

No Grid? No Problem.

Get clean reliable power today, with the option for grid connection when available.

Proven and Resilient

Bloom Energy has deployed over 1,200 MW of Bloom's flagship solid-oxide fuel cell (SOFC) based Energy Server systems across six countries. These power generating assets have produced over 20,000 GWh of clean energy. Over 170 of these installations are microgrids, which have demonstrated resilience to continue delivering power during wildfires, earthquakes, hurricanes, and large-scale grid events.

Fuel flexibility during the global energy transition is especially important when choosing power generation. Bloom continues to build and deploy zero-carbon Energy Server products that can operate on biogas and 100% hydrogen. As hydrogen is not universally available or economical today, Bloom's Energy Server has been optimized with steam reformation so that it operates on widely available pipeline natural gas until hydrogen becomes readily available.

When operating on natural gas, the Bloom Energy Server produces combustion free electricity through a simple electrochemical reaction that separates the hydrogen from the fuel source to produce electricity, heat, and pure CO₂. With negligible NO_x, Sox and no particulate matter, Bloom's SOFC is ideally positioned for today's environment where natural gas is readily available in many geographies.

Because the Energy Server uses a 100% non-combustion technology, when operating on natural gas, it reduces carbon emissions by 25%-30% compared to the average global grid emissions¹ that rely on combustion-based technologies and nearly eliminates all other smog forming particulates like NO_x and SO_x prevalent in centralized power generation plants. With unrivaled availability, the Bloom Energy Server efficiently utilizes natural gas or blended hydrogen until the supply of carbon-free fuels such as green hydrogen are readily available.

Speed and Scale

Bloom Energy understands the needs of customers who build and operate critical infrastructure within data centers and whose uptime is of utmost importance to the success of their business. To address these needs, Bloom has designed the Energy Server with modularity, redundancy, and system uptime in mind. With a

Executive Summary:

The electrical grid is facing unprecedented growth expectations and increased pressure to expand quickly and cleanly. The speed and scale to build out transmission, distribution, and capacity expected of the grid utilities today are not only difficult, but impractical with all the obstacles they have to overcome. Outside of the pure economics of labor, regulation, and funding such a large grid expansion, developers are facing long lead times to secure equipment, permitting, and to adopt technologies that support a bigger and greener future.

Finding a proven and resilient solution that can deploy quickly at scale, offer clean and efficient power, and be grid-independent with the flexibility to connect to the grid if needed in the future, is paramount to solving the global "Time to power" issue that data centers and mission critical facilities face today.

Innovative companies need to come to the aid of the utility sector and locally provide the power these facilities desperately need, bridging the gap until the grid can deliver the required capacity. Bloom Energy has a long-standing capability of providing both grid-parallel and grid-independent power to customers in various markets, including critical industries such as data centers. Its predictable and resilient 'behind the meter' and 'front of the meter' distributed generation systems can be installed immediately to support the growing energy demand and be flexible as energy needs change

Reference:

1. 2022-bloom-energy-sustainability-report.pdf (bloomenergy.com)

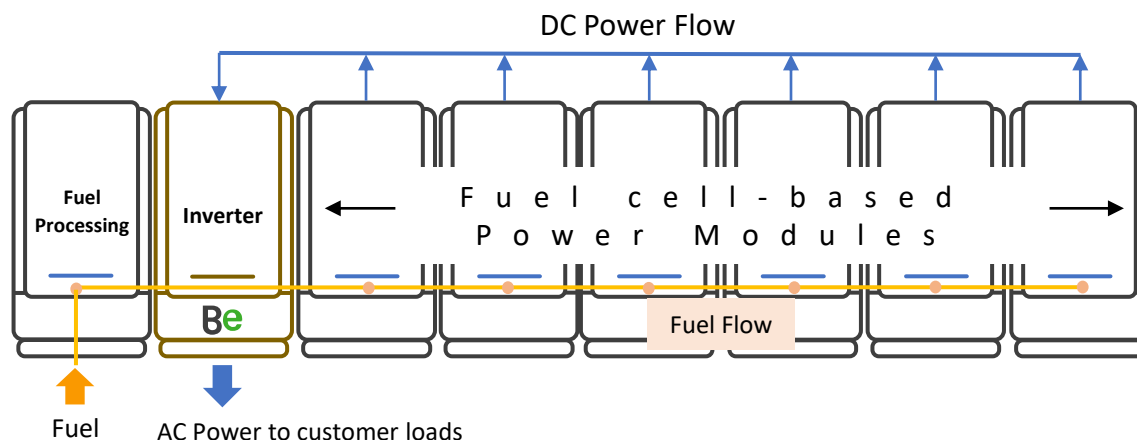


Figure 1: Energy Server

manufacturing facilities capable of producing more than 1 GW capacity of Energy Server systems per year, Bloom can deliver this critical infrastructure in months versus years, when compared to traditional centralized grid expansion projects, which are often quoted as 6-10 years out. The Bloom Energy Server is shipped to the site on a skid, already pre-wired and tested at the factory, and ready to be installed in a matter of days. Bloom's skid-mounted design mitigates many of the traditional installation issues that may arise from variable site conditions.

Bloom's modular design and concurrent maintainability of the SOFC fuel cells inside the Power Modules enable the Energy Server to run continuously 24/7/365 and provide UPS quality power directly to the facility with both flexible fuel and voltage options. (See Figure 1). The base Energy Server can scale to meet any size load from 325 kW to hundreds of MW.

Clean and Efficient

By choosing a Bloom Energy Server, customers are able to take a significant step towards decarbonization today with natural gas supplies, biogas, blended hydrogen, or 100% hydrogen and completely move away from combustion sources that contribute to high amounts of greenhouse gases and particulates. With the current concerns over water consumption by power generation, or more commonly known as the energy water nexus, over 99.9% of water can be saved annually when using the Energy Server in place of other forms of power generation since it does not use water during normal operation. In fact, the Energy Server is water positive as H₂O is a byproduct of the electrochemical process. For more details on water usage, please refer to the Bloom Energy Sustainability report¹.

Efficiency in power generation also plays a part in sustainability and economics for customers. Owing to high-temperature operation, the exhaust from the Energy Server can be captured and used as part of a combined heat and power (CHP) application by producing hot water and steam as well as absorption chillers for cooling applications. The Energy Server leads the industry in efficiency (Table 1). With an average lifetime combined electrical and thermal efficiency >90%, the Energy Server is second to none for making the most of the input fuel to produce electricity.

Table 1: Average efficiency of an Energy Server system operating in a CHP system

Parameters	Expected Lifetime Avg.
Electrical Efficiency	54% (LHV net AC)
Combined Efficiency w/thermal	>90%

Grid Independent and Future Proof

The Bloom Energy Server is often paired with Bloom's microgrid offering, to give customers ultimate control over their site power needs. The Bloom microgrid platform uses smart inverters that can operate in both Grid Following (GFL) and Grid Forming (GFM) modes, with the capability to switch between the two modes. The Bloom microgrid solution offers additional functionality to integrate with third-party Distributed Energy Resources (DERs) and uses ultracapacitor-based step load modules for nearly immediate frequency response, ensuring resiliency when managing variable facility demands. The Energy Server and microgrid solutions offer all the functionality and power quality required by critical facilities.

Reference:

1. 2022-bloom-energy-sustainability-report.pdf (bloomenergy.com)

Most customers today have used the Energy Server to run in parallel with the grid, to increase resiliency, increase capacity, or offset the high cost of electricity, but with the increasing constraints on the grid and the massive delays to upgrading generation and transmission infrastructure, customers are looking to Bloom for a 100% off-grid solution, with a demonstrable improvement in uptime. Bloom Energy's off-grid solution shown in Figure 2, consists of an Energy Server paired with Bloom's an energy storage module to manage and follow load demands. If the infrastructure requires additional power, the design is easily scalable by adding Energy Server systems in parallel.

While operating independent of the grid, the stability of the microgrid parameters is ensured by the robustness of Bloom's custom inverter. The UPS quality power delivered by the Bloom Energy Server meets ITIC requirements, thereby being able to ride through voltage and frequency fluctuations caused by load imbalances/disturbances.

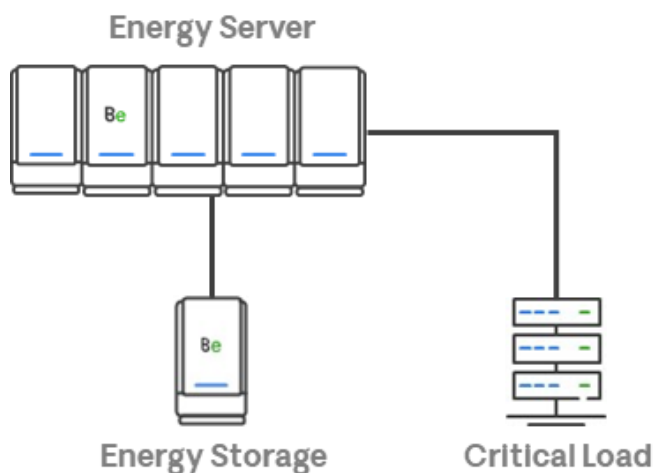


Figure 2: Bloom Energy's off-grid microgrid architecture

Bloom Energy's latest project in California, powering a large-scale food producer's facility, is one of the prime examples highlighting the resiliency offered by the Bloom Energy Server. The installation is an off-grid solution with an 8 MW Energy Server farm, 1.8 MW Solar, 4 MWh of Battery Storage, and 2 MW of backup diesel generators (Figure 3). The Energy Server farm functions as the grid forming source, providing voltage and frequency support, and powering the facility with clean, reliable, and resilient energy. The food producer deploying this solution is able to get reliable power today with Bloom's microgrid solution and in a few years, if grid interconnection becomes available, the off-grid microgrid can be reconfigured as needed.

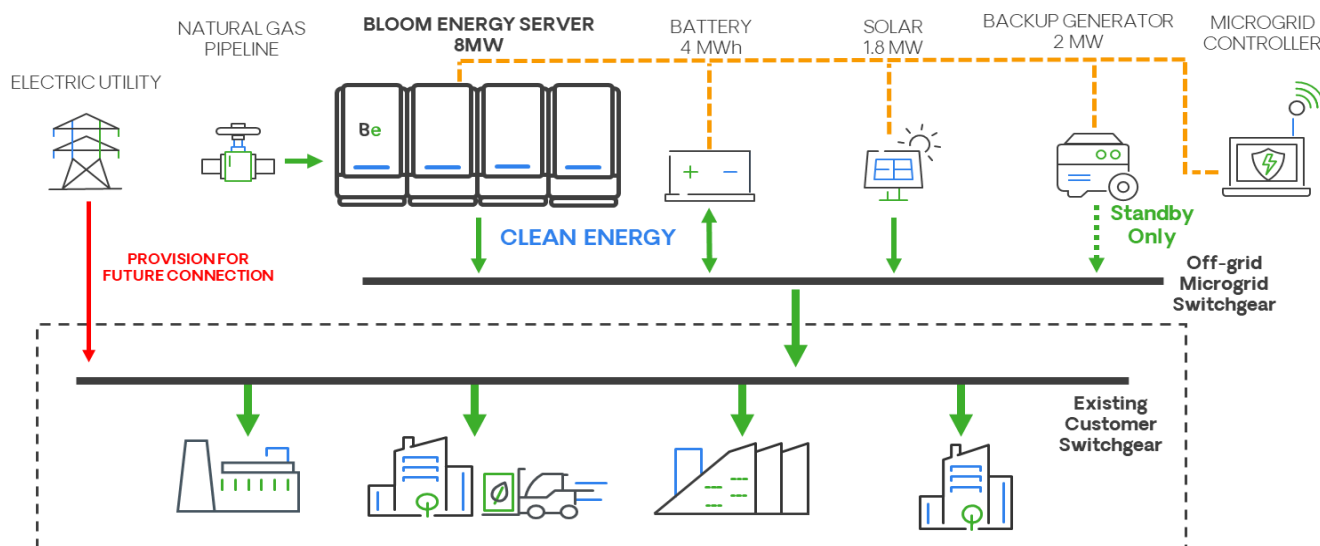


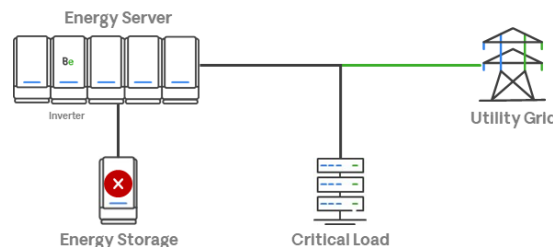
Figure 3: Current 8 MW off-grid solution at scale

At any of Bloom Energy's off-grid microgrid installations, once the utility grid becomes available, the Energy Server farm can be reconfigured to operate alongside the grid and enhance the resiliency of the facility. Shown below are a few choices customers will have when the grid becomes available at the site:

Potential transition options from off-grid to grid connected

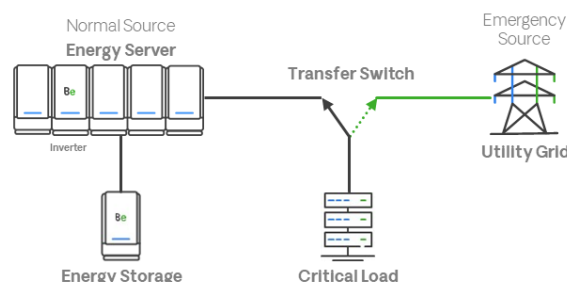
Option 1: Grid Parallel Solution

The Energy Server can be configured to connect to and operate in harmony with the utility in grid following mode. In this mode of operation, the Energy Server simply provides power to the facility and utility simultaneously, reducing the facility's energy drawn from the grid. For this reconfiguration the only downtime will be to add additional wiring/equipment and changing the mode of operation from GFL to GFM.



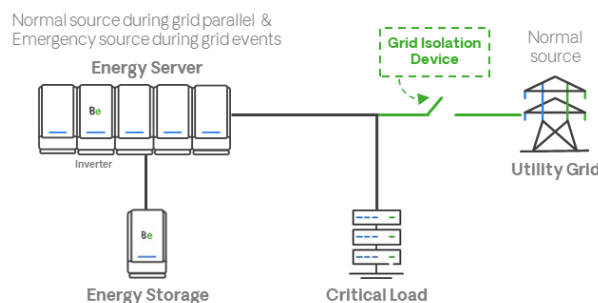
Option 2: Utility Grid as Emergency Source

The Energy Server can continue to serve as the primary source of power to the critical facility, with the utility grid available as an emergency source. This solution involves the addition of a transfer switch for power source selection and control. Control logic will have to be changed to incorporate the utility and implement the new sequence of operation.



Option 3: Grid Parallel Solution with Energy Server as an Emergency Source

The Energy Server can be configured to operate in parallel with the utility grid when grid power is available and can be switched to operate as a load following source, carrying the entire facility during grid events. Unlike traditional backup systems such as generators and UPS whose runtime is subject to availability of on-site fuel and battery capacity respectively, the Energy Server relies on the robustness of the natural gas pipeline (or future hydrogen gas pipeline) and does not possess any traditional run-time limitations. Control logic to operate as a grid forming source during a utility event would be incorporated into the new sequence of operation, if the customer chooses this future operation scenario.



Conclusion

Finding an off-grid solution that can deploy at scale and in months versus years is the #1 priority for critical facility developers. A proven solution that exists today for the data center industry is the Bloom Energy Server. Working seamlessly with or without a grid connection is a capability Bloom has been deploying for years. Bloom's products and solutions have a proven track record of providing clean, resilient, and predictable power on-site and on time. Bloom has multiple critical infrastructure references both to the developer/operator community and to the enterprise facilities. In addition to the extensive track record, proven reliability, and flexibility, Bloom provides a product that reduces carbon emissions by 25%-30% today, uses no water during operation, and is combustion-free. When carbon-free fuels, like green hydrogen, are readily available and affordable, Bloom customers are ready with a future-proof onsite platform. The energy market has come to the realization that the shortfall of transmission and generation capacities are real and pressing. The demand for reliable energy to power critical facilities is only increasing, which means the market must take control of its energy requirements directly, while simultaneously reducing carbon and preparing for a carbon-free future.

For additional technical details about the Bloom Energy Server, Bloom Microgrid, and other Bloom solutions, please visit bloomenergy.com.



Bloom Energy Headquarters
4353 North First Street
San Jose, CA 95134 USA
bloomenergy.com

Flexible. Future Proof.

**Accelerate your path to a
zero-carbon future.**

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