HYBRID GENERATION IN THE POWER GENERATION HIRE MARKET

WHAT IS A HYBRID GENERATOR?

Diesel Generating sets have been used in many different types of emergency / standby or hire applications for very many decades now and as such the operating principles are well understood. An engine is connected via a shaft to an electrical alternator; This allows the fuel (usually diesel) used to power the engine which then turns an alternator to convert the motion of the engine into electricity. These principles have not changed much for over 100 years, although the efficiency has greatly improved.

Over the last few decades, it's become clear that the use of fossil fuel, such as petrol, diesel or natural gas, in general is problematic in terms of their impact on the environmental and the sustainability of their continued use. Diesel is by no means the worst offender – in cars, for example, diesel tends to emit less CO2 than petrol engines, because they use the fuel more efficiently.

In this period of transition from fossil fuels to other energy sources it is beholden on us to find ways of improving the efficiency of energy conversion and by virtue of this reduce the environmental impact of what we do. Technologists in the generator industry have turned their attention to this and the use of hybrid generators particularly in the "hire" sector are in the ascendancy. When correctly used these generator/battery combinations use less diesel overall and hence have a reduced impact on the environment.

In their basic form a hybrid generator consists of a traditional diesel engine alternator combination which is supplemented by a battery pack. In operation either source can supply the required electrical power.

There are many benefits to choosing to use a hybrid generating set on your hire generator application, which include:

- Increased generator efficiency
- Reduced fuel consumption
- Reduced CO2 emissions and hence carbon footprint
- Quiet system operation overnight
- Reduced generator maintenance costs
- Additional redundancy of supply

It is worth noting that these systems can also be used with existing mains supplies, standby generators as well as renewable energy sources such and solar or wind power.

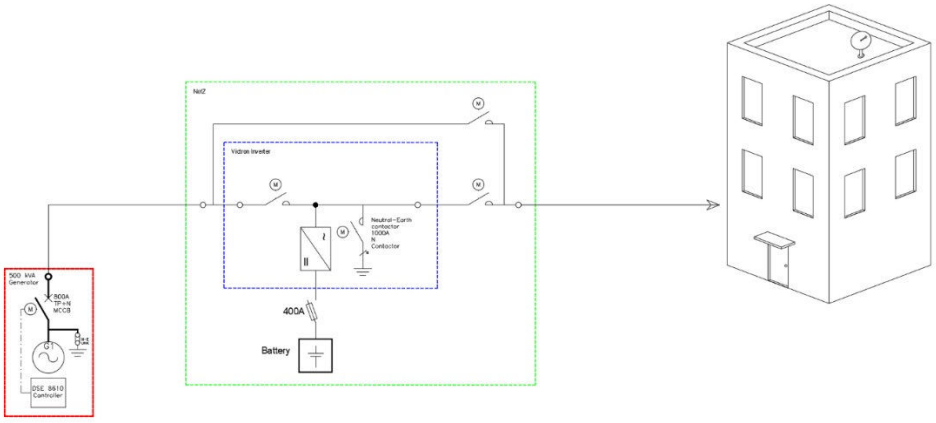
HOW IT WORKS

Much like a hybrid car, the battery system utilises power in the most efficient way. Installed between the generator output and the load, the battery system is designed to complement the operation of a generating set, allowing it to operate more efficiently at higher load levels for shorter periods of time or for the load to be fed by the battery alone. There are several ways in which the "hybrid generating set" can be operated and the savings / environmental impact will vary accordingly.

One such mode of operation would be for example as the system load increases, or as the battery's stored energy level is depleted, the battery system will start the generator; the generator will supply the load whilst also recharging the batteries ensuring the diesel engine is running at its most efficient point. The battery system typically seamlessly transfers between battery and engine power, reducing carbon emissions and generator run hours and therefore any potential maintenance costs.

Another common application is when a generator and battery system combine to power a suite of construction site cabins. Power demand in this type of application is high during weekday days and low overnight and weekends. Typically, overnight the load is lighting, security and during the winter some background heating. The standard mode of operation would be generator running during the day and battery overnight. The generator also picking up battery recharging early in the morning. Whilst this mode of operation is easy to set up and does tick many of the desired performance boxes such as silent operation overnight, eliminates light load low efficient

running of the engine, reduced running hours and emissions it doesn't necessarily provide an optimised operation solution. The key is to optimise the performance of both generator and battery system using them as a fully integrated energy solution optimised for the lowest possible level of emissions.



OPTIMISING THE SOLUTION

Always looking to innovate, WB Power Services Ltd was an early adopter of the combined generator and battery solution particularly on construction sites and 24/7 continuous running applications where low overnight noise levels were key. Early deployments of these packages used battery systems purchased from third party vendors. WB's new product integration team initially set about securing an understanding of how the two devices worked together so that they could develop training packages for both the hire sales team and installation, service, and maintenance teams. The early testing work undertaken combined with a good amount of real-life data led to the realisation that this combined package had much more to offer than was being sold by third party organisations. It led to a determination within WB to fully explore and quantify potential savings for clients, to ensure our teams new how this could be achieved and has ultimately led to the development and production of our own NetZPack battery solution.

WB has undertaken extensive development and testing of the NetZPack product ensuring that operation of the generating set and performance of the battery system are fully optimised ensure we are securing the maximum efficiency of operation when running on generator and secure the maximum possible life from the battery system too. We should not forget that there are significant environmental costs associated with the production and manufacture of Li-Ion batteries.

TESTING

WB undertook a wide range of testing to both optimise its third-party battery fleet but more so when developing the NetZPack product. This was important for a wide range of reasons: -

- Ensuring correct matching of generating set to battery for a range of different load levels, applications and operational settings
- Closely monitoring engine fuel consumption in various load scenarios and on a range of generator ratings
- Understanding optimum operational performance window of the battery under a range of load levels and duty cycles
- Discharge/recharge performance and characteristic of the battery system
- Selection of battery type, expected lifetime performance, battery capacity, string configuration and manufacturer quality

WORKED EXAMPLE

As part of WB's research and development programme it undertook a number of monitored field tests on a range of generator and battery system combination and various load types. One such evaluation was undertaken when working in conjunction with one of our DNO utility clients who was undertaking some overhead power line replacement work in an area with just a few residential properties. The sort of application where a combined generator and battery system work well together.

In this instance the load assessment provided by the client indicated that whilst there would be load on the system 24 hours per day there would likely be three very distinctive peak periods of loading, morning, lunchtime with the largest and longest coming during the evening. Armed with a more detailed profile WB selected a Kohler J66 generating set housed in a close fit canopy and extended run base tank with a NetZPack 30/75 battery unit.

The red line on the first graph shows the actual load profile during a typical weekday 24 hour period. The green blocked areas show periods when the generator was running. The blue line on the second graph indicates the state of charge of the battery system.

The battery system is used to supply the load during the periods of lighter load. The generator is the used to supply the load during periods of higher load whilst also recharging the battery system. When used in this combination it can be clearly seen that the generator:-

- Rarely runs at low levels of load:-
    - Avoiding periods of light load running issues
    - Avoiding inefficient burning of fuel at low load levels
- Generator / Engine
    - Runs for a shorter period reducing running costs and maintenance requirements
    - Is typically always running at a heavier load levels where the engine is
        - Running at optimal engine temperature with minimum
            - l/kWh fuel consumption
            - Lowest level of emissions per kWh
- Generator not running overnight reducing localised noise pollution

In this particular example the results were as follows

- Generator run time reduced by 61%
- Generator average load up by 258%
- Estimated fuel saving of 24%

IMPORTANT TAKE AWAYS

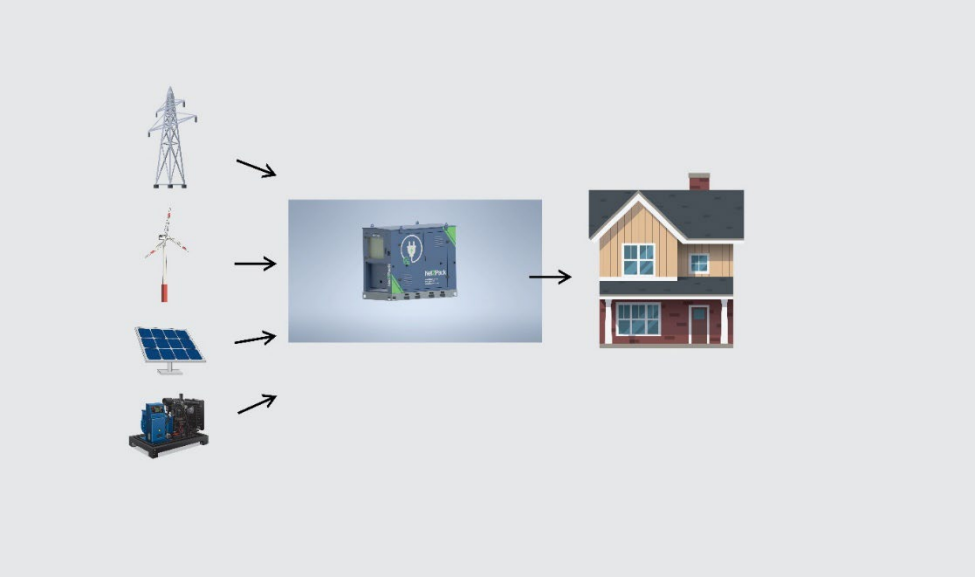
Maximum optimisation can only be achieved if the vendor closely matches the generating set to the battery system. This isn't just down to the getting the correct set rating, but it is down to the performance of the specific engine type/ manufacturer as set/engine performance does vary. WB understands this well and is able optimise this within the NetZPack operational software.

The key to a successfully deployment and use of a hybrid generator package isn't just about reducing fuel consumption of the generating set, it is also about optimising the performance and the life expectancy/life cycle of the batteries too as there is an environmental impact in the materials used and manufacture of these batteries. WB's extensive product development testing and operational experience has found securing optimal performance isn't straightforward but needs to be based on a wide range of design and operation considerations such as:-

- Quality of battery manufacture
- Mix of materials used in manufacturing the batteries
- Battery configuration when combined into a product package
- Selection of battery charger and charging regime adopted
- Seek to maintain the battery operating temperature to optimal levels particularly when charging and discharging
- Ensure
- Optimise the number of charge/discharge cycles the battery is subjected too
- Excursions outside the battery's optimal performance range (typically 80-20% level of charge)
- etc

With so many of these variables will be outside the control of the operator control and supplier but all of which will impacting the operational performance and life cycle of the product. It can be seen just how important it is for the vendor to provide the right product package for the power requirement and load environment if both operational and life-cycle performance is to be maximised.

The knowledge built up during the expensive development testing and operational testing of the NetZPack product has been locked into the NetZPack's operational software and product training imparted into the Hire Sales team when dealing with client enquiries.



The NetZPack is also able to use power provided from other sources such as renewable energy from wind or solar with either or both working in combination with the generating set. Additionally, the system has an input for a grid-based mains supply making a great source of power where the grid supply is unstable and subject to frequent disruption and hence enhancing the reliability and of the grid.

Author

G R Halliday
Business Consultant
WB Power Services Ltd

Geoff Halliday started his career as an apprentice working for Square D (later part of Schneider) before moving into the critical power sector where he has now worked for over 40 years, splitting that time equally between both the UPS and standby diesel generation sectors.

During this period Geoff has held several roles ranging from Customer Service Engineer, Project Manager, Technical Director, Sales Director through to Managing Director.

The Critical Power market exposes the individual to a wide and diverse range of market sectors ranging Health Care, Life Science, Water Treatment, Banking and Finance, Military, Manufacturing, Process Control through to Data Centres of all sizes. Drawing on his management skills, product knowledge and vast application experience amassed throughout his career Geoff now enjoys sharing his knowledge with others.