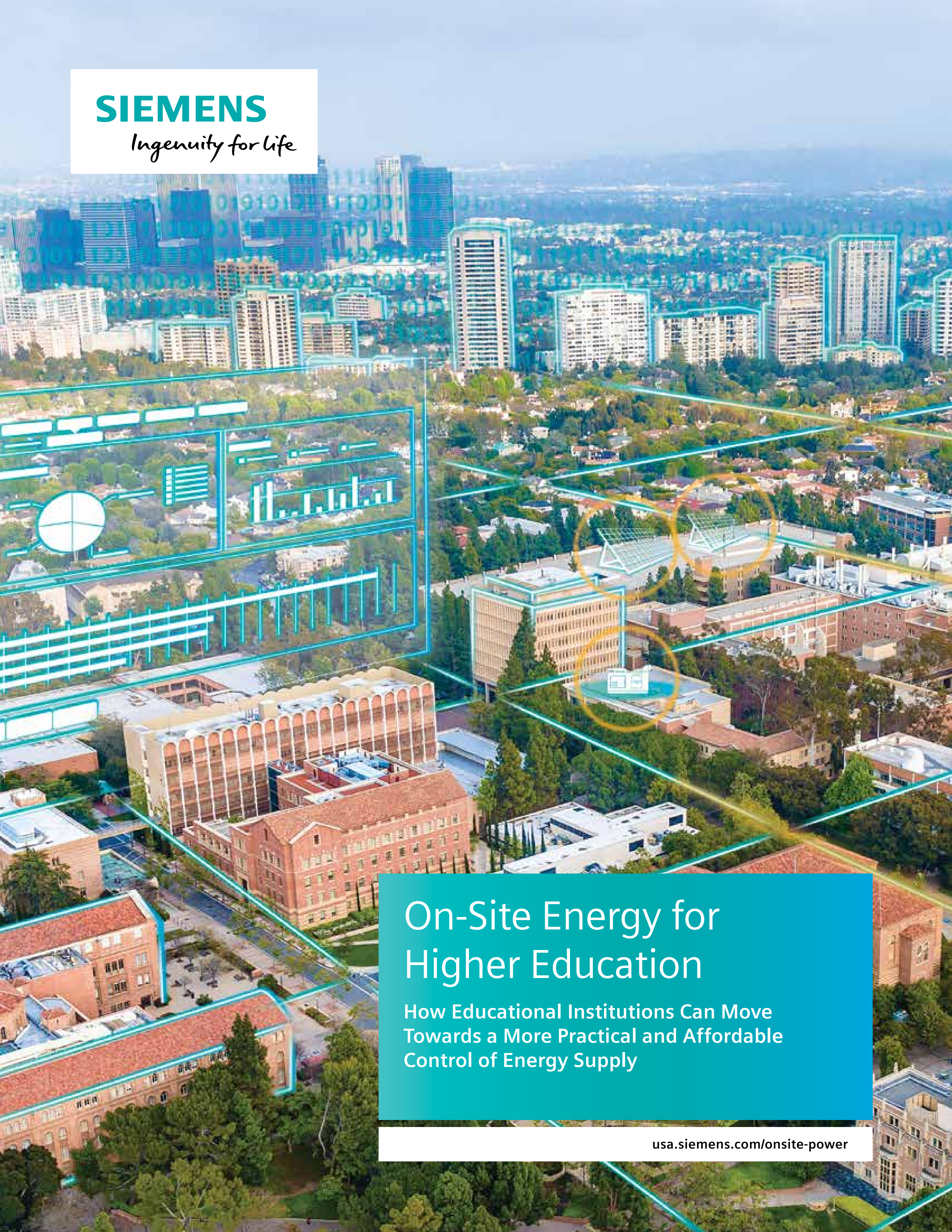

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On-Site Energy for Higher Education

How Educational Institutions Can Move Towards a More Practical and Affordable Control of Energy Supply

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When electrical energy flows, new ideas flourish. But lose that flow and it's anyone's guess as to what could happen. The impact of extreme weather and temporary fluctuations in the grid can stall the mission of educators and disrupt the learning process of students.

Around the world, conventional power systems that provide electricity, heating, and cooling are under strain. Energy consumption is rising. As demand grows, the affordability and reliability of the power supply becomes less predictable. Energy generation and transmission inefficiencies, along with waste on the energy consumer side, complicates the drive to reduce carbon emissions.

Within the traditional model of centralized grid power, electricity flows from plants to local distribution networks and finally to end users, who passively receive and pay for the power according to consumption. This model has now been impacted by new breakthroughs in power distribution technologies. As costs drop for deploying smarter, more flexible grids, many educational institutions are looking for new ways to acquire, store, and consume the energy they require in order to foster more reliable, predictable, and cost-effective operations.

Improvements in energy efficiency are also critical to educational institutions because they represent a significant source of cost avoidance. Implementing energy efficiency improvements is the easiest, cheapest, fastest, and most cost-conscious way to save energy because it drives down demand. For example, according to the International Energy Agency (IEA), its member countries in 2015 avoided the consumption of 870 million barrels of oil barrels, 205 million tons of coal, and 224 billion cubic meters of natural gas as a result of energy efficiency practices[1]. That's enough energy to power the country of Japan for an entire year. The same principle applies to educational institutions. Any consumption avoided can amount to enough savings to fund a new gymnasium or new laboratory, for example.

Smart Heating Solution at Wesleyan University

Following a massive storm that hit the Northeastern U.S. in 2011 and Hurricane Sandy in 2012, Wesleyan University in Middletown, Connecticut, experienced severe power and heating system outages.

To prevent future occurrences, facility management implemented an on-site power generation system.

In March 2014, Wesleyan University completed installation of a microgrid using a combined heat and power (CHP) solution to provide heat to the athletic facility. The 676-kW gas engine saves the university an average of $1,000 per day in gas and electricity charges.

Advancements in energy technologies now enable a higher level of flexibility when it comes to control of power generation and consumption. A foundation has been laid that allows ingenuity in the way energy is controlled to flourish. New, affordable options such as microgrids and local renewable forms of energy are empowering educational institution stakeholders to be creative in the manner they generate, pay for, store, and consume their energy.

Today, end users at academic institutions need not only be consumers of energy. They can also be producers. The grid, which has always been unidirectional (utility power plants to consumers) is now bidirectional (independent energy producing entities selling their excess capacity back to the grid). With a much higher degree of control over energy costs, system efficiency, power stability, and environmental impact, the operational continuity goals of educational institutions are now attainable.

Most universities today are either formulating or implementing comprehensive energy management plans. They are reevaluating their holistic energy consumption and energy cost models. By building formal strategies for measuring energy consumption, implementing energy efficiency improvements, and refining their energy buying strategies, they are positioning themselves to drastically reduce CO2 emissions and to lower their energy costs. In fact, some are committing themselves to aggressive energy reduction targets and are beginning to look at on-site power generation as a possible solution.

[1] International Energy Agency (IEA), "Energy Efficiency Market Report 2016", 2016

This paper will review how new breakthroughs in on-site power generation (such as solar, wind, and thermal energy), combined heat and power (which enables energy generation through reuse of waste heat), and energy storage (so that energy can be sold back to the grid when demand is high) can help educational institutions formulate a more holistic, predictable, and independent energy strategy.

The challenge of aging infrastructure

Today's schools, colleges, and universities are confronted with the challenge of an aging physical infrastructure. In the US, for example, most schools were built before 1970. Within these facilities, much of the physical infrastructure equipment (i.e., electrical equipment, heating, air conditioning, and ventilation systems) has surpassed its useful life and these older designs are not energy efficient. Inefficiency results in high operating costs. In a typical facility, as much as 33 percent of consumed energy is wasted. These costs are unsustainable.

The older equipment also breaks down more frequently, requiring more repairs. When the power supply is disrupted, for example, classes are cancelled, facilities shut down, and coursework – much of which is completed on computers – ceases. Obsolete heating, cooling, and ventilation systems can subject students, staff, and faculty to cold temperatures in winter and warm temperatures without air conditioning in summer. Food storage and preparation are additional challenges during long-term power outages.

Algonquin College embraces renewable energy generation

Algonquin College, one of the largest educational institutions in the province of Ontario, Canada, with 18,000 full-time and 36,000 part-time students, has embarked on a journey to become the pioneer in sustainable education.

Focused on reducing the use of electricity, water, and gas, the university is collaborating with technology providers like Siemens to push the boundaries of energy efficiency, signing off on a $51 million investment over the next 20 years.

The college is incorporating not only renewable generation but also sustainability courses as part of its core curriculum. Improvements to the campus's water, heating, and cooling systems are planned. The college also intends to set up a research facility that targets the reduction of consumer power consumption.

These changes have saved the college $3.7 million in annual operating costs. Today, Algonquin College serves as an example and a catalyst for educational institutions all over the world.

In addition, hundreds of graduate students, faculty, and scientists perform research at the institution. The researchers rely on equipment such as freezers that preserve research specimens. These devices need to remain operational at all times. If an electrical system failure occurs, these specimens and other data that researches have spent years studying are at risk of being lost.

A new, holistic energy strategy can help schools get beyond this costly break/fix cycle. As new energy-efficient alternatives present themselves, innovative methods for bringing down energy costs and improving electrical system reliability need to be implemented.

Energy efficiency also has a direct impact on carbon emissions. At universities, sustainable operations are critical for attracting students and enhancing the image and reputation of the school. According to a 2015 Princeton Review study that coincided with the release of its Guide to 353 Green Colleges, 61 percent of 10,000 students surveyed indicated that a university's commitment to the environment – including reducing waste, conserving water and electricity, deploying renewable sources of energy generation, and minimizing emissions – would influence their decision to apply for admission or enroll.

Benefits of embracing a holistic approach

By enabling power generation close to the point of use, and by combining reliable power distribution with better management and energy storage, educational institutions have more control over their energy consumption than ever before. Consumption requirements can be proactively planned and managed in a way that generates cost savings, improves operational efficiency, and lowers carbon emissions. Access to multiple power resources also reduces the risk of costly downtime when surprise power interruptions occur. These strategies place schools in a position where they are literally ready for anything.

Some tangible benefits that can result from a more localized energy sourcing approach:

- **Cost savings** – By introducing self-generation and by connecting the local energy supply to the power grid, educational institutions can easily adapt their source of power generation to shifts in volatile market prices. When demand is low and the price falls, local generation can be switched off and energy can be taken from the grid. When demand peaks, users can reduce load, switch on local generation, and earn revenue from selling excess power generated back to the grid. Average reductions in energy costs can range from 8-18 percent, and return on investment (ROI) can be achieved within 3 to 7 years.
- **Energy efficiency** – New approaches such as real-time data monitoring and multipoint controls of buildings, plants, and networks enables operational efficiency. Systems are made available when they are needed, and maintenance is predictive (as opposed to break/fix). Modernized electricity, heating, and cooling systems are "smart" and are regulated to respond differently depending upon whether campus rooms sense human occupancy.
- **Security and stability of power supply** – In the event of natural or manmade disasters, the traditional power grid need not be the only resource to turn to. Microgrids can support facilities during emergencies. In addition, when the standard power grid is at or near capacity, the microgrid can be counted on to reduce peak loads and maintain power quality. This helps to eliminate the risk of blackouts and avoids costly investments in grid reinforcement.
- **Emissions and pollution reduction** – Conventional power generation relies on the burning of coal, petroleum, and/or natural gas. High carbon emissions, poor air quality, and public health problems are some of the side effects of burning these fossil fuels. Microgrids that incorporate renewable, low-carbon energy sources reduce the impact of the energy system on the environment, improve air quality, and reduce health risks.

Many of the technological advancements that enable these new ways of managing the energy supply and demand come as a result of digitalization. Digitized systems enable rapid data aggregation, modeling, and analysis of information being gathered and enable simpler data and system management. Since these advanced power systems are linked and networked with computers, they are also designed with cybersecurity in mind.

University of New Hampshire: Landfill gas drives energy turbines

The University of New Hampshire has quickly emerged as a leader in innovative power generation. Instead of allowing landfill gas to escape into the air, UNH has implemented a system where the landfill gas is captured, converted, and blended with natural gas and used as a renewable energy source.

The extracted landfill gas is compressed and passed on to the processing plant where it is cleaned and enriched (by removing the Carbon Dioxide), thus making it suitable for burning in advanced Siemens gas turbines.

By moving towards climate neutrality, the University is confident in its ability to lower carbon emissions 50 percent by 2020 and 80 percent by 2080.

These technologies continuously monitor infrastructure systems and provide access to operating data in real time, which improves system transparency. As a result, system administrators can predict system performance under certain conditions, can uncover inefficiencies or weaknesses, and can rapidly correct critical problems. In addition, stakeholders can formulate comprehensive solutions for reducing transmission and distribution losses, can manage demand, and can encourage changes in consumption patterns. Examples of increasingly popular digitized technologies are smart meters, which automatically report user consumption data, and energy-efficiency-management software. As user interfaces of such systems are simplified, and as transaction costs of data acquisition decline, educational institutions will enhance their ability to control energy usage.

Creative financing can now enable operational continuity

Critical energy projects usually require substantial amounts of start-up money. However, schools and institutions of higher education can fund new energy management and microgrid projects in a number of new and innovative ways. The traditional approaches of borrowing money at market interest rates or issuing shares of stock in a public offering are no longer the only options.

Below are several common methods for funding energy-related infrastructure projects:

- **Build-Own-Operate models** – This financing solution enlists a qualified third party for the installation, operation, and maintenance of the required equipment. Below are two popular versions of this model:
  - **Energy Performance Contracts (EPC):** Customers partner with energy service companies (ESCOs) to share the risk of implementing energy-efficient power-generation solutions. Upon implementation of a solution, ESCOs guarantee cost savings associated with reduced power consumption and improved operational efficiency. Customers submit payments, which should be less than the savings generated, at set intervals. Over time, these projects pay for themselves. If savings fall short of the guarantees, ESCOs pay the difference to customers.
  - **Power Purchase Agreements (PPA):** External developers design, deliver, and operate the microgrid system. In exchange, users purchase power at an agreed-upon price. In this model, consumers buy power from generators rather than utilities.
- **Incentives as direct subsidies** – Many national and local governments run programs that reward organizations for meeting specified carbon reduction targets and for generating energy from renewable sources. Microgrids and power generation and storage solutions can also qualify users eligible for tax incentives that offset costs.

The off-site PPA

A power purchase agreement (PPA), or electricity power agreement, is a contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer).

The Federal Energy Regulatory Commission (FERC) determines which facilities qualify for PPAs under the Energy Policy Act of 2005. If no suitable sites exist on campus, off-site PPAs can be an option. The Massachusetts Institute of Technology (MIT), for example, has heavily invested in off-site PPAs (local property ordinances restrict MIT's use of on-site solar installations). It is estimated that up to 50% of PPAs are utilized to support off site projects.

- **Green banks and bonds** – The "green financing" movement assists in the development of environmentally friendly projects. This financing method uses public resources to bolster private investment in renewable sources of energy.
- **Crowdfunding** – For small-to-medium energy projects, crowdfunding – raising money from a large number of donors – is a viable option. The Internet has helped make publicizing green projects, contacting donors, and collecting funds an easier process. Students, parents, staff, and alumni are good sources of donations for energy initiatives at colleges and universities.

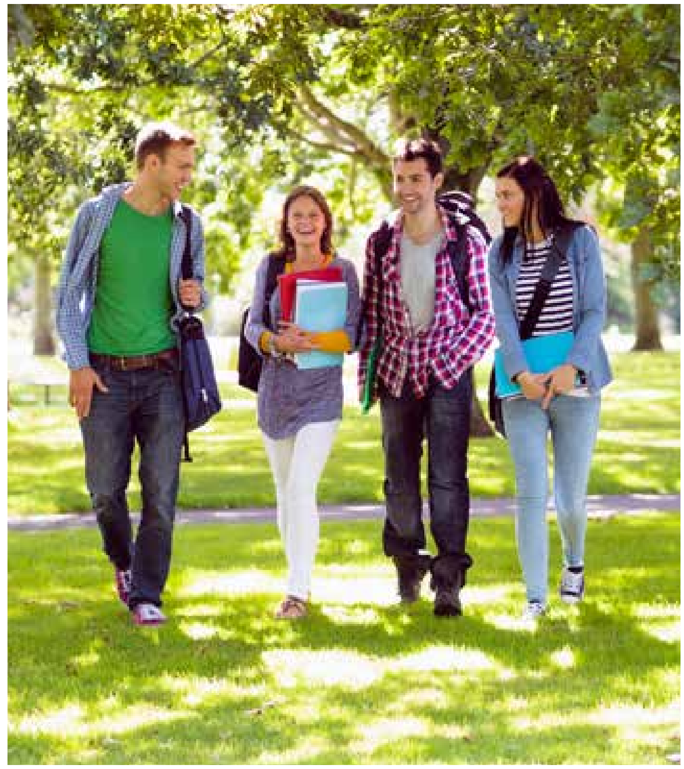
Conclusion

New on-site energy solutions are making it easier for educational institutions to move forward in modernizing their power infrastructure. Investments, facilitated by creative financing options, offer school campuses a way to stay in control even when the unexpected happens.

Institutions that pursue a traditional energy sourcing mindset risk missing out on the benefits of energy cost reductions, enhanced energy efficiency, a stable and secure power supply, and lower greenhouse gas emissions.

Reliable partners, such as Siemens, have the knowledge and expertise to help educational institutions manage each step of their power resourcing and reuse modernization process. Siemens helps schools to maintain their operational continuity by providing the technology to generate on-site power or to assure that the power supply is close to the point of use. Technology for storing power and for automating the control of that power also supplements the execution of a holistic strategy that will drive high efficiency education systems operations.

To learn more about Siemens localized energy solutions, download the full-length white paper co-authored by Siemens and Arup, Distributed Energy Systems: Flexible and Efficient Power for a New Energy Era.



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