

# Hybrid power case studies

**MAN Energy Solutions**  
Future in the making

**Hybrid power systems are the ideal solution for isolated or remote locations that need to reduce energy costs and provide a reliable power supply.**

Hybrid power solutions combine gensets, renewables and storage technologies and are controlled by an energy management system. MAN's hybrid solutions are tailor-made to customer requirements. The benefits are reduced CO<sub>2</sub> emissions, lower fuel consumption, lower electricity costs and enhanced security of supply.

#### **Dynamic and flexible power generation**

MAN engines have start-up and load ramp-up times of less than three minutes and gradual load application rates of up to 100 % per minute. Combined with energy storage system (ESS) technologies, the dynamics are further improved and the power plant output can be adapted to large load changes within milliseconds. This enhances the power quality and opens up new possible revenue streams from providing ancillary services.

#### **Sustainable and affordable security of supply**

For customer applications which require a certain share of operating reserve, this reserve can be provided by ESS instead of using an additional engine. In certain cases, this can result in reduced investment and lower operational costs and maintenance.

MAN's products are the ideal basis for raising the share of renewable energy systems (RES) in your grid and reducing the overall levelized cost of energy (LCOE). The two main applications in which hybrid power plants really create value for our customers are:

- 1) Isolated systems with a high share of RES
- 2) Industrial customers with high load fluctuations as captive power applications.



## MAN hybrid island power plant

### Isolated power system with gensets, renewable energy and storage

The main power production challenges for islands are high volatility due to climatic conditions, fluctuations in power demand (e.g. seasonal tourism), and the high costs of energy and imported fuels. For islands without a connection to the mainland or isolated systems without a central grid, security of supply and power quality are key requirements that cannot easily be met with renewables (RES) alone. By combining RES with highly flexible gensets, the challenge of a reliable power supply can be managed sustainably.

MAN's engines easily compensate for the fluctuations in RES due to their fast ramp-up times. The integration of an energy storage system (ESS) further smoothens the grid by providing the necessary fast, flexible and efficient power reserve. MAN's energy management system also maximizes RES power production and lowers overall generating costs. For an island with a peak demand of 80 MW (including a load increase of 30 MW), the existing 5 engines could be extended by an additional 3 engines to cover a reserve requirement of 20 %.

The number of additional engines could be reduced by adding an ESS to the system. The ESS covers the operational reserve and reduces the investment and operational costs. Adding a photovoltaic (PV) plant further reduces the CO<sub>2</sub> footprint, fuel consumption and the overall LCOE. This can be additionally beneficial depending on the resources available at the site.

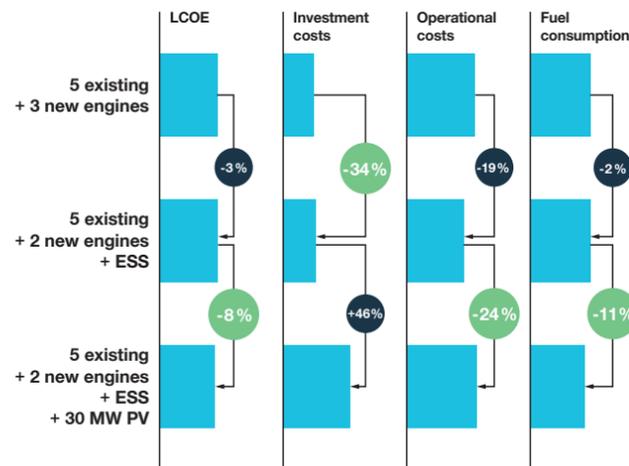
The ideal system design in this specific case includes a 30 MW PV plant. With the hybrid solution described, the overall system LCOE can be reduced by up to 10 %. In comparison to the engine-only solution, the additional investment shows payback periods of less than 4 years, with a ROI of up to 30 %.



### Extension of an isolated 50 MW power system

Peak demand:	80 MW + 20 % operating reserve
Fuel type:	HFO
Fuel price:	€ 66/MWh + 2.5 % p.a.
Engine size:	20 MW
On-/Off grid:	Off-grid

### Key benefits of different system configurations



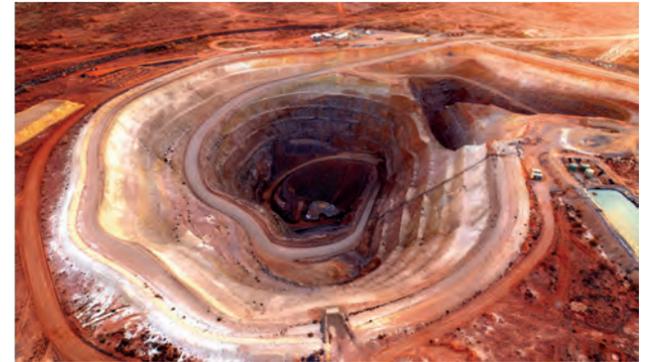
## MAN hybrid power system for a mine

### Captive power and reserve power plant with gensets, solar energy and energy storage

Industrial businesses such as mining or cement production require cost-effective, efficient and reliable operating capacity, especially for sudden load peaks. Depending on the load profile (e.g. variation of day/night), a conventional system would comprise three 20 MW engines to serve the overall base demand. An additional fourth engine for backup is required to cover sudden load peaks. As a result, all engines have to operate below their optimal efficiency rate.

With a MAN hybrid power system, only two engines need to be in operation. By integrating an ESS, the base load can be served with only two engines. As the hybrid system allows the engines to operate at their optimum efficiency point, this configuration reduces operational costs, fuel consumption and the operating hours in partial-load. Adding PV to the hybrid system helps improve the environmental footprint of the power plant. The combination of PV and ESS leads to reduced overall emissions, even further reduced fuel consumption and lower OPEX (operational expenditure). MAN's captive power solutions reduce overall costs and show payback periods of less than seven years in comparison to conventional grid connection. With an engine plus storage solution, an IRR of 20 % can be achieved. Adding PV to the configuration significantly increases sustainability with a similar IRR.

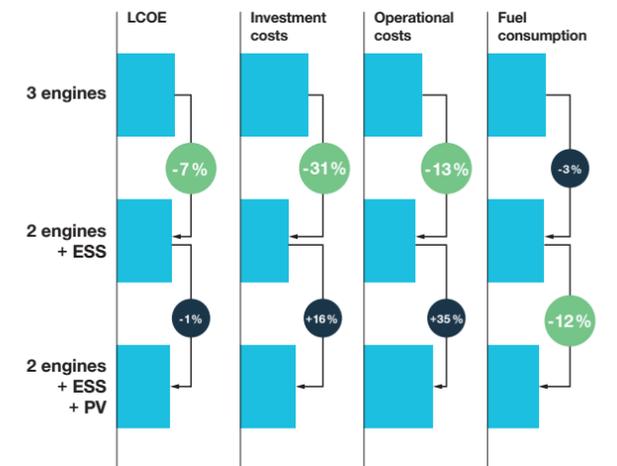
In comparison to conventional plant setups, MAN's hybrid solutions offer reduced installation costs and can increase the profitability of the entire project.



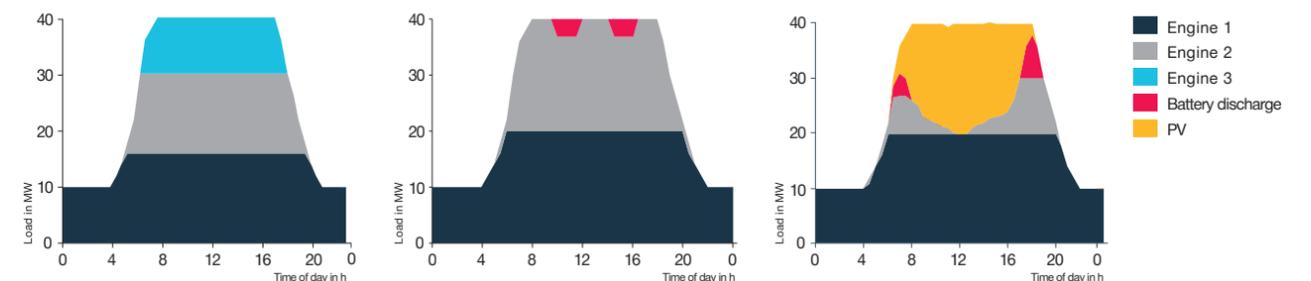
### New build power plant for a mine

Peak demand:	40 MW + 20 MW operating reserve
Fuel type:	Gas
Fuel price:	€ 21/MWh + 2.5 % p.a.
Engine size:	20 MW
On-/Off grid:	On-grid – € 80/MWh + 2.5 % p.a. grid price

### Key benefits of different system configurations



### Load comparison: conventional system vs. hybrid systems



Engines operating at partial-load to meet the reserve requirements.

Engines running at full-load, reserve is provided by ESS.

Engines can be partly shut down due to PV plant. Short fluctuations are managed by ESS.

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