EcoStruxure™
Innovation At Every Level

Microgrids maximize value from solar power – on and off the grid

Empower solar-only facilities with microgrid solutions that enable cost savings, business continuity, and resilience

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Life Is On | Schneider Electric

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The limits of solar-only facilities

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Companies with solar energy systems are choosing to reduce fossil fuel consumption and minimize the carbon footprint of their operations. Still, many pay a high price for relying on a system that cannot operate when the electric utility grid is down.

While they capture the benefit of lower emissions and reduce the cost of electricity consumed, many do not realize the full investment value because of disruption costs that stem from utility grid dependence.

Unfortunately, many companies that install only solar power at their facilities do not realize they need a voltage and frequency reference to use solar panels during grid outages to protect their business from power loss.

Without a local, independently functioning grid-forming resource, solar-powered systems do not have the voltage and frequency reference necessary to generate power during a utility system outage.

This is not just an inconvenience, as the lack of business resilience comes at a significant cost. According to recent estimates by the United States Department of Energy, outages amount to approximately $150 billion in losses to businesses each year.

383
U.S. electrical grid disturbances in 2020

Source: U.S. Department of Energy, Electrical Disturbance Events Annual Summaries

$150 billion
annual cost of electricity blackouts for U.S. businesses

Source: U.S. Department of Energy by Litos Strategic Communication

What happens when the grid goes down?

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The most essential piece of equipment in a solar energy system is the inverter, which converts direct current (D.C.) electricity generated by the solar panels to alternating current (A.C.) electricity used on the electrical grid. An inverter can only create a current with a stable voltage and frequency reference, which it gets from the utility grid. When grid access is interrupted, the solar inverter loses its reference point, which signals the inverter and entire solar array to shut down.

This is a safety procedure to satisfy code UL 1741 SA, which requires a facility to break contact with the grid in the case of an outage so there is no transmission of power onto lines that could require maintenance or repair. While it protects linemen from injury, it also means the solar-powered facility is entirely without power unless a microgrid is in place. In short, the facility experiences a blackout.

Business continuity requires uninterrupted access to power. By leveraging microgrid technologies, previously grid-tied solar-only systems can provide that for the critical businesses they power.

What is a microgrid?

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A microgrid is a group of interconnected loads and distributed energy resources (DERs) within clearly defined electrical boundaries that act as a single controllable entity for the grid.

With a microgrid, when the power goes down on the utility grid, a microgrid controller behind the meter senses the disruption and disconnects from the grid in an islanding process, **see Figure 1**.

When the facility becomes an "island," the anchor source (battery or generator) goes into grid-forming mode. It provides the stable voltage and frequency reference needed for the solar inverter. The solar system synchronizes to the grid formed by the anchor resource and can now generate usable electricity again. When the utility service is restored, the system transitions back to the grid, ending reliance on the anchor resource.

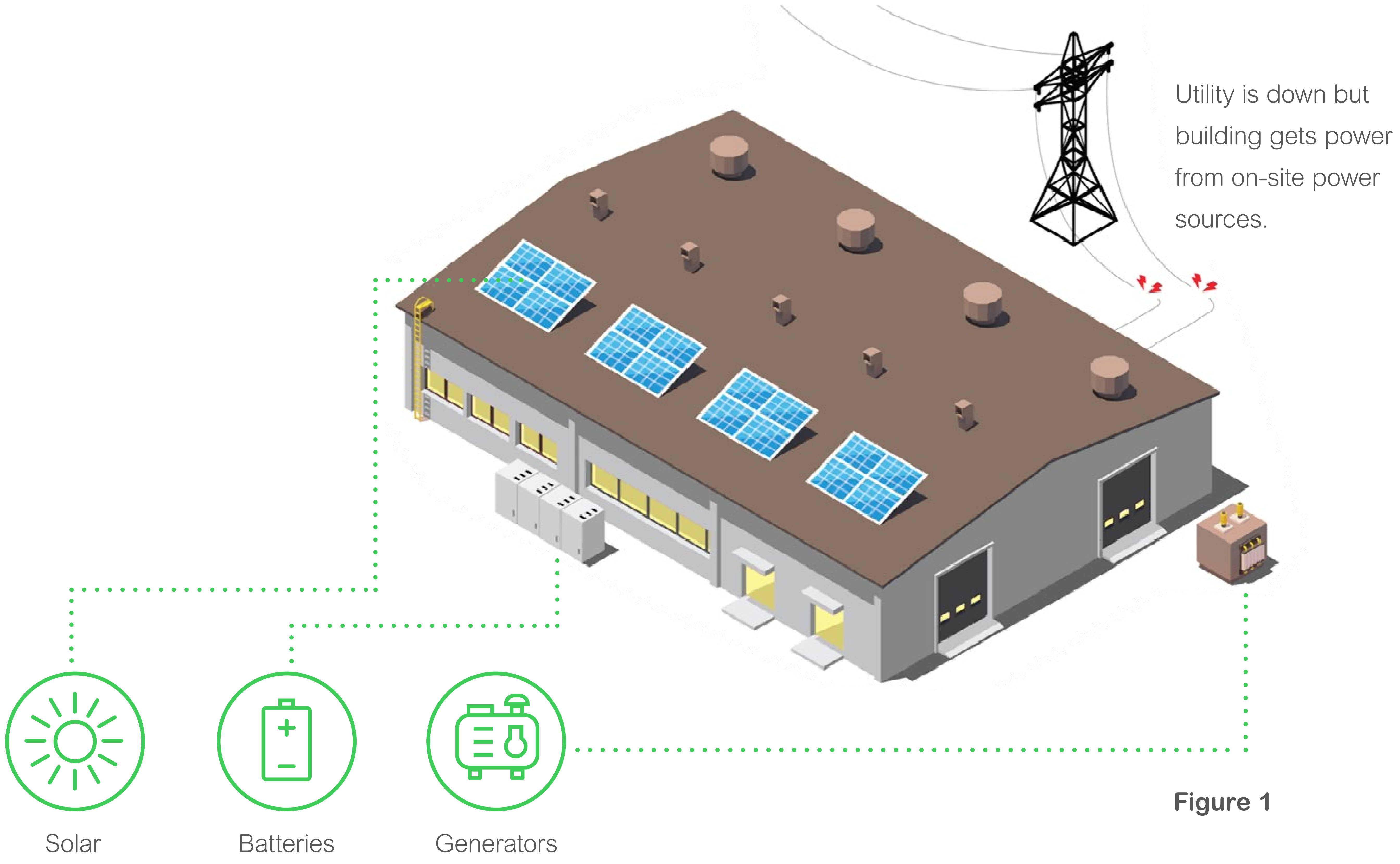


Figure 1

Separating from the grid

Separating from the grid

The ability to automatically disconnect and reconnect to the utility (or macro) grid is essential for operating a microgrid. Still, upgrades to existing electrical infrastructure are sometimes needed to achieve this ability.

Every facility has a main circuit breaker or fusible switch that protects the downstream equipment from dangerous over-current and short-circuit scenarios, see **Figure 2**. In most cases, this device is not equipped with the proper components for a microgrid controller to achieve automated islanding by remotely opening and closing the device.

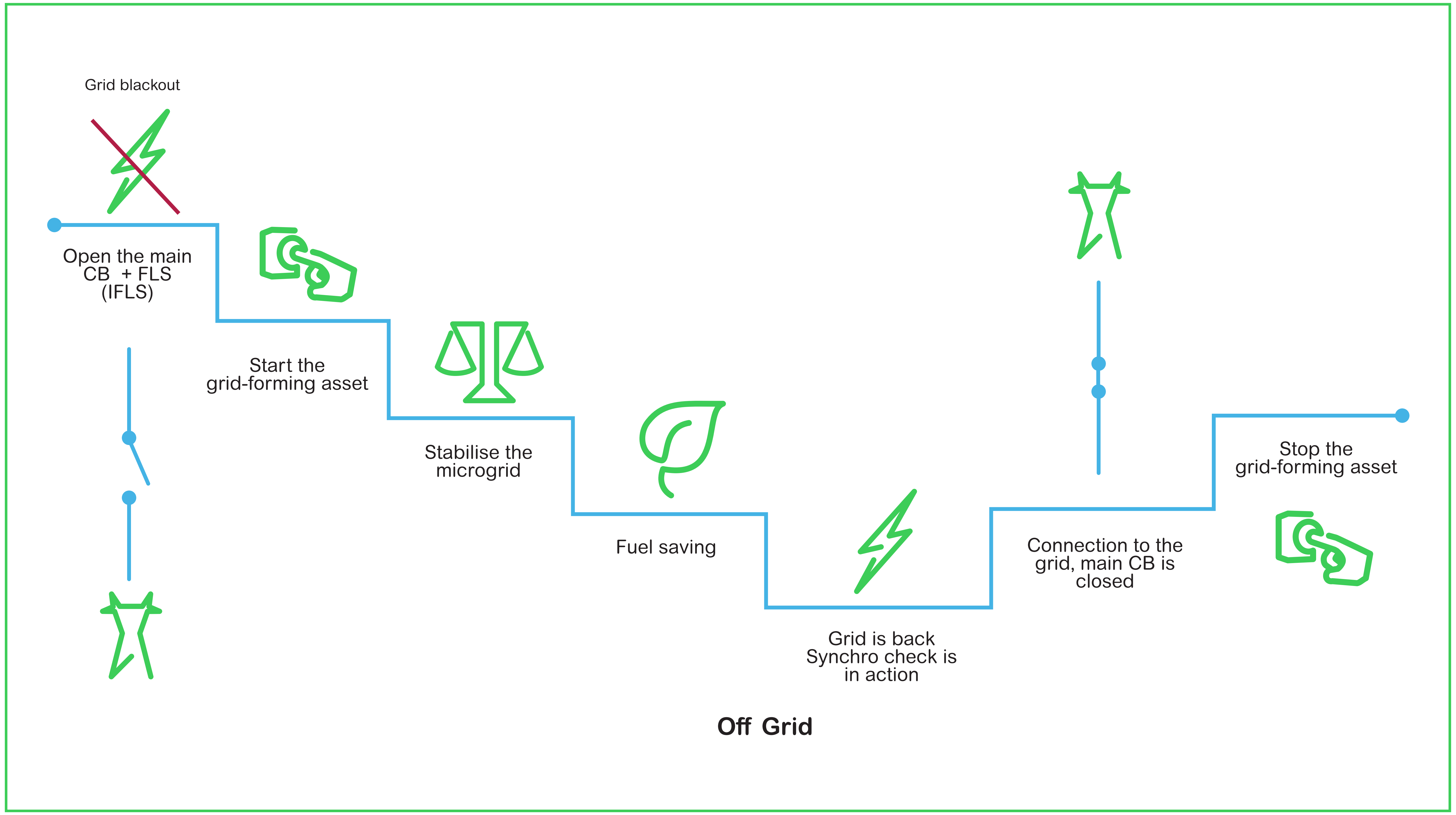


Figure 2

Well-designed buildings are structured with loads organized onto circuits of differing priorities, so the most critical loads are supported during an outage, less essential loads are supported when excess power is available, and nonessential loads can be shed. Retrofitting circuit breakers allows them to open and close so the most critical circuits remain closed (on), and other circuits can be open (shed).

In buildings that use a backup generator, transfer switches automatically pivot from the utility position to the generator position using the voltage reference from the DER. Still, this approach does not natively allow using excess generation to meet additional loads.

Understanding the loads and their configuration in the site electrical is critical.

- For recently constructed buildings, this information comes from as-built electrical diagrams.
- For older buildings, official drawings are often inaccurate, and a site audit must assess the electrical system layout.

When all the details of the layout and the loads are confirmed, the microgrid control system must be able to coordinate solar power generation and the anchor resource. The overarching controller ensures the generating resources are balanced to meet the facility's demand and allows the site to reconnect to the utility grid once the service is restored automatically.

Three fundamental elements enable solar power usage when the grid goes down

1. A breaker or switch that allows the facility to disconnect from the grid to safely use locally generated electricity
2. An anchor resource such as a Battery Energy Storage System (BESS) that can establish a voltage and frequency reference on-site
3. A control system that enables the solar and anchor resource to work together

The value of a BESS in a microgrid

The value of a BESS in a microgrid

Although a generator can deliver power to keep a solar-only facility running, it is not the most environmentally sustainable solution. Generators require fuel and produce greenhouse gas emissions. And while they produce energy, they do not allow the owner to derive full value from the solar energy produced.

Using a battery energy storage system (BESS) instead of a generator improves uptime.

A BESS enables on-site power generation in islanding mode and can improve site economics by making what is usually a stranded asset, like a generator, into a flexible resource. A BESS can:

- Recharge
- Provide power based on demand and peak usage
- Deliver supplemental power when there is insufficient capacity from the grid

Using solar energy to charge a BESS also allows U.S. companies to take advantage of the Federal Solar Investment Tax Credit. Recent decisions by the U.S. Federal Energy Regulation Commission (FERC) lay the groundwork for BESSs to participate in frequency regulation and wholesale energy markets.

A BESS can be a game-changer, but making the transition is not straightforward.

A battery is not a one-to-one replacement for a generator, so the challenge in incorporating a BESS lies in identifying the correct type and size of battery or batteries and what changes need to be made to the electrical system to deliver the most significant benefit.

The cost of making a wrong choice can be high. Hence, the most effective approach involves an experienced partner, like Schneider Electric, that can simplify selection based on a site-specific loading analysis.

A BESS delivers benefits beyond functioning as a backup when the grid goes down

Using a BESS as an anchor source when islanding not only enables the full use of solar energy and stabilizes the microgrid, it also provides considerable value during normal grid-tied operations, including:

Cost savings

- **Demand charge reduction** – Demand charges can make up 50-70% of a facility's energy bill. Reducing peak demand can save 10-20% on energy costs. Charging a BESS during off-peak rate hours and discharging it during mid- or high-peak hours optimizes grid use and saves money.

- **Renewable self consumption** – A BESS can store solar energy on-site when local consumption outstrips renewable output. Charging a BESS using solar energy allows companies to take advantage of the federal solar Investment Tax Credit.

- **Incremental power** – More companies are using electric vehicles which means they need more charging stations at increasingly higher power levels that sometimes exceed what is available from the utility service. A BESS can provide additional power while at the same time reducing site demand charges.

Supplemental income

- **Ancillary market participation** – Several U.S. FERC orders lay the foundation for a BESS to participate in frequency regulation and wholesale energy markets.

- **Demand Response** – a BESS allows companies to participate in Demand Response programs to alleviate demand on the utility grid.

Resilience

- **Solar smoothing** – A BESS evens out power intermittencies to provide a steadier output when there are disruptions to solar energy production.

The path to independence: how to get from here to there

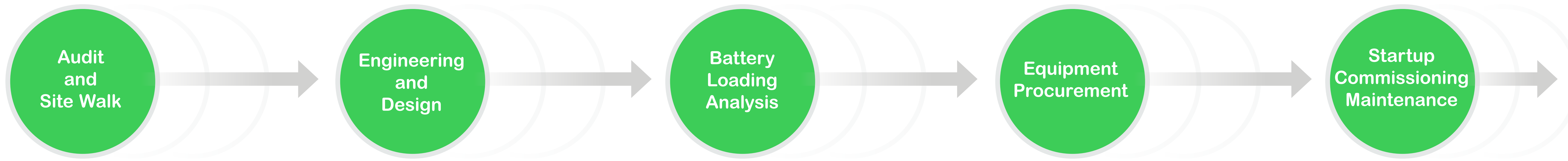
The path to independence: how to get from here to there

Designing and installing a microgrid is complicated and requires specialized knowledge and equipment.

However, with the right partner, companies can leave a world of unmanaged downtime and disruptions and enter one where they can manage energy production and consumption to achieve optimal operations.

Experts at Schneider Electric have the experience to help make solar-only systems into robust microgrids.

That five step journey begins with a site audit and feasibility study followed by front-end engineering and design (FEED), battery loading analysis, equipment procurement, startup and commissioning, and ongoing maintenance.



Conduct audit, site walk, and assessment of microgrid needs

Determine if facility requires a retrofit or needs an upgrade. Complete Front End Engineering and Design.

BESS loading analysis

Procure electrical distribution equipment, BESS, and controls

Install and commission system followed by annual preventative maintenance and islanding tests.

Step 1. Audit and site walk

An audit begins with site-specific information-gathering to understand how the microgrid needs to perform.

This assessment provides the information experts need to determine how to construct the microgrid based on historical solar potential production, the utility grid the facility is on, and local tax incentives.

Typically, a team reviews 12 months of utility bills to understand annual consumption, seasonality, and peak usage, see **Figure 3**. Using 15-minute interval data (provided by the facility or the utility) enables insights into high-volume periods and a clearer picture of demands placed on the microgrid.

The next step is a physical site walk and assessment, during which the team dives deeper into power usage to better understand the critical and non-critical loads. Electrical gear is inspected, and experts look into sources and loads to know how the sources are connected. The team works with site electricians to understand the loads required to provide appropriate resilience based on facility needs during grid power disruptions.

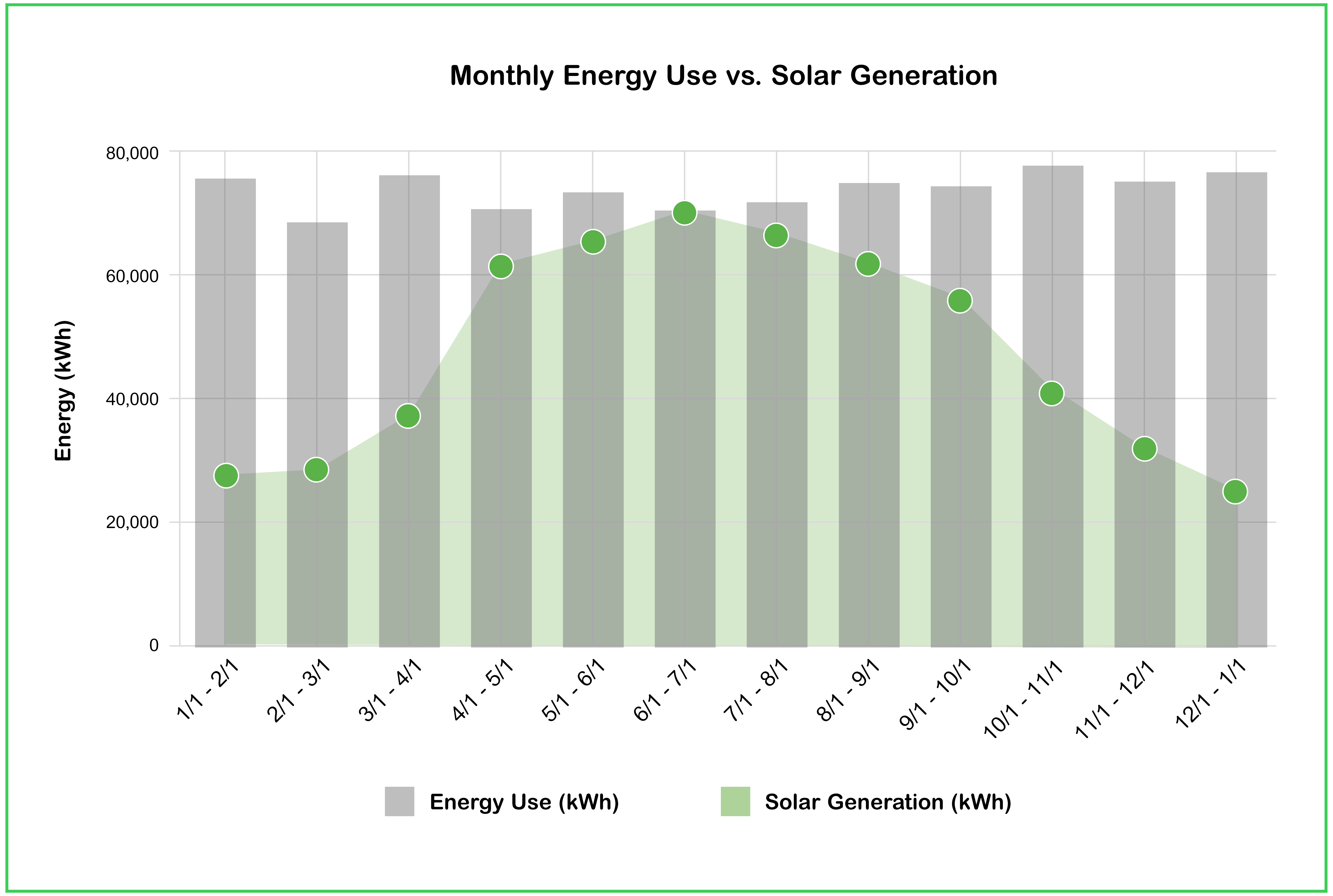


Figure 3

Step 2. Engineering and design

Once the audit is complete, **the information gathered determines how to add and connect the new DER with the solar PV system**.

Will it be possible to retrofit/upgrade or will new switchgear be required to integrate the DER and manage the anticipated loads?

The Schneider Electric team delineates how the facility operates in grid-tied mode and what happens when the grid goes down. The plan is developed for protection and controls to automate operations in grid-tied and islanded mode to meet specific use cases required by the facility (including goals and key performance indicators). The team builds in digital solutions from the outset that include measurement and verification to provide performance metrics for the system.

The final step of the FEED process is to develop plans for ongoing monitoring and condition-based maintenance.

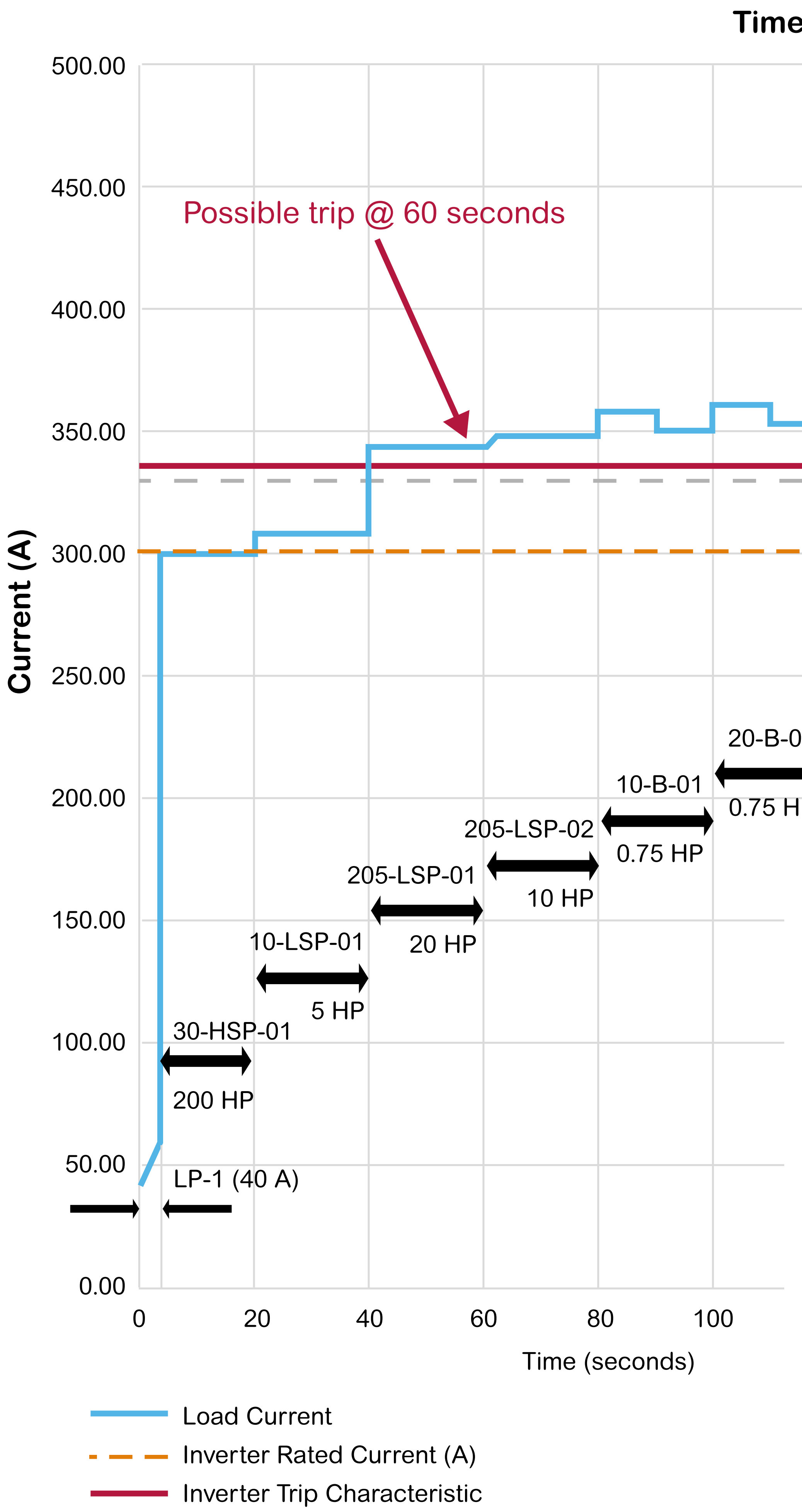
Step 3. Battery loading analysis

Creating a microgrid is not as simple as connecting a battery via a breaker. Because a BESS is an inverter-based resource, it does not perform the same way a generator (non-inverter-based) does with very different load-step curves and inrush current tolerance. This makes a loading analysis essential when using a battery to establish a microgrid.

The analysis determines the capabilities of the BESS for conditions, including energization sequence of site loads from a no-load state (black start), duration of time power can be supplied, inverter overload limit, real/reactive power limits, and current unbalance limits, see **Figure 4**. The results inform the BESS load management strategy during the island mode.

The Schneider Electric team helps determine the battery make, mix, and type to maintain operations when power is out. Batteries can differ in their chemistries, which impacts how they behave. Some battery chemistries are better at delivering power over a longer period, whereas others effectively provide substantial power quantity over a short time interval.

Understanding these nuances is critical to determining the optimal mix of batteries for addressing the energy storage requirements of each project, which the team accomplishes by compiling information on specific batteries and simulating performance under the load profile in a black start scenario.



List of Running Loads

Step	Load	
1	1_Lighting Panel	LP-1
2	2_Lighting Panel	LP-2
3	High Service Pump 1	30-HSP-01
4	1_Low Service Pump 1	10-LSP-01
5	2_Low Service Pump 1	205-LSP-01
6	2_Low Service Pump 2	205-LSP-02
7	1_South Aerator Turbine 1	10-B-01
8	2_North Aerator Turbine 1	20-B-01
9	2_Chlorine Room Exhaust Fan 1	EF-1
10	2_FLouride Room Exhaust Fan 2	EF-2
11	1_Brine Pump 2	10S-BP-02
12	2_Salt Pit Pump 1	205-SP-01

Figure 4

Step 4. Equipment procurement

Once the microgrid components are identified, Schneider Electric sources the battery/batteries, gear, and controls to deliver all the essential parts of a comprehensive microgrid system.

Step 5. Startup, commissioning, and maintenance

Schneider Electric performs due diligence – testing, documenting, and validating the microgrid architecture for cybersecurity and communication to deliver a robust and reliable system – enable seamless fast and site startup and commissioning. The team develops a spare parts strategy to streamline maintenance and repair. A dedicated services team further provides proactive and reactive support with a focus on outcome-based plans customized and purpose-built for the use cases and goals of the site.

Hundreds of Field Service Representatives and Digital Field Service Representatives across the country are available for on-site preventive maintenance and support on electrical distribution equipment, software, and controls.

Asset management solutions continuously monitor system health to enable condition-based maintenance and instant remote support and troubleshooting via cybersecure connections.

Microgrid design

Microgrid design

Capitalizing on Schneider Electric parts and smarts

The decision to install a microgrid can improve operational resilience and economics, but moving from decision to implementation requires expertise that most companies do not have in-house, see **Figure 5**.

Schneider Electric engineers have installed **more than 300 microgrid systems** and have an experienced team that can specify electrical distribution equipment, software, and controls.

Schneider Electric has deep industry relationships with other technology and capital providers to ensure the most sophisticated, reliable, and efficient systems on the market.

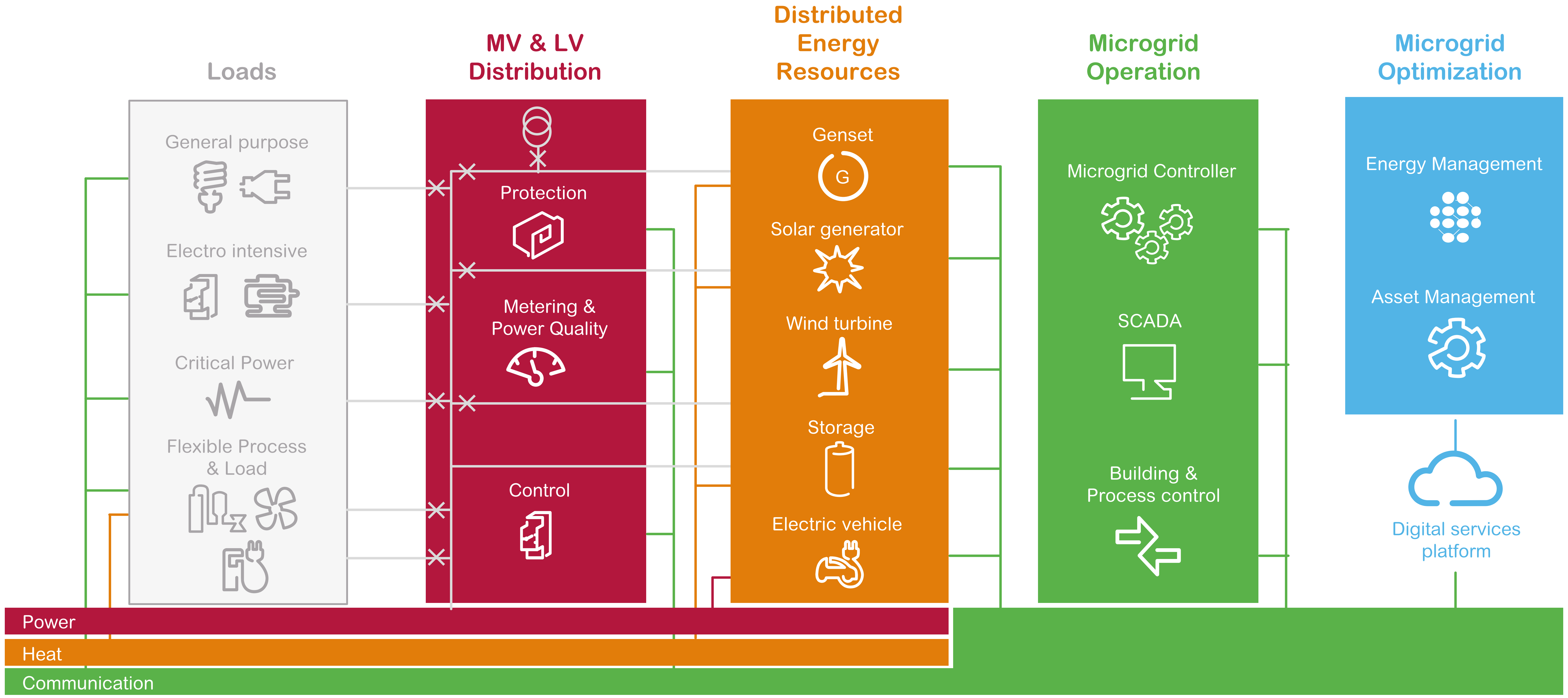


Figure 5 Microgrid Architecture

Proprietary products and services allow owners to extract maximum value from the microgrid, including:

EcoStruxure™ Microgrid Advisor, our cloud-based economic optimization engine:

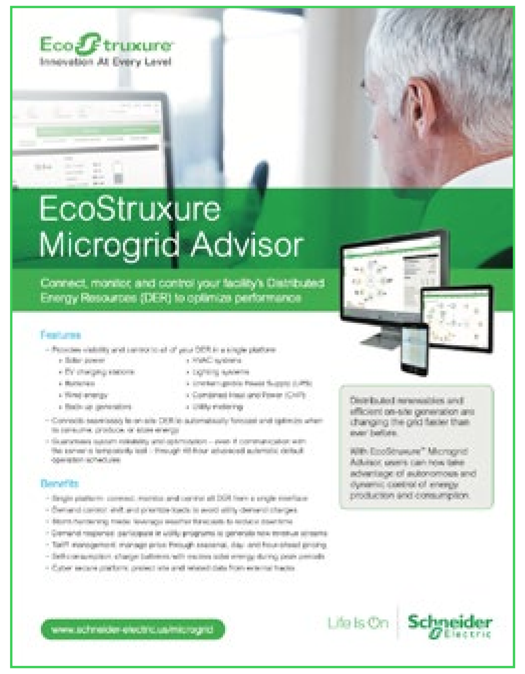
- **Interacts with the on-site microgrid controller** to serve as the "economic engine" behind the system's control.
- **Analyzes load data and energy resources** to determine and dispatch which resources are most economical.
- **Serves as the user interface** to allow operators to remotely access and download information and provides a live look-in on system performance.

EcoStruxure Microgrid Operation, the on-site controller for the microgrid system:

- **Sits on the “Edge”** between the cloud-based analytics platform and the hardware.
- **Passes site-level information** to the cloud for EcoStruxure Microgrid Advisor to analyze and then return commands to optimize system performance.
- **Takes commands** and runs pre-programmed operation sequences to ensure microgrid system stability, taking the system from grid-tied to islanding mode.

Upgrading a solar-only system to a complete microgrid can provide resilience and cost savings, but making that investment requires specialized knowledge and precise planning. **Engaging an experienced partner to help with preparation and execution can differentiate between a solution that captures economies and one that misses the mark**.

Additional resources



If you are ready to improve your solar-only facility's resilience, reliability, and economics, a microgrid could be the solution, and Schneider Electric can help. To learn more, visit:

se.com/us/microgrid

blog

Schneider Electric
800 Federal Street
Andover, MA 01810
Phone: 978-794-0800

998-22086168_US