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6-kW Smart Grid



Smart Grid

A Smart Grid (Smart Power Grid) is an energy distribution network that uses digital technologies to improve the management, efficiency and resilience of the energy supply. It integrates communication, monitoring and control devices to make the grid more responsive, flexible and optimized. Smart Grids make it possible to better manage energy generation, distribution and consumption in real time.

Role in energy management:

The main role of a Smart Grid is to enable more efficient and smart energy management, meeting user needs while optimizing the use of available resources. Thanks to sensors and real-time communication, energy consumption can be monitored and controlled more precisely. The information collected allows better management of fluctuations in demand and variations in generation, particularly during periods of high consumption or grid failures.

Supply optimization:



Smart Grids are designed to optimize energy supply by balancing energy generation and consumption. Through real-time management, the system can adapt to demand by automatically adjusting energy flows between different points of the network. This minimizes energy losses, prevents outages and ensures a stable and reliable electricity supply. In the event of an overload or fault on a line, the grid can reorganize itself to reroute energy more efficiently.

Renewable energy integration:



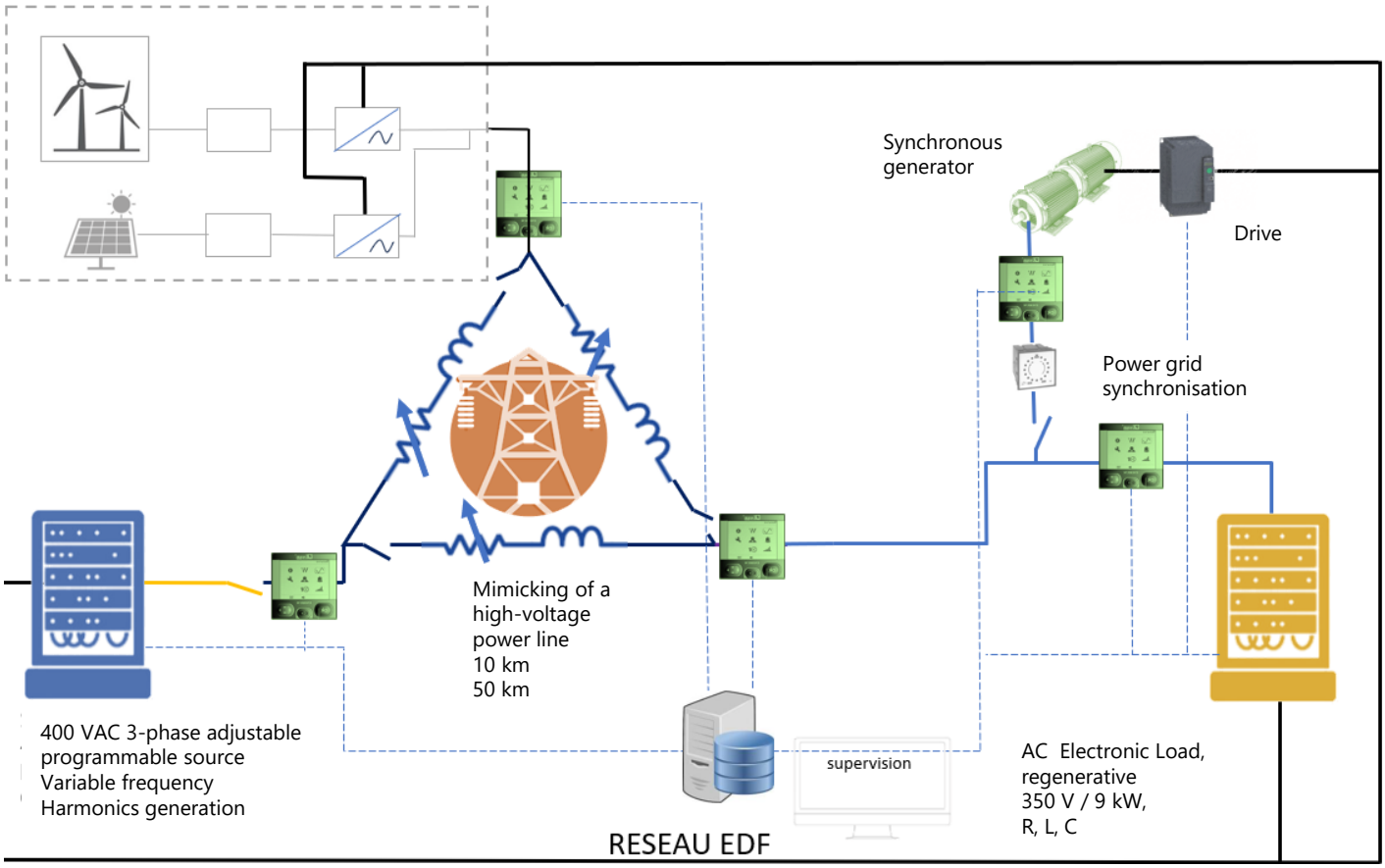
One of the major advances offered by Smart Grids is their ability to integrate renewable energy sources (solar, wind, etc.), which are often variable and intermittent. In a conventional grid, managing these renewable sources can be challenging because their generation may fluctuate depending on weather conditions. Thanks to their flexible architecture, Smart Grids can manage these fluctuations by optimally integrating energy generated from these sources. For example, when solar generation is high, surplus energy can be stored in batteries or energy storage systems, or fed back into the grid for use at another time. This ability to integrate renewable energy sources makes Smart Grids an important driver of the energy transition, promoting a more sustainable and environmentally friendly energy supply.

Smart Grid objectives:

Improve energy efficiency: Optimize energy generation, distribution and consumption to reduce losses and better meet demand.

1. **Strengthen grid resilience**: Through advanced monitoring and control systems, Smart Grids can quickly detect and address grid failures, thereby reducing the risk of widespread power outages.
2. **Facilitate the integration of renewable energy sources**: Enable more flexible and dynamic management of renewable energy sources, even when they are intermittent.
3. **Promote more responsible energy consumption**: Provide consumers with real-time information about their energy consumption, encouraging them to adopt more energy-efficient behaviors.
4. **Reduce the carbon footprint**: Through better resource management, Smart Grids help reduce greenhouse gas emissions by facilitating the use of renewable energy sources.

6-kVA Smart Grid : Schematic Diagram:

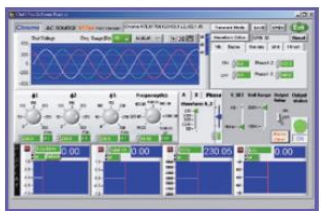


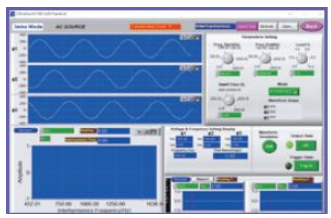
SER 810 000: Programmable Source / Regeneration Cabinet (consumer)

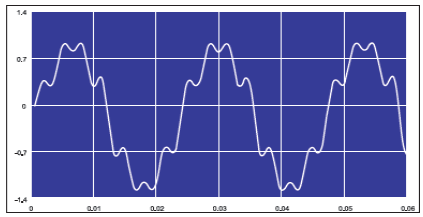


Programmable Source enabling the emulation of a typical voltage generator (nuclear power plant, thermal power plant, etc.). It provides full control over the energy generated, with the ability to create phase imbalances, harmonics, variable frequencies, etc.

The user can configure the source according to their specific requirements.







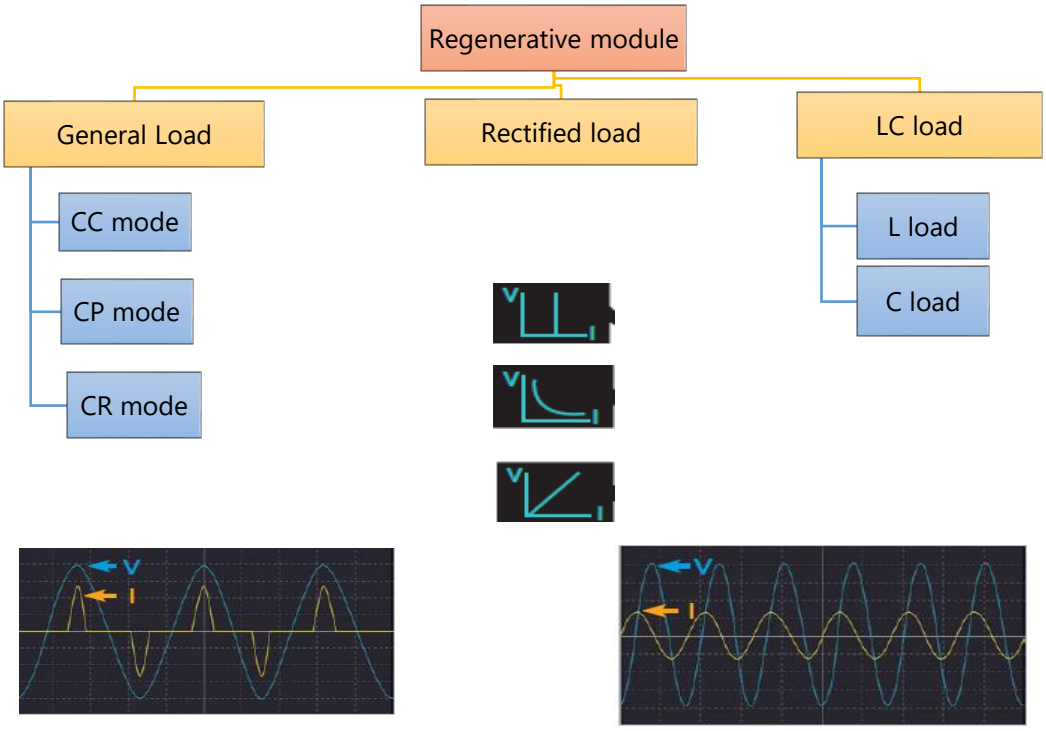
Parameter	Value
Max. Power	6 kVA
AC voltage per phase (resolution)	0 - 300 V (0.1 V)
RMS current (peak)	8 A (48 A)
Frequency	15 – 1,2 kHz
Phase angle per phase	0 – 360°
DC voltage per phase	0 – 300 V

Measurement	Range
Voltage per phase	0 - 300 V
Current per phase	0 - 20 A
RMS current (peak)	8 A
Power	0 – 6 kVA

. Configurable load generator

Load generator objective: This cabinet generates programmable loads to emulate real industrial and/or residential scenarios, with the particular feature of feeding energy back into the grid.

Load configuration: The adjustable parameters are voltage, frequency and load type (resistive, inductive, capacitive), making it possible to reproduce different types of energy consumption.



SER 820 000: Transmission Cabinet



Configurable three-phase transmission line

Role: In a Smart Grid, the three-phase transmission line is a fundamental component for efficiently distributing energy while ensuring greater stability, reduced losses and **more dynamic management** of supply and demand. It also enables better integration of renewable energy and **increased grid resilience** in the face of unexpected events, ensuring more reliable and optimized energy management.

Configurable: Using a set of selectors, our solution emulates transmission lines of different lengths, making it possible to characterize various issues encountered (voltage drop, inductive effects, unbalance, etc.).

Each line section is configured while de-energized.

SER 800 000: Measurement System



The electrical measurement system is a device or system designed to measure various electrical parameters in a power grid or electrical installation. It enables the monitoring, analysis, and control of various electrical quantities such as voltage, current, power, frequency, energy consumption, etc. These measurements are essential to ensure the proper operation and safety of electrical installations.

Here are some examples of equipment found in an electrical measurement system:
1. Energy meters: Measure the energy consumed by an installation or device. They can be used to monitor consumption and for electricity billing.
2. Power quality analyzers: Measure detailed parameters such as harmonics, power quality, voltage peaks, etc., to ensure that the electrical network is stable and compliant with applicable standards.



Powers:
Active
Reactive
Apparent
Distortion



Harmonics
Up to 32nd order



Electrical quantities
Voltages
Phase-to-neutral
Line-to-line
Current
Power factor



Phase diagram

SER 840 000: 300 W Grid Synchronization Bench



MOTOR CHARACTERISTICS	Value	Units
Supply voltage	230	Vac
Speed at rated current	1500	rpm
Mechanical power	300	W
Rated current	0,9	A
Maximum efficiency	77	%

Auxiliary Power Generation Source

Role: Provides a backup power supply in the event of a failure or malfunction of the main power grid.

Purpose of the synchronizer: The purpose is to ensure that the asynchronous machine operates at a speed sufficiently close to the grid frequency before being connected in parallel with the grid. This prevents short-circuit conditions or electrical transients when the connection is made. The synchronizer therefore adjusts the machine's rotor speed so that it is synchronized with the grid frequency.

Applications
Grid synchronizers are used in various applications, such as:

•**Power plants:** For feeding energy generated by induction motors or generators into the grid.

•**Backup power systems:** When an asynchronous generator needs to be synchronized with the main grid.

•**Industrial facilities:** To synchronize generators with the local power grid.

SER 800 000: Supervision



Real-Time Data Collection:
The monitoring server collects data from sensors, programmable logic controllers (PLCs), energy meters, and other connected equipment. This data includes parameters such as:

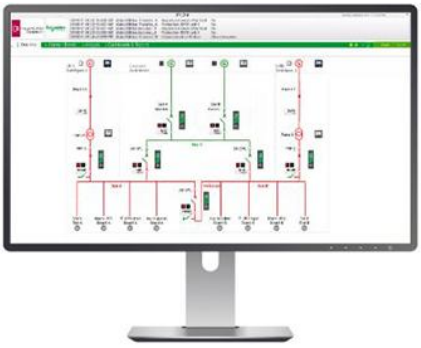
- Energy consumption.
- Equipment status.
- Alarms or faults.

Monitoring and Visualization:
A user-friendly interface enables:

- **Real-time visualization** of the installations through dashboards or dynamic diagrams.
- **Rapid identification of anomalies** through visual or audible alarms.

- The server detects malfunctions or abnormal conditions (overloads, failures, etc.).
- It sends notifications to operators (SMS, emails, etc.) to enable a rapid response.
- Diagnostic functions help identify the root cause of problems and reduce downtime.











Educational objectives



SKILLS – Introductory level

- Define the Smart Grid,
- Introduce renewable energy sources
  Solar,
  Wind,
  CCGT (Combined Cycle Gas Turbine)
- Introduce the basic concepts:
  Smart meter,
  Synchronous machine,
  Energy cost depending on the source,
  Smart grids,
  Battery storage,
  …

SKILLS – Technician level

- Confirm the skills already acquired (beginner level),
- Be able to identify the different elements of an electrical grid,
- Understand and master the characteristics of an electrical power transmission and distribution network (voltage drop, losses, etc.),
- Be able to relate physical quantities to mathematical models.

SKILLS – Engineer level

- Confirm technician-level skills,
- Master the Energy Management System,
- Understand and theoretically explain the various phenomena related to the characteristics of electrical grids,
- Be able to optimize generation, transmission and distribution systems,
- Master the different aspects of electrical grids,
- Know the different characteristics of renewable energy sources.

ETR 800 B: SMART GRID Laboratory consisting of		
Référence	Description	Qty
SER 810 000	Programmable Source and Regeneration Cabinet	1
SER 820 000	Transmission Cabinet	1
SER 840 000	300 W Grid Synchronization Bench	1
SER 800 000	Supervision Cabinet	1



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