Microgrids: decentralized solutions for stable grids

A microgrid can consist of energy loads, generators and storage facilities that are interconnected by intelligent technology

The rising proportion of electricity generated from renewable energy sources presents major challenges for existing power grids. Power generated from renewables is subject to fluctuations and its availability does not always align with demand. This poses potential load problems for the existing grid. Against this backdrop, the energy supply structure is increasingly evolving from a centralized, unidirectional system to a decentralized and bidirectional one. Decentralized grid topologies such as microgrids have a significant part to play in this evolution.

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Microgrids are small, local power grids. Renewable energy sources such as solar modules, wind turbines and small hydroelectric plants can be integrated into them, as can traditional drive technologies such as diesel engines or gas powered generators. In standalone mode, microgrids ensure the power supply independently of the main power grid. In grid connected mode, they share and support resources synchronously with the existing system.

Structure and components

The structure of microgrids can take a wide range of forms and is dictated by the application and location. They typically consist of multiple components such as electricity generators, a distribution grid, loads and in some cases also energy storage systems.

Microgrids feature dedicated management of the generators and loads and therefore require only one external interface, which greatly simplifies grid tasks. Closely interlinked automation components are therefore added at the technical level to optimize the power flow and reduce malfunctions to a minimum.

Benefits of microgrids

One of the key advantages of microgrids is the resulting proximity of generators to loads. Local generation and use of energy keep transmission losses to a minimum, significantly improving the system's efficiency and contributing to a sustainable power supply.

In addition, small-scale and local energy management allows power generation units to be connected or replaced much more safely and easily compared to the previous large-scale. Furthermore, backup systems can be smaller and critical infrastructure is easier to protect with an appropriate security concept. Large-scale blackouts are not to be expected due to the decoupling of small grid sectors.

Challenges and solutions

Integrating the decentralized system into the existing power grid calls for careful planning and assurance of interoperability. To ensure the integration is stable, microgrids must satisfy the requirements of the local grid operator. Compliance standards and certification of used components are critical to safety and reliability.

To ensure grid stability, power plant controllers balance dynamic behaviour in the grid. Without them, volatility in peak injected power and impaired stability could impact negatively on the quality of the power supply. Effective communication between the various components and centralized data management is crucial for optimal control and monitoring of the microgrid.

Ecofriendly commitment to a secure power supply

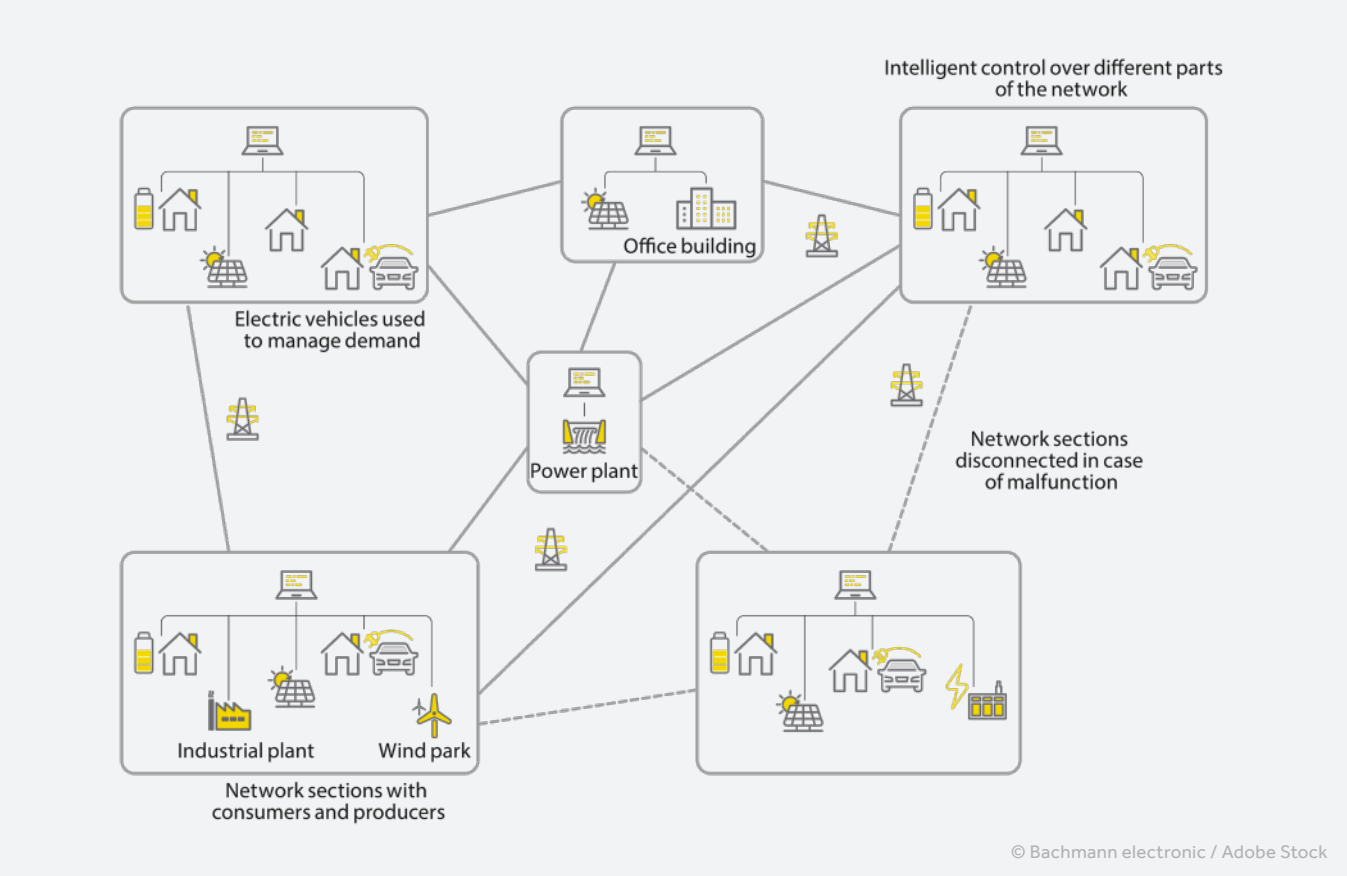
The example of Speedline Aluminium Gießerei GmbH shows how companies can exploit renewable energies for their purposes and create a microgrid. The company, a subsidiary of Alu-met GmbH located in Schlins, Austria, is considered one of the most modern and efficient aluminium remelting plants in Europe.

Sustainable use of resources is embedded in its corporate philosophy. A remelting foundry located in Vorarlberg, Austria, Speedline Aluminium focuses on products that can be recycled. It was therefore self-evident from its energy intensive operations that it needed to produce some of its power itself.

An area over half the size of a soccer field for solar energy

Together with E-Werke Frastanz, the local electricity utility, photovoltaic specialist doma vkw Energietechnik and automation supplier Bachmann electronic, Speedline Aluminium erected a photovoltaic system on its factory roof.

With a collector area of nearly 4,200 square metres, the solar energy plant is over half the size of a soccer field. It consists of approximately 2,100 modules that provide an overall capacity of 885 kWp for the foundry's production process. Mathematically, the yield of these modules is approximately 1 GWh per



In the event of an outage, microgrids decouple themselves from the public grid and use electricity from local sources such as solar systems, combined heat and power plants or battery storage systems. This requires smart management of different parts of the grid

year. And this investment pays off. 'On a good day we generate 5,000 kWh of power for our operations,' says Rudolf Mangeng, Head of Projects and Technology at Speedline Aluminium, who is clearly satisfied with the result.

All the power produced by the solar energy plant is used directly onsite. However, the company could certainly use a lot more solar power, since the processes of the aluminium remelting foundry require considerable quantities of energy.

Fourteen inverters convert the generated electrical energy into alternating current

'With our solar power, we can meet a good 10% of our total requirements for electrical energy,' says Mangeng. However, the company is already planning to increase this figure by expanding the solar energy plant by an additional 150 kWp of capacity on the roof of a second production building. As a supporting measure, the foundry's machine park will be successively converted to E-drive systems.

SPPC supports grid stability and security of supply

Fourteen inverters are connected to the facility's huge rooftop solar plant. The use of a power plant controller is essential for a system on this scale, to satisfy the requirements imposed by the regional grid operator Vorarlberger Energienetze upon power plant control and to operate the plant properly. Integration of the Bachmann Smart Power Plant Controller (SPPC) guarantees a high degree of grid stability and security of supply, despite fluctuations in the plant's generation capacity.

'We were able to set up the entire solar energy plant on the roof and connect it in just six weeks. I consider that to be a great achievement,' says Mangeng. 'Subsequent completion of the tasks, including meter changeover by doma vkw and consultations for implementing plant control, took the same amount of time again.'

Optimal integration into existing infrastructures

The local players involved in setting up a microgrid of their own vary from region to region and project to project. The essential procedure, however, is much the same in any country. One important task in a project of this kind is adapting the selected plant controller to the regulations of the local grid operator.

The project's automation expert may at times have to modify his modules for this purpose. The grid operator follows this by tests and certifications. To ensure that the process runs quickly and smoothly, close cooperation between the client, the local electricity utility and the automation specialists is crucial.

Container-based energy storage systems

The power that is generated is consumed immediately by Speedline Aluminium. No battery storage on the site is therefore required. Since production is continuous and the generated electricity is consumed immediately, a surplus that could be stored does not arise. This shows that the decision for or against an energy storage system depends heavily on the conditions specific to the operation in question. When, though, is a storage system worthwhile?

Container-based battery storage systems are particularly advantageous when power generation is intermittent or consumption uneven. They are ideal for situations where load peaks arise or the energy generated is not consumed immediately. Such storage solutions enable the company to use surplus electricity production for its benefit rather than having to feed it into the public grid.

Expandability and visualization

The scalability of microgrids is crucial. Since they can be modified in size and adapted to local requirements, companies also have the option of expanding them in the future and producing more electricity of their own.

Two further important points for companies to consider when creating a microgrid are its efficiency and ease of operation and visualization of the process data. For the latter, intelligent solutions provide a local visualization of operation and configuration that can be accessed in any browser through a web server installed on the controller. This arrangement should enable topologies, signal flows and diagrams to be displayed and target values set.

Protection against hackers

The growing complexity of power grids is also making them more susceptible to cyber-related risks. So microgrid security is critical. Multi-level security concepts, which include secure communication, configurable access control, robust operating systems and backup and recovery mechanisms, protect the system against attacks and outages. These measures ensure the continuity of the energy supply and thus also reliable operation.

About the author

Frank Fladerer is a journalist with long-standing experience in daily newspapers and technical magazines. He works in corporate communications at Bachmann electronic GmbH.

The solar energy plant for Speedline Aluminium Gießerei is over half a soccer field in size. An expansion is already being planned

Visualization is a function of the power plant controller. It can be called from anywhere with an internet browser. Display options include topologies, signal flows and diagrams and the visualization can be used to set values

What does the future hold?

Besides energy self-sufficiency, the economic viability of microgrids is a key factor in a company's decision in the first instance whether to invest in generating its own electricity. A long-term view is important for a considered decision. In this case, the investment often pays off: the rising costs of energy supplies, possible subsidies for renewable energies and the growing availability of technologies at low cost are making microgrids increasingly attractive.

A long-term view shows that microgrids are key to the energy transition. They offer flexibility, stability and sustainability, which are essential for making the supply of energy fit for the future. Using intelligent automation solutions and integration of energy storage systems, microgrids are able not only to overcome the challenges of the present but also to open up new opportunities for creating a more sustainable and resilient energy system.

Conclusion

Microgrids constitute a paradigm shift in the supply of energy. Besides overcoming the challenges of integrating renewable energies into existing grids, they also enable an autonomous, reliable and sustainable supply of energy to be created. With the continuous, ongoing development of power grids and the rising importance of decentralized systems, microgrids are vital for an effective and sustainable energy system fit for the future.

The future of energy supply is decentralized, smart and secure. The key to this future lies with microgrids.

About the companies

Bachmann electronic GmbH

Bachmann offers an innovative, future-oriented and open automation portfolio for manufacturers and developers of energy applications. The intelligent, scalable technology is based on over 50 years of integrated engineering experience. To attain demanding global climate targets, Bachmann offers renewable energy customers the highest standards of quality, long service lifetimes, absolute reliability and guaranteed safety.

In the wind energy sector, Bachmann is the world market leader for automation systems and its products are used in over 150,000 wind turbines.

https://www.bachmann.info

Alu-met GmbH

Alu-met GmbH, located in Nüziders, Austria, is a producer and supplier of high quality aluminium extrusion billets. The company has two production sites.

Each year, Speedline Aluminium Gießerei GmbH in Schlins, Austria, produces 80,000 tons of aluminium extrusion billets up to 8 m in length and between 178 and 305 mm in diameter.

In this process, scrap aluminium profiles, shredded product, sheet metal elements and wheel rims are remelted, alloys and raw aluminium added and aluminum extrusion billets recast. This results in high-quality new goods for further processing.

https://alu-met.com/

E-Werke Frastanz

E-Werke Frastanz has been active for over 100 years, delivering a broad range of services. With approximately 80 employees, the company supplies its region with power and heat from renewable energy.

It also offers a broad spectrum of products and services for private individuals and companies, ranging from state-of-the-art plant construction and electrical installations to high-tech internet and cable TV.

https://www.ewerke.at/