# BATTERY HYBRID GENERATOR SYSTEMS - OPTIMIZING EFFICIENCY AND FUEL CONSUMPTION

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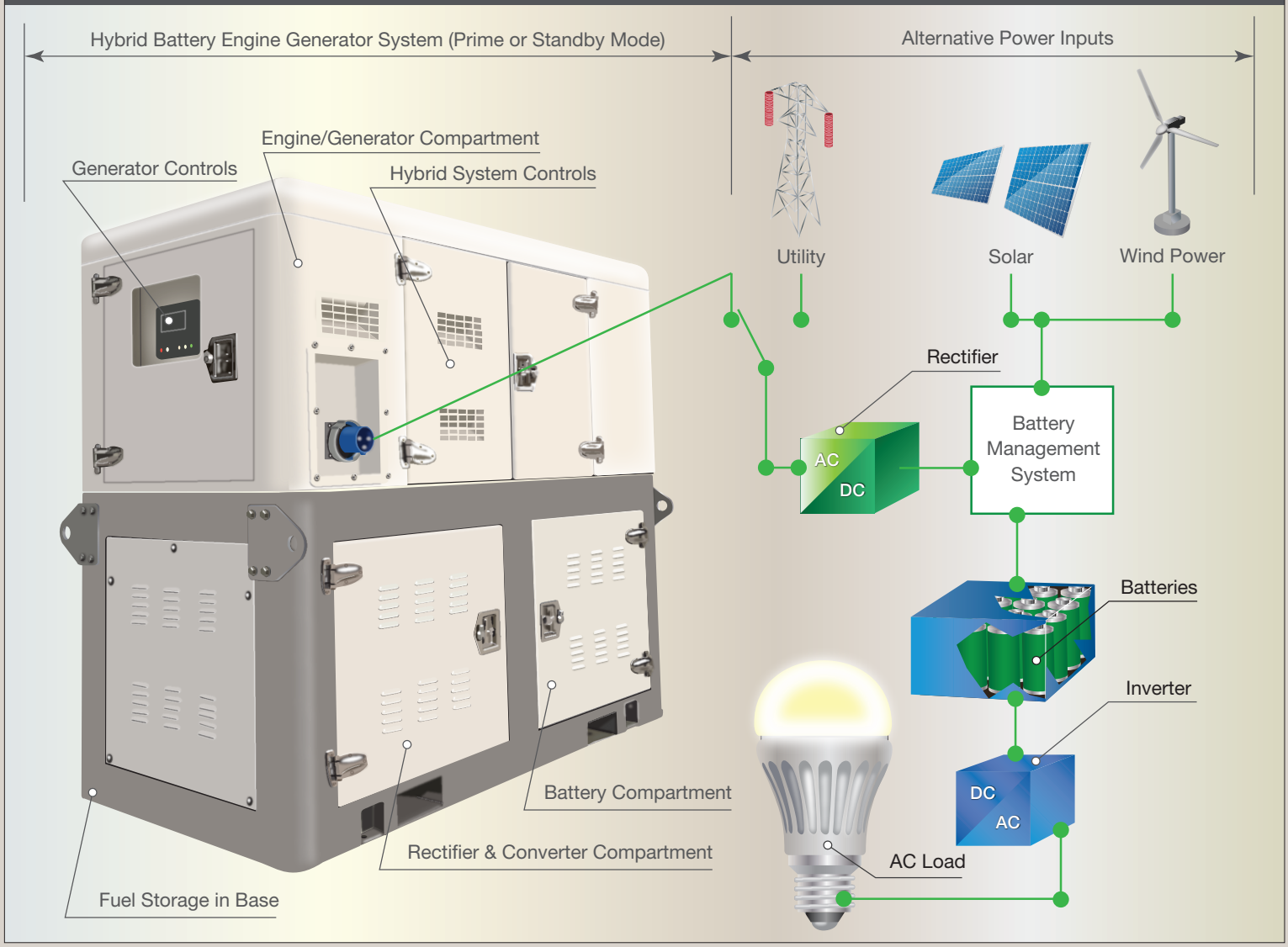
As covered in a prior information sheet, there are hybrid power systems where the engine generator is the back up power system to a hybrid system utilizing several renewable energy sources, primarily wind and solar, and within this system a battery provides an uninterrupted power supply (UPS) as power is switched between the sources. However, a purely Battery Hybrid Engine Generator System is a standalone self-contained package equipped with an engine generator and battery bank. The system can be used to provide standby power to applications having renewable energy as the primary power, but the primary function of a Hybrid Battery/Engine Generator System is to provide improved fuel consumption and better engine capacity utilization. This information sheet discusses the advantages of a Hybrid/Engine Generator System for your power needs, how the systems operate, and how it can be applied to a wide range of power system applications

## 1.0 DEFINITION OF AN ENGINE GENERATOR/BATTERY HYBRID POWER SYSTEM:

An Engine Generator/Battery Hybrid Energy System adopts similar technology to a hybrid car in using the combination of an engine driven generator and a battery power. Using the battery as the engine power storage system enables the engine to only be used at its optimum load for maximum fuel efficiency and a method to have stored engine to address peak demand

*Figure 1*

### Hybrid Battery Engine Generator System



An Engine Generator/Battery Hybrid Power System differs to a traditional generator as follows:

**1.1 SIZING –** A traditional engine driven system matches the power output of the engine with the maximum kW load of the application. The load is divided by the alternator (generator) efficiency (0.85 to 0.90) and converted to kWe, then divided by 0.746 for the required engine horse power (hp). For many prime and standby generator applications, sizing the generator for maximum demand results in an over capacity power source for a high percentage of the operating period.

Applications with high motor loads, even those equipped with motor starting assist devices, require an over-capacity to manage high starting kVAs and in rush amps.

With a Hybrid/Battery system, the system designer can now use the battery capacity to calculate the available power for transient loads, such as motors starting. Sizing of the engine generator can be based on the average steady load and the capacity to maintain battery charge. The battery size will be calculated against 3 specifics:

- Ampere hours capacity to manage transient loads
- Capacity to supply load should the engine generator go off-line
- UPS capacity for any connected renewable energy sources

**1.2 CONFIGURATION –** An Engine Generator/Battery Hybrid package, as for any generator system, can be configured as an open or enclosed package. Whether open or enclosed, the following components are used in a hybrid package - see ***figure 1***:

**1.2.1 ENGINE -** The engine used can be a fuel-efficient diesel engine or a spark ignition engine using gasoline, natural gas or LPG. As a hybrid system has a battery within the system supplying the load, when the engine is not running the output voltage to the battery will be Direct Current (DC). A traditional generator system produces Alternating Current (AC) with the engine coupled to an AC generator, with the generator AC power converted to DC to charge the battery. With the engine running at a constant speed to give a steady 60Hz current.

On smaller kW applications, under 15kW, there is the option for the variable speed engine to be coupled to a DC generator for the battery to be charged without an inverter.

**1.2.2 GENERATOR END -** Most generators, AC or DC, are close coupled to the engine flywheel housing. If AC, the system will employ a brushless rotating field alternator. Brushless is the preferred option to have minimal electrical noise and reduced service requirements by the elimination of brushes.

**1.2.3 BATTERIES -** Batteries are configured into the system to enable the AC load to be supplied from the battery DC output through an inverter. When the system's connected load is low, the battery will supply the load. When the battery ampere capacity reaches a pre-determined level, the generator will start to recharge the battery. Frequently, lithium batteries are chosen due to their superior ability to hold charge in a smaller cube, ability to recharge quickly, and higher life cycle.

**1.2.4 RECTIFIER -** When an AC generator is used, the AC current is converted to DC to recharge the battery bank. A smaller DC generator will charge the battery directly.

**1.2.5 INVERTER -** As the utility grid system is AC the rectified DC current from the generator and the battery has to be converted to AC via an inverter. The AC load is connected to the AC side of the inverter.

**1.2.6 CONTROLLER -** A system controller constantly monitors the load and ampere hour capacity of the battery. The controller has the following functions:

- **Monitoring the Load -** As the load rises or falls, the controller will signal when the generator is to start and stop
- **Monitoring the Battery -** The controller ensures the ampere hour capacity of the battery is maintained to manage increased additional electric motors loads on start up, and has the capacity to supply for a designated period uninterrupted power when all other power sources go off-line.
- **Monitoring the Other Connected Power Sources -** The controller will switch in and out additional energy inputs such as wind and solar.
- **Monitoring Quality of Power -** Ensures AC output is compatible with load requirements by monitoring inverter output. The output from the generator and the rectifier is also monitored.

## 2.0 ADVANTAGE OF HYBRID BATTERY GENERATOR SYSTEMS:

Combining several well-proven technologies in one package provides the user with the advantages including:.

**2.1 ECONOMIC –** Many stand alone generator systems are sized for maximum load that only occurs intermittently. Using the additional capacity stored within the battery to meet peak loads reduces the size requirement of the generator. This saves on initial cost and cost of operation with less fuel and an engine running longer at its mean operating load efficiency.

**2.2 ENVIRONMENTAL –** An engine running at its most efficient load and for shorter periods significantly reduces exhaust emissions.

**2.3 CLEAN POWER –** Electronic control of the power output ensures very stable clean power to sensitive loads.

**2.4 UPS –** In a standby configuration, the battery provides the UPS component.

**2.5 RENEWABLE ENERGY COMPATIBLE –** As the system is already configured with a DC component, it is ready to receive and manage energy from renewable sources such as wind and solar.

**2.6 RELIABILITY –** No longer running the engine on light load eliminates most wet stacking and carbon build-ups, leading to longer engine life and less maintenance.

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