

Transform Your Power Network

to be Energy Aware

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Powering Business Worldwide

Introduction

Data centres can now support the electricity grid and be compensated for it. Eaton's EnergyAware Uninterruptible Power Supply (UPS) allows organisations to make money from their existing investment in a UPS by enabling them to help energy providers balance sustainable energy demands. With certain incentive schemes, an EnergyAware UPS can even stack up financially in its own right, allowing data centre operators to pre-develop their power infrastructure.

The energy transition has introduced exciting opportunities in how we produce and consume energy. Electricity grids are experiencing significant challenges due to the growth of renewable energy and the introduction of new forms of energy demand – heating, transport, and digital controllers.

The energy industry is committed to producing greener energy using renewables, but renewable energy is less predictable, and production can be more volatile – making it harder for energy providers to balance production and demand for electricity. This has increased the need for new models of participation in the energy system. Increasingly, electricity consumption is requiring a two-way relationship between customers and grid operators. It is no longer a one-way system.

The digital revolution is central to this change. Many digital requirements are moving into the cloud and the demand for centralised data storage and processing has increased exponentially. Data centres are designed to be highly resilient to external energy shocks, while also depending on an increasing supply of low-carbon energy.

Large data centre operators, such as colocation and cloud service providers, can be compensated for supporting the system to help the grid avoid power outages, without compromising critical loads. Can data centres and the electricity grids that power them combine their intelligence to become more energy-aware? Can existing assets be deployed to help to accelerate the transition to low-carbon energy?

This white paper looks at the opportunities in existing data centre assets, particularly data centre UPS systems, to support the growth of renewable energy. It describes a bespoke service for data centres which is safe, flexible, and reliable. The benefits include improved green credentials, new revenue, and improved competitiveness.

Data Centres

Growth of Digitalisation

The energy system is experiencing a major shift in supply and demand modes. This is led by increased electricity demand due to the electrification of heat and transport, and the growth in digital demand. Decarbonisation of the grid driven by corporate customers and government policies means more variable renewable energy sources are replacing traditional fossil fuels.

Data centre demand continues to be a key driver for the development of new electricity grid infrastructure. Digitalisation has the potential to transform energy use in transport, buildings and industry. The International Energy Agency's assessment of the potential impact of digitalisation on the power sector included improved system efficiency, reduced O&M costs, the avoidance of unplanned outages, and extended asset lifetimes. Integration of more renewables into power grids can be facilitated by increasing digitalisation.

Total global data centre energy demand remains steady at about two hundred terawatt-hours (TWh) annually – see Figure 1. The trend to date has been moving towards centralised data processing in the cloud. This has led to the growth of larger (hyperscale) data centres. So far, these have replaced traditional inefficient data rooms in offices, doing much more with the same amount of energy. It can be expected that the trend in data growth will begin to push up the overall energy demand from datacentres.

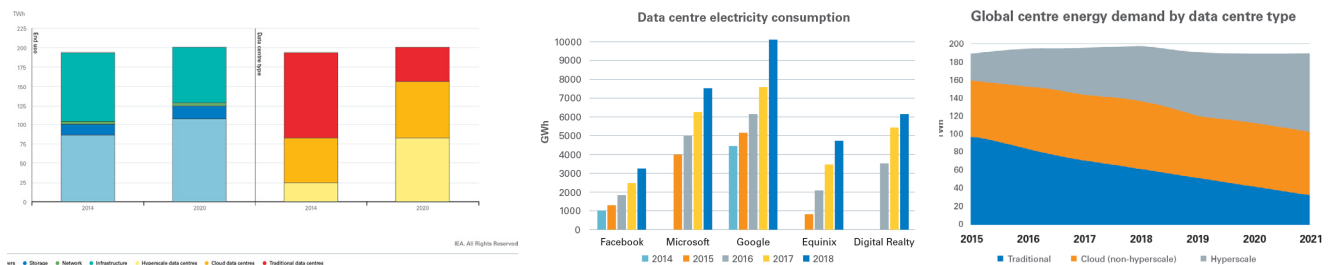


Figure 1 – Growth in Hyperscale datacentre demand and trend away from traditional inefficient computing resources.

Data centre Redundant Design

Modern data centres are designed with highly redundant power supply systems. These can include dual utility supplies, redundant power paths, backup engines, batteries and UPS systems. Various topologies of increasing resilience are shown in Figure 2. The 2(N+1) arrangement is common in hyperscale facilities.



Figure 2 - Data Centre topologies

“The maximum tolerable period of disruption (MTPD) is continuing to decrease for most companies because there is less tolerance for their operations experiencing any sort of downtime. There is growing pressure and necessity for companies to be able to maintain uptime and recover more quickly from a disruption, no matter how it was caused.”
- Digital Realty

With all these backup systems, data centres tend to revert to “island-mode” when they detect anomalies in the utility supply. Data centre operations can continue unaffected. With data centres growing in proportion to the overall system, the grid operator’s response may be to defer connection of new renewable generation in the longer-term, or to curtail existing nuclear or renewable energy generation.

Data Centre Redundant Infrastructure Can Support the Grid

The redundant infrastructure in a data centre can help the grid in a number of ways. It can act either as a system reserve or as a fast frequency response mechanism (see Figure 3), without ever compromising its primary purpose.

Data centres can support energy providers by:

- Adapting to renewable energy demands and providing a flexible power reserve.
- Balancing the power reserve without using fossil fuels in order to contribute to sustainable energy.
- Helping energy producers to take hydro power out of reserve and use it for energy production.

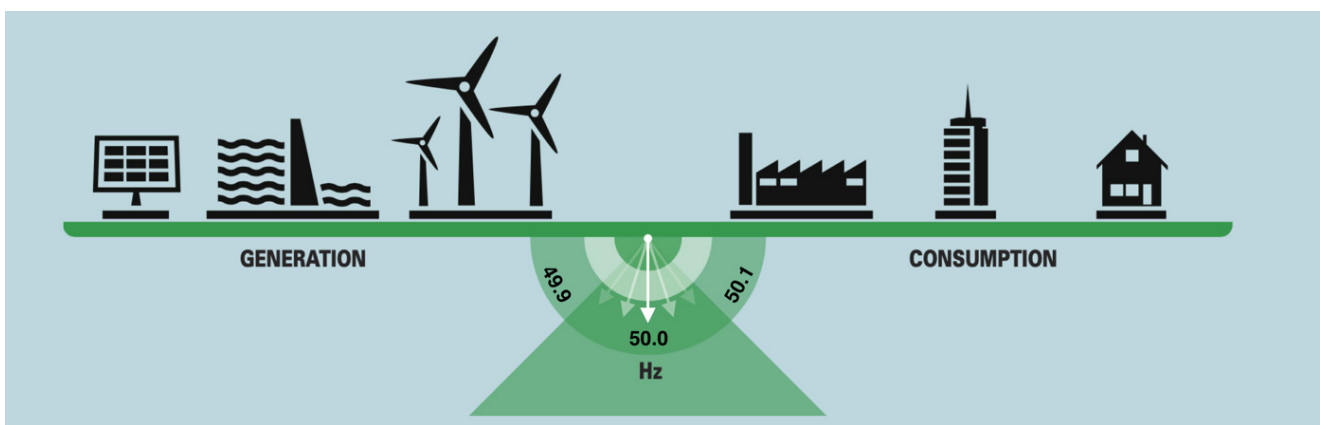


Figure 3 - Frequency response balancing electricity grids.

Uninterruptible Power Supplies (UPS) and Battery backup systems – Technical Note.

Data centres typically use double-conversion UPS systems. These are arranged with batteries in a redundant topology. They are designed to provide backup power for a sufficient time to allow generators to attempt several starts. They operate in a seamless manner, and also use this functionality to smooth any grid-borne power irregularities. The job of the UPS is to ensure the delivery of continuous and stable power to the sensitive IT equipment.

The majority of modern double-conversion UPS systems are designed using insulated gate bipolar transistors (IGBTs) as core power electronics components. They enable bi-directional power flows. A UPS can interact intelligently with the grid, while still performing its primary function of load protection

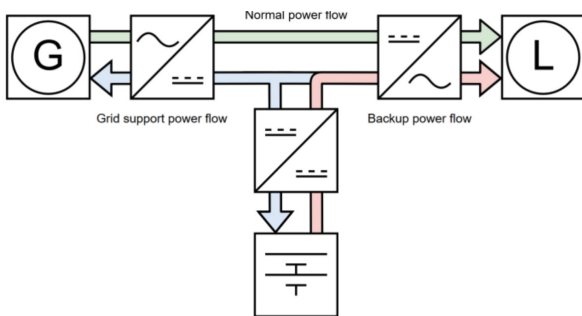
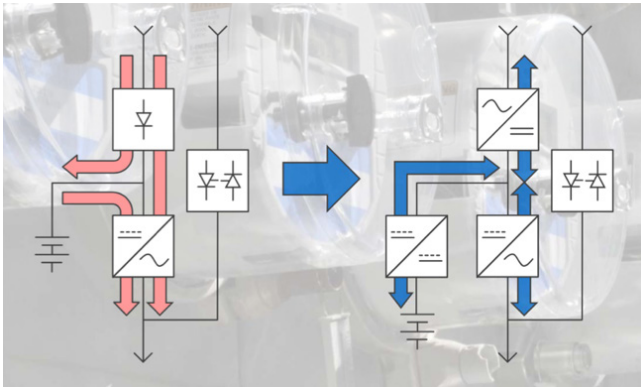
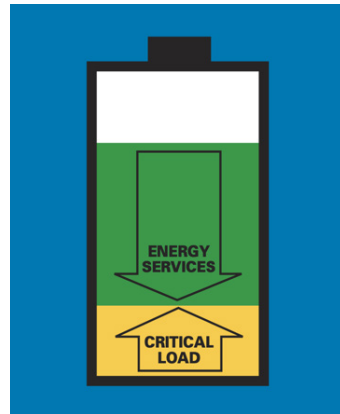


Figure 3. Different power flows between the grid (G), the UPS (3 converters) battery system, and the critical load (L).

UPS Capacity Allocation

By allocating only a specified portion of the stored energy in the UPS system, the primary function of the UPS is always maintained. The data centre operator always retains control of their system. The algorithms built into the UPS system guarantee that only the specified portion of stored energy is available to the grid, and parameters for the interaction can be adjusted as required. Think of it as a virtual machine made available to the grid operator under specified conditions and backed by a pre-defined agreement.

The spare capacity can be used for fast frequency response or other agreed services, depending on the requirements of the grid in which the system operates.



Battery Health

Battery types and vary in their capabilities in different applications – see (Figure 4). Eaton ensure that the correct battery is specified to suit the application. The critical load is never compromised.

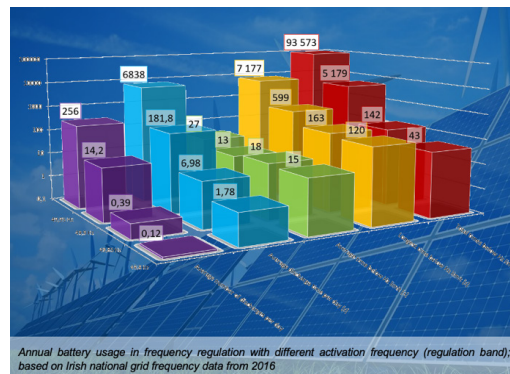


Figure 4 - Battery technology testing.



The Carbon-Negative opportunity for Data Centres

For data centres and cloud operators looking to improve their green credentials, there are proven ways to improve efficiency in operation and design. Procuring 100% renewable energy through power purchase agreements has become mainstream practice – tech companies are among the biggest purchasers of renewable energy through PPAs.

The next level of environmental responsibility can involve supporting the electricity grid to integrate more renewable energy and therefore to achieve a negative carbon impact. Using data centre UPS systems to do this provides a broad set of benefits for both the grid and the data centre operator:

- Financially positive – market incentives are in place to pay back the extra investment
- Resource efficient asset optimisation
- Potential to become carbon negative
- The result is a more robust and stable electricity grid for all

The Eaton EnergyAware UPS offers a safe, flexible and versatile solution:

- Safe: Technically robust solution which maintains priority for the load at all times.
- Flexible: Can fit requirements for any market.
- Versatile: Helps with integrating local energy sources.

To learn more about Eaton's EnergyAware UPS, visit:

<https://www.eaton.com/gb/en-gb/products/backup-power-ups-surge-it-power-distribution/backup-power-ups/backup-power-solutions/eaton-upsaar.html>

- Eaton EnergyAware UPS: <https://www.eaton.com/gb/en-gb/products/backup-power-ups-surge-it-power-distribution/backup-power-ups/backup-power-solutions/eaton-upsaar.html>
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