

Power Management Reimagined

DC Forum Stockholm 2023

Luca Maretti

AC Power Application Engineer, EMEA and ROW



Market Drivers: Critical Power Infrastructure

Adding Sustainability Considerations

Drivers	Trend
Reliability / Service Level	<ul style="list-style-type: none">• “Fail Small” / Reduce “blast radius” of equipment failures• Lower system level redundancy while reducing single points of failure• Power quality / harmonic mitigation• Fault Management
Operating Capability / Costs	<ul style="list-style-type: none">• Increase infrastructure utilization / lower physical redundancy• Larger building block architectures, align equipment sizing• Controls: Increase automation, reduce cost of implementation and risk of human error
Deployment / Modularization	<ul style="list-style-type: none">• Deploy in modular chunks vs total build up front, “Normalized” designs• Parallel path design / build activity• Move work from site back into the supply chain (lower cost and improve quality control) – Skids, MERs, FOK testing, remote FWT/CX testing
Sustainability / Decarbonization / Power Availability	<ul style="list-style-type: none">• Deploy energy saving operating modes / piloting grid services• Reduce diesel generator starts• Enable integration of Distributed Energy Resources (DERs)<ul style="list-style-type: none">• Fuel Cell, BESS, Linear-Generator, on-site renewables• Manage the challenging landscape of BYOP (Bring Your Own Power)

Initiatives to meet Sustainability Market Drivers

Increase delivered UPS power and efficiency

Increase N+1 utilization

Convert to lithium-ion batteries

Value engineer the critical power system

Reduce diesel generator presence

Environmental certification and LCA

A three-step approach to achieving carbon-free operations

- ❖ The first step, which many organizations have already taken, involves matching current energy use with renewable energy.
- ❖ The second, which is gaining traction today, focuses on increasing the utilization and efficiency of critical data center infrastructure.
- ❖ The final, and ultimately most transformational step, involves the shift away from utility power as the primary data center power source



Dynamic Power Architecture Evolution












UPS as Energy Center

- UPS is both source of power quality, backup and the energy manager
- Grid support capability
- Battery Energy Storage Systems (BESS) Integration
- BESS, Fuel Cell and other sources integrated on DC-bus with UPS
- Seamless transition between Operating Modes (Dynamic Online operation mode, Dynamic Grid Support, Load Sharing)
- Bi-directional rectifier to support mechanical loads

Dynamic Power Portfolio of Hybrid Power Solutions for Mission-Critical Environment

- Enable users to sustainably integrate and control their always-on power infrastructure and local energy sources
- Reduce/Eliminate Generator CO2 emissions
- Support grid balancing, renewables, and microgrids

UPS as Energy Center Key Technology Elements

	Customer Needs	Technology Enabler	Market Interest
Available today	Minimizing energy waste	Highly reliable, high efficiency equipment and its usage	
		Highly efficient UPS operating modes	
Early Pilots / Targeted Geo	Grid support to reduce carbon footprint, increase profit / costs savings	Peak Shaving: UPS batteries enable cost savings with demand management	
		Frequency Regulation: UPS batteries to support power generation constraints through rapid response to grid frequency variations	
Lab / Proof of Concepts / Initial customer approaches	Back up power and reduction of operational and embodied carbon footprint	BESS as an AC source power backup. Need separate solution for power quality.	
		MV Line Interactive UPS for higher efficiency and lower carbon footprint (Rotary UPS to start with). Supporting also Long Duration Batteries	
		Fuel Cell Integration: Integrate Fuel Cells to the UPS for backup	
		EM Controls while integrating multiple AC and DC energy Sources Including Long Duration Batteries in HVDC and FC	
		Other technologies (e.g. Phinergy, Mainspring Linear Generator,...)	
Future Direction	Integrate multiple local energy sources	UPS integration with renewables/low CO2 sources (FC, PV, wind) in DC (on battery bus or DC bus) for both backup and prime power	
		Micro-Grid: Energy Manager using different energy sources in DC (connected to UPS) and AC	

Dynamic Grid Support



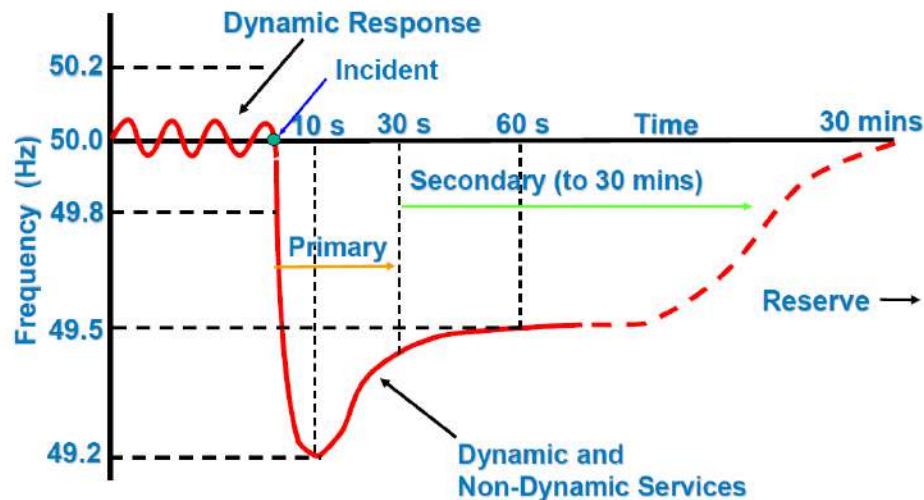
Grid Services Opportunities

Demand & Response Services can be broadly categorized to target Frequency Management and Demand Management

Frequency Management

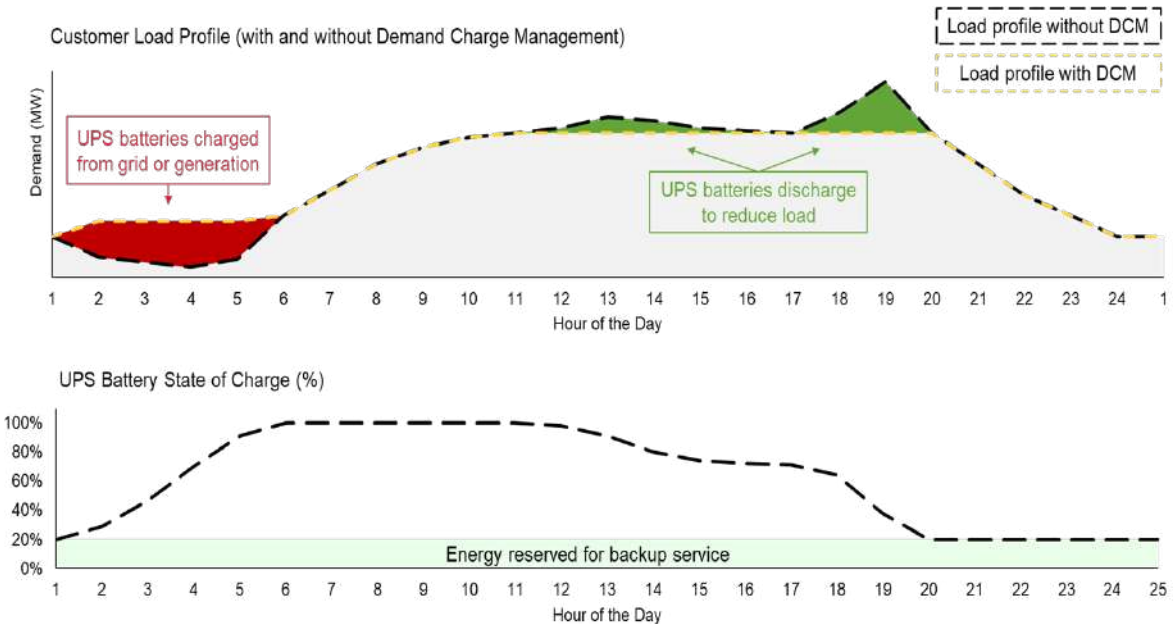
A **fast-acting balancing system** is needed to provide a quick response to sudden frequency variations and increase or reduce the electricity demand within a few Seconds (**fast frequency response** and primary reserves) or minutes (secondary reserve).

The faster the response, the higher the revenue opportunity.

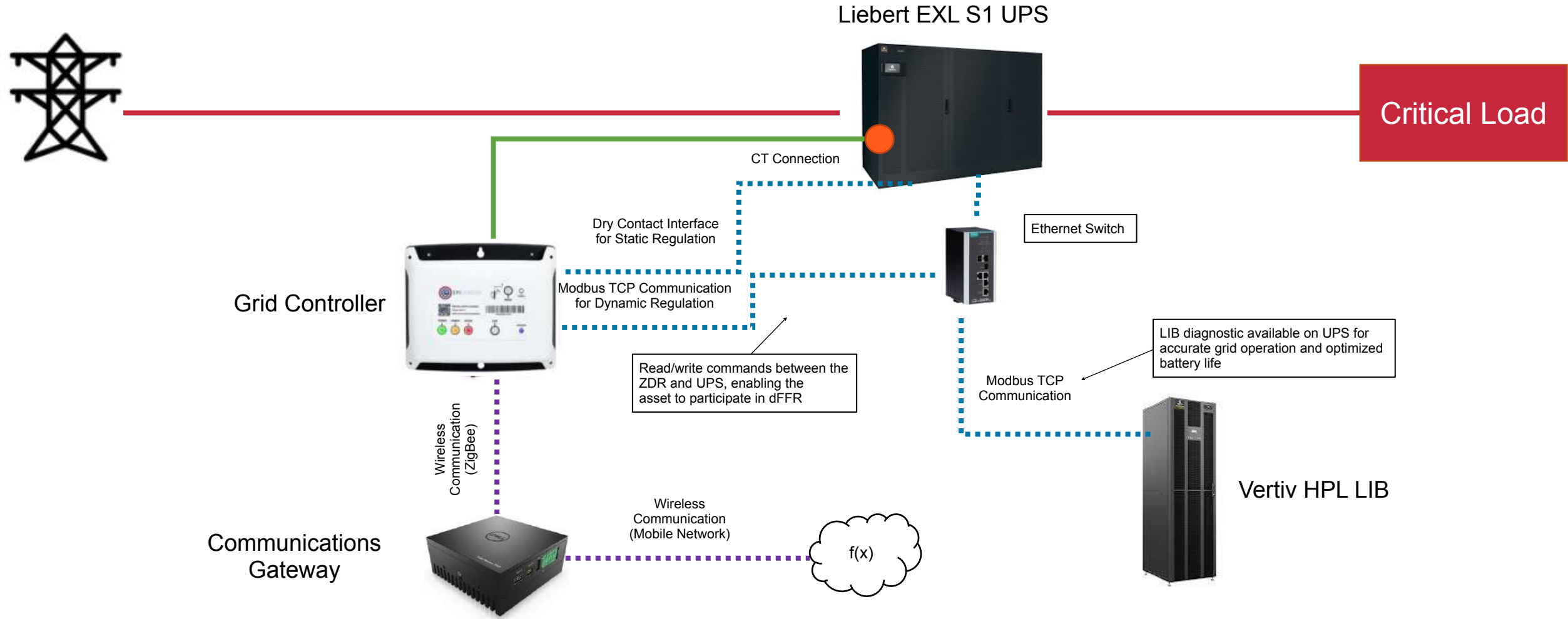


Demand Management (Peak Shaving)

In times of low demand or high supply, energy is fed into storage, from which it is released at times of high demand or low supply. Alternatively, consumers adjust their energy consumption according to the changes in electricity market price or management of different auxiliary power sources.



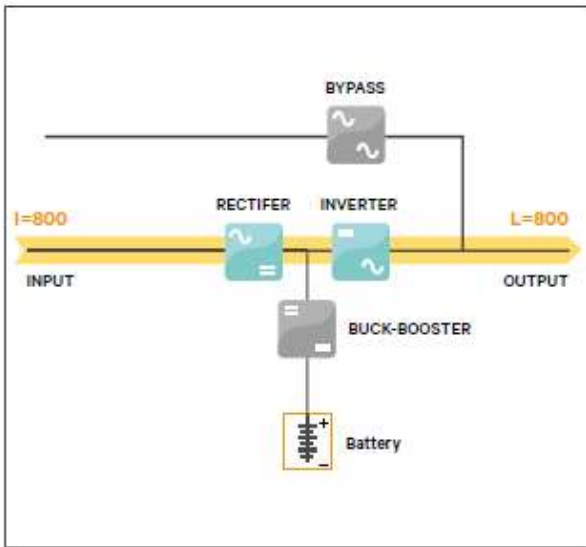
Liebert EXL S1 for Frequency Management – System Outline



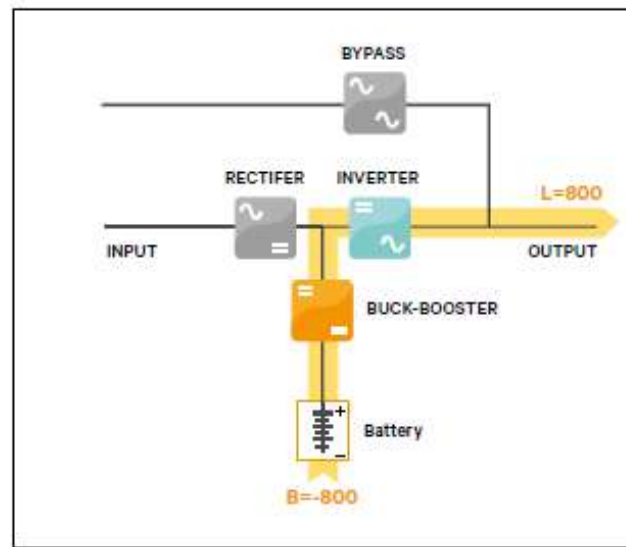
Static regulation via dry contact with predefined fixed power response activated at a predefined frequency deviation
Dynamic regulation via Modbus with dynamic power response based on frequency deviation

Intelligent Power Converter Operating Modes

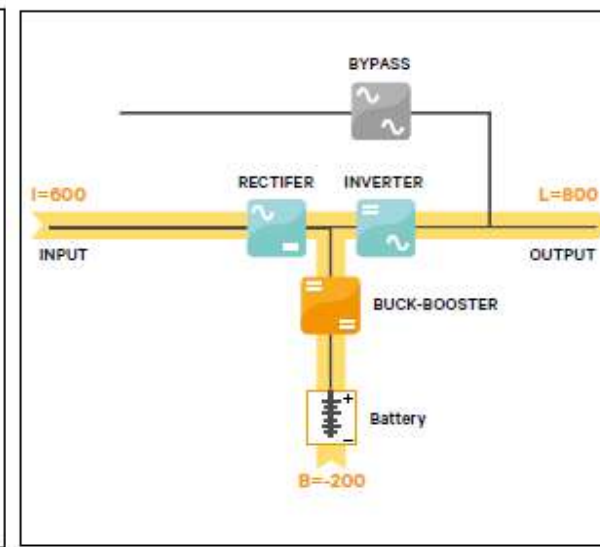
Normal UPS Operation



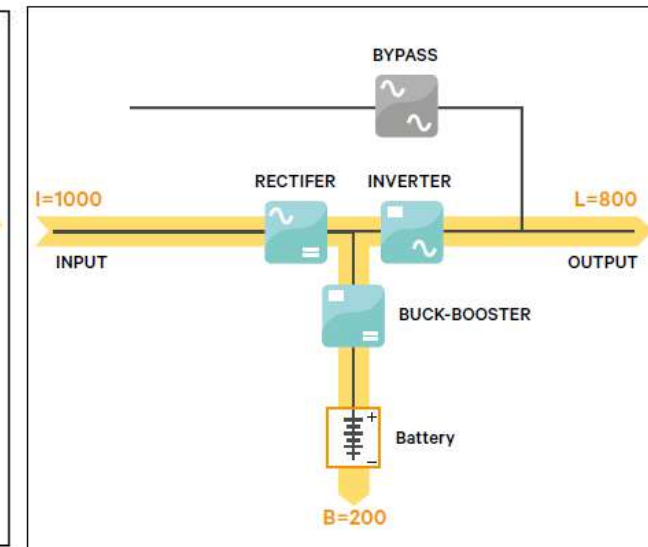
On Battery Mode



Source Sharing Mode



Battery Recharge Mode



Export Mode (Not Shown): The UPS is also able to manage energy export into the grid. When required, the UPS works as a bi-directional power converter, by discharging the batteries to inject power upstream the UPS.

BESS



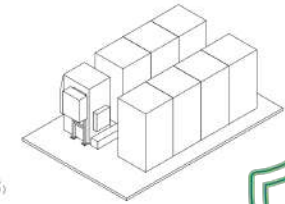
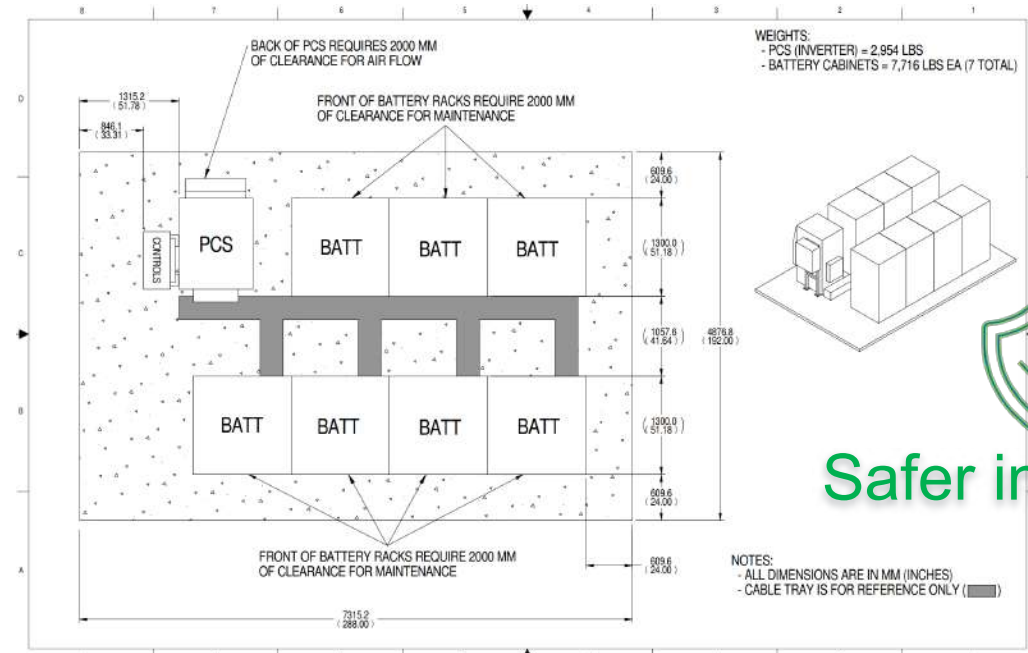
Vertiv™ DynaFlex BESS – Modular Design

Modular, scalable, and Microgrid Approved
Vertiv Power Converter

- 250/500kW
- 1.5MW
 - Scales to $1.5 \times 4 = 6\text{MW}$ (bus connected)

Batteries

- LFP and NMC
 - UL9540A, UL1973
- Product has Global Certifications
 - International Certifications for Interconnection



Safer installation



Vertiv BESS
Controller
Microgrid Ready!



State of the ART
PCS

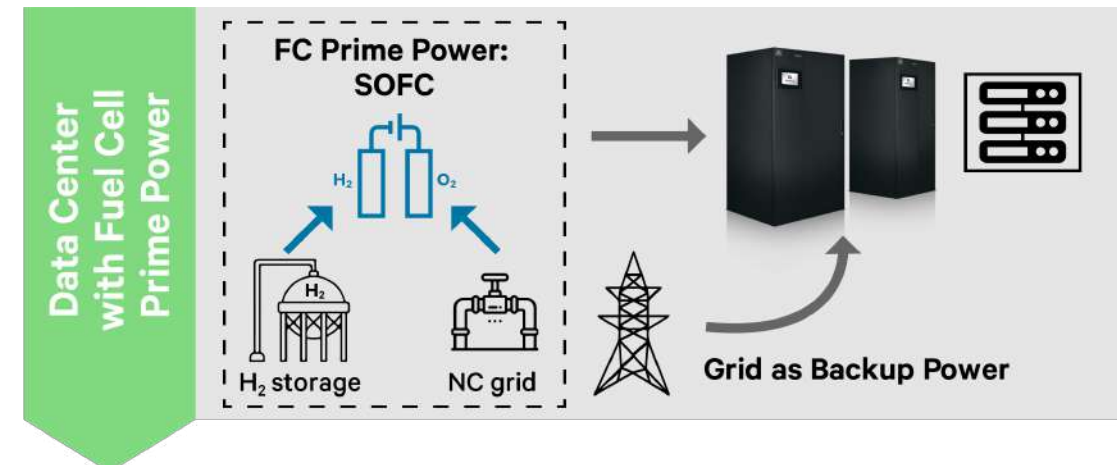
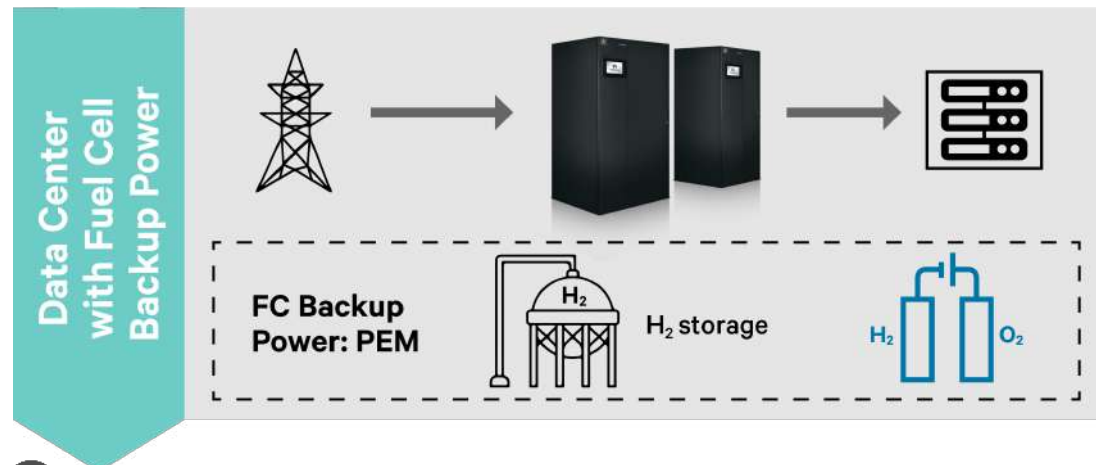
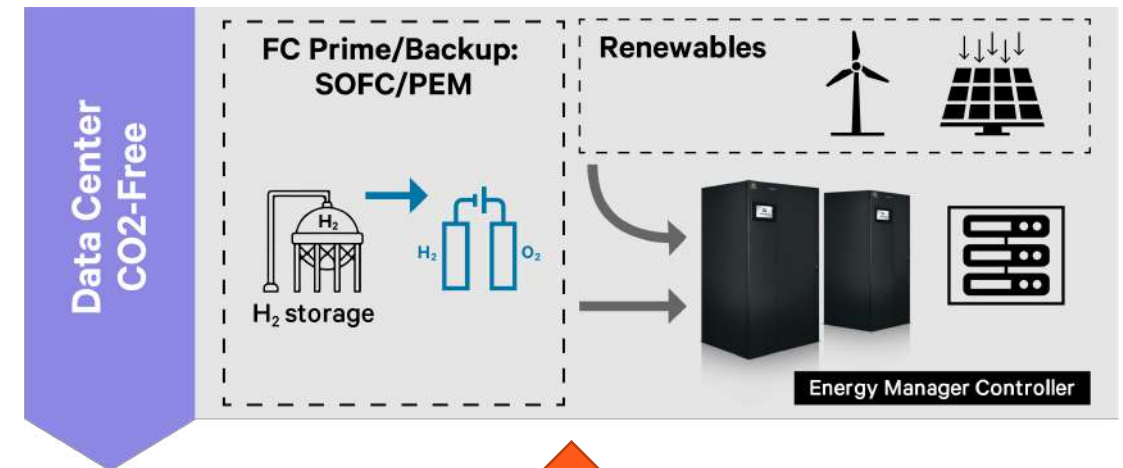
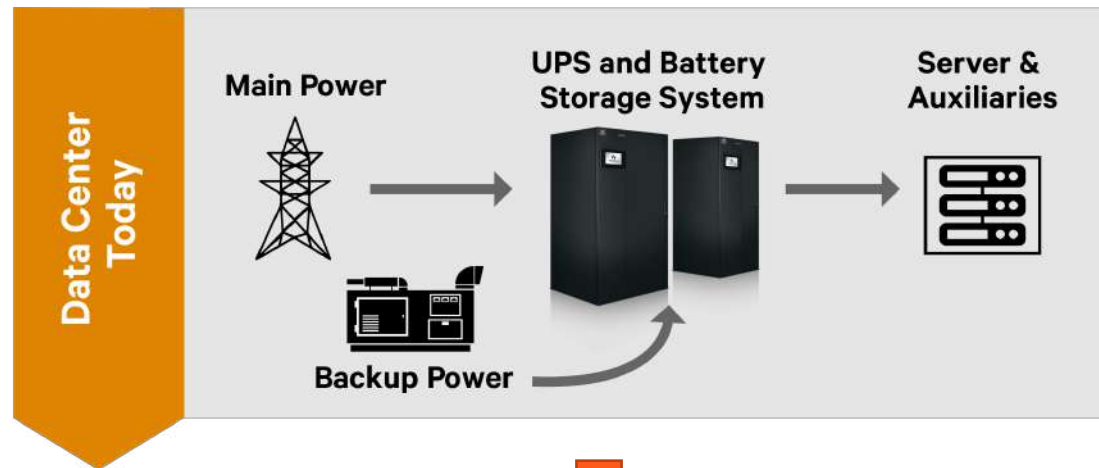


Liquid Cooled LFP

Fuel Cells integration



The Path to CO₂ Free Operation: Fuel Cell Integration for Backup and Prime Power

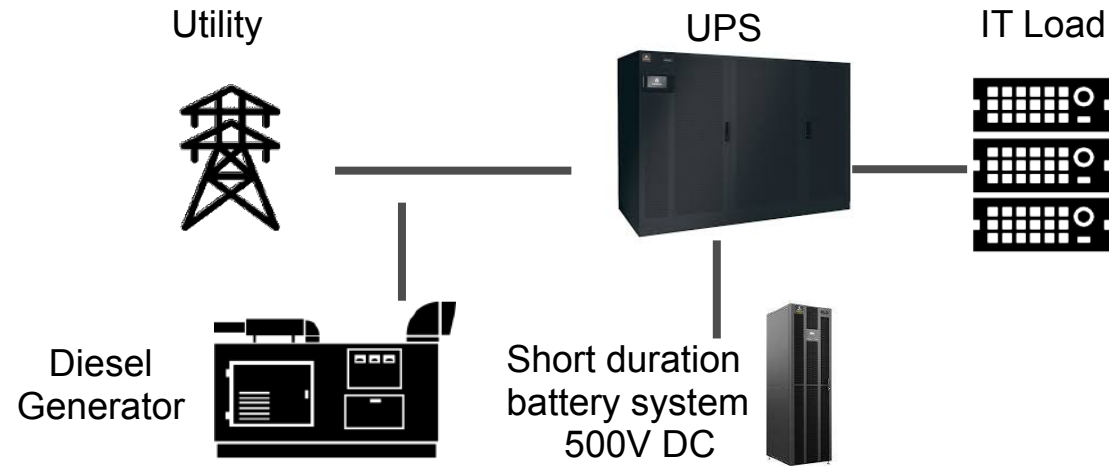


Backup Power Options



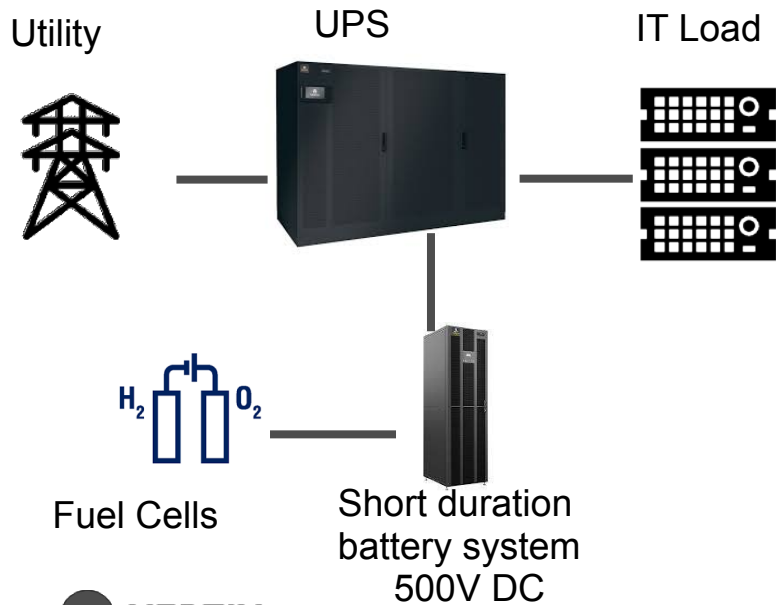
Backup Power Options- Current and Future

CURRENT

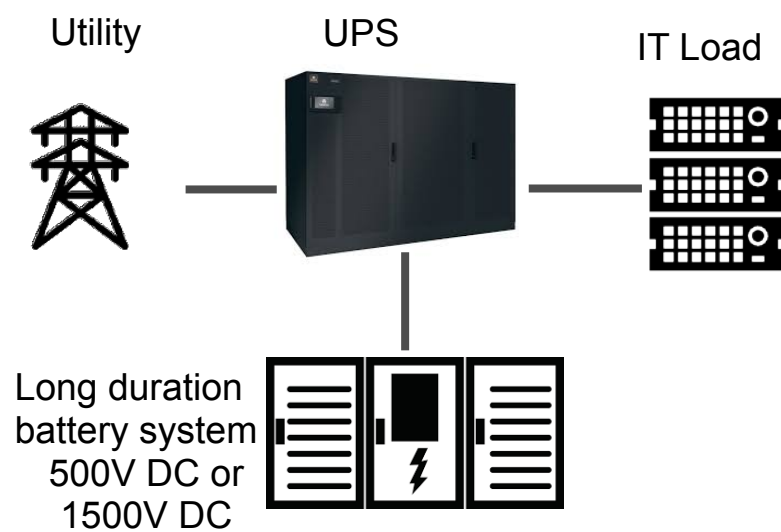


FUTURE

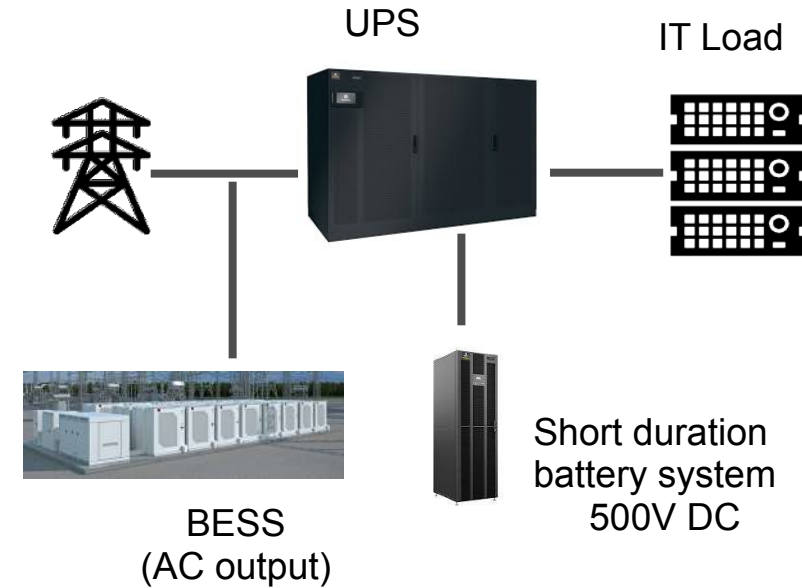
Scenario 1



Scenario 2



Scenario 3



Vertiv Proof of Concept (Delaware)



BESS and Fuel Cell Proof of Concepts (POC)– Del, OH Facility

Fuel Cell Integration

- 400kW fuel cell solution packaged in a SmartMod
- Initial scope to support EXL S1; Expansion to other Vertiv UPS models in future
- HPL batteries to provide transient ride -through
- H2 stored on -site in tube containers
- Availability Target: **Q4 2023**

Battery Energy Storage System (BESS) plus Solar

- 1.0MW AC Solar PV
- 1.0MW/1.48MWh Battery Energy Storage System (BESS)
- Integrated Energy Management System (EMS)
- Setup for Future Microgrid
- Virtual controls demonstration available
- Availability Target: **Q4 2023**

Hydrogen Storage
Tanks

400KW PEM Fuel
Cell Module

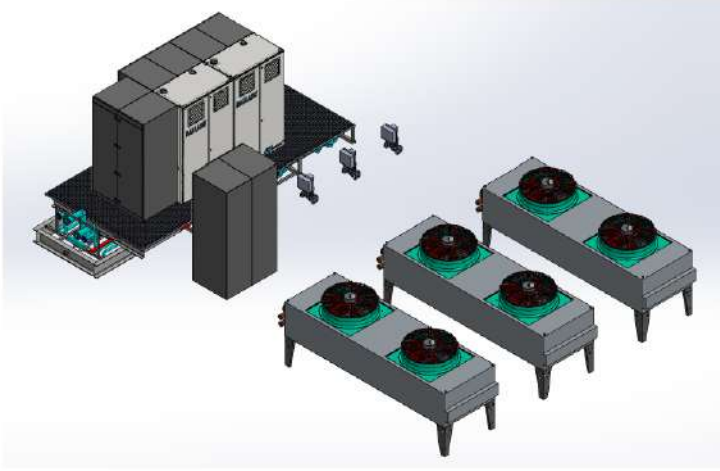


1.5MWh Battery Energy
Storage System (BESS)

1.0MW Solar Array

UPS Integration with Fuel Cells- Proof of Concept

FC 400kW, FC DC/DC, Cooling system



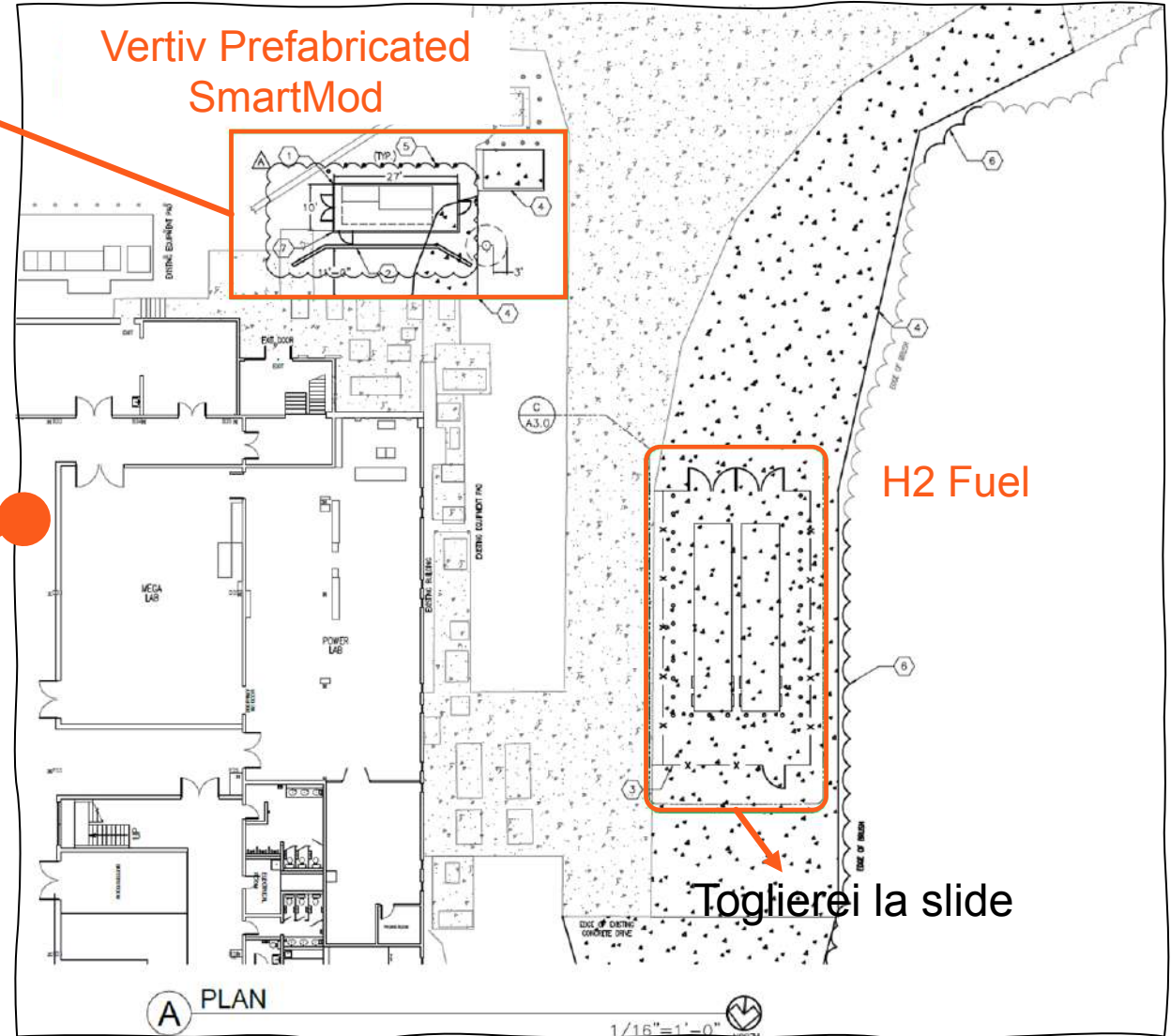
Demonstration area



EXL S1 1200kVA



Vertiv Prefabricated SmartMod



H2 Fuel

Toglierei la slide

Final Installation



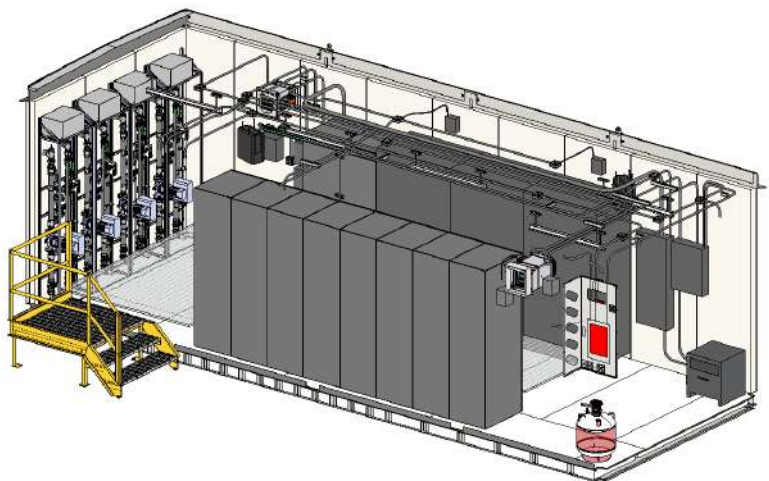
Customer Experience Area

Still under construction

- Will have multiple monitors that will display waveforms on the scope.
- Cameras will be installed in the Fuel Cell container to watch the equipment during live operation.



H2 Power Module



Cut off view of the Vertiv™ Power Module H2

The rise of new technologies, like generative AI, IoT, AR/VR, is increasing the need for energy in today's data centers and it is often surpassing the capacity available from existing power grids resulting in an urgent call for onsite power generation.

Traditional back-up options such as diesel generators, are becoming less viable due to the urgent need to combat global warming and the resulting sustainability regulations that are one of the prevailing challenges in data center industry today.

The Vertiv Power Module H2 is a sustainable alternative for

meeting escalating energy demands of future data centres as well as targeting zero-emission power generation.

The PowerModule H2 is available in a range of 200kW - 3200kW based on specific requirements for backup or continuous power operation.

Vertiv Power Module H2 - The Future of Data Centre Power

Advantages of Vertiv™ Power Module H2

By merging UPS and hydrogen Fuel Cell technology into a single solution, the Vertiv Power Module H2 extends the application of reliable UPS backed-up power:

- As an alternative to Diesel Generator
- To prime power application with zero emissions and low CO₂ footprint

Vertiv Power Module H2 is also retaining all the well proven benefits of a prefabricated Power Module design:

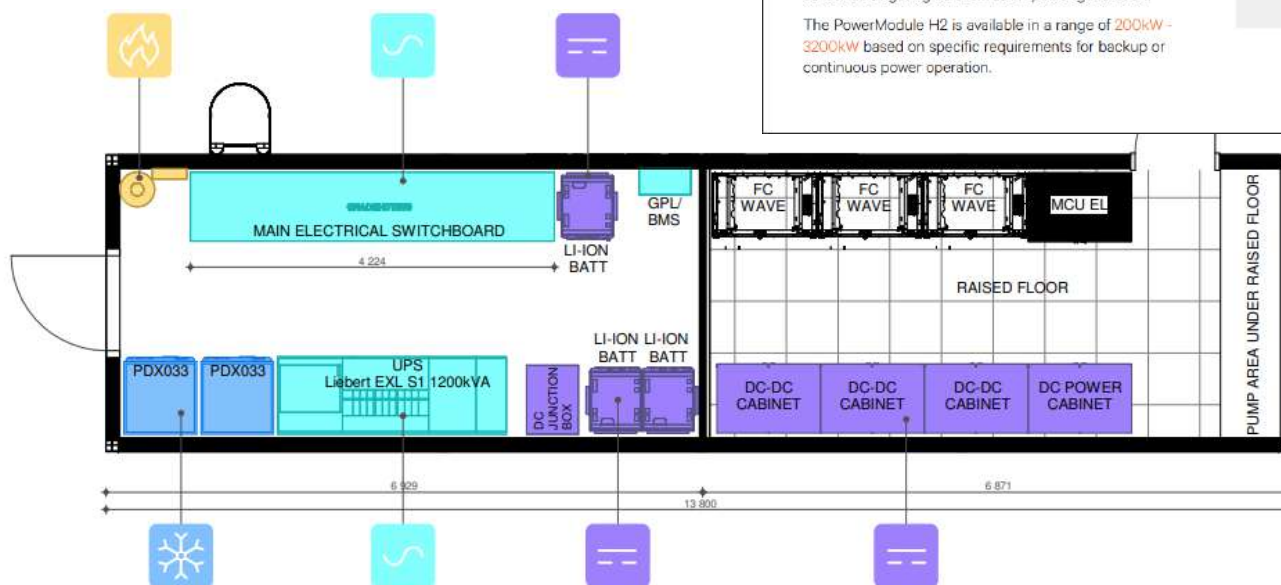
- Single-supplied complex power infrastructure solution
- Rapidly deployable and factory tested
- Simple, seamless on-site integration
- Scalable design, pay-as-you grow model

Fuel cell benefits

- Proven and established power solution for various applications
- Can support true carbon-neutral data center operation
- Increased operational reliability and energy management in data center operations when paralleled with UPS and Li-Ion batteries
- Longer back-up times compared to batteries; can support up to 48 hours of continuous operation for 1 MW data center
- Superior efficiency and less maintenance compared to diesel generators



Exterior view of the Vertiv™ Power Module H2



Toglierei la slide

Conclusions

Vertiv Dynamic Power reimagines power management for companies who want to build new critical infrastructures but struggle to meet increased power demand and the constraints and complexity of available power.

- **Reducing dependence on carbon-based fuels** represents a competitive advantage in the short term and a necessity in the long term.
- Working with a forward-thinking and innovative infrastructure partner like Vertiv puts you in the position to move forward **with proven technologies** that allow you to take steps today toward a carbon-free tomorrow.
- Vertiv stands ready to work in partnership with customers seeking **to reduce or eliminate their reliance on carbon energy sources.**

