SIEMENS

Efficient network integration of renewable energy resources on the distribution level

Renewables integration

Discover solutions for the integration of renewable energy resources and new challenges

The following sections provide an overview of five main fields of action within the scope of the integration of renewable energy sources – the challenges, the solutions Siemens provides, and case studies that illustrate the implementation of several technologies in a specific context.

New energy resources, new challenges

Renewable energy sources are gaining ground worldwide, and they are rapidly changing the nature and composition of the energy system. A highly complex Power Matrix has replaced the unidirectional, relatively easily manageable energy conversion chain of former times.

Power generation from renewable sources such as wind and the sun is intermittent, relatively small-scale, and distributed. Moreover, grid infeed takes place on the distribution level.

However, most power distribution infrastructures were never built to handle multiple, distributed generators, power swings, intermittency issues, and even power flow reversals. They often lack both the capacity and the technical prerequisites today, but with renewable energy sources gaining further momentum, meeting the new challenges on the distribution level becomes more and more essential for the entire energy system.

Making renewable energies happen: distribution grid modernization and automation with Siemens technology

While renewable energies gain an increasing share in the energy mix, the overwhelming majority of power from renewable sources is fed into the grid on the distribution level. That's why large-scale distribution grid infrastructure modernization and automation are an indispensable prerequisite for the further grid integration of renewable energies. Around the world, existing grids need to become Smart Grids able to integrate considerable amounts of distributed generation, handle intermittency, ensure power quality, and enable the reliable and economically efficient supply of increasingly power hungry societies. In short: The modernization and automation of the distribution infrastructure is a prerequisite for future supply reliability.

Smart Grid technologies are the key

Figures show that the importance of this issue has already been recognized by transmission and distribution system operators, who also have to face several substantial changes in their business environment, while the transformation of a solely supply-oriented energy system into a more demand-oriented system has become an objective of many political bodies around the world. This transformation comes together with a shift from centralized to distributed generation, along with the demand for increased efficiency and reliability, and the handling or prevention of overproduction – issues that can only be covered with Smart Grid technology. A technology that will also enable network operators to provide suitable system services, such as flexible load management, that help keep and stabilize voltage and power quality within tolerable limits.

A comprehensive offer from Siemens

An expert partner of utilities and distribution system operators, Siemens has long anticipated the need for intelligent distribution grid technology and has developed a comprehensive suite of Smart Grid technologies, solutions, and services based on the company's unparalleled know-how and decades of experience in the field of power generation and distribution. This makes Siemens the ideal partner for mastering the challenge of integrating more and more power from renewable sources in the energy system.

The comprehensive range of products, solutions, and services comprises sustainable technologies for infrastructures, building and security technology, power distribution and Smart Grid technology, and state-of-the-art conventional medium- and low-voltage products. Taken together, these technologies enable the implementation, extension, and maintenance of a powerful and reliable distribution infrastructure that meets today's and tomorrow's challenges.

This makes Siemens the partner of choice for future-proof power distribution solutions, because the company provides expert consulting and support throughout the entire life cycle of infrastructure assets – from planning and design to delivery and commissioning, all the way to maintenance and repair – even when it comes to the development of new business models.

The following sections provide an overview of the five main fields of action within the scope of distribution grid modernization and upgrade – the challenges, the solutions Siemens provides, and case studies that illustrate the implementation of several technologies in a specific context.

Network analysis and planning

The integration of Smart Grid technologies, such as distribution automation, distributed generation, energy storage, and microgrids, can have far-reaching implications to all aspects of the electrical power system: from equipment ratings to protection and control schemes, tariff structures, and business processes.

Understanding the new technologies, deploying them, and making distribution infrastructures fit for future challenges requires methodology-driven analysis and planning based on comprehensive insight, experience, and tools. Siemens' exceptional understanding of the entire power system is the basis for network analysis and planning tools that enable optimal business decisions.

Evaluating the existing and the required state

A number of questions need to be answered in order to establish a reliable, cost-efficient, and powerful distribution system able to meet the requirements of the changing energy system.

How much renewable energy can the existing system handle – and how much will it be required to handle in the future?
The thorough analysis and calculation of a system's capacity is the indispensable first step in all modernization and automation projects, paving the way for reliable planning.

Will the further integration of renewables affect the system's protection settings?
Continually evolving power systems and quickly changing operating conditions make it a complex task to calculate, verify, and validate protection settings and call for a dynamic assessment approach.

Where are appropriate grid connection points for larger wind or solar power plants?
Precise profiles for renewable generation infeed and load consumption based on exact measurements are required for the analysis of a system's characteristics and capacity in order to minimize modernization and extension efforts.

What does it take to make the entire system ready for the future?
The current transformation of the energy system entails much more than the possible need for new hardware, and may even affect business models and much more. Many factors and increasingly complex dependencies must be considered, e.g. how to balance fluctuations caused by renewable energy, guarantee a reliable supply, and maintain the quality of electricity, as well as considering the economic aspects at the same time.

Network analysis and planning with Siemens

PSS SINCAL

PSS®SINCAL is a complete all-in-one software system that can replace a set of other software programs. The high-end analysis software solution for all power system planning requirements provides a full unbalanced power system model and supports the design, modeling, and analysis of electrical power systems. Modular and fully integrated, PSS SINCAL enables a high level of customization according to individual requirements and is the optimal solution for all planning tasks.

In-depth information online

SIGUARD PSA

Using combined power and protection system simulation, SIGUARD® PSA enables protection engineers and operators to perform fast protection security assessments for reliable protection-setting determination, secure system operation, and cascading trip prevention. It includes customizations for application in planning, operation, and training. Protection system audits and certification are available as consulting services.

In-depth information online

Smart Grid Diagnostic Kit

The Smart Grid Diagnostic Kit enables concrete recommendations for efficient grid expansion that are based on exact measurements and precise knowledge of the situation in the grid. It unveils problem areas and helps reinforce grids in a targeted, anticipatory manner. This approach makes grids more efficient and reduces costs, because inefficient measures and misinvestments are consistently prevented.

In-depth information online

Smart Grid Compass

The Smart Grid Compass is a consulting and evaluation approach that provides safe navigation toward the network of the future. Its value-added approach is based on a time-tested and proven method that ensures a high degree of decision-making security in the process of finding the optimal path for turning a distribution system into a Smart Grid.

In-depth information online

A case study: Smart energy for New Brunswick, Canada

The challenge:

The Canadian province of New Brunswick laid out »a strategy for the province's energy future« based on a ten-year plan that called for a forward-looking approach with a particular focus on the area's chief electrical utility, NB Power. The electrical supply system required modernization, and greater customer choice, control, and education were needed to help balance consumption and generation. NB Power's aim was to become a global reference for the ›utility of the future,‹ providing load-following generation capabilities and sustainable electricity, while also placing even more focus on its customers and reducing rate increases.

The solution:

Using Smart Grid Compass methodology, Siemens designed a road map for NB Power based on Siemens' Demand Response Management System (DRMS) and Decentralized Energy Management Suite (DEMS).

The benefits:

The implementation of the road map will allow the utility to manage electricity distribution in a more flexible, intelligent, and efficient way. A comprehensive KPI catalog supports budget planning, giving a clear overview of aspects such as peak reduction and energy saved, among others.

End consumers will have more choice about how and when they use their electricity in the future as NB Power is able to expand its services. The Siemens technology will enable the utility to introduce innovations such as information dashboards and smart thermostats.

More case studies online

Network modernization

Strongly growing numbers of distributed and especially volatile power sources, e.g. photovoltaic panels, biogas plants, and wind farms, are continually increasing requirements on the distribution grids. Additional load capacity, changing directions of power flow, and load and voltage fluctuations make the low- and medium-voltage grids of today go to their limits.

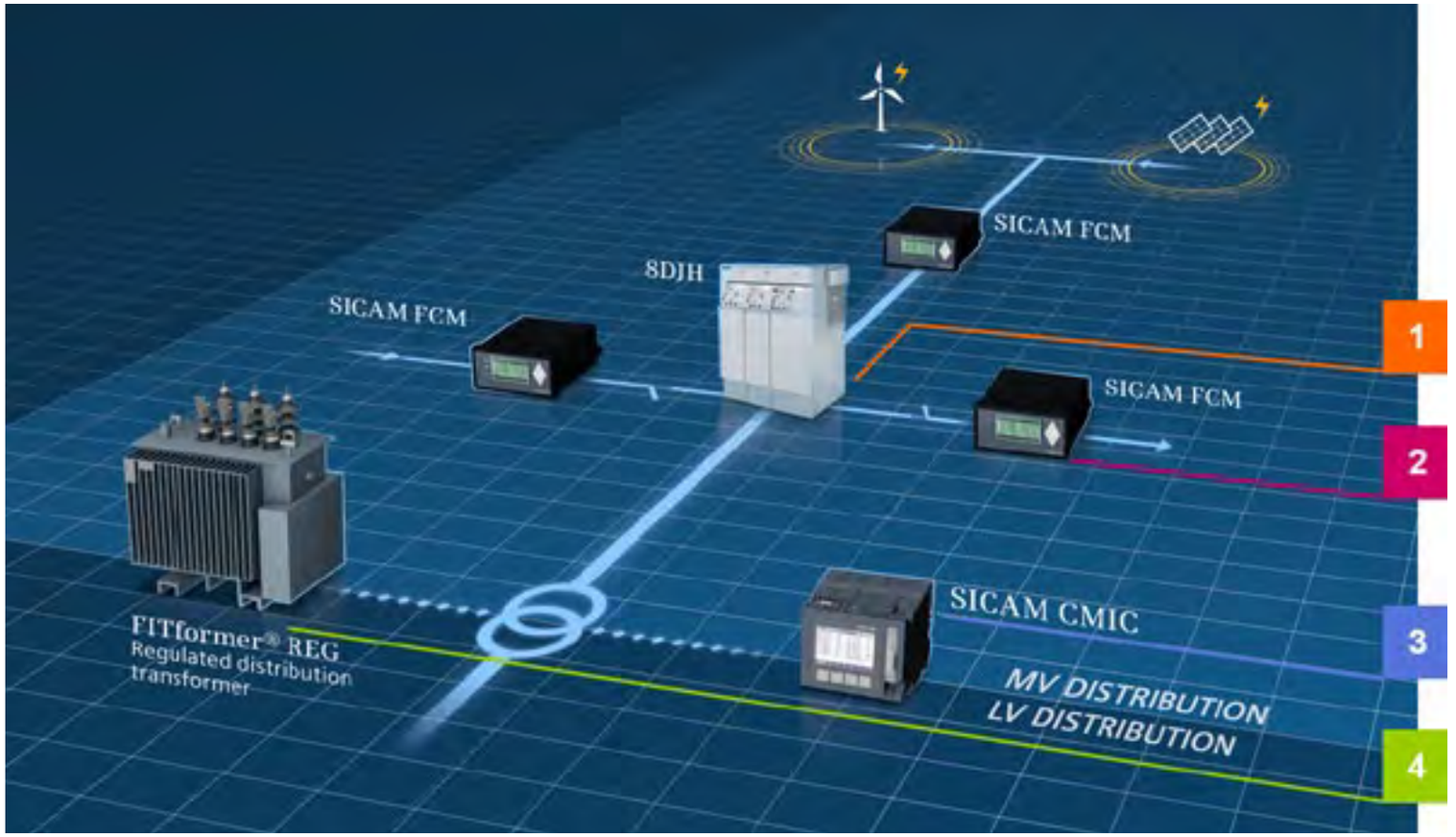
Many of today's transformer substations were originally designed for a merely unidirectional power flow. Today, this design is no longer capable of coping with the effects related to integration of volatile power sources. The consequences are increasingly frequent supply disruptions in the classical distribution grid, with ever-increasing downtimes. To reduce downtimes notably and to limit the associated blackout costs, quick adjustments to the existing power distribution grids are a must.

Turning the distribution grid into an active system

While the additional load capacity required due to the expansion of renewable energies can be provided through simple grid expansion, the effects resulting from the alternating direction of power flow, load fluctuations, and voltage range limitation can only be handled with intelligent solutions.

What does it take to connect and integrate distributed generation smoothly?

The answer is an active distribution grid with intelligent transformer substations that turn the inanimate distribution grid into a fully automated, intelligent infrastructure that works reliably without the need for expensive grid expansion measures. These intelligent transformer substations contribute to active load management in the distribution grid by early detection and controlling of overload situations, and enable rapid, automatic fault clearance in case of blackouts.



Network modernization with Siemens

Intelligent transformer substations

Siemens provides a consistent concept for intelligent transformer substations including suitable components for every task. The concept comprises compact medium-voltage switchgear with communication capability, regulated distribution transformers, and integrated telecontrol and automation solutions that monitor and control the medium- and low-voltage grid. In this way, overloads of operational equipment are detected earlier and voltage stability is ensured, e.g. by the stipulation of set-point values for the distributed generators.

In-depth information online

8DJH switchgear family

The centerpiece of an intelligent transformer substation is the gas-insulated 8DJH medium-voltage switchgear. Its modular and compact design enables a multitude of configurations and offers more space for additional feeders. The hermetically sealed enclosure makes the 8DJH insensitive to aggressive ambient conditions and tight to ingress of external objects, thus forming an intelligent transformer substation.

In-depth information online

FITformer REG

The Siemens regulated distribution transformer FITformer® REG can change its voltage ratio under load. This helps the power supplier remain within the permitted voltage range. For this purpose the transformer has a three-step low voltage load regulator.

In-depth information online

SICAM CMIC

SICAM CMIC is a universal automation and remote terminal unit with a small, compact design and a high EMC resistance especially designed for distribution grids. It can provide supervision/monitoring, remote control, and automation and load flow control functionality to the intelligent transformer substation.

In-depth information online

SICAM FCM feeder condition monitoring

The SICAM FCM is a short-circuit and ground fault indicator with direction indication that uses protection algorithms and the latest low-power sensor technology according to IEC 60044. SICAM FCM provides comprehensive measured values to monitor the load of distribution network components, thus providing accurate data on the network condition.

In-depth information online

A case study: A Smart Grid for Wachtendonk, Germany

The challenge:

Stadtwerke Krefeld is a publicly owned multi-service provider in North Rhine-Westphalia. Within its service area is the 8,000-strong community of Wachtendonk, where about 80 percent of the electricity is generated by distributed generators, primarily photovoltaic panels. To keep the distribution grid stable despite the high percentage of electricity coming from renewables, Stadtwerke Krefeld was looking for a way to modernize its grid in a cost-efficient manner.

The solution:

Siemens and Stadtwerke Krefeld will transform the existing power supply system in Wachtendonk into a Smart Grid. Siemens installed smart meters in about one hundred homes to collect the status-related data needed to operate a Smart Grid. The smart meters feature a special power snapshot analysis that turns the devices into »eyes« for the monitoring of the grid.

Five new intelligent transformer substations will also help ensure greater stability. They will compensate for voltage dips that can result when clouds form over the solar panels in Wachtendonk. The substations are equipped with communication-capable medium-voltage switchgear, adjustable local transformers, and remote-control and distribution grid automation components.

The benefits:

A key advantage of the project will be the acquisition of detailed information about the behavior of a smart distribution network. Additionally, the technical and the commercial concept for this pilot project can serve as models for other distribution companies.

Despite the high renewables infeed, Stadtwerke Krefeld can avoid investments in immediate grid extension as it gains approximately 35 percent of additional grid capacity. Furthermore, savings potential can be easily identified, and future grid extensions will be based on reliable grid analyses.

All this will ensure a stable and reliable future power supply for the town of Wachtendonk.

More case studies online

Network stabilization and control

Intermittency is a main characteristic of most renewables, but power grids require an exact and steady balance of generation and load. Even the slightest imbalances can seriously affect voltage and frequency stability as well as power quality. That’s why a distribution grid’s current stabilization and control capabilities need to be analyzed carefully and why technical measures must be taken to prevent imbalances caused by the intermittent nature of renewables.

Balancing generation and load reliably

There are a vast number of influencing factors and levers in the field of network stabilization and control. The right combination of technology, software, and expertise makes them accessible and reliably manageable.

Is the control center ready for the integration of renewables?

The special characteristics of distributed generation from most renewable sources may require additional tools to analyze the state of the network and counteract critical situations instantly.

Will additional data be required for reliable and efficient system operation?

The more distributed generation and volatile infeed a distribution system has to cope with, the more important is the utmost transparency. Precise real-time information about the state of all assets within the system is key. Additional sensors, a suitable data communication infrastructure, and IT within the system may be necessary to achieve the required level of transparency.

Which measures must be taken to prevent voltage dips and frequency variations when integrating renewables in a distribution grid?

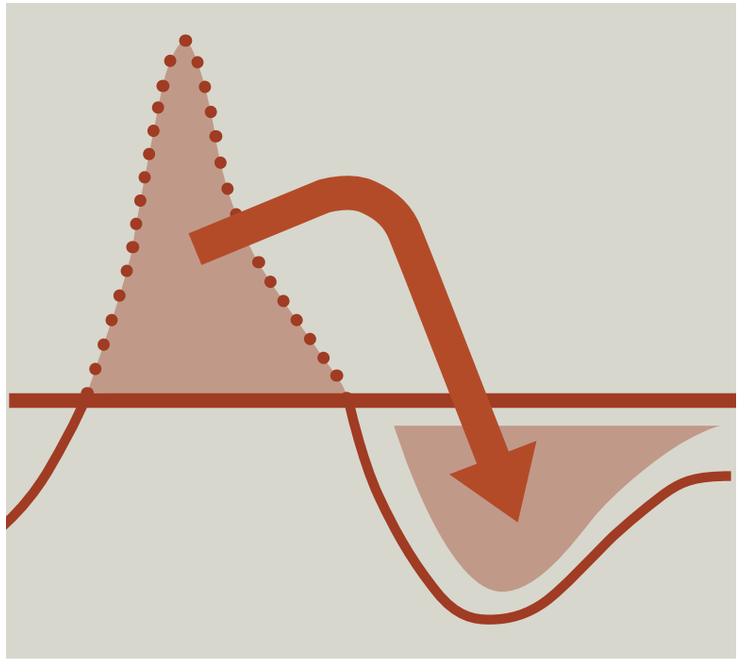
Options for the fast and flexible compensation of intermittency are a basic requirement once renewables have gained a certain share in the energy mix of a distribution system. This requires intelligent, active equipment and suitable software. Furthermore, storage systems have assumed a new importance under these cirumstances.

Which measures can ensure consistently high power quality?

Sags and swells, as well as harmonics, may require additional support and filtering equipment, such as fast intermediate energy storage based on capacitor banks.

What is the best way to identify and prevent system overloads?

The consistent and comprehensive introduction of intelligent substations, a software solution that controls grid infeed, and suitable energy storage facilities are required to prevent overloads while keeping infeed reductions within the permitted limits.



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In-depth information online

SICAM SGU Smart Grid unit

The SICAM SGU can be used for Smart Grid purposes such as demand response, the management and control of virtual power plants, renewables integration in microgrids, or as a small RTU.* It comes with built-in secure cellular communication that enables the connection to an energy management system.

In-depth information online

SICAM power quality and measurement devices

The SICAM range of products comprises devices for power monitoring and power quality recording, disturbance recorders, and phasor measurement and system software applications.They all provide precise measurements and the acquisition and reporting of all necessary information required to keep a system healthy.

In-depth information online

SIESTORAGE

The modular electrical energy storage system SIESTORAGE combines cutting-edge power electronics for grid applications and high-performance Li-ion batteries. The design of SIESTORAGE can be adapted to specific demands in a large field of applications.

In-depth information online

* RTU = Remote Terminal Unit

Spectrum Power ADMS

Siemens has entered the next era of power control systems: Announcing the Spectrum Power™ Advanced Distribution Management System (ADMS), the integration of distribution SCADA, outage management, and advanced fault and network analysis, all operated under a common user environment.

In-depth information online

Spectrum Power ANM

Spectrum Power™ Active Network Management (ANM), is a smart tool for distribution grids. It displays the current load flow directions and calculated load values as well as voltage range violations and overload situations. Spectrum Power™ ANM also provides functions for convenient voltage range and capacity utilization management. This makes it easier to predict voltage violations and equipment overloads – and substantially reduce them with control algorithms.

In-depth information online

A case study: Self-healing grid for Rotterdam harbor, the Netherlands

The challenge:

Stedin, one of the largest Dutch grid operators, wanted to significantly reduce the SAIDI (system average interruption duration index) in their medium-voltage grids. Since the Dutch medium-voltage distribution grid consists of underground cables, it cannot be quickly repaired in the event of faults nor can automatic reclosers be used. That's why a special solution had to be developed that would work for the Dutch network system.

The solution:

In collaboration with Stedin, Siemens developed a self-healing network solution. Substation automation was upgraded by implementing new distribution grid automation functions. The solution, based on a »regional controller« on the substation level, ensures automatic fault localization, isolation, and restoration. The regional controller serves as an interface with the control center that collects data from the distribution grid and hosts the regional, centralized applications of Stedin's self-healing grid.

Part of the solution consists of an intelligent local substation. Upgrade kits were installed to modernize older RMUs.* Where this was not possible, older RMUs were replaced by new RMUs.

The benefits:

With the innovative self-healing grid solution installed, Stedin will significantly reduce its SAIDI and resupply most of its customers with power in less than a minute in the event of a power outage.

This will result in satisfied customers as well as considerable cost savings by minimizing the heavy contractual penalties that must be paid in case of power outages.

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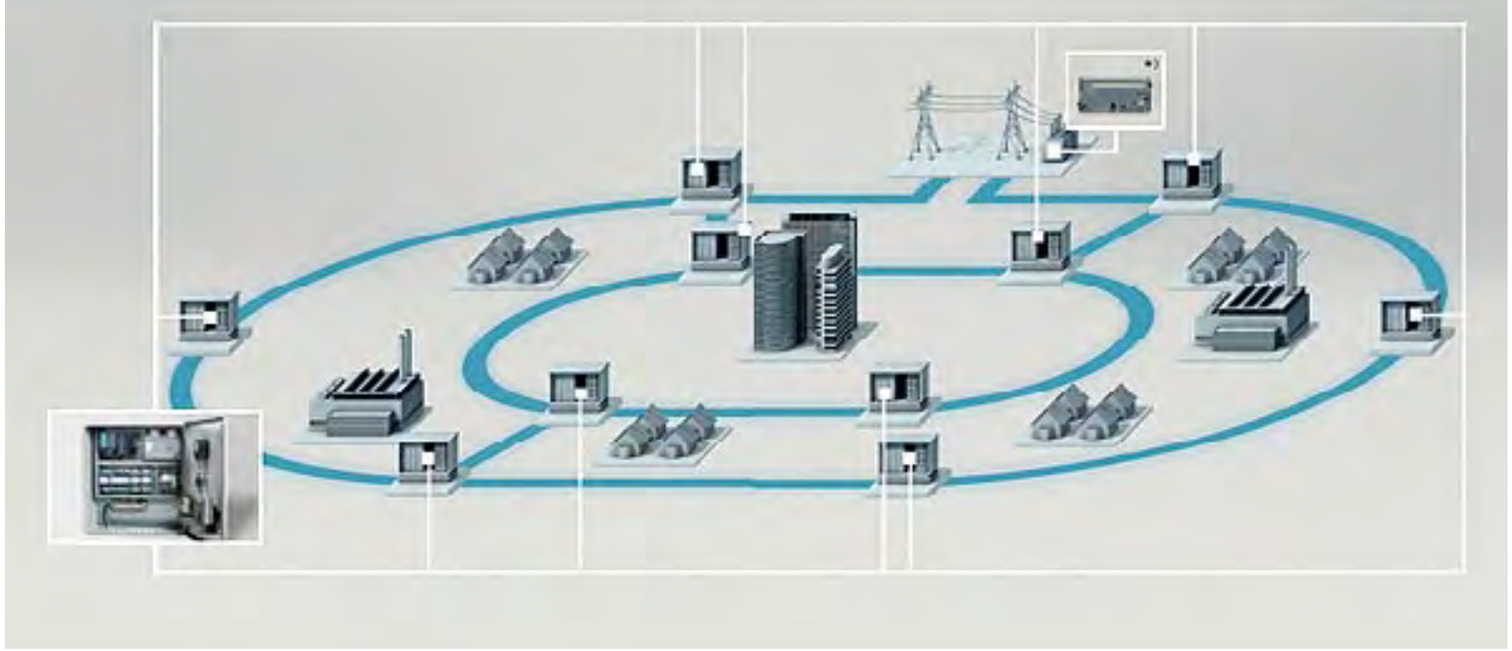
* RMU = Ring Main Unit



Energy trade

The environmental benefits of renewables over traditional energy sources have led to a number of factors that have created market incentives for the development of renewable generation. On the other hand, market liberalization has turned electricity into a tradable commodity in many countries. This situation creates new business options for power generators as well as utilities and municipalities. At the same time, it calls for a rethinking of traditional market roles and for the implementation of adequate technical prerequisites.

Capitalizing to the full on renewable energy

Deregulation of the energy market has fundamentally changed the energy situation. It requires considerable effort to operate and market the growing number of small distributed generation sources, storage, and loads. This brings not only challenges, but also opportunities.

Is there a way of flexibly integrating distributed renewable generation and bringing it to market?

Distributed energy resources offer attractive marketing potential. As a single unit, however, they are too small to allow for efficient energy trading, and power generation from renewable sources varies too much for reliable planning of these resources. The solution is to combine them into a large unit – a virtual power plant – that can be efficiently controlled.

Energy trade with DEMS from Siemens

Distributed energy management system DEMS 3.0

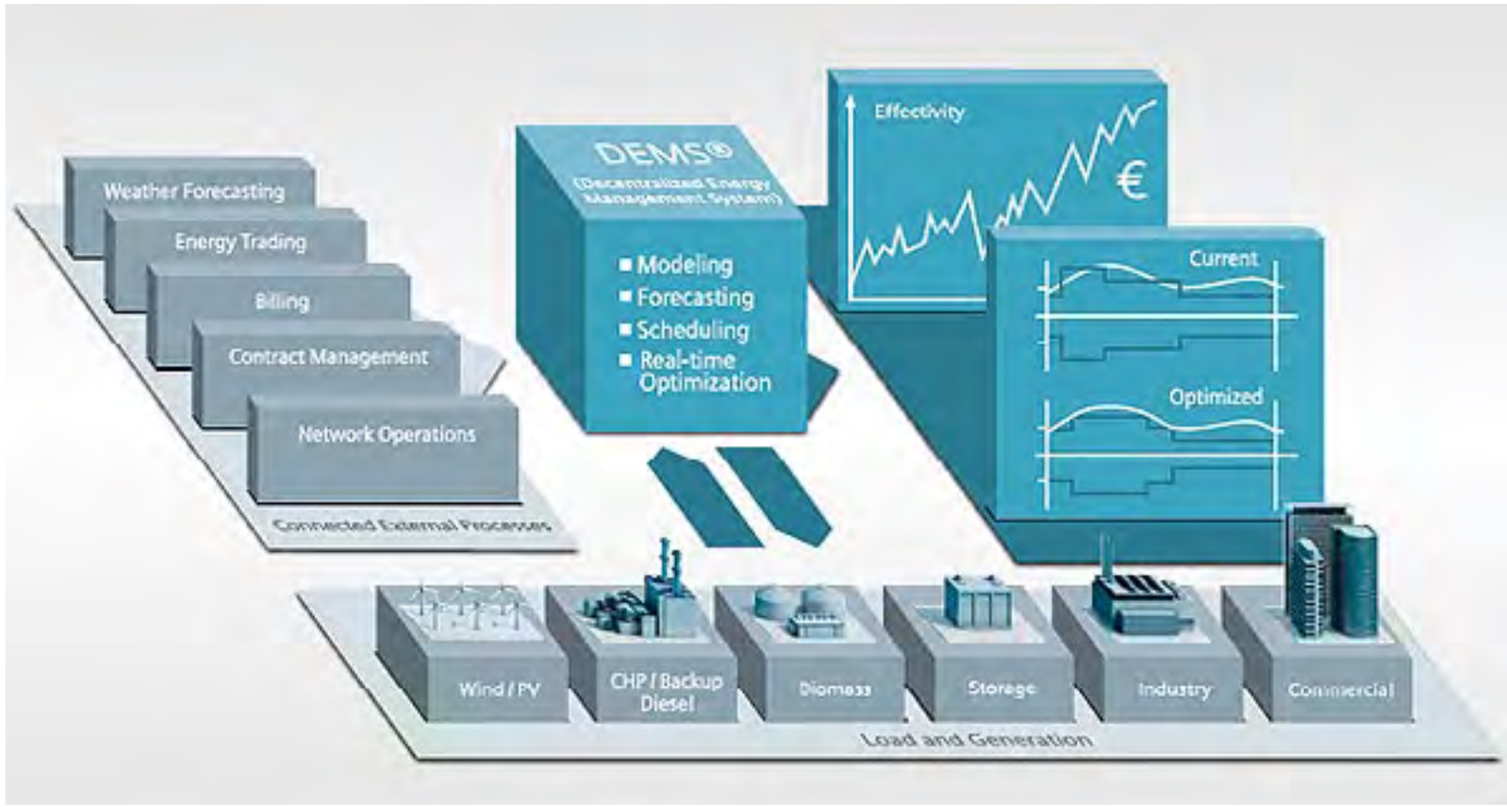
DEMS 3.0 networks and pools the individual distributed energy sources on the basis of sophisticated information and communication technology, so as to be able to control them centrally as one virtual power plant. The system processes all important information, such as weather forecasts, current electricity prices, and energy demand. Based on these data, a deployment schedule for all included plants is drawn up and monitored. For example, thermal loads are predicted depending on weather forecasts and day type in hourly time resolution. The anticipated level of generation from renewable energy sources is based on weather forecasts and on plant characteristics. The calculated deployment schedule consequently minimizes the costs of generation and operation in the plants making up the virtual power station. Deviations from this schedule that occur in the course of system management are allocated to generation, storage, and controllable loads in real time, so that overall planned targets can be met.

DEMS 3.0 enables energy traders to expand their energy portfolio, it can be used on the market for minute reserves, and it is prepared for use in the secondary regulated energy market. DEMS 3.0 also makes it possible for operators of microgrids to operate their networks more efficiently.

DEMS Compact

As the cost required to set up and operate virtual power plants frequently exceeds the economic benefits, small and medium-sized municipal utilities in particular often dispense with this technology, so they are unable to offer adequate products to their customers. DEMS Compact offers a solution and provides small power generators and municipalities with a cloud-based web service. This service enables them to interconnect their small-scale distributed power generation units and offer bundled power to an operator of a large virtual power plant system for marketing.

In-depth information online



A case study: Reliable and efficient power supply with a virtual power plant, Munich, Germany

The challenge:

Stadtwerke München (SWM), Munich's public utility and one of the largest energy and infrastructure companies in Germany, needed to integrate an increasing number of distributed small-scale power generation units into its power grid. It needed a solution that would improve the reliability of planning and forecasting of distributed power generation sources, loads, and storage in order to ensure a stable power supply. At the same time, SWM was looking for a way to optimize marketing opportunities.

The solution:

SWM and Siemens created a virtual power plant that pools many small-scale, distributed generation units and operates as a single plant. In a first step, cogeneration plants and renewable energy plants were integrated.

The core component of the virtual power plant is Siemens' distributed energy management system DEMS.

The benefits:

The virtual power plant enables reliable and cost-effective operation while benefitting the environment through the integration of renewable energy into the energy system.

In addition, the implementation of the virtual power plant opens up new business options and enables them to be optimally exploited through energy marketing.

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Cyber security

The way grids are operated and managed has changed dramatically due to the integration of renewable and distributed energy resources, the need for network optimization, the interaction with prosumers and consumers, and the participation of new market entrants.

With information and communication technology penetrating down to the distribution network and even households, the growing interconnections create more points for potential attacks to critical infrastructure. Consequently, cyber security is a primary concern for utilities today.

Comprehensive Smart Grid security solutions

Cyber security is an area grid operators need to address today. A trustworthy partner supports the navigation of regulatory requirements and implements future-proof solutions.

Siemens' proven solutions are ready to meet even the most demanding security requirements. And the right approach will be defined for the implementation of a comprehensive cyber security solution that protects grid utilities' networks and their customers.

How can can it be ensured that a distribution network complies with the current cyber security standards?

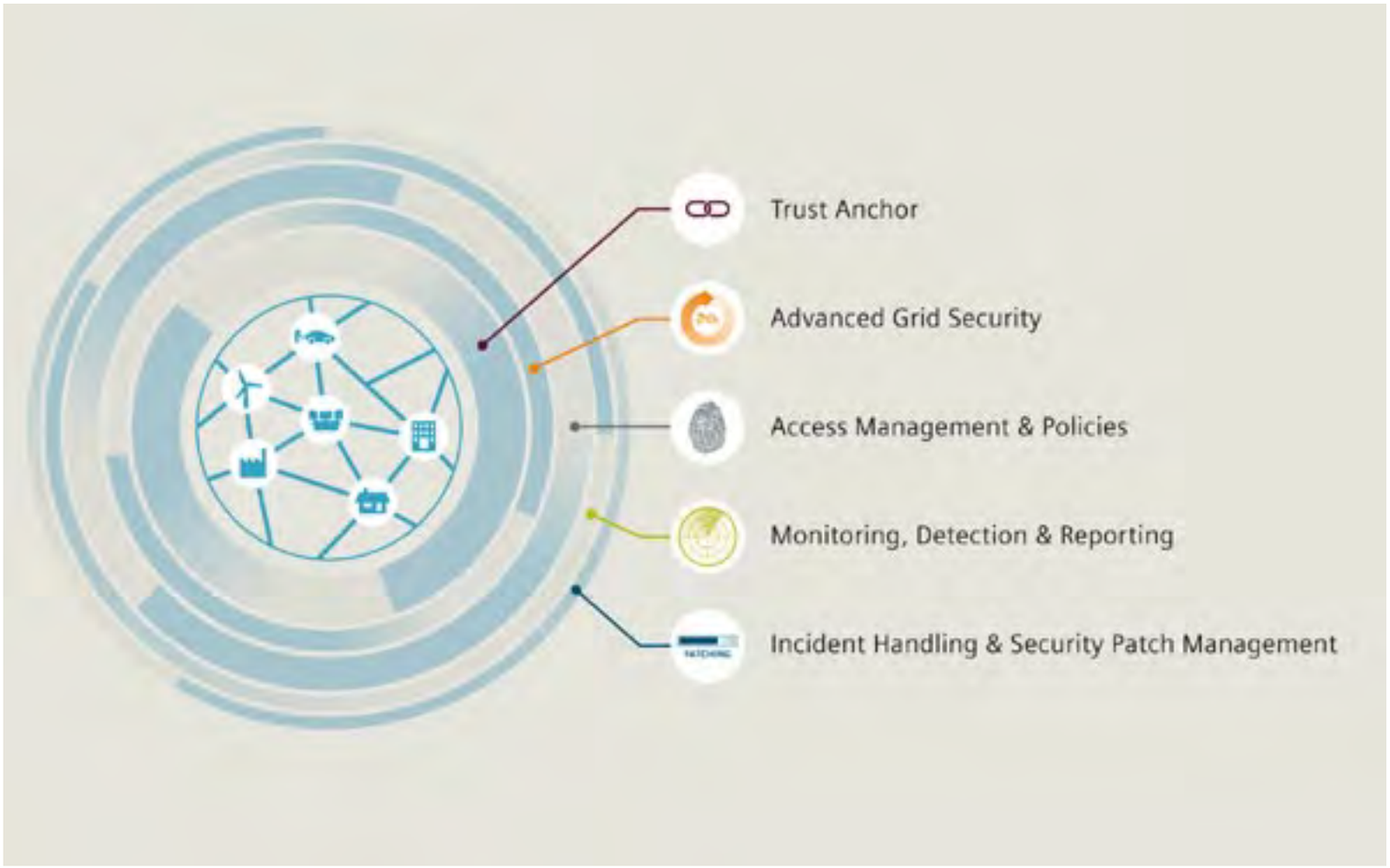
State-of-the-art security requires a holistic and integrated approach. Siemens bases its concept on a strong partnership with its customers and cyber security controls that provide multiple protective circles for the grid. These protective circles are interwoven, flexible, and adaptive to customers' specific needs. To address key security challenges, Siemens has combined five layers to ensure a solid foundation to protect businesses.

The Smart Grid security circle: holistic, layered, comprehensive

Trust anchor
There is no security without trust. Working with Siemens gives grid operators the advantage of an experienced, reliable partner that has cost-effective and certified cyber security solutions ready to go.

Advanced grid security
The ultimate goal of security is to ensure a system that is always on and not corrupted. Siemens provides solutions that integrate cyber security into customer's business-critical systems to increase confidentiality, integrity, and, especially, the availability of their grid.

Access management and policies
Siemens' cyber security solutions comply with regulatory requirements for role-based access control. Authorized users will have access when they need it, and their grid will be protected from operational misuse. So they can take control of their grid operations, increasing reliability while minimizing risk.



Monitoring, detection, and reporting
Continuous monitoring and analyzing of network events allows grid operators to respond quickly and take control. When a potential threat occurs, continuous monitoring helps to identify and isolate the problem, significantly reducing any possible damage to networks and businesses.

Incident handling and security patch management
When a security event occurs, critical systems must be protected – quickly. Siemens' services for incident handling and patch management provide regular security patch updates to keep systems running and to help in case of security incidents.

In-depth information online

The ideal partner for lasting success in renewables integration

Siemens has created a broad portfolio of equipment, systems, software solutions, and services to enable the conversion of distribution networks to Smart Grids and to allow and accompany the integration of renewable energies into the energy system:

- High-quality strategic and technical consulting
- Planning tools such as network simulation, evaluation, and optimization software
- Compact and intelligent medium-voltage switchgear
- Regulated distribution transformers
- Telecontrol and automation components
- Energy storage solutions
- Control and protection systems and devices
- Distributed energy management systems
- Comprehensive cyber security solutions

Based on this comprehensive range of products, solutions, and services and decades of experience as the world's most integrated energy technology provider, Siemens offers a comprehensive, integrated partnership for the reliable and cost-efficient integration of renewable energies into distribution systems.

Visit our website

siemens.com/energy-management