



Sustainable Power Systems

Holistic Concepts for Isolated Power Systems

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Awareness of the holistic issues is needed to ensure all power system designers and installers consider designs from a sustainable approach. The issues are discussed in the following notes. These notes are aimed at Small & Medium Size Power Supplies, say between 10 kW and 150 kW largest genset.

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THE SINGLE-DIESEL SYSTEM

(for all sizes of installations)

Numerous locations rely on one diesel genset operating “24/7” for many months (say in the “wet”), with maybe another set for the remainder of the year. This is energy inefficient, and unsustainable, as these gensets are always oversized and underloaded. The “un-sustainability” is usually hidden. The fuel costs (20% to 55% higher than need be) is paid from a different account than the repairs, and a different account than the purchase of a new machine. Lights and appliances are deliberately left on to “give some load” to the genset. The time in solving problems and oil changes are “free” because the time of valuable people is not recorded (they could be doing other valuable things). Unreliability is never costed, but costs. Time is wasted writing purchase orders for failing equipment, and the boss’s time is wasted. These costs are never fully brought together, so the real cost is never acknowledged.

LOAD ESTIMATION & OVER-SIZING

Numerous remote locations in the past, have had grossly oversized power systems. Designers normally size power systems with emphasis on the peak kW delivered, usually referred to as the Maximum Demand (MD). Many do not appreciate that in small and medium communities, the peak loads are very brief, and the minimum loads are dramatically below the peak [they may be 5% of the peak or less] and the minimums are very sustained.

The resulting oversizing has dramatically increased fuel use, and damaged gensets with underloading, all beyond the means of community members to resolve. The genset damage results in grossly unreliable power. The result has been power that is expensive to build, expensive to run, and less reliable than necessary.

These power systems need to be designed to the Diversified Peak Load (not the MD). Estimating this takes considerable experience and accurate calculation together. There is no “rule of thumb”, skill is essential.

THE PLACE FOR RENEWABLE ENERGY & HYBRID SYSTEMS

The true place of renewable energy in isolated power systems, and the complex issues of affordability, operability, control and maintenance have to be assessed. Some very remote locations may in fact be inappropriate due to the greater complexity of renewables, a difficult conundrum to resolve.

POWER STATION AUTOMATION & DATA LOGGING

The appropriate use of power station automation is not simply to improve fuel efficiency, but also to extend the life of gensets, to give more reliable power. The automated stations are data-capable, and can effectively use remote data communication to external service specialists. In preparation for this we suggest installing 2off data phone lines to power stations, in advance of automation. If spare phone lines are not available at least 4 other options using mobile data and satellite transfer are available.

OPERATOR RESPONSIVE INTERFACE DESIGN

The design of the operator interface and the redundancy issues must be considered for all power stations.

In small remote locations the level of technical ability and literacy level of power system operators results in different switchboard design from a power station operated by qualified technicians (say at a mine site).

Analogue instruments [amps, kW, volts] with large discrete and clearly labelled push buttons and indications are more suited to unskilled operators. The purpose is to make the basic functions clear and accessible. People who are qualified and literate in other occupations can be intimidated by the “specialist” look of a power station. This cannot be avoided, but these people can be assisted by logical layout, and unambiguous analogue instruments.

If we want the manager, labourer, accountant, community nurse, store man, or school teacher to fill in for the local operator at a moments notice, the design can help them.

The "soft touch" controls, PC screens, digital instruments may also be present, but are principally for the qualified technician. The analogue interface design allows more ready implementation of power operator training programmes, ultimately increasing local skills.

ENERGY “SUPPLY & DEMAND AUDITS” FOR ISOLATED COMMUNITIES

We have investigated and modelled the energy use patterns of many locations, Australian and overseas. In these projects we have inspected the buildings, all energy using facilities, and have analysed the total energy use, fuel cost, power generation efficiency, payment methods, cost recovery and allocation through energy ‘supply and demand’ audit studies.

Every energy-using item must be considered, coolrooms, water treatment and reverse osmosis, cooling and heating, lighting, PCs and IT equipment, waste water, pressure pumps, cooking (etc).

Remote power is expensive power and the studies reviewed some of the social impact of that cost, and methods of cost control and cost recovery. These studies looked at the affordability and equity issues associated with energy metering and cost recovery in general, along with a total energy audit of each energy consuming facility.

SUSTAINABLE COMPONENT SIZING

For long term planning some components need provision for growth, while some should NOT be oversized. The following components need capacity now for future development:

- ◆ Switchboard cabinets (spare space, eg larger isolators)
- ◆ Switchboard main power bus (at least 2x or 3x power capacity for growth)
- ◆ Community power distribution network (consider a 10 year window of growth).

Accurately size the gensets to match **known** loads and realistic 2 to 3 year window:

- Avoid oversized gensets, particularly in small communities.
- Oversized gensets and power stations are inefficient and are UNSUSTAINABLE.

Plan the power shed, power distribution and switchboard bus for longer-term significant growth, 5 to 10 year time window estimates, if reliable.

In hybrid systems the inverter size should generally not be less than 70% of the genset size, and can be moderately oversized for future provision for growth in peak load, up to 125% of the present genset size.

REDUNDANCY

Small Power Systems

These are usually built with limited backup power. This is possible if the water supply is from an independent power source (say: solar).

- If water pumps depend on the power station, at least 2 gensets are required.
- Consider a separate dedicated feeder to supply power to water bores.
- Does the water treatment (eg UV) need 24 hour power.

Medium & Large Power Systems

Large power systems usually already have redundant power (that is: backup gensets). Consider what will occur if the backup genset available is smaller than the total load. Some 'non-essential' power will have to be turned off. This can be difficult unless pre-planned:

- Provide separate dedicated feeder to supply power to essential services (water, sewer, shop, clinic), independent of the feeders to residential buildings
- The cost may be significant, review the cost estimates and advise in Options report.

Fuel Saving - Small Power Systems

A renewable power system (genset + solar hybrid) is efficient delivery 24 hour power. A genset-only system is not efficient for 24 hour power supply. The cost of operating a small genset into small loads are horrendous.

For genset-only systems it is recommended to shut off power overnight. Significant fuel saving and full genset service life can be achieved by restricting power to 2 periods a day of 5 to 6 hours.

Consider solar lights in public areas and toilets to reduce the need for overnight genset operation.

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