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Bloom Energy Fuel Cells: A Clean, Reliable and Scalable Way to Power Data Centers

The iMasons Legacy Podcast
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Bloom Energy Fuel Cells: A Clean, Reliable and Scalable Way to Power Data Centers

Photo courtesy of Bloom Energy

From Mars to AI

This is far out. Technology that was originally developed to sustain life on Mars is the best kept secret to powering the revolution in artificial intelligence on Earth.

The technology intended for Mars converted electricity into oxygen and fuel. The team of scientists that developed this life support system then re-engineered it to turn oxygen and fuel into electricity without combustion on Earth. They launched their company, Bloom Energy, which manufactures solid oxide fuel cells, to the public in 2010.

Today, it turns out that the operational characteristics of Bloom's fuel cells help solve critical challenges to the sustained growth of the data center industry, according to KR Sridhar, Founder, Chairman and Chief Executive Officer of Bloom Energy.

Chief among these challenges is the inability of the electric power grid to keep up with the data center demand for power, especially in markets where data centers cluster such as Silicon Valley, Virginia and Ohio in the United States, and Dublin, Ireland.

As data center demand for power outstrips the ability of the electric power grid to supply it, more data center developers are turning to onsite power solutions. Bloom Energy forecasts that by 2030, onsite power will contribute to keeping nearly 40% of the U.S.'s data centers up and running.

The fuel of choice for these onsite power solutions today is natural gas, which is abundant and available in most existing and emerging data center markets around the world.

"It is well known that you can convert natural gas to electricity using a reciprocating combustion engine or a rotary gas turbine," Sridhar said. "Less well known are fuel cells, an available choice at scale today, and increasingly selected by AI leaders."

Photo courtesy of Bloom Energy

Affordable, Available, Scalable

Fuel cell technology is particularly relevant today because onsite power generation with natural gas is the only way for many data center developers to meet project schedules and stay in the race to win AI dominance, Sridhar explained.

AI data centers require enormous amounts of power - from tens of megawatts for inference to multiple hundred megawatts or gigawatts for training, which is enough electricity to supply hundreds of thousands of homes. Few electric power grids have that much spare capacity. That's why data center developers are increasingly turning to onsite power.

"Without onsite power, you cannot power the AI revolution," Sridhar said.

Fuel cells are an affordable, available and scalable onsite power option to meet the needs of AI data centers today and help developers maintain budgets, timelines, and community and corporate relationships, according to a white paper Sridhar co-authored to explore the benefits of fuel cells for onsite power at data centers.

The paper explains that fuel cells deliver power at costs competitive with reciprocating engines and gas turbines, and provide faster time to power, better reliability, and more rapidly follow AI workloads.

In addition, fuel cells are clean and quiet – they don't burn fuel and run at about 65 dBA, which is less than the background noise in a coffee shop. This means fuel cells lack the air pollution and noise levels that are a source of friction in communities where data centers are located. These attributes streamline the process for developers to secure the regulatory permits required for onsite power generation.

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Bloom Energy's case for the digital infrastructure industry to embrace fuel cells align with iMasons' initiatives to address the power, perception and planet challenges.

"These fuel cells are easier for communities to accept," said white paper co-author Peter Gross, Managing Partner at PMG Associates Consulting and Advisory and a leading expert at the intersection of the technology and energy industries who led the Mission Critical Systems group at Bloom Energy from 2012 to 2018.

Time to power, community perception and protecting the planet are three of the biggest challenges to sustainable growth of the digital infrastructure industry, noted Santiago Suinaga, Chief Executive Officer of Infrastructure Masons, a global nonprofit professional association for the builders of the digital age.

Bloom Energy's case for the digital infrastructure industry to embrace fuel cells align with the association's initiatives to address the power, perception and planet challenges including innovative power solutions, increased community engagement and authentic commitments to protect the planet.

"The paper shows the strong value proposition for fuel cells as a solution to several of our industry's biggest challenges," Suinaga said. "Onsite power is becoming necessary for many data center deployments, and natural gas the most widely available fuel. Fuel cells are also clean and quiet, which eases integration with communities."

Myth Busting

When Bloom Energy debuted to the public in 2010, its fuel cells were considered too expensive for mass adoption, Sridhar recalled.

In the years since, innovation and incremental improvements in manufacturing, material performance and system design have resulted in a total cost of power that is today on par with conventional solutions.

Bloom Energy's fuel cells have been in operation for 17 years, with over 22,000 of its power boxes in the field. The first full-off-grid system was installed 10 years ago and has experienced zero load affecting failures, the paper notes.

Today there are dozens of operating off-grid deployments of the company's fuel cell system, the Bloom Energy Server®. Bloom offers its fuel cells in multi-hundred megawatt stamps and today can deliver 100 MW of power within as little as 90 days of purchase order.

The Bloom Energy Server arrives on a skid ready to connect in days to electrical, water and gas infrastructure. The system is modular and enables onsite fuel cell deployments to grow in sync with the data center, allowing for greater cost control and coordination with business needs.

"This solution provides full control over your power destiny," said Gross. "You have the flexibility and scalability you need, and you can control costs by hedging the cost of natural gas."

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AI Workload Synergy

AI training data centers face volatile power loads that can swing from 20% to more than 150% of provisioned power in milliseconds.

Bloom's fuel cells are also uniquely suited to handle the volatility of AI workloads, according to Gross.

Traditional data centers typically serve hundreds of thousands of simultaneous users engaged in a mix of activities that results in a consistent, or flat, load on the electric power supply. The electric power grid as well as onsite reciprocating engines, gas turbines and fuel cells can serve this load reliably and consistently, the paper notes.

AI training data centers are focused on a specific, singular task spread out across thousands of densely packed high-powered silicon chips in server racks with an ever-changing, volatile power load that can swing from 20% of the provisioned power to more than 150% of provisioned power in milliseconds and these swings can happen tens of times every minute.

"A fuel cell can adjust to that load in seconds whereas a large mechanical turbine or reciprocating engine can only adjust to that in tens of seconds to minutes," explained Sridhar. "That means the amount of backup batteries you will need will be significantly larger than with Bloom fuel cells."

With less data center space dedicated to power delivery, storage and protection equipment, fuel cells maintain the computational performance benefits of tightly packed clusters of high-density server racks needed to win the race to AI dominance.

"The entire hardware evolution over the next few years is all about proximity of the compute and it is getting denser and denser. You need to put things closer and closer," Sridhar explained. "If you have to put in additional equipment to take care of the load following, you lose the efficiency."

‘Social Accord’ Alignment

Dean Nelson, Founder and Chairman of iMasons, sees a bright future for fuel cells in the digital infrastructure industry, especially as a solution to short and long-term challenges related to power, the industry’s perception and the industry’s impact on the planet.

iMasons is scaling up an initiative, the iMasons Social Accord, that includes a framework on how to address these challenges as it works to achieve economic, social and ecological balance with the communities where data centers are deployed.

The technology embedded in solid oxide fuel cells can help data center developers “achieve a design that has a minimal impact on the environment and brings the most benefit to the community,” noted Nelson.

Onsite power generation relieves the community of development costs for new power infrastructure, which is a source of friction between community members and the digital infrastructure industry. Onsite power also eliminates visual impacts of new grid infrastructure and associated loss of open space.

If a grid connection is available, data centers with onsite power can augment the stability of the grid through interactive services such as frequency regulation and demand response, turning the data center into a grid asset rather than a drain on local power resources.

In addition, fuel cells operate with minimal noise, without combustion and near zero emissions of nitrous oxide and sulfur dioxide that are an increasing source of air permit denials for data centers with onsite power.

“They don’t have the hum, they have virtually no NOx and SOx,” Nelson said of the fuel cells. “They have an optimal way of handling all these issues. They’re quiet, clean, reliable and scalable. They can handle the workload. They really are one of the best kept secrets to powering AI.”

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— Dean Nelson,
Founder & Chairman,
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