available data (note that the weeks coinciding with the Christmas and New Year bank holidays have been excluded since these weeks are not representative of normal site use). The weekly profiles have been plotted by averaging each data point associated with a half hour of each day of the week before and after installation. The following chart shows this comparison.



The graph above indicates that whilst consumption patterns during the working week are broadly similar before and after the installation, consumption at the weekends is considerably lower after installation. This reduction appears to be attributable to a change of loading at the site, since the consumption profiles for weekends are very different. In order to exclude the effect of this difference and also the differences observed in the overnight consumption, we have assessed the difference in consumption for weekdays from 06:00 to 20:00. On this basis of comparison, there is an average reduction in kWh consumption of **11.0%**.

A reduction of **11.0%** equates to a projected annual emissions saving of **136,500 kg** of carbon dioxide and an annual financial saving of £19,000. In addition, the powerPerfector is ensuring that the site operates at a higher level of efficiency, as well as benefiting from improved power quality and protection against transients of up to 25,000V. Further details of 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.

