VOLTAGE POWER OPTIMISATION: ENERGY EFFICIENT FACILITIES FOR MUNICIPALITIES

EFFECTIVELY MANAGING AND IMPROVING YOUR POWER SUPPLY WHILE SAVING ENERGY - a brief overview of efficient safe reliable voltage management to deliver improved electricity power quality with good energy savings in a non disruptive manner.

To date, making significant electricity energy savings within any facility has often meant making either significant shifts in process procedures, or making major investments across various technologies. The majority of 'easy' savings in electricity have often come from introductions downstream of the mains distribution room: usually achieved with the use of low energy light bulbs, complex management control systems, upgrading to modern equipment that costs less to run, lighting control systems, motor controllers or just simple initiatives to remind staff to turn off the lights! Few people however consider fully and deal with the actual quality of power quality that they receive from the grid and that enters their building.

Most facility managers of buildings, plant, workshops, etc seldom really question their electricity power quality that they receive until there is some inexplicable problem arising. It's a bit like putting low grade petrol in your car and then seeing you are getting less performance efficiency from your motoring. So, how do you get better electrical 'fuel' when we only have one standard 'fuel' type that's available.

Ever since Ohms Law, many scientists have tried various means and methods to manage voltages from the power supply and thus effect energy savings. However, up until recently, the methods to do this have been uncertain, relatively inefficient and / or unreliable, thus negating the whole objective. Fortunately, the Japanese have now solved this problem. This is probably because of them having had to tackle the same pressures on fuel and energy prices going back well over ten years ago, and that we ourselves now face worldwide today. They focused a lot of attention on the incoming electricity supply voltage level and quality. And in response they invented and perfected a unique technology specifically designed to save energy and improve electricity supply quality – efficiently and reliably.

The benefit of this common sense Japanese approach is obvious in that an entire site would then be able to be made energy efficient in one 'hit'. Thus this not only simplifies the problem with minimal disruption, but also ensures the whole facility and its equipment is receiving optimal energy. This is additionally important in that the incoming site's power is then 'cleaned up' and prepared for the application of any further incremental energy saving solutions as and when required (and reassuringly all in the knowledge these added technologies are been well protected and 'fed' perfect optimal power).

So why are voltages an issue?

Voltage limits and service levels

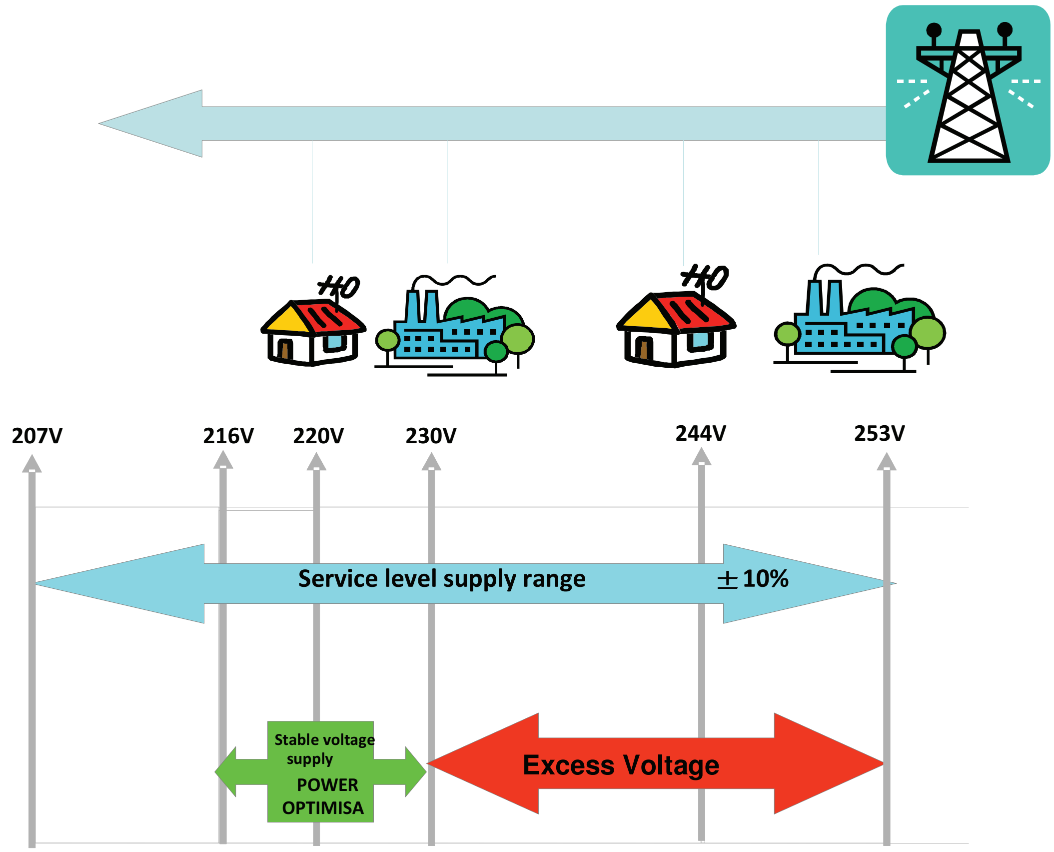
In South Africa, when we plug into the electricity mains, most of us don't give any thought about how the voltage level might affect the efficiency of our electrical equipment we connect to it. We know that in an extreme, when the voltage is far too high, light bulbs glow more brightly, motors heat up and vibrate (and saturate), and all equipment will also break with alarming (and costly) regularity; whilst with very low voltages, TVs will flicker and motors struggle and possibly overheat (amp surges , etc). In between these two extremes, though, there is a voltage range within which the effects are more subtle and less noticeable, but can still be very significant in terms of energy efficiency and cost savings.

The statutory voltage band, within which the South Africa electricity providers deliver our three phase electricity, has changed in recent years from 380 volts to 400 volts (220 volts single phase to 230 volts), plus or minus 5% (or +-10% in the prescribed range within which all electrical equipment must operate effectively). Therefore all electrical devices must be able to operate effectively between 207 volts and 253 volts single phase. See diagram below.

It is not uncommon for electricity companies around the world and here to set voltages slightly towards the high end of the statutory band for a large proportion of their customers from the point of final delivery. They do this for a few reasons:

- they need to ensure that the customer at the end of a particular distribution feed receives sufficiently high voltages (due to voltage drop over the distance distributed);
- higher voltage transmissions produces lower losses on the electricity companies' transmission systems, so it saves them money to keep the voltage high;
- lower voltages mean less energy and thus less income, and
- if the power utility adds more customers to an existing feed, they tend to increase voltages to ensure sufficient energy reaches all new and old customers.

As a consequence a large proportion of industrial consumers receive higher than required voltages for some if not all of the time.



Optimising voltages and power management

So what does this mean for a municipality. Well, as major power users they are very likely receiving excess voltages into their own extensive portfolio for significant periods of time (often without knowing it) and this is thus wasting their own energy. What the Japanese have done (and now also many other major corporations and governments – and even energy producers - are now using it around the world) is to use this new technology to reduce and stabilize their voltages to their bespoke safe level and save money and energy. There are over some 180,000 plus sites around the world now benefitting from this. As municipalities are also 'energy resellers' they may be reluctant to promote the same technology to their customer base for obvious reasons, but remember two things: Inevitably the customer will do their own energy efficiency actions, and secondly, if their customers used such technology themselves then the municipalities will benefit directly from lower customer Kva loads which the municipality can resell or defer infrastructure investments..

What does Voltage Optimization do (also known as 'Voltage Power Optimisation' – Wikipedia) ? The technology saves energy and load by various means, including automatically and very efficiently reducing voltages down to a preset level within 'tap down' ranges. This means that the voltage levels are managed within your own predetermined safe ranges. It thus ensures all your equipment works at its best rated efficiency levels, but without the waste associated with upward fluctuating volts. In recent installations in South Africa customers are seeing savings ranging from 8% to 12% on energy KwHr's alone, and even higher % cost savings when Kva load factors are calculated and added. It is estimated that within the cities and environs probably 60% plus of the facilities will be in this over voltage situation. The savings achieved will vary with load types and the extent of over voltage levels.

The added benefits from the other functions of such technology are also persuasive. Typically, users will see large savings on extended equipment life, lower maintenance costs, improved harmonics and power factor, improved phase voltage balancing, reduced neutral currents, and a lot less production down time. Similarly, such technology also acts as a voltage transient 'spike' protector, and hence many major corporations and the largest data centres also use it not only for energy management, but also to protect sensitive equipment, computer facilities, robotics, and the like.

The graph below shows an actual Eskom tested South African example of energy measurements before and after using this technology. The data was independently measured in 5 minute Kw consumption readings. Voltages in this example were reduced by an average of 8%.

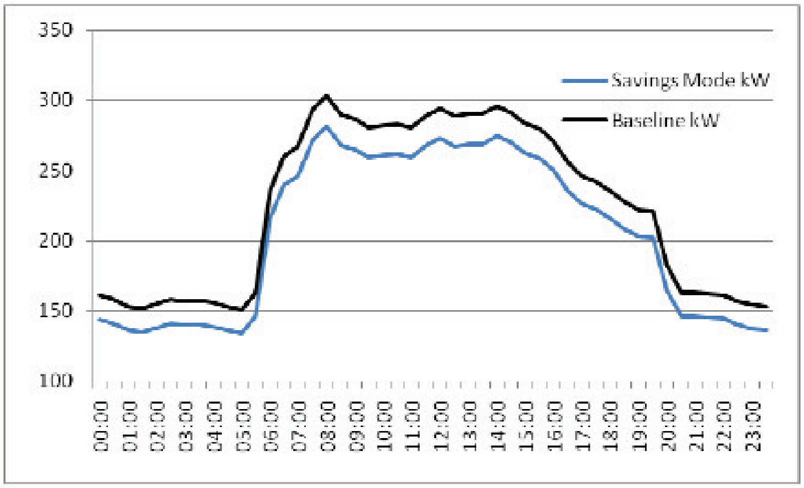


Figure 3 – Averaged demand Profiles – Weekdays

Eskom Report: "The unit has effectively reduced both the demand and energy consumption at the client's site. "

How does voltage optimising technology work?

It filters, optimizes and manages your voltage levels down to a pre-set level in an efficient reliable safe and automated manner. In this way, the V in P=V^2 / R is reduced and energy saved on your upstream supply meter.

Many people, however, think that by just reducing the voltage level on the high voltage transformer side, you would still save substantial amounts on your own energy bill. I am afraid this is wrong, and has often proved so by empirical studies in the Europe. In these instances some small savings were indeed made by doing this, but the savings achieved were three to four times lower than if they had simply installed a voltage management technology downstream of their HV transformers. So why are the results so much better than if they had just reduced voltage on the MV transformer?

First, it is rare to find an MV transformer with more than 5% reduction capacity so the extra 3% to 5% that would be left to manage has not been taken advantage of. Secondly, the Japanese technology is so efficient that it has losses of just 0.3% or less through its entire operating range because it is a completely different design to transformer technology. It is also solid state and so reliable that it has no maintenance requirements, and is actually designed to last between 35 years to 50 years. Thus virtually all the savings made are passed through to the customer and are not lost (via heat, vibration, noise, etc) like in the process of transforming - as in a traditional transformer design. Some other reasons to consider, are that if your energy provider did indeed tap down their transformer for you, they will themselves be wasting energy and stressing their own infrastructure - and they are consequently not incentivized to do so. Alternatively, you may even share your transformer with other users and your voltage drop could affect them adversely. In any event, by not managing the voltages to a singular base level, but rather just 'tracking' them down via an MV transformer tapping is likely to lead to many other electrical dangers to the facility and is a risk few are willing to take. Some people even tap up and then apply the technology to assist with 'brown outs'. Think about it. It makes sense.

Here are some basic differences within the technology I am discussing. A transformer's coils are wound from copper conductors, typically in the form of round wire and rectangular strip. The Japanese voltage management technology, however, utilises wide copper sheets of the highest possible purity. Sheet production is outsourced to major Japanese suppliers with large, hi tech accurate machines rolling sheets up to 800 mm wide, between 0.05 and 3 mm thick; this is then insulated and wrapped around a uniquely designed flaked silicon iron core. Separate star and delta windings are included which act to generate a strong internal magnetic field that assists in balancing the incoming three phase supply, while suppressing harmonics [1]. Other design features also stop any transients (spikes) from entering a building. As a by-product, this solid state technology also improves power factor in a building by around 3% to 10%. All of this function is then controlled automatically in a patented software method while adjusting voltages every 10 milliseconds to the optimal level.

Most of the savings with voltage management are realised within induction motors and lighting equipment. When you efficiently manage the voltage to motors to within their normal operating range, the core and winding losses are significantly reduced. They thus run more efficiently, with less stress, and last longer. By removing the fluctuating voltages, it's a bit like the analogy of driving along a motorway. If you kept accelerating and decelerating your car you will use more fuel than if you kept a steady throttle for the same average speed. Lighting also benefits greatly by them being returned to their 'design' voltage and brightness, so that both current and power is reduced and lamp life is increased substantially.

Economics

Good financial returns are the key to any successful adoption of any energy saving technology. Whilst some 'green' customers may show limited support for wind and solar technologies [with paybacks often of 10 years or more] realistically many technology adopters are forced to look much more closely at the shorter term returns on investment. Here the news is good as a voltage management solutions for a typical facilty will often return 30% and better on their investment (ie/ a savings versus cost payback of 3 years or better). Professionals find this return very persuasive for a simple 'one hit' , reliable, efficient and 'green' solution reliably lasting 30 years. Compared to most known technologies, that themselves average a 5 year lifespan or less, the economics are very compelling.

Importantly, voltage management is the best starting point to 'clean up' your energy supply and save money; and it does not preclude the opportunity to implement many other energy efficient products on the market today (like motor controllers and lighting control systems). To the contrary, these other technologies are performance enhanced by stable voltages and their own life expectancy (and your investment in them) will likewise be improved.

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References:
[1] Angus Robertson, 'Electricity Management' - Energy Institute, Energy World, January 2006