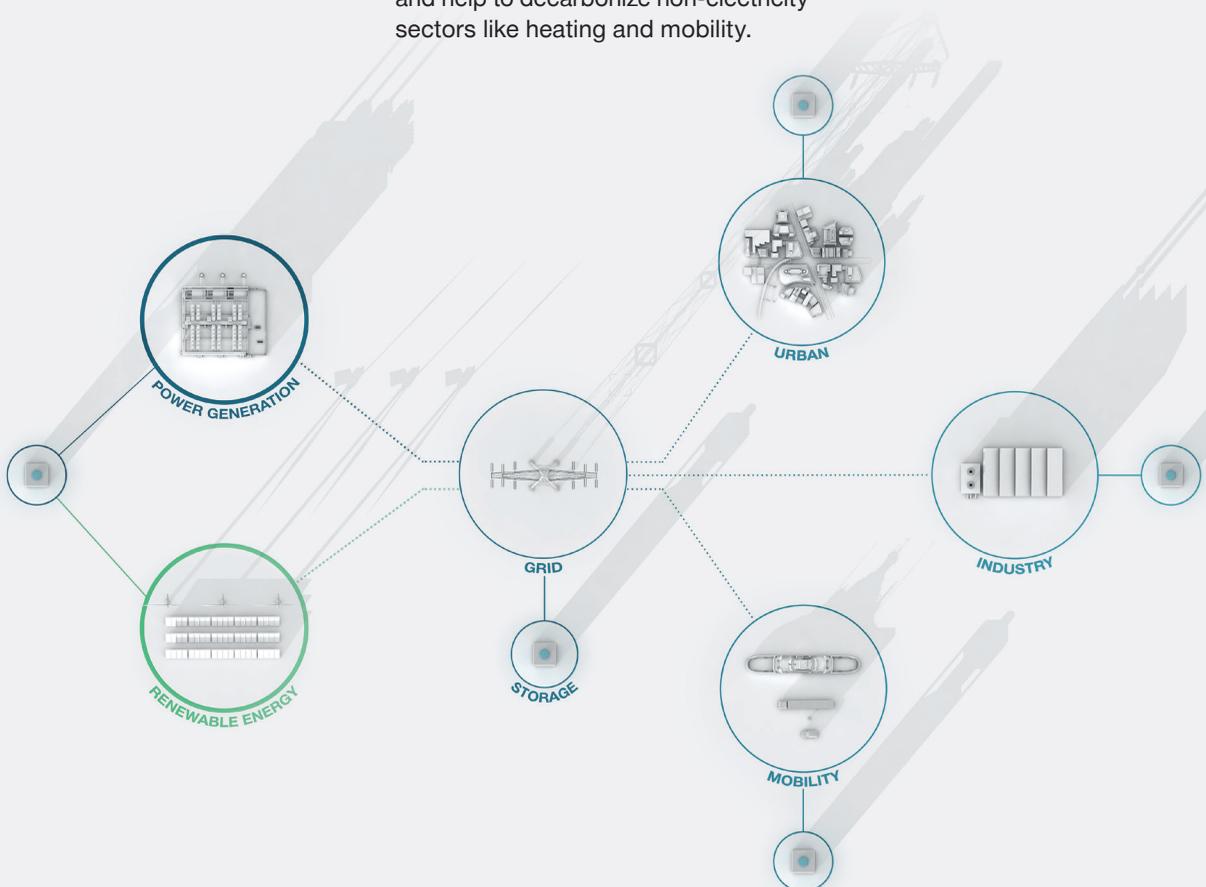


Energy storage solutions

To reduce CO₂ emissions, global energy markets are moving away from centralized generation based on fossil fuels and towards renewable energy systems (RES) like wind and photovoltaic. However, renewable energy is not always available when needed and is creating instability in the grids due to its fluctuating nature. MAN energy storage systems are a key building block for decarbonization and help to solve these problems: they balance the supply and demand of renewable energy, stabilize the grids and help to decarbonize non-electricity sectors like heating and mobility.

Benefits at a glance

- Broad range of complementary storage technologies
- Provides the most suitable technology for a specific use case
- Global EPC competence and capability to handle complex energy projects
- All components of an integrated solution from a single source

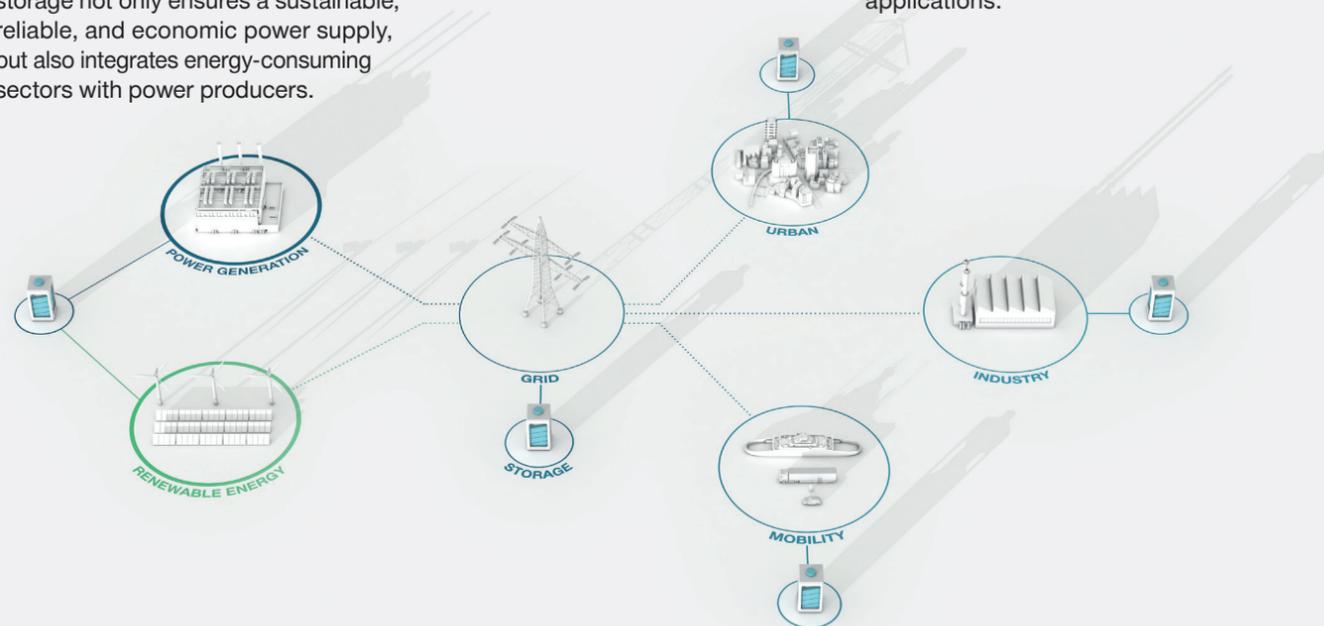


Green and fit for the grid

Integrating a high share of renewable energy

Adding renewables to a grid causes periods where there is too much or too little green electricity, stretching base load power plants and grid infrastructure to their limits. Currently, thermal power plants stabilize grids with their rotating masses and provide important services such as frequency control. With an increasing share of renewable energy, thermal power plants have to be switched off and their functionality has to be provided by other elements in the power system.

Energy storage systems solve this problem by storing surplus energy and making it available when needed. The stored energy can also be used directly in the form of heat and cold, or as fuel for transportation. Energy storage not only ensures a sustainable, reliable, and economic power supply, but also integrates energy-consuming sectors with power producers.



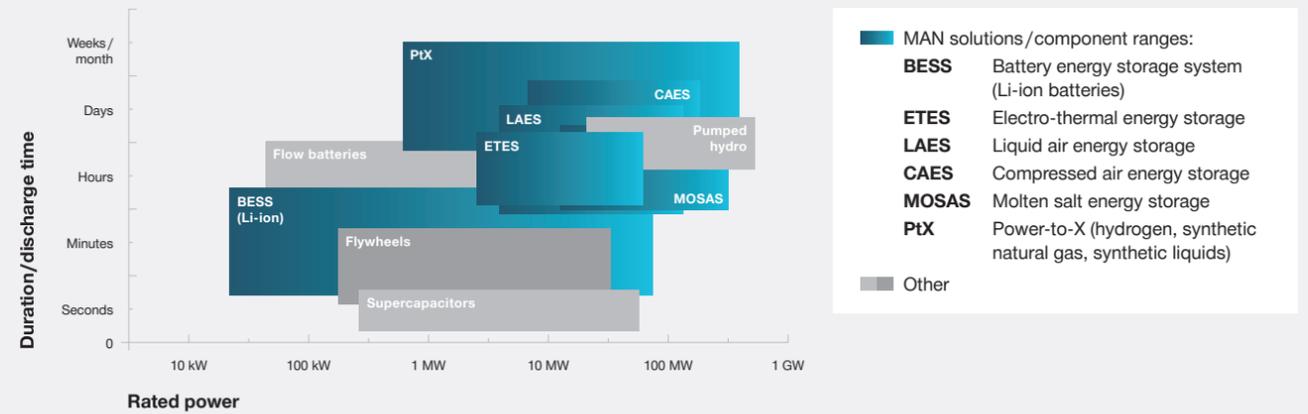
Flexible storage solutions

Thanks to their flexibility, energy storage systems can be used in many different applications. System operators, utilities, and IPPs as well as industrial and commercial customers can significantly improve the cost-effectiveness, security and sustainability of their energy supply.

MAN offers solutions for battery energy storage systems (MAN BESS), electro-thermal energy storage (MAN ETES) as well as power-to-X (MAN PtX). In addition, MAN provides key equipment for a variety of other storage technologies such as liquid air energy storage (LAES) or compressed air energy storage (CAES).

General competence

As a global company with EPC competence in power plants, MAN possesses extensive knowledge of complementary energy storage technologies. This means we can help our customers to find the optimal solutions for their specific challenges. One of our key skills is the integration of various systems and the capability to provide a complete solution from a single source including project development, project implementation, operations, and maintenance. We provide all the essential components for an integrated system, therefore guaranteeing the best possible performance of the system as a whole. Our competence is not limited to stationary systems only, but also extends to storage solutions in marine applications.



System solutions

Battery energy storage system

MAN BESS improves the reliability, availability and efficiency of a grid's power supply and makes it possible to integrate RES in a hybrid power plant. The system is ideal for applications which have fast response times and high power demands over a short or medium duration such as peak shaving, frequency control and load balancing.

Electro-thermal energy storage

MAN ETES is based on converting electrical energy into thermal energy by storing it in the form of hot water and ice. The thermal energy can be either converted back into electrical power or used for process cooling or district heating purposes, just to mention two of many other applications. This three-way multifunctional system is scalable, can be used regardless of site and has a very low environmental impact.

Liquid air energy storage / compressed air energy storage

MAN provides key turbomachinery equipment, which is the heart of LAES and CAES installations. Thanks to our broad portfolio and flexibility with regard to size, pressure and flow, MAN compressors and power turbines can be deployed in a wide range of storage systems.

Molten salt energy storage

Renewable energy is used to generate heat, which is stored in molten salt and later used to produce steam for power generation when needed. The MAN MOSAS solution achieves an excellent efficiency due to the high operating temperature and heat transfer properties of the molten salt.

Power-to-X

Our power-to-X solutions (MAN PtX) convert electricity into synthetic natural gas or liquids. Transforming large amounts of electricity into what are referred to as syngas opens up possibilities in the mobility, heat and electricity sectors. The syngas can be used directly, e.g. for green transport, or they can be stored for later re-electrification.

Key applications

- **Grid services**
Balancing fluctuations, managing frequency and reactive power.
- **RES smoothing and integration**
Compensating the weather-based fluctuations of RES.
- **Backup/UPS**
Maintaining system stability, especially during emergency conditions and unforeseen load fluctuations.
- **Synfuel production**
Conversion of green electricity into synthetic fuels.
- **Sector coupling**
Connecting the three end-use sectors of buildings (for heating and cooling), transportation, and industry with the power sector.
- **Heating and cooling**
Absorption, storage and generation of thermal energy, e.g. for cooling or heating.

MAN Energy Solutions

86224 Augsburg, Germany

P + 49 821 322-0

F + 49 821 322-3382

info@man-es.com

www.man-es.com

All data provided in this document is non-binding. This data serves informational purposes only and is not guaranteed in any way. Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.

Copyright © MAN Energy Solutions.
D2366610 Printed in Germany
GGKM-AUG-19021