Requirements for load management and availability

Integrating renewable energy sources into industrial onsite networks

Whether operating with a stand-alone grid or with an onsite grid connected to an outside energy supply, industrial plants with their own power generation have specific requirements for load management and availability. Power management systems (PMS) already offer proven solutions with very high control speeds for generation with classic fossil fuels. However, as the share of renewable energy sources increases, these conventional industrial solutions are increasingly reaching their limits. One way out of this dilemma is to adopt ideas and approaches from the microgrid sector – and rely on an innovative combination of previously separate worlds.

Port facility with wind turbine

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Energy-intensive industrial companies and plants, such as refineries or cement works, usually produce their own electricity and use it for internal operations as a stand-alone grid.

Such grids are typically characterized by a large output ranging between 50 MW and several hundred MW primarily distributed as medium voltage. This electricity is usually generated centrally with conventional fossil fuels in, for example, gas turbines.

Power management systems offer proven solutions for the safe operation and ensured availability of classic industrial grids. Their primary task – in fact, the only one in around 80% of the solutions used – is to provide rapid partial load shedding.

In case the total electrical output doesn't cover a plant's current power needs, the PMS switches off individual consumers or parts of the system within milliseconds, following specified priorities. Or, if the plant's power supply is not fully stand-alone, the PMS automatically increases feed-ins from the local power grid to cover peak loads in the plant. With their fast and automatic responses, power management systems ensure the safe and uninterrupted operation of a plant grid.

With one important restriction: Conventional power management systems are only suitable for grids predominantly powered by classic fossil fuels like natural gas. And in view of the evolving energy transition, these systems are no longer fully future-proof.

Renewable energy sources lead to new requirements

The share of renewable energy sources is growing worldwide, and not only in the industrial sector. In 2020, power generation in Germany with renewables for the first time exceeded generation with fossil fuels (coal, gas and oil). In the power sector, the share of renewable energies increased from 42.0 percent (2019) to 45.4 percent (2020) of the country's gross electricity consumption. In total, around 251.0 billion kWh of electricity was generated from renewable energy sources in 2020. This was around 9 billion kWh more than in the previous year, marking an increase of 4 percent. [https://www.umweltbundesamt.

de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#strom – Status: March 4, 2021/accessed on January 3, 2022]

This trend is also reflected in the growing demand being made on companies when it comes to sustainability, energy efficiency and climate protection. And this naturally also has consequences for companies and plants producing their own electricity. In Germany, for example, the Renewable Energy Resources Act (EEG) has provided a legal framework for developing and expanding renewable energy production over the past 20 years, with the aim of reaching the country's targeted climate protection goals.

Given this situation, growing numbers of companies are deciding to use renewable energy sources, in particular photovoltaic (PV) systems, to provide or supplement their power supplies. On a small scale, they face the same complex challenges as large grid operators: In order to guarantee the quality of their power supply at all times, these power systems must reliably control rapidly fluctuating energy flows coming from decentralized sources. After all, even the shadow of a passing cloud affects the output of a PV system, and renewable energy sources with their perturbations can influence the quality of a grid.

Innovative approaches used in microgrids offer state-of-the-art alternatives

The integration of renewable energies into a power grid leads to fast load changes and high flexibility. Conventional industrial power management systems, however, face major challenges when having to handle anything above a 10 percent share of green electricity. The solution here is to integrate several types of power generation (renewables) together with storage capacity, such as batteries. This integration offers new opportunities for balancing peak loads, but also presents challenges when it comes to regulating generation fluctuations.

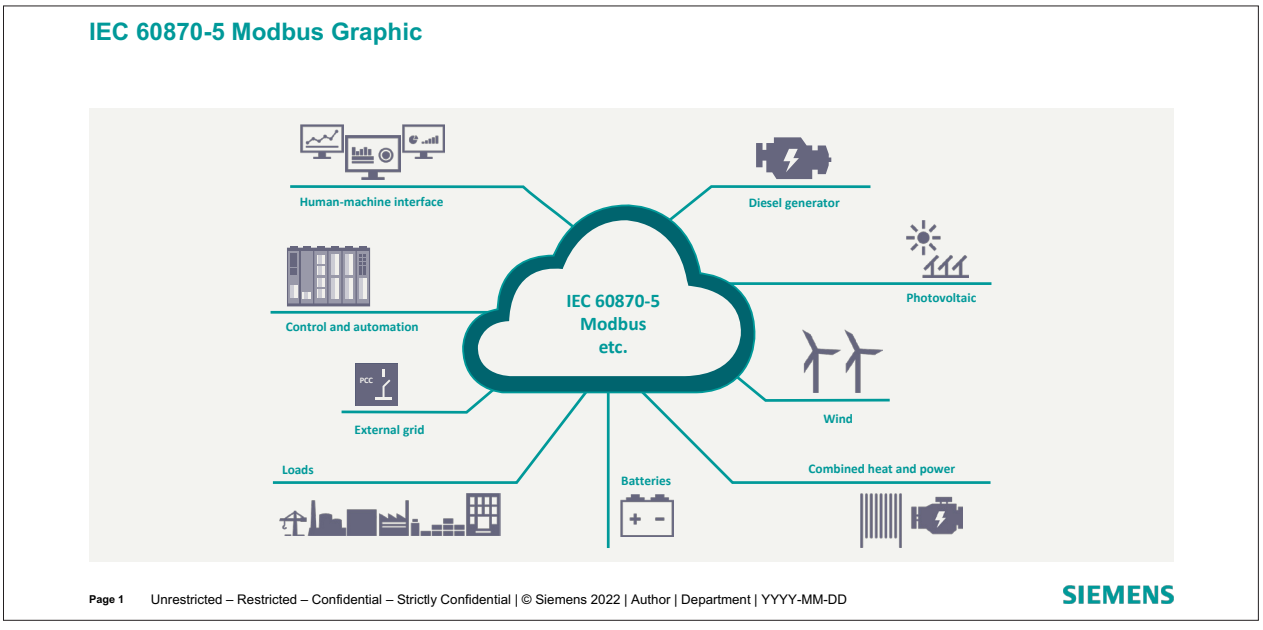
Solving these challenges requires a significantly higher degree of intelligence and automation than was previously provided by power management systems. Suitable solutions already exist yet have scarcely been adopted in industrial environments. Modern infrastructures, such as hospitals, airports and even shopping centers, rely on small sub-networks, or microgrids. Unlike typical industrial grids, these microgrids generally operate in the 15-MW range. Power generation is decentralized and primarily uses renewable energy sources. The grid topologies are correspondingly simple.

Overview of the portfolio of Sicam and Siportec products

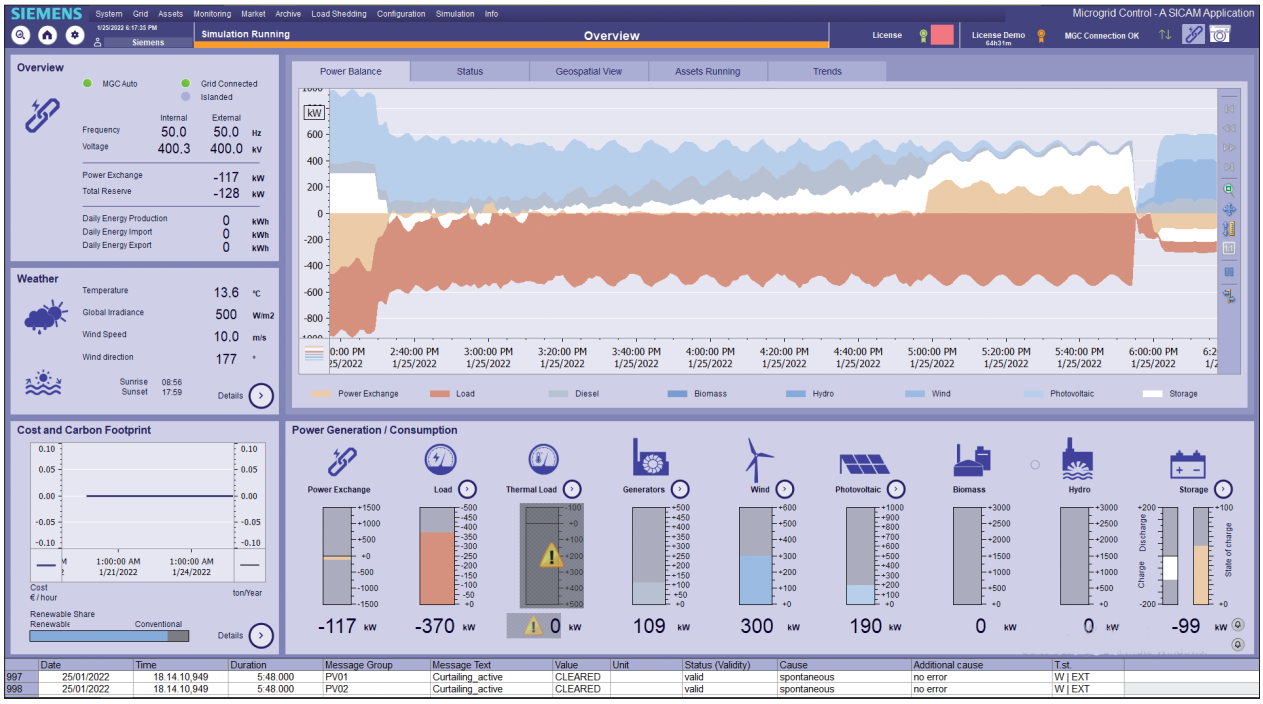
These microgrids are managed by highly automated microgrid controllers (MGC). Relying on algorithms, MGCs can react within seconds to any change in a system's energy production.

Solutions from Siemens

As a highly competent partner in the changing energy landscape and drawing on decades of experience in the industry and infrastructure sectors, Siemens has developed a solution for integrating renewable energy sources into onsite grids.



Layout of the integration of renewable energy sources into onsite grids



Exemplary visualization of a Power Management System

This solution is both new as well as self-evident: expanding classic power management systems with functionalities taken from microgrids in order to ensure a well-regulated grid at all times.

In an industrial stand-alone grid, such solutions precisely regulate the output of the gas turbines based on the current output of a PV system. When the sun is shining and PV output is correspondingly high, either individual generators are turned down or electricity not currently needed is temporarily stored in batteries. If there is a risk of an excess supply from the PV system, such as during the summer, the PV storage can also be reduced since conventional generators typically can no longer operate stably below roughly 30 percent nominal power. And since planning and forecasting also play an important role here, appropriate algorithms (such as for weather forecasts and predefined processes) can also be integrated into the power management system, as they are in a microgrid.

The actual linking of the two system worlds of power management and microgrid can, for example, be done with the SICAM A8000 CP-8050 processor module. The hardware basis for this is the SICAM A8000 series, a modular series of devices for telecontrol and automation applications in all areas of energy supplies. Joint monitoring and control is provided by SICAM SCC visualization software, also from Siemens' SICAM portfolio.

Perspectives for the grid edge

Finally, attention in energy systems is increasingly focusing on the "grid edge" – the point where consumers, prosumers and the smart grid interact. The way we generate, consume, store and share energy is changing. The primary drivers behind this change are the growing demand for energy efficiency and decentralization, and the global push for decarbonization and greater sustainability. In the end, all of these drivers and goals are driven by digitalization. The digital transformation is enabling new business models and offering opportunities for all players along the entire energy value chain.

The new approaches presented here for integrating renewable energy sources into industrial grids also open new possibilities at the grid edge for coordinating and optimizing the generation, storage and consumption of electricity. And they open new possibilities for all the involved players. The result: complete solutions across hardware and software that can be seamlessly integrated into real operations.

Literature

[1] https://www.umweltbundesamt.de/en/topics/climate-energy/renewable-energies/renewable-energies-in-figures

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www.siemens.de/smart-infrastructure