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Siemens Defines the Future of Energy with Resilient, Carbon Neutral Microgrid Campus

Siemens “living lab” shares leading-edge microgrid solution research with customers and partners

Across the globe, an extensive transition is taking place surrounding energy generation, delivery and consumption. Led by governments, NGOs and key business leaders, the general effort focuses on reinventing and modernizing the energy sector. Stakeholders are searching for examples where integrated and renewable energy approaches, using modern technologies, are demonstrating enhancements in the areas of energy efficiency, carbon neutrality, and resilience.

One effort that addresses these requirements and that has garnered much attention, is the Siemens “living lab” microgrid campus located in Princeton, New Jersey. In addition to being the primary energy source for the Siemens Corporate Technology North American Headquarters, the microgrid serves as the basis for groundbreaking research which explores the role of energy across multiple dimensions– including sustainable development and resilience.

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Global Executive Director
of The Resilience Shift

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The active research analyzes how microgrids, in addition to helping businesses and municipalities better adapt to climate change, can accelerate energy access, energy security, and reduce the adverse impacts of energy uncertainty on human health and the environment.

According to Seth Shultz, Global Executive Director of The Resilience Shift, the research being conducted within the Siemens living lab serves as an early indicator of microgrid evolution. "The Siemens project is an open laboratory that helps to raise the awareness and understanding of the importance of interconnected power infrastructures," he said. "The project is being closely watched as a possible model for setting distributed energy resilience and decarbonization trends over the next 15 years."

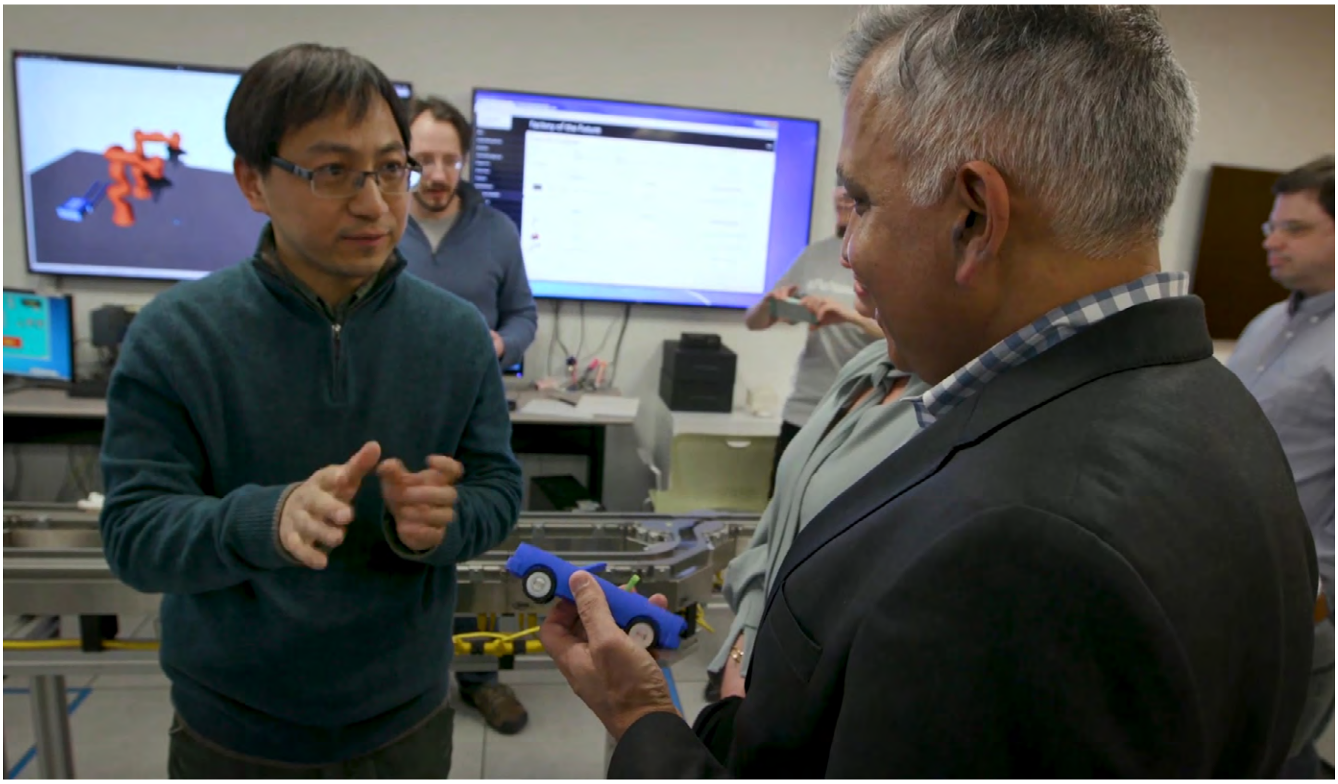
Balancing the business continuity critical success factors

Because global integrated supply chains, just-in-time manufacturing, sophisticated product repackaging and rapid shipping have evolved to become much more interconnected, business continuity will become more susceptible to power interruptions. In order to accommodate this new future, Siemens is staying ahead of the curve by accounting for two important pillars in its Princeton microgrid design:

- **Resilience** – By bringing in processes, programs, tools, and resources that both enable minimum exposure to hazards and associated risks (like unanticipated blackouts) and rapid reaction and recovery from unplanned events (e.g., stored energy) the Siemens microgrid design enhances the ability of organizations to control their own energy destinies in times of crisis and uncertainty. For example, when a power outage occurs, the Princeton microgrid has the ability to disconnect from the main grid and operate in islanding mode.

- **Sustainability** – More efficient systems and renewable resources translate into fewer carbon emissions. By combining field-tested energy management technologies across building, energy generation, and energy storage systems, Siemens is fulfilling what it views as its mission and responsibility: to reveal what's possible, to demystify how these technologies can work together, and to provide microgrid operators with a holistic view that minimizes energy spend while maximizing comfort and security.

The knowledge that Siemens has acquired designing, commissioning, installing and operating microgrids across the globe has helped to build a robust stable of living lab contributing experts. Thus, organizations looking to lower energy-related risks can count on Siemens to both address their energy challenges of today while also positioning them for a more digitalized energy future.



Princeton Island Grid Dashboard

While the use of renewable energy is necessary to address growing demands on the power grid, a smart grid system that optimizes energy flows between key system components also helps maximize cost and CO_2 savings. The Princeton Island Grid Dashboard uses simple visual language to visualize the energy flow between renewable energy sources, the power grid, energy storage and energy consumers of a campus microgrid.

Modern microgrids: More innovation, far less risk and much more affordable

According to Guidehouse research, overall costs for new-generation microgrids have declined by 25-30 percent since 2014. As a result, growth is expected to expand at a robust clip over the next five to seven years, even despite the unpredicted aftershocks of the global pandemic. The new generation of microgrids is more flexible in terms of both electrical topology and power flow evolution. The Siemens Princeton campus takes the microgrid concept a step further, combining new technologies that serve together in an integrated capacity.

The purpose of the Siemens living lab is to push the innovation envelope, to show what is possible in the realm of microgrids, and to research and demonstrate how various energy-related generation, storage and building management products behave and work together in a dynamic real-life microgrid environment. In addition, the facilities that support the living lab provide a co-creation space for public and private organizations looking to deploy highly integrated, sustainable and resilient microgrid solutions.

The Princeton campus site was chosen because it was small enough to assure a rapid deployment, but big enough, with an occupancy of around 400 people, to demonstrate a significant energy savings and energy resilience impact. The work involved in proper site assessment also helped the project stakeholders to gain a deeper understanding in how to better scale microgrid applications to other facilities and sites.

Site selection centered around variables such as energy consumption history, campus electrical loads, budgetary requirements, target payback period, strategic objectives, resiliency planning, renewable energy sources available, and energy storage options. Before any products were ordered, research teams simulated numerous configuration options in order to best optimize the size of solar cells and storage batteries, based on current and future anticipated demand. The research experts also consult with outside clients in the areas of power systems optimization and advanced modeling. Using tools such as the Siemens PSS® Portfolio power system, engineers and operators are able to simulate, analyze, model, and create digital twins for power transmission, distribution, and industrial power systems. Users benefit from accurate and efficient power system analysis while catering to technical, regulatory, and economic industry requirements. Such consulting services and tools are now available to businesses, healthcare institutions, universities and municipalities.

Siemens uses automated microgrid design tools to develop optimum solution configurations. Factoring into the design parameters are combinations of technologies that address the business needs of lower CO_2 footprint and lower energy costs. Another top priority is to maintain a reliable and stable power environment to keep the staff of research scientists up and running during all testing and deployment phases.

Key microgrid value-add elements

As the principal stakeholders look back at the architectural elements that contribute the most to the Princeton microgrid's resilience, sustainability, and ease of use, many agree that the business value of the solution amounts to more than just the sum of its parts. Combining the core validated and field-tested components demonstrates why many energy experts expect microgrids, as they interconnect and codify across the industry, to become the new norm in distributed energy. Listed below are some key highlights:

- **Dual purpose photovoltaic (PV panels) -** Solar panels generate the main source of energy for the facility and also act as a roof that shields parked automobiles from outdoor weather elements (no having to remove snow from your windshield with a plastic scraper before driving home from work). The solar panels currently supply 60% of the facility's energy (while using the local power grid for the balance of the energy generation). The goal over the next three years is to have the solar panels supply energy 80% of the time.

- **Energy storage for powering a building -** The energy storage system has a capacity of approximately one megawatt hour. With the normal building load ranging between 400 and 500 kilowatts (kW), the building energy needs can rely solely on the battery for a period between two to three hours. If building power consumption can be reduced to 200 kW, then that battery runtime can be extended to approximately five hours. These types of scenarios represent some of what will be researched and tested at the living lab.

- **Building management integration –** Building management systems are rarely, if ever integrated into microgrids. Here, the Princeton living lab sets a new precedent. Digital twin simulation is used to optimize the energy consumption of the building. The digital twin, for example, can measure the impact of replacing an HVAC system or lighting within a building and indicates ahead of time how such changes will influence how the microgrid is managed. Those projections are then later be compared to real world results. Though not typically used in microgrid environments, the digital twin serves as a valuable research tool for predicting building system energy behaviors.

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Seth Schultz, The Resilience Shift

- **Energy analytics dashboards –** In order to track the real-time status of the entire microgrid, dashboards are available to both building occupants and to engineers who are operating the microgrid. From day one, the data being produced by the microgrid, such as energy savings and CO_2 reductions, is on display for interested stakeholders to see. The dashboards are easy for building occupants to interpret and indicate the direction in which the energy is flowing (like excess solar energy being used to charge the batteries) and the quantity of energy being consumed by the various components.

- **Electric vehicle integration** – The microgrid also integrates multiple electric vehicle (EV) charging stations located in the adjacent parking lots and made available to building employees free of charge. EV charging consumption rates are monitored and EV loads are factored into the overall facility energy consumption model.

- **Integration of third-party technologies –** In addition to Siemens microgrid management software and hardware solutions, numerous third-party components (such as switchgear and inverters) were integrated in order to field test the ability of the microgrid system tools to manage mixed technology environments.

Best practices involve robust collaboration

As with any projects that involve a high degree of innovation, a body of best practices is emerging as the Princeton microgrid continues to evolve. Most include developing an ability to be both flexible and adaptable:

- **Exercising collaboration and communication early and often** – The project involves both Siemens internal units (such as the real estate department and multiple business units with product expertise) and external partners (such as the United States Department of Energy National Laboratories). Building relationships among these various groups and communicating on an ongoing basis are critical to secure funding, simplify complexity, and to avoid additional expenses. Like many private and public sector entities, the Siemens project team, although they found themselves in the position of installing Siemens systems into a Siemens-owned building, had to juggle and accommodate the interests of multiple stakeholders. Rather than view these additional parties as obstacles, much benefit resulted from the open and frequent communications. For example, since the microgrid is installed in an older building, the combined knowledge of the Siemens real estate experts came in handy when accurately sizing and configuring the electrical systems.

- **Managing legal and local constraints –** Although Siemens used its own research and development facilities to host the microgrid, outside influences still impact the type of deployment that can result. Local governments all have legal provisions that may place certain constraints on how microgrids are designed and deployed. For example, because of nearby residential neighborhoods or other regulatory constraints, it may not be possible to deploy wind turbines or diesel generators as part of the solution.

As a microgrid deployment partner, Siemens is unique in its willingness to explore multiple solution approaches depending on customer needs. By possessing a detailed understanding of the life cycle conditions and resilience of microgrid systems, Siemens is in a position to guarantee an optimal level of performance in its contracts.

To learn how your organization can work jointly with Siemens in launching and implementing co-creation or research project, visit our corporate technology web site or view our systems integration web site to see how a microgrid can directly benefit your facility.

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