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TRANSFORMERS/ GREEN POWER GRID 2016

FUTURE OF UTILITY COMMUNICATIONS pg18
COMMUNITY RENEWABLE ENERGY AND RELIABLE SERVICE pg24
UTILITIES BANK ON IoT TO DECREASE LOST REVENUE pg30

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Community Renewable Energy and Reliable Service

Are They Mutually Exclusive?

BY GEORGE BRENDAHL, Marketing Manager, Utility and Nuclear, EnerSys®

This past winter, extreme weather cost the United States more than $5 billion in property damage, closed businesses and travel disruptions. Early indications also forecast a viciously cold winter for the 2015-16 season. With this extreme weather, many assume they will suffer power loss. In fact, a 2014 report from Climate Central has found that major power outages have increased 10 times since the early 1980s, with extreme weather responsible for 80 percent of outages between 2003 and 2012. The impact is staggering, with an average of 15 million customers experiencing a major power outage each year.

According to *Inside Energy* and the Department of Energy (DOE), between 2000 and 2014, the five-year annual average of outages has doubled every five years. This is attributed to an aging infrastructure, a growing population and more frequent weather extremes.

According to the *New York Times*, "With utility companies straining to keep up with power failures after storms, homeowners are increasingly taking matters into their own hands." Generators have become popular with families in metropolitan areas that have been hard hit by recent "super storms."

Businesses have more at stake, including financial losses and future business. Electrical power outages, surges and spikes bring about more than $150 billion in annual damages to the U.S. economy.

It is estimated that the average cost of downtime is $8000 per minute and the long-term results can be devastating. The Small Business Administration and FEMA recently revealed that 40 percent of businesses that suffer a downtime event never recover.

Behind-the-Meter Backup Power Solutions

These businesses are driving demand for emergency backup power and, according to an article in *Business Energy*, "it's a trend that doesn't look likely to slow any time soon." This is evidenced by the strong sales of generators purchased by homeowners and businesses trying to cope with this winter's destructive storms.

A standby generator can provide energy for several days, but users may find them complicated and costly. Some home models may cost more than $20,000 installed. There's also the cost of fuel to consider. Internal combustion engines run on the home's natural gas or on liquid propane or diesel stored in an outdoor tank. All of these systems run on a finite amount of fuel that rely on delivery, which could be hampered by weather conditions and increased demand due to severe weather.

As an alternative to standby generators, homeowners and businesses are turning to Energy Storage Systems (ESS) similar to the large systems that utilities use for backup power.

Utilities: Reliability and Renewable Energy

Like their customers, utility providers are struggling to cope with the trifecta of increased demand, aging infrastructure and increasingly severe weather. However, utilities have another challenge to face — incorporating renewable energy sources.

The Energy Information Administration projects that total renewables used for electricity and heat generation will grow by 3.8 percent in 2015. The share of electricity coming from renewable sources is projected to grow from 10 percent in 2012 to 16 percent in 2035. The International Energy Agency predicts solar generators may produce most of the world's power within 50 years.

Intermittencies are an inherent challenge with renewable resources. Solar radiation is zero at night and affected by cloud cover during the day. Wind energy also varies according to weather systems passing over a given location, with recurrence times typically between one and three weeks. Even hydropower, which is generally stable, varies seasonally as dictated by the components of the water balance, including precipitation.

Utilities and Energy Storage

Increasingly, energy storage is being regarded as a way to balance the grid. Electric utilities already are among the largest owners and users of electrochemical battery systems. A 2012 Black & Veatch study indicates that more than 20 percent of utilities are planning to add storage, and the global energy storage market is expected to grow 71 percent per year in terms of capacity from 2014 to 2023, according to Navigant research.

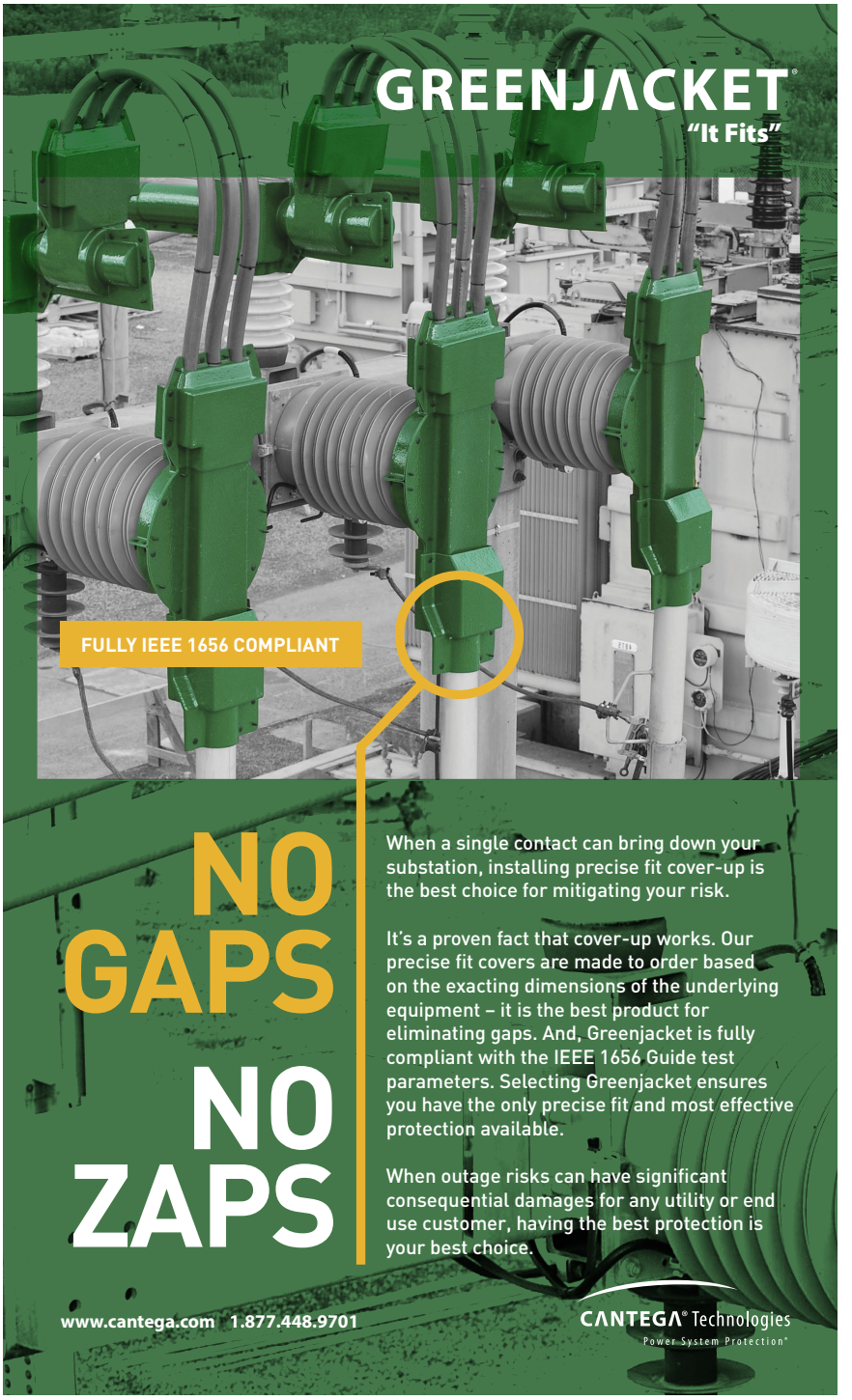
Energy storage augments conventional power generation, providing ready-to-use power. In addition to balancing intermittencies in renewable output that can cause grid instabilities, energy storage also can benefit utilities by:

- Providing grid stabilization for voltage regulation, frequency regulation and ramp control
- Managing peak shaving, providing an opportunity to cut costs by purchasing power during off-peak periods without downtime or work stoppages
- Providing an alternative to new construction, upgrades and expansion
- Supporting reliable, efficient and environmentally sound grids while reducing dependencies on conventional generation assets
- Allowing the achievement of curtailable power goals during continuous operation without schedule/demand constraints

Pumped hydro and compressed air systems are the most widely used bulk storage systems. While more expensive per kilowatt, a distributed energy system provides more

Energy Storage Systems:

- **Provide immediate power output in response to blackouts**
- **Help commercial manufacturing facilities maintain productivity and reduce energy bills**
- **Help businesses protect against loss of valuable data**
- **Help hospitality facilities maintain guest satisfaction by avoiding power outages**



At the Rutland, Vermont installation, each 30'x 10' x 12' shelter houses 480 batteries. The shelters are painted green to blend with the environment

flexibility. With a distributed energy storage network, the utility can focus on specific regions, storing and providing energy for immediate use, such as in heavy commercial or population-dense areas, and also allows for more efficient use of renewables.

Choosing the Right Energy Storage System

To choose the right energy storage solution, the utility must develop a clear profile of the application by addressing several key decision-making factors.

Performance

Correctly designing a power-and-backup system and selecting the right storage batteries for the renewable application can have a significant impact on overall performance, efficiency and longevity.

Renewable applications are characterized by deep discharge-and-recharge cycles intermixed with Partial State of Charge (PSOC) cycles. As such, the batteries for these applications should exhibit the following performance characteristics:

- Long cycle life
- Cycling in state of discharge
- Low rate of self-discharge
- Large electrolyte reserve

Size

One of the most common mistakes in battery selection for renewable applications is the improper battery sizing. This occurs when the installer miscalculates the number of days of autonomy and the amount of power needed to support the load and charge the batteries.

When sizing the solar panels, it is important to accurately estimate the system load, amount of sunlight, average output of power, daily discharge and days of autonomy. "Energy in" must be greater than "energy out." Without enough power generation, the batteries become depleted. With no recharge period, they plateau and then discharge again, creating a downward "stair step" cycle pattern. Continuously discharging lead acid batteries greater than 80 percent will irreversibly harm the battery. Therefore, the more cycles anticipated, the lower the depth of discharge should be. For maximum investment, it is best to not discharge the battery more than 50 percent in a diurnal system.

Chemistry and Design

Utilities must weigh their options to find the optimum solution. High energy, high cycling solutions sound impressive, but energy density comes at a premium and is only required when space is limited. For example, in many applications, lead acid batteries may deliver the necessary performance requirements at greater savings than other high-energy storage solutions.

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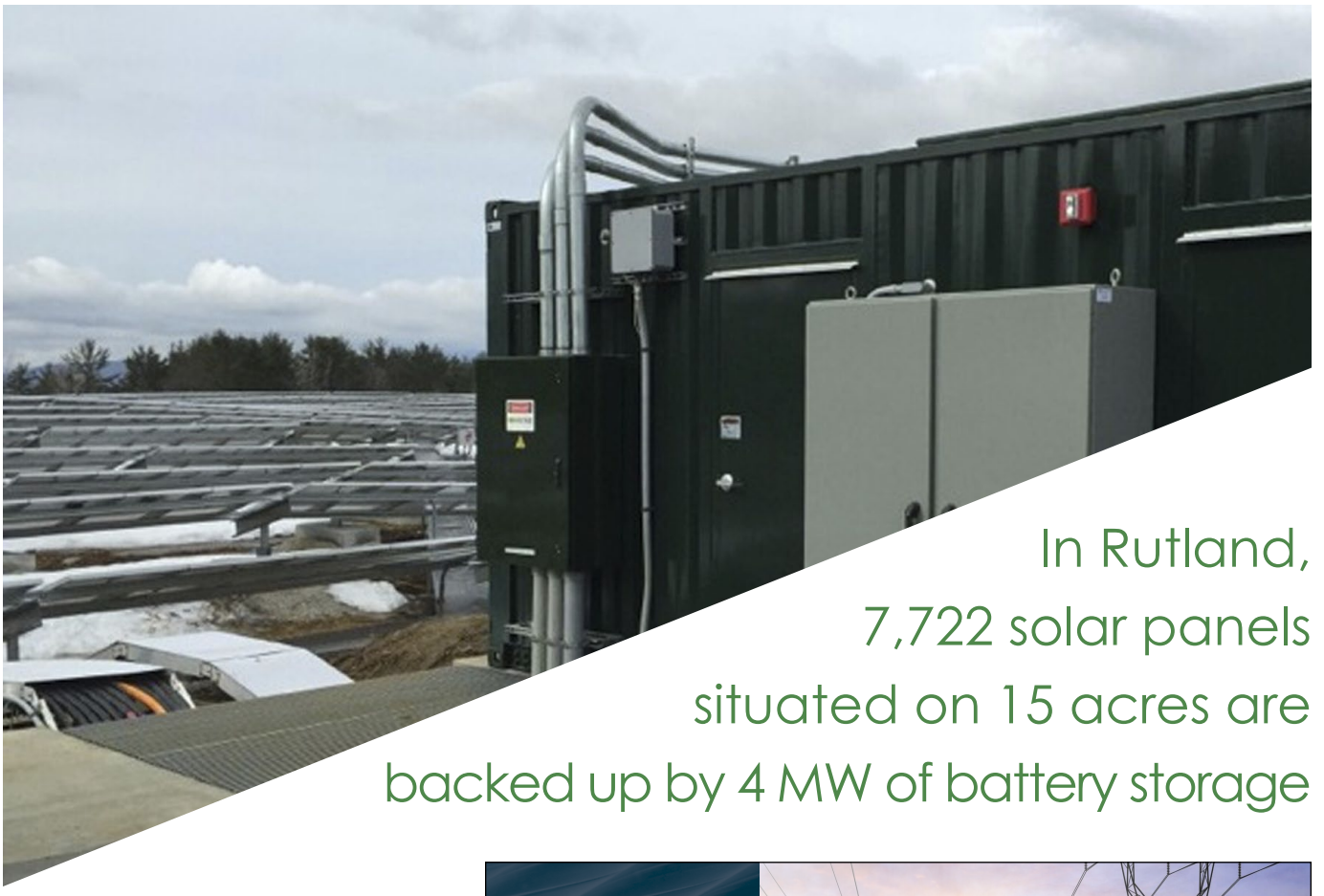

In Rutland, 7,722 solar panels situated on 15 acres are backed up by 4 MW of battery storage

Although flat plate designs are the principal battery design used in stationary utility and switchgear applications throughout North America, tubular positive plate designs are widely used in renewable energy applications, in which maximum cycling is key. The current carrying lead metal in tubular designs is entirely surrounded by active material, both of which are encased in a gauntlet. This keeps the active material tightly against the spline and helps to ensure long life. Splines provide more surface area that comes into contact with the active material. This combination of greater positive surface area and better paste adhesion allows for excellent cycling capacity.

A Community Case History

With memories of devastating Hurricane Irene still fresh, one Vermont community — Rutland, population 17,292 — made huge strides in energy innovation in 2014. According to the DOE, The Stafford Hill Solar Farm in Rutland is the first microgrid to be powered solely by solar and battery backup. The Stafford Hill Solar Farm was built on a brownfield site, contributing to community brownfield redevelopment efforts. The local utility, Green Mountain Power, developed the innovative solar project to improve resiliency and safety in its communities.

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The Rutland, Vermont microgrid is comprised of solar panels, backed up by OptiGrid™ Stored Energy Solutions by EnerSys®. It is the first solar microgrid funded by the U.S. Department of Energy (DOE) and the first system in the country that will be able to maintain mission critical power on renewables and storage alone for extended periods of time

With 7,722 solar panels situated on 15 acres, The Stafford Hill Solar Farm can generate 2.5 MW of electricity, enough to power about 2,000 homes during full sun, or 365 homes year-road. The project also includes 4 MW of battery storage for solar generation. EnerSys® supplied the 4 MW OptiGrid™ Stored Energy Solutions and local company, Dynapower, provided modified, multi-DC port, air-cooled IPS 500 inverters. The integrated OptiGrid™ Stored Energy Solutions utilizes lead acid and lithium ion batteries and offers operators flexibility to manage PV ramp rate and shift peak loads and allows the disconnection of an entire circuit from the grid in an emergency to provide critical power for an emergency shelter at Rutland High School. As such, it is the first microgrid to provide full backup to an emergency shelter on the distribution network. Completed in December, the site is helping Green Mountain Power reach its goal of making Rutland the "Solar Capital of New England."

Summary
Today's energy storage systems have emerged as viable solutions for addressing power failures, the intermittent availability of renewable energy sources and the reality of transmission constraints. The key is to choose the right energy storage solution and partner for the application at hand and not to overlook familiar technologies.

George Brendahl, Marketing Manager, Utility and Nuclear, EnerSys®, the global leader in stored energy solutions for industrial applications. Manufactures and distributes reserve power and motive power batteries, battery chargers, power equipment, battery accessories and outdoor equipment enclosure solutions to customers worldwide.

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