SIEMENS

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SIESTORAGE

The modular energy storage system for a sustainable energy supply

Answers for infrastructure and cities.

The challenge: reliable energy supply

Power generation from renewable energy sources is a key factor in ensuring economic power and prosperity. Next to hydropower, wind and solar energy play a decisive part in this.

The use of renewables on a large scale, however, leads to new challenges for grid stability: Short-circuit power is a measure for grid stability and generators that use wind and solar energy cannot usually provide this. The infeed of energy from distributed sources can cause a reversed load flow. In unsuitable distribution grids, this can lead to damage and outages.

Power generation from renewable sources varies naturally – sometimes even to a great extent. This quite often causes imbalances between generation and load, which impair the stability of a grid. Distribution grid operators face the challenge of providing enough balancing power to ensure a uniformly high-quality power supply.

Energy-efficient processes are of the highest importance for industrial businesses as well as for building and infrastructure companies in order to keep energy costs at the lowest possible level. Those businesses fix a price for maximum load with the utilities. Exceeding the maximum load only once can cause high costs.

In addition to that, even the shortest interruption of energy supply can lead to a complete failure of production plants. The consequence can be an enormous loss of quality and time, and noticeable financial damage.

The answer: Meet every challenge for modern energy supply head-on with SIESTORAGE

Energy storage systems are the right solution in all these cases. Siemens Energy Storage (SIESTORAGE) is a modular system that combines cutting-edge power electronics for grid applications with high-performance lithium-ion batteries. It can reach a performance of up to 8 megawatts at a capacity of 2 megawatt-hours. Thanks to its modularity SIESTORAGE can be used for all applications.

Conventional energy storage systems cannot readily ensure the stable grid operation on the lower distribution grid levels needed today. There is a high demand for energy storage solutions that can provide balancing

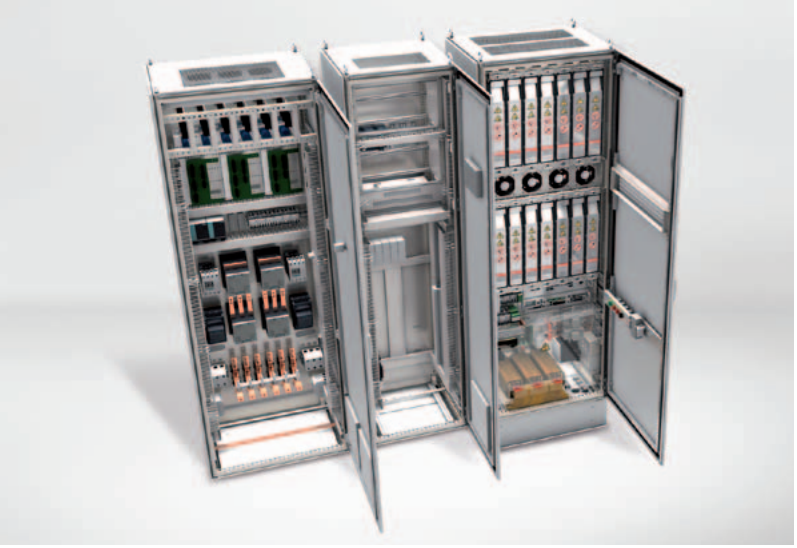
power until the power plants for primary balancing have been started. Such a solution has to be distributed, available with next to no delay, and to be able to deliver sufficient power.

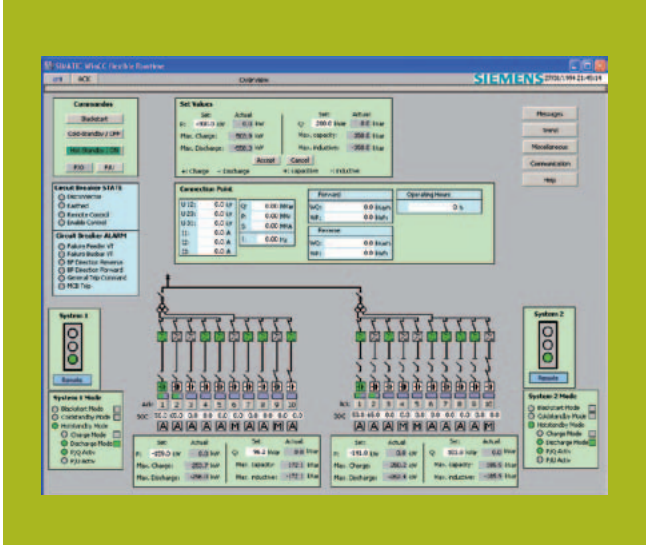
SIESTORAGE compensates for variations in generation within milliseconds and secures stable grid operation. The energy storage solution makes it possible to integrate an increasing amount of solar and wind power plants into distribution grids without extending them immediately. In addition to that, SIESTORAGE ensures a self-sufficient, reliable energy supply in microgrids with renewable generation. Plus, the solution from Siemens secures an uninterrupted power supply for industrial plants and in building technology and helps to avoid expensive peak loads.

The advantages at a glance

The SIESTORAGE energy storage system from Siemens is ideally suited to various applications. Compared to other energy storage solutions, it has a number of additional advantages, such as:

- high degree of availability and reliability thanks to modular design
- suitable for all requirements due to highest flexibility
- easy handling of battery modules (safe low voltage) ensures the highest degree of safety for system and persons
- completely integrated turnkey solution throughout the entire life cycle
- parallel connection of energy storage cabinets on AC-side ensures the highest flexibility
- proven experience in power electronics for grid applications
- black start capability for microgrid application
- emissions-free solution and improvement of CO_2 footprint





A modular energy storage solution based on proven components.

Always the right storage solution

Modular design

SIESTORAGE is a modular energy storage solution. Batteries and control electronics are inserted in cabinets as plug-in units. This facilitates maintenance and the exchange of individual units. One energy storage cabinet contains up to 16 battery modules, each with a maximum voltage of 60 V DC. The individual battery modules can be pulled out, inserted, and moved safely. The required power and capacity are achieved through a parallel connection of several cabinets on their AC-side. Both parameters can be adapted to fit the particular requirements of a project.

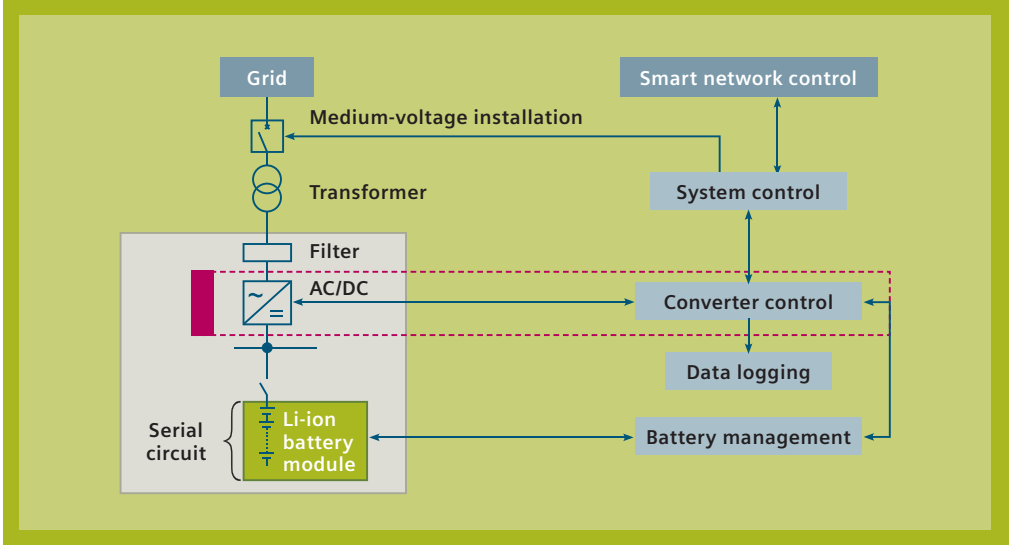
The intelligent battery management system (BMS) monitors state of charge, voltage, and temperature of the individual battery modules, among others.

SIESTORAGE's core is the SIPLINK converter product platform. The batteries are charged and discharged at the AC grid using SIPLINK active front ends. The SIPLINK power electronics were developed especially for sophisticated grid applications such as MVDC grid couplings, and are the basis of the various SIESTORAGE applications.

The control components for the entire storage unit are accommodated in a separate cabinet. The system is controlled with SIMATIC S7, either on-site or over the Internet. Information on the system's operating state, for instance on batteries, auxiliary systems, medium-voltage switchgear, and error messages, are displayed on the human machine interface (HMI). Up to 12 energy storage cabinets are connected to one control cabinet and one grid connection cabinet. This results in additional redundancy in the control system of larger units.

Integrated containerized solution

The integration of the cabinets into a containerized enclosure ensures a particularly easy application. It is easy to transport the containers and they can be positioned flexibly. An air-conditioning system makes the smooth operation possible even at extreme ambient temperatures. Comprehensive safety functions ensure the safety of the system and operators.



A modular concept

	Usable capacity[1]	Rated power	Peak performance	Rated voltage	
	16 kWh up to 24 kWh[2]	32 kW up to 96 kW[2]	48 kW up to 144 kW[2]	230 V AC or 400 V AC	Smallest unit available.
	48 kWh up to 72 kWh[2]	96 kW up to 288 kW[2]	144 kW up to 432 kW[2]	230 V AC or 400 V AC	A combined control and grid connection cabinet is used for up to four energy storage cabinets.
	80 kWh up to 120 kWh[2]	160 kW up to 480 kW[2]	240 kW up to 720 kW[2]	230 V AC or 400 V AC	One control and one grid connection cabinet are used from five up to 12 energy storage cabinets. Larger systems are scaled from groups of 12 (12 energy storage cabinets and one control cabinet as well as one grid connection cabinet). The storage units can be connected to the medium-voltage grid with a medium-voltage transformer and switchgear.
	Up to 500 kWh in standard container	1 MVA up to 2 MVA[2]	1.5 MVA up to 3 MVA[2]	230 V AC up to 52 kV AC (with LV/MV transformer)	Example: 24 energy storage cabinets and two control as well as two grid connection cabinets can be installed in a standard container. The storage unit can be connected to the medium-voltage grid with a medium-voltage transformer and switchgear.
	Multiples of 500 kWh[3]	Multiples of up to 2 MVA[3]	Multiples of up to 3 MVA[3]	230 V AC up to 52 kV AC (with LV/MV transformer)	Example: Systems larger than two MVA/500 kWh can be scaled with several standard containers. The storage unit can be connected to the medium-voltage grid with a medium-voltage transformer and switchgear.

[1] The usable capacity is ensured until the end of the life cycle.

[2] Depending on battery type [3] Depending on number of containers

SIESTORAGE offers solutions for distribution grids with a high share of distributed renewable energy sources.

Integration of fluctuating renewable energy sources

The performance of generators based on renewables depends on natural factors such as solar radiation and the strength of the wind. It is only predictable to a certain degree and cannot be regulated. The difference between generation and load can be quite high in some cases. Most medium- and low-voltage grids are not suitable for the infeed of high amounts of distributed power from renewable sources. This can lead to overvoltage, the overload of assets, and nearly uncontrollable energy flow. In the worst case this can lead to the switching off of grid sections and to outages. SIESTORAGE can compensate for the adverse effects of fluctuating generation at the crucial points of the grid.

Regulation of reactive and active power for grid support and voltage stabilization

During low load periods, energy can be taken from the grid and stored. It can be fed into the grid during peak loads. In addition to that SIESTORAGE can provide reactive power compensation on the basis of its converters. This means that the energy storage system can provide on-demand active and reactive power at any desired ratio and compensate for voltage fluctuations. The result is an optimized grid operation. This means that grid operators can better meet the high demands that industrial and infrastructure businesses have on the quality of power supply.

Balanced load leads to grid relief

Fluctuating infeed can cause noticeable strain on low- and medium-voltage grids, which leads to damage in the long run. SIESTORAGE can compensate for this strain. A generation peak occurs around noon in photovoltaic power plants. The energy that is generated during this peak can partly be stored with an energy storage system and be transferred to a later point. This means that the amount of energy that has to be transmitted remains constant and the load on the distribution grid even. The congestion of grids and the extension that is required for its relief can be reduced – inclusive of the associated approval procedures and costs. SIESTORAGE can also be used for performance buffering at electric vehicle charging stations.

Spinning reserve for reliable grids

The power frequency's degree of variation from the nominal value is a measuring value for the dynamic difference between power generation and actual load. Spinning reserve helps compensate this difference. SIESTORAGE reliably provides balancing power. This ensures a constant energy supply and saves costs for power generation and the provision of additional balancing energies. The increasing share of renewable energy in the grid leads to an increasing demand for quickly available spinning reserve for primary control. In addition to that, power generators can trade the stored renewable energy at electricity exchanges in a more targeted manner.

SIESTORAGE ensures a continuous supply of green power in microgrids.

Self-sufficient energy supply for microgrids

Self-sufficient microgrids supply a limited area that is not, or only to a certain degree, connected to the public power grid. SIESTORAGE ensures a continuous, eco-friendly supply of power in such cases. The energy storage system improves the short-circuit power and with it the selectivity as well as the stability of the grid and the dependability of assets. SIESTORAGE's black-start capability ensures the complete independence from additional sources of power. Unlike diesel generators the system does not emit CO_2 and other harmful substances.

Improved voltage quality

Flexible control mechanisms and fast reaction times ensure grid stability in microgrids that are supplied primarily by renewable generators. SIESTORAGE can improve the grid stability because the system compensates short power failures, voltage imbalances, and undesirable harmonic waves. Single clouds can cause short voltage slumps at photovoltaic power plants that can be compensated by the energy storage system.

Black-start capability and continuous power supply

Power grids require a power source in order to start up after an outage. Power plants fulfill this task in conventional grids. Microgrids that are supplied by renewable generators do not have this option in case an outage occurs. The black-start capability of SIESTORAGE enables microgrids to start up faster. The stored energy suffices to start a gas turbine and bridge the grid's power requirements. This means that "green" microgrids do not require starting aid any more.

Reliable reserve for industry, buildings, and infrastructure facilities

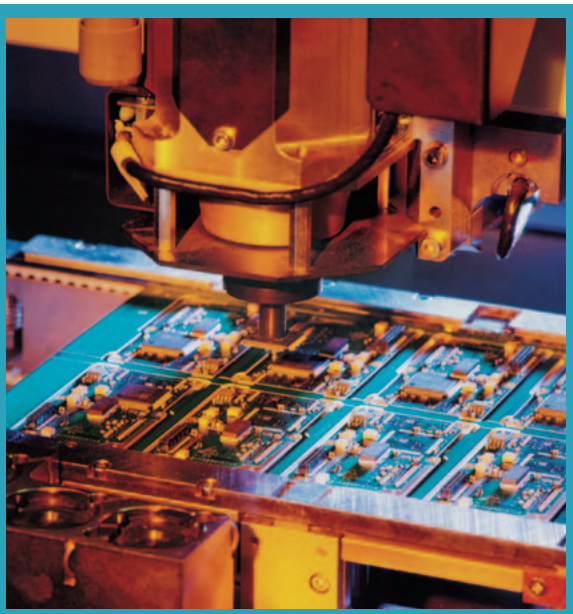
The use of energy storage systems has many advantages for industry and infrastructure as well. They ensure high reliability and quality of energy supply in order to avoid costly peak loads and to ensure uninterrupted power supply.

Peak load management

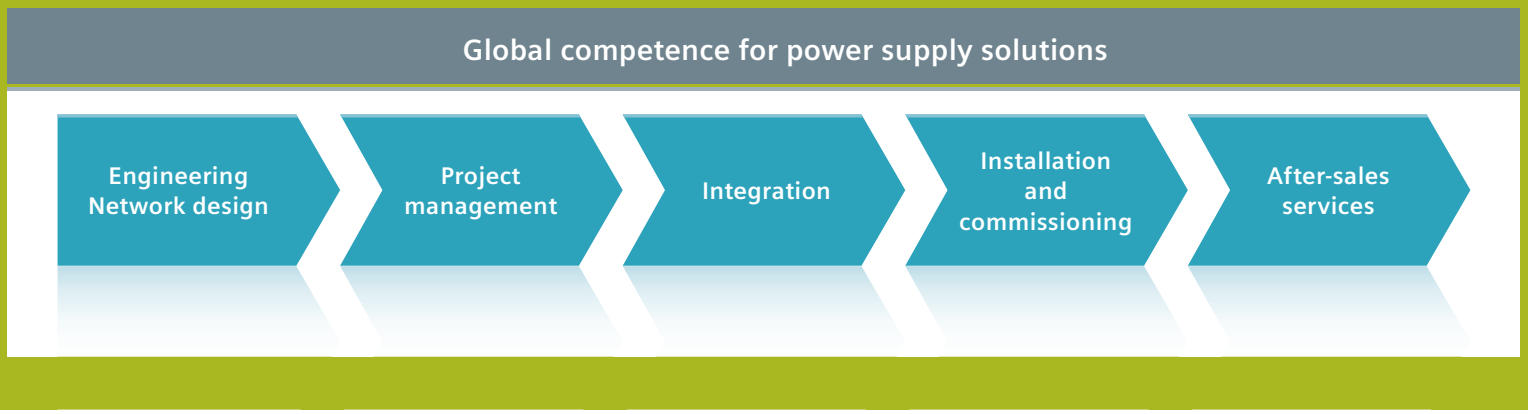
Utilities and their customers, for instance from industry, fix a price for maximum load. Industrial businesses pay a high extra fee if they exceed the maximum load only once. Industrial businesses generally use their own generators in order to avoid the costs for increased use of energy. These generators often emit a substantial amount of CO_2. SIESTORAGE supports eco-friendly operation, unlike generator-based solutions. The energy storage systems are a low-maintenance alternative to conventional solutions, too. Thanks to the SIPLINK converter the energy is readily available and peak loads can be compensated with energy that has been stored previously.

High-speed reaction for critical power

A supply of energy that never fails for even a split second is of vital importance for the process industry. Even a very short outage can cause the complete failure of an industrial plant. Computers in data centers lose all data, production lines have to be started up again in a time-consuming step-by-step process, and chemical processes freeze irreversibly. SIESTORAGE ensures an uninterrupted power supply even in extreme situations, for instance for a hospital's intensive care unit. In case of outages in the public supply, the system ensures the continuous supply of individual consumers or even of parts of the grid in the short term.



SIESTORAGE ensures high reliability and quality of the energy supply for data centers and industrial processes. Costly peak loads are avoided and continuous supply is ensured.



Support throughout the entire life cycle.

The solution provider for complete integration

Turnkey solutions all over the world

Siemens' know-how in energy supply is based on decades of experience and constant innovation. The company's production facilities and centers of competence can be found around the globe. It is a provider of integrated solutions – from engineering and network planning to project management and all the way to installation, commissioning, and additional services. Siemens supports the local creation of value and ensures that a competent contact person is in close reach of every project. The Siemens experts bring their experience in project management, financial services, and life cycle management to every project. This enables them to consider all aspects of safety, logistics, and environment protection.

Eco-friendly and sustainable

Siemens' comprehensive approach contributes to the maximizing of returns and the optimization of energy consumption. Damages to the environment are minimized and the long-term profitability of operations is ensured. The cooperation with certified regional partners makes sure that a consistent recycling concept for battery modules is available.

First pilot project in Italy

Enel connected the first pilot system with a performance of 1 MVA and a capacity of 500 kWh to the medium-voltage grid. The company is Italy's largest energy distributor. The energy storage system was successfully commissioned in February 2012 and is used to explore new smart grid solutions. The utility employs SIESTORAGE for the efficient integration of photovoltaic power plants and for an e-vehicle charging station. The stored electrical energy is used for load regulation and voltage stabilization in both cases. The system's black-start capability makes possible the start-up of the grid when the main supply is not available.

First pilot project: The utility uses the energy storage system for the efficient integration of photovoltaic power plants and for an e-vehicle charging station.

Engineering Network design	Project management	Integration	Installation and commissioning	After-sales services
■ Consulting ■ Planning ■ Expertise ■ Integration design	■ Standard PM process (based on CMMI, PMI, PMBOOK) ■ Certified project staff ■ Regular MPM* assessments ■ Quality expediting	■ Full integration of all distribution equipment ■ Worldwide sourcing ■ Global Siemens product range ■ IEC and ANSI	■ HSSE** and quality management ■ Construction and site management. ■ Commissioning, planning, and execution	■ Training ■ Warranty ■ Organization of after-sales services

*MPM: Maturity in Process Management
**HSSE: Health, Safety, Security, Environment

Safe in every respect

Assessments that were carried out by an independent testing institute prove that the modular SIESTORAGE energy storage systems offer the highest degree of safety in every respect. The safe operation is confirmed on the basis of a risk assessment. The energy storage systems improve the availability of systems and the safety of all equipment and machines that are connected to the grid. The safety of persons who work with SIESTORAGE is ensured because the maximum voltage is less than 60 V DC during handling of individual battery modules. Dangerous direct current voltages remain safely inaccessible inside the battery cabinet. The cabinets do not have to be synchronized on the battery side thanks to their parallel connection on the AC side. SIESTORAGE's modular design ensures an extremely high availability of the systems and a very low maintenance effort.

Standards

Siemens is committed to meeting the highest standards and environmental requirements (according to SN 36650 (1997-6) Part 1).

SIESTORAGE has been developed in accordance with the relevant standards.

SIESTORAGE: Applied standards

DIN VDE 0100	Erection of power installations with rated voltages below 1,000 V
DIN VDE 0101 VDE 0101: 2000-01	Erection of power installations with rated voltages above 1 kV
IEC 60439-1: 1999 + A1: 2004	Low-voltage switchgear and control gear assemblies – Part 1: Type-tested and partially type-tested assemblies – Guide for testing under conditions of arcing due to an internal fault (DIN EN 60439-1:1999 + A1: 2004)
IEC 146-1-1: 1991	Semiconductor converters – General requirements and line commutated converters; Part 1-1: Specification of basic requirements (DIN EN 60146-1-1:1993)
EN 50272-2: 2001	Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries
EN 50160: 2010	Voltage characteristics of electricity supplied by public electricity networks
IEC61000-2-2: Electromagnetic compatibility (EMC): 2003	Environment compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems
IEC 721-3-3	Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – German version EN 60721-3-3: 1995

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Power Distribution Division
Order No. E50001-G710-A440-X-4A00
Printed in Germany
fb 4585 WÜ WS 04122.0

Printed on elementary chlorine-free bleached paper.