OPTIMISING POWER INFRASTRUCTURE IN RURAL AUSTRALIA

The rural power network

If they think about it at all, most Australians regard the availability of electrical power as a simple commodity; if you need it, you get it. But this is not the reality for much of rural Australia. While 90% of the population is supported by a robust network of Three Phase Power, beyond the cities there are serious power distribution issues affecting existing industry and projected economic development.

Expanding the existing network is an expensive process, often prohibitively so if the cost must be borne entirely by individual consumers in remote locations. Therefore it makes sense to explore different strategies that will more fully utilise the infrastructure that is already in place.

Some areas have no access to 3-Phase power

Because of Australia's unique position of having a vast terrain to serve with very low population densities, the cost of universal 3 phase distribution has been prohibitive. Hence much of rural Australia is supported by **Single Wire Earth Return** (**SWER**) system to deliver **240V Single Phase** power, or by the '**Two-phase 480V'** variation. (which is actually two regular 240V circuits coupled together) All Australian states use this type of technology to a small or large degree. For example, Queensland alone has some 63,000km of SWER lines servicing more than 26,000 customers in this way. These Single Wire networks much cheaper than 3 phase networks to implement and can span long distances. When a remote rural customer is faced with a $20,000 to $70,000 installation fee to extend 3-Phase power to their property, simple economics will dictate the type of service that can be provided.

Why is access to 3 Phase Power so important?

The SWER line connections that provide energy to thousands of rural Australians ***cannot*** support Three Phase equipment. A common myth is that Three Phase equipment is for heavy industrial use only and that has little place in rural, agricultural environments. This is not the case. Three phase motors are cheaper to manufacture than their single phase counterparts. As a result much electrical machinery being built today include small three phase motors as an integral part of their operation.

Some common Three Phase installations are:

Milk chiller systems for Dairies
Fruit grading & packing equipment
Refrigerated containers
Chaff processing & elevating plants
Vehicle servicing hoists
Pivot irrigators
MIG welding equipment
Electric roller doors & gates

The simple absence of three phase power in much of the rural sector has placed serious limitations on the sorts of value adding activities that may be carried out. **Often farms with a reliable single phase supply will revert to using diesel powered generators just to supply their Three Phase equipment needs**. This can have an immense impact on operational costs for rural enterprises, not borne by competing businesses operating in or near city centres.

Getting the most from existing Networks

With an escalation of power customers wanting to install a range of new equipment at their rural locations, the daily demands on power infrastructure just keep rising. Power companies must remain vigilant to balance and to sometimes limit what some customers can connect in order to minimise the impact to adjacent properties.
A fundamental question for power customers often becomes: ***How can I get the most from the available energy of my existing supply?*** There are two broad approaches to this problem. One is to make the customer loads more efficient in order to reduce the actual power demand. The second is to spread the impact of the power demand over a longer time interval so that high current loads operate in staggered time delays of minutes, hours or even days.

Load Reduction techniques

A very common assumption is to blame the more conspicuous domestic appliances for creating a large impact on their supply. Devices such as radio's, televisions, fluorescent lighting and even idle equipment like DVD players and plug pack phone chargers may receive a disproportionate amount of blame. In reality, the largest impact on rural infrastructure comes from equipment with heating elements and large single phase motors.

Some common culprits are electric fan heaters, Hot water services, irrigation pumps and refrigeration compressors. These are all typical high-impact loads. *One fan heater can consume more energy than ten computers or a hundred DVD players.* Heating elements frequently draw high levels of current and cause prolonged voltage dip events on rural networks. The typical Single Phase motor require *twice* the start-up current of similar sized 3-Phase motor and this can make the motors responsible for lighting flicker effects and computer re-starts, many times per day

A common requirement for dairies is to have a large supply of hot water for cleaning and sterilising. The impact of several kilowatts of power drain from a conventional hot water service is too much to ignore. Solar hot water panels have a proven track record to assist with power reduction, as does additional insulation fitted to the water tank and pipe work, particularly in the colder months. Modern heat-exchanger hot water systems work like reverse-cycle air conditioners, these can also provide huge reduction in power consumption when compared with heating elements.

Reducing the impact of Single Phase motor starts can be problematic as most motor soft-start systems are designed for use with 3-phase motors only. Where air conditioner units must be used, Inverter style systems have significantly less impact to the supply lines during stops and starts.

An 8kw 3-Phase Power Converter operating an irrigation pump

Another popular option is the **Singe-Phase to 3-Phase Power Converter unit**. These devices create 415V, 3 phase power from a 240V power source. When these are used to drive 3-phase motor loads, they can halve the instant surge currents of medium and large motors. This will help to reduce the creation of power line spikes in rural locations. Where 3-Phase Power Converters are used to replace 3-phase diesel generators, they may be five times cheaper to operate and don't have the ongoing requirement of liquid fuel replacement.

Increasing in popularity are the Grid-connectable PV (photo-voltaic) Solar power Systems. These won't help deal with high start-current equipment, but they can make a serious overall reduction in kilowatt consumption during daylight periods.

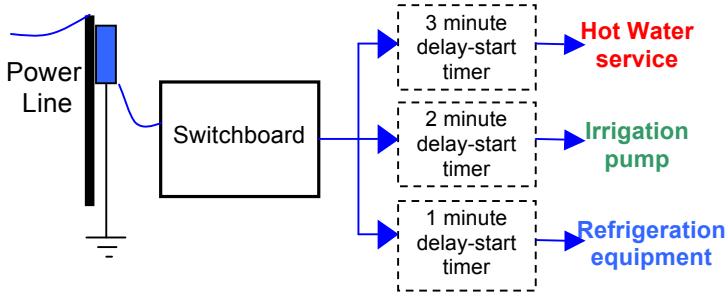
A D.C. pump system operates from sunlight

A further off-the-grid power reduction option is the use of high voltage D.C. pumps that run direct from Solar arrays, without the need for storage batteries or inverters, so that when the sun shines, water is being pumped. When the sun goes down it stops. Modern microprocessor control ensures that the pump won't stall and burn out at dawn and dusk periods.

Using the sun to directly heat & pump air

One creative way to supplement to home heating fully independent of the AC mains supply, is the solar air heater concept. A small DC solar panel (*right*) drives low voltage fans to circulate household air through a solar air heater box. Even with modest sunlight exposure the air passing through the system can be elevated by 20º. Multiple systems can be installed in parallel in order to heat larger areas.

Load balancing techniques



Using staggered start delays to reduce mains power dips

Where the available power is extremely marginal it is possible to stagger the starting of loads using automatic time delay modules, or priority switching circuits so that high current start-up events don't all try to occur at the same time.

For example, it may help if an electric hot water system is temporarily deactivated while an adjacent refrigeration system is being started. Some of the more modern 3-Phase Power Converter systems also incorporate this type of facility within their design.

Installing New equipment does not necessarily need to mean that more energy and infrastructure will be needed. The aim of this document is to highlight the changes in power demand and smarter ways of getting the most out of the infrastructure that is already in place.

Information Sources: *www.phasechanger.com www.solarsource.com.au www.phazer.com.au*