



MORE THAN **BATTERIES**

Turning Distributed Energy
Storage into a Virtual Power Plant



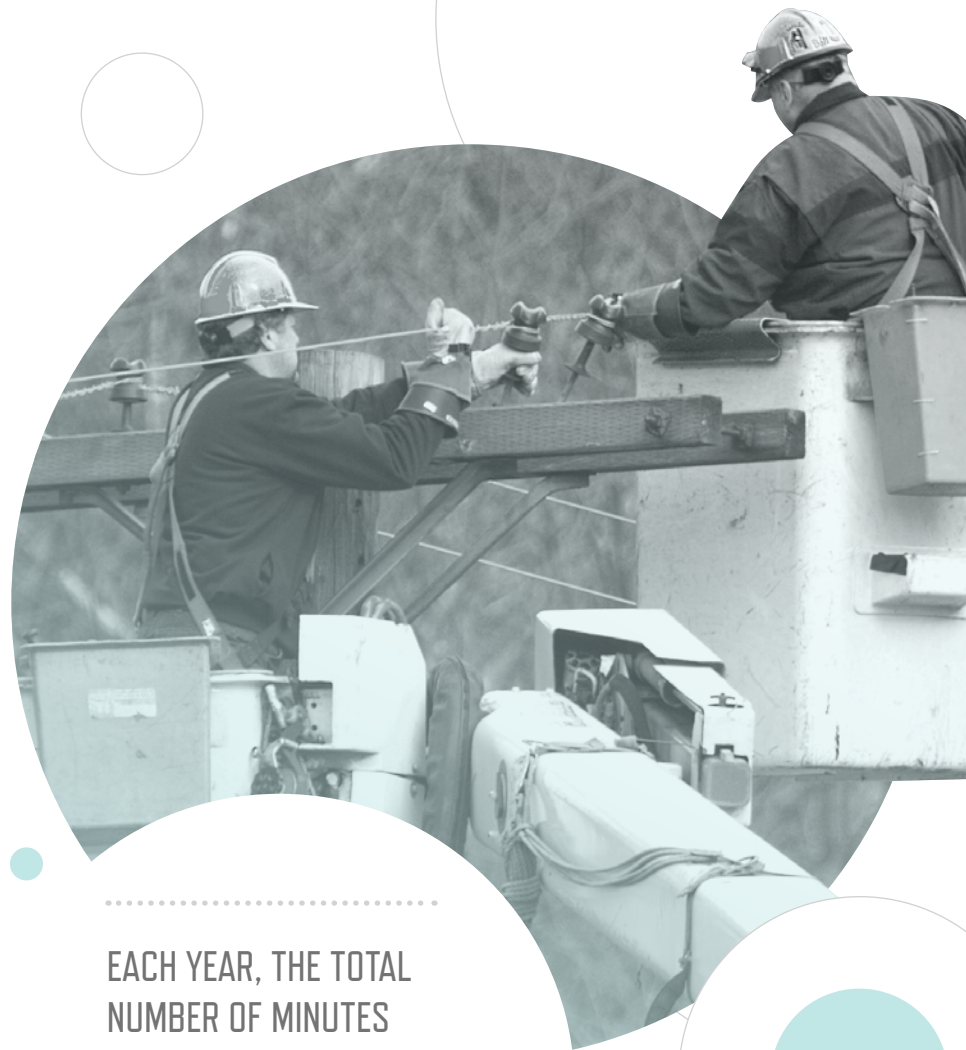


S THE COLD MONTHS OF WINTER SETTLE IN, consumers are bracing themselves for lower temps and higher bills. With chilly air the norm for so many across the country, keeping warm is not a question, and going without the power to do so is not an option.

Not having the proper energy supply to stay warm in the cold months—and cool in the warm months—however, is becoming increasingly more common. The reliability of the electrical grid is decreasing; each year, the total number of minutes without power is increasing by 5% to 10% for customers.

Back-up power in general, even with batteries, is not a new concept for consumers. But as customer-sited renewables become far more prolific and increasingly involve battery systems thanks in part to sharply falling battery costs, consumers can now satisfy their desire to cut their electricity bills while minimizing the severity and duration of power outages with on-site distributed energy storage.

Coincidentally as peak demand grows and distributed renewables reach higher levels of penetration, utilities are also focusing more on the benefits storage can provide. Some of these benefits include reducing transmission and distribution costs, shifting consumption from peak-demand periods, balancing intermittent resources, postponing the need for new generating plants or other infrastructure and providing frequency, and voltage support to the grid.



.....
**EACH YEAR, THE TOTAL
NUMBER OF MINUTES
WITHOUT POWER
INCREASES BY 5% TO
10% FOR CUSTOMERS.**

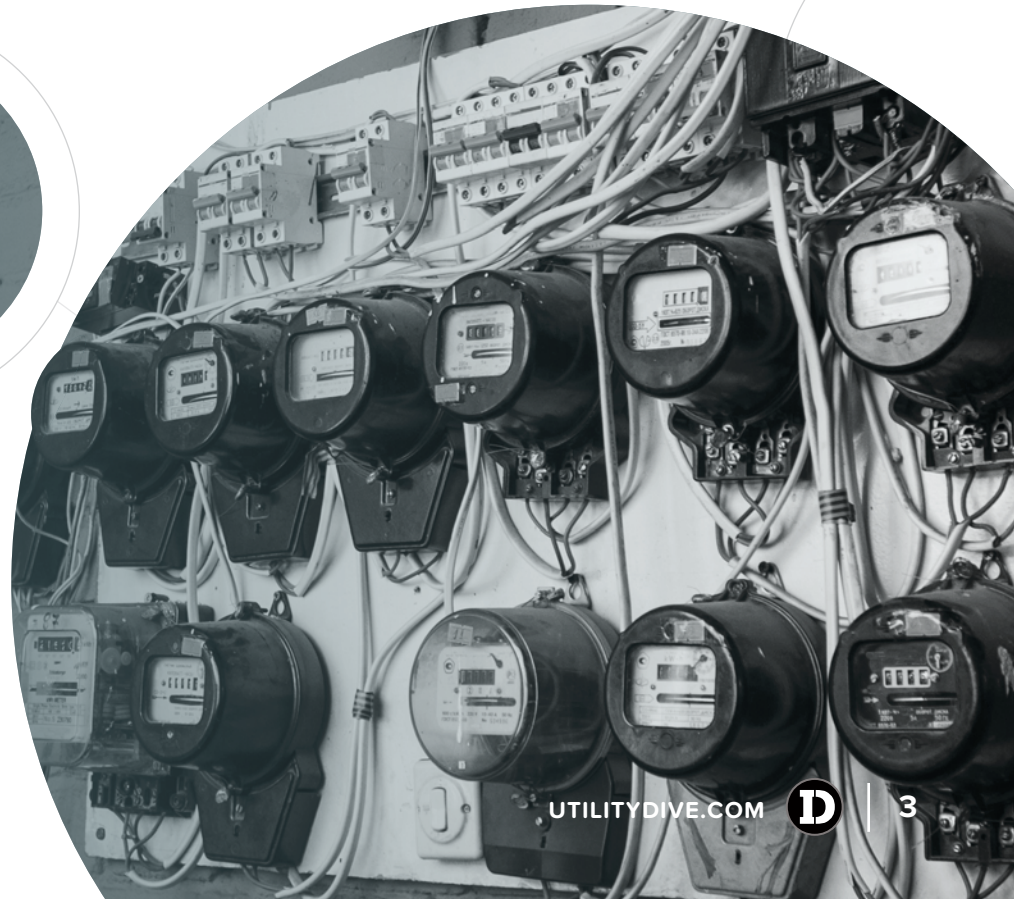


FALLING PRICES, RISING OPPORTUNITY

Falling battery costs have been key to the growth. The Rocky Mountain Institute (RMI), a nonprofit energy and environmental think tank, earlier this fall declared 2015 the “Year of the Battery,” explaining that the cost of lithium-ion cells have plunged from about \$1,000/kWh in 2007 to about \$300/kWh now. And industry projections suggest still further cost reductions of 60 percent or more are likely.

Although falling battery prices have greatly improved the economics of storage, the RMI study said that considering costs alone captures only half the argument in support of on-site battery storage.

“We found that batteries can deliver up to 30 diverse services, from frequency regulation to distribution and infrastructure upgrade deferral to customer bill management,” Garrett Fitzgerald, a senior associate in RMI’s electricity practice said. And the closer those batteries are to the customer, he adds, the greater number of services they provide. And that makes them more economic for today’s energy customer.





POWERING UP WHEN **MOTHER NATURE BEARS DOWN**

In addition to lowering customers' electricity bills, battery systems are proving attractive to residential and commercial customers interested in minimizing the impact of power outages, which are increasing in both number and duration.

Indeed, a recent study by the U.S. Department of Energy's Lawrence Livermore Laboratory and Stanford University found that increasingly severe weather events have led to a 5 percent to 10 percent per year jump in the duration of power outages. A report from InsideEnergy.org, a public media news outlet, notes that the number of annual reported major grid outages has risen from 44 over the 2000-2004 period to 200 over the 2000-2013 period. A major grid failure is an unplanned event that affects at least 1,000 customers for a total downtime of at least 1,000,000 customer hours.

These severe weather events have pushed the growth of the battery storage market. Ken Munson, CEO of San Francisco-based Sunverge, said his company expects to have more than 1,000 of its Solar Integration System (SIS) units in operation by the first quarter of 2016, and the company projects business will double next year and jump fourfold from that level by 2019.

The power stored in the SIS batteries can be sliced and diced in a number of ways by providing customers with outage protection, a reliable source of energy when the sun isn't shining, or a way to avoid peak managing rate charges. Further, utilities can call upon the stored energy for additional capacity or voltage and frequency support during severe weather events, to keep consumers power-full, instead of power-less. The SIS units combine batteries, power electronics and multiple energy inputs in a UL-certified appliance controlled by software running in the cloud, which adds a unique component to maximize the value of distributed energy resources.

Peter Asmus, principal research analyst with Navigant Research, said systems like Sunverge's SIS, which threaten to disrupt the traditional model under which power is sent to customers from central generating stations, are "now at a level where they can't be ignored." And as a result, utilities of all sizes are evaluating or piloting energy storage systems.

What is clear, Asmus added, is that municipal utilities are "leading the way. We've seen medium-size munis being the early adopters, but more and more utilities are trying to figure out their roles."

.....
"WE'VE SEEN MEDIUM-SIZE MUNIS BEING THE EARLY ADOPTERS, BUT MORE AND MORE UTILITIES **ARE TRYING TO FIGURE OUT THEIR ROLES.**"

- **Peter Asmus**, Navigant Research



PARTNERING FOR POWER

In 2015, Sunverge teamed up with PowerStream, in Ontario, Canada, in a pilot that involves the installation of rooftop solar systems coupled with Sunverge's battery and control systems at 20 homes in its service territory.

Neetika Sathe, PowerStream's vice president for corporate development and smart grid technologies, said the utility is aiming to have all 20 homes equipped with the systems by the end of 2015 and expects those customers will be better able to deal with the intermittent nature of solar by drawing on battery power during cloudy days and reduce their bills by drawing on battery power during periods of peak demand.

The systems also can be called upon to provide backup power during outages for key home loads, such as lights, refrigerators and Internet service and alarm systems, she added. Moreover, using Sunverge's real-time control system, PowerStream will be able to direct the homes' solar systems to feed all energy into charging the batteries if forecasts are calling for severe weather that could disrupt service.



“We hope to showcase several value streams – clear bill reduction for customers, but also system benefits through voltage and frequency regulation. And we hope to assess the value of aggregation, the benefits of a virtual power plant and how it might help us to offset future gas-fired power plants,” Sathe explained.

Sunverge also partnered with SunPower and New York’s Con Edison in 2015 to kick off a project that will demonstrate how aggregated fleets of combined solar and storage energy systems can provide collective benefits to the power grid, resiliency services to customers in the case of an outage, as well as value to the power company.

For utilities, the project outline notes, “storage can smooth intermittency of solar and be used to dispatch energy at times when customers need it most. For the residential customer, solar plus storage provides access to a clean alternative to backup generators and that can also be dispatched to respond to price signals from the utility.” As the fleet of residential systems is aggregated into a virtual power plant, it opens up the opportunity to deliver multiple benefits to homeowners, utilities, and grid networks.”

For distributors, stepping outside of traditional roles is a must in today’s energy market. Customer-sited storage is one of many factors that are driving change, and creating, Sathe says, “a greater need for real-time monitoring and user-friendly apps that allow customers to better manage energy use and greater environmental awareness.”

“WE HOPE TO SHOWCASE
SEVERAL VALUE STREAMS
– CLEAR BILL REDUCTION
FOR CUSTOMERS, **BUT
ALSO SYSTEM BENEFITS
THROUGH VOLTAGE AND
FREQUENCY REGULATION.**

- **Neetika Sathe**, PowerStream’s
vice president for corporate
development and smart grid
technologies



DRIVING INTEGRATION

Outside of the home, SIS units can also help integrate the growing number of electric vehicles (EVs) onto the grid. Utilities are concerned that increased deployment of EVs could add demand to the grid as vehicle owners charge the batteries during evening and overnight periods – times of day when consumption is traditionally low and utilities have been able to conduct plant and grid maintenance.

The Los Angeles Department of Water and Power partnered with Sunverge to address this issue. The company notes that with the book-shelf-sized SIS units located at the homes of EV owners, the systems can create additional capacity and reduce the need for additional generation, transmission and distribution infrastructure.





SMALLER SCALE, **BIGGER BENEFITS**

As customer-sited storage rapidly grows, it's not just the larger energy grid that is disrupted. Under a project with the Sacramento Municipal Utility District, Sunverge installed a 2.25 kW solar array, an SIS unit, smart plug load controllers and smart thermostats at 34 homes at a development built by Pacific Housing, an affordable home developer. This, in essence, created a "micro-grid" for consumer usage.

The project delivered impressive results, including dispatching 100 percent of target stored capacity during demand-response events and reducing the net peak load of the 34 homes to zero during peak load reduction scenarios. In addition, customers with the systems saw an incremental 33 percent reduction in their bills compared with homeowners who only had solar system. Further, the SIS units were able to take 70 percent of daily solar generation from the 34 test homes and shift it for use during the utility's peak load hours of 4 p.m. to 7 p.m., offsetting load and allowing power to be exported to the grid.





GOING VIRTUAL

In south-central Kentucky, the Glasgow Electric Plant Board, a municipally owned utility, began installing SIS units at residential customer sites in July 2015. By early November the utility had completed 44 installations, and hopes to have 165 homes equipped with SIS units by the end of 2016.

Glasgow elected to not pair the units with rooftop photovoltaic units because the region's climate makes the benefits of solar less attractive, according to Michael McIntyre, an assistant professor of electrical and computer engineering at the University of Louisville, who serves as a consultant to the Glasgow Electric Plant Board. Instead, the pilot program is aimed at producing overall energy savings and reducing the utility's peak load.

Glasgow buys its power from the Tennessee Valley Authority, under a formula that includes both consumption and demand charges. In January 2016, the utility will launch a new rate for its customers that will include peak-hour demand charges.

McIntyre said the municipal utility earlier installed smart meters for all customers and has used social media to inform consumers of peak

demand conditions and asked them to reduce demand. They also installed highly efficient heat pump water heaters at 330 homes in its service territory, and outfitted each of the homes with smart thermostats to control space heating and cooling.

But while the efforts delivered significant demand improvements at a minimal capital cost, it became clear that more gains could be achieved with additional technology. Convincing customers to change their habits, by, for example, taking a shower at night rather than before heading out to work in the morning, and thus saving energy costs, proved fruitless.

To address that, Glasgow decided to install SIS units at 165 of the 330 homes equipped with the new water heaters and smart thermostats.

Under the pilot, Glasgow will charge customers' batteries during low demand periods and allow the homeowners to draw upon that power during peak periods. "We saw the batteries as a way to lessen the effects of people being uncomfortable," McIntyre said. Having the batteries gives Glasgow "the ability to add or take away load to advantage the power system."

.....
"WE SAW THE BATTERIES
AS A WAY TO **LESSEN THE
EFFECTS OF PEOPLE BEING
UNCOMFORTABLE.**"

- **Michael McIntyre**, an assistant professor of electrical and computer engineering at the University of Louisville

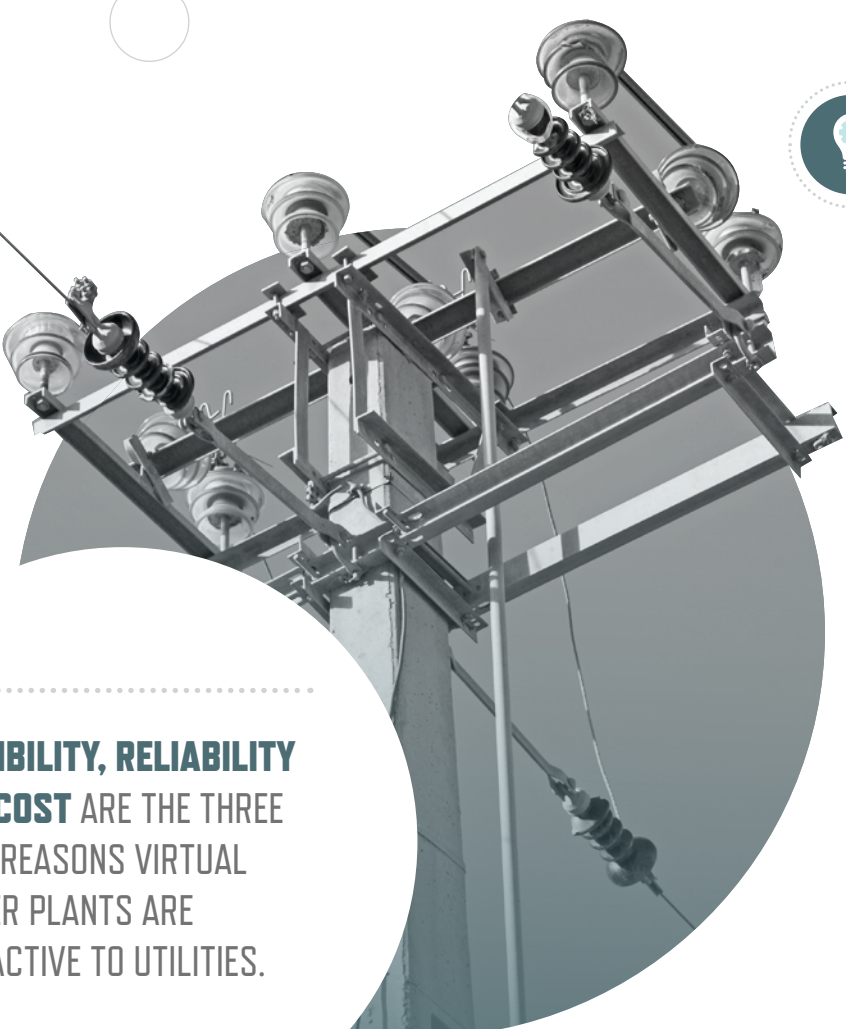


BECAUSE EACH OF THE SUNVERGE BATTERY-EQUIPPED HOMES STORES SURPLUS ENERGY AND USES IT DURING HIGH-DEMAND PERIODS, **THERE COULD BE THAT MUCH LESS NEED TO DISPATCH OLDER, MORE POLLUTING CAPACITY DURING PEAK PERIODS.**

The batteries, he added, provide Glasgow with “an alternate source of power – a virtual power plant, in effect – to help further increase the load factor” for homeowners, who in turn save money on peak demand charges without making major lifestyle changes.

In addition, McIntyre said he expects the pilot could provide environmental benefits in an area where roughly half the power is supplied

by coal-fired generating capacity. Because each of the Sunverge battery-equipped homes stores surplus energy and uses it during high-demand periods, there could be that much less need to dispatch older, more polluting capacity during peak periods.



**FLEXIBILITY, RELIABILITY
AND COST** ARE THE THREE
MAIN REASONS VIRTUAL
POWER PLANTS ARE
ATTRACTIVE TO UTILITIES.



MOVING FORWARD **WITH ENERGY AND INNOVATION**

As more renewable energy comes on to the grid, energy storage systems are playing an increasingly vital role in the creation of both virtual power plants and microgrids. And that means savings and benefits for customers and utilities alike.

Sunverge's Munson listed flexibility, reliability and cost as the three main reasons virtual power plants are attractive to utilities. In addition, consumers who own them also have the assurance of reliability they have first call on their own power.

"Battery costs are coming down faster than anyone predicted five years ago and we're seeing the creation of demand-response markets and frequency regulation markets and there may be voltage market," Navigant's Asmus said.

"If you can make it work today, then it's only going to be better in five years as costs fall further, the market develops and markets for new services open."



ABOUT SUNVERGE

San Francisco-based Sunverge Energy was founded in 2009 with the vision of integrating solar, storage, and smart management software to maximize value for both electricity consumers and providers. The company makes the Sunverge Solar Integration System (SIS), a distributed energy storage and management appliance comprised of powerful storage batteries, power electronics, and system-management software running in the cloud. The Sunverge SIS lowers costs, increases energy reliability, strengthens the grid, and accelerates the adoption and integration of distributed renewable energy. Investors include Southern Cross Venture Partners, Siemens Venture Capital, Softbank China Venture Capital and Total Energy Ventures International.

For more information, please visit

WWW.SUNVERGE.COM