

PS System Efficiency

General Information

When designing the PS System two main design objectives were given priority:-

- Reliable long life
- High system efficiency.

Firstly the system is designed and built to have a long and reliable life.

Secondly we believe that the PS System is the most efficient 24/7 off-grid power system available.

High system efficiency means significant cost savings over a long period of time year on year. Using less fuel, reducing pollution and saving money.

The PS System comes at a price but the high efficiency more than compensates with immediate fuel savings, extended generator life, lower maintenance costs and fully automatic operation.

Some of the unique features making the Powerguard PS System very efficient are as follows:-

- Generator run time is kept to a minimum.
- Batteries are charged correctly to maximise battery life.
- Battery discharge is kept to a minimum to maximise battery life.
- Predictable operation - generator runs to power the heavier loads - inverter powers the light loads.
- The system operates in the most efficient way possible to minimise fuel use, pollution and cost.

System Losses

The following simplified sketch shows the layout of the PS System.

The path from the generator to the load is shown with the red lines. If the load is within an optimum band of over 60% of generator capacity this is the most efficient way to use the power.

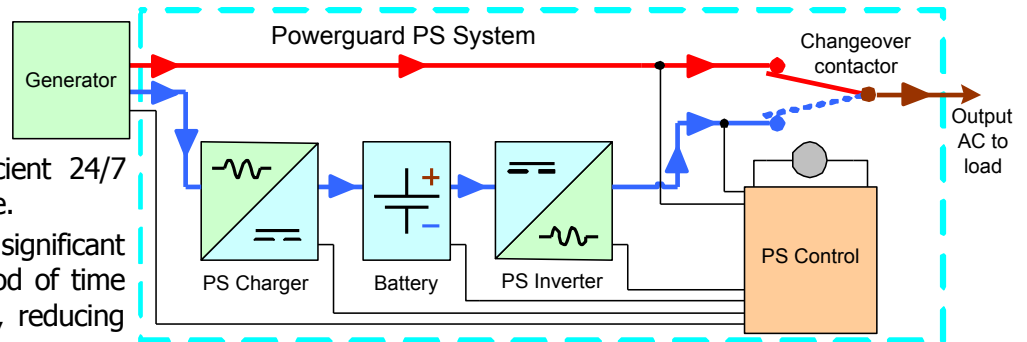
The alternative path to the load is through the charger, battery and inverter shown with blue lines. This path is most efficient when the load is less than 30% generator capacity.

There are losses incurred converting AC power from the generator to DC power to charge the batteries and then back into AC power for the load. The PS System has the most sophisticated charge and control system available. Even so these losses can be up to 22%.

It is false economy to use too much power via the

inverter. Competing systems that do so cannot be as efficient as the Powerguard PS System.

The PS System is designed to supply the heavy loads from the generator and at the same time utilise the spare capacity to recharge the batteries. The generator



Simplified Schematic of a PS System

operates within its most efficient load band and the inverter is used to power the light loads. This increases efficiency and keeps fuel use to a minimum.

Battery Life

Battery life is directly related to the depth of discharge. The deeper the regular discharge the shorter the battery life.

The PS System manages the system so that the generator is run to recharge the batteries regularly which reduces the depth of discharge.

Predictable Operation

The PS System is designed to operate the generator in a predictable way so that the user can use heavier loads such as washing machines, dishwashers, driers or electric cookers at times that suits them. The PS System will automatically start the generator outside these periods if it needs to but generally operation will usually be within the timed periods.

Control

The PS System uses sophisticated control to enhance the performance and efficiency. Each PS System has five powerful micro-controllers monitoring all of the parameters in the system including:

- Battery voltage, current and capacity.
- Output voltage and current
- Temperature
- Renewable energy input voltage and current

By gathering all of the data the PS System can adjust to

operate in the most efficient way possible saving fuel and reducing pollution.

Generator

The PS System can operate with any auto-start generator. However the Powerguard PS Generators are designed for prime power applications and can be up to 20% more efficient.

For example PS Generators have dedicated single phase alternators.

The engines are fitted with pre-heaters so that starting in cold weather is reliable without having to use energy for heating the engine.

Diesel powered generators are much less efficient when they are running on light loads. Typically using 30% to 50% more fuel per kW at 25% load compared to full load. Long periods of light load running will cause serious problems resulting in expensive maintenance.

This is the reason why the PS System can save so much fuel.

Maintenance costs are reduced dramatically for two reasons:-

- The engine will operate within an efficient load band reducing soot and internal carbon deposits.
- The hours run by the generator on a typical system are reduced by more than two thirds.
- Generator life is increased by a factor of three.

Battery Charger

The PS System is fitted with a high frequency charger that is over 90% efficient. The output has very low ripple for enhanced battery life.

The charger automatically adjusts its output in 4 steps so that it can make very good use of the varying spare load capacity on the generator.

The input is power factor corrected with minimum distortion to ensure the generator operates at maximum efficiency saving fuel and reducing pollution.

Battery Charging

Battery charging is an important part of the operation for two reasons. The first is that battery life can be extended by a properly controlled charger. The second is that overall system efficiency can be affected by the type of charge control that is used. In our experience only the PS System charges batteries with such high efficiency.

It is not generally appreciated that as a lead acid battery charges the charge efficiency goes down. The first 80% of charge is efficient but after that the efficiency reduces because the chemical reaction is not uniform all over the battery with some parts more charged than others. This causes heat to be generated and the charge efficiency to drop.

In the past with cheap energy this has never been a problem and even now battery charge efficiency is not

the issue it should be.

However battery charge efficiency is a very important issue in the PS System.

Because the charge gets less and less efficient the more charged the battery becomes other competing systems have to keep the generator running for longer to reach full charge.

The PS System reduces these problems dramatically by careful control. The system accurately calculates the Amp/hours going into and coming out of the battery using Hall-effect sensors and micro-controllers.

For six days the battery is charged to a level chosen by the system according to demand. On the seventh day the battery is charged to a higher level.

Every 21 days the battery is charged to a level where there is no significant change in the value of the charge current for three hours ensuring a complete charge.

The system adjusts the charge daily for optimum efficiency, cutting generator run-time, saving fuel and reducing pollution.

Renewable Energy

The PS System battery pack needs charging daily. PS System efficiency would be increased if the battery could be charged from an alternative supply.

The PS System is designed with an input for a renewable energy source such as a wind generator or PV solar panels. The PS System monitors and controls the input and reduces the generator run-time accordingly.

The PS System has a sophisticated charge control and this means that a relatively small wind turbine such as the Futureenergy 1000W or equivalent can make a significant contribution to overall efficiency. A wind turbine is about 50% more effective when connected to and controlled by the PS System when compared to other competing systems.

If PS System efficiency can be improved further by adding another wind turbine at a later date it can be installed to operate efficiently in parallel with the original.

Inverter

The Powerguard PS System Inverter is a sophisticated twin channel ferro-resonant type. We have chosen the design because it has a good efficiency and meets our other major design criteria. It is extremely reliable.

The inverter can be severely and repeatedly overloaded without damage. It can be short circuited for more than 5 seconds and when the short is removed will power the load up as normal.

By sophisticated control we have increased the efficiency to a higher level than is normal for this type of inverter. Our 48VDC systems are over 85% efficient at full load, over 85% at half load and over 80% at quarter load.