EBOOK

THE ROLE OF DATA CENTERS IN MAINTAINING **GRID STABILITY**


MICHAEL SAGAR
ENERSYS®


LUCA CASSANI
ENERSYS®


MIKE DAFFRON
ENERSYS®

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INTRODUCTION

In the future, electricity generation will not be as dependent on the use of fossil fuels, with last year's COP 27[1] climate change conference seeing close to 200 countries pledge to phase out their usage. Concerns about air pollution and rising levels of greenhouse gases - and the respective implications these have on human health and the environment - mean that a much greater level of importance will be put on renewable alternatives. A major knock-on effect of this change in emphasis is that the power distribution infrastructure must be adapted. The following article will explain how this might be done and what part data center operators are set to play.

CONCERNS ABOUT AIR POLLUTION AND RISING LEVELS OF GREENHOUSE GASES - AND THE RESPECTIVE IMPLICATIONS THESE HAVE ON HUMAN HEALTH AND THE ENVIRONMENT - MEAN THAT A MUCH GREATER LEVEL OF IMPORTANCE WILL BE PUT ON RENEWABLE ALTERNATIVES.

Figure 1:
Example of a photovoltaic plant generating electricity from solar energy

UNDERLYING TRENDS IN THE ENERGY SECTOR

Ecological concerns are one of the main factors leading to the decommissioning of coal, gas, and diesel-fueled power stations. At the same time, solar and wind generation sites are being brought online to replace them. Figures published by the International Environment Agency (IEA) show that renewable electricity generation increased by 8% in 2021[2] compared with the previous year. The IEA now estimates that the proportion of electricity generation that renewable energy sources are responsible for globally has reached 30%[3].

Over the last few years, countries worldwide have been working to reduce carbon emissions in accordance with the UN's Paris Agreement[4]. One example of this has been the EU setting a target that at least 40% of the energy consumption of its member states will come from renewable sources by 2030[5].

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ISSUES THAT RENEWABLE ELECTRICITY GENERATION PRESENTS

Until the recent application of renewable electricity generation, large-scale power stations were almost entirely responsible for serving electrical distribution networks. Therefore, if electricity demand increased, it was relatively easy to ramp up additional generation capacity in response. With solar and wind generation, however, things are not that simple - as they depend on the external conditions at that location at that specific time. These conditions can be unpredictable, with daily and seasonal variations needing to be considered. Therefore, it is not possible to raise the output capacity from renewable sites when demands are high since there are too many factors that cannot be directly controlled.

The distribution networks of the future are going to become much more reliant on intermittent inputs - with wind and solar making up a bigger share of the overall generation capacity. Methods must therefore be found so that extra output may be added when required.

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MAINTAINING A CONSISTENT GRID FREQUENCY

To ensure grid stability is fully synchronized, a country's electrical infrastructure must run at the same grid frequency. Regional differences mean that while the US, Canada, South Korea, and Central America all operate on the 60Hz grid frequency, the EU member states, the UK, Australia, China, New Zealand, South America, and most of Africa use 50Hz instead.

Regardless of location, the grid frequency needs to be kept at a constant value - with only small deviations from this being tolerated (in most countries this is usually just 0.01-0.02%). Any fluctuation beyond this margin will mean a threat of power outages occurring. This is where grid balancing technology comes in. It provides the means to access stored energy at times of peak demand so that the optimal frequency is sustained.

By drawing on energy stored in large banks of batteries that are connected to the grid, the optimal frequency value can be maintained. Additionally, these batteries can be charged up when the input from renewable generation sites is in surplus. The stored energy can then be discharged when heightened grid demands dictate.

The essential element necessary for grid balancing activities is access to a large energy storage reserve. Data center operators will generally have abundant energy storage capacity available to them, which can often be underutilized. That is why, in some locations, they are now starting to investigate how this capacity might be put to use. With heavy investments already made in Uninterruptible Power Supply (UPS) systems, the constituent battery units at data center sites could be assigned to grid balancing. In doing so, operators would be able to create some additional revenue to offset some of their running costs.

WITH HEAVY INVESTMENTS ALREADY MADE IN UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS, THE CONSTITUENT BATTERY UNITS AT DATA CENTER SITES COULD BE ASSIGNED TO GRID BALANCING.

BUILDING A GRID BALANCING STRATEGY

Let's assume data center operators employ the UPS battery reserves that they have available for grid balancing. In that case, they must first have a good understanding of all the dynamics involved. To start with, they should look at different business model approaches they could take. Each of these has its own distinct merits.

Some operators might want to have control of the full process. They will initiate negotiations with the electricity distribution company, make all the necessary investments and take care of everything else required. Though this will have some associated inconveniences and potential risks, the upside is that the revenue derived should be significantly larger.

Other operators may choose to offload the grid balancing work completely. In such cases, the electricity service provider would deal with the electricity distribution company, manage the balancing work, and take charge of ongoing battery asset maintenance and replacement. The electrical company would then capture most of the revenue because of this approach. Another option is to incorporate elements of both concepts – providing the data center operator with a satisfactory level of revenue, but without having too much risk or system complexity.

It is paramount that data center operators make certain that assigning their battery reserves to such activities does not have a detrimental impact on the ability of these batteries to carry out their core functions. For example, if backup power supply responsibilities are compromised, with a shortening of the standby time they can support the critical load for, then the risks involved in following such a strategy will simply be too great.

Securing uptime must always be the priority. An interruption in the service that a data center provides, resulting from being inadequately prepared when a power outage occurs, could have a disastrous outcome.

Grid balancing activities cannot mandate an increase in the number of batteries required by the data center. However, if additional provisions were needed, this would have repercussions for both the available budget and space utilization.

IT IS PARAMOUNT THAT DATA CENTER OPERATORS MAKE CERTAIN THAT ASSIGNING THEIR BATTERY RESERVES TO SUCH ACTIVITIES DOES NOT HAVE A DETRIMENTAL IMPACT ON THE ABILITY OF THESE BATTERIES TO CARRY OUT THEIR CORE FUNCTIONS.

Sophisticated mechanisms need to be installed - so that when batteries reach a predefined State of Charge (SoC) threshold, the grid balancing work will cease. Operators must also be advised on what proportion of their overall battery resources can be assigned to grid balancing without leaving themselves vulnerable. In addition, they also need to know which batteries are best suited to this type of work.

Historically, data center operators have been unable to adopt grid balancing on their sites. The limitations of traditional lead-acid batteries could not effectively support the increased cycles that are required. Newer battery chemistry and technology, coupled with highly responsive monitoring systems, are enabling operators to consider grid balancing. However, operators will need to take into consideration the Total Cost of Ownership (TCO) of their batteries, plus any management and administration expenses related to this work, against the additional revenues that will be created.

By specifying batteries that possess strong charge/recharge durability, data center operators will be better positioned to participate in the concerted effort to maximize grid resilience. In addition, correctly selected data center battery units may then be employed for storing energy so that any imbalance between electricity consumers' demands and available generation capacity can be better aligned.

Lead-acid is the foundation for most energy storage activities, and its popularity continues to grow[6]. A combination of elevated energy density levels (so batteries can fit into compact form factors), charge cycle endurance, and cost-effectiveness mean that this is the most popular[7] battery chemistry in a data center context. As a result, projections published by industry analyst firm Grand View Research[8] expect the worldwide lead-acid battery business to push beyond $93 billion in annual revenue by 2027.

Figure 2:
EnerSys® battery stacks deployed within a data center

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Continually driving innovation in lead-acid battery technology, EnerSys® has a proven track record in the data center sector - acting as a valued technology partner to the leading operators. Drawing on the knowledge of experienced engineers and their innate understanding of the challenges posed by advanced power supply system design, EnerSys® is very well placed to partner with data center operators when they start looking at grid balancing as a prospective revenue stream.

The thinner plates used in the proprietary thin plate pure lead (TPPL) batteries that EnerSys® has developed present an engineering advantage by substantially boosting the lead-acid performance. It means that more of these plates can be stacked together - resulting in an increased reactive surface area that translates into elevated power densities. The purity of the lead in the grid construction, the electrolyte, and numerous other components used in battery construction, coupled with the expertise in battery design that EnerSys® provides, are all key attributes. Together they are significant contributors to extended working lifespans. Furthermore, the electro-chemistry of some TPPL products has been specifically engineered for high cyclic requirements, whereas standard absorbent glass mat (AGM) and valve-regulated lead-acid (VRLA) designs offer much lower cyclic performance. As a result, EnerSys® batteries featuring TPPL technology enable high-performance UPS solutions to be integrated into modern data center operations.

EnerSys® TPPL battery technology has already seen widespread deployment in the data center sector. These batteries exhibit exceptional fast charge and cycling capabilities necessary for grid balancing. There are other benefits of TPPL to consider too. With up to a 5-year warranty, certain EnerSys® TPPL models can run at 30°C / 86°F. This will allow data center operators to reduce their cooling costs, as well lowering their carbon footprint. Alongside these products, EnerSys® offers astute technical expertise to assist data center operators that are looking to explore commercial opportunities of this kind.

If the future continuity of electricity supply is to be maintained, there needs to be a balance between renewable energy and grid stability. Based on all the points raised in this article, choosing the right battery chemistry - and working with a vendor that can make recommendations on how best to implement their technology - will be vital for data center operators to capitalize on the opportunities that grid balancing offers. In addition, through engaging with EnerSys®, operators will be able to get complete visibility of how their sites will be affected by this work - allowing them to formulate superior energy strategies for the future.

With appropriate guidance, data center operators will be able to look at the related capital and operational costs and then compare these with the revenue that could potentially be generated. Consequently, operators can make a well-informed decision on whether grid balancing is a good fit for them.

For more information about the data center batteries available from EnerSys®, please visit: www.enersys.com

REFERENCES

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About EnerSys®

EnerSys®, the global leader in stored energy solutions for industrial applications, manufactures and distributes energy systems solutions and motive power batteries, specialty batteries, battery chargers, power equipment, battery accessories and outdoor equipment enclosure solutions to customers worldwide. Energy Systems, which combine enclosures, power conversion, power distribution and energy storage, are used in the telecommunication, broadband and utility industries, uninterruptible power supplies, and numerous applications requiring stored energy solutions. Motive power batteries and chargers are utilized in electric forklift trucks and other industrial electric powered vehicles. Specialty batteries are used in aerospace and defense applications, large over-the-road trucks, premium automotive, medical and security systems applications. EnerSys® also provides aftermarket and customer support services to its customers in over 100 countries through its sales and manufacturing locations around the world. With the NorthStar acquisition, EnerSys® has solidified its position as the market leader for premium Thin Plate Pure Lead batteries which are sold across all three lines of business.

Sustainability

Sustainability at EnerSys® is about more than just the benefits and impacts of our products. Our commitment to sustainability encompasses many important environmental, social and governance issues. Sustainability is a fundamental part of how we manage our own operations. Minimizing our environmental footprint is a priority. Sustainability is our commitment to our employees, our customers, and the communities we serve. Our products facilitate positive environmental, social, and economic impacts around the world. To learn more visit: https://www.enersys.com/en/about-us/sustainability.

OUR PRODUCTS FACILITATE POSITIVE ENVIRONMENTAL, SOCIAL, AND ECONOMIC IMPACTS AROUND THE WORLD.

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INFORMATION ABOUT
THE **DATASAFE® XE**
BATTERY RANGE.

World Headquarters
2366 Bernville Road
Reading, PA 19605 USA
+1 610-208-1991 / +1 800-538-3627

EnerSys EMEA
EH Europe GmbH
Baarerstrasse 18
6300 Zug Switzerland

EnerSys Asia
152 Beach Road
Gateway East Building #11-08
Singapore 189721 / +65 6416 4800