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Energy Storage Power Electronics

By: Joe Schwartz



For decades, off-grid battery-based energy storage systems powered by PV or other renewable energy sources such as wind and small-scale hydroelectric turbines have been cost-effective for many rural and remote residences across the US. The financial case for deploying energy storage in residential grid-connected applications has been a more difficult one to make. However, technological advancements, constrained electric grids with high penetrations of PV systems and the gradual erosion of net energy metering programs across the US may usher in a new era for distributed, grid-connected energy storage systems.

Numerous manufacturers are banking on the expected proliferation of highly integrated, customer-sited energy storage systems. This article provides manufacturer and product line overviews for 14 power electronics and battery system vendors that are positioning themselves for the new energy storage market. Some of the companies, or current incarnations of them, were foundational to the US solar industry a decade before grid-tied systems began to gain popularity. Others are recent entrants to energy storage and solar energy. And a third group of established solar power electronics manufacturers are reimagining their products for modern energy storage applications.

Adara Power

Founded in 2013, Adara Power (formerly JuiceBox Energy) develops lithium-ion energy storage systems layered with monitoring and control software for peak shift, load shave and backup power applications. As of early June 2016, it has units

deployed in seven US states. Adara aims to ramp up the adoption of its energy storage technology in key markets, including Hawaii, Nevada and California, via its Adara Energy Storage System Certified Installer program.

At the core of Adara's 8.6 kWh residential Energy Storage System (ESS) are Samsung lithium nickel manganese cobalt oxide (NMC) cells, configured to operate at 50 Vdc nominal. Adara specifies a rated energy capacity of 8.6 kWh, 5.5 kW continuous power output and a round-trip battery charge and discharge cycle efficiency of 98%. Rated power at a C/2 discharge rate per the California Self-Generation Incentive Program (CA SGIP) is 4 kW. The Adara energy storage system uses a web-enabled interface that allows homeowners to monitor real-time and historical system performance. Integrators have access to 140 battery, inverter and charge controller parameters for remote system diagnostics. Safety protection includes over-voltage and over-temperature shutdown, three-level redundancy on over-voltage control, eight independent temperature measurements and autonomous operation of the product's safety systems if web connectivity is lost. The system's battery is certified to UL 1642, and has a specified minimum life of 10 years.

The Adara ESS is compatible with the Schneider Electric XW+ 5548 inverter/charger. Designs can dc- or ac-couple solar arrays to the Adara system. While system designers should verify available support and warranties for ac-coupling products from different manufacturers, integrators have deployed ac-coupled Adara systems with various string inverters, including products from SMA America and SolarEdge.

Adara Power • Milpitas, California • 844.223.2969 • adrapower.com

concept by US

Based in Pompano Beach, Florida, and founded in 2012, concept by US has developed a scalable utility-interactive energy storage system, the Powerstation 247, for residential and small business backup power and self-consumption applications. The product line is ETL listed to UL 1741. Concept by US reports that it designs and manufactures all the product's main components in house, with the exception of the system's lithium iron phosphate (LiFeYPO₄) batteries. This is a high degree of vertical integration for a relatively young company.

The Powerstation 247 integrates up to three 5 kW Powermodule hybrid inverters, MPP trackers, charge control, batteries and all required field wiring terminals, disconnects and overcurrent protection in a NEMA 1 enclosure intended for indoor environments. Regardless of the number of Powermodules it includes, the Powerstation 247 employs 17.28 kWh of battery storage configured for a nominal dc bus voltage of 96 Vdc (93–105 Vdc operating voltage range). The battery is ETL certified to UL 1642.

Each Powermodule includes two MPP trackers along with PV wiring terminals and disconnects integrated with the unit's enclosure. Electrical specifications for each PV input are 500 Vdc maximum, 180–500 Vdc operational voltage range, 240–400 Vdc MPPT range and 3,000 W maximum power per PV input channel. The Powerstation 247 is available with one, two or three Powermodules for ac power outputs of 5 kW, 10 kW and 15 kW, respectively. AC output in both grid-tie and stand-alone modes is 120/240 Vac. The Powerstation 247 has a 5-year warranty.

concept by US • Pompano Beach, Florida • powerstation247.com

Eguana Technologies

Eguana Technologies designs and manufactures power electronics for distributed smart grid and microgrid applications. Founded in 1999, Eguana initially focused on developing low-voltage inverters for utility-interactive fuel cell systems. It launched its first-generation Sunergy inverter in 2010 and second-generation Paralex inverter for thin-film PV applications in 2012. In 2014, Eguana introduced its Bi-Direx inverter for grid-tied energy storage systems. The inverter's initial target was the European energy storage market, where it shipped more than 4,000 units in 2014–2015. In 2015, Eguana launched the AC Battery, an integrated battery-ready power electronics platform for solar self-consumption and backup power applications, in the North American market.

The flexibility of Eguana's AC Battery system allows for integration with diverse storage technologies that include LG Chem's lithium-ion batteries, Aquion Energy's saltwater electrolyte Aqueous Hybrid Ion products and Primus Power's flow batteries, as well as VRLA lead-acid battery models from various manufacturers. Eguana manufactures five Bi-Direx inverter models. Developed for the US market and certified to UL 1741, the B5048US model is designed to integrate with 120/240 Vac 60 Hz electrical services. On the dc side, the B5048US has a nominal voltage of 48 Vdc and an operating range of 40–66 Vdc.

The standard AC Battery configuration couples Eguana's Bi-Direx inverter with LG Chem M4860P2S2 lithium-ion batteries configured at 48 Vdc nominal (42–58 Vdc operating range) for use with the AC Battery product. Five battery storage system capacities are available with ratings at C/1 of 6 kWh, 9 kWh, 12 kWh, 15 kWh and 18 kWh. The batteries are rated for 4,000 cycles at 90% depth of discharge (DOD), 25°C and C/1. Users can ac-couple solar arrays to the system via third-party string or microinverters, which perform system MPP tracking and array dc-to-ac conversion. The system's SunSpec-compliant Modbus communications interface integrates with third-party energy management systems and gateways that enable self-consumption functionality. Eguana Technologies' AC Battery carries a standard 10-year warranty.

Eguana Technologies • Calgary, Alberta, Canada • 403.508.7177 • eguanatech.com

Enphase Energy

Founded in 2006, Enphase Energy is largely responsible for creating the modern microinverter product class. With an eye toward current and projected changes in net energy metering programs and policies that limit exporting solar energy to the grid in the US and beyond, Enphase developed its AC Battery for global markets that benefit from or require self-consumption functionality or energy time-of-use optimization. After announcing the product in October 2015, Enphase began marketing the current design in February 2016 and expects US availability in late 2016.

The AC Battery is a scalable, modular energy storage system. Designs can ac couple it with Enphase's microinverters and module-level online monitoring platform. Enphase also designed the AC Battery for compatibility with any grid-tied system, regardless of the brand and model of a given system's inverter or modules, with the addition of its Envoy-S Metered gateway and Enlighten monitoring products.

The Enphase AC Battery uses lithium iron phosphate cells configured to provide 1.2 kWh of capacity. It can discharge to greater than 95% of rated capacity and has a round-trip cell efficiency specification of 96%. Weighing only 55 pounds, the AC Battery is designed for single-person installation and interconnection with standard household wiring. Its enclosure is NEMA 2 rated for indoor installation in an unoccupied space. Certifications to UL 1741, UL 1973 and UL 9540 are pending. The AC Battery carries a 10-year or 7,300 cycle warranty for greater than 80% of its initial rated capacity.

Enphase Energy • Petaluma, California • 877.797.4743 • enphase.com

Fronius USA

Founded in 1945 in Pettenbach, Austria, as a welding equipment manufacturer, Fronius today focuses on products and systems for welding, battery charging and solar energy applications. Fronius USA is headquartered in Portage, Indiana, where it develops and manufactures string inverters and related equipment for the US solar market. In 2014, Fronius began rolling out its SnapInverter generation of single and 3-phase string inverters for solar projects in North America.

Fronius gained its early experience with power electronics for energy storage applications in the European self-consumption market, where the company combined its long history in battery charging– equipment design and manufacturing with its solar product development efforts. With established availability in Europe, the Fronius Energy Package includes a Fronius Symo Hybrid multiport inverter, a lithium iron phosphate Fronius Solar Battery and a Fronius Smart Meter to monitor system energy flow.

In 2015, Fronius shared the headlines with Tesla as one of two inverter manufacturers developing a high–dc-voltage multiport inverter for integration with Tesla's Powerwall Home Battery. Fronius' initial relationship with Tesla stems from the welding systems it supplies for manufacturing Tesla electric vehicles. Scheduled for a Q4 2016 release, Fronius' first dc-coupled storage system for the US market is its multiport Primo Hybrid. The Tesla-compatible inverter will be available in power classes ranging from 5 kWac to 11.4 kWac and will feature three dc inputs: two solar MPP trackers and one battery input. The MPP trackers' input voltage range is 80–600 Vdc. For seamless integration with Tesla's Powerwall battery, the inverter's dc bus operates at 350–450 Vdc. Both the Fronius Primo Hybrid inverter and the Tesla Powerwall battery are rated for outdoor installations.

Fronius has also partnered with JLM Energy to integrate Fronius inverters with JLM's lithium iron phosphate battery systems, as well as its products that monitor and control self-consumption and energy time-of-use optimization. JLM's battery products and the Fronius inverters communicate via the SunSpec-compliant Modbus RTU interface. JLM's residential solutions couple Fronius' standard Primo inverter with JLM's Energizr 200 storage system to create an integrated system for self-consumption, peak shaving and load shifting applications.

Fronius USA • Portage, Indiana • 219.734.5500 • fronius-usa.com

JLM Energy

Based in Rocklin, California, JLM Energy designs and manufactures products for energy storage, management and control. It specializes in proprietary software developed in-house for automation and component integration. Founded in 2011, JLM Energy has two core products for residential applications—the Energizr 100 and the Energizr 200. Both use specific configurations of the JLM Battery Pack. Each lithium iron phosphate (LiFePO₄) battery pack has a nominal voltage of 52 Vdc, a nominal capacity of 50 Ah, and an operating voltage range of 40–57.6 Vdc. JLM specifies a cycle life of 3,000 cycles at 80% DOD and discharge under 25°C, and a cycle life of 5,000 cycles at 50% DOD and discharge under 25°C. The Energizr 100 uses four Battery Packs configured in parallel for a nominal operating voltage of 52 Vdc and a capacity of 10.4 kWh. The higher-capacity Energizr 200 accommodates up to eight Battery Packs in series for a nominal voltage of 416 Vdc and a storage capacity of 20.8 kWh.

JLM developed the Energizr 100 primarily as a grid-independent system for backup power applications. Its design allows installers to integrate the battery system with a residence's grid-direct PV system string inverter, electrical loads, the utility grid and even a backup ac generator. During a utility outage, the product creates a local microgrid that allows the grid-tied inverter to continue to generate energy for battery charging. If the grid is unavailable and the battery is at a full state of charge, the Energizr 100 regulates battery charging. In backup mode, the product has a continuous output power rating of 4,400 W and a 5-second surge of 8,500 W. The Energizr 100 is also compatible with AGM, gel and flooded lead-acid battery types. Measurz, JLM Energy's cloud-based monitoring platform, monitors the system in real time.

The more feature-rich Energizr 200 offers peak load shaving and integrated support for smart thermostats, real-time whole-house power measurement and load control. JLM's Measurz software analyzes user habits and provides efficiency recommendations for homeowners. The mobile app enables remote control of appliances, including HVAC systems and smart thermostats.

JLM Energy • Rocklin, California • 916.304.1603 • jlmei.com

Magnum Energy

Magnum Energy, founded in 2006, designs and manufactures inverter/chargers for mobile, marine, off-grid and backup power applications, as well as PV charge controllers, component integration panels and system monitoring equipment. The company's DNA goes back to the formation of Trace Engineering in Arlington, Washington, in 1984. In 2014, Sensata Technologies, a supplier of sensing, electrical protection, control and power management solutions, acquired Magnum.

Magnum was the first manufacturer to offer inverter/charger models with split-phase 120/240 Vac output in the US. Magnum designed its MS-PAE series of inverter/chargers to connect to the grid for ac battery charging, but never chose to develop utility-interactive models that export power to the utility grid without the integration of an ac-coupled third-party string or microinverter system. In hindsight, this was an interesting choice given the current shift to non-exporting PV systems in some US markets.

The MS-PAE 120/240 Vac series inverter/chargers are available in 24 Vdc and 48 Vdc nominal versions. The 48 Vdc MS-4448PAE model has a continuous power rating of 4,400 W and surge capability to power larger inductive loads such as well pumps. The MS4448PAE has a 5-second surge rating of 8,500 W, a 30-second surge rating of 6,000 W, a 5-minute surge rating of 5,400 W and a 100-millisecond surge current rating of 40 Aac line-to-line. In 2015, Magnum launched its PT-100 solar charge controller, which is compatible with 12, 24 and 48 Vdc nominal battery systems and has a maximum output power rating of 6,600 W. Its maximum input voltage is the lower value of either 200 Vdc plus battery voltage or 240 Vdc. The PT-100 controller also provides GFDI and AFCI circuit protection. Magnum offers an extensive line of prewired Magnum Panels and accessories for component integration.

In 2016, Magnum announced its MicroGT 500 microinverter. Designed for integration with the company's battery-based inverter/charger systems, as well as for use in grid-direct power export applications, the MicroGT 500 communicates seamlessly with Magnum Energy battery-based inverters in ac-coupled mode to taper charging based on temperature-compensated battery state of charge (SOC) parameters. Each dual-MPPT microinverter supports two PV modules. Magnum's ECU communication interface allows system owners and integrators to monitor system PV production via a web-based dashboard.

Magnum Energy • Everett, Washington • 425.353.8833 • magnum-dimensions.com

OutBack Power

OutBack Power is a manufacturer of power electronics for battery-based renewable energy applications including solar, wind, microhydro and utility-interactive systems. Engineers integral to the early success of Trace Engineering—and the company's SW series inverter/charger that became an early staple for battery-based renewable energy, backup and utility-interactive systems—launched OutBack in 2001. In 2010, the Alpha Group acquired OutBack Power.

OutBack's flagship power conversion products, the FX series inverter/charger and MX series solar charge controllers, have evolved over the years. The current FXR/VXFR series of grid/hybrid inverter/chargers offer stand-alone, backup and utility-interactive solar export functionality. The FXR/VXFR line features seven operational modes, including GridZero, which prioritizes the use of battery or renewable sources to power loads and uses renewable energy sources such as PV only to recharge a system's battery pack. An Advanced Battery Charging profile option supports lithium-ion battery technologies. The 60 A and 80 A FLEXmax models, the successors to OutBack's original MX60 MPPT solar charge controllers, operate at dc voltages up to 150 Vdc.

In 2011, OutBack released its Radian series of hybrid, utility-interactive split-phase 120/240 Vac inverter/chargers. Available in 4,000 W and 8,000 W power classes, the Radian features two ac inputs for grid and ac generator connectivity. The 8,000 W GS8048A and the 4,000 W GS4048A have a 100-millisecond maximum output current rating of 70.7 Aac and 35.4 Aac, respectively. These models also include OutBack's GridZero mode and Advanced Battery Charging option.

Since its launch, OutBack has focused development efforts on system integration packages that allow prewiring and testing at certified facilities to reduce installation time and complexity in the field. OutBack's current SystemEdge prebundled equipment packages build on this early component integration focus. With the introduction of four VRLA storage batteries optimized for specific applications such as float service or regular deep cycling, as well as integration with its power conversion equipment, OutBack now offers an extensive product family for energy storage applications listed to the relevant UL standards from end to end.

OutBack Power • Arlington, Washington • 360.435.6030 • outbackpower.com

Pika Energy

Headquartered in Westbrook, Maine, and founded in 2010, Pika Energy manufactures bidirectional inverters, solar charge controllers, substring solar optimizers and small wind turbines. Pika's patented bidirectional REbus DC nanogrid, a 380 Vdc (360–440 Vdc operating range) dc bus, enables power transmission, control and data functions to share the same conductors via powerline carrier communication (PLC). Pika Energy developed its Pika Energy Island system to provide residences and small businesses with a single inverter solution for backup power, self-consumption and demand charge reduction functionality. The Energy Island uses two Pika products, its X7601 Islanding Inverter and Pika's PV Link dc optimizer, as building blocks for the system.

The Pika Energy X7601 is a 7.6 kW bidirectional inverter that connects PV, energy storage, electrical loads and the grid, and supports 120/240 Vac critical loads without requiring an autoformer. Pika designed its inverter to leverage the efficiency advantages provided by a high-voltage 380 Vdc bus used in conjunction with lithium-ion batteries. However, the inverter can also integrate with 48 Vdc nominal lead acid batteries as well as Aquion Energy's AHI energy storage products. The X7601 inverter has a power rating of 7,600 W in grid-export mode and an 8,000 W continuous power rating with a 12 kW 10-second surge in stand-alone mode. It is certified to UL 1741, meets Rule 21 requirements and carries a 10-year standard warranty extendable to 20 years.

Pika Energy's PV Link S2501 subarray PV optimizer supports the creation of 380 Vdc nominal arrays compatible with its 7.6 kW bidirectional inverter and 380 Vdc system bus. The PV Link can interconnect two to nine modules to create subarrays of up to 2,500 W. The product is rapid-shutdown compliant and provides MPP tracking (60–360 Vmp range), shade mitigation, ground-fault protection, arc-fault protection and substring monitoring via PLC. Pika Energy backs its PV Link subarray optimizers with a 25-year limited warranty.

Pika Energy • Westbrook, Maine • 207.887.9105 • pika-energy.com

Schneider Electric

Schneider Electric's roots date back to 1836 when two brothers, Adolphe and Eugene Schneider, acquired mines, forges and foundries and became part of the Industrial Revolution. At the time, the company's main markets were heavy industry, railroads and shipbuilding. Today, Schneider Electric is a global manufacturer of power distribution and automation systems. Headquartered in Rueil-Malmaison, France, Schneider entered the solar industry with its 2008 acquisition of Xantrex Technology (Xantrex acquired Trace Engineering in 2000).

Schneider offers two inverter/charger lines suitable for residential energy storage applications. For nonexport systems, its Conext SW-NA hybrid inverter/charger line offers models with nominal dc input voltage of 24 Vdc or 48 Vdc and continuous output power classes of 2,400 W and 3,400 W at 24 Vdc and 3,800 W at 48 Vdc. The inverter/chargers have split-phase 120/240 Vac output and are compatible with flooded and VRLA lead-acid battery types. The Conext SW-NA supports ac- and dc-coupled configurations and enables grid backup, self-consumption with solar prioritization, peak shaving and ac engine generator assist.

The more feature-rich utility-interactive Schneider Conext XW+ NA inverter/charger line was one of the first to support integration of lithium-ion battery types. As such, complete energy storage hardware and software solutions from other vendors commonly integrate with this equipment. Like Schneider's Conext SW-NA inverter/chargers, the Conext XW+ NA supports ac- and dc-coupled configurations and enables grid backup, self-consumption with solar prioritization, peak shaving and ac engine generator assist. It can also export power to the utility grid.

Schneider offers system integration panels for its inverter/chargers, as well as two MPPT solar charge controllers that customers can network with the overall power electronics system. The MPPT 60 150 controller has a maximum PV array open-circuit voltage rating of 150 Voc and a maximum output power rating of 3,500 W. The MPPT 80 600 model has a maximum PV array open-circuit voltage rating of 600 Voc and a maximum output power rating of 4,800 W at 48 Vdc nominal. Schneider Electric's MPPT charge controllers carry a standard 5-year warranty. Its Conext SW-NA and XW+ inverter/chargers carry a 2- to 5-year warranty, depending on the country of installation.

Schneider Electric • Andover, Massachusetts • solar.schneider-electric.com

SMA America

Founded in 1981, SMA Solar Technology has its global headquarters in Niestetal, Germany, and its US division is headquartered in Rocklin, California, with a US production facility in Denver. SMA was the first manufacturer to offer high-voltage string inverter models in the US market. It also pioneered the use of ac-coupling grid-direct string inverters with battery-based inverters and energy storage, a configuration common to many of the systems highlighted in this article. SMA has significant experience with self-consumption and energy storage systems in Europe and plans to offer additional equipment, such as its Energy Meter, in the US as markets develop.

SMA America offers single-phase Sunny Boy string inverter models, in power classes from 3,000 W to 11,000 W, that are suitable for ac-coupled residential PV applications. It also offers two models of its Sunny Island battery-based inverter/chargers—the 4548-US and 6048-US, with rated power outputs of 4,500 W and 5,750 W, respectively. SMA designed both models for operation with 48 Vdc nominal battery banks. They are compatible with lead-acid, nickel-cadmium and lithium-ion battery types as well as external battery management systems. Sunny Island inverter/chargers have single-phase 120 Vac output. Split-phase 120/240 Vac applications require two Sunny Island inverters or an autoformer.

In ac-coupled utility-interactive systems where one or more Sunny Boy inverters are connected to the ac side of a battery-based Sunny Island system, the Sunny Island limits string inverter output power via frequency shift if the batteries are at a full state of charge and the grid is unavailable. The Sunny Boy string inverter identifies and analyzes the frequency adjustment. When the power frequency increases and exceeds a defined value, the Sunny Boy limits its power accordingly. The result is well-regulated and optimized battery charging.

SMA plans to release a high-voltage Tesla-compatible battery-based inverter for the US market in early 2017. Coupled with SMA's energy-management platform, the power electronics and storage energy solution will enable streamlined integration with existing PV systems as well as cost-effective new solar-plus-storage projects.

SMA America • Rocklin, California • 916.625.0870 • sma-america.com

SolarEdge Technologies

Founded in 2006, SolarEdge Technologies began commercial shipments of its string inverter, module-level dc optimizer and monitoring systems in 2010. The company's global headquarters are in Herzliya, Israel, and its US division is headquartered in Fremont, California. SolarEdge was one of two inverter manufacturers participating in the PR wave that announced Tesla's lithium-ion Powerwall Home Battery and is the first inverter manufacturer to have fielded Powerwall systems in the US.

SolarEdge's single-inverter StorEdge system has four primary components. The system's single-phase StorEdge dual-port inverter and Connection Unit functions as an optimized PV inverter that also provides power conversion and management for battery charging. Tesla's 6.4 kWh lithium-ion Powerwall Home Battery provides energy storage. A 120/240 Vac split-phase autoformer performs phase load balancing in StorEdge systems configured for backup power during grid interruptions. Finally, the addition of SolarEdge's Electricity Meter enables smart energy management functionality that includes export power control, time-of-use shifting, maximized self-consumption, demand response and peak shaving capabilities.

The StorEdge inverter for the US market, model SE7600A-USS, has a rated ac power output of 7,600 W and a maximum ac power output of 8,350 W when feeding electrical loads or exporting to the grid. In backup mode, it has a rated power output of 5,000 W and a maximum 10-second ac surge rating of 7,600 W. The inverter's nominal dc bus voltage is 400 Vdc. SolarEdge's StorEdge inverter and module-level dc optimizers provide NEC 2014 Section 690.12 rapid-shutdown functionality for the PV array and battery. StorEdge system's Electricity Meter carries a 5-year warranty. Its autoformer and inverter carry a 12-year warranty, with an option to extend that to 25 years on the StorEdge inverter.

SolarEdge Technologies • Fremont, California • 510.498.3200 • solaredge.com

sonnen

With corporate headquarters in Bavaria, Germany, and US headquarters in Los Angeles, sonnen has deployed more than 10,000 of its sonnenBatterie-integrated energy storage systems, primarily in European self-consumption markets. Founded in 2008, sonnen announced availability of its sonnenBatterie eco and sonnenBatterie pro models for the US market in December 2015. One element of sonnen's long-term vision for its business is a virtual power plant model, the sonnenCommunity, that aggregates customer-sited sonnen energy storage systems and monetizes the pooled stored energy capacity and associated grid resources.

The sonnenBatterie eco energy storage solution, designed for residential self-consumption and grid backup applications, integrates power electronics, Sony Fortelion lithium iron phosphate (LiFePO₄) cells, and proprietary management and monitoring software. The eco comes in seven energy storage capacity options, ranging from 4 kWh (eco 4 model) to 16 kWh (eco 16 model) in 2 kWh increments, with a usable capacity based on a 100% cell DOD. sonnen has configured the lithium iron phosphate cells for a low-voltage dc bus with an operational range of 48–56 Vdc. The company warrants the eco system's batteries for 10 years or 10,000 cycles.

The eco system has a split-phase 120/240 Vac output and can be ac coupled with existing or new PV installations. In stand-alone mode, the eco 4 through eco 8 models have a 100-millisecond maximum power rating of 8,500 W and a 5-second maximum power rating of 6,000 W. The higher-capacity models, the eco 10 through eco 16, have a 100-millisecond maximum power rating of 17,000 W and a 5-second maximum power rating of 12,000 W. Non-revenue grade PV and load metering is standard. The sonnenBatterie eco system's power electronics are certified to UL 1741 and carry a 10-year standard warranty.

sonnen • Los Angeles • 310.853.2404 • sonnen-batterie.com

Sunverge

Headquartered in San Francisco, Sunverge was founded in 2009. In February 2016, it announced its second-generation Solar Integration System (SIS) energy storage platform, with a streamlined design, more battery options and greater system intelligence than the original SIS. While other vendors offer fully integrated system packages for residential and small business storage systems that couple power electronics with lithium-ion batteries and are certified to the relevant UL standards, Sunverge has a forward-looking vision for its SIS product, with the goal of aggregating reserve energy from every SIS system under management and pooling it in the cloud. The resulting virtual power plants of cloud-aggregated SIS units would provide utilities and third parties a pooled resource they could monetize and use to balance grid demands.

Sunverge's current SIS product integrates lithium-ion batteries, power electronics and cloud-based management software in a single enclosure with options for indoor or outdoor installation. It supports multiple lithium-ion battery chemistries and storage capacities from 6 kWh to 25 kWh. For residential installations, its power electronics package interconnects with split-phase 120/240 Vac services. It is designed to ac-couple existing or new PV systems of up to 8 kWdc, with options to support larger secondary systems. Operational modes include backup, self-consumption, self-consumption with grid leveling, time-of-use optimization and peak shifting. The Sunverge SIS is certified to UL 1741 and UL 1778 and carries a 10-year standard warranty.

Sunverge • San Francisco • 415.795.3660 • sunverge.com

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