

## CASE STUDY

### PRUPIM

#### Brunswick Shopping Centre

Installed: October 2009

Report: January 2010



*"From the moment we started to look at the benefits of power optimisation the input from powerPerfector team has been very professional. The initial readings taken indicated some very useful savings and once installed we could tell from our own readings that we were going to make major savings against our budgets. Installing one of these systems made good business sense, combining excellent cost savings while prolonging the life for our machinery and most of all, a significant reduction in our carbon footprint."*

**Jim Hughes, Centre Manager, Brunswick Shopping Centre**

# PRUPIM



## **About PRUPIM and Brunswick Shopping Centre**

PRUPIM is one of the leading real estate investment managers in the United Kingdom. It forms part of the M&G Group of Companies which is the asset management arm of Prudential Plc in the UK and Europe. It manages around £15 billion of real estate assets, and is invested in over 800 properties with approximately 4,500 property occupiers worldwide. PRUPIM offers fully integrated Real Estate Investment Management: fund management, asset management and property management services.

Brunswick Shopping Centre in Scarborough is owned by M&G and managed by PRUPIM. It is home to 30 shops and stores on 130,000 sq ft and five floors.

## **How powerPerfector were able to help PRUPIM**

After receiving the annual electricity consumption details for Brunswick Shopping Centre, it was possible to give a provisional quote for a powerPerfector unit and to outline the potential for energy savings. A voltage logger was then sent for a week, which recorded the voltage level at the site by connecting it to a regular mains socket. It was found that the average voltage at the site was 249 volts (V), 19V higher than the nominal supply in the UK. After a survey of the site by a powerPerfector Approved Contractor, the installation took place on a Sunday. Analysis following the installation showed that there was an average reduction in kWh consumption of **17.7%** attributable to the powerPerfector installation despite a significant proportion of the electrical load of the building being comprised of motors controlled by Variable Speed Drives (VSDs). A 17.7% reduction in kWh consumption equates to an annual carbon dioxide emissions saving of approximately **65,700 kg**.

## **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.

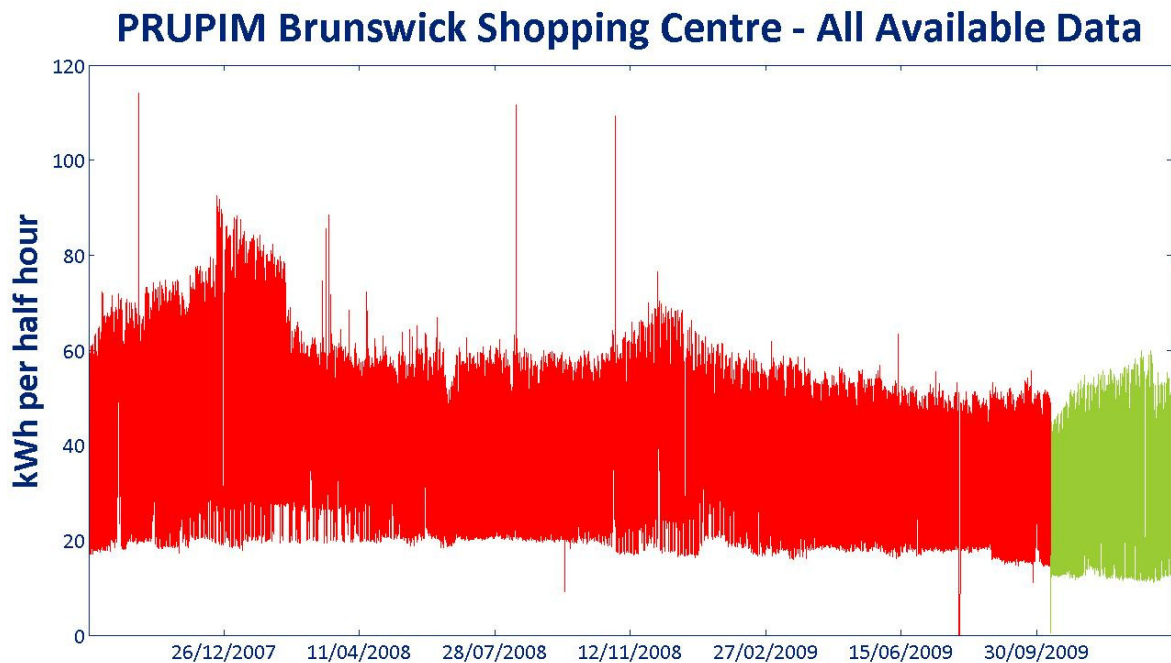
#### Savings Summary for Brunswick Shopping Centre:

- Reduction in average kWh consumption: **17.7%**
- Projected annual carbon dioxide emissions savings: **65,700kg**
- Projected annual financial savings: **£13,630**



A 210kVA powerPerfector unit was installed at Brunswick Shopping Centre on 11<sup>th</sup> October 2009. The following report is an analysis of the half-hourly data for the site up to January 2010. It concludes that there is an average reduction in kWh consumption of **17.7 %** compared to expected levels. This equates to an annual carbon dioxide saving of **65,700 kg** and an annual financial savings of **£13,630**.

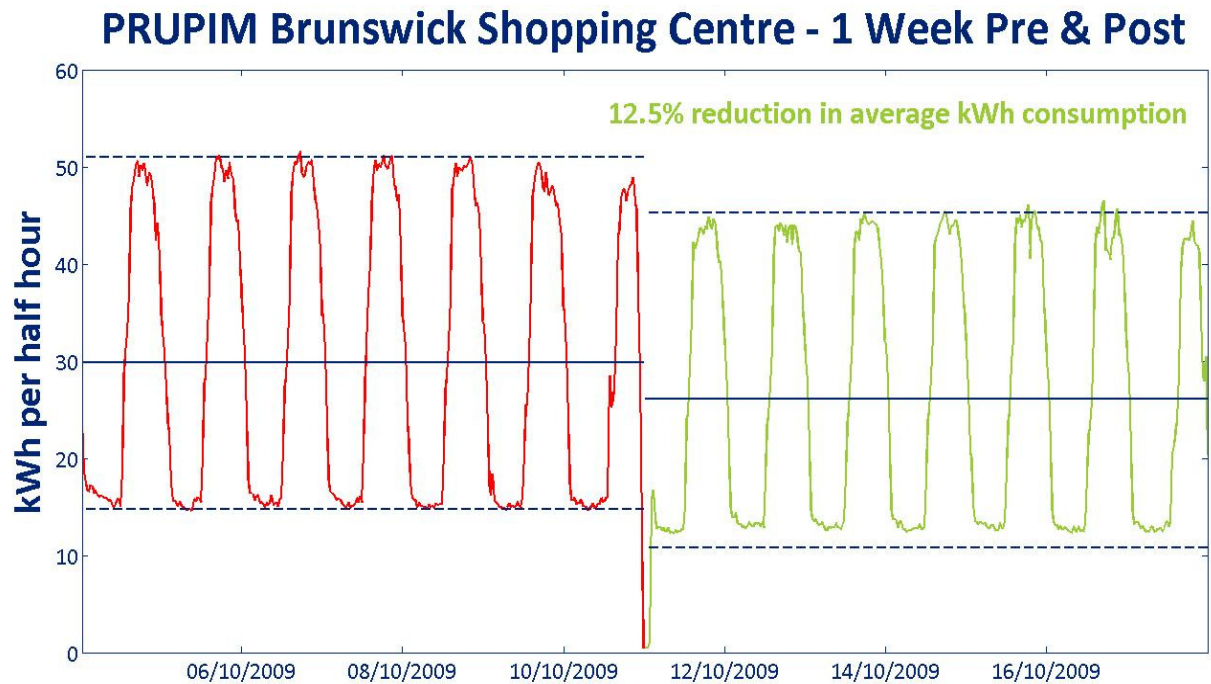
The chart below shows all available kWh data for Brunswick Shopping Centre, from 10/09/2007 to 16/01/2010. Data before installation is shown in red and after installation in green.



The consumption profile above shows that this site is affected by seasonal variations in external temperature. Energy consumption is higher in the cold winter months, because some loads are used more heavily in the winter: the operating hours of lighting equipment are increased and heating fans are switched on.

Consumption seems to be atypically high during the first 5 months of the dataset, up until mid-February 2008. We have been informed that the lighting equipment has been replaced in the Hall in March 2008, which could explain the reduction in consumption that can be seen from that date. Baseload remains relatively high until May 2008. At the end of 2008, baseload appears to be reduced, and maintains itself at those levels until the end of the pre-installation data. It is also our understanding that the lighting equipment in some bays has been replaced in June 2009, but this does not seem to have a substantial effect on consumption.

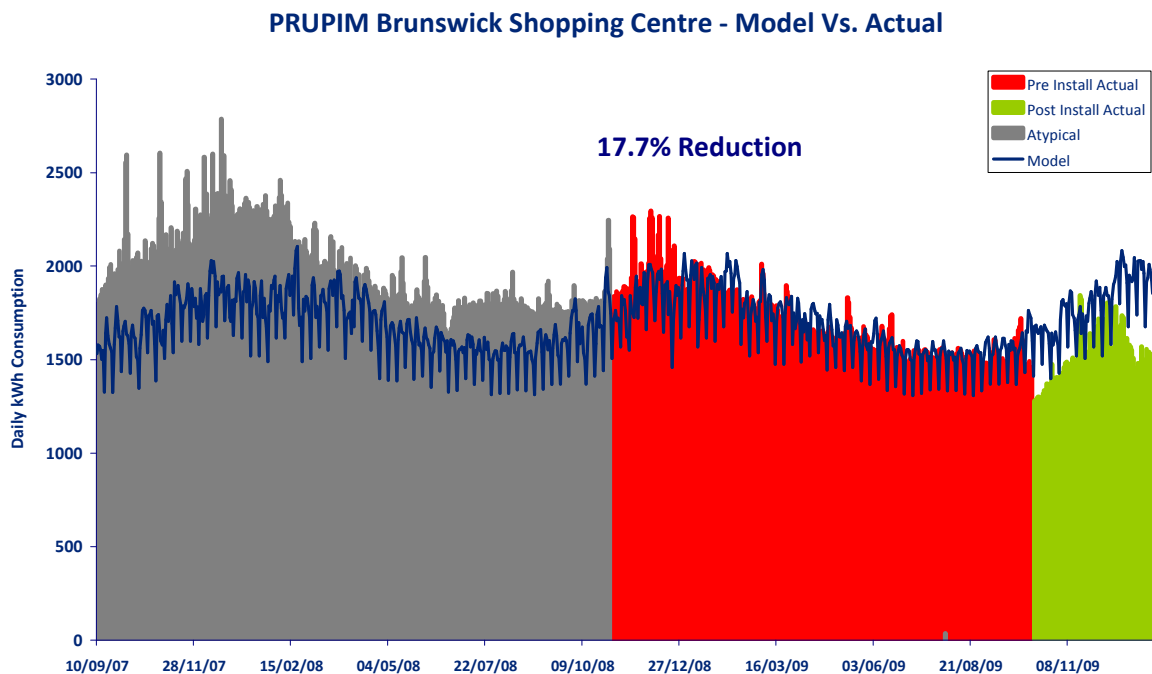
After the installation, consumption is immediately reduced, with both baseload and maximum demand displaying a reduction in the first weeks post-installation. To show the immediate effect of the powerPerfector installation, this can be displayed in higher resolution in the chart below, which shows the consumption in the week before and after installation. On this basis of comparison there is a **12.5 %** reduction in average kWh consumption.



However, this figure is only intended to provide a snapshot of the immediate effect of the powerPerfector installation, but does not take into account seasonal variations. An accurate and established method of analysis used to quantify the effect of seasonal variations is known as a “degree days” analysis. Degree days are calculated from Met Office temperature data for regions of the UK and represent the difference between actual temperatures and a baseline temperature for a given period of time. A degree day value can therefore be used to establish an expected level of consumption.

Since consumption is displaying peaks in winter months, degree days with a base temperature of 15.5°C have been used to produce the analysis below. The daily degree days model shows a good correlation with the actual energy consumption with an  $R^2$  value of 0.69. The  $R^2$  value, also known as the coefficient of determination, can be interpreted as the proportion of the variance in the energy consumption attributable to the variance in degree days (1.0 indicating perfect correlation and 0 indicating no correlation).

The green data in the following graph represents the consumption after installation of the powerPerfactor, and the red data is the consumption before installation. It should be noted that the analysis starts on 23/10/2008, when the baseload is broadly stable, excluding the atypical data prior to that date (as mentioned above). The blue line is the regression line of the pre installation consumption data – the difference between actual and expected levels further demonstrates the accuracy of the model for this period prior to installation. The chart shows that, having taken into account the external temperature, the energy consumption at the PRUPIM site has been, on average, 17.7% lower than would have been predicted had the powerPerfactor not been installed. Any additional information on load changes post-installation could be incorporated into this model if required.



In conclusion, the electricity consumption at PRUPIM, Brunswick Shopping Centre has been reduced by **17.7%** since the installation of the powerPerfactor. This equates to a projected annual carbon dioxide emissions saving of approximately **65,700kg** and an annual financial saving of **£13,630**.

The powerPerfactor 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.

