POWER ON!

ENERGY RESILIENCE IMPROVEMENT STRATEGIES FOR BUSINESSES AND BUILDINGS

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This year's hot buzzword is *resiliency*, but the concept is not new. Successful business and building owners constantly evaluate risk and overcome vulnerability, so why is the new buzzword *resiliency*?

In the first 10 months of 2017 alone, the U. S. experienced 15 natural disasters with losses exceeding $1 billion each.[1] These extreme weather events are a leading cause of large-scale power outages, outages that left millions of households and businesses across the country without power for days, weeks, and, for some, months. These outages have caused business and building owners to seek to invest in measures that generate value quickly and reduce or avoid loss.

Traditional power systems are extremely reliable under normal conditions, but we are experiencing a new definition of normal. This new status quo means that our current power systems may not always be able to provide the level of uninterrupted power supply we historically enjoyed. Successful building and business owners will leverage cost-effective resilience strategies to create value, remain competitive, and keep the lights on, even when the power goes out.

SOURCES OF POWER RESILIENCE

Resilient infrastructure and enterprises anticipate, absorb, adapt to, and rapidly recover from disruptive events.[2] This should not be confused with reliability, which is a binary (on/off) measurement of the length and frequency of outages. Resilient approaches emphasize that disruptive events happen and system design should include the ability to learn, adapt, and bounce back.

The first level of power resilience is energy management. Efficient buildings and companies require less power to operate, saving money and decreasing demand on the electrical grid. Energy audits can be a great first step to identifying efficiency and demand management opportunities. Even buildings and companies with energy management systems may have the potential to improve. Innovative techniques and technologies, including the internet of things and machine learning, are revealing new opportunities for savings.

The second level of power resilience is on-site energy storage. Battery storage is uniquely capable of instant response and is already widely used to keep servers functioning during a power outage. Thermal storage tanks can help provide thermal energy. A detailed analysis of different factors such as the power and energy required, resiliency goals, room available, initial investment, internal rate of return, etc. can help companies select the best solution for their needs.

The third level of power resilience is on-site power generation. Local, decentralized distributed energy systems, are capable of being configured to operate independently of the power grid. This distributed generation could be provided by backup generators, combined heat and power (CHP) systems, solar energy, wind turbines, and fuel cells. Backup natural gas or diesel generators are quite common but require significant maintenance and are typically only used when the power is out. The other types of on-site power production can provide power and cost savings all year long. CHP systems have provided reliable power through many of the recent natural disasters.[3]

Considering the right mix of generators is also a strategy to increase the resilience of your building or business. A resilience strategy based on solar or wind should include energy storage. Usually, these renewable energy systems with storage perform well during short power blackouts (milliseconds to hours, sometimes longer, depending on system design). However, wind and solar systems may be vulnerable to strong winds, floods, and storms and, thus, need to be designed appropriately.

The fourth level of power resilience is redundant or external energy infrastructure. The natural gas distribution grid has proven to be highly reliable during many severe weather events. A properly-sized redundant or oversized natural gas pipe combined with external fuel tanks and dual-fuel diesel/gas generators can also help keep facilities operational. Large critical facilities will also often work with the utility provider to ensure that there are redundant power supply feeds so that if there is an issue at one substation, the facility can continue to receive power. However, depending on the facility and location, it may not be easy or cost effective for the utility to provide electricity from two independent power lines.

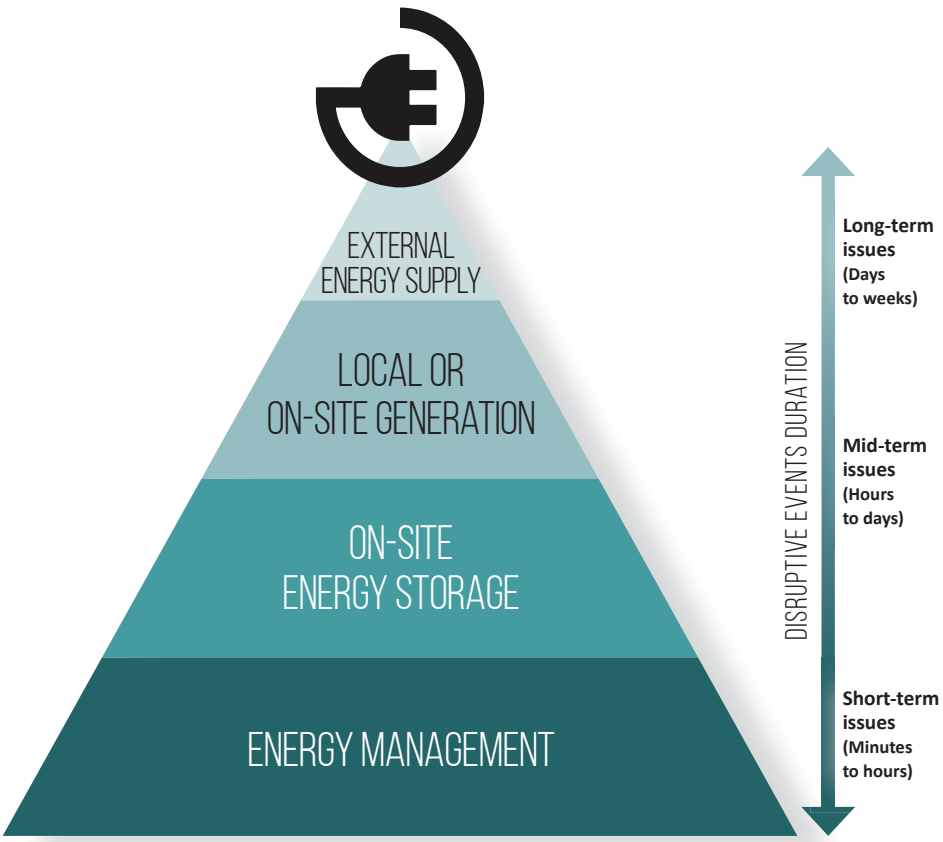

Figure 1. Power Resilience Hierarchy

YOUR POWER RESILIENCE PLAN

Most business owners have in hand business resilience strategies such as back-up plans guaranteeing supply chain or logistics. When it comes to power resilience, typically only critical and industrial facilities have a plan. Most building and business owners have based their energy supply only on the interconnection to a local utility, possibly with a backup generator for emergencies. Much of the centralized electrical grid infrastructure is aging and requires significant investment in order to continue to meet the growing capacity needs of an economy that is dependent upon reliable energy sources.

For a business or building to be resilient, realistic plans must be developed based on energy needs, resiliency goals, and cost constraints. A framework for a power resilience plan is shown in Figure 2. The plan needs to identify appropriate

Figure 2. Resilience Framework

Figure 3. Power Resilience Planning Process

roles for individuals, and they need to be trained to ensure that best practices are followed for the lights to remain bright.

The most resilient solution is rarely the least expensive alternative, so trade-offs and systems must be appropriately tailored to the needs of the individual business or building. When valuing resilience, it is important to consider controlling potential loss along with safety, environmental damage risk minimization, and other strategic goals. Figure 3 presents a process to identify business energy goals so a power resilience program can be tailored to a specific location, as well as requirements and applications.

In developing your power resilience plan, you should do the following:

▲ *Identify potentially disruptive events*. There are four general components of the electricity system: power generation, transmission, distribution, and the end user. Damage to any of these components can endanger the overall power supply. Damage may be related to weather, accidents, vandalism, etc. There may also be insufficient supply to meet demand (e.g., brownouts caused by high usage during heat waves).

▲ *Assess potential economic loss.* Many times, this economic risk provides the motivation for considering a holistic resilient power strategy.

▲ *Identify potential threat mitigation strategies*. Given the possible disruptions and their potential impact, identify approaches to protect the infrastructure, business, or building. For example, disruption due to wind could require different tactics than a disruption due to flooding. The mitigation strategies should identify internal responsibilities and necessary external resources.

▲ *Define resilience requirements*. Evaluate the costs and benefits of the potential mitigation strategies considering the probability of occurrence and magnitude of potential impacts. Modeling can be used for risk analysis. Depending on the size of the project and the project needs, these risk analyses techniques can be complex. Consider the number of

scenarios, detail of the weather forecasts, and techniques to be used. For larger projects, a company may benefit from employing external consultants to help.

▲ *Analyze local infrastructure*. Be sure to consider how local infrastructure has historically performed and what future conditions might affect future performance. *A* low quality power supply might drive a decision to install energy generation or storage technologies. Data on the reliability of utilities and historic outages may be available online.

▲ *Create and prepare a power resilience plan.* The plan should define resilience improvement strategies and associated investments. The plan should be reviewed and updated annually.

Outages can be expensive. With resilience planning and action, the impact can be minimized. These steps will allow the organization to create an action plan that identifies key system assets and identifies methods to adapt to changing conditions and recover rapidly from disruptions.

TEAMWORK IS KEY

It is important to have the right team in place. Include subject matter experts to identify gaps, draft best practices, and implement your carefully crafted plan to ensure that you have power when you need it most. Your multi-disciplinary team should include facilities design and operations, energy modeling, energy management, engineering, finance, emergency management operations, and communications. External consultants can provide additional subject matter expertise. Change will not happen overnight. Be realistic about the current state of resiliency in your building and business operations and the levels you want to achieve. Set your targets and keep in mind that resilience is an integrated and ongoing strategy. **N**

1. https://www.ncdc.noaa.gov/billions/
2. https://www.dhs.gov/xlibrary/assets/niac/niac-a-framework-for-establishing-critical-infrastructure-resilience-goals-2010-10-19.pdf
3. https://www.energy.gov/eere/amo/chp-deployment

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