Response to RFI

CUYAHOGA COUNTY UTILITY & MICROGRIDS

Siemens Industry, Inc.

7/15/2022

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Contents

Attachments provided in zipped folder:

Cyber Security Energy Automation Whitepaper

DEOP Whitepaper

ESCO Success Story (EGO-DEOP)

Microgrid Infographic

New Brunswick Power End to End Energy Consulting Case Study

Siemens DES Utilities Brochure

Siemens Microgrid Controls

Siemens PTI Consulting

Vienna Campus Microgrid Flyer

Whitepaper - Grid Edge for Municipalities

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for information
regarding the proposal

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Executive Summary
Experience and Expertise

We are excited to submit a response to Cuyahoga County's Request for Information to provide support in the development of a municipal electric utility and multiple microgrids.

As a leading energy project developer and technology provider, Siemens has unparalleled experience delivering complex projects with innovative technologies. We bring a team of highly experienced engineers dedicated to delivering seamless, sustainable, and reliable solutions and work with our customers every step of the way to ensure that project objectives are achieved, challenges are met, and expectations are surpassed.

Siemens products generate and deliver more than one-third of all the electricity produced in the US, and we are leading the energy sector in the complexities of moving toward distributed generation, optimized integration of renewables and electric vehicle charging. There is no other vendor like Siemens producing a full range of products combined with project design, implementation, financing, and operational expertise addressing the dynamic evolution of the energy value chain. We look forward to the next step in the process and stand ready to support Cuyahoga County in its efforts to enhance the resiliency and sustainability of its facilities to better serve your needs.

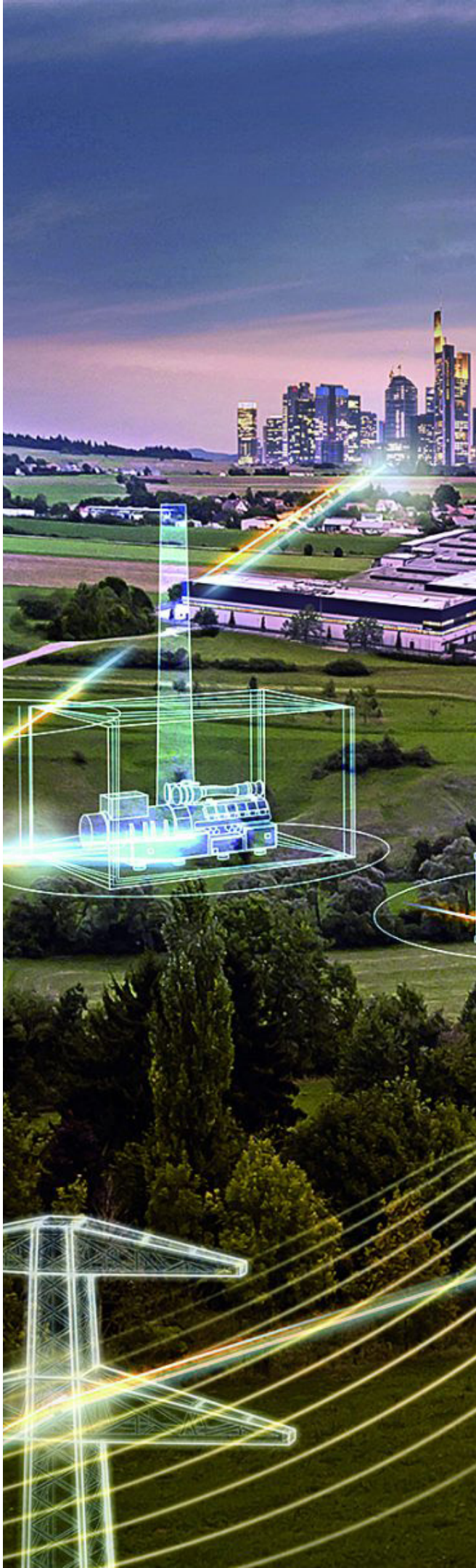
Siemens is one of the largest and most established companies in the world. Our company has more than a 170-year track record of solid financial performance and growth. Siemens Industry, Inc. is the U.S. subsidiary of Siemens AG, a firm with an S&P Global "A+" rating with revenues of $97.9 billion. This excellent credit rating combined with our outstanding record of performance creates confidence in Siemens' project execution and performance. In the past eight years, Siemens has directly financed projects worth over $5.9 billion within the energy sector.

We believe we are uniquely qualified to support the requirements of this RFI. By partnering with Siemens, Cuyahoga County will realize the following benefits:

- Having deployed 21 GWs of wind and 2.3 GWs of solar, Siemens is a true global leader in clean, renewable energy.
- Siemens has the ability to incorporate energy efficiency, CHP, intelligent load management and smart grid applications into the project and financing, which offers increased economic and environmental benefits.
- Siemens takes a Total Energy Management approach to each project. Leveraging our experience in energy efficiency, on-site energy generation and storage, and energy procurement ensures that the maximum value is derived from each transaction between Siemens and Cuyahoga County and the businesses they serve.
- Siemens has strong capabilities in grid interconnection, smart grid applications, and intelligent load management to optimize the benefits of on-site energy systems
- Through our capabilities in modeling grid balancing, Siemens is capable of fully evaluating and optimizing the impacts of integrating distributed energy applications into Cuyahoga County's operations. Ensuring optimum operational conditions for Cuyahoga County is paramount to Siemens.

Siemens has a long history of building trust-based partnerships with countless customers around the world. Our approach: we offer unmatched know-how, which encompasses all energy topics, to help you achieve your business goals in the most sustainable way.

- **World's Most Recognized Name In Advanced Microgrids by Navigant Research**
- **World's Largest Provider of Energy Storage**
- **Managed, Executed and Commissioned 3,000 Projects in the Past 15 Years**



Smart Energy System
for Cuyahoga County Utility

We understand that Cuyahoga County's goal is to develop energy districts that will transform Northeast Ohio's energy grid to be cleaner, more resilient, more secure and more cost effective for its residents, industries, and commercial businesses.

Siemens Grid Software (GSW) provides state of the art software for the grid planning and operations for various sizes of the electrical grid – transmission and distribution. Siemens GSW has helped utilities around the world to manage and operate their grids to deliver power to their customers in economical and reliable ways for decades.

Siemens GSW and competencies can help realize Cuyahoga County's vision of the energy districts that provide high degree of reliability and resilience to its residents. Siemens can help Cuyahoga County to create "energy secure" districts that can attract various types of investments and generate various income streams for the Cuyahoga County Utility.

Siemens GSW Grid Control Technologies

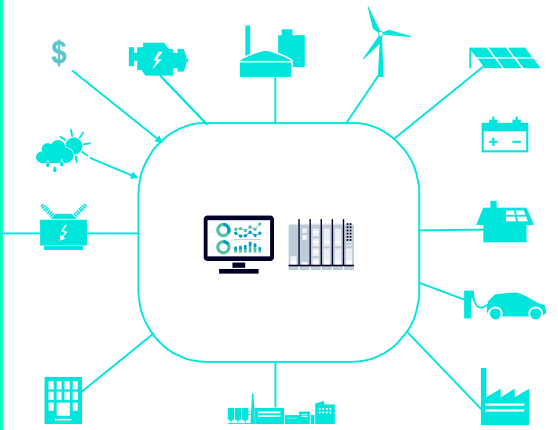
Siemens GSW can provide control and management software that can be deployed at various levels to realize the smart energy districts. Siemens' Grid Control software can provide following capabilities for the smart energy district network:

- Autonomous reconfiguration for increased reliability
- Autonomous operation as clustered microgrids or sectionalized grid in the event of widespread outages
- Revenue Generation for Cuyahoga County Utility and its residents via:
  - Virtual Power Plant operation
  - Demand Response
  - Demand Management (e.g., peak shaving)
  - Energy Arbitrage
  - Wholesale market participation

The Siemens GSW has state of the art optimization technology that can help Cuyahoga County Utility to achieve objectives such as maximizing revenue from different revenue streams. The Siemens GSW software will help Cuyahoga County to be prepared for the future of energy distribution such as the distribution market or transactive energy implementation. In addition to the GSW, Siemens has capabilities to provide end-to-end products and services from planning of the distribution grid improvements, distributed energy resources to local microgrid control products.

What roles will Siemens fulfill?

Siemens can support your project from origination to ownership, including front-end consulting, site identification, engineering and construction, financing, turnkey generation and BESS installation, turnkey substation, equipment O&M, and capacity augmentation. A brief description of the primary roles Siemens can fulfill to help Cuyahoga County achieve their vision are itemized below and on the following pages. Please click on each of the blocks above for more detailed information.



Utility Management

Support and management of the utility's operations

Developer

Utility Customers, Distributed Generation Projects, and Microgrids

Financed Solutions

Total lifecycle management and unique EaaS financed solutions

EV Charging Infrastructure

Design & build EV infrastructure and IoT systems

Design and Construction

Engineering, Procurement, Construction) of Distribution Infrastructure, Distributed Generation, and/or Microgrids

Power Distribution and Services

An integrated approach to medium-voltage power distribution

Utility Management:

Energy business advisory: First and foremost, the County must have a solid **business model** that will serve as the foundation for everything else that follows. Siemens can support the development of the County's business model through our experiences working with utilities throughout the world. Identifying and leveraging new potentials: Digitalization and sector convergence is creating a whole series of opportunities that can be used to design new business models.

Power system consulting: From strategic advisory service and technical consultancy to state-of-the-art software: Siemens Power Technologies International (PTI) provides a holistic view to master the technical and economic challenges of today's and future energy systems. Our strategic consultants help optimize value by providing guidance in the fields of business transformation, infrastructure development, as well as market and transaction advisory service.

Customer recruitment: Siemens operates a branch in Garfield Heights that does several million dollars of business with large energy users located in Cuyahoga County, including Cleveland Clinic, Cleveland Hopkins Airport, GSA, Case Western Reserve, NASA Glenn Research Center, the Cuyahoga County Public Libraries and Medical Center Company, the district energy company serving the University Circle community. Siemens can leverage our relationship with these organizations to support the County to recruit customers.

Developer of Distributed Generation/Microgrid Projects

Siemens plans, designs, builds, owns, and operates onsite energy production and storage assets for large behind-the-meter energy users and in-front-of-the-meter electric utilities. In doing so, we deliver cost savings, cost certainty, resilience and low-cost energy grid augmentation. We employ a wide range of best-in-class technologies in solar, integrated solar-battery solutions, hybrid systems, standalone batteries, microgrids, combined heat and power, and centralized heating and cooling infrastructure.

Let's begin by looking at the areas grid edge technologies hold the potential to revolutionize energy trading, energy storage, grid-interactive buildings, sector coupling and EV charging, to name just a few examples. These solutions are leading the change in efforts to increase efficiency and sustainability by integrating renewables, stabilizing the grid and optimizing the energy performance of buildings, infrastructure and entire industrial complexes. The potential savings, in terms of both carbon footprint and expenditure, are massive.

Design and Construction

As noted in the section directly above, Siemens offers DBOOM turnkey project development where we Design, Build, Own, Operate and Maintain our distributed energy solutions.

Electric Vehicle (EV) Charging Infrastructure

The adoption of EVs is accelerating as more and more auto manufacturers are producing **electric vehicles.** EVs have many benefits for society, consumers and even the electric grid – provided charging is managed and mostly done off peak, which is why utility market participation is so crucial for sustainable EV growth. Siemens can help Cuyahoga County maintain grid stability while meeting consumer demands with the implementation of our smart chargers and managed charging systems integrated with the microgrid.

Power Distribution and Services

A comprehensive portfolio for medium-voltage **power distribution** enables a more economical and responsible use of electrical power through the utilization of smart grids. An integrated approach to medium-voltage power distribution is the basis for green cities; energy-efficient infrastructure, buildings and industrial applications, and high supply reliability.

Financed Solutions

In partnership with Macquarie's Green Investment Group, Siemens has formed **Calibrant Energy**, a company dedicated to supporting the evolving needs of utilities as they strive to manage their own energy transitions. Calibrant delivers a fully integrated and managed (EaaS) solution that requires no upfront CapEx investments. In addition to flexible financing options, Calibrant takes over operational and performance responsibilities.

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Overcoming key challenges
and lifecycle execution timing

Siemens believes developing a business plan, economic model and balancing infrastructure buildout with a customer acquisition strategy will be among the biggest challenges for Cuyahoga County in the effort to realize the Initiative. As these challenges are addressed, the infrastructure needs will become more apparent and can be built into the power system design.

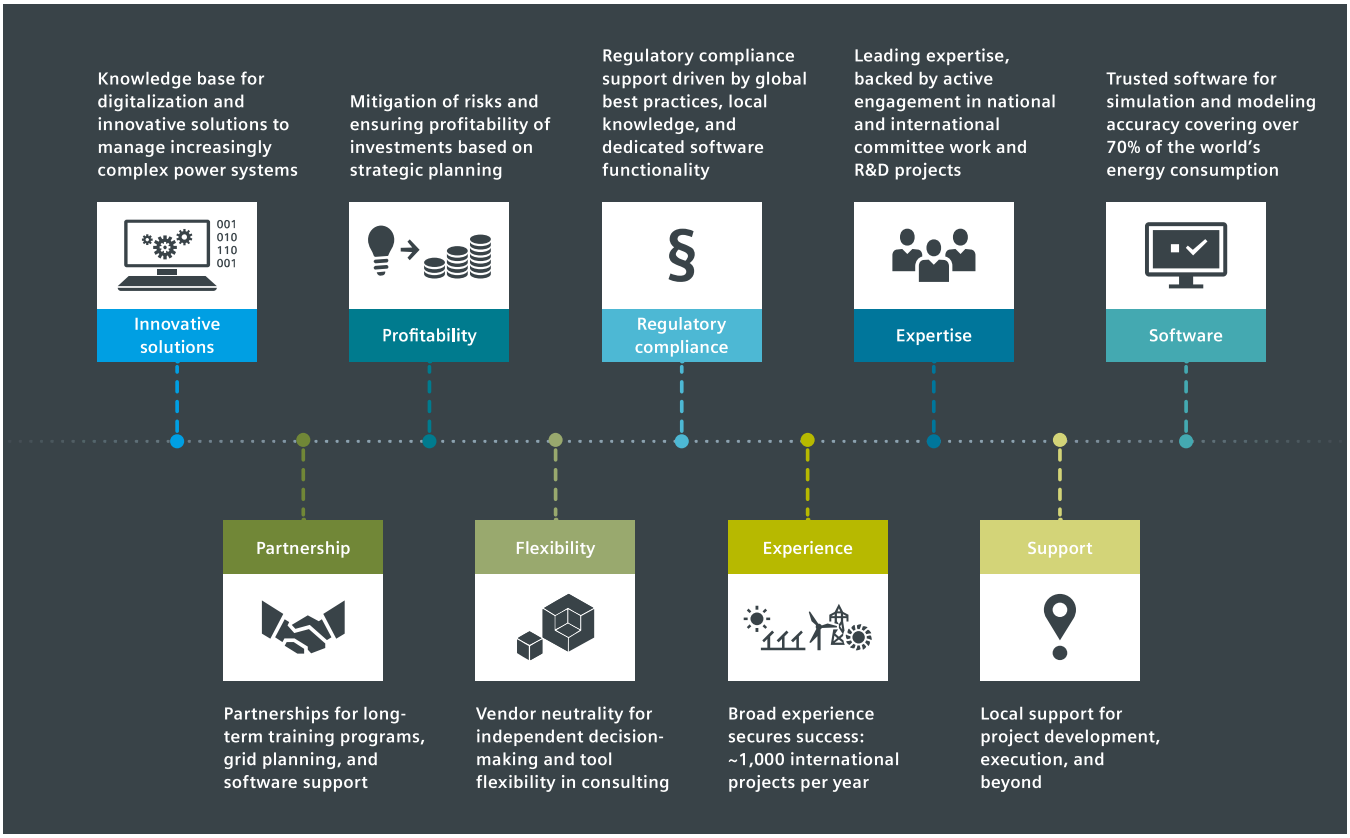
The business plan and economic model is critical to managing risk for the County, their customers and any 3rd party partners/investors. In setting up the business, the County is in a unique position to leverage the best components of the utility model combined with the best components of the independent/3rd party investment model. As the development partner for almost every aspect of the Initiative, Siemens' will provide business/economic model and power system consultancy services to address these key challenges.

Siemens is very close to our customers in the vertical markets we operate and we understand their energy needs and decarbonization goals. This knowledge is critical in the development of a customer acquisition strategy, for which Siemens can support. Customer acquisition can be difficult and timely when you consider the level of commitment and risk organizations are willing to take. Large energy users are critical to the development of the County's Initiative and managing that risk is critical to securing off-takers. In addition to leveraging Siemens local market intelligence and brand, Siemens can support the County in developing a marketing awareness campaign that will likely include additional 3rd party partners.

Once these strategies are developed, Siemens can begin developing the power system. It will come with its challenges from technology to regulatory compliance and Siemens will provide its consultancy and EPC resources along the way to design, build and operate Cuyahoga County's **Power Grid of the Future.**

"With our VPP based on DEOP, we have created a new revenue stream for EGO that adds value to our customers. Moreover, we boost sustainability in energy by delivering 150 MW of energy created from distributed energy resources that does not need to be generated by conventional resources.

Pietro Bosso
Head of Digital Energy Services, Gruppo EGO



The Foundation Blocks for Flexible, Efficient, and Resilient Power Grids

The timeline for completing the roles Siemens is presenting as core capabilities is difficult to define because we're starting from scratch, the solutions can be complex and include multiple stakeholders across the ecosystem. Many of the roles can be done in parallel to condense the timeline. Developing the business structure and economic model can easily take 6-12 months. Developing, designing and building out the infrastructure will typically take the same amount of time. And finally, the off-takers that will be committing to long term contracts will often take 12-24 months before signing an agreement, which is then followed by implementing the solution(s).

Siemens is very interested in meeting with Cuyahoga County to learn more about this exciting Initiative, further explain how Siemens can play a role in fulfilling the County's vision and answer any questions. We also appreciate the opportunity to be placed on a list of other respondents to this RFI.

Responses to Appendix:

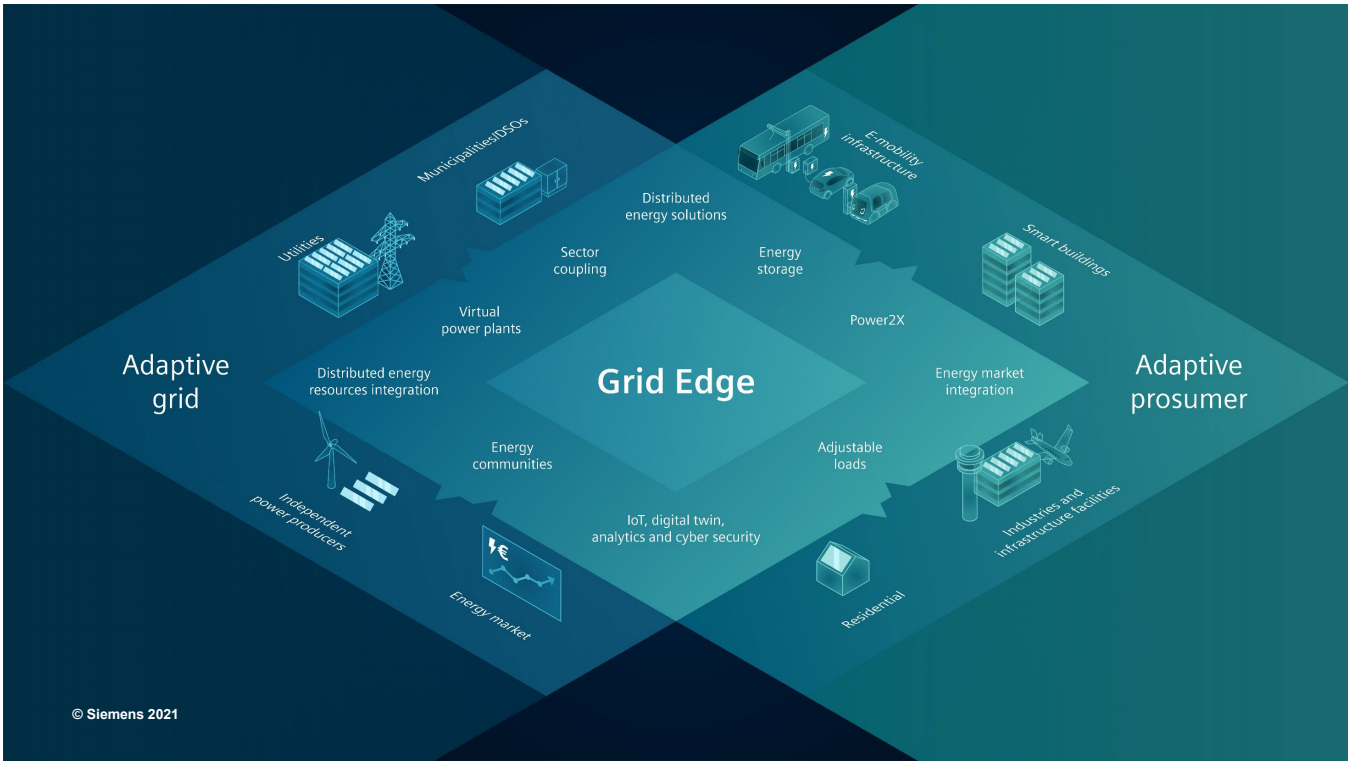
The questions posed in the Appendix are very thoughtful and absolutely need to be addressed during the course of developing and executing a strategic plan to meet the goals of Cuyahoga County's Initiative. Many of the answers to these questions are addressed in the descriptions of the core services identified above and the embedded website links.

Lacking a full and clear understanding of the County's goals, it is difficult to provide answers to all the questions in the Appendix. In an effort to help Cuyahoga County identify their next steps, Siemens will provide some insights and try to address some of the questions in each section of the Appendix:

Vision:

Cheap, clean, renewable electricity as the primary energy source of our society inevitably leads to a coupling of different sectors. Therefore, supply and consumption will happen more and more at distribution grid level, driven by diverse and smaller entities. These new kinds of stakeholders (e.g. prosumers, aggregators) and assets (e.g. heat pumps, EV charging infrastructure) can have a significant impact on the stability of the energy system without even being a part of the grid itself. Distribution System Operators (DSO) and municipalities, the most important players at distribution grid level, cannot ignore these huge changes. Especially with the decommissioning of more and more central power plants, they need to investigate ways to leverage these resources and stakeholders for efficient and effective system operations. This interaction between players and assets on the customer side and traditional grids is referred to as the grid edge.

The grid edge constitutes the connection and management of actions and effects resulting from the interactions of central energy supply, decentralized generation, and demand; leveraging smart and connected technologies for grids, buildings, infrastructures and industrial facilities to create sustainable value for all stakeholders.



The grid edge is where Cuyahoga County's opportunity lies! As a trusted partner, Siemens wants to support the County in capitalizing on the changes at the grid edge and creating the utility of the future.

Business Economic Models:

Siemens welcomes the opportunity to partner with Cuyahoga County to develop a business plan and supporting economic model. The economic model will largely depend on the County's goals, risk tolerances and agreements with the 3rd party partners and off-takers.

The likely most efficient way to flow and be structured is for the revenue to flow from the Customer(s) to the County to the microgrid developer. This structure would enable the County to bridge gaps in term length, customer size, credit strength, etc. of the customers.

The pass-through or pledging of the revenue from Customers/off-takers is not a problem per se, but that revenue must be backstopped by an entity that can support the investment. To address some of the largest challenges for the County operating the envisioned microgrid we need to get answers to questions like:

- Who is the anchor customer who will support the overall investment?
- What happens if the anchor customer departs? What happens to rates, stranded assets/ investment?
- Which customer(s) get to set the technical resiliency, redundancy specification or carbon emissions standard etc. which all others will be forced to pay for? How are like customers identified, pooled and commonly developed?
- How are rates set such that the last customer in doesn't obtain all the economic efficiency benefits of the investment that is supported by the first/anchor customer?

Form must follow function when considering tariff design. Tariffs need to be something Customers will find compelling that will incentivize long-term investment and commitment. A tariff should not come first with the hope that a new customer would find it acceptable. It often makes sense to bring key anchor customers into the tariff development/making process as a show of good faith and that this is truly a different model. As noted above, Siemens offers expert consulting and advisory services to help local utilities develop tariffs.

To meet the funding challenge associated with the energy transition, several options have come to the fore. One model, **Energy-as-a-Service (EaaS),** is finding new importance in providing access to renewable energy as it requires no upfront capital investment. Models like this highlight the importance of public-private partnerships, and when utilized in tandem with grant programs for communities and energy tax credits they can help move the nation forward to build the utility infrastructure of the future.

In partnership with Macquarie's Green Investment Group, Siemens has formed **Calibrant Energy,** a company dedicated to supporting the evolving needs of utilities as they strive to manage their own energy transitions. Calibrant delivers a fully integrated and managed (EaaS) solution(s) that requires no upfront CapEx investments. In addition to flexible financing options, Calibrant takes over operational and performance responsibilities.

Often, public private partnerships of the sort envisioned by the County establish check-in points where there is pricing review, technical value engineering sessions etc. during the development process. There

can also be upfront alignment on subcontractor use and preferences that the County is engaged in and has influence in selecting. From that point, the process and degree of oversight can be defined such that the pricing outcomes, major cost components have oversight, and the County's value judgments can be incorporated while ensuring that the process remains efficient with the ability to move forward and stay on track. The developer that is putting up the capital and therefore has the capital at-risk should be the party driving the process.

Organizational Models:

Siemens is very interested in partnering with Cuyahoga County to be responsible for the full scope of the Initiative. A true partnership between our organizations will ensure we're working toward the same long-term goals. The County's Initiative is not a single project but a large, complex system that will evolve over time and must be scalable and flexible to adapt as new technologies are made available. This makes it almost impossible to provide a meaningful response to an RFP/Q for the development and execution of a specific project.

Not having a full understanding of the County's procurement requirements, public entities will often be able to use a Request for Information to choose a partner they feel is best suited to help them meet their goals.

Some of the key advantages to partnering with a single firm like Siemens include:

- The County's costs and resources are minimized by not having to write RFPs for every project.
- The complete process from conceptual design to execution is accelerated because the County doesn't need to go through the RFP process for every project.
- Standardization of controls and technology of the microgrid and sub-microgrids is critical to operational performance.
- A developer must bring together providers for controls, electricity, generation and much more. As microgrid technologies advance and options proliferate, it can be difficult to keep pace with the latest options and make the right procurement decisions. The company that develops and designs a project/solution should also be responsible for procurement, construction and long-term operational performance and maintenance. The eliminates potential conflicts between parties. The pitfalls of making the wrong decisions regarding major equipment from vendors, such as DERs or the microgrid system control, include development challenges that remain hidden until they are at their most difficult to solve.

The relationships between Siemens and the County, as well as other stakeholders, will need to be aligned with the business plan to ensure the County is getting the highest value solution. The continued inclusion of your existing consultants may be in the County's best interest as well.

Agreements:

At this time, it's premature to suggest what type of agreements will best suit the relationship between Siemens and Cuyahoga County. The scope of work will dictate and the County's contracting requirements will dictate the type of agreements. We can envision a Master Agreement to establish our commitment to partner which can provide rules for multiple sub-agreements that may include Consultancy Agreements,

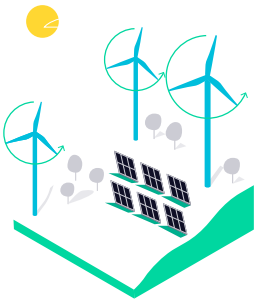
Project Development Agreements, Power Purchase Agreement, Energy Service Agreements or other X-as-a-Service Agreements. Depending on the scope of work, PPAs, ESAs and EaaS type Agreements will typically be 15-30 years long.

Initiative Timelines:

The scope of work, terms and conditions and the number of stakeholders involved will ultimately determine how long it takes to negotiate and execute an Agreement. It typically will take as little as 3 months up to as long as 12 months.

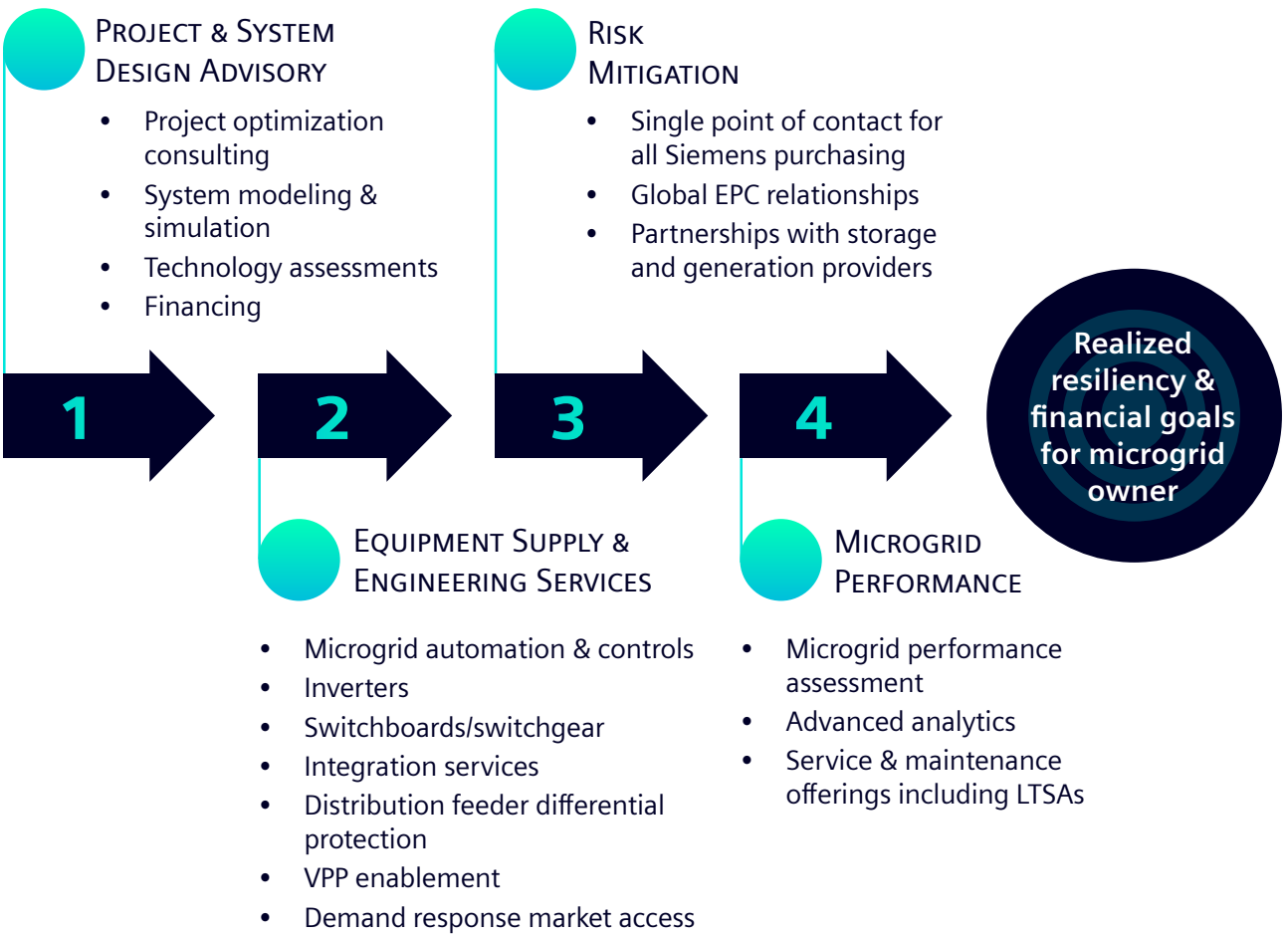
The timeline for procurement and execution of specific projects will also be highly dependent on the scope of work and lead times for some hardware items may be several months in the current economic situation.

The graphic below illustrates a high level overview of a typical **microgrid project lifecycle.** The graphic does not show the important task of acquiring customers for which Siemens is excited to get involved and support.



Siemens is experienced in all stages of microgrid implementation — **from origination to ownership.**

Siemens - your trusted microgrid partner throughout the project lifecycle

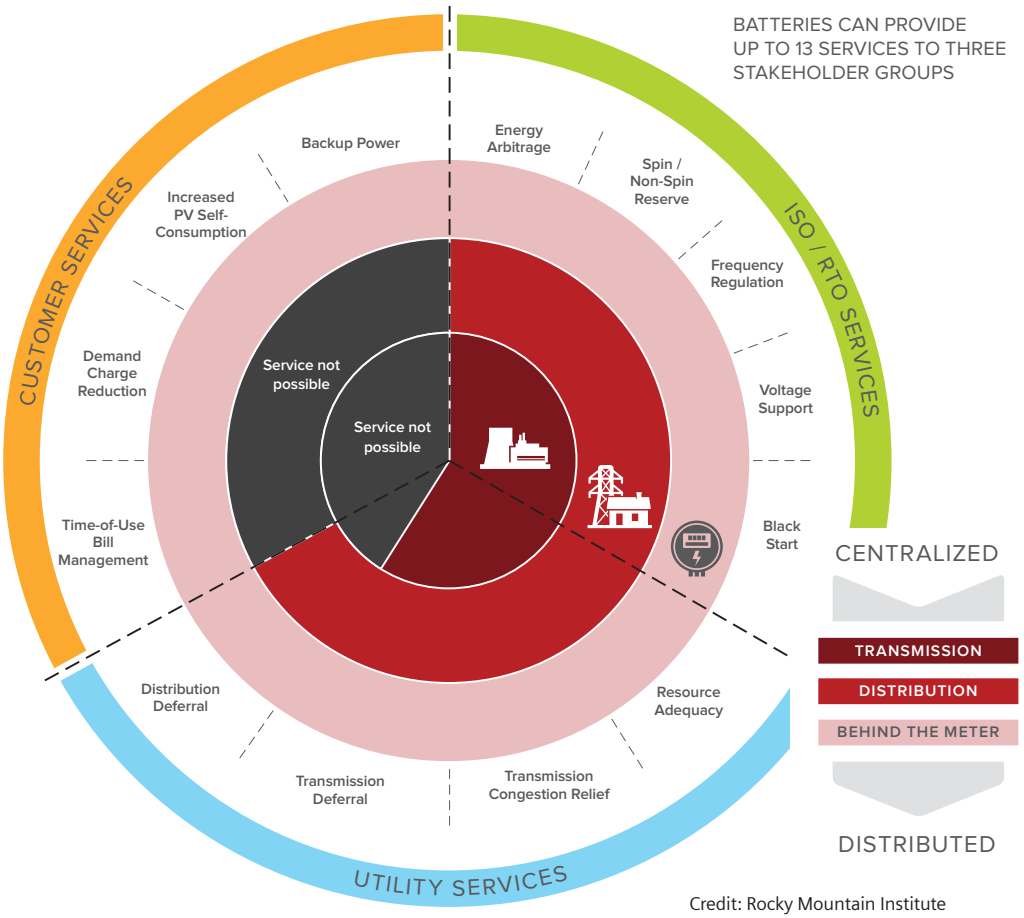


Technology:

Siemens will approach the opportunity to deliver the County's Initiative by learning about all the stakeholders' goals before we will get into what technologies we'll deploy in any solution. When it comes to developing and integrating a microgrid with existing infrastructure, there are no one size fits all solutions. The design and cost of a solar system will be dictated by the size, type, location, interconnection among other factors. The use case and size of a Battery Energy Storage will dictate the design and price.

Siemens takes a holistic approach when developing distributed energy solutions with the focus being on maximizing value to the energy user and meeting their goals. For instance, if the goal is to reduce or not increase the net energy spend, or meet a certain price or ROI, we'll design the system and controls to meet the goals. The design of the system will depend on many factors, including the tariff, the cost of energy and supply terms, the demand and load profile, the client's critical loads, etc.

As an example, if reducing capacity and transmission demand is a goal, Siemens will predict coincident peaks and automatically discharge a battery energy storage system (BESS) or run gas peakers or backup generators. Sometimes we'll design controls to shed load to different times of the day or dispatch other energy storage assets such as thermal storage. This is all done in balance with other savings or grid edge revenue opportunities in addition to the possibility of negotiating a more favorable supply contract that will allow the client to take advantage of energy arbitrage opportunities. When we evaluate the different use cases for a BESS, the demand charges don't always dictate the size and design of the system. As shown in this graphic developed by the Rocky Mountain Institute, a BESS can provide up to thirteen use cases from which we can extract value related to savings, revenue or power quality and resiliency.

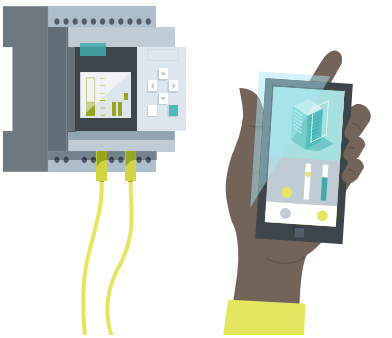


Credit: Rocky Mountain Institute

> To every grid operator hesitant to introduce a digital twin, I say: Don't wait any longer.
>
> Jussi Jyrinsalo
> Senior Vice President, Fingrid

Click here to learn more about Fingrid's digital twin

In this new digital world, data accuracy, model complexity and automation are the foundation to maintain operational excellence and maximize future investments. That is why Siemens has developed the **Electrical Digital Twin,** utilities are able to harness the power of transparency with a single source of truth for data across their entire utility IT landscape. A common network model is there to facilitate grid simulation across all domains relevant for reliable, efficient and secure electrical system planning, operation and maintenance.



Siemens offers well-thought-out products, systems and solutions to ensure the security of the energy automation infrastructure. From the outset, they meet the most stringent cyber security requirements of which you can learn more about in an attachment provided with this RFI.

Diversity:

Siemens is a multicultural organization with a global workforce of nearly 400,000 and operations in nearly every country in the world. Our diversity practices are built on awareness and respect for local histories, cultures and needs. Here in the United States, Siemens promotes diversity at all levels, from entry level to management, as well as through our employee training, cultural activities and events, and community outreach. We recognize and respect differences and similarities, which not only strengthen our U.S.-based companies but also puts us at a competitive advantage.

We drive Diversity, Equity and Inclusion (DEI) through leadership opportunities and mentoring programs with our employee resource groups, professional development programs and supportive, inclusive working environments for our employees. We actively work to create awareness and engage our workforce around the value of diversity and its business impact.

Within this three-pillar framework, we apply Diversity, Equity and Inclusion methodologies to existing business goals and processes, from how we work with suppliers and how we hire talent to how we build teams for projects and how we interact with our customers.

At Siemens USA, where we have a team of 50,000, diversity extends beyond inherent attributes such as gender, age or ethnicity. It also mirrors who we are through acquired attributes such as education, socioeconomic background, nationality, job experience, religion, sexual orientation, etc. As an inclusive business, we strive to empower employees to always be their authentic selves at work.

Our commitment to DEI extends to our customers in executing projects and to our suppliers in procurement of technology and services. In fact, more than 3,700 of our suppliers, roughly a quarter of our entire supplier base, represent small and diverse-owned businesses. Annually, we spend $972 million doing business with these companies. In creating these partnerships and others throughout our supplier base, we're supporting supply chains that are more resilient and ready for the future. We all benefit when the best ideas can be brought to the table. Diversity in the marketplace fosters this growth and innovation, just as it does in our workplace and in our workforce. It's good for business and society.

Other:

There are several links to external content embedded in this RFI response that will provide even more information that should be of interest to Cuyahoga County.

The challenges are big, but they are not insurmountable. They are real, but they can be met head on and overcome!

If Cuyahoga County wants to meet with Siemens to better understand our ability to lead the development of the Initiative, we would like to extend an invitation for you to visit our facility in Princeton, NJ. The Siemens **Princeton Microgrid** is one of the first to combine renewable energy solutions with both building management and energy management solutions. The result is an innovative, resilient and cost-effective solution that serves as a live test bed for Siemens customers and partners.

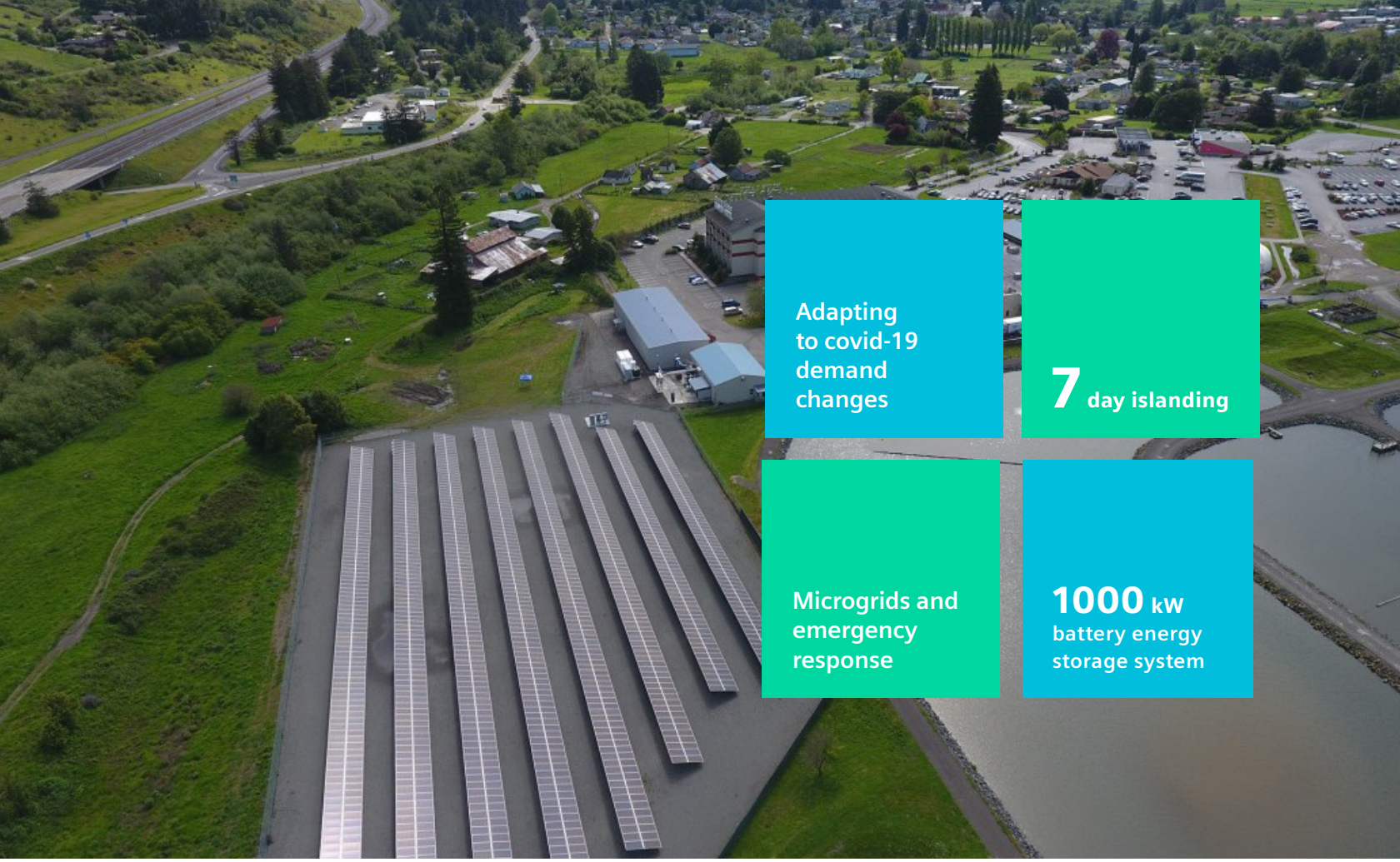
Supplemental Information
References

Siemens generates or delivers more than one-third of all the electricity produced in the U.S. and is leading the energy sector through the complexities of moving to distributed generation and optimized integration of renewables. Having deployed 21 GWs of wind and 2.3 GWs of solar, Siemens is a true global leader in clean, renewable energy. We have long been a major player in the solar market, delivering projects for more than 30 years. During this time, we have continued to innovate, and our latest generation of manufactured solar modules and inverters are installed in some of the largest utility scale projects around the world. Over the last few years, Siemens has become increasingly focused on a downstream solutions-based business model, where we implemented Distributed Generation solar projects for our global client base.

We include on the following pages several case studies where Siemens has successfully worked with utilities and organizations to plan, design, build and operate microgrids.

Siemens Experience, Expertise
Decarbonization to Electrification

- 2.3 GWs of Solar PV
- 1 GW of Battery Energy Storage
- 2,500 MW of CHP Solutions
- Microgrids in 16 Countries



Blue Lake Rancheria
Humboldt County, CA

Blue Lake Rancheria Microgrid is setting a new standard to remote community energy projects. It sits in an outage-prone region frequented by natural disasters. To better serve its community, the Native American tribe sought to build a microgrid to ensure power resiliency and reliability. The Tribe set goals for its investment in line with their key tenets of Emergency, Economics and Environment. These goals included support for seven days islanded operation, 25% reduction in energy cost and CO2 reduction of 195 tons. The Blue Lake Rancheria Microgrid project added 420kW of solar PV, 1MWh of battery storage and an advanced Siemens software control system to tie it all together. Siemens also provides electrical system stability and grid impact study to investigate the potential impact to grid stability of installing a microgrid within a utility distribution network. The project reduces annual energy consumption delivered over the grid by 680 MWh, produces lower cost and/or more sustainable local renewable generation, and improves overall power supply reliability and resilience. Click on the boxes above to learn more about the Blue Lake project.

Jana Ganion, Sustainability and Government Affairs Director
PO Box 428, Blue Lake, CA 95525
(707) 668-5101 x 1044
jganion@bluelakerancheria-nsn.gov

Algonquin College
Ottawa, Ontario

Siemens helped Algonquin College launch the ESCO2 project. It is based on a 20-year energy performance contract, within the scope of which Siemens delivered infrastructure upgrades (from HVAC retrofits to cogeneration (CHP) facility installation, chiller plant optimization, and building automation control optimization). The partnership goes further however: Siemens also helped Algonquin College not just cut its energy use, but also its carbon emissions. This was achieved through Distributed Energy Systems, in the form of a natural-gas-fired cogeneration plant, along with micro-grid technology. All of which enables the College to create, direct and store its own energy. Last but not least, Siemens is supporting the College's educational mission by providing new research opportunities for the students: All the technology is on display, turning the College into a living lab in which Siemens experts are also teaching students about sustainability, through a new graduate certificate program that enables specialization in the subject.

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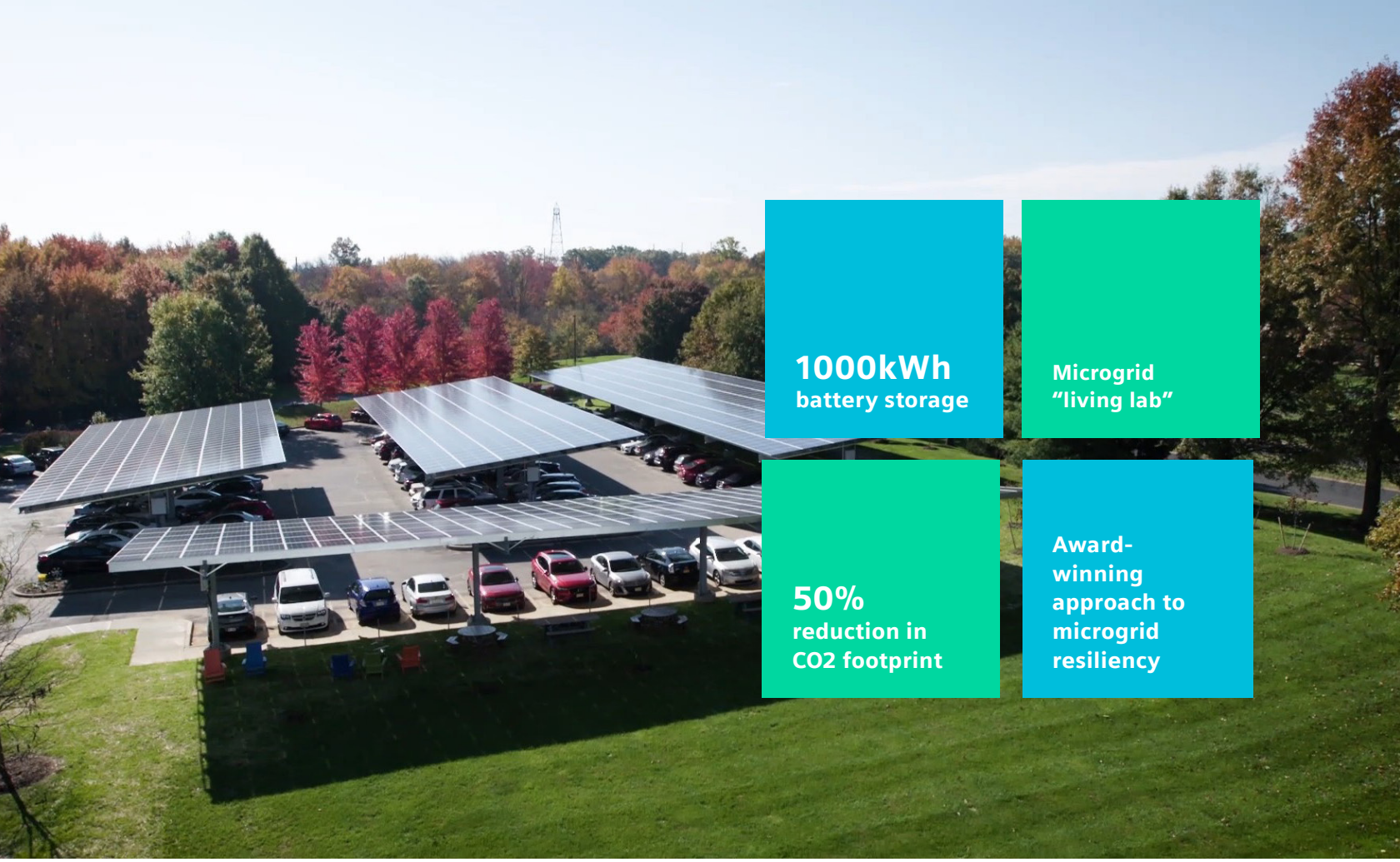

Siemens R&D
Princeton, NJ

Siemens has launched an advanced microgrid research and demonstration environment at its U.S. Corporate Technology headquarters in Princeton, NJ. This living lab will validate the latest technologies in order to provide the market with a comprehensive blueprint of how microgrids can be flexibly operated in similar locations such as universities, office parks and industrial sites.

The Princeton microgrid integrates technologies across the company's Smart Infrastructure portfolio including photovoltaics (PV) integration, battery storage, electrical power infrastructure, building management systems and microgrid management system, allowing researchers to study each component of the microgrid and the system as a comprehensive whole. The living lab will also result in a 50% lower CO2 footprint of the Princeton facility.

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GLOBAL SOLUTIONS FOR ENERGY AUTOMATION

Cybersecurity

SIEMENS

Contents

Cybersecurity is a highly sensitive area that demands a trustworthy partner. A technology partner who understands how products, systems, and solutions integrate with the processes and people behind them.

We combine an industry-leading smart grid portfolio with extensive experience and expertise in delivering cybersecurity solutions. As a multinational company with a global reach, we have the size and competence to provide reliable and sustainable support that you can rely on.

Our domain knowledge and integration capabilities make our portfolio the most comprehensive in the industry. We offer product, solution, and service security that includes unique life-cycle support.

We actively work with international standards organizations to develop and improve security standards for smart grids, and we advise regulatory authorities on technical and process-related topics.

We facilitate a Siemens wide Computer Emergency Response Team (CERT), and our oversight of CERT gives us increased visibility into global cybersecurity threats.

I. Cybersecurity in the Digital Grid

Providing a cost-efficient, secure and reliable energy supply is the core business of electric utilities that operate critical infrastructure. The way grids are operated and managed has changed dramatically due to the integration of renewable and decentralized 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 house- holds, the growing interconnections create more points for potential attacks to critical infrastructure. Consequently, cybersecurity is top of mind for power system operators today.

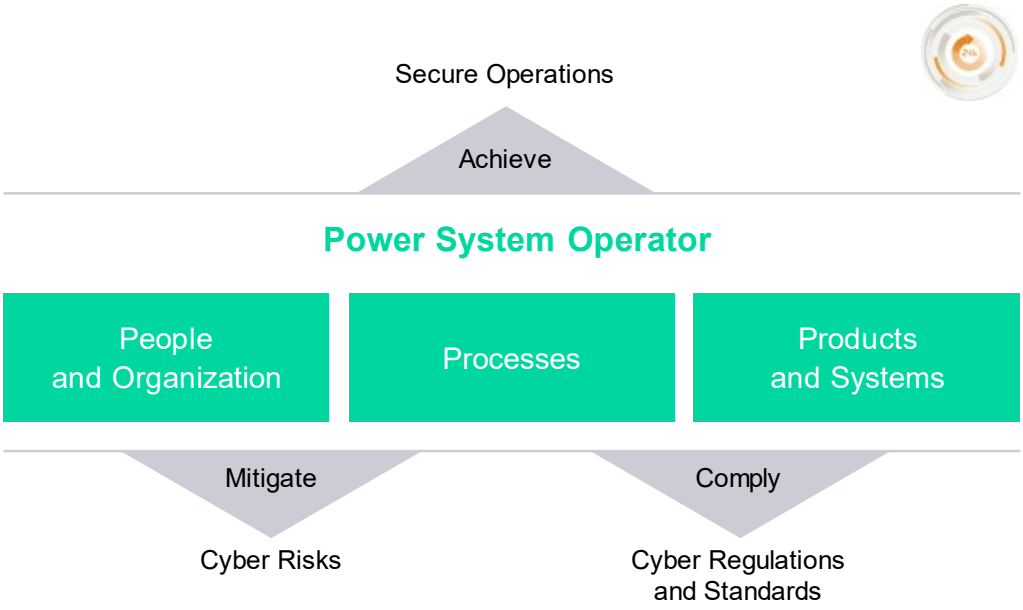

Figure 1: Cybersecurity Targets to a Power System Operator

As shown in Figure 1, one key target of a power system operator is to secure operations, i.e. to ensure a stable supply of power and the protection of assets at any time, at competitive costs and while considering regulations. From that perspective cyber threats are perceived as risks jeopardizing the security of supply. Cybersecurity encompasses all the measures dealing with mitigating such risks, following industry standards, and where relevant, meeting local regulation related to cybersecurity. To achieve this target, the power system operator:

- Must comply to cyber related regulations which are describing “What must be done”
- Should be conform to cyber related standards who are describing “How should it be done”
- Must mitigate cyber risks

Cybersecurity controls can be implemented in the area of **p**eople and organization, **p**rocesses, and **p**roducts and systems. This reflects the so called ‘3’P’s’ relevant for a holistic cybersecurity approach.

Siemens products and solutions enable operators to be compliant with cyber regulations. Furthermore, the products adhere to international standards in order to support interoperability with third-party components. Siemens provides cybersecurity consultancy services that cover assessments for regulatory compliance and establishment of protection concepts for mitigating cyber risks in energy automation.

II. Siemens Cybersecurity Framework

The Siemens cybersecurity framework defines the way how cybersecurity has to be addressed by the various actors in the energy value chain. It is based on the following:

- **Cybersecurity regulation**
  Cybersecurity regulations must be supported by all actors within the energy value chain
- **Cybersecurity standards**
  Existing international standards describe cybersecurity ranging from governance to specific realization options in products. The three key standards in energy automation are ISO/IEC 27001, IEC 62443 and IEC 62351
- **Cybersecurity guidelines**
  Guidelines give recommendations on cybersecurity implementation. The most common and recognized guidelines for power grids are: NIST IR 7628, NERC CIP, BDEW whitepaper

As part of the guidelines, Siemens defines 14 categories of security measures, see Figure 2. Reflecting a holistic approach to cybersecurity, these categories encompass the so called '3 P's':

- People and organizations: those who are running the company
- Processes: those used by the people and organizations to fulfill the business needs
- Products and systems: the underlying infrastructure to support the business needs

Categories of security measures related to organization and processes are indicated in the gray boxes in Figure 2. Security measures related to products and systems are categorized over the green boxes in Figure 2.
The categories of security measures are described here:

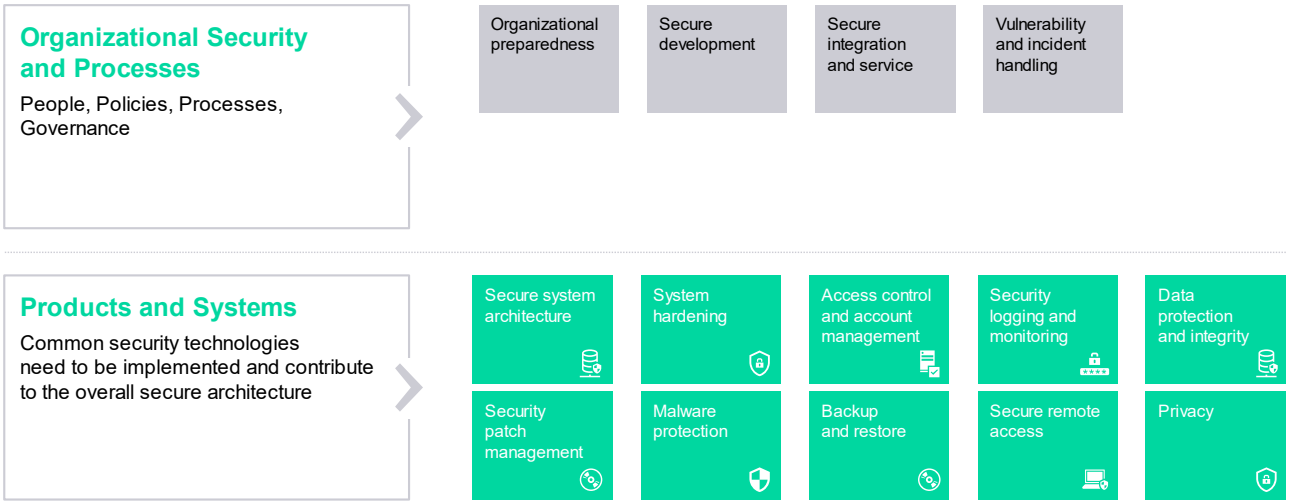

Figure 2: Siemens categories of cybersecurity measures

1. Organizational preparedness

Establish security measures to develop, integrate and maintain secure products and solutions. This impacts the whole organization in the form of defined roles, clear responsibilities, adequate qualification, policies, processes, tools, and communication. The information security policies at Siemens are in accordance with the information security management system standard ISO/IEC 27001. The Siemens Digital Grid (SI DG) business is certified to be compliant to ISO/IEC 27001:2013 with the scope of applicability including development, production, engineering sales and service of its products, systems and solutions.

2. Secure development

Secure development is a systematic approach to integrate cybersecurity into the product and solution development lifecycle. It is part of the complete process chain, from cybersecurity requirements to cybersecurity validation. It also covers the securing of the IT infrastructure that is needed for the development organization. At Siemens Digital Grid, the security development lifecycle is in adherence to the IEC 62443-4-1 standard.

3. Secure integration and service

Cybersecurity is an integral part of Siemens' processes to deliver solutions to the customer, who receives solutions with design, integration and commissioning executed according to cybersecurity best practices, ensuring optimal support for secure operations. At Siemens Digital Grid the secure integration and service process is certified to be compliant to the IEC 62443-2-4 standard.

4. Vulnerability and incident handling

Vulnerability and incident handling is the process defining how an organization reacts to and handles security vulnerabilities and incidents, including the related internal and external communication. The process also interfaces as required with the regular vulnerability monitoring and patch development process of the product or solution development.

Siemens has its own in-house Computer Emergency Response Team (CERT). The Siemens ProductCERT team is mandated with monitoring and analyzing security issues and publishes product related advisories on vulnerabilities and associated mitigation recommendations in conjunction with the respective Siemens organizational units. Additionally, with its recognized expertise in penetration testing Siemens ProductCERT checks Siemens products and third-party components used within the Siemens portfolio for weak points by means of selective hacker attacks, resulting in recommendations on implementation guidance to the respective Siemens organizational units.

5. Secure system architecture

A cybersecurity architecture must not only support the regulatory requirements, but should provide security by design, too. Protecting the power system requires a defence-in-depth approach, addressing cyber risks and supporting secure operations through people, processes and technologies.

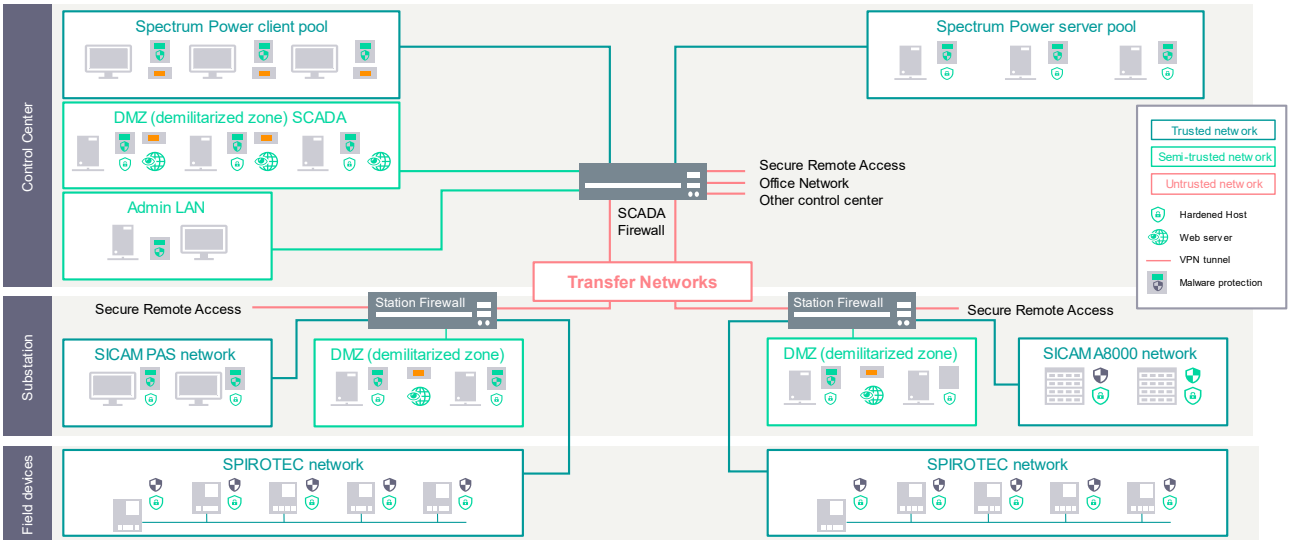

Figure 3: Cybersecurity architecture

The architecture is the most visible part of a comprehensive cybersecurity approach. It forms the basis for applying further measures in people, processes and products as defined covering this cybersecurity framework.

6. System hardening

Hardening reduces the attack surface of the products and solutions by means of secure configuration. This is reached, e.g., by removal of unnecessary software, unnecessary usernames or logins, disabling of unused ports, or OS hardening. Siemens provides guidelines for products and systems on hardening and can support operators in hardening of their infrastructure.

7. Access control and account management

Access control is the selective restriction of access to products, solutions, or infrastructure, by authenticating users (and systems) and authorizing them by granting appropriate permissions. Account management is the definition of different user accounts with suitable privileges that is best performed in a centralized way with unified security policies. Siemens can support system operators in design and implementation of a central and hierarchical access control and account management system. Power system operators can integrate Siemens Digital Grid products and solutions seamlessly into their central user management solutions alongside products from other vendors.

8. Security logging/monitoring

Security logging/monitoring means to capture and monitor all security related activities performed across the system, including user account activities such as login/logout, or failed login attempts. Alarms are reported for further follow-up accordingly. Siemens products and solutions support centralized logging of security events and alarms by means of the syslog messaging standard, thereby providing the basis for sophisticated Security Information and Event Management (SIEM) solutions.

9. Security patching

Security patch management includes vulnerability monitoring for all software components (own and third-party) used in a product or solution, classification of the vulnerabilities and available patches, security patch compatibility tests and, if needed, the development of additional security patches to address incompatibilities. For a solution, this includes the delivery and maintenance of a system with up-to-date security patch level installed. Siemens offers comprehensive patch management services to energy automation operators.

10. Malware protection

Protection of a product or solution against malware is ensured through the support of appropriate malware protection solutions (e.g., classical antivirus, application whitelisting, or software signing) and appropriate procedures to ensure that all systems are protected against latest malware. Siemens has malware protection available for key components used in the energy automation, offers technical solutions for malware protection and supports customer to establish a secure update process for antivirus patterns.

11. Backup and restore

Backup is the process of copying and archiving of software, configuration data, and operational data, such that a product or solution can be restored, e.g., after a data loss event. This includes appropriate measures and procedures for disaster recovery. Siemens has backup and restore concepts available and supports system operators to assess and establish respective process.

Backup and restore is the basis for a disaster recovery process on operator side.

12. Secure remote access

Secure remote access in context of energy automation systems is the encrypted, authenticated and authorized access to control center and substation assets from remote sites through potentially untrusted networks. Siemens offers a ISO/IEC 27001 certified secure remote access solution optimized to the needs of power system operators.

13. Data protection and integrity

Data protection ensures the protection of all sensitive data across the system both in rest and in transit. Such data must be accessible only to authorized persons or processes. In addition, also the integrity of data and communication across the system, and the availability of the data needs to be ensured through appropriate methods. Siemens components support the required functionality to meet data protection and integrity needs, while processes implemented within Siemens ensure that customer data are managed with due care at all phases of customer projects.

14. Privacy

This ensures the users' ability to control when, how, and to what extent information about themselves will be collected, used, and shared with others. Information privacy is a particularly sensitive matter where personally identifiable information is collected, e.g. such as in Smart Metering application. The Siemens portfolio helps operators to comply with the associated regulatory requirements such as the General Data Privacy Regulation (GDPR) in the European Union.

III. Operational security

In operational security, the interplay of the '3 P's' becomes obvious: products and systems, people and organizations need to work together according to the defined processes. In operational security, key functionalities include measures such as security patch management, access control and account management, security logging and monitoring, and malware protection. These measures are necessary to establish a protective and detective environment, where accountability and traceability of all actions involved in operation of an energy grid become relevant and support the possibility to take corrective control within the operational environment. Siemens has the target to support operational security by relying on international standards.

1. Vulnerability and incident handling
Handling vulnerabilities and incidents is one of the mandatory requirements to protect the energy network.

Vulnerability handling includes the definition of counter- measures, if required, and the communication towards the operator in order to inform appropriately about relevant vulnerabilities, workarounds, and available patches, see Figure 4. This enables power system operators to analyze provided security advisories, and to define and apply countermeasures effectively.

Just as vulnerability handling supports to protect the business, incident handling addresses the needs to respond to, and recover from, cyber incidents in an effective manner. Although the security measures needed for incident handling are similar to the measures for vulnerability handling, it requires a corresponding organizational preparedness in effective handling of incidents.

2. Security patch management
One of the most crucial activities in cybersecurity is patch management. Due to the increased interconnectivity, the threat that attackers utilize known vulnerabilities has increased tremendously.

Standards such ISO/IEC 27002 and IEC 62443-2-3 give guidance to operators about how to implement adequate measures for a patch management process. A summary of the recommended process steps for operators are:

- Taking a complete asset inventory
- Monitoring and analysis of reported vulnerabilities
- Checking available patches
- Checking compatibility
- Testing in an environment that reflects the production environment
- Scheduling the patch installation
- Installing patches or mitigation measures
- Updating the asset database

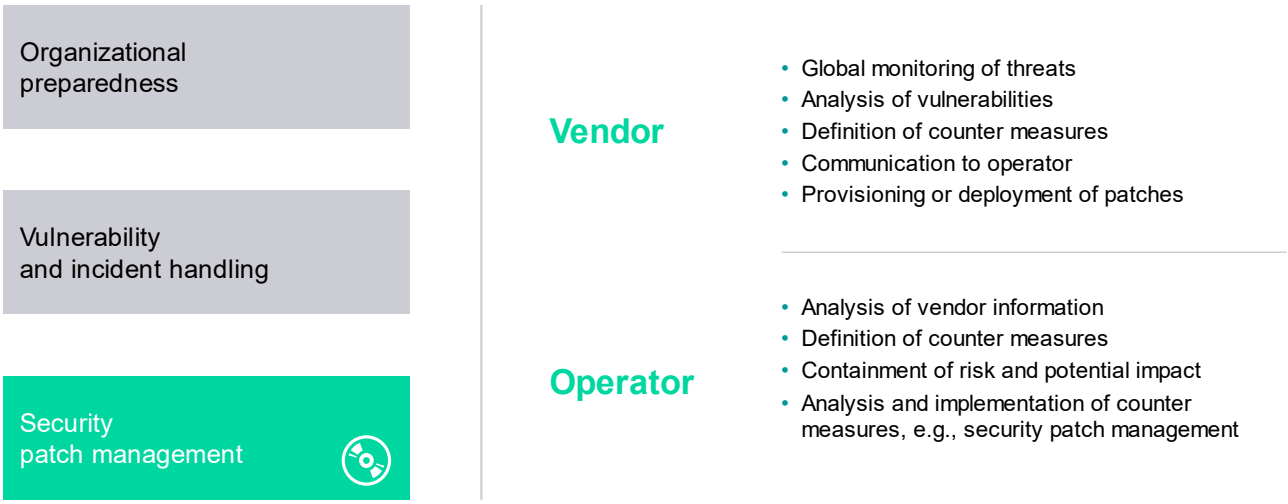

Figure 4: Tasks and Capabilities Needed in Vulnerability Handling

Equally, defined requirements for system vendor on patch management are defined in standards such as IEC 62443-2-3 and IEC 62443-2-4:

- Providing documentation concerning patch management policies for components and systems
- Verification of patches concerning compatibility and applicability for own and third-party components
- Providing the patch information and patches to the operator
- Providing lifecycle information for products and systems including end-of-life information.

Siemens meets these requirements with a comprehensive patch management process for products and systems. This includes a regular patch test for own and third-party components, and the provision of the test results to customers. Hereby, Siemens in-house CERT is used for a comprehensive vulnerability scanning and communication of vulnerabilities and advisories for all Siemens products, see section II item 4. Additionally, as a prerequisite for a patch management process, Siemens provides 'back-up and restore' documentation on product and system level.

A simplified process is shown in Figure 5, with the initial activities and the cyclic activities of a complete patch management process from the operator's point of view.

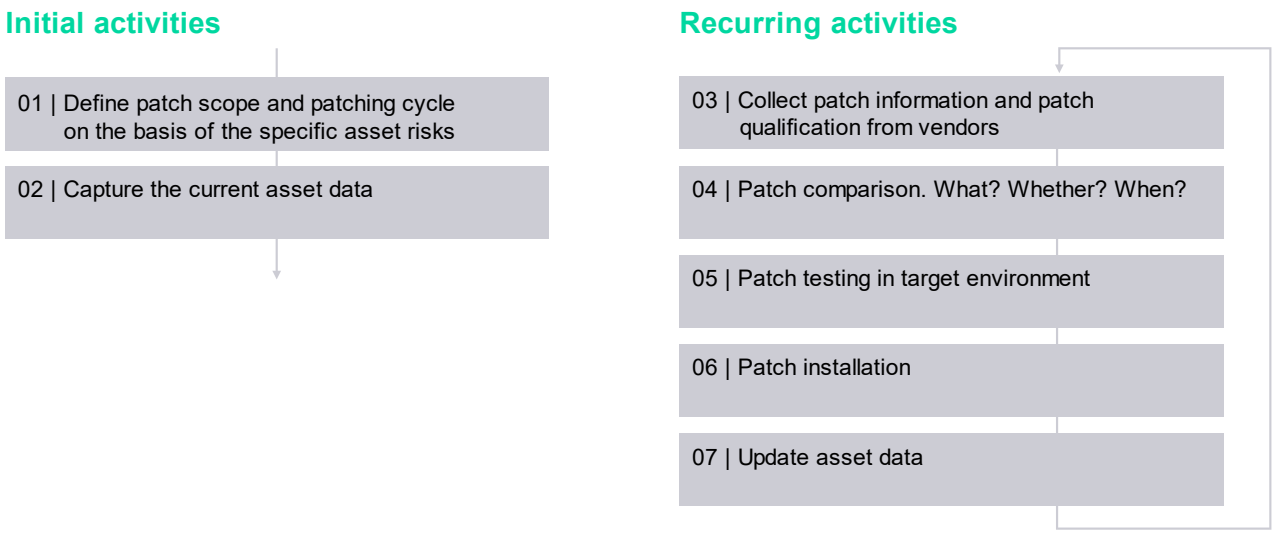

Figure 5: Simplified Patch Management Process

The initial activities include the migration to a secure system the definition of the assets to be taken into scope, and prepare the asset data as required in order to be able to perform patch management (steps 1 and 2).

The recurring activities start with the collection of patch information based on the asset inventory (step 3) and a decision, what, whether and when patches have to be installed (step 4); the patch validation (step 5) and the patch installation (step 6) follows accordingly. Finally, the asset data needs to be updated (step 7).

Siemens offers comprehensive patch management services for products and systems to meet the regulatory requirements derived from ISO/IEC 27001 based on all process steps. These services include, as option, vulnerability notification and reporting for customer OT systems including 3rd party products (routers, switches, substation components, ...)
The service is offered in adherence with the IEC 62443-2-3 and IEC 62443-2-4 standards.

3. User management and access control
The basic principle of access control is shown in Figure 6. Access control ensures that users (and systems) can only interact with resources as intended. This is only possible if the user is authenticated, i.e., if it is verified that the user is who he claims to be, and also authorized, i.e. it is verified that the user is permitted to perform the operation he intends to perform with/on the resources. Identity management is the trust base in this pyramid, as it manages the users and credentials to be controlled. For completeness, access control does not only consider the users, but also any resources such as devices or applications.

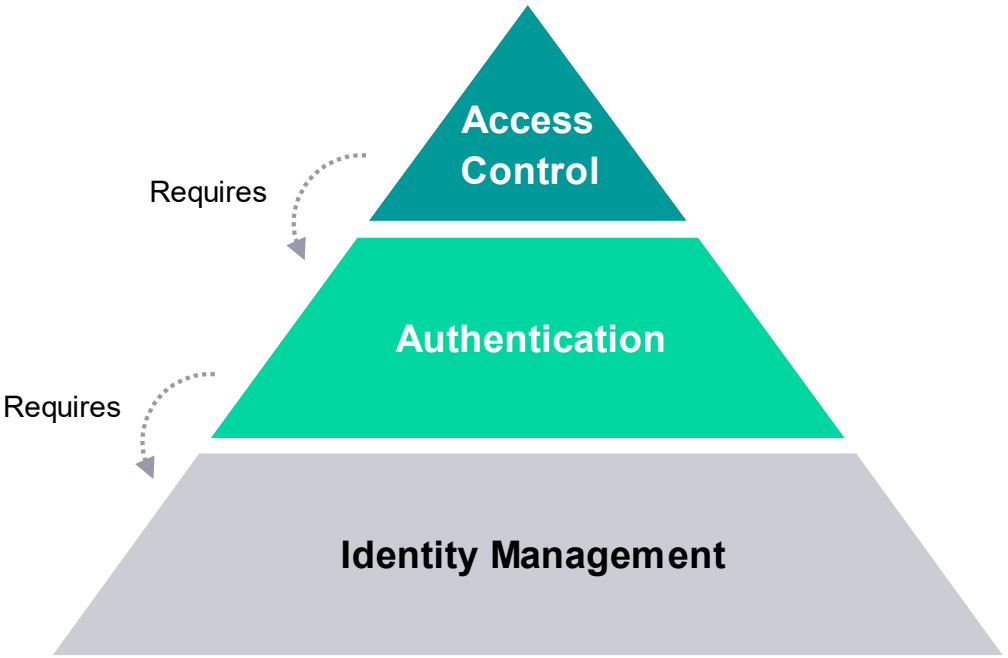

Figure 6: Identity- and Access Management – The Basic Principle

Access control is relevant in all lifecycle phases (from commissioning, operation and renovation to decommissioning) of systems and networks. The most crucial phase for cybersecurity is during the daily operations. Typical access control scenarios include physical access, HMI access, IED access, remote access, etc. Additionally, due to safety reasons, emergency access routes are defined in order to grant access to authorized personnel in times of unplanned unavailability of the regular access control mechanisms.

There are several options to realize access control in the power grid with different levels of depth and security. A typical solution for a centralized approach is the usage of LDAP or RADIUS servers in order to manage identities. Authentication and authorization can be established by means of password verification or by using a public key infrastructure (PKI) based handling of X.509 certificates. The access rights are defined by the system or device, as these are specific to those devices based on the operational function provided.

State-of-the-art energy automation products and systems use central user management to implement role-based access control based on standards such as IEC 62351-8. See Figure 7 for a solution variant.

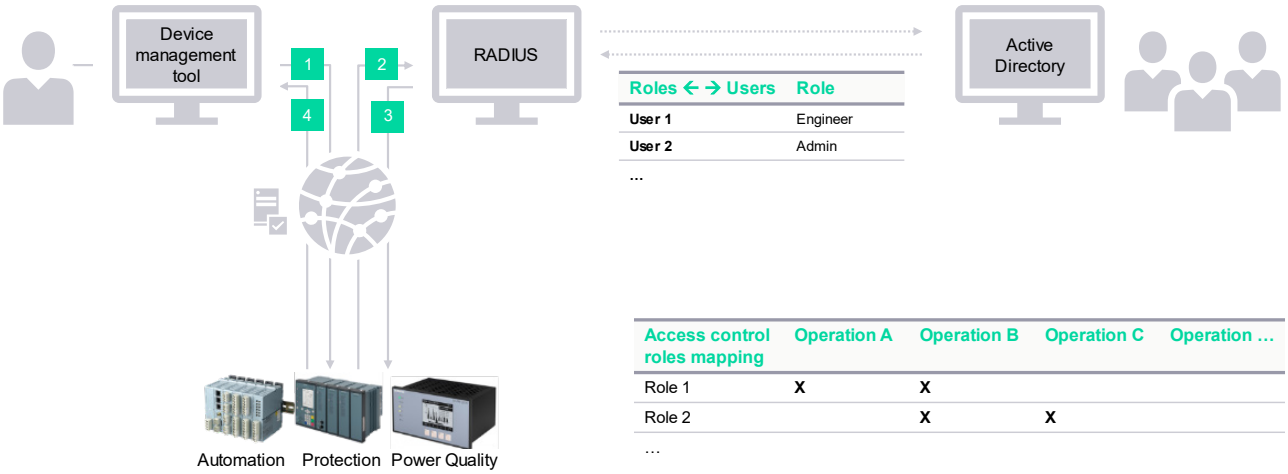

Figure 7: Role based Access Control Example

A user is requesting access to an IED via a device management tool (1). The IED sends this request to the central user management server for authentication of the user (2). The server replies with the result of the authentication, including the role(s) assigned to the user in case of successful authentication (3). If the user has been successfully authenticated by server, the IED initiates the role-based user session (4).

Due to the multi-vendor environment of power grids, a standardized approach based on IEC 62351 is most crucial for an effective access control implementation in order to support interoperability.

It is important to consider transitionary technologies and tools that address the restrictions of the generation-old secondary equipment that will continue to represent the majority installed base along the years to come. Multi-vendor, proprietary access management solutions for older generation secondary equipment can be deployed alongside standard user management systems in order to close the gap in managing the users and rights for both, old- and newer generation installations.

4. Security Information and Event Management

The protection of an energy automation system alone is not enough. Attempts to attack the systems must be recognized at an early stage so that appropriate measures can be taken before the functions of the systems are adversely affected by the attack.

International standards such as IEC 27001, IEC 62443 and industry recommendations such as the BDEW white paper also address the topics of “logging” and “logging and monitoring”.

A manual evaluation of the information is not possible in a modern energy automation system due to the sheer volume of log events generated by the monitored systems. The fulfillment of these monitoring requirements requires the implementation of an automatic evaluation of the information. The solution for this is a Security Information and Event Management system – SIEM.

A SIEM collects all security related logs from all components of the system and stores them immutably in the chronological order. The security-relevant event log messages from energy automation components are sent via “syslog” protocol to a syslog server for site-local persistence and protection of the event information. The syslog server on substation level acts as a buffer in relation to the central SIEM. With some constraints regarding availability addressed, it is also possible to send the syslog information from the components directly to the central SIEM system.

The security related information differs depending on the type of component. In general, events such as login attempts, changes of configuration, detection of potential malware are reported. For example, a firewall logs in addition the blocked traffic.

All the information are combined and evaluated in the SIEM in order to correlate and detect abnormal behavior of/in the system.

If the SIEM detects an attack or an anomaly, an alarm message is issued and the operator is informed, for example via email.

The syslog information is stored in the SIEM so that it can be used for a forensic analysis after a cyber incident. A SIEM can generate reports of security events that cover a specific malfunction or a specific period.

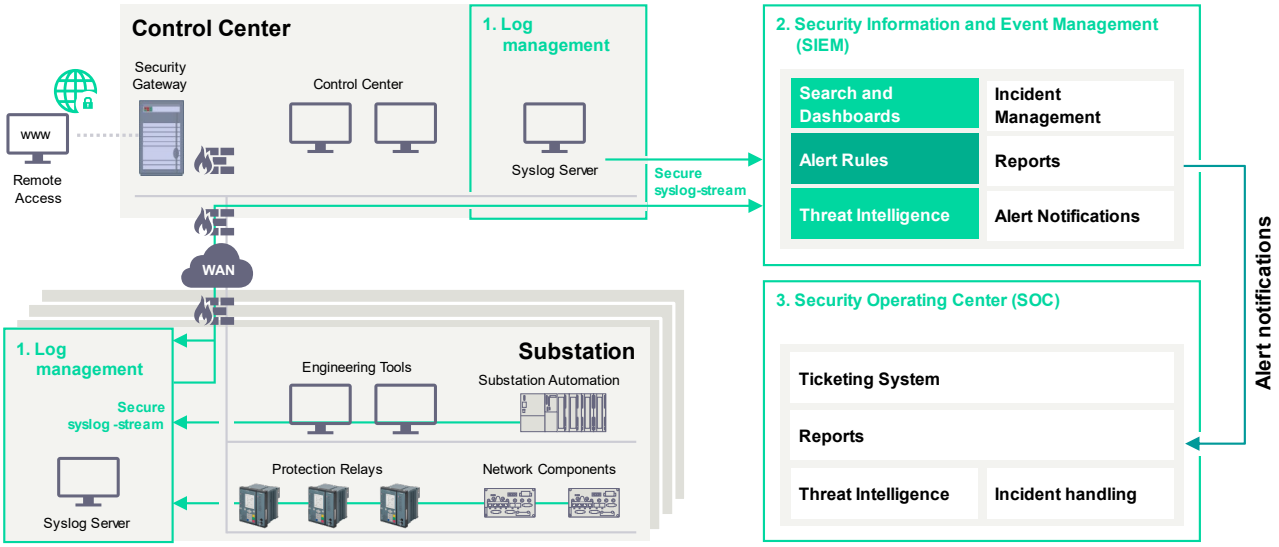

Figure 8: SIEM as on-premise solutions

Architecture

The logging system collect the security event information in the substations and in the control center sites in local syslog server installations. The information is then transmitted from the local syslog servers to the central SIEM system.

- The logs are buffered in the local syslog servers. In case the SIEM is not reachable due to communication issues, the logs are still available locally at each monitored site
- This ensures a lean, secured and encrypted interface from the automation systems to the SIEM for the transmission of security events
- This simplifies to transfer the data to other or additional systems in the future without interfering with the existing infrastructure

Boundary conditions

The essential components of the energy automation system must detect the security-related events, record the related information and make them available via the syslog protocol. The Siemens components for energy automation and communication such as SIPROTEC 5, SICAM A8000 and Ruggedcom meet these requirements.

SIEM-as-a-Service

In addition to on-premise SIEM solutions, Siemens offers SIEM-as-a-Service solution. The general components in the substation or control center are the same. The difference is only the location of the SIEM system. Instead of installing the SIEM in a data center of the power system operator, the SIEM is installed in a secured cloud environment managed by Siemens.

The main advantages of a SIEM-as-a-Service are:

- No efforts for the administration of the SIEM hosting on operator side
- High availability
- Scalable
- Security patches and software updates for the hosted SIEM infrastructure are managed by Siemens

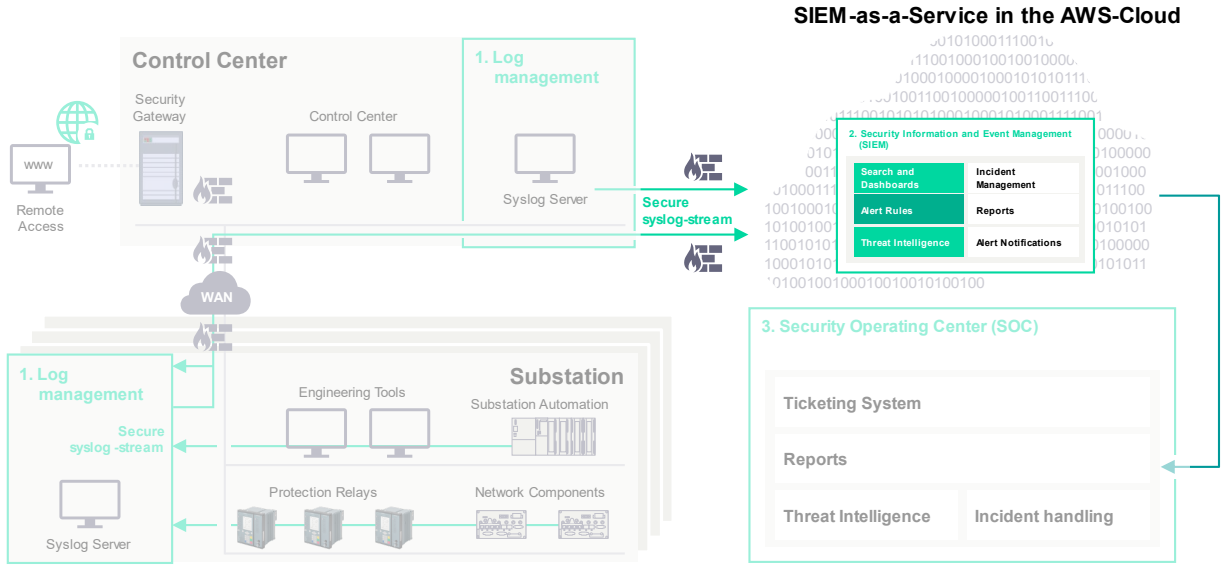

Figure 9: SIEM-as-a-Service solution

A cloud solution must fulfill the same security requirements as a solution on premise. A state-of-the art security is essential for the SIEM-as-a-Service solution. The foundation is given by the Amazon Web Services (AWS) cloud infrastructure as basis, which is in line with the Cloud Security Alliance (CSA) best practices for security assurance within Cloud Computing. A secured communication from the OT systems to the cloud infrastructure complements the overall security.

The SIEM-as-a-Service constitutes:

- SIEM with analysis and alarming functionalities provided as a cloud service on a per-customer basis
- SIEM-ready upgrade of your operational systems that need to be monitored
- Implementation of alarm rules in the SIEM system
- Regular update and adaptation of the alarm rules to evolving cyberthreats
- Training on SIEM usage for customer employees

Contact your local Siemens partner for more information.

IV. Applied cybersecurity

An effective cybersecurity requires addressing cybersecurity on various levels. This section will provide best-practice examples in which the methodology and security measures described above have been applied in order to protect products and systems.

The implementation of cybersecurity requires to consider the requirements as defined in the cybersecurity framework (section II), and to support operational cybersecurity requirements (section III).

1. Product security

Siemens has taken a holistic approach for the energy automation portfolio including processes, communication, employees and technologies. First, cybersecurity is established in the organization by defined roles, rules and processes; a governance structure has been implemented according to ISO/IEC 27001. Second, secure product development, adherent to a secure development lifecycle processes such as IEC 62443-4-1, is part of the product lifecycle management that satisfies the stringent demands on cybersecurity and incorporates a secure product architecture.

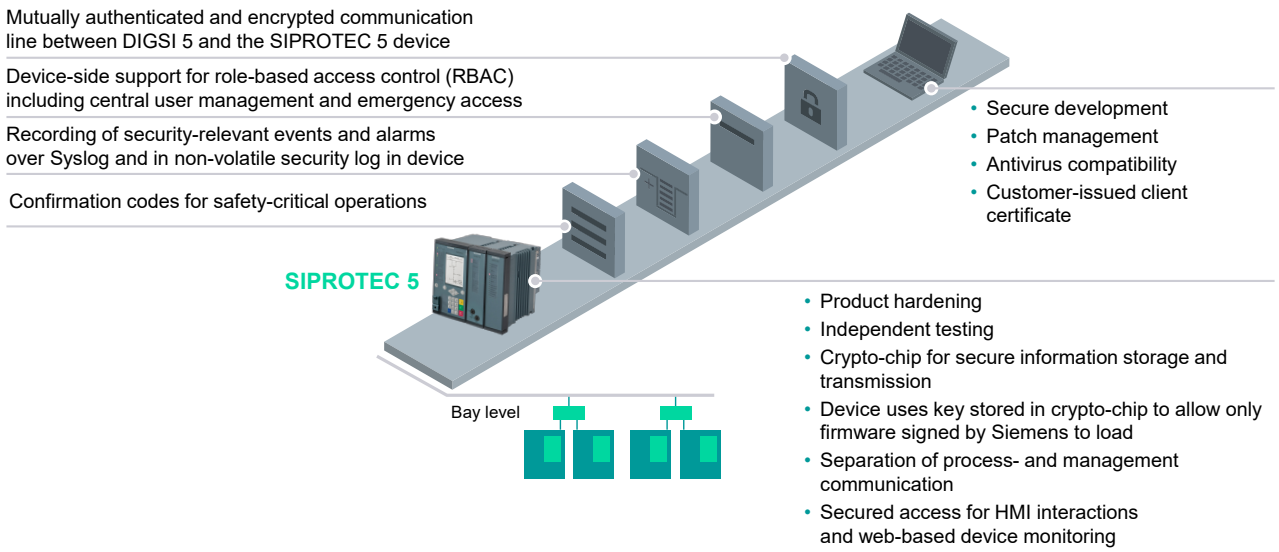

Figure 10: Security features of a current generation protection device

Product development includes the secure design starting with security requirements, the implementation of software, and the execution of systematic cybersecurity tests. Cybersecurity of Siemens' own infrastructure also plays a major role. Internal design documentation and the source code have to be protected against unauthorized access and tampering in order to secure the integrity needs by applying ISO/IEC 27001 controls.

Security-enabled energy automation products are the foundation of a secure energy automation system. Cybersecurity requirements for the products depend on various factors, including the intended function (protection, control, operation or monitoring) and the spatial layout of the products. Security functions in modern energy automation products follow the general goals of cybersecurity: availability, integrity and confidentiality, and meet the industry specific standards. Current generation protection devices can satisfy these needs, see Figure 10. Secure communication between the engineering software and the device is crucial for secure operation. The encrypted connection is only established after mutual authentication of each other's X.509 certificates. Customers may choose to issue their certificates to the engineering software installations from their own public key infrastructure (PKI) for higher operational security. Role-based access control (RBAC) is applied for user authentication and authorization, that is adherent to the IEC 62351-8 RBAC

standard, the IEC 62443-4-2 standard, and the BDEW whitepaper and NERC CIP recommendations among others. All security-relevant events are logged in a non-erasable security log and optionally over the syslog protocol to a central logging server. The protection device is equipped with a crypto chip that assures the cryptographic functions, including a cryptographic integrity check of the digitally signed device firmware in a protected environment.

During software production, the firmware is provided with a digital signature which the device can authenticate in order to ascertain that the firmware has not been tampered on its transit from the production facilities to the device itself. Furthermore, the device enables a physical and logical (V-LAN) separation of IP- and Ethernet-based process and management communication. Devices communicating outside of a physically protected zone have to satisfy higher communication security requirements than devices communicating within a physically protected area.

Siemens periodically tests security patches and virus patterns on a reference system in order to verify that regular installations of operating system do not affect the availability of energy automation functions.

For distribution automation scenarios, where it is not always possible to establish adequate physical security measures to protect automation equipment from process communication manipulation, Siemens A8000 RTU products support end-to-end encryption using TLS and end-to-site encryption using IPSec. The SICAM A8000 RTUs securely communicate via IEC 61850 MMS/IEC 104/DNP3i protocols to the control centers and other sites in adherence to the relevant process communication security standards IEC 62351-3/-4/-5, see Figure 11.

The RTU/Gateway can automatically obtain required certificates from a standards-compliant certificate authority (CA) server for securing its IEC 60870-5-104, DNP3i and IEC 61850-MMS communication in master/slave and client/server roles.

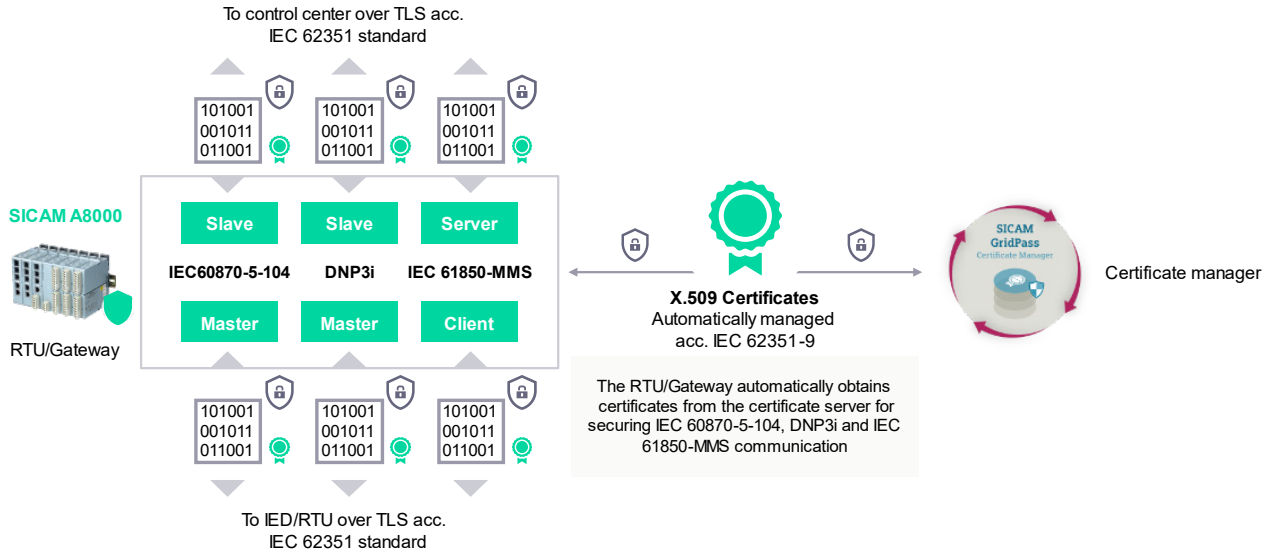

Figure 11: Communication security features in a current generation RTU

2. System security – digital substation example

As a system integrator, Siemens is responsible for integrating products in a secure way. This task, too, requires dedicated process descriptions, guidelines, and technical descriptions to ensure secure integration. The system configuration is subsequently carried out according to the technical descriptions. Security measures are validated during the Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) based on defined test cases. The Siemens Digital Grid (SI DG) secure substation blueprint and security program are certified to be compliant to IEC 62443-3-3 and 62443-2-4 respectively. The certified secure substation blueprint comprises a complete digital substation including protection relays, RTUs, communication gateways, runtime and service PCs, engineering software, routers, switches GPS clocks, logging server, firewall and intrusion detection system.

For substation automation systems, the realization of security functions is subject to a number of constraints like the requirement of availability, expected 24/7 operation without interruption. A substation is typically a mixture of PC-based and embedded systems from various vendors with life spans of up to 40 years. Hence, an energy automation system is frequently made up of various components from different vendors, different technologies, and different technological generations. Many of the established office IT measures prioritize protection goals differently, or inadequately account for the special boundary conditions. This calls for the implementation of strategies tailored to the needs of energy automation.

In Figure 12, the security measures applied to a digital substation are shown. All cybersecurity measures basically follow at least the security design principles “Defense in depth principle”, “Least privilege principle”, and “Network Segmentation”.

Network segmentation is a powerful protection mechanism. The fundamental idea is to group network elements with sensitive communication needs and similar level of protection into the same subnet. Firewalls filter inbound and outbound traffic. These zones also called “trusted zones”. It is not allowed to bypass the firewalls. The trusted zone is not accessible from outside, from untrusted net- works. To get access to the trusted zone from outside, Siemens uses a “buffer” zone, the Demilitarized Zone (DMZ). With this approach, the security requirements for “trusted zone” internal communication can be often reduced to a feasible level for typical industrial components, compared to a larger network that does not rely on security zones.

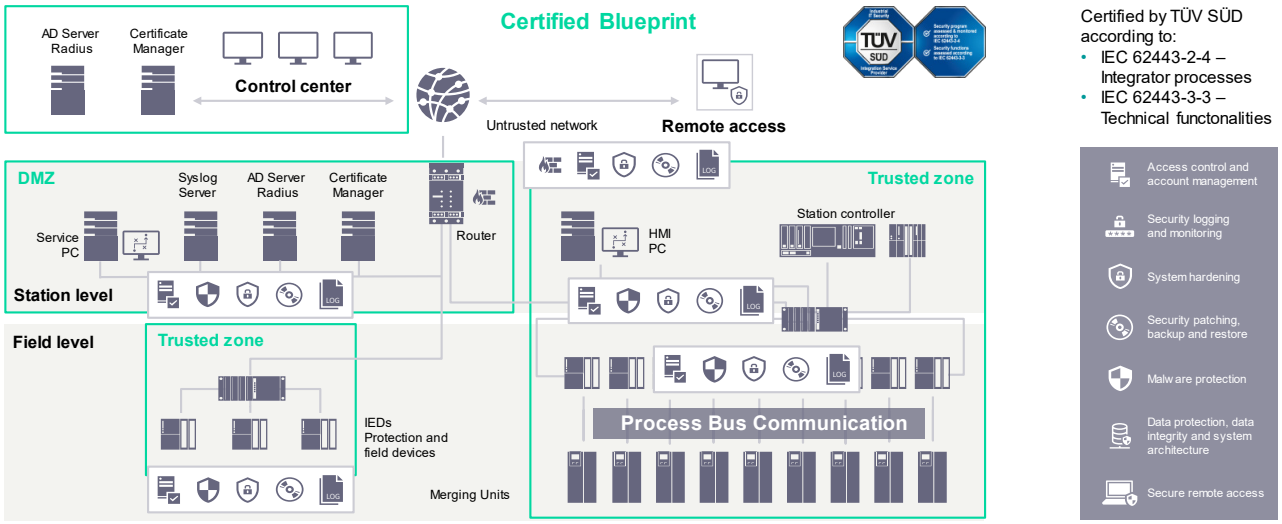

Figure 12: Secured Digital Substation compliant to IEC 62443-3-3 and IEC 62443-2-4

The principle of least privilege is the practice of limiting access to the minimal level that will allow desired functionality. Applied to human users, the principle of least privilege means that the user has the lowest level of user rights to be able to execute the desired tasks. The principle is also applied to all other "members" of a system like devices, software applications, services, and processes. The principle is designed to limit the potential damage of any security breach, whether intended or unintended.

Defense in depth is the coordinated use of multiple security controls to protect a system. The goal is to provide redundancy in case one security control fails or vulnerability in one security control is exploited. Components of defense in depth include, for example, the security controls such as firewalls, account management, malware protection, and secure hardening.

All security measures are implemented under considerations of the general limitations of substation automation systems and the security design guidelines. The cybersecurity measures are (cf. Figure 2 and section II on security categories):

- Access control and account management
- Security logging and monitoring
- System hardening
- Security patching, backup and restore
- Malware protection
- Data protection, data integrity, and system architecture
- Secured remote access

Looking into malware protection as one cybersecurity measure example, the implementation offers different options.

Blacklisting/Antivirus
Classical antivirus solutions that compare the content of the PC file system with patterns of known viruses.
In case of a positive match, the antivirus software alerts the user.

Application whitelisting
An application whitelisting solution is a protection mechanism that allows only trusted programs and applications to run on a system. After installation of the system software and applications, additional whitelisting software is installed on the virus-free system. After installation is complete, a whitelist of programs, applications and services will be generated by the whitelisting solution. All applications/programs/services on the list will be signed or secured by a checksum. This ensures that only approved software will be executed. Downloaded software or viruses that might potentially have infected the system after activation of the whitelisting protection will be prevented from executing.

All Windows-based PC systems are equipped with appropriate malware protection. The advantage of the application whitelisting is that it is not necessary to install regular pattern updates for newly developed malware immediately.

The decision on which solution fits best to the system operator's requirements and operational management must be taken on a project- or system-specific basis.

Siemens offers comprehensive services and technology to support operators in defining protection concepts for digital substation and migration towards a modern architecture and defense-in-depth approach.

3. Securing Control Centers

With Spectrum Power, Siemens provides a future-oriented solution for central and distributed energy management. Spectrum Power is integrated into a powerful end-to-end range of products and solutions and cybersecurity is an integral part of Siemens Spectrum Power solutions.

When designing the security measures in the control center environment, the security design principles “Defense in depth principle”, “Least privilege principle”, and “Network Segmentation” as described in the preceding chapter about substations are followed.

Siemens provides a system blueprint and associated documentation for Spectrum Power. To provide defense in depth, it is recommended that the network layout be split into different security zones. Parts of the system communicating outside of the control center are in separate DMZs. In general, the Spectrum Power system is separated into security zones separated by firewalls, i.e. the servers are separated from other network zones or DMZs by firewalls. This approach not only increases the effective defense but also provides disconnection points to isolate compromised system components or zones. For example, if a UI Client or a web server located in a DMZ is compromised, the firewall between the DMZ and the core system could be used to block interactions and access.

The zoning structure and the categorization of the zones according to their protection needs is depicted below.
In general, the component with the highest security demand defines the security level of all components in a zone.
The core system is categorized as a system operation critical zone with the highest protection need.

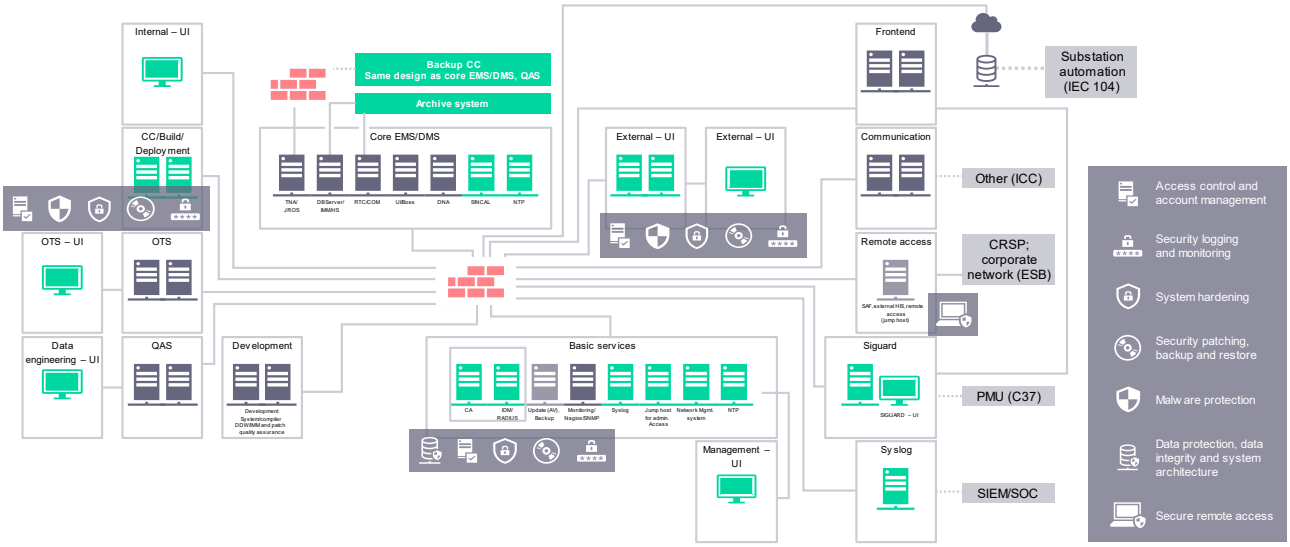

Figure 13: Zoning structure and the categorization of the zones according to their protection needs

Inter-control Center Communications Protocol (ICCP) is a standardized and widely used protocol to exchange information between control centers. The data exchanged typically consists of real-time power system monitoring and control data, including measured values, scheduling data, energy accounting data, and operator messages. The ICCP application provides security as recommended by the International Electrotechnical Commission (IEC Technical Committee 57, Working Group 15 – IEC 60870-6 TASE.2). The secure ICCP capability includes TLS (Transport Layer Security) for authentication and encryption. The Spectrum Power secure version of ICCP conforms to the TASE.2 standard for secure communications. It incorporates Public Key Infrastructure (PKI) security into the stack, providing support for strong encryption and node authentication.

The Siemens Categories of Cybersecurity Measures are implemented as follows in Spectrum Power:

Access Control and Account Management
Spectrum Power includes features for secure user access. User accounts are created with password restrictions and account lockout upon repeated login failures. The system is built with minimized use of privileged accounts. In addition, the system defines permissions according to specific functions.

Security Logging/Monitoring
Spectrum Power provides various security and alarm logs for detecting, reporting, and analyzing an electronic security incident. Significant security events generate alarms that will appear on the alarms and events summary display. Security-related alarms and connection requests are logged to disk in readable, searchable files.

Data Protection and Integrity
Siemens components support the required functionality to meet data protection and integrity needs, while processes implemented within Siemens ensure that customer data are managed with due care at all phases of customer projects. In Spectrum Power a cryptographic integrity check will be deployed. The integrity check covers system files, applications and configuration files.

Malware Protection
The recommended antivirus product maximizes the protection against data and application corruption, and includes centralized management, policy enforcement, updating, and reporting.

System Hardening
Hardening reduces the attack surface of the products and solutions by means of secure configuration. This is reached, e.g., by removal of unnecessary software, unnecessary usernames or logins, disabling of unused ports, or OS hardening. Spectrum Power 7 design follows the 'Security by default' principle.

Patch Management
Siemens offers comprehensive patch management services. Updates will be provided through a central update instance located in basic services zone which has access to every existing zone.

Backup and Restore
Siemens has backup and restore functionality available and supports system operators to assess and establish respective process. Spectrum Power has built-in capabilities, such as redundancy and back systems concepts, to overcome emergency and crisis scenarios in a defined and tested way. This includes component redundancy concepts and back-up control centers.

Secure Remote Access
Siemens provides a certified secure remote access solution based on a central remote access platform called Siemens cRSP (common Remote Service Platform). The Siemens cRSP is an online platform that enforces strong authentication and authorization for Siemens or customer (using the CWP – Customer Web Portal) remote access based on user ID/Password or on smartcard tokens (multi factor authentication).

Privacy
Information privacy is a particularly sensitive matter where personally identifiable information is collected, e.g. such as log files. The Spectrum Power system provides access control mechanisms to follow security by design and the minimal need-to-know principle.

V. Cybersecurity consultancy

Cybersecurity in the energy sector is a broad topic where a lot of domain-specific knowledge and expertise is required in order to define appropriate measures. Siemens supports operators regarding the verification, definition and implementation of cybersecurity in systems, services and processes.

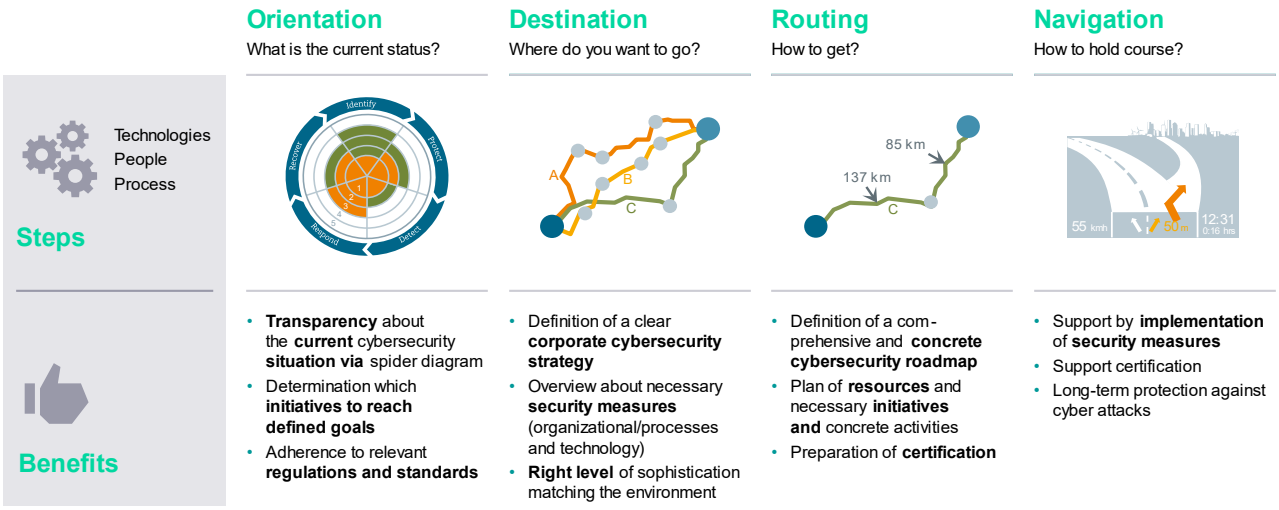

Figure 14: Cybersecurity Process Consultancy

Siemens' cybersecurity consulting approach is based on the well-proven Smart Grid Compass® model, which has been developed by leading experts at Siemens and has since then been used to successfully transform a wide variety of system operators worldwide into an 'utility of the future'.

As shown in Figure 14, cybersecurity consultancy offered by Siemens is structured into 4 phases:

- **Orientation**: Comprehensive and objective analysis of the current cybersecurity status in the technology, process and organizational environments.
- **Destination**: Definition of the aspired security levels also with regard to the relevant regulatory requirements and standards, and derivation of concrete security measures
- **Routing**: Development of holistic cybersecurity. implementation roadmap based on derived measures and including recommendations for implementation.
- **Navigation**: Continuous customer support during the implementation of security measures.

Systems with a high degree of protection against cybersecurity attacks are feasible when cybersecurity methods and functionality are implemented consequently. Siemens can support power system operators during assessment, definition and implementation of cybersecurity and has guided customers in the implementation of ISO/IEC 27001, and conducted cybersecurity assessments related to BDEW Whitepaper, NERC CIP and other power systems related security standards and guidelines

Published by
Siemens

Smart Infrastructure
Digital Grid
Humboldtstrasse 59
91459 Nuremberg,
Germany

For the U.S. published by
Siemens Industry Inc.

100 Technology Drive
Alpharetta, GA 30005
United States

Distributed Energy Resources (DER) on the rise

Maximizing the value of local energy generation with data.
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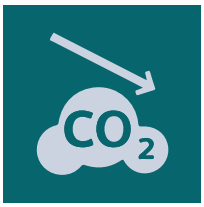
1. DEOP: Sustainability and Flexibility in Energy Markets

Energy Markets differ a great deal from country to country, but they all have three significant concerns in common.

Cost
Generation businesses want to reduce cost of production, customers want to reduce cost of consumption, while distributors want to cut out energy losses and improve their own margins.



Carbon emissions
There have been some dramatic changes in recent years, not just to public opinion but to business practices. Sustainability is rapidly becoming one of the most important of business indicators, and the drive to cut emissions from power generation, distribution and usage is altering the business environment fast.

Stability
Grid operators need balance of supply and demand to provide stable grids, while large consumers need continuity of supply at all times, no matter what happens within the wider grid.

This paper provides a short introduction to the changes now remaking our energy grids, and focuses on how best to adopt one key concept: Distributed Energy Resources (DER) as a potential source of business advantage. In this first section, we introduce key enablers for change and show how these can act as catalysts for new ways to optimize assets, enhance services and grow profitable new business lines.

Sustainability
The climate crisis is driving significant change across the energy market. The most visible sign of this is the growing importance of renewable energy sources, notably photovoltaic and wind-generated power. These now account for a much higher proportion of total energy usage in developed countries than even optimists thought possible a few years back.

Volume growth has been matched by cost reductions, with solar and wind-generated energy now competing successfully on price with fossil fuel alternatives. We expect this trend to continue over the next few years, and even to accelerate, as public pressure, governmental commitments and continued technology advances make sustainable solutions more viable.

From one directional to bi-directional
The growing appetite for local generation and consumption is enabled by energy management systems that make it possible for power to flow both ways through the grid, which is already a completely normal part of business as usual in many countries. This has created the "prosumer" concept, in which individuals and organizations of many kinds can both consume energy from the grid as needed, but also supply energy back to the grid, when their own generating capacity gives them an energy surplus.

National and regional grids are now increasingly engineered to permit two-way traffic of this kind, and commercial contracts are being revised to recognize prosumer status through reduced costs or even potential profit for local generators. Industry observers consider the rise of Distributed Energy Resources, enabled by bi-directional flows, as potentially one of the most disruptive changes ever to impact on to grid structures and operations.

Flexibility and balance
In bi-directional grids, the focus is now increasingly on how to use assets and, in particular, **those able to buffer energy**, to provide extra flexibility within the grid. We see increasingly inventive uses of existing assets to provide balance, for example, or top-up power to areas of need, and other forms of flexibility. Options can be varied and wide-ranging. Schemes exist for enabling energy to be redirected away from residential areas to deal with a surge in demand elsewhere, with individual houses able to opt-out if they wish, while those opting-in are rewarded for their flexibility by lower bills.

This approach can also include any asset that stores energy, from electric vehicles connected to the grid through an EV charging point, to production assets in factories to water heaters, air conditioning and other storage or flexible units. All of these can temporarily deliver some of the energy they store to the grid and, when enough of them are connected to a bi-directional grid, this can have a very positive effect on smoothing out peaks and troughs of demand, without affecting the operational integrity of the assets concerned.

Campus power operations
Locally generated power can be significant as part of a campus microgrid or as a way to balance requirements and generating capacity within an organization, or group of organizations. This is especially the case as new technologies start to become more widely adopted.

For example, the now very rapid move from petrol or diesel to electric vehicles makes it necessary to provide a new infrastructure of charging units. A large commercial campus will also need large-scale batteries to balance production and consumption, mitigating some of the risks related to peaks and troughs of supply and demand.

By consolidating all sources of power availability on-site (within the campus or wider organization), these players can take effective steps to reduce their requirements for grid-delivered power, cutting their costs and also moving faster to meet sustainability targets.

Virtual Power Plants

Businesses operating across geographically separated sites, not just those limited to a single campus, can also explore the option of creating Virtual Power Plants (VPPs), in which DER are networked together and operate as a unified whole. This enables the VPP operator to negotiate better terms for power supply and to market flexibility **as a source of added value** to the grid, while also balancing generation and demand across their own environment more efficiently.

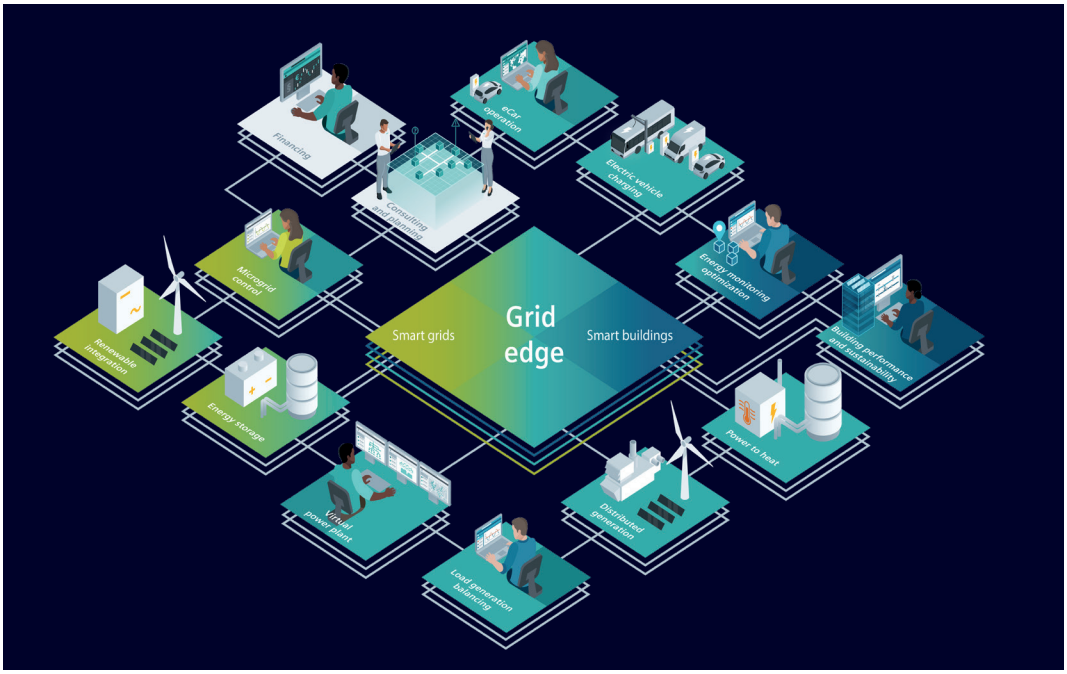
The VPP concept has enabled the rise of "software energy companies", which do not own production capabilities, but aggregate existing generation, flexible loads and energy storage assets to aggregate them or build growing communities of energy providers. This enables them to deliver overspill, balancing and stabilizing input to grids, providing extra flexibility, while opening revenue opportunities to members of these growing communities.

This emerging business model is opening a new line of business to organizations that own production or storage assets of any kind. It is becoming increasingly normal for businesses to monetize their assets through grid sales via VPPs, and it will become unusual to find businesses **that do not use their assets in this way**.

The new Grid Edge era

The rules of the game are changing in power supply and usage due to a combination of all these emerging technologies and systems.

- Power generation can now take place efficiently, not just on a national scale but also at a very local level, using largely (but not entirely) sustainable methods.
- Bi-directional capability in the grid means power can be supplied both to or through the grid as well as from the grid.
- Assets used for local generation and for energy storage (which can even include parked electric vehicles) can be incorporated in DER services to provide extra flexibility to the grid as and when needed.
- Grids are being transformed from highly centralized constructs, based on very large central generators, to much more flexible, multi-directional systems, in which innovation increasingly takes place at the Grid Edge.



We can see that a similar process of evolution is happening in power grids as for very large-scale integrated communication and IT networks. We are moving rapidly away from centralized processing, with data flowing from the edge to the center and commands coming back from the center to the edge.

Instead, advanced components (in power grid terms, this means everything from small solar arrays to sensors to automated/local control systems) operate only at the edge of the grid. These are integrated, not only edge to center/ center to edge, but point to multiple points within the environment. Grids are likely to become more decentralized and distributed, more agile, resilient and open to participation by a great many different players, of different sizes, with their own strategic goals.

Sale of energy to the grid remains a low profit activity, but these new techniques make it easier for organizations of many different kinds to achieve economies of scale by aggregating energy generation across multiple sites (through VPPs). They can also balance their usage and production more efficiently to ensure that a higher proportion of their needs are reliably met through their own local resources.

The key requirement for turning opportunity into outstanding performance is a combination of visibility end to end across the entire asset base, with the ability to manage usage dynamically in order to optimize usage. That is the role of DEOP – the Siemens Software for the optimization of distributed energy assets.

2. Growth of Distributed Energy Resources: Challenges and Opportunities

Distributed Energy Resources (or DER) is a term widely applied to both local power generation and energy storage capability that is interconnected via smart networking (normally through bi-directional energy grids). The diagram below gives an overview of expected growth in different forms of DER, as predicted by leading market intelligence firm Guidehouse Insights.

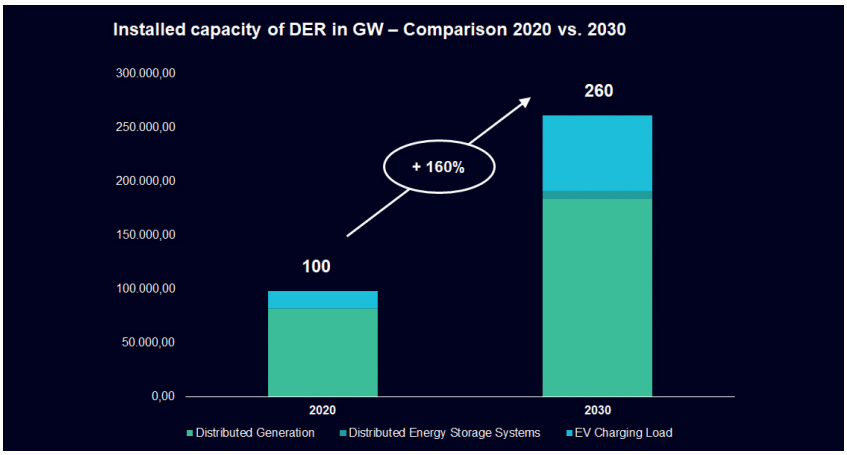


Figure 1: Expected growth in use of DER.

A more than 250% increase in distributed generation is also highly significant, but the most remarkable factor in this prediction is the rise of distributed storage. The figure for storage in 2020 was only 0.7 GW, but the predicted total for 2030 is 7.2 GW, a rise of over 1000%. This gives a clear indication, not only of high growth rates but also of a change in the balance of power in the market.

As we have already shown, access to large, distributed storage capacity is a key factor in providing greater flexibility and stability to the market, while also being central to the growth of such important new concepts as VPPs.

This review covers the current decade, ending in 2030 and it shows an increasingly steep rate of adoption and usage. Globally, annual new installed DER capacity is expected to reach 260 GW by the end of the decade, divided between distributed generation, storage and EV charging points.

As the automotive market makes an historic transformation from fossil fuel driven vehicles to the point where, in most markets, the only new vehicles for sale will be electrically powered, it is not surprising to see such a remarkable rise in EV charging points: a 950% annual increase in capacity*.

* Find more information on the growth of the EV market and software for charging infrastructure in our eMobility Whitepaper.

DER Overview

There is no "typical" DER format or structure, but the campus diagram below helps show how DER contributes to business operations and can offer competitive advantage. We will see later how energy management, through the DEOP concept, applies to this campus and its resources to enable optimization of energy use.

Figure 2:
Campus layout

This campus contains a range of energy resources already in place. Production assets on-site include photovoltaic panels, small wind turbines and also a small-scale Combined Heat and Power (CHP) generation unit, driven by natural gas. A battery unit has been installed, as well as building management systems to help balance power demand and generation through "intermittent" methods (sun and wind).

One of the most eye-catching requirements in the campus is the need for charging points to supply electric vehicles. This illustrates the potential importance of DER to commercial organizations, and also the potential impact of DER on power grids more widely. Businesses running large fleets of electric vehicles can benefit by using locally generated electricity, rather than power taken from the grid at normal rates.

This is an illustration of how energy optimization can be used to improve bottom line profitability, while also challenging current grid operational models. It also illustrates how management of Distributed Energy Resources can deliver significant financial gains, while enhancing corporate agility and flexibility. This is the prize now being targeted through DER. So how can we deliver on this promise?

DER Management

Let's go back to the campus illustration we saw in figure 2 and show the same scene with some additional information.

At the center is the Siemens software DEOP for the optimization of distributed energy resources, which integrates both supply and demand across the organization, its business requirements and its interface to the grid. Using the electric vehicle example already introduced, the DEOP system will prioritize use of locally produced wind and solar power for EV charging where possible. Energy stored in and delivered via the installed battery is the next priority, with local CHP the back-up option.

All assets that store energy and are connected to the network can potentially be used to supply to the campus or to the wider grid, based on clearly defined and constantly monitored business rules. Electric vehicles can also be used for profit-generating energy supply to the grid. Depending on the capacity of the EV charging points, for example, it is possible to charge a fleet of vehicles during the evening, then allow some of the energy stored to flow back into the grid if a high demand event should arise, before recharging in time for use the following morning. The same principle applies to other forms of asset.

DEOP ensures that vehicle operation is not compromised and the net cost of charging is positive for the organization concerned. The grid gains in flexibility and the operator reduces their overall energy costs. It is a win for all concerned.

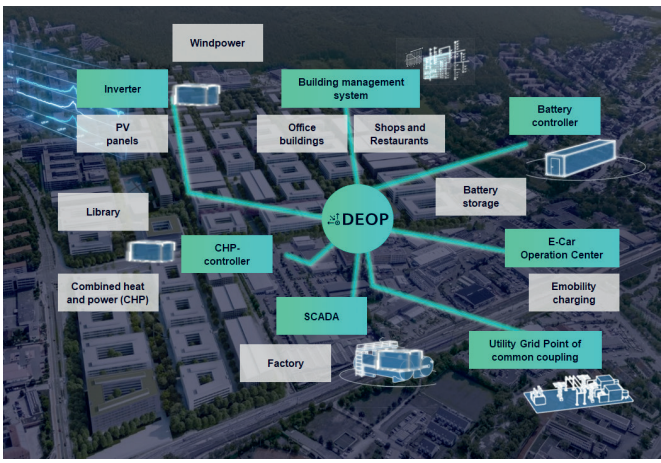


Figure 3: Campus with key management and monitoring points highlighted

DER aggregation

The net gains made by any individual organization in the example given above will be marginal. Benefits arise when this becomes a regular occurrence, and when many different organizations are aggregated within a single virtual network. Utilities are already seeking ways to aggregate available energy supply (generated or stored locally) to provide effective added value, both in terms of greater flexibility to the grid and in monetary terms to the asset owners or local power generators. Commercial organizations, or groups of organizations, can carry out similar activities by managing their own distributed resources across widely separated locations, effectively becoming Aggregators in their own right.

The principle is the same as for the approach taken by large utilities. DEOP permits the user group (Aggregator) to manage power output and usage within their own defined (but geographically distributed) areas, and deliver "home-generated" power to where (in the group) it is most needed. The bi-directional capabilities of the grid permit DER-generated electricity to be delivered to the grid in one location and then from the grid to another location where it is needed, at significant cost savings to the organization (or group of organizations) concerned.

Again, this is a source of opportunity to commercial organizations that possess significant distributed power generation and/or energy storage capability of their own, but it is a challenge to traditional power generation businesses and potentially to grid operators. Grids may now act as a conduit for aggregator energy in the same way that a telecom network acts as the conduit for other organizations' content.

3. How DEOP works

DEOP provides the management systems, connectivity, monitoring, and control required to ensure that energy produced or stored locally is used in the most effective possible way.

Cloud-based

DEOP is fully digital, and operates from a secure cloud, enabled by the partnership between Siemens and AWS. Within this partnership, AWS provides and secures its own virtual datacenters that provide almost infinitely scalable, low-cost hosting, while complying with all regulations related to data location and privacy.

Siemens establishes and secures its own private cloud locations within the AWS environment, and is responsible for applications, data management and customer connectivity. DEOP customers therefore gain the cost, fast access and scalability advantages of cloud, while also benefitting from Siemens' proven security record and rapid, efficient remote support.

IoT Monitoring

DEOP is based on continuous monitoring and analysis of sensor data, generated by all relevant and connected systems across the specific environment. Siemens' leadership in Grid Edge means that low-latency processes (such as alarms) are managed on-site, without the need to exchange data in real-time across the cloud, while patterns in data flows are analyzed and used for highly granular control by customer management.

DEOP connects all core systems within the customer environment. This even extends to building management systems. The intention is to give end to end, top to bottom visibility and transparency, by providing a single source of the truth regarding energy use.

Automation

Increasing numbers of key processes can be automated, if required, by using DEOP. Fast response to alarms and indicators that demand instant response will be governed by algorithms to sharpen control and enhance performance. Without compromising on customer-defined policies, automation will progressively improve performance and effectively support management to achieve their cost and performance goals.

Grid Edge

DEOPs one of the increasing number of applications and services that Siemens is bringing to market connected to the Grid Edge concept. This strategic development has been covered in the Siemens white paper **The Grid Edge Revolution**, which provides a comprehensive overview of the concept, its applications and likely development path.

All solutions based on Grid Edge thinking and technology aim to decentralize power generation and distribution, reducing the dangers inherent in over-centralized systems, making power provision more resilient and robust, while also driving rapid decarbonization. Driving beneficial change from Grid Edge technologies requires use of rich data flows (from sensors and IoT devices), enabled by automation (increasingly informed by machine learning and, eventually, AI) to balance power services and power supply.

This approach means that KPIs (see below) can be reliably met with the smallest possible energy usage, cutting costs and carbon, while opening up DER opportunities.

KPIs

These will naturally be defined by customers, but we anticipate progressive reduction in CO2 emissions and identification of every opportunity to reduce energy usage as being natural outcomes of successful DEOP implementation. Asset owners remain entirely in control of the way they choose to balance objectives (cost, energy applications, availability vs restricted use, environmental factors...) and DEOP enables them to define and vary at will the priorities they choose to apply.

Support

DEOP as a software is delivered in a Software as a Service (SaaS) model. It is possible to provide DEOP as a Managed Service, in a service "package" for external delivery, or to keep it as a wholly internal process, owned and managed by the relevant customer department. Visibility is provided through customizable, highly intuitive dashboards, while specialized support from Siemens' specialists, is always available.

Summary

DEOP forms part of the growing number of Siemens digital, cloud-based and delivered software applications, incorporating Grid Edge and IoT monitoring to provide the best balance of low-latency responsiveness and low-cost cloud native management.

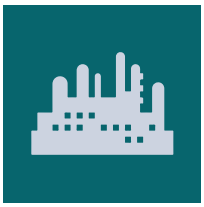
The goal, as with all related Siemens products is to use automation, machine learning and remote support to accelerate optimization, with full control staying in the customers' hands, and expert support from Siemens always rapidly accessible. This formula is delivering measurable benefits in market sectors as diverse as Asset Performance Management, Diagnostic Services, Proactive Maintenance and now Optimization of locally generated power.

This also confirms our view that the Grid Edge is where most innovation is currently happening in this industry, and DEOP is designed to enable full and trouble-free integration with all relevant business, operational and environmental systems already in place. It is based on MQTT, the most widely used IoT Protocol, with gateways for protocols like IEC 60850-5-104, IEC 61850, Modbus TCP and others, together with proven API integrations to the Siemens applications DESIGO CC & E-Car OC.

4. Verticals and Use Cases

4.1 Who Benefits? Existing and Emerging Verticals

DER can potentially provide an added value service to a wide range of different industry sectors. These include a number of emerging service sectors that are enabled in large part by the development both of DER as a concept, and by the arrival of DEOP and other management solutions.



Manufacturers

Both discrete and process are very large users of power. The ability to balance energy produced under their own control on-site with grid-delivered electricity gives these companies a vital tool for reducing overhead costs and staying competitive in often very difficult financial conditions.

At a leading Italian pasta manufacturer, use of DEOP has led to enhanced production efficiency, while reducing carbon emissions and improving management control through a customized optimization algorithm and intuitive dashboards. DEOP has enabled better testing of applications and production methods before go-live and has successfully addressed a key concern of the company: how to boost production and improve output, while at the same time reducing carbon emissions.

Industrial units

Where large numbers of independent manufacturing and other industrial businesses are based on a single geographical location, are natural users of DERs.

At the Diangzhong industrial zone in Yunnan province, China, DEOP has facilitated development of a local cloud platform, accessed by all customers on the site, which enables them to optimize energy use and reduce both costs and emissions. The zone covers 480 square KM and is constantly evolving and expanding. It includes wind and solar energy production, combined heat and power, electricity charging stations and extremely complex energy needs, all of them optimized and enhanced via DEOP. (Read more about this project here)

Real estate
Businesses, such as shopping centers, have been hard hit as a result of the Covid pandemic.

At the Sello shopping mall in Espoo (Finland's 2nd largest shopping center), DEOP helps manage local DERs that include 600 KW of photo-voltaic power, 50 electric vehicle charging points and 1.68 MW battery storage. DEOP has optimized energy usage, enabled participation in the Fingrid market through Vibeco, and integrated with building management systems to help reduce consumption, while providing asset transparency. (Read more about this project here)

Educational institutions
such as large universities or specialist research centers, use management and energy use balancing capabilities to ensure maximum efficiency at a time when budgets are under pressure.

At Keele University in the UK, a world-ranked research establishment specializing in sustainability systems, several DER operate on the University campus, including solar, battery and micro-CHPs, together with a "living lab" carrying out research into decentralized energy systems. DEOP integrates micro generation and digital evidence systems, providing detailed management information and playing an active part in driving down carbon footprint by 35% from baseline levels.

We have already seen how utilities, large-scale energy generation companies and grid operators are building new skills in aggregation, VPP and other concepts to balance supply and demand dynamically, cutting wastage and reducing environmental impact, while meeting all availability obligations. (Read more about this project here)

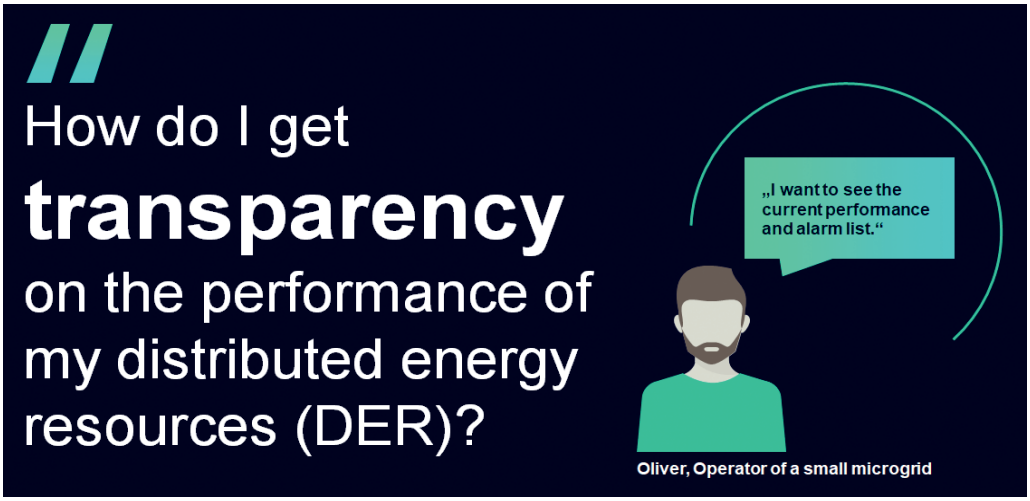
We are also seeing the rise of specialist **Energy Aggregators and Energy Service Companies**. These businesses use energy flows from VPPs as a resource for bidding into grids for supply contracts, without the need to build their own power generation units, and help grids and utilities enhance their own efficiency performance, creating a more effective and reliable market.

One such company is EGO Group in Italy, which is a leading VPP provider, integrating 400 flexible assets (and growing) with production capacity of 150 MW. DEOP helps EGO optimize operations and offer standard packages, while also delivering VPP options to the market. A growing community of businesses is working with EGO to optimize their asset value and monetize key aspects of their normal business operations through energy supply to the grid.

The customizable dashboards provided enable the company to manage the application exactly as they require it, while a market participation gateway and algorithm enhance monetization. Business models of these kinds would not be possible without grid evolution, enabling more flexible, two-way energy flows, and without advanced management software, such as DEOP. This is another example of how digitization is helping to transform the energy landscape.
(Find out more about the collaboration with EGO in this video)

4.2 Main use cases for DEOP

In all cases, users focus on three major use case types:
Monitoring and Transparency; Cost Optimization; and Revenue Generation.



Monitoring and Transparency
DEOP (together with all performance enhancing management solutions) is ultimately based on rich data flows. DEOP collects data from all connected sensors and devices in real time and visualizes this in easy to understand standardized or customized reports (to be used within the organization or by the Managed Service provider), delivering an integrated, complete and always current view of performance. This enables the organization concerned to understand current performance on a minute-by-minute basis, while also permitting fast intervention as needed.

Automation, driven by algorithms and increasingly enhanced by machine learning, enables continuous optimization within defined parameters, while also enabling hands-on intervention as and when needed.

The monitoring capability within DEOP permits recurring or emerging patterns to be identified, with potential enhancements also set out. Reports can be generated at any point to provide detailed, auditable information for review and as input to strategic planning. The growing and evolving role of IoT will enrich the data available to monitoring solutions, providing deeper insights and enabling better decisions.

Cost Optimization

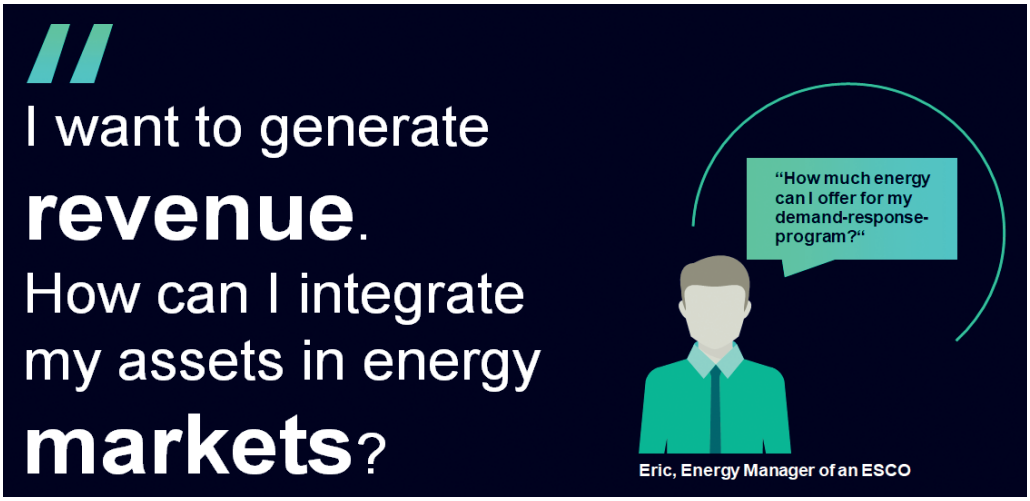
Although cost reduction is not the only reason for using DEOP (or DER, for that matter) yet it is a key factor in driving adoption. We all appreciate the fact that energy supplies are not infinite and come with serious downsides: including constantly rising costs and major environmental concerns.

DEOP makes it possible to **see clearly** the levels of usage in every specific area of a customer's working environment; to **spot trends**, together with root causes; and to **develop strategies** that enable maximum efficiency, leading to cost optimization at every location, process stage and usage type.

DEOP is based on an analytical engine that reviews and presents rapid insights on all aspects of energy consumption, including:

- Who is using energy, when and for what purposes?
- How that energy is being supplied, at what cost and when?
- Where is energy being stored and how much could potentially be available for flexible offering to the grid or to local operations?
- What levels of emissions are being generated as a result of this usage, and how these can be successfully reduced?

The algorithms supplied as part of DEOP rapidly learn the details of the customer environment, and then continue to develop a deeper understanding, day by day, increasingly through machine learning and (in the near future) AI. This enables the solution to identify possible issues and, most important, propose areas for dynamically intervening in both usage and supply patterns to drive down costs.



Revenue Generation

The two previous use cases are both primarily focused on efficiency gains within the organization concerned, but the rise of DER and management solutions such as DEOP also open the possibility of using locally-produced and stored energy or flexibility as an additional line of business in its own right.

Aggregators, in particular, are constantly searching for energy sources to include in their own VPPs for packaging and sale into the grid, ideally at times when prices are attractive. A single campus owned by a manufacturer, large research and educational center or headquarters of a major commercial body, can provide the energy equivalent of several hundred houses fitted with photovoltaic panels.

This improves the Aggregator's offer by making their own energy supply and flexibility sale, and therefore their value proposition more reliable, reducing the cost of sale and raising profitability. The flexible interfaces provided as an integral part of the DEOP solution enables simple participation in this business model.

Summary

The options covered in this section are broadly indicative, rather than being exhaustive.
New opportunities are being developed, in terms of industry verticals and specific options for cost reduction and profit generation. The key factor in DEOP is its extreme flexibility, with industry standard interfaces, continuously kept up to date, ensuring a good fit with the market at all times.

5. Role of Cybersecurity

DEOP is a cloud-based solution that includes multiple points of integration with sensors, business systems and databases. As with all digital systems delivered from the cloud, security is a key element of its design, configuration and management.

Siemens Security Protocols

The solution adheres to Siemens' own design and operational principles for cybersecurity, which are based on a profound understanding that interconnecting OT and IT systems risks exposing operational management solutions by making them accessible online. At every stage in the design and production process, therefore, Siemens protocols aim to remove risk, close loopholes and continuously update in response to emerging threats.

Siemens DEOP development follows OWASP general coding practices, with a quality and security automation pipeline, which includes a wide range of checks at all stages, backed by concepts such as secure zoning, access control, hardening and security logging following security by design principles. All access to the Siemens DEOP platform undergoes a state-of-the-art, strong authentication mechanism. The principles apply to all solution components and defense in depths is used for the security controls.

Hyperscale Partnership

As described earlier, Siemens works with AWS to ensure that all Siemens digital services combine the benefits of true hyperscale cloud (scaling, fast set up, very low costs) with the security characteristics delivered by a meticulously designed and managed private datacenter approach.

The AWS and other cloud platforms are certified to conform with ISO 9001 (quality management), ISO/IEC 27001 (information security), ISO/IEC 27017 (cloud security), ISO/IEC 27018 (cloud privacy), SOC 1 (Audit Controls Report), SOC 2 (Security, Availability, & Confidentiality Report) and SOC 3 (General Controls Report) standards.

Secure data transfer

The secure IoT protocols, such as MQTT or connections secured by VPN are used for managing transfer of data from customer devices or sites to the Siemens locations in the cloud. These are proven solutions that also connect with on-site Edge devices to ensure that low-latency processes are managed locally, while keeping all records up to date.

ments of ISO/IEC 27001, NISTIR 7628 Guidelines for Smart Grid Cybersecurity in order to provide a comprehensive coverage of cybersecurity controls relevant to cloud-based applications and managed service in the cloud.

Compliance

Siemens DEOP complies with all relevant national, EU and North American regulations, and is constantly updated to ensure compliance. This includes EU Directive (EU) 2016/1148, commonly known as the Network and Information Systems Directive (NIS-Directive) and EU Regulation (EU) 2018/151, which focuses on ensuring that digital service providers take appropriate security measures to protect their assets and notify their national authorities about serious cybersecurity incidents.

As a technology provider in North America, Siemens understands NERC CIP standards, which are applicable to operators of bulk electrical systems in order to protect their critical infrastructure against cyber risks. Siemens works to international standards, which also cover the requirements of NERC CIP-005 for Electronic Security Perimeter protection. This includes, too, requirements of ISO/IEC 27001, NISTIR 7628 Guidelines for Smart Grid Cybersecurity in order to provide a comprehensive coverage of cybersecurity controls relevant to cloud-based applications and managed service in the cloud

Summary

Siemens believes that digitalization, with development, delivery and management handled in the cloud, is the best way to provide customers with the most advanced, efficient and high-performing solutions, enabling them to optimize their operations and enhance business success. Security is the non-negotiable key enabler for successful moves to the cloud, and security is built into every aspect of DEOP design and implementation.

This also confirms our view that the Grid Edge is where most innovation is currently happening in this industry, and DEOP is designed to enable full and trouble-free integration with all relevant business, operational and environmental systems already in place. It is based on MQTT, the most widely used IoT Protocol, with gateways for protocols like IEC 60850-5-104, IEC 61850, Modbus TCP and others, together with proven API integrations to the Siemens applications DESIGO CC & E-Car OC.

6. Long-Term Market Impact

The DER concept is now widely accepted as being highly disruptive to the power and utility industry because it is facilitating development of new lines of business that may significantly change business models in the wider utilities landscape. Our main focus right now is on the potential offered by DER to alter the economic realities for energy users within a growing range of organizations, in multiple sectors.

By using real-time data flows to monitor in real time, analytical engines to identify trends, opportunities and root causes, and intelligent algorithms to enhance decision-making, organizations will reduce their costs, cut emissions and improve energy efficiency. This makes DEOP an extremely useful tool for achieving a range of mutually supportive and beneficial goals:

- Encourage further systematic investment in renewable energy sources.
- Help grids to become more resilient and cost-efficient.
- Make organizations more energy efficient and therefore both more sustainable and viable for the long term.

The rise of Grid Edge technology is set to accelerate in the immediate future, as DER becomes more attractive to users in many different sectors, and this brings the same challenges we find in any emerging technology space. Evolution is fast and it is essential to partner for the long-term: a solution that fits today's market will need to develop, potentially out of recognition, and you will need to know that the best available support is always there when you need it.

Siemens is committed to DEOP as its flagship product for the DER market. Our key recommendations for every participating business are these:

- **Strategic thinking**
  DERs are now a strategic issue. They should be on the C suite agenda from now on, and COOs need to be directly engaged.
- **Continuity**
  It is essential to have a policy that is achievable and flexible enough to develop as the market changes. That depends to a great extent on the relationships you build with strategic partners today.
- **Learning and development**
  DERs require a steep learning curve and the sooner a business engages and builds a broad range of competence, the more likely it is to safeguard investments and maximize returns.
- **Focus**
  There is profit to be made in this market, and we suggest that all potential participants focus on the low-hanging fruit available to them today, while analyzing potential to target larger profit in the future.

The thinking we propose for DERs fits in with the strategic guidance we offer for every market in which we participate. We are seeing a historic shift towards decentralized systems, highly automated and managed at the edge (the grid edge or the network edge). The earlier you invest in the opportunities this strategic change offers, the better it is for competitive position, business security and long-term profitability.

Published by
Siemens AG

Siemens Smart Infrastructure
Digital Grid
Humboldstrasse 59
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For the U.S. published by
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Article No. SIDG-B10086-00-7600

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CUTTING-EDGE TECHNOLOGY FOR AN ENERGY SERVICE COMPANY

Establish a new value stream with DERs

The Italian EGO Group leverages DEOP, the Siemens software for Distributed Energy Optimization to offer added value to its customers.
siemens.com/deop

This new revenue stream resulted in a 150 MW VPP (Virtual Power Plant) with more than 400 assets from different sources (e.g. CHP, ESS, Hydro) included and a DEOP digital community of more than 140 users among EGO's customers.

Customer requirements

EGO prides itself on being top-notch in the use of cutting-edge technology. Therefore, it had a clear vision to anticipate the transforming energy market's needs by generating a new digital energy business.

EGO Group was looking for a platform with which it could optimally dispatch a large set of distributed energy assets. The installation of a virtual power plant (VPP) to perform grid balancing was a vision EGO wanted to turn into reality.

Starting with the VPP pilot projects in 2017, EGO has been developing more and more diversified business models – from energy efficiency to cogenerator monitoring as well as energy-process optimization – leveraging DEOP technology and the Siemens team's expertise.

Watch the interviewvideo with Carlo Corallo, CEO of Gruppo EGO.

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HOW TO GENERATE A NEW REVENUE STREAM FROM THE DIGITAL ENERGY MARKET

Unlocking the potential of **distributed energy resources**

The energy market evolution generated new business opportunities that the energy service company EGO in Genoa exploited with Siemens' help.

DEOP features and benefits

EGO benefits from DEOP's flexible configuration with interfaces and open APIs to smoothly integrate DEOP into its existing systems and tools. With the adaptable and scalable platform, the group can monitor around 400 assets incl. storage, PV, CHP and loads. Based on the data collected in DEOP, EGO optimizes its assets' operation and can perform KPI tracking and benchmarking. DEOP's interoperability allows EGO to use its algorithm gateway to participate in existing markets, generating additional revenues from the VPP that has been set up.

The multi-user option allows EGO to set up dashboards for its end customers under one roof with multiple users. Together with Siemens, EGO created a set of standard packages to offer to EGO's customers, like CHP monitoring and optimization, a package for flexible loads and generators and the VPP functionality previously mentioned.

Conclusion

EGO has set up a VPP with more than 150 MW, based on the generation of more than 400 flexible and renewable energy assets. A community of 145 users joined together on EGO's platform, contributing to a more sustainable, yet stable energy landscape in Italy.

About Gruppo EGO

EGO is a leader of exploiting energy produced from distributed sources and boosting energy efficiency through AI-based digital monitoring, aggregation and dispatching platforms, based in Genova, Italy. Well-established on the market, its robust financial position combined with the use of cutting-edge digital technology makes EGO Group one of the main players in the new distributed energy market in Italy.

> "With our VPP based on DEOP, we have created a new revenue stream for EGO that adds value to our customers. Moreover, we boost sustainability in energy by delivering 150 MW of energy created from distributed energy resources that does not need to be generated by conventional resources.
>
> **Pietro Bosso**
> Head of Digital Energy Services, Gruppo EGO

Published by
Siemens AG

Smart Infrastructure
Digital Grid
Humboldtstrasse 59
90459 Nuremberg, Germany

For the U.S. published by
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Article No. SIDG-B10084-00-7600

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MICROGRIDS AT A GLANCE

Why microgrids are the future of energy management

The traditional power grid provides reliable power – most of the time. But when natural disasters or security breaches threaten the grid, the ensuing blackouts can be catastrophic and costly.

That's why companies and utilities are working together to build resilient, flexible power systems called microgrids. Operating either as part of the traditional grid or independently (or both), microgrids are revolutionizing the way we manage our energy resources.

Why do **microgrids** matter?

Microgrids can generate, distribute, and control power in a campus setting, a small community, in critical infrastructures, military institutions, commercial and industrial areas, remote locations, and on islands.

They're reliable and flexible

Microgrids are designed to provide uninterrupted, 24/7 power and to balance load demands for an organization with changing power needs.

They can save money

Using sophisticated software, operators can optimize power usage based on demand, utility prices, and other factors.

They're resilient

Because microgrids aren't dependent on the traditional grid, their stability in bad weather is important for mission-critical structures such as hospitals and military bases.

They store and incorporate renewable energy

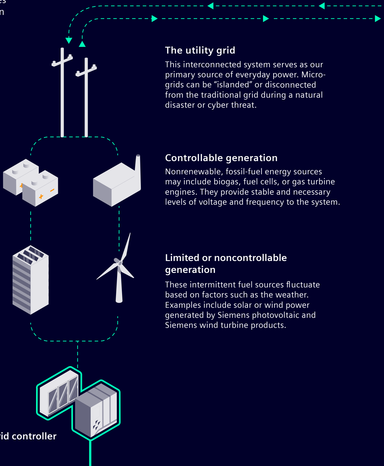
This can save money and reduce carbon-dioxide emissions, as often required by government regulations.

They're more secure

Their distributed generation (power is generated locally rather than transmitted from one central utility source) and smaller size make microgrids easier to keep safe – both physically and, given the right control system, from cyber threats.

How do microgrids work?

An advanced control system enables microgrid components to operate in a coordinated, optimized way.



The utility grid

This interconnected system serves as our primary source of everyday power. Microgrids can be "islanded" or disconnected from the traditional grid during a natural disaster or cyber threat.

Energy storage solution

Batteries store the electricity for use, keeping the power always on hand.

Controllable generation

Nonrenewable, fossil-fuel energy sources may include biogas, fuel cells, or gas turbine engines. They provide stable and necessary levels of voltage and frequency to the system.

Controllable load

Control solutions (such as the Siemens Desigo CC Building Automation System) optimize energy use within a building, depending on critical need and priorities.

Limited or noncontrollable generation

These intermittent fuel sources fluctuate based on factors such as the weather. Examples include solar or wind power generated by Siemens photovoltaic and Siemens wind turbine products.

Microgrid controller

Managing **microgrids**

A comprehensive control system is required to manage the daily operation of microgrids. Siemens provides an advanced control and management system with the following capabilities:

During outages, the microgrid management system coordinates with the utility grid and enables microgrid owners to become, in essence, mini utilities.

Microgrids take full advantage of renewable energy sources by optimally dispatching stable fossil-fuel generation and/or battery storage to ensure the grid is always operating in a reliable state.

The easy-to-use interface doesn't require constant monitoring – a key advantage for smaller operations.

Power can be optimized according to availability, efficiency, and/or cost. If it's windy, the system may switch to wind power. On calm days, natural gas may be more cost-effective.

Microgrids encompasscreates a flexible and scalable system that can adapt as energy infrastructure plans change over time.

$$$ **Ultimately, implementing the right microgrid controller solution can provide several hundred thousand dollars of savings per year.**

Conclusion

Companies and communities with an absolute need for dependable energy are looking to the microgrid as an efficient, powerful, and ingenious solution. These reliable, emergency-ready systems can lead to fewer blackouts, greater cost savings, and less dependence on fossil fuels.

A variety of financing options are available. Find out more about Siemens microgrid solutions at www.siemens.com/microgrids

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Ingenuity for life

Shaping the utility of the future

End-to-end Smart Grid consulting for New Brunswick Power

At a glance

For its electrical network modernization project, the integrated utility New Brunswick Power (NB Power) was looking for a partner with profound expertise in the technology domain as well as in business strategies. They found such a partner who can help them become a "Utility of the Future" in Siemens. Siemens delivers end-to-end Smart Grid consulting services around the world. This includes designing of extensive modernization plans and enabling of the operational deployment while ensuring continuous value management.

NB Power is currently implementing a ten-year Smart Grid Reduce and Shift Demand (RASD) network modernization plan together with Siemens. The aim is to improve both the electrical network operations as well as the economic situation for the utility and its customers. Simply put, every dollar invested within the program shall be returned by two. As a result of the successful deployment of Smart Grid technologies maximizes the benefits for all stakeholders: the utility, the province as well as its end-customers.

Our solution: End-to-end Smart Grid consulting

To start transform New Brunswick Power into a "Utility of the Future", NB plan's implementation, NB Power will save 1.3 billion $ CAD of CAPEX and OPEX costs (net present value) over 25 years. The implementation of this ambitious and future oriented modernization plan makes NB Power a leader in the Smart Grid world today.

The challenge

A key operational challenge for NB Power is the extreme spread between summer and winter peak in electricity demand due to the rough climate and the predominant use of electrical energy for heating space and water. Generation capacity of almost 1,000 MW is foreseen to accommodate peaks that occur only 10-20 days per year.

In addition to the challenges posed by large seasonal peak demand, NB Power has also set a target to integrate a 40 per cent share of renewable generation by 2020 in its service territory.

Naturally, expansions in generation and network capacity that are only needed to accommodate seasonal demand peaks are a significant cost driver, both for the utility as well as for the end-customer. Faced with these challenges, NB Power recognized the urgency of having more control over electricity consumption to realize significant cost savings on both generation and network side.

From a strategic angle, NB Power had defined three leading objectives:

- to become a top quartile performer compared to public and private utilities in North America,
- to systematically reduce debt, while investing in new generation and maintaining stable rates for its end-customers, and
- to invest in technology, educate customers and incentivize consumption that will reduce and shift demand (RASD) to ultimately defer significant generation investment.

Taken together, NB Power's ambition was to leverage innovative technology solutions in order to master the challenges imposed by climate, energy generation mix and network operations. NB Power wanted to prove that

Énergie NB Power

NB Power is the vertically integrated, publicly-owned electric utility of the province of New Brunswick in Canada. It serves nearly 400,000 residential, commercial and industrial customers and has 2,300 employees. It is connected to four other jurisdictions: Prince Edward Island, Nova Scotia and Quebec; as well as Maine in the U.S. The utility has the ability to import or export 60% of its 4.000 MW generation capacity. The diversified generation portfolio ranges from hydro over coal and oil to nuclear with an ambitious target to accommodate a large share of wind power in the coming years.

> “We wanted a partner that could do everything [...]. Although there is enough evidence around the world to show that the component parts of the Smart Grid work, it is the integration of all the parts that has to be done. Siemens is the perfect partner to help us achieve that.”
>
> Gaëtan THOMAS, CEO at NB Power

successful deployment of Smart Grid technologies maximizes the benefits for all stakeholders: the utility, the province as well as its end-customers.

End-to-end Smart Grid consulting

To start transform New Brunswick Power into a “Utility of the Future”, Siemens’ Smart Grid Compass™ was used as a guiding framework, incorporating the Reduce and Shift Demand (RASD) strategy of the utility.

The framework includes a holistic and systematic methodology that aligns business objectives, business capabilities with the corresponding technologies. For NB Power, using Smart Grid Compass™ methodology ensures that solutions and planning are directly correlated to business objectives and value-creation instead of following industry hype cycles. The current partnership between NB Power and Siemens rests on the strong foundation of Smart Grid Compass™ and its structured, systematic and value-oriented methodology.

The Smart Grid Compass™ is executed in three modular phases and addresses the five key domains of a utility’s business: network operations, customer services, asset and workforce management, smart energy, and smart organization.

NB Power and Siemens have jointly executed the phases of Orientation, Destination to Routing. As an outcome of this journey, Siemens has designed NB Power’s Smart Grid roadmap that also includes key initiatives addressing all five domains. A clearly positive business case and a sound ROI has been the underlying principle guiding all technology deployment decisions.

Value improvement – a cornerstone of the Smart Grid Compass™ – is ensured by systematic leveraging of technology synergies. This means that technology solutions which enable multiple capabilities in different directions are deployed earlier in order to minimize technology costs, maximize value-generation and provide return on investments as soon as possible.

Consequently, “end-to-end” consulting in this context comprises the strategy and roadmap development for NB Power, as well as coaching and support throughout operational deployment, ensuring that targets are reached in the most effective and efficient way.

While Siemens’ Smart Grid Compass™ provides a strategic framework for capturing the vision of NB Power by quantifying the company's objectives and recommending concrete actions, implementation of concrete actions takes place through the value management program embedded within the NB Power Smart Grid program.

The Value Management Program focuses on the project as a whole rather than its modular components taken separately. Opportunities for innovation are monitored at every stage to find the most cost-effective means of implementation. A closed-loop approach for review, evaluation and action ensures that potential for business improvement are recognized and dealt with in a structured process. Key performance indicators (KPIs) are used to define and control actions and performance along the entire program deployment timeline.

Embedding value management into Smart Grid deployment is a unique Siemens approach. The aim is to reach the assigned value targets efficiently in order to meet NB Power’s business objectives. This is accomplished by delivering the deployment program steps at least-cost and consistent with the required levels of quality and performance.

Conclusion

NB Power’s plans for the future will not only influence the way it does business today, it will also have a significant impact on all its stakeholders. A fundamental business transformation is needed at NB Power to enable it to evolve and adapt flexibly as multiple waves of technology and business changes ripple through its environment in the next 10 years.

NB Power’s Smart Grid program articulates a fundamental business transformation that will have significant positive impacts for the end-customers, the utility as well as the provincial economy. This fundamental business transformation is made possible thanks to Siemens’ “end-to-end” Consulting approach that leverages synergies systematically, reduces complexity and risk for the utility, and realizes value improvement in short as well as long term.

Siemens’ “end-to-end” consulting approach enables NB Power to realize its aspirations and commit to a shared future through the long-term partnership agreement between the two companies.

Published by
Siemens AG 2017

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SIEMENS

Ingenuity for life

On-Site Energy Solutions: Utilities

Meet new demands and new opportunities for distributed energy resources.

usa.siemens.com/onsite-power

Stay Ahead of the Change

Siemens on-site energy solutions help utilities deliver distributed energy resources to customers expecting more.

Today's electrical grid is transforming faster than ever. The evolution from centralized generation to a distributed network ecosystem brings with it more challenges but also new opportunities. Utilities able to navigate this new landscape strategically and successfully will find themselves out in front of customer expectations and market demands.

Bring Power to Your Customers

The transformation of customers from passive consumers of electricity to engaged prosumers is already underway. Organizations of all types are exploring ways to ensure a predictable energy supply, better manage costs, and secure their peace of mind. Distributed energy resources (DER) are playing a key role. The adoption of these systems – which produce electricity or reduce usage at or near the point of consumption – is changing customer expectations of what a utility should be and what energy means to their organization.

With Siemens on-site energy solutions you'll be prepared to help your customers benefit from the new energy paradigm. Our on-site energy solutions provide the technology for local energy generation, distribution, storage, and management. We help you engineer tailored solutions for customers looking to take control of their power supply and take advantage of the promise of DER.

Meet New Demands

Today, a 24/7 always-on presence is the norm, breakthrough technologies are more widespread, and organizations are looking for any way to maximize their budgets and create competitive advantages. Businesses of all types are looking at local generation as an important – and viable – resource to ensure operational continuity and protect both their reputation and bottom line.

By leveraging solutions that support distributed generation, you can help them secure what matters most with energy supply, storage, and management solutions for enterprises of all sizes and needs. New technologies, such as efficient turbines and solar photovoltaics, can work with your and you customers' existing assets to create a smart, customer-centric ecosystem that keeps the power flowing 24/7.

Take Control

With Siemens on-site energy solutions you can capitalize on new revenue streams, meet demands for distributed, clean, flexible energy, and stay ahead of the rapidly changing market.

New service offerings, such as on-site solar, can provide a profitable way to address customer demand for renewables while meeting state and local sustainability goals or requirements. Siemens technology supports installations at the customer site along with effective grid management by utilities.

Other customers are looking to generate on-site power using more traditional means. Siemens provides the strategy, systems, and controls to make it happen. No matter where your customer wants to be on the DER spectrum you'll be positioned to help them achieve their goals.

Deliver More

On-site energy solutions from Siemens help you bring new innovations and the latest technology to market. You'll have access to the newest advancements in microgrid control, power generation and energy storage. We have years of experience working with utilities, municipalities, and retail customers, setting a new standard of energy generation, distribution, and management.

Our team of energy experts can help develop distributed generation capabilities that align with you overall DER strategy and is configured around the present and future needs of your customers. In the process we can help you stay in front of challenges as you move along the path from utility to smart integrator to full energy services provider.

Powerful Automated Controls

Local microgrids, made smart and simple to operate

Solar with Scale
Using Siemens SICAM monitoring and control platform, Arizona's largest utility, APS, has been able to integrate residential and grid-scale solar in a controllable way that ensures grid reliability.

A pilot program has added 1,600 residential solar installations to the local grid, a number that APS plans to double in the near future. It's a significant shift to solar that is both popular with customers and cost effective for APS.

Provide Independence

Siemens automation algorithms and controllers for energy generation assets and microgrids help you manage supply and demand in a new era of self-sustainability and independent operation. Spectrum Power 7 MGMS is an advanced control and optimization software, used to maximize the value of your on-site energy resources in coordination with local utility or wholesale market rates. SICAM Microgrid Controller provides cloud-based optimization in a basic controller that has been tried and proven worldwide in the important tasks of grid monitoring and control, particularly for solar-plus-storage. From regional power plants to residential solar panels, you can control it all.

With Spectrum Power 7, you and your customers can plan, optimize, and professionally manage local generation and DER programs more effectively. The software predicts power loads and dynamically controls assets by integrating generation data with forecasting data and outside information, such as weather conditions. It is powerful enough for your own operations and simple enough for your customers to use to manage their own, local microgrids and adopt programs such as demand response.

Bring it All Together

Siemens automated control technology is the "glue" that brings new and existing assets together into a single, operable microgrid for your customers. It provides a detailed view of all power assets to proactively manage and optimize generation and usage. During outages, customer can use automated controls to easily island their operations from the grid.

Siemens automation controls create a seamless grid that's resilient and cyber secure. In addition to monitoring standard power generation, they also integrate diverse power sources such as wind and solar, energy storage, thermal generators, and cogeneration plants, and any legacy systems. Even assets from different suppliers can be integrated. It provides an ideal solution to create and manage different energy portfolios without fear of outages or power interruptions.

Power Generation Assets

A complete range of generating assets designed to meet any need

A leading player in power generation, Siemens offers one of the broadest portfolios of generation assets in the market, including gas turbines, combined heat and power (CHP), and renewables. We supply power generation that supports DER initiatives for organizations of all sizes and needs, ranging from universities and hospitals to energy-intensive manufacturers to local communities and power cooperatives. No matter what the specific needs are for power efficiency, reliability, and intensity, we have the assets to match it. We can help you recommend, provide, and commission the power generation that is ideal for your customers' energy needs and capabilities.

Tailor-Made Performance

Our industrial gas turbines range from 250kW to 53MW and are ideal for small energy producers and industrial operations. Aero derivative gas turbines offer a compact, lightweight design that delivers efficiency and power with ultra-fast start-up. Large and multi-building customers can access high-performance steam and gas turbines up to 100MW. Gas engines less than 2MW feature dynamic fuel blending; ideal for biogas facilities requiring fuel flexibility.

We have extensive experience in developing CHP solutions for residential, institutional, commercial, and industrial applications – including biogas/biomass. Using a gas turbine and a steam turbine that recycles heat exhaust, efficiency is improved by as much as 90%, reducing fuel consumption and carbon emissions.

Siemens renewable solutions deliver reliability along with sustainability. Our experts can specify, design, and install complete solar arrays or customize a wind solution using technology developed for mid-to-low wind sites. We configure new solutions to work with other renewables and legacy assets in a full, turnkey solution.

With Siemens you'll be ready to meet any customer need for distributed generation. From a single location to a campus-wide microgrid, we'll work with you to identify and configure power generation assets for your customers looking to take advantage of the benefits of DER.

Project Financing Options
At Siemens, we're committed to providing financially viable solutions that make it easier for your customers to adopt an on-site energy solution. Siemens Financial Services offers investment solutions ranging from advisory services to technology and equipment financing. Our new turnkey approach, DBOOM (short for Design, Build, Own, Operate, and Maintain), provides upfront construction financing and removes the burden of infrastructure ownership with payments made based upon energy usage.

Energy Storage Solutions

The latest technology adds flexibility and cost savings

Modular energy storage systems make distributed generation solutions that much more efficient, and offer new opportunities for you and your customers. They provide one of the greatest grid services of all – flexibility. Energy storage solutions enable customers to accrue energy and then release it during peak periods. In the transformation to DER, it is a critical tool.

Performance Guaranteed

Siemens energy storage systems are built around Lithium-ion battery technology that is integrated into the local energy system via automated controllers. All our solutions are designed based on upon the specific infrastructure at your customers' locations and backed with a performance guarantee.

In addition to managing supply and demand cost-effectively, our energy storage solutions help ensure balance throughout on-site energy systems and across the grid. Storage technology can optimize the performance of all power generation and distribution assets by stabilizing frequency and voltage.

Energy storage solutions can also be used to mitigate the intermittency of renewable assets, like wind and solar, storing energy when it is sunny or windy, and releasing it when it's not. As customer demand for on-site renewables continues to grow, battery technology will provide the backbone to support the use of these resources long-term.

Built to Last

Energy storage solutions from Siemens are customized to the specific needs of you and your customers. Designed with scalability in mind, they can provide storage for smaller demand now and greater demand as more assets are added in the future. They integrate with a wide range of generation solutions, including renewables and fossil-based generation, as well as legacy and third-party assets – such as solar arrays and diesel generators.

Energy Engineering Expertise

Customized, engineered solutions with support at every stage

Our mission is simple: provide solutions that enable organizations of all types to implement, run, and optimize a distributed generation system that meets their specific goals for DER. We bring to the table expertise from across the energy spectrum to make this happen.

A Smarter Approach

Siemens provides expert consultative and technical services to support utilities and their customers with on-site solutions from installation through commissioning.
The process begins with conceptual design and technology selection and includes project feasibility studies, project design, construction and commissioning, and service and performance. We can provide you the right resources at the right time to make your customers' projects a success.

For all projects, we utilize on-staff energy modeling experts to match demand and supply needs and provide ongoing optimization based on factors like cost and weather conditions. Our process is designed to ensure smart integration of new and existing assets – providing maximum flexibility and value.

A Technology Partner

You can trust Siemens technology experts to provide guidance and direction that encompasses the entire project – from generation, to storage, to control – and for utilities and customers of all sizes, needs, and capabilities.

Committed Support
Siemens provides service and support to ensure optimal operations and maintenance of distributed generation solutions. We provide flexible service options based upon your customers' specific needs and capabilities. Services are designed to support the entire project lifecycle – including upgrades and condition monitoring – to optimize performance and maximize success. We help secure your customers' long-term satisfaction.

Siemens Corporations
300 New Jersey Ave. N.W.
Washington, D.C. 20001
Tel: (800) 743-6367


SIEMENS
Ingenuity for life
Microgrids –
the future of energy
management
siemens.com

Power generation made smart

Microgrids are a reliable alternative wherever a stable power supply is needed. Siemens can leverage its comprehensive microgrid portfolio and tackle challenges throughout the entire system.

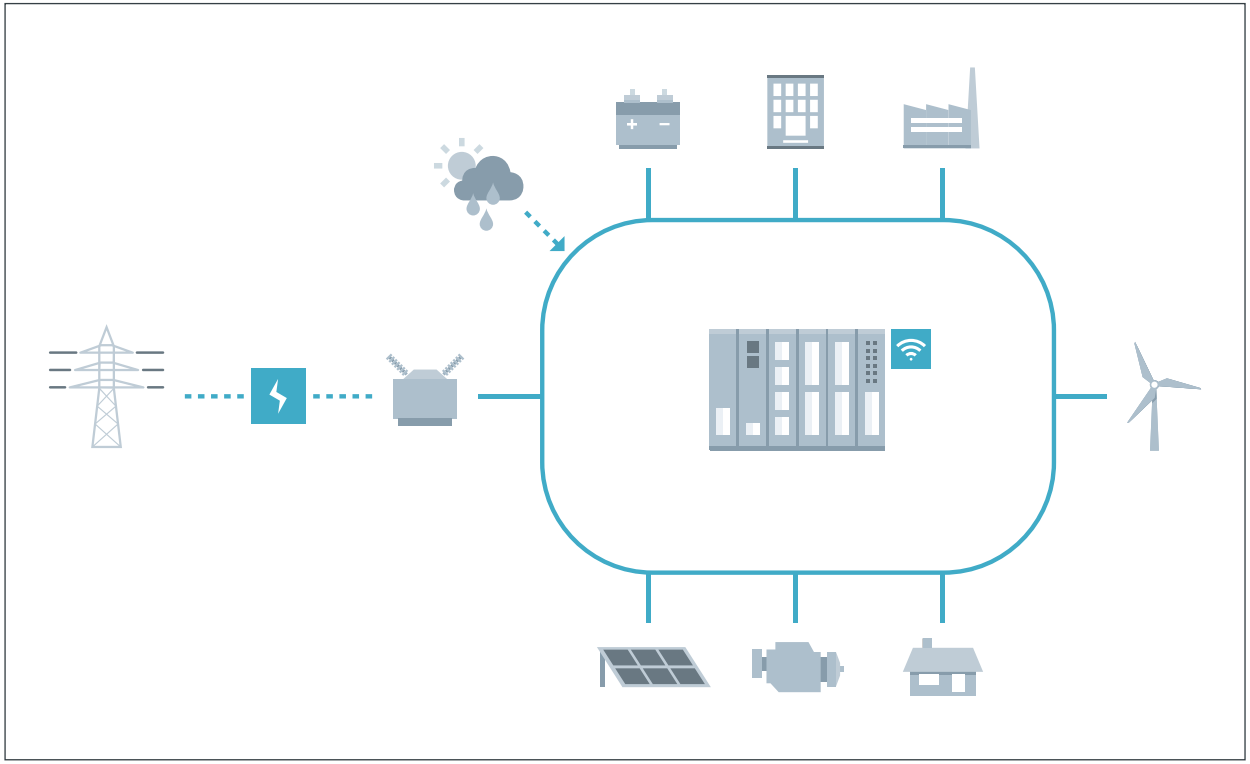
Microgrids are efficient, resilient, and sustainable distributed energy systems

Two major trends are driving the transformation of the energy world: digitalization and the shift from centralized unidirectional to distributed energy systems. These trends as well as prosumers' needs are driving the development of microgrids.

Microgrids contain all the elements of complex energy systems, they maintain the balance between generation and consumption, and they can operate on and/or off grid. They are ideal for supplying power to remote regions or locations with no connection to a public network. In addition, more and more industrial operators are using microgrids to produce the electricity they need cost-effectively, sustainably, and reliably.

Microgrids use a variety of energy sources, including photovoltaic and wind-power plants as well as small hydro-power and biomass-power plants. Biodiesel generators and emergency power units, storage modules, and intelligent control systems ensure the security of supply.

Siemens provides a comprehensive portfolio of products, solutions, and services to help build and operate microgrids of any size. They provide generation and distribution of electrical energy as well as monitoring and controlling of microgrids.

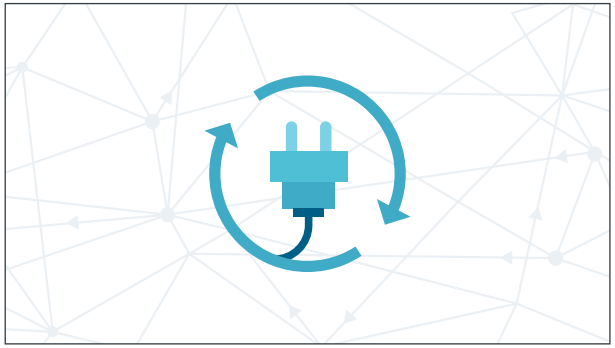


Benefits at a glance

Economics and energy efficiency

Using sophisticated software, operators can optimize power usage based on demand, utility prices, and other factors. Application areas most impacted are campuses as well as commercial and industrial areas.

↗ Reference Algonquin College



Reliability and resilience

Microgrids are designed to provide uninterrupted 24/7 power and to balance load demands for an organization with changing power needs. Relevant applications are critical infrastructures, military institutions, commercial and industrial areas, remote locations and islands.

↗ Reference Blue Lake Rancheria

Sustainability

By using primarily renewable energies, microgrids reduce carbon-dioxide emissions, which is often required by government regulations. That makes them especially attractive for campuses, utilities, and islands.

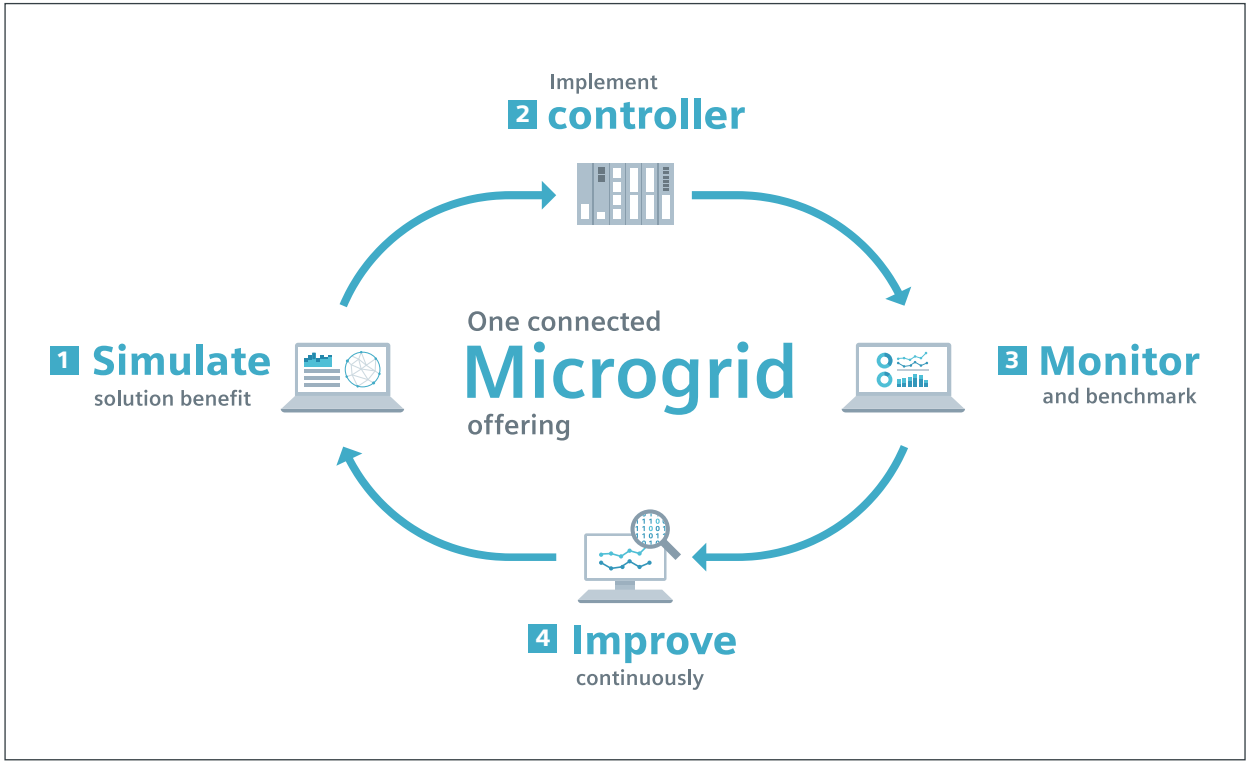
↗ Reference Ventotene Island

Mastering all challenges with Siemens

One offering for distributed energy systems

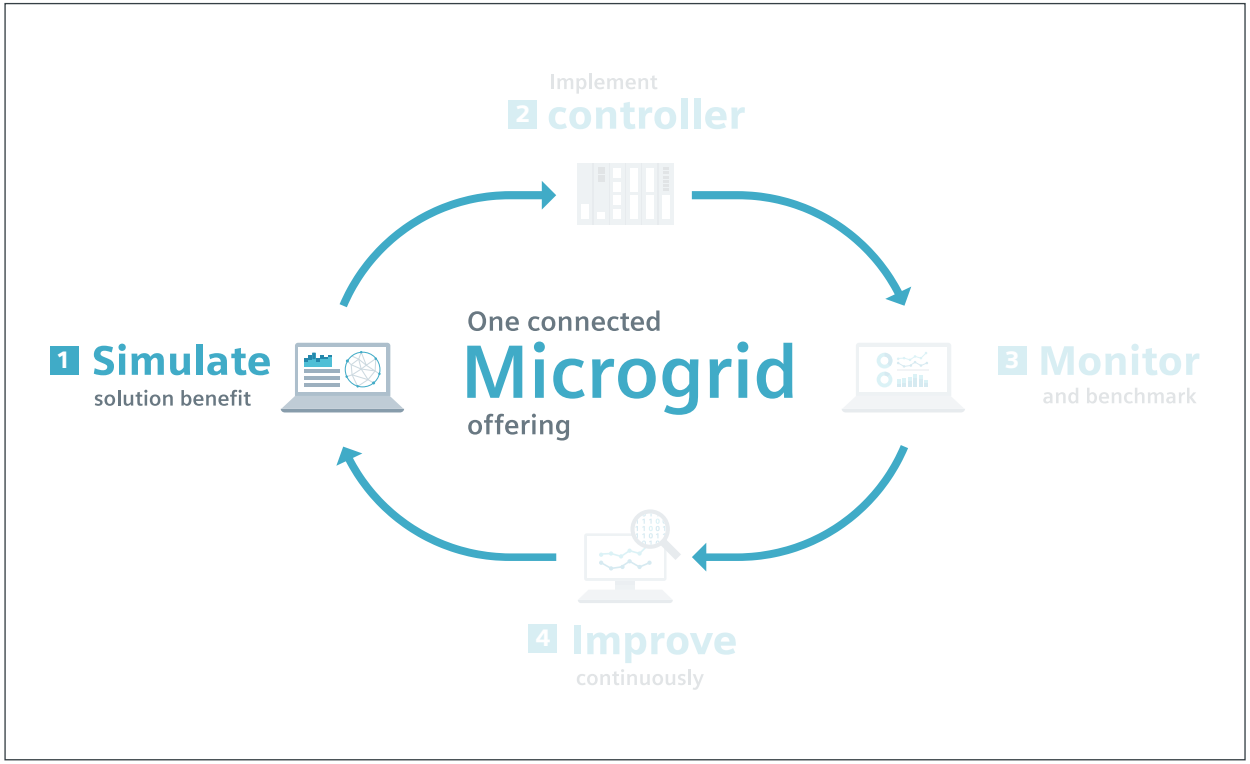
To integrate distributed energy systems (DES), we support you in several steps to reach the most efficient system. Define and simulate, integrate the right controller, monitor and improve the system. Several portfolio elements help you create a microgrid solution that meets your requirements perfectly.

We will work with you to design and deliver a comprehensive, and integrated microgrid solution for your energy infrastructure project. Our proven expertise with complex decentralized energy sources, leading control systems, and transmission and distribution systems, along with our suite of services, make us an ideal partner for stakeholders.



1 From simulation with an energy twin to solution benefits

The first process step is the energy twin: We simulate the entire microgrid project using virtually integrated control modules. What's more, we evaluate the DES baseline and solution benefits.



2 The right controller for your microgrid

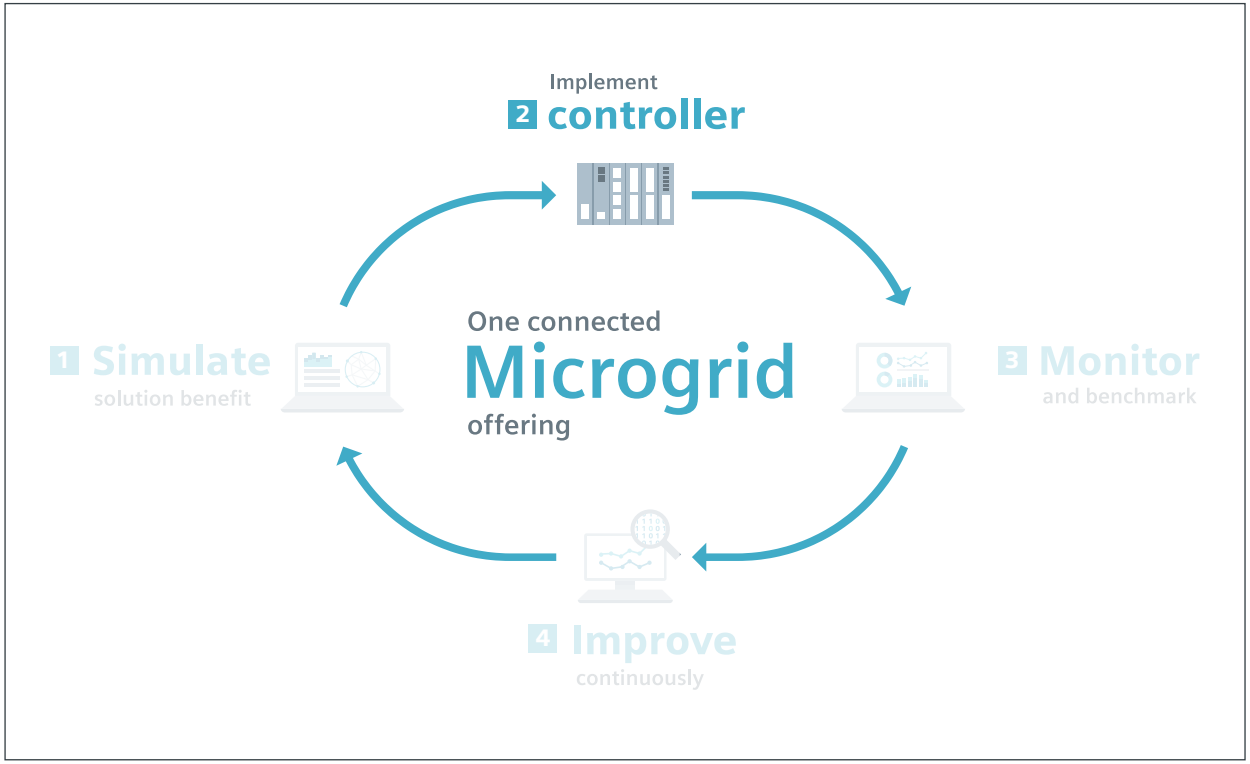
The scope and design of your microgrid determines the appropriate controller to implement. With Microgrid Control – a SICAM Application and Spectrum Power MGMS, Siemens offers the right product for any application.

Microgrid Control – a SICAM Application ensures reliable monitoring and controlling of microgrids. It protects your independent power supply from blackouts and balances out grid fluctuations and fluctuations in power consumption.

↗ Learn more

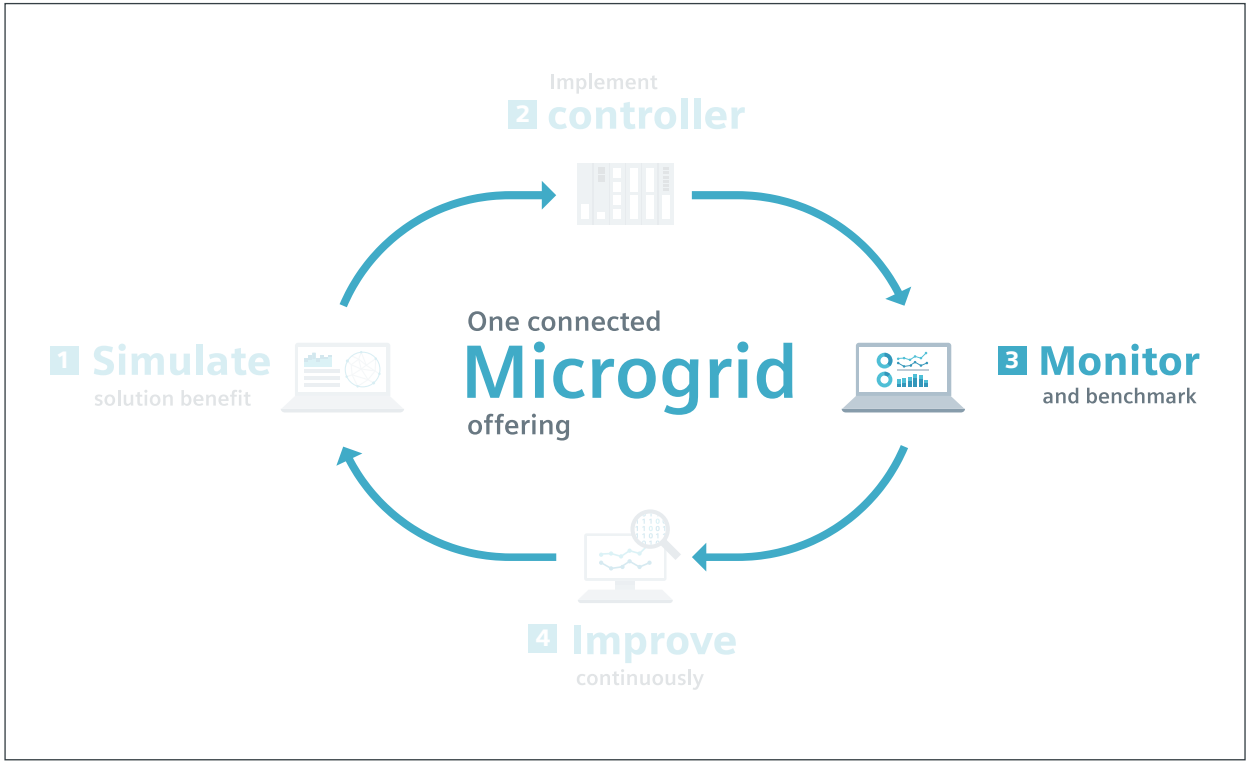
Spectrum Power MGMS is a software solution for optimal microgrid management and control. Some of its advanced functions include seven-day load and generation forecasting, unit commitment optimization, load shed, seamless transition to and from island mode, and market participation tools.

↗ Learn more



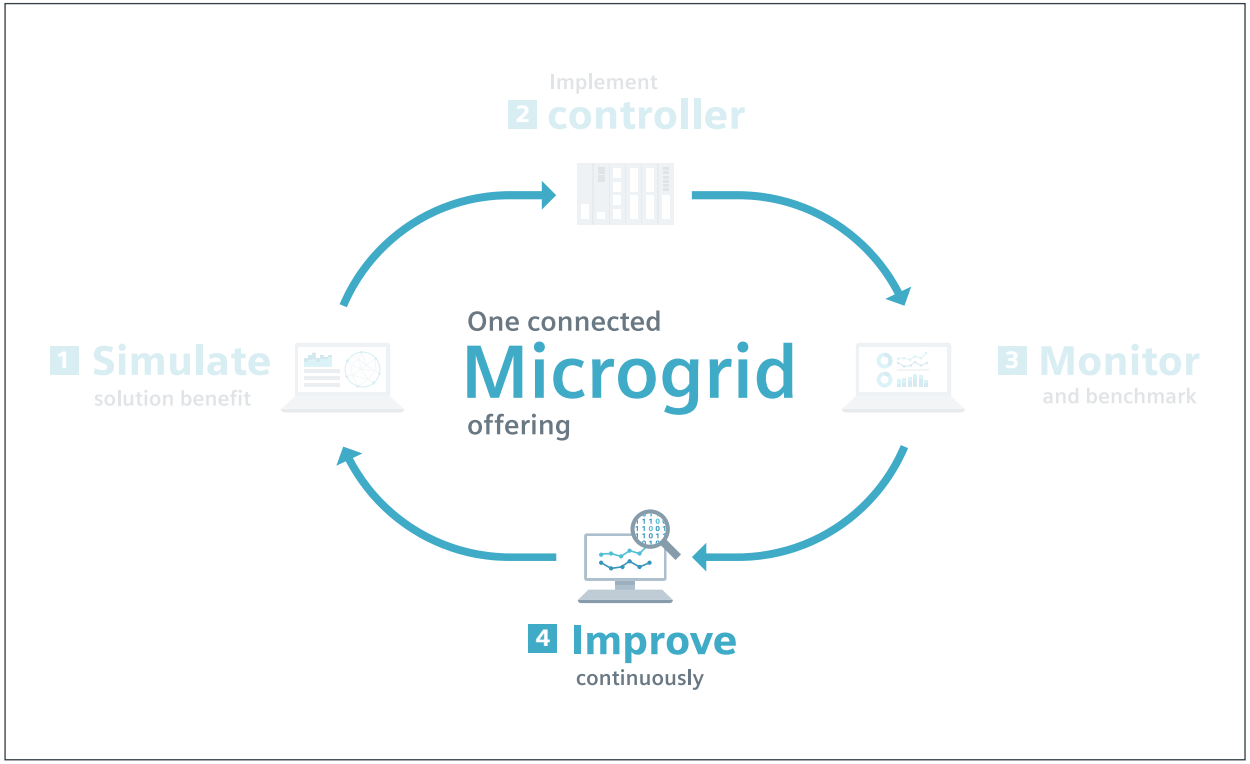
3 Data gathering and monitoring

DER Performance Analytics and Management is an IoT energy management platform from Siemens. In a self-contained energy system, it gathers relevant DER data, supports the reporting of KPIs, and provides benchmarking data analytics. During Expo 2015 in Milan, Italy, Siemens managed the entire smart city with this application. It covered not only the grid technologies, but also smart building, smart lighting, and electric mobility.



4 Operational improvement through data analysis

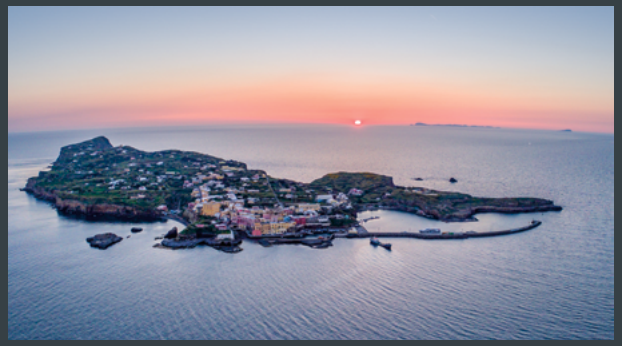
Attaining data is good, but not enough. We want our customers to extract the most value from it. Siemens Managed Services supports customers to analyze the data with powerful tools. Based on the analysis, we provide recommendations to improve the operational efficiency system and suggest structural changes. Once the improvements have been identified, the recommended changes can be simulated and the savings can be quantified.



Blue Lake Rancheria, California, USA

Algonquin Campus, Eastern Ontario, Canada

Buenavista del Cobre, Cananea, Mexico



Ventotene Island, Italy

IREN2, Wildpoldsried, Germany

Expo 2015, Milan, Italy

Savona University, Genoa, Italy

Blue Lake Rancheria, California, USA

A microgrid on a Native American reservation

- A typical application for the microgrid use case “Municipality”
- A microgrid powers a 100-acre reservation including offices, casino, hotel, and Red Cross safety shelter
- Siemens’ microgrid management software allows the distributed energy resources to be intelligently managed

↗ Learn more

Blue Lake Rancheria, California, USA

Algonquin Campus, Eastern Ontario, Canada

A unique spirit of partnership

- A typical application for the microgrid use case “Campus”
- The College of Applied Arts in Technology is on an ambitious journey to becoming a sustainable institution of the future
- With Siemens, it found a partner to help educate, operate, collaborate, and innovate for a clean energy future

↗ Learn more

Algonquin Campus, Eastern Ontario, Canada

Buenavista del Cobre, Cananea, Mexico

A reliable grid can move mountains

- A typical application for the microgrid use case “Industry”
- Using a Siemens control system, a copper mine realized a 60 percent reduction in downtime and significant cost savings
- Siemens constructed a new state-of-the-art DCC that integrates the Spectrum Power grid control platform

↗ Learn more

Buenavista del Cobre, Cananea, Mexico

Ventotene Island, Italy

How to optimize an island’s power supply

- A typical application for the microgrid use case “Islands”
- A SIESTORAGE battery storage system secures the power supply on the Italian island of Ventotene
- The solution enables the more economical and efficient operation of the entire energy system

↗ Learn more

Ventotene Island, Italy

IREN2, Wildpoldsried, Germany

Smart technology combined with science

- A typical application for the microgrid use case “Municipality”
- Ingenuity meets pioneering spirit: The first microgrid test of its kind outside the laboratory
- The village set up stable grids with a functioning electricity supply from a range of renewable sources

↗ Learn more

IREN2, Wildpoldsried, Germany

Expo 2015, Milan, Italy

The art of setting up a smart grid

- A typical application for the microgrid use case “Cities”
- At Expo 2015, Siemens delivered the intelligent grid technology that supplied the fair with electricity
- The energy management system was based on sophisticated cloud technology

↗ Learn more

Expo 2015, Milan, Italy

Savona University, Genoa, Italy

IQ power for tomorrow's *dottore*

- A typical application for the microgrid use case "Campus"
- Implement an intelligent microgrid for the university campus in Savona, Italy
- Goal: Provide electrical and thermal energy. Benefits: High efficiency and grid stability, lower emissions, easy control

↗ Learn more

Savona University, Genoa, Italy

Shaping viable energy infrastructures

Trusted expert advisory service in a transforming energy sector

siemens.com/power-technologies

Energy transition is now – and it has just started

There is a worldwide need for integrating growing capacities from renewable energy sources and new loads, such as electromobility charging infrastructures, into our energy supply network. At the same time, more and higher quality power needs to be supplied to end customers. Our power grids are transforming into increasingly digital, decentral, and sustainable energy systems. These changes are no longer just ambitions for a distant future, but are backed by practice-proven technical capabilities that are not only already available, but also largely economical today.

Whatever the situation in a specific system, all have one challenge in common: The expectations on energy systems, both from legal entities and the public, are rising. New technologies and concepts offer new possibilities and potentials, both in technical and in economic spaces. And the energy transition has only started. More advances at shorter intervals are to come.

Already today, the changes in regulatory requirements and technologies are often very significant.

Consequently, the adaptation and development of the physical energy systems – especially of the networks – cannot keep pace. System operation is pushed closer to technical, often even to economic and regulatory, limits. At the same time, our modern, fully digitalized societies and economies are highly dependent on a secure, reliable, and cost-effective power supply. How can we ensure that our energy systems can fulfill these demands? As our energy systems grow increasingly complex and safety margins are being reduced, "traditional" power engineering and economics ingenuity are becoming more important. Today, this expertise must be complemented by a detailed understanding of how we can leverage digitalization to create real benefit in practical applications, such as concepts for digital twins of energy systems. For the development of low or zero-carbon strategies and concepts, capabilities such as forecasting and extrapolating relevant operating scenarios provide planning and investment security. And with energy being more than just electricity, it is important to look into coupling the power system with different sectors such as mobility or heat.

Only the knowledge of all relevant stakeholders and a deep understanding of existing and emerging business models can ensure a profitable business case. This rising complexity makes it important to take an integrated planning approach considering strategic as well as technical aspects in order to achieve the flexibility and efficiency that is needed in future-proof energy systems.

Establish the foundations for flexible, efficient, and resilient digital grids

From strategic advisory service and technical consultancy to state-of-the-art software: Siemens Power Technologies International (PTI) provides a holistic view to master the technical and economic challenges of today's and future energy systems.

Our strategic consultants help optimize value by providing guidance in the fields of business transformation, infrastructure development, as well as market and transaction advisory service. Drawing upon more than 60 years of international experience and continuous innovation in power system planning, Siemens PTI addresses the full scope of analysis, design, and optimization studies. Latest user requirements and our project experience continuously shape the design of the comprehensive PSS® portfolio for power system planning, simulation, and model management.

Managing industry change and leveraging digitalization while safeguarding system performance is our key mission. As your long-term partner, Siemens PTI will continuously focus on your needs and value-add, and innovate for the greater needs of the power industry.

Knowledge base for digitalization and innovative solutions to manage increasingly complex power systems

Innovative solutions

Mitigation of risks and ensuring profitability of investments based on strategic planning

Profitability

Regulatory compliance support driven by global best practices, local knowledge, and dedicated software functionality

Regulatory compliance

Leading expertise, backed by active engagement in national and international committee work and R&D projects

Expertise

Trusted software for simulation and modeling accuracy covering over 70% of the world's energy consumption

Software

Partnership

Partnerships for long-term training programs, grid planning, and software support

Flexibility

Vendor neutrality for independent decision-making and tool flexibility in consulting

Experience

Broad experience secures success: ~1,000 international projects per year

Support

Local support for project development, execution, and beyond

Manage complexity and increase efficiency

Dynamic markets, changing regulations, digitalization, and an increasing number of grid interconnections multiply the aspects and the number of projects that need to be addressed to remain competitive. In Siemens you have the right partner, with profound strategic and technical expertise to make your grid sustainable and future-proof.

1 Grid access and grid code compliance

When connecting new generation units to the transmission grid, interconnection criteria and grid codes have to be met in order to safeguard the system's operational performance. Our services include:

- Verification of grid code compliance considering all relevant operating scenarios
- Assessment of dynamics and interactions with the power system
- System design and verification, e.g. cable sizing and transformer design verification
- Support certification process by creation and/or validation of the performance of simulation models of generating and control units for acceptance tests

2 Smart city scoping and planning

With rising environmental awareness, technological complexity, and cost pressure, urban centers need innovative and integrated infrastructure scoping and planning. We can support with:

- Smart city scoping studies to examine all available options and technologies to create future-ready, sustainable, and smart cities
- Scenario and simulation-based planning of urban energy systems leveraging digitalization and innovative technologies
- Integrating smart buildings, decentral energy structures, storage systems, demand side management, Power2X, eMobility, and more

3 Strategic grid planning

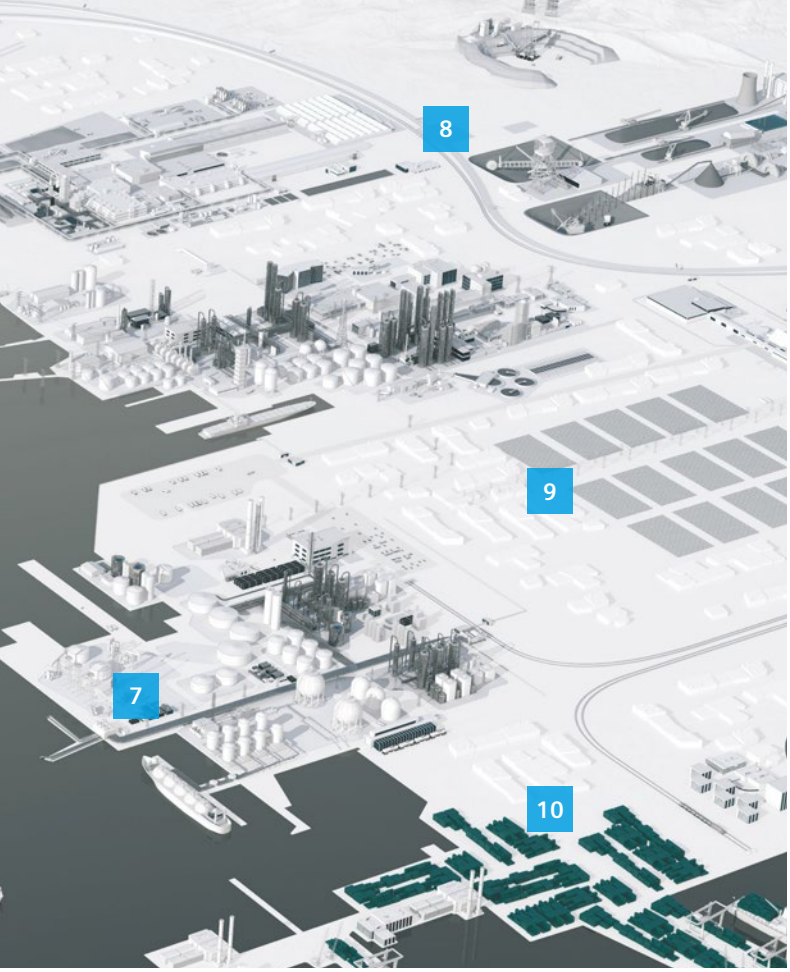
Energy transition is challenging the secure and economic operation of our power grids and calls for various adaptations in planning and operation. Our services include:

- Identifying weak points and bottlenecks in systems
- Designing resilient and compliant grid concepts based on predefined design priorities, e.g. cost-efficiency and environmental concerns
- Deriving optimized grid development and investment plans to avoid stranded investments and identify no-regret-measures
- Integrated resource planning
- Transmission compass: development of technology adoption road maps

4 Digitalization strategies and grid model management

Digitalization is key for the planning, operation, and management of increasingly complex energy systems and utility companies. Siemens PTI supports with:

- Development of a strategic vision and road map to improve operational excellence and reshape existing business models
- Recommendation of a grid data management concept based on individual requirements and the existing software landscape
- Data quality check of data within and across different domains
- Implementation of digital twin concepts across all domains as the foundation for advanced analytics and future digitalization use cases



5 Designing of microgrids and distributed energy systems

If properly designed, microgrids and distributed energy systems allow for a more efficient, resilient, and sustainable power supply. Our offer includes:

- System and strategy definition to develop business models and scenarios
- Simulation and optimization of an energy supply portfolio including DER sizing and storage, as well as emissions reduction
- Grid studies and concepts to leverage local generation and storage for highest resilience and cost-efficiency
- Detailed implementation plan to define operational tasks and responsibilities and evaluate financing options

6 eMobility consulting

The rapid development of electric mobility requires stakeholders to transform their businesses models and planning principles. We help on that pathway with:

- eMobility strategies and implementation road maps to define roles and business models
- Demand modeling for eMobility patterns at the city and district level according to regulative and market developments
- eDepot concepts to identify the optimal charging infrastructure and electricity supply, as well as IT/OT integration and process concepts
- Stress tests to assess the impact of eMobility on the grid impact and develop measures in line with the existing asset management strategy
- Customized eMobility workshops for best practice exchange and curriculum training on technologies and regulation

7 System protection concepts and parameterization

Reliable operation of protection systems is crucial for the overall reliability of electrical power systems. We assist in:

- Designing clear, system-wide protection concepts
- Dimensioning of instrument transformers and parameterization of protective relays according to the defined concept
- Support for NERC PRC-027-1 compliance including creation of audit-ready documentation
- Protection security assessment: automated evaluation of the selectivity, sensitivity, and speed of the protection system performance for different operating conditions

8 Power electronics

As more and more generation and appliances are based on inverters, power electronics characteristics are becoming predominant for system operation. We provide:

- Assessment and verification of inverter solutions for different applications
- Solutions for grid coupling and system stability improvement
- Analyses of the impact on frequency and voltage stability and definition of suitable control strategies
- Dynamic analyses of inverter-based islands and microgrids and verification of black start capability

9 Integration of renewable energy sources

Successful integration of renewable energy sources (RES) into transmission and distribution grids relies heavily on effective planning and operational strategies. Our offer includes:

- Techno-economically optimized RES sizing, placement, and integration
- Hosting capacity study to ensure reliability and stability
- Voltage control concepts for increased reliability and cost-efficiency
- Business case studies to leverage (new) businesses, roles, and applications
- Business operation model definition according to regulative and market framework

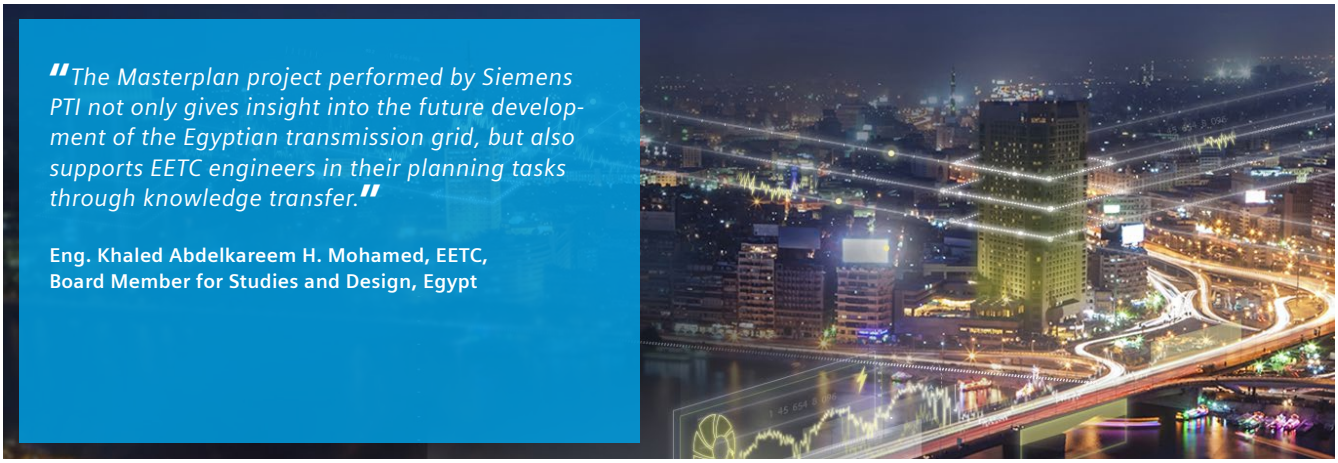
10 Energy supply concepts for industry

Industrial power supply deals with conditions that are more extreme than in typical public systems. Still, high power quality is key to ensuring reliability of the industrial processes. Our studies include:

- Utilization of equipment according to relevant standards
- Determination of appropriate circuit arrangements, voltage levels, switching, and protection devices
- Evaluation of arc flash, motor start, harmonic resonance, shunt compensation, series compensation, power quality, voltage flicker, insulation coordination, stability, and efficiency
- Design and assessment of islanding and island operation

Creating sustainable value

For the success of any consulting project, trusted collaboration is key. Close alignment ensures that all strategic, technical, and financial targets are met. New insights gained during project execution empower you to actively address and manage future demands. At the same time, they help us to continuously improve our offer to you. Learn about some of our customers' challenges, and how our experience has helped them to achieve their goals.



"The Masterplan project performed by Siemens PTI not only gives insight into the future development of the Egyptian transmission grid, but also supports EETC engineers in their planning tasks through knowledge transfer."

Eng. Khaled Abdelkareem H. Mohamed, EETC, Board Member for Studies and Design, Egypt

Strategic road map for Egypt's national transmission grid

- Digital model for simulating grid scenarios for the expansion of the Egyptian power system
- Grid expansion improving overall performance and dynamic stability
- Full-spectrum system approach

"Together with Siemens, we developed new, innovative business ideas based on our long-standing experience in the field of network operation and digital technologies. With their techno-economic knowledge and methodological competence Siemens supported us to achieve a transparent view on possible business opportunities."

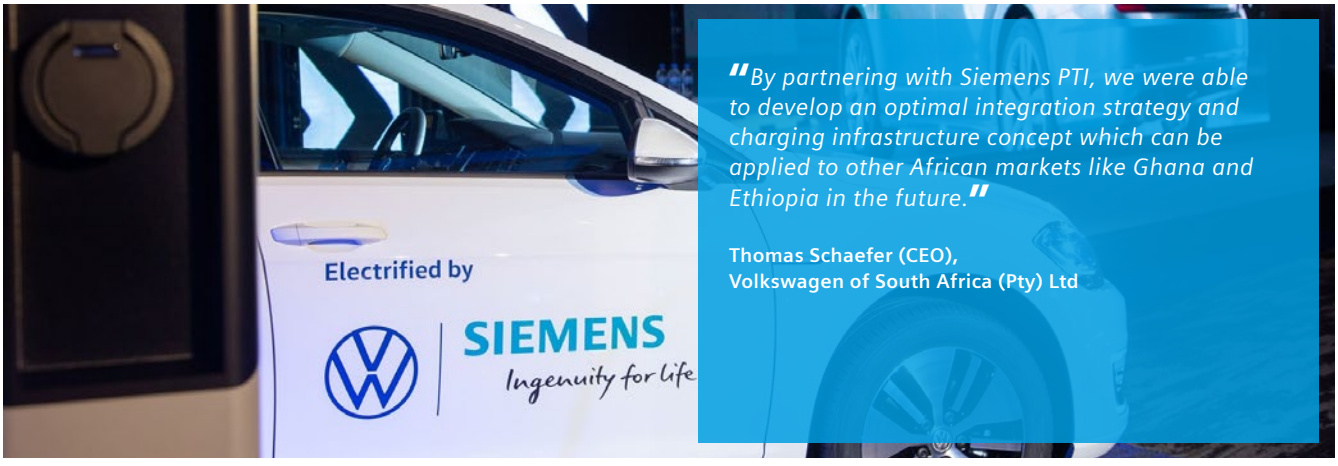
Giorgio Di Lembo, Enel Global I&N, Head of Remote Control and Protection Solutions, Italy

Development of customer-oriented business models

- Increasing digitalization of low-voltage networks offers new business opportunities
- Guided business ideation and modeling, identification of new value propositions for consumers
- Analysis of business model costs, revenue streams, and viability

Highly reliable power supply for Titan Cement plants

- Complete data survey, documentation and modeling of the power and protection system with validated high quality
- Performance assessment of the existing system and development of new improved network structures with respect to reliability, power quality, protection, and personal safety
- Know-how transfer and staff education through workshops and customized training



Grid integration for eMobility car-sharing services in Kigali, Rwanda

- Selection of sites for charging hubs and demand forecast to determine required charging points (CP)
- Network analysis to prepare grid connection
- Techno-economic analysis of different hub variants and final implementation road map

Understanding the big picture

To achieve sustainable improvements, it takes a holistic view. At Siemens PTI, experts from the various fields work closely together to meet the requirements of an individual project. Within our global team, we will always find an expert who understands your needs. This enables us to partner with you in a multitude of tasks across the complete infrastructure project life cycle.

Strategic advisory

Digital Business Strategy and Transformation

Digitalization, decarbonization, and decentralization are drivers for change in the energy sector defining the operational, technological, and business models of utility companies.

- Utility of the future strategies
- Business model transformation
- Managed transition programs

Smart Infrastructure Advisory

Smart technologies and digitalization are defining the requirements for future infrastructure of countries, cities, and districts determined by socio-economic and environmental values and factors.

- Smart infrastructure strategies and concepts
- Strategies for design and operations of decentralized energy systems
- Valuation and transaction advisory

Planning and Regulatory Advisory

Adequate models, plans, and strategies to enable clients to not only survive but thrive in challenging regulated markets and environments.

- Strategy and integrated planning
- Energy market forecasting and analytics
- Energy portfolio optimization
- Regulatory strategies

Implementation and Solution Advisory

Complex technologies and solutions need to be integrated into existing operational models and technology stacks in an effective, efficient, and secure manner.

- Cybersecurity services and consulting
- Data structure and integration advisory
- IT/OT implementation advisory

Steady-state analyses

Practice-proven concepts that optimize system performance with respect to technical and economical requirements.

- Calculations and simulations of present grid structures and configurations
- Development and performance validation of alternative structures and configurations
- Neutral grounding concepts and configurations
- Grounding system design
- Techno-economic analyses ensuring profitable business models

Protection and control

Sound concepts for protection and control, and detailed coordination of devices ensure system safety and stability.

- Design of optimized protection concepts and dimensioning of instrument transformers
- Coordination of protection devices and relay parameterization
- Concepts and configuration of equipment for communication, automation, and control
- Analysis of disturbance events and on-site measurements
- Protection security assessment: automated evaluation of the selectivity, sensitivity, and speed of protection system performance
- RTDS-based hardware-in-the-loop tests to verify setting values of relays, measuring equipment, and controllers

Power quality

Measurements, model development, performance assessment, and solution design to ensure reliable system performance.

- Power Quality Analytics service for performance monitoring and outage prevention
- Measurement, evaluation, and analysis of power-quality-related phenomena, especially harmonics
- Filter design and performance validation
- Analysis of interferences from power supply systems on other networks and systems

Dynamics

Modeling, analysis, and optimization of the dynamic system performance for stable and secure system operation.

- Dynamic modeling and stability analysis including rotor angle, voltage, frequency, and small signal stability
- Controller and machine measurements, modeling, and validation
- Positioning of controllers and optimization of control strategies and parameters
- Power electronics modeling and analysis including converters, FACTS, or HVDC
- Assessment of energy storage solutions to support frequency control

Transients

Modeling and analysis of transient aspects to minimize the risk of equipment damage and to increase system resilience.

- Modeling and analysis of transient phenomena, e.g. lightning strikes, switching operations, or overvoltages
- Insulation coordination and overvoltage protection concepts
- Simulation of fast and very fast transient surges
- Studies of circuit breaker stresses (e.g. transient recovery voltage, missing current zero crossings) and recommendation of mitigation measures
- Time-domain analysis of system resonances

Published by
Siemens AG

Smart Infrastructure
Digital Grid
Humboldtstrasse 59
90459 Nuremberg, Germany

For the U.S. published by
Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA 30005, United States

Article No. SIDG-B10053-00-7600
fb8747 WS 1020

SIEMENS CAMPUS WITH MICROGRID CONTROL – A SICAM APPLICATION

Reduction of CO_2 footprint and power peaks at **Siemens Campus in Vienna**

The Siemens Campus Microgrid is an intelligent system for the optimization of the electricity and heating demand on the company's premises in the Viennese district of Floridsdorf. It consists of photovoltaic power generation, e-charging infrastructure, battery storage and the microgrid controller. Next to a safe and reliable provision of electrical energy, it simultaneously reduces the CO_2 footprint and electricity peaks.

siemens.com/vienna-campus-microgrid

Customer
Siemens Real Estate

Location
Siemens City Vienna, Austria

Timeframe
established in 2020

Scope of delivery
The intelligent system consists of:
- Microgrid Control – a SICAM application
- Photovoltaic Power generation
- E-charging infrastructure
- Battery storage

The task

The Siemens Austrian subsidiary in Vienna set the goal back in 2010 to build new headquarters as a showpiece of energy-efficient construction and innovative environmental technology.

The aim is to:
- reduce annual CO_2 emissions;
- fulfill emerging electrification requirements such as e-mobility which place greater demands on the grid;
- maintain resilience while integrating renewable energy sources;
- enable operations team to use the existing infrastructure as efficient as possible.

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A broad range of the measured data is visualized in the Visitor & Advanced Service Center.

The Compact Power Charger with an output of 50 kW DC.

The solution

The project executed in combination with the infrastructure of an existing industrial enterprise is a game-changer.

The showcase demonstrates the behavior and the benefits of microgrids using Microgrid Control – a SICAM application as the brain of the Campus Microgrid. The application runs on the SICAM A8000 platform which is globally used in critical infrastructure. This high-performance system manages a total output of around 2.5 MW, which roughly corresponds to the power consumption of 700 households. The controller integrates all functionalities and optimizes the power supply regarding district heating, electricity peaks, and renewables generation.

The higher-order optimization, visualization and operation will in future be realized by using DEOP - the IoT-based cloud system for optimization of distributed energy resources. A broad range of the measured data and influencing factors are visualized at the Visitor & Advanced Service Center.

Furthermore, the Siemens building management system Desigo has also been integrated, making it possible to adjust the amount of heating provided to the main building in the event of district heating peaks, and thus optimizing the volume of power drawn from the district heating grid.

The result

More than 100 tons of CO_2 per year can be saved by powering our local Siemens car fleet by the integrated photovoltaic systems, which span a total area of 1,600 m^2. A battery storage solution is used in combination with the microgrid controller to manage electricity peaks. This enables the realization of future-oriented solutions for e-car parks and electric vehicle charging management on the basis of existing consumption behavior.

Furthermore, the Siemens showcase highlights how intelligent load management components can contribute to the integration of electric mobility and photovoltaic power generation to reduce the need of grid expansion to an optimum.

Key Facts

- Photovoltaic systems: Total area of currently 1,600 m^2 and peak performance of 312 kWp
- Battery storage: Capacity 500 kWh, output: 500 kW
- Fire protection for battery storage: Extinguishing system Sinorix
- 30+ charging stations for electric vehicles
- Future proof easy extendable e-car charging solution
- Desigo building management system
- Microgrid Control – a SICAM application running on the SICAM A8000 platform
- Additional feature: Pre5G campus network pilot installation in cooperation with the partners A1 and Nokia

Published by Siemens AG

Smart Infrastructure
Electrification & Automation
Mozartstraße 31 C
91052 Erlangen
Germany

For the U.S. published by Siemens Industry Inc.

100 Technology Drive
Alpharetta, GA 30005
United States

Article No: SIEA-B10013-00-7600

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WHITE PAPER

Shaping a **smart energy world at the grid edge – exploring opportunities** for municipalities and DSOs

Strategic roles, valuable use cases and practical references to illustrate the potential for market players

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1. Foreword

Energy systems around the world are undergoing constant and radical transformation. Catchphrases like decentralization, digitalization and decarbonization have evolved from hyped buzzwords into the new reality. Recent climate protection initiatives like the European Green Deal, the return of the USA to the Paris COP21 agreement, and stronger awareness of sustainability are further driving this change. The energy sector is already making a significant contribution to decarbonization with a decline in fossil fuel investments, flanked by a 150% increase in renewable energy source (RES) investments between 2015 and 2050[1]. On the consumption side, 81% of S&P 500 companies have set emissions-reduction targets[2] and cities are striving for a 90% reduction in GHG emissions by 2050[3].

The energy system is visibly transforming into a highly intertwined system of central generation plants and millions of decentralized, intermittent, smart electricity generators, storage facilities, electric vehicles (EV) and intelligent, manageable loads. Of the 2 million photovoltaic (PV) installations in Germany, the lion's share is made up of small-scale, behind-the-meter installations[4]. In the US, PV installations have grown by 43% year on year, reaching a record 19.2 GW of new capacity in 2020[5]. The demand side is also in a state of flux. By 2040, 58% of all passenger vehicles sold will be electric[6]. The Boston Consulting Group estimates that in Europe alone, the number of public chargers will have to rise from 200,000 today to over 1.8 million by 2030, resulting in an additional energy demand of 86 TWh[7]. A second catalyst is the ongoing proliferation of digital solutions in our everyday life. The internet of things is becoming reality for businesses through concepts like "Factory of the future"; for energy companies through the "Internet of energy"; for commercial customers through intelligent buildings; and for private consumers through smart homes.

Dr. Michael Schwan
Head of Siemens Power Technologies International Power System Consulting expert, Siemens

The combination of these two factors makes up an explosive and transformative mixture for the energy world: The traditional grid not only needs to integrate new, smart customers but also has to closely collaborate with them. This area is called the grid edge. It is characterized by a constant state of "hybrid", where traditional "dumb" assets must work together with modern "smart" devices,

1 Guidehouse (2020): Financing the Energy Transformation: Capitalizing on New Investment Opportunities

2 Bullard, N./ Harrison, K. (2019): Businesses finally think big about cutting emissions, in Bloomberg 2019

3 Borunda, A. (2019): This is what cities need to do by 2050 to meet climate goals, National Geographic 2019

4 Fraunhofer ISE (2021): Aktuelle Fakten zur Photovoltaik in Deutschland

5 Stevens, P. (2021): The U.S. solar industry posted record growth in 2020 despite Covid, in: CNBC 2021

6 Bloomberg NEF (2020): Long-Term Electric Vehicle Outlook

7 Hagenmaier, M. et.al. (2021): Winning the Battle in the EV Charging Ecosystem

where fossil generation goes hand in hand with intermittent RES, and where consumers turn into prosumers. This will require not only new technological solutions (e.g. software applications, data analysis) but also agile and open-minded players. They can utilize these changes for their advantage and for the well-being of the overall system. Players at the grid edge must be able to work in ecosystems, take on new market roles, and proactively address their customers with new offers - turning the passive power connections into active assets of the energy ecosystem.

This is a true revolution! But do we need to be afraid of the future? No! These new developments open a plethora of opportunities for all players in the energy sector, especially DSOs and municipalities which are at the forefront of this transformation. As a trusted partner for municipalities and DSOs across the world, Siemens wants to support them in capitalizing on the changes at the grid edge, and creating the utility of the future. In this paper, we will present hands-on use cases which illustrate how current technologies help to integrate new players and assets to improve the core business of municipalities and DSOs and allow them to tap into innovative business models.

2. Grid edge – the new frontier

Cheap, clean, renewable electricity as the primary energy source of our society inevitably leads to a coupling of different sectors. Therefore, supply and consumption will happen more and more at distribution grid level, driven by diverse and smaller entities. These new kinds of stakeholders (e.g. prosumers, aggregators) and assets (e.g. heat pumps, EV charging infrastructure) can have a significant impact on the stability of the energy system without even being a part of the grid itself. DSOs and municipalities, the most important players at distribution grid level, cannot ignore these huge changes. Especially with the decommissioning of more and more central power plants, they need to investigate ways to leverage these resources and stakeholders for efficient and effective system operations. This interaction between players and assets on the customer side and traditional grids is referred to as the grid edge.

The grid edge constitutes the connection and management of actions and effects resulting from the interactions of central energy supply, decentralized generation, and demand; leveraging smart and connected technologies for grids, buildings, infrastructures and industrial facilities to create sustainable value for all stakeholders.

The grid edge is not a physical place. It is a thought model to better grasp the new energy landscape. It initiates a change of perspective from "just delivering electricity" through the grid to the consumers to "constantly interacting with prosumers" to manage the grid. This perspective results in the grid edge being a multifaceted array of use cases which revolve around the optimal combination of intelligent hardware, software and service solutions. These use cases have four distinct characteristics:

- They always **affect and benefit the municipality or DSO and the consumer** at the same time. This is a significant shift from the traditional approach to delivering electricity, keeping the grid stable and receiving compensation in exchange. Now consumers are turning into producers of electricity or providing access to their assets to allow load management.

- Each use case needs a **dedicated operation model** with respect to the usage scenario, assets, objectives, abilities and actions of the different stakeholders. An industrial customer who wants to install a microgrid to save energy has different requirements to those of a charge point operator installing hundreds of EV charging points in a city.

- A **dedicated business model** needs to be developed for each use case. The complete technology value chain, including metering and grid control, distributed generation, distributed storage, flexible load and demand optimization, can be used to enable different business models. These can include more efficient operations, reduction of maintenance costs, or achieving additional revenues, e.g. through consulting or operation of third-party assets. Regulators need to develop more flexible and open guidelines to enable and support these new business models.

- The multitude of players, assets and technologies as well as small-scale projects leads to a **high degree of complexity**. New players in the energy system often do not have grid stability, resilience or power quality on their agenda. They want to deliver on their personal agenda.

The grid edge calls for open-minded and forward-thinking companies that are willing to adopt a customer-focused mindset and a highly agile approach, and offer business models for the world of "the new stakeholders". If new technological and market mechanisms are intelligently deployed, DSOs and municipalities can leverage the grid edge to achieve a new dimension of efficiency, reliability, resilience and sustainability in the modern energy ecosystem.

3. Municipalities & DSOs have a head start in the race to conquer the grid edge

Municipalities and DSOs have the unique opportunity to become the designated champions of the grid edge. However, they cannot remain passive and rely on the regulator and designated grid codes to solve the upcoming challenges. They must proactively meet customers' demands and the technical requirements to adequately support the speed and the extent of the energy transition. They are optimally positioned at the intersection of a highly abstract energy system and a very tangible, customer-focused community network. Therefore, they can unite the unique combination of a strong (end-) customer relationship with the connection to the TSO and the central grid.

Municipalities, integrated utilities, and DSOs need to be aware that, depending on their size and the regulatory environment, they may not be able to take advantage of all grid edge opportunities. With all the disruptions, municipalities and DSOs need a clear strategy for how they want to proceed. When looking at the different players and the opportunities at the grid edge, three typical roles which can act as a blueprint for planning future engagement have emerged:

1) **The cautious observers:** Optimizing the core business of managing the distribution grid and providing customers with secure, reliable, sustainable electricity at low cost is top priority. They keep a close eye on everything happening on both sides of the grid (e.g. via mandatory reports or incentives to the customers). This helps to estimate the impact on the grid and to utilize smart software solutions for ensuring stability or identifying optimal spots for extension. Compared to a passive role, the cautious observers can reduce management and maintenance costs and achieve a higher degree of preparedness for unforeseen events. This role requires only minimal investments in new technologies, but needs an open attitude to transformation. Experiences from pilot projects are typically used to plan the next steps.

2) **The trusted consultants:** Improving grid management and creating business opportunities, based on existing assets, are paramount. For most new players at the grid edge, electricity is just a means to deliver on a clear business agenda or sustainability goals. Municipalities and DSOs are trustworthy counterparts for these endeavors. The consultants collect data and leverage their energy know-how, regulatory expertise and manpower to manage the energy projects in close collaboration with customers. They can jointly develop blueprints, find the right technology partners, or become system integrators themselves. In addition to direct revenue streams, the data from these installations can be used to optimize the core business.

3) **The active pioneers:** Utilizing as many assets as possible for grid management and business impact across all sectors is key. They acquire expertise in grid edge projects and create a strong ecosystem of partners. They think beyond their traditional grid and initiate sector coupling (e.g. transportation, heating) or microgrid projects, and are willing to take over the operation of these installations. With such a scope of projects, the active pioneers have the broadest opportunity space. They can follow up with new business models on the customer side and take on new roles on the grid side. With the deep domain know-how and access to many flexible supplies and loads, they could even become aggregators. This is the most demanding role at the grid edge, which necessitates a broad scope of new skills and a clear strategic roadmap.

These different typical roles help each individual player to determine their optimal speed of change. As manifold as the opportunities are, we want to give our readers some ideas on where and how municipalities and DSOs can create value for them and for the system at the grid edge. Therefore, we present dedicated use cases to show the potential of the grid edge.

4. The grid edge opportunity space: Optimizing grid management and creating new business across five use cases

In this white paper, we have selected five use cases that are highly relevant for municipalities and DSOs. This is, of course, not a comprehensive overview of everything that currently happens at the grid edge and some of these cases may overlap. But these use cases provide an ideal stage to illustrate how municipalities and DSOs can exploit the opportunities at the grid edge by integrating new assets for better grid management, collaborating with new players or developing additional business models and revenue streams.

4.1. Use case 1: Drive smart grid evolution with proactive distributed energy integration

The structure of the energy grid, especially at distribution level, is being dramatically changed. More and more small-scale renewable generation sites are emerging, and electricity is becoming the primary power source for different sectors, leading to additional consumers with new load profiles. In the future, the decarbonization of industrial processes as well as hydrogen generation and storage could become a further issue that needs to be considered. These developments are here to stay and significantly influence the way electricity is generated, consumed and managed.

These changes meet a grid, which is still highly dependent on hardware-based infrastructure, consisting of copper and aluminum lines, substations and transformers. This set-up has been built and designed with a time perspective of 30-plus years, and with enough spare capacity to accommodate the most extreme stress. This "fit and forget" approach is now rendered impracticable by the speed and extent of the energy transition. In such a highly hybrid state, municipalities and DSOs need to leverage smart, digital solutions, sensors and power electronics to achieve transparency over their grid and the distributed energy resources (DERs) to make the system fit for bi-directional flow of power and new load profiles.

What makes this transition even harder is that municipalities and DSOs cannot count on much support from the prosumer side. Private or commercial consumers only see the potential of DERs for their personal agenda and do not consider potential repercussions on the grid. They even expect their grid operator to ensure that the installation of their assets works seamlessly and instantly without further hassle. On the other hand, municipalities and DSOs are encouraged or even obligated by the regulators to facilitate these demands, knowing that they can lead to grid congestion, load and voltage fluctuations, and increased grid management efforts.

A step-by-step approach to reap the benefits of the DER integration

The integration of RES and additional DERs (e.g. batteries, heat pumps, flexible loads/demand-side management) at local level encompasses two perspectives. First, the technical integration, i.e. how to connect the assets with minimum impact on the grid. Second, the business integration, i.e. how to utilize the DERs to achieve the best possible outcome for grid operators and customers alike.

Municipalities and DSOs need to know about DERs with significant impact on the grid. But it would be even better to also utilize the many unregistered DERs like controllable heat pumps and heating, ventilation and air-conditioning (HVAC)

systems. Currently, the rise of DERs can mostly be managed with the existing grid infrastructure. But forward-thinking municipalities and DSOs should already plan ahead. The intermittent nature of many RES and hard-to-predict load profiles can lead to significantly higher fluctuations across their grid if a critical collective capacity is reached. That can impose major stress on a medium- and low-voltage grid. Therefore, municipalities and DSOs should increasingly rely on digital solutions to support automated grid management and control of these DERs, to the extent possible. Investments in traditional grid expansions should be based on extensive data revealing where these funds can yield maximum impact on grid stability and resilience. Existing assets should be retrofitted with sensors to enhance the degree of transparency of the grid. This provides better insights into the status of the grid and allows condition monitoring of key assets. With the acquired data, software can be leveraged to predict load profiles, engage in predictive maintenance, or identify critical areas in the grid.

Municipalities and DSOs should not be confined to the passive role of an agent which connects when required. They should actively forecast and plan for the expected DER development within their grid instead of dealing with each new DER, one at a time. These insights can be implemented into grid development plans and future management approaches. Thereby, they are better prepared and can even think about utilizing the DERs for grid management and creating additional revenue streams.

The local nature of DERs comes in handy. With access to the assets, grid operators can use them to better utilize the local grid and actively manage capacity peaks, offer primary or secondary grid services, address voltage fluctuations, or provide reactive power to the system. These benefits grow as more and more DERs are installed. Therefore, municipalities and DSOs could incentivize their customers to give them the right to manage them (within predefined limits). Straightforward approaches are lower electricity tariffs if PV installations, wall boxes or batteries are manageable. They could also offer subsidized products like smart thermostats, lighting, water boilers or heat pumps which are part of a demand response program. Going one step further, municipalities and DSOs can act as system integrators who consult their customers on the ideal combination of DERs to optimize their energy mix, e.g. for commercial and industrial (C&I) customers who want to reduce their energy costs or become more sustainable. Going down the value chain, they can sell equipment or offer attractive financing options (e.g. leasing of PV installations). Of course, the degree of involvement needs to match their internal capabilities and individual customer structure.

On the customer side, DERs offer the ability to save on energy bills through self-consumption, enhanced efficiency, or by selling excess electricity to the market. If the assets are smart and manageable, they can also be used to participate in local demand response programs. This leads to additional revenues or makes them eligible for lower tariffs or connection fees.

What it takes to succeed

Municipalities and DSOs need to develop a clear vision for the future topology of their grid and identify the critical areas of the system where DERs can have the most beneficial impact. In general, leveraging sensors for transparency, smart digital solutions for automation and analysis, and expert systems for data-based predictions should be a priority. These can be deployed much faster and more cost-efficiently, and are more flexibly adapted to the changing demands of grid and customers. The vision is also the basis for a dedicated roadmap to determine the right skill-sets among employees. Software programming, cybersecurity and data analysis skills will become more important. In addition, proactive engagement with customers necessitates enough manpower to ensure a high-quality customer experience across the different touchpoints, from initiating a project up to installing or managing the assets. Whatever role the municipality or DSO wants to play, a proactive approach ensures that they have more options to influence the installation and management of the DERs.

Case study: Integrating renewable, distributed energy resources to power the Galapagos Island of Isabela

The diesel-powered plant that served the residents, hotels and restaurants emitted high levels of smog and noise, and endangered the environment of the largest national parks of the Galapagos Islands. Therefore, Siemens developed a hybrid energy system that is highly reliable (over 99% availability), silent (30 decibels noise reduction) and environmentally friendly (reduction of 134t CO_2 per month). It consists of some 3024 photovoltaic panels, a 1625 kW biodiesel generation system made up of five 325 kW generation sets, and a battery storage element which can add 660 kW instantaneously. Tying it all together and ensuring the highest levels of reliability and stability is an intelligent control system which manages, among other functions, the energy flows to and from the batteries. Remote monitoring of the plant from Austin (USA) and Munich (Germany) makes the full range of Siemens' expertise in energy generation available to the local operators of the plant. The result is a system that acts as a showcase for optimal integration of renewables into a stable system. In addition, excess PV energy is stored in the battery system, allowing the complete shutdown of generation sets, providing daytime stability, and giving the biodiesel power units time to start when the clouds come. From a business perspective, Siemens was able to offer an innovative guarantee concept. It encompasses all relevant aspects for the operation of the power plant, losses, self-consumption as well as the performance of the different parts, which are automatically managed according to the overall targets.

For more information see:
https://new.siemens.com/global/en/products/energy/references/galapagos.html

4.2. Use case 2: Optimize capacity, flexibility and market value through distributed energy aggregation

A new approach is required to create a harmonious and reliable energy system that overcomes fundamental differences between the distributed renewable resources and the traditional, central, large-scale power plants. This leads to a completely new role in the market: the aggregator. This stakeholder brings different agents in a power system (i.e. consumers, producers, prosumers) together so they can act as a single entity when they engage with power system markets (both wholesale and retail) or sell services to grid operators. The aggregator operates a virtual power plant (VPP), which combines different distributed resources like demand-side assets (e.g. storage units, industrial sites, HVAC systems, water boilers) or flexible supply-side resources (e.g. private and commercial PV installations, biogas, combined power and heat plants) or a combination thereof like public and private microgrids.

In the future, the rise of connected and controllable devices will lead to literally millions of manageable loads like heat pumps or EVs with Vehicle-to-Grid capabilities. Just imagine how much flexible load could be provided by utilizing the slow thermal elasticity of modern homes. They take several hours to lose 2 degrees Celsius of temperature. Shutting off the 1 million installed heat pumps in Germany[8] for one hour can add up to 457 MW without the occupants noticing any change. And now add all the air conditioning units, EVs or smart buildings with much higher consumption. There will be enormous potential to generate grid flexibility and revenues from operating VPPs.

This short example shows the enormous potential but also that aggregation is not exclusively for the traditional energy players like TSOs, DSOs, retailers or municipalities. Technology companies with a large installed base of connected devices like smart air conditioners, refrigerators or EVs could become serious aggregators, too. Completely new players, like start-ups, can also build a sound business case around this role if they manage to get hold of enough capacity.

Aggregation is a win-win situation for all sides

Aggregators manage their VPPs in such a way that they behave like traditional power plants in the energy market – with standard attributes such as minimum/maximum capacity, ramp-up, ramp-down, etc.. They can thus provide two major benefits: Aggregators can help to operate the power system by providing primary and secondary services (e.g. frequency regulation, reserve capacity). They can enable real-time shifting of loads to provide demand-side management services to grid operators, based on price signals. With a holistic, data-driven software platform, they can increase system flexibility. They can mitigate sudden fluctuations across RES by shifting up and down the power output based on the current prices on the spot market. They thus significantly contribute to the overall stability of the system by providing their services to the TSOs, DSOs and municipalities. With enough capacity under their control, aggregators can also act as resellers on the energy market. This allows many small-scale electricity generators to tap into a new revenue stream. For C&I customers that generate more electricity than they need or private PV site operators that are not or no longer subsidized, this is a highly attractive option to improve their business case. In the long run, this also helps to bring more renewables into the grid, further lowering the CO_2 footprint of the energy sector.

8 Amelang, S. (2020): Germany crosses threshold of one million heat pumps, Dec. 10, 2020, https://www.cleanenergywire.org/news/germany-crosses-threshold-one-million-heat-pumps

Depending on the local regulatory framework for DSOs and municipalities, they can take on different roles. If regulation prohibits their direct engagement in the retail sector, they can aggregate local resources to stabilize their own grid, or just buy the service from other players. Either way, it helps to avoid unnecessary grid expansions, prolong the lifetime of critical assets, provide higher power quality, and ensure that more distributed resources can be connected to the grid.

As full-fledged aggregators, municipalities and DSOs can sell their services on the energy market. This not only increases the efficiency of the core business, but also creates new revenue streams. In addition, municipalities and DSOs can utilize this role to further strengthen their customer relationships. They help their customers get access to the energy market and reimburse them by a percentage of the revenue or by customized electricity tariffs. The combination of integrating and aggregating DERs is the real value driver. DSOs and municipalities can earn money by helping customers to install and manage DERs, aggregate them to offer additional services to the grid, and locally manage the DERs to optimize grid control and reduce costs.

What it takes to succeed

Aggregators need a holistic, strategic view of the energy system and the market mechanisms, and a clear understanding of the different assets (e.g. load profiles, generation characteristics) that they pool in their VPP. In addition to their domain know-how, aggregators need a central IT platform and software system to bundle and manage the different resources as well as an extremely good forecasting system. The latter needs to collect, integrate and analyze historic and current data from diverse resources (e.g. assets, weather forecasts, load projections) to achieve highly accurate predictions about the demand side, supply side and power prices. This is of utmost importance to reliably provide the promised services and realize a successful business case. The combination of distribution grid and transmission grid expertise would be beneficial as TSOs are the key customers for these services.

Municipalities and DSOs are in a prime spot to act as aggregators if this is compliant with the local regulations. Yet they must be aware that becoming an aggregator demands a clear strategic approach and capabilities that are not freely available. They will require employees with the skills to operate the aggregation platform and perform the necessary data analysis. In addition, they need skills and manpower to design the business model, close the contracts and set up a system that continuously grows the base of managed DERs.

Case study: Intelligently leveraging local resources for grid stability and business success in Wunsiedel

SWW Wunsiedel GmbH and Siemens are working together as technology partners on innovative ways to shape the decentralized power supply of the future. Zero CO_2 emissions is the ultimate target for the municipality. Sector coupling is the basis for the path of SWW Wunsiedel: the utility is currently aggregating a wide range of power generation assets (e.g. several wind energy plants, a solar park, a virtual natural gas power plant, and several biomass thermal power plants), energy storage infrastructure (e.g. 8.4 MW Siestorage battery) and even a hydrogen production plant. As the generation capability often exceeds the local demand, hydrogen is primarily generated from solar and wind power using PEM electrolysis. This can be used not just as a raw material, but also as a long-term storage medium. The plant thus helps to relieve bottlenecks and add flexibility to the power grid. The by-products oxygen and waste heat are also integrated into the energy cycle. The Siemens control system works as "software as a service" on the MindSphere cloud-based platform. Data from the control system can be analyzed, evaluated, and used by SWW Wunsiedel and its end customers to create a stable and extremely reliable power supply system that allows excess production volumes and reserves to be sold on the energy market.

For more information, see:
https://new.siemens.com/global/en/products/energy/references/wunsiedel.html

4.3. Use case 3: Foster e-mobility uptake with charging infrastructure integration and operations

The mobility sector is still responsible for 24% of direct CO_2 emissions as a result of fuel combustion[9]. This makes it a prime target for climate protection measures. Governments around the world are promoting electromobility, consumers have overcome their initial skepticism, and car manufacturers have also fully adopted the e-mobility trend, finally offering a vast number of affordable EVs. Powering electromobility with renewable generation is a prime example of sector coupling, with benefits for both the climate and the quality of life in cities. The increase in the number of EVs calls for a massive expansion of the charging infrastructure, which is managed by new commercial and private players. These charge point operators (CPO) and the end-customers are focusing on the mobility needs and not on the significant potential impact of their actions on the grid. For municipalities and DSOs with their responsibility for the local electricity grid, e-mobility is not a choice. If they fail to proactively provide solutions to intelligently integrate and manage it in a way that reduces stress on the grid, they will be confronted with the consequences on their infrastructure. The interaction of the electrical implementation, with managing new mobility concepts in an ecosystem of players will be key.

Ecosystem players need to work together to make the future happen

Too many EVs charging at the same time and location could lead to severe problems (e.g. grid congestion, outages / supply interruptions). Solving these problems with hardware and wires is often not a viable option. Especially in cities, the installation of larger power lines and new substations is an expensive organizational nightmare. In addition, it just makes no macro-economic sense to expand the electrical system to accommodate such extremely high, but also extremely short, peak periods. Therefore, grid operators need to find smart ways to identify the optimal spots where the existing grid infrastructure can accommodate additional loads and where the local mobility patterns point to a demand for charging. This is hard enough for chargers installed in public spaces, i.e. streets or public parking spaces. In addition, chargers are also deployed on private property (e.g. garage), on semi-private property (e.g. company parking spaces) or semi-public property (e.g. customer parking space for short- and long-term parking). And last but not least, public transport providers are also starting to switch over to electrically powered buses, which leads to huge demand at bus depots and terminuses. Everybody has their own motivations for embracing e-mobility and specific requirements for the charging infrastructure and its management. Municipalities and DSOs should thoroughly analyze these different stakeholder groups and their respective demands to decide which ones could be addressed and what is the optimum business approach to meet each demand.

But there are even more players within the ecosystem that need to be integrated. With the expansion of the (public) charging infrastructure, the role of charge point operator (CPO) has emerged. The CPO is responsible for the installation and maintenance of the charger as well as the procurement of the electricity. In addition, the CPO or the electromobility provider manages access to the charging infrastructure and invoicing over a digital back-end. The next level is the mobility service provider (MSP). The MSP is responsible for providing access to different modes of transportation like public transport, EV sharing, e-scooter sharing or e-bike sharing. The MSP is responsible for a large part of the electricity demand and has deep insights into the mobility patterns.

Municipalities and DSOs need to develop a community-wide e-mobility strategy that clearly defines the role they want to play. It must also identify the key stakeholders to be addressed,

9 IEA (2020): Global Energy Outlook 2020

outline dedicated offers for those stakeholders, and also define the provider/partner ecosystem. This can range, depending on the local regulatory framework, from being the preferred electricity provider, operating the power management system through to financing and installing the infrastructure, operating it and even bundling different modes of transportation on a proprietary platform.

Data-driven value generation at the heart of e-mobility

Municipalities and DSOs can act as a consultant and provider of hardware when it comes to installing the infrastructure by leveraging their energy expertise and close contact to the local businesses and residents. For example, corporate parking sites with numerous charging stations need a dedicated audit. This encompasses the grid requirements, the operating model and business cases to be in line with local regulations and the financial benefits. Grid operators can use financing or leasing offers and reduced electricity tariffs to ensure that they are eligible to manage these assets. Going one step further, they can sell bundles comprising solar installation, battery, charger and management system, allowing private or commercial customers to optimally leverage their self-generated, renewable energy to charge their EVs. Shopping malls, hotels or amusement parks which offer charging infrastructure to their customers will need tailored charge management and clearing systems which should be linked to their reservation system or overall cash register.

All of these activities should be utilized to get access to and insight into as much of the charging infrastructure as possible. The more assets municipalities and DSOs can manage, the better they can utilize them for grid services and leverage the acquired data to create models to predict load profiles and identify critical areas of the grid where new installations should be avoided. They can also determine how the charging process can be managed to relieve the grid of unnecessary stress.

Installing charging infrastructure in the public space is a challenging business case due to high investments, technological uncertainties and volatile demand. Therefore, Vehicle-to-Grid approaches could be pursued to create viable business models (e.g. leverage EVs for grid stabilization through bi-directional electricity flow, offer ancillary services, use data for smart city management). In the private or semi-private realm, it helps to reduce grid management costs for the grid operators. Fleet operators can yield significant reductions in the total cost of ownership, and even individual EV owners can reduce their energy bills. CPOs, whether independent or belonging to the municipalities, can leverage their digital billing system to offer value-adding services to semi-public or semi-private customers who are interested in providing EV charging opportunities. CPOs profit from operating as many charging stations as possible to build up a solid data-driven business model and position themselves as an attractive partner. MSPs on the other hand need this infrastructure to boost their business. They help to reduce traffic and create a highly innovative and sustainable city.

What it takes to succeed

Municipalities need to put a clear e-mobility strategy in place which clarifies how they will act in this market. Doing a little bit of everything will stretch resources and fail to provide significant impact. Ideally, they will start with a business case which complements their existing capabilities, assets and skills and helps to generate initial insights into operating models and data. Selling and installing the charge points and providing the related (integration) services for private, commercial and public stakeholders is straightforward. They need low upfront investments targeted at existing customer groups that are closely aligned with the technological solutions needed for grid management. Ideally, municipalities will focus on larger customers like industrial sites, fleet operators or public transportation. In this case, they will be dealing with fewer stakeholders and the management of these installations can have a

significant impact on the grid. Targeting private consumers requires much more manpower and a more customer-centric sales process. Other business models, like Vehicle-to-Grid or utilizing data to optimize traffic flow and grid management are not yet proven. Therefore, a cautious, step-by-step approach is required here.

Case study: Enabling the growth of electromobility through digitalization at the grid edge with Stromnetz Hamburg

The rapid growth of e-mobility can result in medium- and low-voltage distribution grids reaching their capacity limits. A physical expansion is expensive and time-consuming. Therefore, Stromnetz Hamburg and Siemens are collaborating on a pilot project to develop a digital solution. Smart, decentralized monitoring and control of private charging equipment on the secondary distribution network provides a fast, cost-effective solution for distribution network operators. They can maintain the high reliability of their networks, avoid extensive expansion of the low-voltage networks, and prevent overload situations. A smart monitoring and control unit in the secondary substation autonomously monitors the low-voltage network and transmits set points to the home charging station in the event of overload. No communication with a central system is necessary during operation, thus enabling it to be selectively rolled out in a targeted manner. The use of self-learning processes makes it possible to minimize outlays for commissioning and maintaining the digital secondary distribution network. By intervening with control and regulating measures, low-voltage network operators can exploit the flexibility of home charging stations to relieve the network, for example by distributing the load. This enables Stromnetz Hamburg's customers to meet their changing mobility needs and be able to rely on a stable and secure power network in the future.

For more information, see:
https://new.siemens.com/de/de/produkte/energie/mittelspannung/loesungen/emobility/digitales-ortsnetz.html

4.4. Use case 4: Ensure energy resilience with DES and microgrids in modern district grids

Stability and resilience are becoming more important as the influx of DERs and threats from natural disasters or targeted attacks on the grid are increasing and sector coupling picks up speed. In addition, the increasing share of digitally connected assets on both sides of the grid is leading to a heightened risk of cyberattacks at critical points of the system. Such a situation demands reconsideration of the traditional operational paradigm. Reliability, stability and resilience can probably not be maintained through asset redundancy in centrally controlled grids anymore. Therefore, a smart, secure control of connected multi-energy microgrid systems at the district level could be an ideal way forward.

Such a microgrid comprises low- and medium-voltage distribution systems with generation (fuel cells, photovoltaic, wind, CHP, etc.), storage devices (batteries, flywheels) and flexible loads (e.g. EVs, smart buildings, HVACs). It can operate when either connected to or disconnected from the main grid. The controllable loads – enabled through digital technologies – are especially important to microgrids because load variability will be more extreme than in bulk-scale systems.

These microgrids can be implemented in two different ways. The first is a "private microgrid", which is owned by a C&I customer and installed with the main goal of optimizing the energy management of the DERs at the customer's site (e.g. supply via private PV installation and diesel generator, controllable load via HVAC, production machinery, EV charging infrastructure). The second option is an "embedded microgrid", owned and operated by the DSO or municipality within the distribution grid. It can pool DERs owned by the grid operator but also integrate privately owned DERs or private microgrids if it has permission to control them.

Every clearly defined area with manageable and flexible supply and demand (e.g. a small village, a city district, a business park, a bus depot) can be the playing field to introduce a microgrid. The installation of smart meters and the retrofitting of existing buildings with more flexible loads and sometimes even PV installations make brownfield applications a viable option. Combined with other local loads and already existing generation capacity (e.g. waste incinerator plants, small-scale wind parks), they can be consolidated into an "embedded microgrid", owned and operated by the DSO or municipality. Even better is the development of new city quarters with a clear microgrid and sector coupling philosophy. Prominent examples are Siemensstadt[10] in Berlin or Vienna's Aspern[11] district. These developments are planned with RES, energy-efficient buildings, electrification of the heating and cooling sector and the integration of EVs and new mobility concepts in mind. All these assets are managed by a microgrid which can either be owned and operated by the local grid operator, the project developer or even the community itself. Depending on the ownership structure ("private" vs. "embedded" microgrid), such a project can be utilized in different ways to achieve benefits for the stakeholders (lower electricity costs etc.) and the overall energy system (improved grid management etc.). Either way, success calls for cooperation across players from the energy sector, the municipality, utilities from other sectors like heating and water, the real-estate project developer, the solution providers and the private as well as commercial tenants.

10 https://www.siemensstadt.siemens.com/en

11 https://new.siemens.com/global/en/products/buildings/references/aspern-viennas-urban-lakeside.html

Microgrids as real value creators: Increasing resilience, saving costs, creating business opportunities and enhancing public image

The ability to operate in grid-connected and islanded modes, the re-dispatching of controllable resources in response to internal events related to the load and generation profiles, and the ability to respond to external orders make microgrids an ideal tool to increase the resilience of local electricity grids. In the event of local voltage fluctuations, overloading of transformers or feeders, or high harmonic distortion levels, microgrids can switch to island mode and prevent the faults from spreading to the whole grid. In addition, the microgrid controller will utilize the built-in frequency and voltage control, energy management software and protection systems to resolve these issues on a local level. This autonomous management of smaller areas significantly increases the efficiency and effectiveness of grid management. DSOs and municipalities must only manage several microgrids by defining key parameters instead of managing many separate DERs. Further economic advantages are the smoothing of peak demand or the reduction of curtailments as well as the mitigation of expensive grid expansions. Microgrids can also be used to offer ancillary services to the overall grid, creating an additional revenue stream and reducing costs for GHG emission certificates by allowing more RES.

A further revenue stream for DSOs and municipalities can be created by focusing on private microgrids. They can advise companies that want to create a microgrid on the technological and regulatory requirements. In addition, they can act as system integrators, bringing together the role of project developer and the solution provider ecosystem. Once installed, they could act as operators of private community grids or utilize them in their role as an aggregator to take part in the energy market (see use case 2).

From a consumer perspective, the ability of microgrids to significantly reduce the energy demand and improve the CO_2 footprint are major advantages. The aggregating function of microgrids means that ancillary services can be offered to the DSO/municipality, significantly improving the business case for the installation of smart DERs or creating additional revenues. With the establishment of more flexible tariff regulations, "private microgrids" can also ensure cheaper electricity costs for tenants and consumers. Ultimately, it can even enable real-estate developers or owners to realize higher prices when selling or renting their property.

What it takes to succeed

Municipalities and DSOs need a comprehensive approach, extending from grid planning to operation, to successfully establish microgrid structures within their own system. A holistic system view helps to identify areas where the existing generation capacity can be combined with flexible, accessible loads. In addition, investments need to be shifted from traditional hardware-centric grid expansions to upgrading assets with sensors, providing secure communication infrastructure and installing smart software solutions. Control systems need to utilize artificial intelligence with advanced algorithms to improve load forecasting and optimize control of DERs. Such a grid topology can only be achieved with a high degree of digitalization and automation across all levels of the grid, as monitoring and balancing of DERs must be executed without direct involvement of the grid operator. With all operational prerequisites in place, DSOs and municipalities need to develop new business models to facilitate customer engagement regarding the access and control capabilities of the assets. Demand-response approaches with lower tariffs or kick-back options, financing models for DERs or the opportunity to access the energy market can be potential routes. This cost side must be matched with new revenue streams on the energy market or significant cost reductions to develop an attractive business model.

Municipalities and DSOs are also the natural go-to-guys when it comes to building and operating a "private microgrid" and realizing simple, straightforward business cases. A barrier to success could be the complexity of microgrid solutions regarding technology and stakeholder management. Microgrids mostly operate on a smaller scale and require much more digitally enabled hardware and software. Therefore, municipalities and DSOs must make sure that they have the right experts internally or from a partner network on board. They need a clear customer focus and deep understanding of their demands to be able to optimally design the right solution, integrate all requirements and balance the different objectives. This is not only a matter of mindset but also calls for additional manpower in project and ecosystem management. Ultimately, municipalities and DSOs need to be aware that microgrids and the "built-in" sector coupling will become a reality – if not driven by them, then through political initiatives or customer demand. Therefore, they should take a proactive role and gain as much experience as possible.

Case study: A power island in the storm – real-life proven resilience of a solar power-based microgrid at the Blue Lake Rancheria

Together with Siemens, the Blue Lake Rancheria decided on a microgrid solution to ensure a reliable, environmentally friendly and cost-efficient supply of electricity to its people. It can balance generation and consumption and can operate on grid or seamlessly switch to island mode if necessary. The Blue Lake Rancheria microgrid incorporates a Spectrum Power Microgrid Controller from Siemens, a solar array with 420 kW AC combined with 2,000 kWh lithium-ion battery storage. The Siemens microgrid management system (MGMS) automates a significant portion of the microgrid's functions, rendering traditional 24/7 monitoring unnecessary, and allowing the microgrid to efficiently shed loads and incorporate changing electricity rates with immediate economic optimization. This is how the microgrid saves the tribe over $200,000 in annual energy costs and cuts greenhouse gases by around 200 tons per year. Besides these economic and environmental advantages, the microgrid has proved its resilience already in two major incidents. During the wildfires in 2019 when over 30 counties in California were without electricity, Blue Lake Rancheria was one of a handful of places with continuing service and extensive back-up power due to its microgrid. Residents and emergency response agencies were able to access essential services and supplies (e.g. fuel, ice, internet connection). Lives were saved because the hotel was opened for medical patients dependent on equipment that uses electricity.

During the recent COVID-19 crisis, the Siemens engineers were able to access the data and see that the microgrid controller was one step ahead of everyone. It anticipated looming problems and virtually stepped in to avert them during the power load reductions resulting from the lockdown. A stable energy supply allowed essential employees to make and store pre-packaged meals to be provided to the community. The project has worked so well that the Blue Lake Rancheria reservation is now expanding with the addition of two more microgrids that will go into service in the future, more than doubling the amount of power produced in this initial project.

For more information, see:
https://new.siemens.com/global/en/products/energy/references/blue-lake-rancheria-resilient-microgrid.html

4.5. Use case 5: Optimize economic value of DES and microgrids for business customers

Many commercial and industrial companies, university campuses and critical infrastructures are starting to realize the enormous opportunities the energy transition offers. It can help to reduce costs, ensure the quality of production processes and achieve sustainability targets. The cost competitiveness of renewable generation and storage together with microgrid controllers and highly sophisticated energy management solutions allow them to intelligently combine the supply and demand side in such a way that their particular energy objective can be achieved. Intelligent and connected assets, like machinery, heating and cooling systems or EV fleets with their charging stations, can also be integrated and utilized in dedicated microgrids for maximum impact.

Especially large commercial and industrial entities (e.g. shopping malls, hotels, energy-intensive factories) or campuses (e.g. universities, hospitals) are the ideal target group for energy providers. They already have many controllable assets with a sufficient degree of flexibility on the consumption side and often their own power supply installed. Other interesting customer groups are real-estate developers and commercial tenants. Real-estate developers can use intelligent buildings to escape the "dollar-per-square-feet" competition and differentiate themselves. Commercial tenants need to fulfill sustainability goals and are in a constant war for talent. The new generation of smart buildings already constitutes a local microgrid, combining solar-generated electricity with storage, smart lighting and intelligent HVAC control. Thereby, the building can even produce more electricity than it consumes, and in combination with further IoT-enabled solutions, offers its tenants ideal working conditions with the feeling that they are actively contributing to protecting the climate.

Microgrids create value on both sides of the grid

Municipalities and DSOs can profit in two ways from the installation of microgrids for their business customers. On the one hand, they can offer the whole value chain from project consulting, designing and planning through to installation of the hardware and even operation of the microgrid. Besides traditional revenue models (buy and lease), "X as a Service" offerings could be an option. Customers only subscribe to the utilization of a microgrid which is owned and operated by the municipality, based on mutual service level agreements. As an alternative, only parts of the microgrid (e.g. management software, storage) could be offered "as a Service", allowing the municipality or DSO to utilize them also for their grid management. Customers have the flexibility of only paying for the service if it is really needed and they achieve an attractive shift from CAPEX to OPEX. On the grid side, municipalities can save on management costs or investments in grid expansion if they can utilize microgrids for demand response programs or other grid services like frequency stabilization or reactive power.

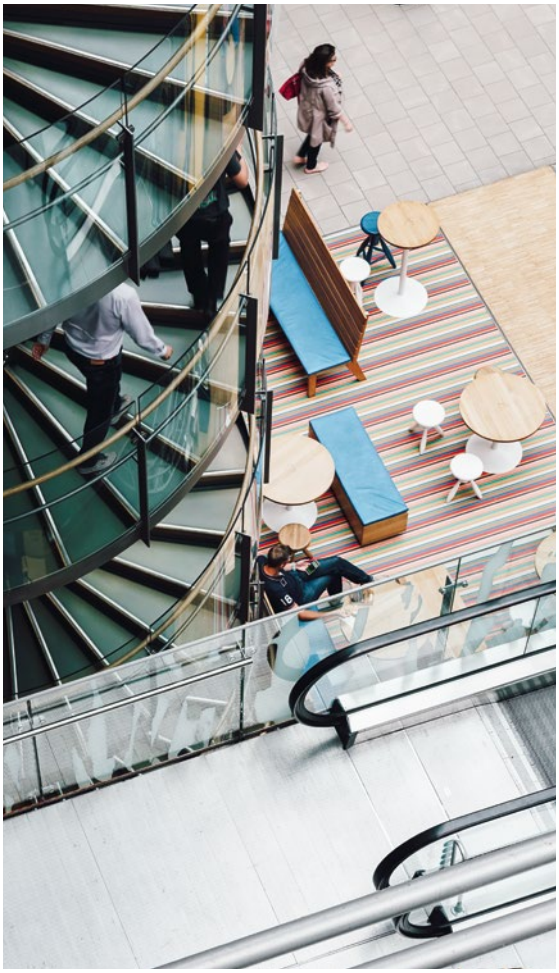
Such close partnerships for building or even operating a microgrid strengthen customer retention and provide a highly effective churn protection mechanism. Municipalities and DSOs can act as an advocate of sector coupling and thereby compensate losses from savings or customers' generation. The experience gained in sector coupling from the microgrid can be used at a later date for larger projects on a district grid level (see use case 4) or even city level. This is even true for new and emerging energy sources like hydrogen. Together with industrial customers, municipalities and DSOs could start pilot projects exploring the use of hydrogen as a storage resource to better utilize renewable generation.

Customers on the other hand deliver on their energy agenda: they can reduce energy costs, increase power quality or enhance reliability. Microgrids allow them to optimize energy consumption across different sectors by integrating heating assets like CHP, HVACs or heat pumps and mobility infrastructure like wall boxes or charging stations. With sustainability on the business agenda, these activities help companies to reach their goal of becoming CO_2-neutral and positioning themselves as sustainable organizations. By utilizing new business models like "as a Service", they can shift CAPEX to OPEX, freeing financial resources for investments into their core business to secure long-term success.

What it takes to succeed

DSOs and municipalities need to be aware that the members of the target group are not energy experts. They need a competent and trusted partner who understands their business needs, can translate them into the appropriate technological solutions, and has the expertise to install them on-premise as well as integrate them into the grid. If municipalities and DSOs want to become the preferred partner for everything revolving around microgrids, they need to address these different motivations and be prepared to design the optimal solution for each use case.

Turning the business potential of microgrids into profit for municipalities and DSOs is essentially a question of size and human resources. Close interaction with customers and other stakeholders (e.g. hardware providers, building companies, other utilities) coupled with the long duration of such projects most certainly require additional employees. They must bring the right expertise, project management skills and entrepreneurial mindset to the table. This is highly attractive for large organizations with enough available expertise which can be easily leveraged. But if it would require building up expertise and manpower from scratch, it is recommended to engage in partnerships and create ecosystems with energy consultants and hardware providers. Municipalities and DSOs can contribute their knowledge about the local energy system and their close customer ties. They act as a door-opener and help the whole



ecosystem to flourish. This allows them to play an integral role, gain experience and promote their interests, but without too much upfront investment.

When it comes to defining potential target customers, size does matter. In a first step, customers like business parks or campuses should be targeted. They are sufficiently large to have enough financial resources and enough different assets that can be combined. At the same time, they are small and "simple" enough so that municipalities only have to interact with a few contact persons.

Case study: Sello shopping center has its own virtual power plant, creating a positive business and environmental impact

Sello in Leppävaara, Espoo, is Finland's biggest shopping center mall and has been a partner of Siemens for over 10 years. Together, they are working on turning the shopping center into a

prime example of smart, energy- and cost-efficient infrastructure that is also customer-centric. The previous installation of smart building technology (e.g. lighting, climate control) had already reduced energy costs, increased air quality and created a superior shopping experience for customers. The latest project targeted energy efficiency and a low carbon footprint to manage the running costs and sustainability concerns.

Siemens developed and is currently also maintaining a virtual power plant which aggregates the local assets through a microgrid and optimizes the consumption, purchase and storage of electricity. This not only creates a cost-efficient, more self-sufficient energy system for Sello, but also helps to smooth out spikes in demand on the national grid. The system consists of a 550 kWp solar panel system, intelligent LED lighting, and approximately 2 MW in electricity storage capacity. The overarching microgrid controller allows the shopping center to use its electricity flexibly. The generated energy is usually used directly, and if excess electricity is produced, it can be stored in the accumulators, either for self-consumption at a later point or for sale on the electricity market.

In addition, the accumulators can be charged with cheap electricity during the night, reducing the need to purchase expensive energy during the daytime. In practice, electricity storage generates significant energy savings for Sello, equivalent to the electricity needed to heat 20 detached houses every day during the winter. This virtual power plant achieves economic savings in the order of hundreds of thousands of euros every year, halving the repayment period for the investment in renewable energy production. In addition, the significant reductions in energy consumption lead to a steep drop in CO_2 emissions.

For more information, see:
https://new.siemens.com/global/en/company/stories/infrastructure/2020/sello-virtual-power-plant.html

5. Invitation for co-ideation

Here at Siemens we see the grid edge as one of the most exciting spaces in the entire energy industry. At the grid edge, the right decisions and actions by all stakeholders will determine the success of the energy transition. The grid edge offers huge potential to develop innovative strategies and business approaches, and to utilize state-of-the-art technologies to deliver on the individual energy goals of all involved players.

As a long-standing, trusted partner of all players at the grid edge, we are used to integrating different technologies, markets, software and hardware into our projects as well as achieving the right balance of ideas and actions. We utilize our expertise, experience and innovative strength from the different vertical units like energy generation, energy management, energy distribution, smart buildings, factory automation and mobility and combine them in best-of-class digital solutions for each use case. That is not just lip service. Our factory in Bamberg leverages IoT technology on the shop floor and connects it with smart IT solutions. This is setting new standards in energy efficiency and productivity. In Siemensstadt in Berlin, we are investing more than 600 million euros in a project to turn a 700,000 m^2 area into a future-oriented living and working district with DERs and microgrid technologies. Our own campus in Erlangen, Germany, is currently being transformed in cooperation with the local utility N-Ergie into a future-ready showcase where microgrid technology is combined with state-of-the-art building management and customer experience apps.

Digitalization offers smart solutions for a wide range of challenges. With its applied domain know-how and long-standing experience, Siemens can make energy data meaningful, manageable and profitable. This helps our customers develop applications to optimize grid management, improve asset utilization and lower CO_2 emissions – thereby achieving a significant value contribution to their businesses. We strongly believe that the more ideas are brought to the table and the more stakeholders exchange their views, the better a project becomes. We are looking forward to sharing our ideas on the grid edge with our customers and are always ready to listen to their challenges.

Further reading:

www.siemens.com/municipalities

Contact:

Do you need help or want to talk to a technical expert? Contact us:
https://new.siemens.com/global/en/products/energy/contact.html

6. Imprint

Siemens Smart Infrastructure intelligently connects energy systems, buildings and industries to adapt and evolve the way we live and work. We work together with customers and partners to create an ecosystem that intuitively responds to the needs of people and helps customers to better use resources. It helps our customers to thrive, communities to progress and supports sustainable development. Creating environments that care.

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Published by Siemens Switzerland Ltd
Smart Infrastructure Global Headquarters
Theilerstrasse 1a
6300 Zug Switzerland
Tel +41 58 724 24 24

For the U.S. published by
Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA
30005 United States

Article No. SI_0205_EN