ELECTRIFICATION INNOVATION

A Single Device to Manage Solar, EV Charging, Storage, and Energy Use in Homes and Businesses

Sunil Chhaya spends a significant amount of his time helping utilities capture the value of distributed energy resources (DER), which include rooftop solar, residential storage, and electric vehicles (EV). "Many utilities are aggressively pursuing ways to use DER to shift load to off-peak times and to provide grid frequency and voltage regulation," said Chhaya, an EPRI expert on grid integration of EVs and other DER.

With accelerating DER adoption and the emergence of tools to aggregate and manage DER, utilities increasingly see DER as a valuable tool to support grid operations and increase customer satisfaction.

"Initially, utilities focused on integrating DER to do no harm to the grid," said Chhaya. "Now they are looking at ways to manage DER so that they provide benefits to the grid and meet their customers' needs."

One innovative DER integration tool attracting attention from utilities is the Smart Power Integrated Node, or SPIN. Designed for homes and small businesses, SPIN is a single device that simultaneously manages and optimizes solar photovoltaic (PV) energy production, battery storage, EV charging and discharging, and building energy use, eliminating duplication of power electronics.

"The initial value proposition was to simplify the power electronics needed to accommodate solar energy, energy storage, EVs, and other large loads and energy sources deployed at homes and businesses," said Gregory Smith, one of the former General Motors engineers who founded Flex Power Control, the company that is developing SPIN.

Today, homes and small businesses that install rooftop PV, energy storage, and EV chargers must pay equipment, wiring, and labor costs for three separate electrical installations. There is usually no coordination among the three systems. Additionally, today's EV charging stations enable power flow in one direction only: from the grid to a vehicle's batteries.

SPIN combines the functions served by EV chargers and the inverters that convert DC power from rooftop solar and battery storage into AC power for home use and grid export. By making it unnecessary to purchase multiple power electronics devices, SPIN aims to lower the cost of DER for homeowners and businesses. A recent University of Kentucky study found that the use of SPIN shortened the payback period for a residential PV system by three years.

SPIN collects large amounts of data on building energy consumption and uses weather forecasts to predict building loads and solar generation. Based on all this information, analytics optimize home or business use of grid energy, on-site solar production, energy storage, and EV charging to minimize consumer costs. For example, SPIN can automatically use solar generation and discharge batteries during peak demand when grid electricity is expensive. SPIN can disconnect

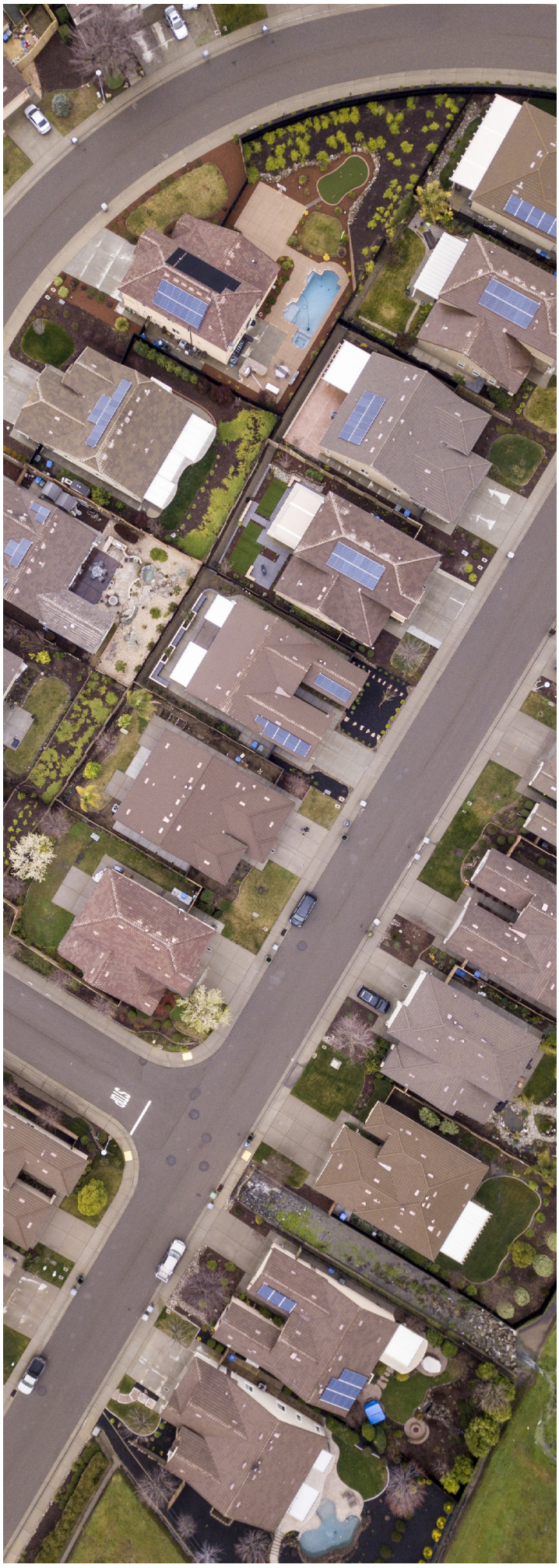
An artist's rendering of information that could be displayed on an app for customers who have installed SPIN. It shows the various energy resources and loads that SPIN monitors and controls. Image courtesy of Flex Power Control.

from the grid during a power outage and deliver electricity from vehicle batteries, other on-site storage, or rooftop solar. As batteries get larger, opportunities to deliver backup power increase.

"Customers typically only drive 30 to 40 miles each day," said EPRI's Chhaya. "Today's vehicles carry larger batteries with a range of up to 400 miles, so they're usually underutilized and can be used for power outages."

Additionally, SPIN enables power from EV batteries to be discharged and exported to the distribution grid. "With SPIN, vehicle batteries can potentially provide grid services that earn homeowners and business owners extra income," said Chhaya.

Flex Power Control is developing analytics and aggregation capabilities that enable the device to control the flow of power from solar, energy storage, and EV batteries to and from the distribution grid. SPIN can aggregate the various energy resources and loads at a home or business so that a utility can control them as a single resource in response to changing grid conditions (such as peak demand). Control over energy use, production, and discharge can lower bills for homeowners and business owners who pay time-of-use electricity rates.



Developing and Testing Prototypes

EPRI, the U.S. Department of Energy (DOE), the California Energy Commission, Oak Ridge National Laboratory, and the National Renewable Energy Laboratory have partnered with Flex Power Control on SPIN's development. EPRI's Technology Innovation Program funded work on an early design.

"EPRI was the first to see there was potential in the concept and engaged with us on numerous projects to help develop the technology and evaluate its performance in real-world settings," said Smith, president and CEO of Flex Power Control.

Since 2016, EPRI has worked with Flex Power Control on five development and demonstration projects. Early projects modeled the potential grid benefits and developed monitoring, communication, and control capabilities.

After initial positive results, DOE funded projects to develop an initial prototype and to test it in a California microgrid along with vehicle-to-grid technologies (devices that enable EVs to transmit power from their batteries to the grid). The prototype was built using commonly available electronics components rather than custom-built parts, and the tests demonstrated that SPIN could control the flow of power.

Based on the results, Flex Power has developed a more advanced prototype with additional functions. The next step is for DOE's Oak Ridge National Laboratory to test various functions, such as fast EV charging, delivering an EV battery's electricity to the grid, and directing rooftop solar and EV batteries to power a home during an outage.

Can SPIN help utilities reduce peak load? University of Kentucky researchers simulated a feeder with 70 houses, each equipped with SPIN, a 7-kilowatt PV system, a 10-kilowatt-hour energy storage system, and an EV charger. The result: SPIN reduced the feeder's peak load by 42%. Flex Power plans to examine peak load reductions in field demonstrations.

Other potential utility applications of SPIN include improving system resiliency, providing backup power for the home during severe weather, using excess solar generation to charge EVs, and aggregating and controlling DER.

If SPIN were to become commercially available, who would purchase it—utilities, consumers, or both? "Right now, we don't know," said Smith. "If the main value proposition is reducing the consumer's cost of energy and improving the consumer's resiliency, then the consumer will buy it. If it can help utilities manage their distribution systems, they may decide to install SPIN across their service territories."

According to Chhaya, one possible outcome is that homes and businesses install SPIN and utilities assist in those purchases through EV, storage, or PV incentive programs.

For more details on SPIN, contact EPRI's Sunil Chhaya (schhaya@epri.com, 650-855-2148).