SIEMENS

Ingenuity for life

SIESTORAGE

The modular electrical energy storage system for a reliable power supply

siemens.com/siestorage

The power to make power happen

SIESTORAGE for future-proof energy supply

Content

Intelligent grid solutions

From generation to consumption

Electricity today and tomorrow

Electrical power is the foundation of modern life. It is the main resource for industry and infrastructure, the enabler of growth and progress, and is paving the way for a more friendly environment for the future. Redevelopment of the energy system is gaining momentum due to the renunciation of fossil fuels, market liberalization, and growing environmental awareness. At the same time, there is a shift from centralized, large-scale power generation to a highly-complex, distributed generation landscape in which cost-efficient integration of renewables is paramount, and demand for energy is continuing to rise.

Making grids fit for the future

This development is resulting in new and highly demanding challenges. For example, grids must now be flexible enough to handle both bidirectional power flows and intermittency. New capacity has to be developed, existing equipment has to be upgraded, and grid operation must be optimized in order to meet future demands. The solution will determine just how efficient, reliable and safe power systems will be in complex modern environments with the support of the new options created by growing digitalization.

A powerful partnership

Siemens helps to make future energy systems secure and stable – from the power producer to the customer. The electrical energy storage system SIESTORAGE is a key element of Siemens solutions towards the three main challenges of power supply: optimizing grid connections, providing flexible energy for modern grids, and supporting large energy consumers. With Siemens, you benefit from a comprehensive portfolio and a fully integrated solution.

Benefits at a glance

Conformity with standards

Certified system, in compliance with international standards

Advanced technology

Cutting-edge power electronics, advanced control – and Li-ion batteries

Modularity

Flexible design for various power and capacity needs

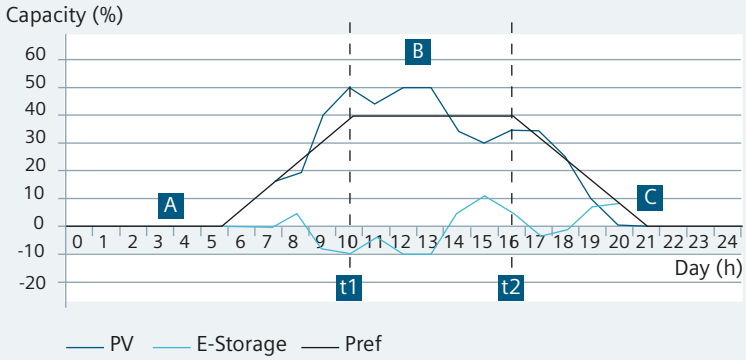
One-stop solution

Analysis, planning, design, manufacturing, system integration, installation, commissioning, financing and service

Optimizing grid connections

Security of supply – everywhere

SIESTORAGE ensures compliance with grid codes



A Ramping-up phase
B Stationary phase
C Ramping-down phase

t1 End of ramping-up phase
t2 Beginning of ramping-down phase

With SIESTORAGE, grid operators can ensure their grid infrastructure is fit for the future.

Securing electrical supply

More and more weather-dependent renewable energy sources with hard to predict output capacity are used for generation. Balancing grids in order to optimize power flow from generator to consumer is the main challenge modern grid operators have to face. Growing peak demands further add to this challenge. Given the increased amount of distributed generation now being connected to the network, grid operators are looking for new answers to the challenge of delivering a stable electrical power supply down to the lowest levels.

Available power with next to no delay

Grid operators require more ancillary services such as frequency regulation to ensure stability. With its fast response times and high efficiency, SIESTORAGE outperforms the gas-fired power plants traditionally used for ancillary services. Through its ability to both absorb and deliver energy, it is the optimum solution for regulation applications, as it can react to upward as well as to downward frequency and voltage drifts very quickly by providing active and reactive power within milliseconds.

Grid relief

SIESTORAGE also helps to optimize asset performance by supporting applications such as congestion management, which is often temporary or seasonal. By strategically placing storage facilities at key nodes within the grid, seasonal congestion can be managed and costly infrastructure upgrades can be avoided or deferred. Thus, SIESTORAGE is the cost efficient answer to the rising demands and indeed offers a modern, eco-friendly alternative to managing distributed generation along the entire value chain.

Reference

EDP, Portugal – key facts

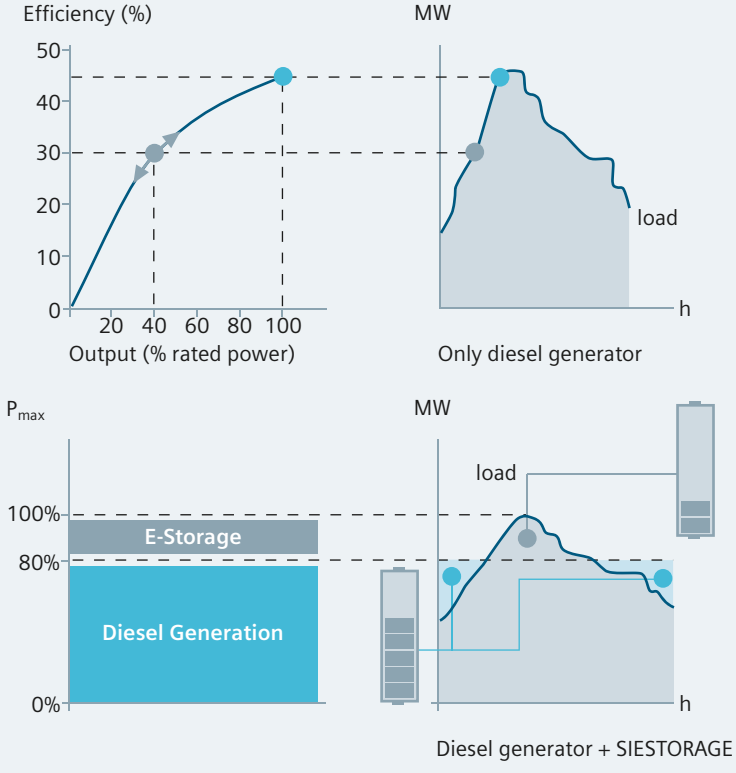
- 472 kW / 360 kWh SIESTORAGE system
- 8 battery cabinets, 4 three-phase converters, 1 transformer, and 1 gas-insulated switchgear
- Main applications: backup power, voltage regulation, peak shaving
- Fully containerized turnkey solution

EDP Distribuição awarded Storage InovGrid tender in Évora in Portugal to SIESTORAGE. The system is used for energy backup, voltage regulation and peak shaving. It plays a leading role in EDP's grid stability and reflects the benefits of intelligent grids related to grid operators.

Providing flexible energy

Sustainable power for microgrids and off-grids

SIESTORAGE optimizes the efficiency of diesel generators



SIESTORAGE provides the agility to meet all of the future demands of the energy market and stay ahead of the challenge.

Grid independence

Microgrids are independent, small-scale power grids that can be either geographically delimited or defined within the boundaries of an industrial or infrastructure facility, with or without a connection to a larger supply grid. Their main features are self-sustainability and independent operation from upstream networks.

Optimizing generator performance

On the generation side, remote locations like islands often combine conventional generators with renewables. These generators are often oversized for balancing out the unsteady input from the renewable sources. Thus, they operate inefficiently, generating more costs and emissions than necessary. In high demand situations, SIESTORAGE enables diesel generators to be run at optimum efficiency, storing electricity during renewables oversupply periods and feeding it back to the grid when needed. In low-demand situations, SIESTORAGE takes over the supply duties minimizing diesel consumption.

A sustainable grid

The use of renewable sources plays a key role in eco-friendly microgrids. Balancing tools are required to reduce the volatility caused by load variations and to prevent unpredictable power fluctuations. SIESTORAGE ensures network stability and optimizes the use of renewable energy sources by balancing consumption and generation throughout the grid. In addition to that, SIESTORAGE can provide emergency functions such as black start in the event of a fault or a total grid collapse. SIESTORAGE secures power supply, ensures network stability, and optimizes the use of renewable resources, thus enabling a sustainable grid.

Reference

ENEL, Italy – key facts

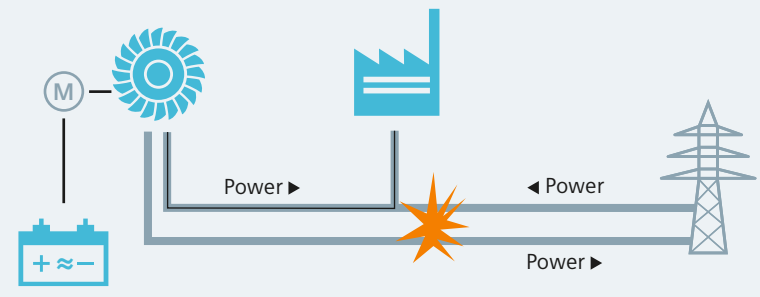
- 500 kW / 600 kWh SIESTORAGE battery energy storage system, accompanied by a Microgrid Controller
- Approx. 15 % diesel fuel savings
- Approx. 55 % savings in diesel generator operating hours
- Reduction of CO_2 emissions and maintenance costs
- Improved grid stability

Off-grid electrification of the Mediterranean island Ventotene by ENEL in Italy: SIESTORAGE enables a more efficient and regular management of the island grid absorbing or releasing power according to the actual demand. It optimizes the operating mode of the four diesel generators of 480 kW each which provide the power supply as the island is not connected to the national grid. It further ensures the black-start functionality in case of a power outage and provides primary and secondary frequency regulation. The system can manage the increase of connected users and renewable energy sources in a flexible manner.

Supporting large energy consumers

Reliable energy supply for the industry

SIESTORAGE provides black-start power for emergency generators



SIESTORAGE ensures that the power supply for business operations work in the most reliable, safe, and efficient way.

Keeping consumption under control

Energy costs have a key economic significance for large consumers that need solutions to mitigate times of higher demand and to avoid high network charges. SIESTORAGE takes the energy from the grid during low load periods and stores it for peak load periods. SIESTORAGE therefore helps to prevent expensive peak loads and to minimize energy costs.

Stability issues

In order to ensure a reliable and continuous power supply in production processes, industrial consumers often utilize extensive backup facilities, the amount needed being directly proportional to the quality of supply from the utility, and often geographically different. SIESTORAGE can be used to balance supply anomalies and therefore help to prevent disruption of sensitive process devices that may result in production downtime.

Security of supply

With its black-start capability, SIESTORAGE helps to secure energy even in the event of outages. It provides the energy for the emergency generators when the main supply is not available. The energy stored by SIESTORAGE is sufficient to start a gas turbine several times, substituting conventional diesel generators more efficiently, while providing opportunity for additional revenues from ancillary services.

Reference

VEO, Germany – key facts

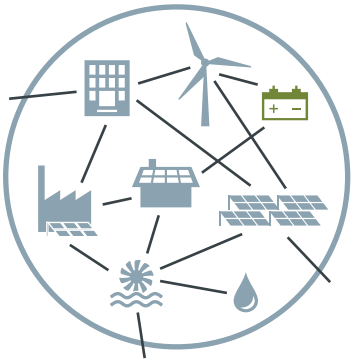
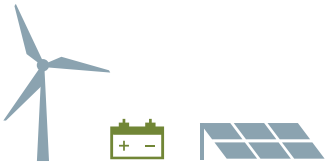
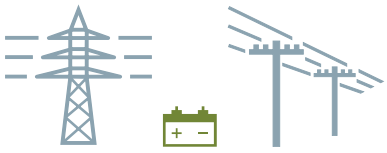
- 2.8 MVA / 1.2 MW SIESTORAGE system capacity: 1080 kWh
- Supply security for the steel and rolling mill if the local grid is interrupted
- Independency of the power plant by switching over to off-grid
- Black start of a gas turbine

SIESTORAGE helps Vulkan Energiewirtschaft Oderbrücke GmbH (VEO) secure its power supply at the industrial location in Eisenhüttenstadt. A blast furnace gas-fired power plant operates the largest integrated steel and rolling mill in Eastern Germany at the industrial location. In the case of failure of the local 110 kV distribution network, VEO switches over to its own supply system to provide the location with energy. This industrial microgrid keeps the critical production processes at the steel mill operating, and thus prevents follow-up damage which could cost millions. The SIESTORAGE energy storage system is able to black start the gas turbine at any time from the de-energized state, and without feeding in power from the public grid.

Unmatched versatility

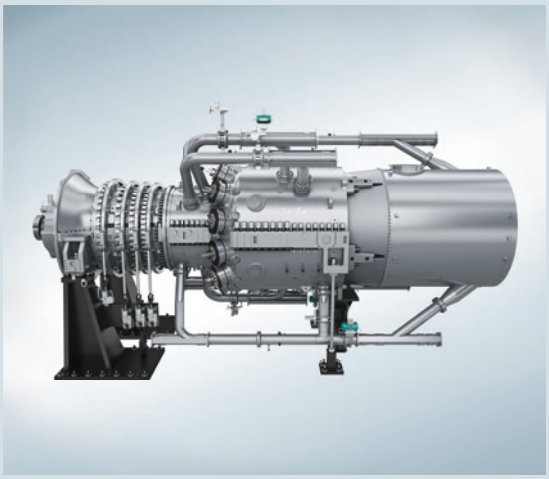
Typical applications and use cases

SIESTORAGE provides energy storage for a large range of applications. From generation to consumption, it helps to optimize asset performance by stabilizing frequency and voltage, and balancing variations in supply and in demand.

Applications		Use cases
	**Electricity supply for off-grids/microgrids**	Black start
		Ramping control
		Time shifting
		Capacity firming
		Diesel offset
		Frequency regulation (primary control reserve)
		Peak load management
	**Electricity supply for industry**	Black start
		Critical power
		Diesel offset
		Peak load management
	**Integration of renewable energy**	Ramping control
		Time shifting
		Capacity firming
	**T&D upgrade deferral**	Peak load management
		Ramping control
		Frequency regulation

Use cases	Description
Black start	Black start is the process of restoring the operation of an electric power plant or part of a power grid without relying on an external grid. SIESTORAGE is responsible for grid forming through voltage and frequency regulation of the connected grid. It can also run in combination with other generators, such as diesel generators, with the power division being controlled by static droop curves. Generally, power plants or off-grids use small diesel generators to start larger generators, or to provide power references such as voltage and frequency to allow renewable energy generators to reconnect. Due to its speed of response as well as advanced control, SIESTORAGE can be used as an alternative to a black-start diesel generator, saving time and increasing reliability while providing an opportunity to generate additional revenues. Furthermore, SIESTORAGE is able to provide the necessary short-circuit power to ensure a given protection sequence.
Ramping control	In order to protect grid stability, many grid codes specify a ramp rate or rate of change (in %) over time for generators connected to the grid. Compliance with ramp rates ensures that the grid operator is able to manage variations in load and generation, and maintain a proper frequency. Due to its reliance on changing weather patterns, renewable energy output is susceptible to rapid rates of change. SIESTORAGE can be used to counteract the variability of renewable energy output by using set points to respond. This can be achieved either by injecting energy into the grid, or by harnessing energy from the plant to ensure compliance with set ramp rates. Therefore, SIESTORAGE feeds the grid with the required controlling energy to maintain frequency and voltage stability.
Time shifting / arbitrage	Often, there is a mismatch between the availability of renewable energy and demand. Wind output is normally at its highest during the night, and solar output at midday, for example. Peak demand, however, is generally in the mornings or evenings. High demand for electrical power is often reflected by higher purchase prices. In order to maximize the use of renewable energy generators and speed up return on investment, renewable energy developers and operators can time-shift the plant output to offer it to the market when it is most profitable. By storing overcapacity when supply exceeds demand, and by injecting energy when demand exceeds supply, SIESTORAGE provides a means for boosting plant efficiency.

Use cases	Description
Capacity firming	To ensure grid stability, system operators use forecasts to schedule or match generation and load. This activity is normally carried out in 15-minute time blocks throughout the day, one day in advance. Time intervals can, however, also be more closely aligned with real time. In order to encourage scheduling accuracy, regulators impose rules for accuracy of forecast vs. schedule vs. dispatch. Power producers are encouraged to reduce deviations between what they are contracted or scheduled to deliver and what they actually deliver. Even with modern forecasting tools, the natural variability of renewable energy means that accurate scheduling is far more difficult compared with conventional generation. SIESTORAGE can be used to balance out the variability of renewable energy output by either injecting energy into the grid, or by harnessing energy from the plant according to the schedules.
Diesel offset	High costs are associated with the purchase, transport and storage of fuel. The insurance needed to run diesel generators adds to the financial pressure placed on operators of unreliable grids and off-grids. Furthermore, the pollution associated with running diesel generators inefficiently when ramping to match demand is a growing concern, especially in congested cities and areas of natural beauty. SIESTORAGE complements various generation resources by balancing power supply and demand. This enables diesel engines to be run more efficiently and less often, therefore reducing overall reliance on diesel fuel.
Frequency regulation	Grid frequency is an indicator of grid stability and, under ideal conditions, will be either 50 or 60 Hz, depending on the country. Differences between power generation and power demand cause the grid frequency to fluctuate, and can result in damage to equipment, unwanted tripping, or even a blackout. Grid operators use reserves to maintain grid stability in the event of an anomaly that has not been previously corrected as a result of grid inertia. Primary reserves are the fastest services and are first in line to stabilize frequency deviations or to 'stop the drift'. Thanks to the fast response times of SIESTORAGE technology, it can provide both upward and downward regulation, and can be used as an alternative to the conventional slower responding generators, therefore reducing costs and increasing supply reliability.
Peak load management	Managing variable loads is associated with high costs caused by purchasing peak-load-priced power, high contract demand charges, infrastructure upgrades for assets used part-time, or even technical losses associated with underused assets. At the same time, the customers' expectations for cheap energy puts great pressure on plant and grid operators to optimize the performance of their assets and ultimately reduce operating costs. Using SIESTORAGE to utilize lower cost electricity and support load during peak times helps to reduce both power purchase (OpEx), and infrastructure (CapEx) costs.
Critical power	Voltage dips as a result of transient faults in the grid can cause sensitive process equipment such as variable speed drives and robots to disconnect or malfunction, often resulting in high production losses. Whilst these devices generally have a certain ride-through capability, the nature of transient faults is unpredictable both in magnitude and duration, and a certain percentage of faults will be outside the ride-through capabilities of the devices. So, for example, while most dips can be addressed through reactive power compensation such as SVCs and StatComs, these devices tend not to respond until 20 ms so for dips shorter than drives and other plant critical equipment may trip and stop production. The usual approach to address this problem is to install a dynamic rotary UPS or DUPS to provide support until other (often diesel-based) back-up devices can respond. SIESTORAGE combined with a fast switching unit offers an economic and clean alternative to the above, enabling fast disconnection from the grid and extremely fast support to avoid tripping of sensitive devices.



For gas-fired power generation, SIESTORAGE enables black start of gas turbines to increase the power plant performance and operational flexibility

SIESTORAGE solutions enable stable grid performance by balancing the variable infeed from renewable energy sources

At the point of consumption, SIESTORAGE enables a seamless power supply and independence from power fluctuations in the grid

Equipped to meet every demand

System description

Battery energy storage system

SIESTORAGE is a modular energy storage system based on Li-ion battery technology. It provides a flexible solution for increased efficiency, greater asset utilization, and improved power quality in power generation, transmission and distribution.

With the help of SIESTORAGE technology, active power can be exchanged between an energy storage medium and an electricity grid. In addition, it can be used to provide reactive power to stabilize grid voltage.

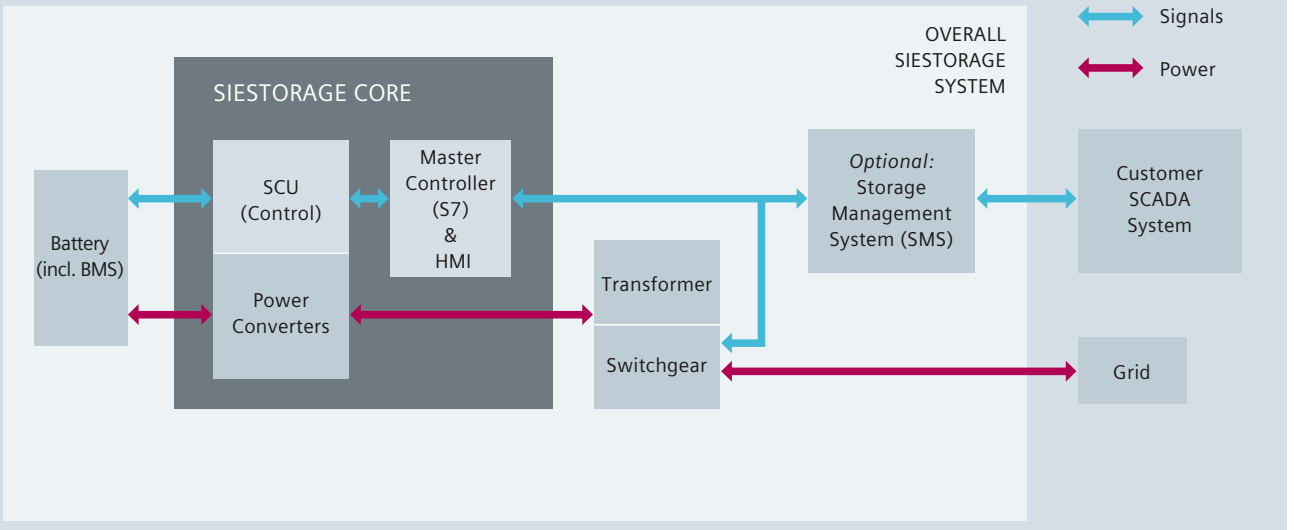
Control and governance

The SIESTORAGE converter system operates with one central controller, consisting of a real-time system for the fast control of voltage, current, frequency and power. The renowned, safe and reliable SIMATIC S7 provides governance control.

The SIMATIC HMI visualizes the current status warnings and alarms, and is able to show data trend analysis for several values. All relevant information can be stored for later analysis. Optional Siemens service is available via remote access.

The SIESTORAGE Control Unit (SCU) is a real-time data acquisition and control system. It measures records and analyzes numerous signals such as AC voltage and power at the Point of Interconnection (POI) to the grid, status of the battery units, temperatures, and positions of switching devices. The SCU runs the control algorithms received from the SIESTORAGE Master Controller, which is regulated by the customer's SCADA system or an operator.

Configuration model



Best-in-class performance and safety

High specification and compliance with international standards

System configuration

The core of the SIESTORAGE system comprises power converters, the SCU and the SIESTORAGE Master Controller as well as LV/MV transformers and devices for protection, control, and switching.

External components

SIESTORAGE batteries are supplied by specialized companies that are Siemens-qualified partners. Apart from that, the overall SIESTORAGE system just needs a physical connection to the customer's power network or grid and an electronic connection to the customer's supervisory control or SCADA system to operate.

Cutting-edge technology

SIESTORAGE is made possible by Siemens high performance power electronics, automation, and state-of-the-art Li-ion battery technology. Its fast and accurate response times allow it to consume and discharge energy with high precision, helping to provide an assured power quality. With its flexible and scalable design, it is able to provide unmatched reliability through a redundant system architecture.

Safe in every respect

Independent assessments prove that the modular SIESTORAGE energy storage systems offer the highest degree of safety in every respect. Safe operation is confirmed on the basis of a risk assessment. The energy storage systems improve the availability of grids and the safety of all equipment and machines connected.

Siemens is committed to meeting the highest environmental standards. All components of SIESTORAGE are CE certified.

Applicable regulations/standards and conformity	
Conformity (LV-D 2006/95/EG)	CE
System standard converter system	EN 61439
System standard batteries	EN 50178, EN 50272-2
EMC immunity system	EN 61000-6-2
EMC emission system	EN 61000-6-4
Degree of protection (EN 60529)	IP20
Protection class (EN 61140)	1

A modular system

Flexible and scalable

Efficiency through modularity

All SIESTORAGE components are mounted in standardized cabinets for easy setup. This enables quick and efficient configuration of scalable systems by simply combining the required number of module types. All modules and combinations have been fully tested to guarantee operational performance and reduce integration time on site.

A Grid connection cabinet

- Cable terminations
- Busbar

Grid connection

The SIESTORAGE Power Conversion System (PCS) and the switchgear are connected via AC busbars in the upper part of the cabinets.

Connection on the AC side can be made directly via busbars to an LV-distribution panel or to an LV/MV transformer. Alternatively, an AC cable connection can be used. For a secure cable connection, the optional SIESTORAGE grid connection cabinet is recommended.

Grid connection transformer

The SIESTORAGE system can be connected to any grid via transformers. The LV/MV Siemens GEAFOL cast-resin dry-type transformer is recommended.

MV switchgear

For gas-insulated switchgear, type 8DJH is recommended.
For air-insulated switchgear, type NXAIR is recommended.

B Converter cabinet

- 140 / 800 kVA / 400 V

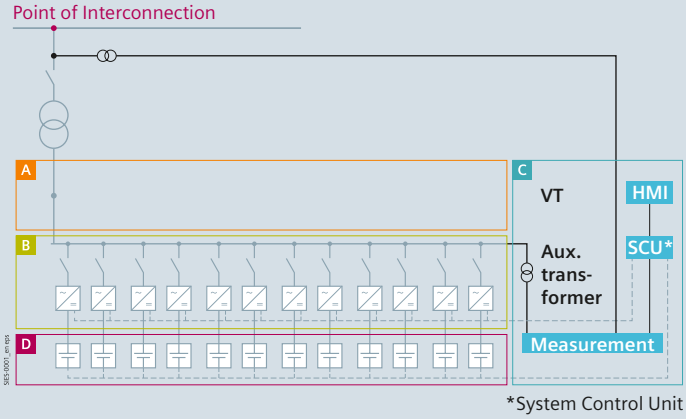
Power conversion

The SIESTORAGE Power Converter System (PCS) converts the DC voltage of the battery into grid-compliant AC power. If required, reactive power can be provided. To charge the battery from the grid, the converter operates as a controlled rectifier.

The SIESTORAGE PCS is built into standard SIVACON S8 cubicles and can be aligned with other SIVACON LV systems such as busbar trunking systems, LV switchboards, and LV distribution panels.

The SIESTORAGE PCS modularity consists of power stacks in panels, which are aligned by the AC busbar connection. The panels include all of the necessary converter components from DC connection, pre-charging device, converter stack, sinus-filter reactor and capacitor, AC contactor, fuses, and three-phase AC busbar. A 24 V DC power supply for control and ET200 control interface with a PROFIBUS connection to the main control unit are also included.

The fuses are mounted in a manual disconnector so that individual systems can be safely disconnected while the other systems remain in operation.



SIESTORAGE
fuctional diagram

C Control cabinet

- HMI (Human-Machine Interface)
- SCU (System Control Unit)
- Ethernet switch
- 24 V DC power distribution
- Auxiliary power transformer

Control

The SIESTORAGE Master Controller (S7) and the SCU are responsible for the entire operation of the SIESTORAGE Power Conversion System (PCS).

SIESTORAGE Master Controller

A Human Machine Interface (HMI) is used for setting operation and control modes, system status display and for local control and diagnostics. The Master Controller also serves as a data logging platform and a communications interface to external supervisory control or to a SCADA system.

SCU

The System Control Unit (SCU) provides closed loop controls and pulse modulation for the power semiconductors. It is responsible for fault monitoring of power electronics and batteries, and for the coordination of the control sequences for proper and safe operation.

D Battery cabinet

- Power applications
- Energy applications

Batteries

Siemens has strategic partnerships with leading battery manufacturers and can therefore ensure optimal technical performance specific to individual applications. Project-specific technical data sheets are provided on request.

A perfectly integrated solution

Comprehensive equipment and advanced technology

Quick setup times

With Siemens, you benefit from a comprehensive portfolio that optimizes the electrical design and equipment layout. The integration of the cabinets into containerized enclosures that are delivered as pretested and pre-commissioned systems helps to reduce expensive and time-critical integration on site. SIESTORAGE modularity provides design flexibility to meet a variety of requirements with regard to power and energy.

Single interface competence

You also benefit from a single interface for the overall electrical design, procurement and construction utilizing best-in-class equipment and technology related to MV and LV systems, auxiliary equipment, and building technologies for a safe operation. With SIESTORAGE, you benefit from a completely integrated solution.

Standardized container layout

Containers can be divided into rooms with different climatic zones. Container designs are standardized and comply with international norms.

Example of a 40 ft. container layout

SIESTORAGE components

1. Converter cabinet
2. Grid connection cabinet
3. Control cabinet

Battery cabinets incl. battery management system

1. Battery cabinet
2. Paralleling cabinet

LV + MV components

1. 8DJH gas-insulated medium-voltage switchgear
2. SIVACON S8 low-voltage switchboard
3. GEAFOL cast-resin rectifier transformer

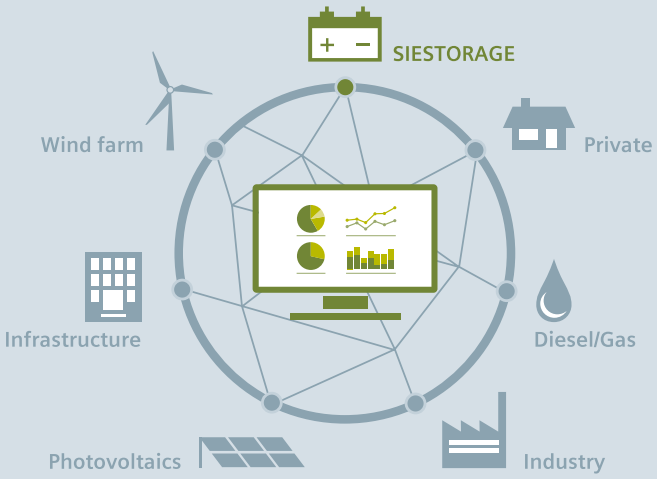
HVAC, fire fighting and safety equipment

1. HVAC
2. Fire detection and extinguishing system

SICAM Microgrid Manager

The SICAM Microgrid Manager from Siemens is a fully developed end-to-end solution to monitor and control microgrids – a smart, user-friendly and versatile tool for energy management needs. It constantly monitors and controls the grid, power generation, energy storage and consumption, and is capable of managing complex interfaces in the operation process.

With the combination of SICAM Microgrid Manager software and the SIESTORAGE primary technology, Siemens provides a seamlessly coordinated grid management solution.



SIESTORAGE advanced technology

Flexible configuration covering all BESS* applications

- Power Converter System (PCS) hardware and software developed specifically for BESS applications
- Grid-forming parallel operation with wind, solar and diesel possible
- Black start capability
- High system dynamics: POI voltage regulation within < 10 ms
- High short-circuit power (2...3x rated power)
- Choice of different external communication interfaces (IEC 61850, IEC 60870-5-104, DNP3 and others)

*Battery Energy Storage System

International compatibility

- Wide voltage range (LV/MV grids +/-15% voltage deviation from nominal)
- Wide frequency range (45...65 Hz)
- CE-certified
- IEC-compliant

High quality

- Best-in-class overall efficiency
- Longevity: design lifetime ≥ 20 years
- IT security (remote access) according to IEC 62443-3-3

High level of reliability

- Response in milliseconds
- High redundancy for outstanding availability

Taking all necessary steps

One-stop solution

Taking a closer look
Everything begins with an analysis of the grid or site to determine the most appropriate business case. A simulation of potential applications is carried out, including the most efficient use of SIESTORAGE. Siemens offers a complete consulting service that includes power flow calculations, reactive power analysis, contingency analysis, short-circuit current calculations, probabilistic reliability analysis, dynamic stability calculations, and protection coordination.

Reducing interfaces
From planning to engineering and from project management to the complete system integration, Siemens guides its customers through every step and all phases of the project. Reliable and competent local support is provided right from the planning phase to the after-sales service.

Providing value through service
Siemens examines a company's particular situation, identifies all opportunities and helps select the best solution.

This ultimately produces a specific concept that contains all required steps. This consulting approach also includes help in managing regulations and public-sector incentive programs. In the end, Siemens offers continuous support of the system through tailored services.

Financing
Siemens offers investment solutions to help address tomorrow's energy needs today. With a global network of energy finance professionals, the company provides capital and expertise that is backed by more than 160 years of Siemens' industry innovation, financial strength and diligent risk management.

Lifecycle optimization

Analysis of grid and user requirements

Development of business cases

Planning of the complete project

Engineering and project management

Construction and integration of components and systems

Installation and commissioning in E-houses, existing buildings, or containers

Service over the entire asset lifecycle

Fully integrated SIESTORAGE solutions installed
in a container or existing electrical building

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