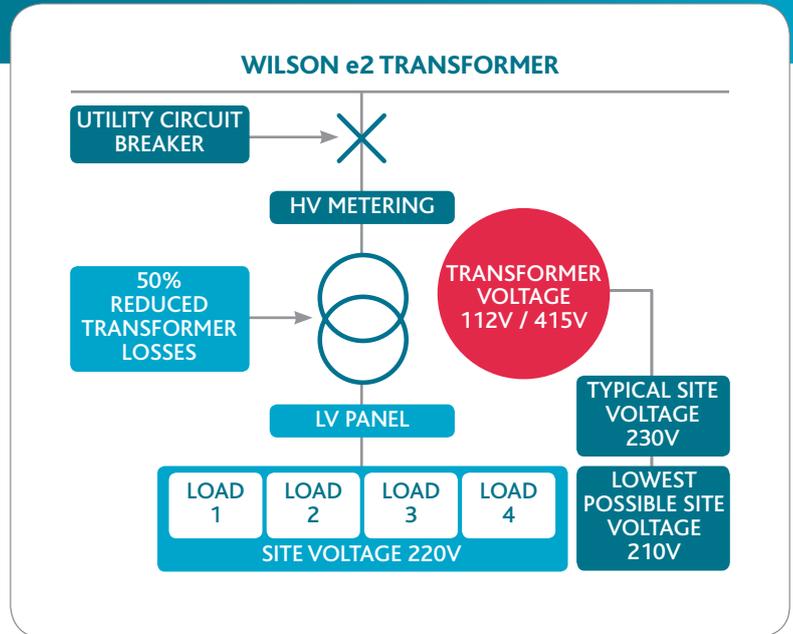


Modifying electrical supply infrastructure - Voltage managements best kept secret?

Wilson Power Solutions *Best Practice Series*

Dr Lore Grohmann of Wilson Power Solutions explains why modifying electrical supply infrastructure can be the simplest, most cost effective and least invasive voltage management solution for sites with MV supply



Due to prevailing grid conditions, the average supply voltage in the UK is 242V. This relatively high voltage level has remained unchanged despite recent Electricity Quality and Supply Regulations (EQS) aimed at achieving supply voltage harmonisation across Europe. As a result, electricity supply to site through the UK distribution system often runs at a higher voltage than is necessary and is responsible for significant energy losses.

Voltage management is an energy saving technique addressing this issue by systematically modifying supply voltage to a site in order to reduce losses in voltage dependent equipment. The need for voltage management has developed an entire new industry with a whole array of companies offering solutions ranging from simple fixed ratio autotransformers to advanced variable ratio equipment. Suppliers of dedicated Voltage management equipment are claiming superiority of their respective offerings and promoting their products as the best available solution. The fact many of these providers would rather you did not know is that for sites with MV supply, a simple, straight forward and cost effective solution exists that doesn't require any dedicated VM equipment: Modifying incoming supply infrastructure.

Replace existing MV/LV transformer(s) with super low loss amorphous transformers – The 2in1 option

Most sites with MV supply are currently operating a supply transformer that is designed to provide a nominal phase voltage of 240V. Where sites can benefit from reducing supply voltage, replacing existing transformer(s) with modern units (such as a super low loss amorphous transformer) that offer a nominal voltage of 230V alongside an extended tapping range which would operate satisfactorily down to 207V can be an extremely cost effective

solution. Why? Replacing the supply transformer does not require any additional equipment to be installed. This eliminates the risk of system disturbance, avoids additional transmission losses, minimises the total plant footprint and is virtually maintenance free. Recent field trials have shown that optimising site voltage through supply transformers can achieve the same (if not better) levels of savings as comparable, fixed ratio voltage management units. What's more, in addition to savings made through optimised site voltage, site owners benefit from energy savings through reduced transformer losses of up to £4000 per year (based on a typical 1000kVA unit) making this an attractive 2in1 solution (see below and figure 1).

Tap down your existing transformer - The basic option

Most distribution transformers have off-circuit selectors installed to allow for manual ratio adjustment to LV side voltage. These "tap changers" typically offer a range of $\pm 5\%$ either in one per cent or 2.5% steps. Tapping down an existing transformer where site supply voltage is higher than required is a low cost option which can lead to a quick, if limited, reduction in energy use.

Despite the comparatively moderate savings it is always worthwhile to ensure that transformers are running on the best possible tap setting for a site's requirements and can be a temporary measure where installation of new equipment is not an option.

Limitations to fixed ratio solutions

A disadvantage of controlling supply voltage through fixed transformer taps lies in the lack of control over the voltage output level. This is no major concern where supply voltage is stable but becomes problematic for sites where supply voltage fluctuates: If supply voltage levels drop significantly the output voltage will be reduced at the same ratio running the risk of sub-optimal supply to site and in the worst case equipment failure. Where site supply fluctuates and a constant output voltage is required a new generation of distribution transformers with on load tap changers provides the solution. How?



Dealing with network supply fluctuations - Super low loss amorphous distribution transformers with on load tap changers

Most sites in the UK experience some level of network supply fluctuations. These are typically cyclic with voltage levels rising during the night as a result of overall drop in demand. Such fluctuations are mainly moderate and relatively easy to take into account when planning adjustments to site voltage through fixed ratio equipment (i.e. off-load transformer tap switch).

There are however instances where supply to site fluctuates parodically and significantly. This can be due to numerous causes, for example large industrial loading causing network voltage drops for periods of time.

In addition, the growing need for integration of intermittent generation from renewable sources is likely to increase network supply fluctuations further, in particular on local distribution networks with small scale renewables. To address the risk of supply fluctuations as well as maximise the savings that can be obtained from optimising site voltage a new generation of super low loss distribution transformers has been developed. These units operate on load tap changers (OLTC's) that are continually controlled to maintain the required LV side voltage within a desired bandwidth. Investing in a distribution transformer with OLTC's will help secure safe operation of small distribution networks over the next decade.

Additional energy savings from reduced transformer losses

Two types of losses are inherent in the running of all distribution transformers: no-load losses that occur in the transformer cores due to hysteresis and eddy current losses which are constant and present as soon as the transformer is energised, and load losses that occur in the transformer's electrical circuit due to resistive losses that are a function of loading conditions. According to the Carbon Trust, annual energy savings of close to £4,000 can be achieved through transformer loss savings when replacing a standard loss 1000kVA transformer with a super low loss equivalent.

Super low loss amorphous metal core transformers

Super low loss amorphous core transformers combine conductors having low current density with amorphous core technology to significantly reduce load and no load losses, when compared with standard CRGO products.

The use of high quality copper conductors has been widespread in Europe and the US to reduce load losses with products being promoted as 'low loss' transformers.

Amorphous metal core technology has been intensively deployed in countries with notoriously overstretched supply networks (i.e. India) for over two decades and has a proven track record of performance. Super low loss transformers combine the two loss reducing approaches, hence the name 'super low loss amorphous transformers'.

Wilson e2 - super low loss amorphous metal core transformers

The Wilson e2 transformers are manufactured according to IEC76/BSEN60076 standard and available for ratings from 315kVA to 3MVA. In addition to the reduced transformer losses the Wilson e2 super low loss amorphous transformer comes with an extended tapping range as standard, allowing for easy adjustments to supply site voltage.

Where site supply voltage fluctuates and a constant supply is required, the Wilson e2+ comes with an automatic voltage regulator that operates on load tap changers to provide stabilised output voltage (+/- 1.25%) Despite a slightly wider footprint, the Wilson e2 is interchangeable with most existing installations enabling straight forward transformer replacements.

Launched in 2009, Wilson Power Solutions has today supplied over 450 super low loss amorphous transformers and helped organisations including leading supermarket giants Tesco and Asda, the Natural History Museum and the NHS reduce operating costs and associated emissions through reduced transformer losses and voltage management.

Summary

A thorough review of existing supply transformer(s), power demand and transformer ratings is recommended before commissioning dedicated voltage management equipment.

Changing existing supply transformer(s) for correctly rated, super low loss equivalent(s) with extended manual tapping range (or on load tap changers) is one of the most cost effective and least invasive Voltage Management solutions available for sites with MV supply.

