Case Study

MarelliMotori Powering the future®

BERGEN ENGINES ON LAND. AT SEA.

PILLER Power Systems Nothing protects quite like Piller

100MW Industrial Microgrids

Each Industrial Microgrid has unique characteristics depending on the load, quality requirements and application

SUMMARY

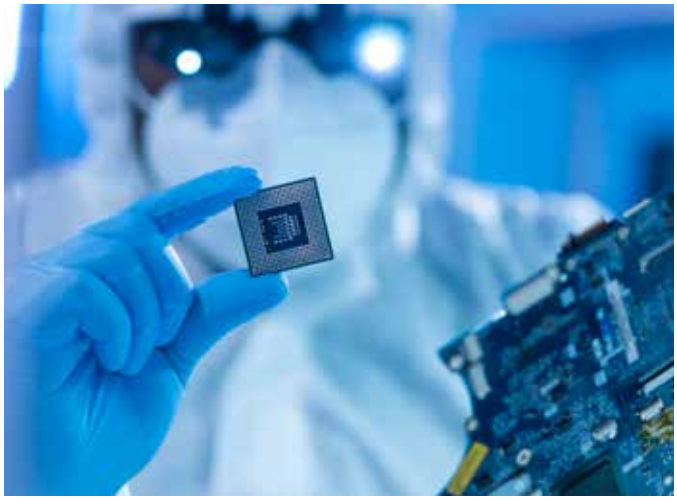
The following is an example of a microgrid development and deployment to provide reliable power for industrial manufacturing use.

This short study sets some of the common challenges faced by industrial users and the solutions available as they seek to execute sustainable, long term independent power generation strategies.

Using Power Solutions' Power of 10 technologies it is a description of a 100MW microgrid build out, starting with a 30MW deployment and extended in increments of 10MW supplied for a power intensive and power quality sensitive manufacturing operation of high-tech components such as semiconductors.

Such manufacturing processes are highly sensitive to perturbations such as harmonics, voltage dips and frequency fluctuations which have to be avoided to ensure a reliable power supply for the critical load.

> The system is designed to maintain power quality without dips in voltage or frequency when coupling and decoupling from the main grid.



The project example covers the engines, energy storage, power conditioning, stabilisation and connectivity of microgrid operation which can couple and decouple from the main grid when required.

In this study the requirement is for an on site microgrid to act as the primary power supply for the manufacturing process machinery. The combined heat and power (CHP) system provides electricity, steam, and hot water. The main utility grid acts as a back up. There are no renewables in play on day one, however RERs (Renewable Energy Resources) can be added in future to work in harmony with the microgrid power system.

The Power Solutions 'Power of 10' Bergen Engines, Marelli Motori and Piller combined approach ensures the continuous maintaining of voltage and frequency within predetermined limits. This is true when operating in island mode disconnected from the utility grid supply system, or when coupled and using the main grid for back up power.

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Continuous secure back up provided by the Piller 10MW Integrated Power Conditioning and Stabilisation (IPCS) system which uses clean, reliable POWERBRIDGE kinetic energy storage to provide the required ride through for planned and unplanned switching between island and grid integrated modes.

The grid connection capability allows for bi-directional power flow to both take power from the public grid and with the option to supply power to the main utility grid at times of low on-site demand.

The on site microgrid system provides electricity and heat (cooled through a heat exchanger) for air conditioning and environmental management and the steam production needs of the facility.

The engines meet strict noise and vibration requirements to ensure the nanometre scale manufacture process is undisturbed, using strong foundations and double insulations against vibrations between the engines and the ground the manufacturing is based on.

This study is provided in the context of utility grid independent power generation being a policy agenda item for all large industrial users across Europe and beyond.

THE SOLUTION COMPONENTS

For an initial 30MW primary power requirement three Bergen B series, 10 MW reciprocating engines running a blend of Hydrogen and Natural Gas are deployed. Bergen Engines has a sustainability roadmap for increasing the percentage of hydrogen to natural gas mix to achieve low and no carbon operation.

These 750rpm engines are equipped with specially designed Marelli Motori 10MW alternators.

Marelli Motori has optimized its 10MW alternator for integration with the Bergen engine to ensure that the generators can tolerate operating at continuous full load for many years.

The design complies with the stress and fatigue parameters required for power generation alternators. It avoids any mode-shape issues which could combine with the harmonic forcing from the engine.

The alternator set up manages precise voltage regulation in the microgrid, supported by the IPCS units if required.

The quality of the on-site generated power is categorised as HQ (High Quality) versus the backup GQ (Grid Quality) utilisation power.

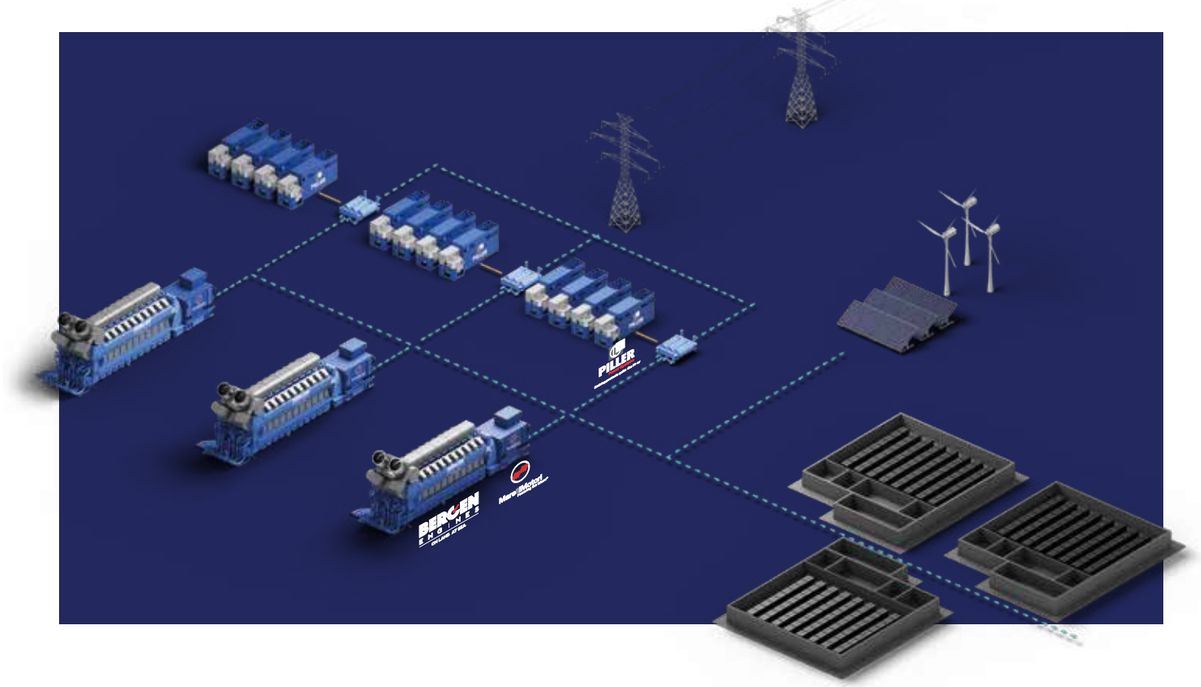
The microgrid uses Piller's latest UB-V Series 10MW IPCS units for continuous power conditioning, and emergency supply. The IPCS is combined with Piller POWERBRIDGE Kinetic Energy Storage power back up.

The POWERBRIDGE 21 modules provide 10MW of power ride through for more than ten seconds.

Piller's IPCS technology provides the required stabilisation. It protects the high quality microgrid from utility disturbances and outages while it allows bidirectional power exchange while connected. In island operation, disconnected from utility, it ensures a tight frequency tolerance in the case of load changes and possible disturbances in the power supply.

INDUSTRIAL MICROGRID IN ISLAND MODE

Features of the integrated use of Bergen Engines, Marelli Motori alternators and Piller IPCS make it ideal for primary power of islanded microgrid industrial applications.



Systems form a high-quality local supply network and to supply the critical loads with uninterrupted power at constant voltage and frequency.

Systems are highly efficient - the solution fulfils the entire energy requirements of the site.

By utilising the electrical power and heat through combined heat and power CHP to simultaneously generate electricity and use the resulting waste heat the efficiency of the gas engines system is 85% compared to 35% without waste heat utilization.

Such a system ensures the continuous maintaining of voltage and frequency within predetermined limits to meet the high demands made on the quality of the supply voltage:

- Voltage 20kV at a tolerance of ± 8 %
- Frequency 50 Hz at a tolerance of ± 1 %

This is maintained in island operation when the microgrid is disconnected from the utility grid supply, or when integrated and using the main grid for back up power (see below).

To achieve resiliency with three 10MW modules initially deployed the third unit acts as the N=2 plus one redundant unit redundancy layer. This removes the need for standby back up high speed diesel generators and large battery farms to power UPSs.

As the system grows out to 100MW there are always units available to provide reserve power at times of maintenance, continuously ensuring N+1 redundant operation.

At full 100MW capacity 2x Piller UBV IPCS 10MW units provide stability to the system.

IPCS is a frequency stabilisation and voltage support module coupled to the Bergen Engine power generation module. The 10MW size comprises 4 x Piller 2.5MW UB-V Series modules combined to one single unit, each equipped with 2x POWERBRIDGE PB21 kinetic

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energy storage devices. They are directly electrically coupled to the engines in the microgrid and are creating a protective grid connection via a 10MW decoupling choke. Conditioned power is then distributed as required up to 10MW per IPCS module.

The IPCS configuration ensures stable operation of the CHP microgrids units. Critical frequency fluctuations due to the reaction times of the gas engines to load fluctuations of any kind do not appear.

Integrated Microgrid – integration and decoupling

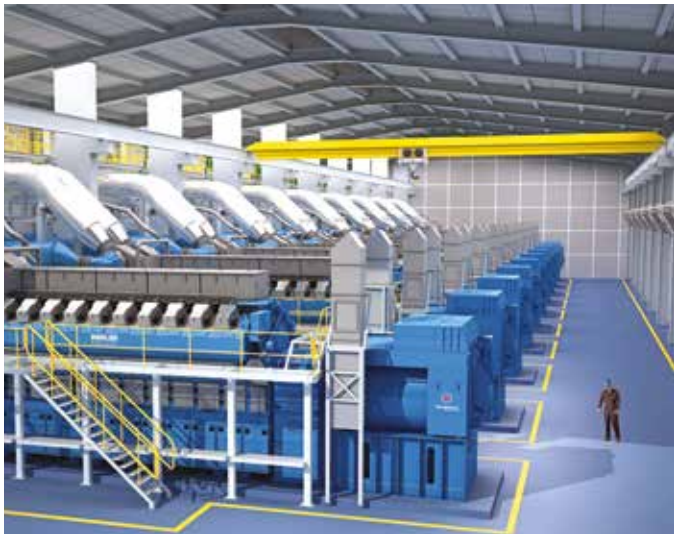
Features of the integrated use of Bergen Engines, Marelli Motori alternators and Piller UPS, energy storage and IPCS stabilisation technology make it ideal for integration with and decoupling from the traditional utility grid in microgrid industrial use cases.

The system is designed for bi-directional power flow. The Power Conditioning Device establishes the link between the system (grid quality bus, GQ) and the parallel operating CHP station (High Quality Bus, HQ). The system is designed for bidirectional energy transfer between AC line supply and CHP station.

The systems perform equally well for continuous load provision, for primary baseload power and coupling and decoupling from the grid for back up during grid brown outs, and at times when grid constraints require peak shaving and load shedding.

The IPCS system enables interaction between the microgrid and the utility grid. The configuration can support the utility grid by the power of the systems installed in the microgrid. With a Piller system installed at 20MW it is possible to import or export 20MW of clean conditioned power to and from the utility.

During utility connected operation the grid gate system protects the Microgrid from utility outages. The Piller choke ensures smooth changeover to island mode with no loss of quality of power in terms of frequency consistency with Bergen supplying the stable voltage.



In the case that power is imported or exported a sudden disconnection from the grid in case of a utility outage causes a power imbalance in the microgrid that is compensated by the kinetic energy storage devices of the IPCS until the Bergen engines have balanced their power.

The POWERBRIDGE PB21 kinetic energy storage devices of the IPCS also ensure proper resynchronization to reconnect to utility while keeping the Bergen engines in a balanced power condition.

Industrial Scale to 100MW

Industrial Microgrids supplying 100MW + power to large standalone manufacturing plants and factory campuses are becoming increasingly common.

Companies reshaping their relationships with the traditional power generators and transmission system operators through microgrids are turning to the Power of 10 for independence and security.

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