VHT VAN HALTEREN TECHNOLOGIES

How to optimize old energy systems with new technology

Revolutionize your energy consumption with
the Power Management System from Van Halteren Technologies

Introduction

Having reliable access to power is essential for any business, and the technology that can provide this power has existed for a long time. For so called ‘off-grid’ power supplies, diesel generators are used by companies all over the world, and they remain popular to this day thanks to abundant access to the fuel, together with straightforward technology that costs relatively little.

However, using diesel and other fossil fuels is becoming more and more difficult to justify, and the regulations around their use are steadily becoming stricter. This is because the combustion of these fuels causes long term damage to the environment, and it’s essential for all businesses to explore more sustainable approaches.

The development of more sustainable power supply solutions is currently heavily invested in but for many applications no mature and economic solutions are available yet.

VHT has designed the Power Management System (PMS) so that it can be implemented within an existing energy supply. By adding energy storage devices like batteries and using clever control algorithms, a significant reduction in fuel consumption of the diesel generators can be obtained. This results in less exhaust emissions, less fuel consumption and less maintenance. The PMS can revolutionize any existing local energy solution, reducing costs and environmental impact while improving efficiency.

The common challenges with diesel generators

In addition to mains power supply from the grid, many rely on diesel generators for energy that can be generated locally. These generators tend to be reliable, and the fuel is abundantly available, so industries have been utilizing them for many years.

The main issue with them is that they are simply not sustainable, and using them regularly has a negative impact on the environment. This is why regulatory bodies are introducing restrictions around emissions, with the hope that we can collectively operate in a more sustainable way. This doesn't mean that systems relying on diesel generators will become obsolete overnight, but it is necessary to find better ways to make use of them before, eventually, embracing greener energy sources.

Changing the way we use generators

Typically, diesel generators have been used as a primary energy source. This means that they were always running and ready for action, and had to burn more fuel as they mostly run less efficient at low power. As a result the diesel engines are more susceptible to timely maintenance in order to avoid black out situations.

With a PMS installed, the diesel generator is used as a secondary energy source while the PMS uses the energy storage as the primary source. Depending on the power consumption, the generator is used only to periodically re-charge the batteries, while the PMS provides the required power to the consumers.

This has a range of benefits, including:

- **More efficient energy use:**
  The generator runs only periodically at its optimal power setting, thus consuming less fuel.
- **Reducing emissions:**
  By burning less fuel, the carbon footprint is reduced. This means a more sustainable operation which is good for your business and for the environment. As the generator only runs periodically, less noise is emitted and, when required, the operation of the generator can be programmed not to run at certain periods (e.g. during night)
- **Compliant with new regulations.**
  In addition to the environmental benefits of reduced emissions, you can also ensure that you're fully compliant with regulations that may come into force. This is made even easier by the fact that you can closely control and monitor fuel use with the PMS.
- **Lower costs:**
  Using less fuel and increasing the maintenance intervals can have a significant impact on operational cost (OPEX). As the generator is only used as a secondary energy source, it does not longer needs to be sized to the peak demands from the power consumers. Smaller sizing can result in a significant reduction of installation costs (CAPEX). By reducing the amount spent on the generator power plant, the PMS can help improve your profit margins.
- **Easy to go green.**
  Thanks to the way we've designed the PMS, it is easy to make the switch to renewable energy sources when the time comes. This also means you will have a significant portion of the energy infrastructure already in place.

What emissions regulations can affect diesel generators?

Regulations are coming into force all over the world with regards to diesel generators. Most territories that are taking action are doing so gradually, so making restrictions stricter with each passing year.

If we take Europe as an example, the EU emissions regulations are directives which are designed to limit emissions from diesel engines. The emissions here are carbon monoxide, nitrogen oxides, hydrocarbons and particulates, and the EU has set out a sliding scale where different power bands have to meet different regulations.

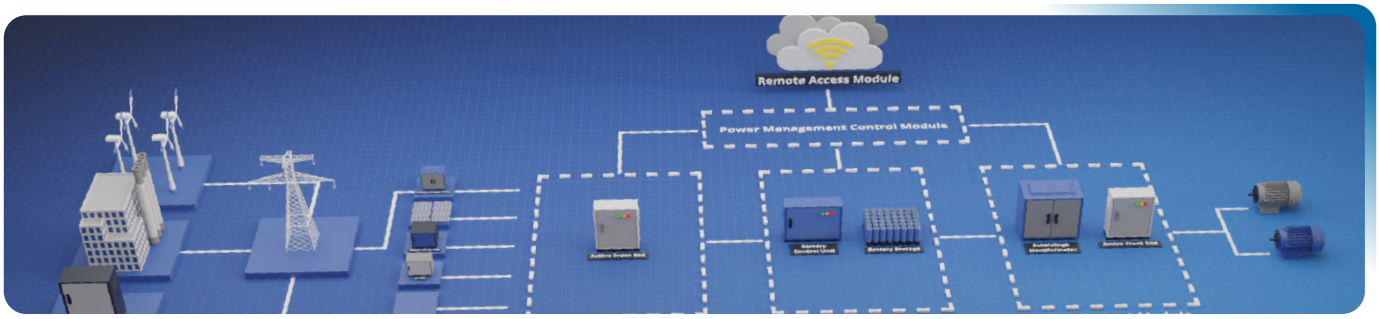
The rules can be difficult to navigate, but by introducing a PMS into your energy ecosystem, you can reduce peak power levels and fuel consumption, which in turn means you're more likely to comply with regulations.

Similar regulations are being applied in many territories, and the PMS can help ensure that wherever you are, you can meet them.

Preparing for a fossil-free future

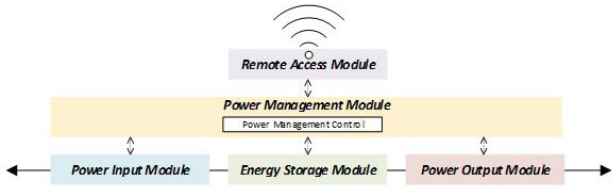
The long-term ambition, of course, is to be able to stop using fossil fuels altogether. If and when this happens, the PMS can help with an easy transition thanks to its ability to store and distribute energy from a number of different sources. The distribution will always be as required, regardless of whether the original source is consistent or inconsistent, which makes it ideal for handling power from solar or wind farms.

The Van Halteren Technologies Power Management System



Van Halteren Technologies has developed a modular Power Management System (PMS) for local energy solutions (including microgrid) that aims to optimize the use of on-site energy sources. The Van Halteren Technologies PMS is made up of the following components:

- power input module
- energy storage module
- power output module
- power management control module
- remote access module



The PMS is limited to Low Voltage applications (less than 1000 VAC).

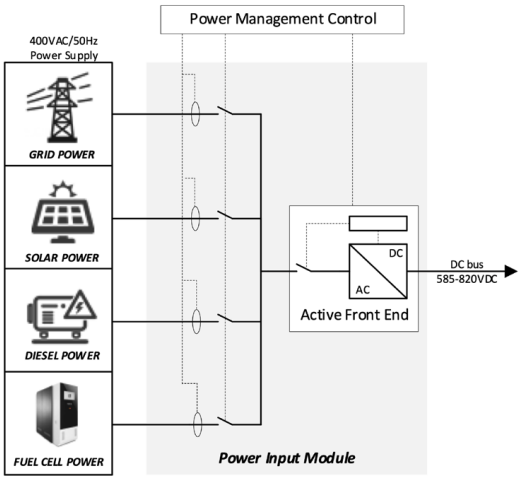
Power input module

The power input module is linked to the various energy sources available on-site.

An active front-end (AFE) provides 4 quadrants of operation and reduces harmonic distortion (THD). In addition, the AFE can follow a forced AC voltage ('grid mode'), such as the electricity grid, or impose an AC voltage ('island mode').

Mains voltage, current and frequency of connected sources are measured by the power management control to safely link and disconnect the desired energy sources.

The AFE is linked to the DC bus whose voltage varies with the voltage of the energy (battery) storage module. The AFE firmware is capable of supporting storage-only operation ('island mode') or a combination of energy storage devices and external sources ('grid mode').



Energy storage module

Why is energy storage essential?
Local energy storage offers many benefits, including:

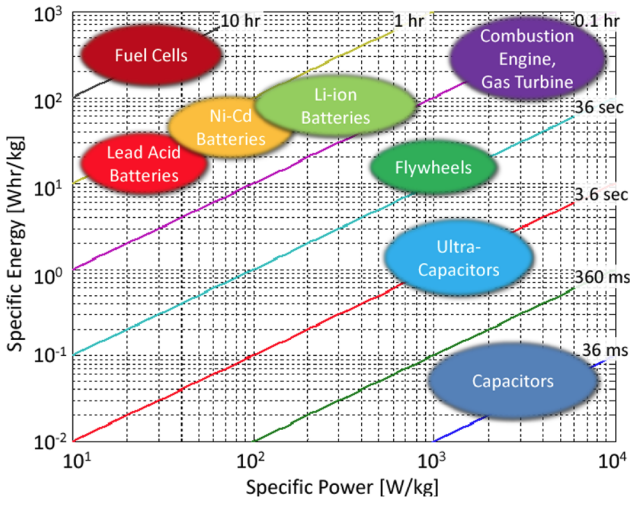
- harvesting energy at the moment of availability
- saving energy return for reuse
- reducing energy consumption average with peak shaving
- the ability to temporarily take over local power supply in case of grid failure

Electricity is considered to be the energy source of the future and there are currently 3 common methods of storing electrical energy:

- batteries
- super capacitors
- flywheel

The Ragone diagram below broadly indicates the areas of application of different energy storage methods. The method of choice is in principle determined by the average loading and unloading time (oblique axes in the diagram) as well as the power demands.

Super or ultra-capacity can handle large powers in a short time, only the storage capacity is limited to a relatively small extent.



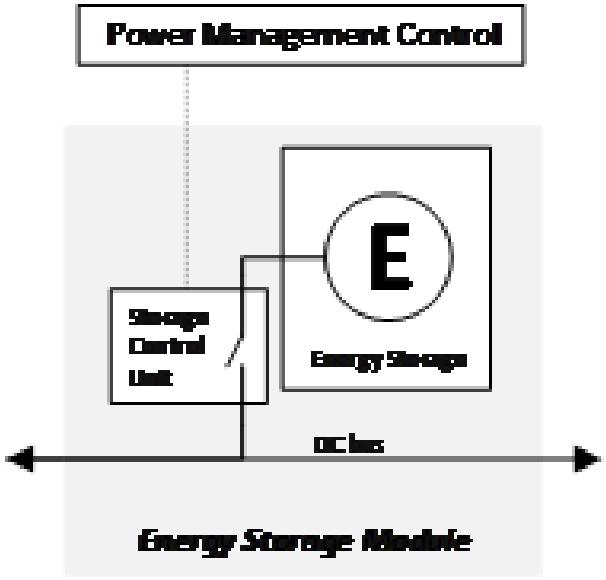
Flywheels can handle cycles from a few seconds to approximately half an hour while handling considerable power.

Modern batteries can now handle cycles from minutes to several hours while handling significant power and are therefore an attractive medium for use in power supplies.

Efficient use of energy storage leads to increased efficiency, improved sustainability and reduced operational costs.

The energy storage module typically includes:

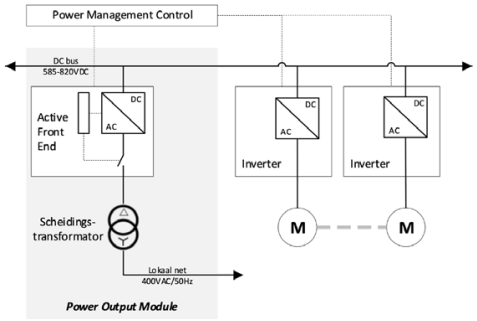
- Single or multiple storage devices, coupled in parallel and/ or in series, matching the required storage capacity
- Provisions to control and monitor power to and from the storage devices as well as stored energy ('state of charge')



Power output module

The power output module includes:

- Active front end to create a local AC power supply network for local consumers
- An transformer to provide galvanic isolation and compensate for load imbalance from connected AC power consumers
- DC power supply and communication with inverters which power motors for various drives through frequency control (when applicable)



Power management control module

The control module for the power management system ensures the correct and safe functioning of the individual modules through various internal communication lines. A programmed state machine ensures smooth transitions between the different operating situations.

Via the OPC-UA (Unified Architecture) machine interface protocol, the control provides access to system variables and parameters via the Remote Access Module.

If necessary, a link can be created with a parent operating system. It also provides redundant and UPS-assisted control voltage.

The control includes algorithms that:

- Allow for optimal use of one or more external energy sources via the Power Input Module
- Use an optimal strategy for the use of energy sources (Power Input Module) in combination with the energy storage (Energy Storage Module) and consumers (Power Output Module)

In the event that external energy sources are lost, the PMS is able to supply energy to consumers as long as the energy storage is sufficiently charged. The consumers will not notice any of this at first.

Since the operation often takes place remotely or automatically, the user interface consists of a simple control panel and interactive display. The modular design allows the PMS to adapt relatively easily to create a higher level of redundancy and reliability.

Remote access module

The power management system can be provided with a gateway that connects to the cloud. This remote access allows you to:

- monitor key system variables
- configure the system and set parameters
- download and initialize software

At VHT, an artificial intelligence-based cloud service is currently being finalized which will include key features like:

- remote monitoring of plant condition (‘asset management’)
- monitoring energy flows per application
- cloud-based adaptive management of energy flows
- optimization of diesel generator operation
- optimization of solar power generation including use of weather forecast
- battery management with a view to lifetime optimization

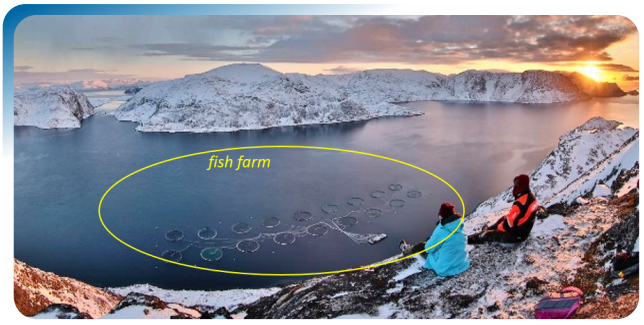
Choose what works for you

The PMS is fully modular, so it’s possible to implement the modules that will benefit your operations the most. VHT took this design approach as we know that every application has different needs, and we want to ensure that every customer has the right solution for their specific requirements.

Use cases for energy storage

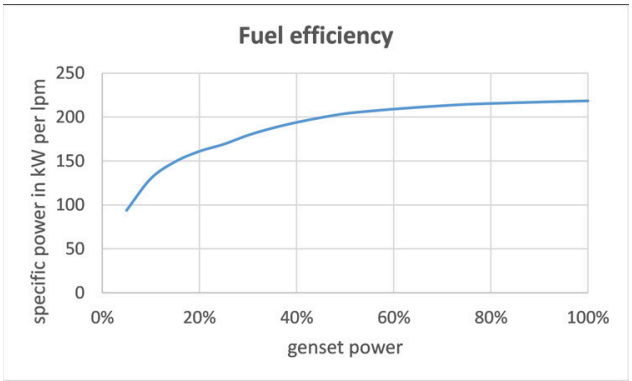
Local energy storage is at the heart of the PMS and in combination with a traditional diesel generator it allows you to provide the power you need with the highest fuel efficiency and lowest emissions. Here is an example showing the emission reduction and fuel saving potential.

Example 1: A remotely located fish farm



(photo courtesy Fjord Maritime AS)

In Norway fish farms are located at remote locations where the fish is kept in large nets. Their power supply for feeding and lighting totally rely 24/7 on diesel power only. In order to avoid that the genset runs inefficiently at low power consumption (reference graph below) a PMS is implemented.



The PMS uses batteries as prime power source while the genset (sized 175 kVA) is used to charge the batteries periodically at its optimum working point of 150 kVA (85%). Illustration shows a daily load cycle (red), available battery energy used (green) and periodical operation of the genset (purple).

By using the PMS in this way, a daily diesel fuel saving of about 80 liters can be obtained or 29200 liters on a yearly base. This saving is equivalent with a reduction of 72 tons of CO2 emission. This solution has been implemented as new build and retrofit in existing installations.

VHT implements battery systems of various suppliers depending on the application. The battery strings are directly connected to the DC bus without DC-DC converters. Typically, the voltage of a string at 400VAC/50Hz (3 phase) mains voltage is between 585 and 820 VDC. Each battery module contains connected cells in series and each cell is individually monitored (cell voltage and temperature) by a battery management system (BMS). Circuits for passive or active cell balancing must ensure that differences in cell voltage do not become too large. The type selected depends amongst others on the load cycle of the batteries.

The cell temperature of batteries must be within close limits which mostly requires control of the temperature of the room in which the batteries are installed. Depending on the load cycle, it may also be necessary to apply liquid cooled batteries. The battery control unit monitors the 'State or charge' (SoC) and communicates with the power management control in order to safely operate a battery string.

Why Van Halteren Technologies

The PMS from Van Halteren Technologies offers more than a smart power management system. It offers a whole range of benefits, in addition to making your business more energy efficient, cost conscious and environmentally friendly. These benefits include:

- On grid and off grid power supply solutions
- Peak shaving and uninterruptable power supply
- Emission reduction by reducing the need for fossil fuels
- Easy to switch to renewable energy sources due to power modulation
- Modular and scalable platform can be configured to fit your needs
- Open standard controls
- Standard industrial components which are easy to repair and easy to replace
- Compact and powerful solution, with high power density

Our turnkey solutions can be retrofitted into existing power systems, or can be installed as part of a totally new arrangement.
We can supply different parts of the system based on your specific needs, whether you need just the control unit and battery storage or the entire infrastructure.

We also provide remote access and monitoring, so you can always see relevant key performance indicators, and we can carry out remote maintenance where and when its needed.

In addition to this, the modular nature of the PMS ensures that it can be designed to fit exactly where you need it. Rather than adapting your space to fit the PMS, we adapt the PMS to fit your space.

To find out more visit
vanhalterentechnologies.com

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