Dynamic Grid Support

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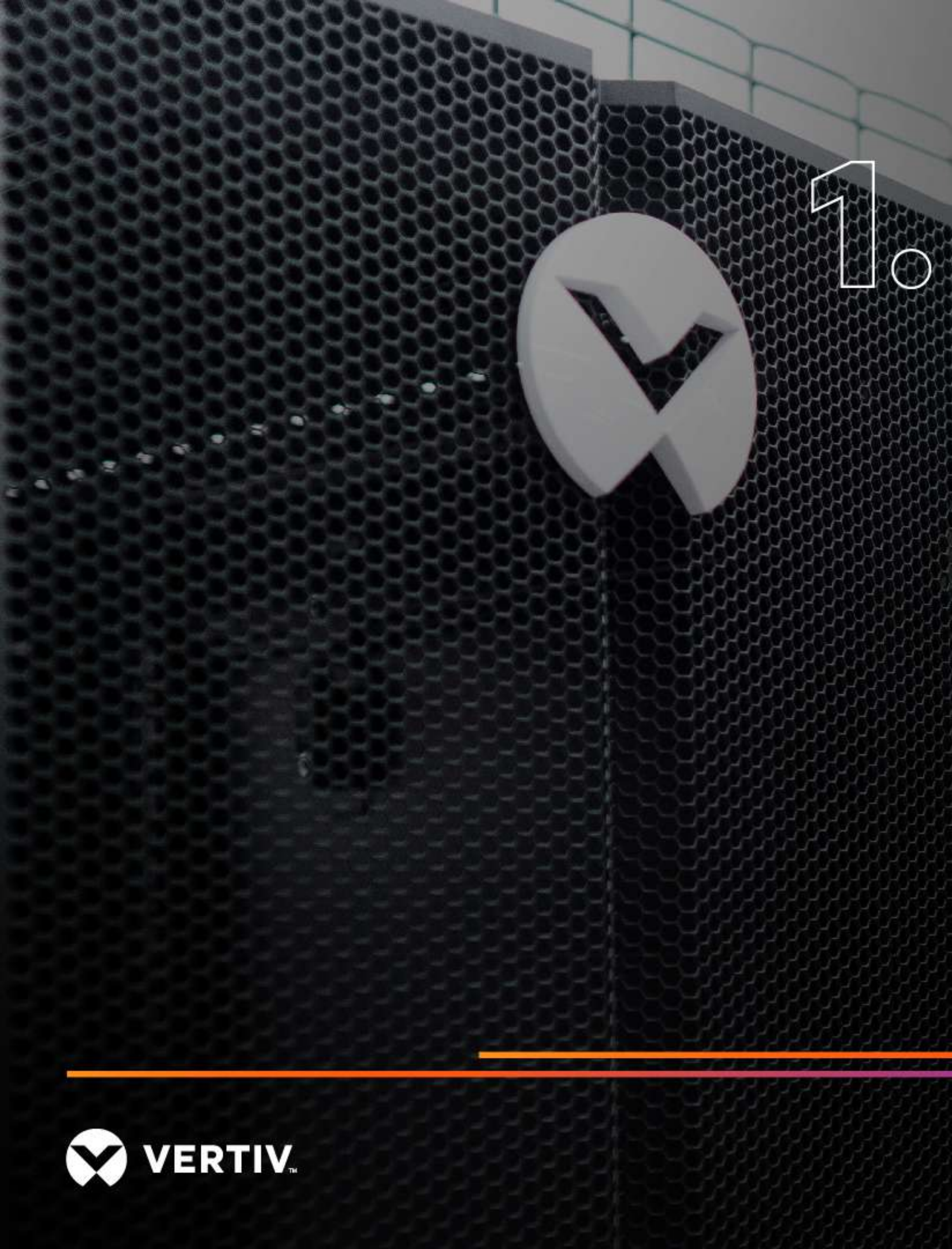
Dynamic Grid Support

- Bolster data center UPS
- Address the imbalance related to renewable power generation
- Meet sustainability goals
- Generate revenues and monetize backup capacity
- Reduce energy bills



1. Data Centers Face Increasing Regulations

- Governments at all levels are taking a hard look at data centers' energy and water consumption.
- Data centers are responsible for an estimated 1-3% of global electricity consumption, with the average hyperscale facility consuming 20-50MW annually – theoretically enough electricity to power up to 37,000 homes.

Let’s think outside the box

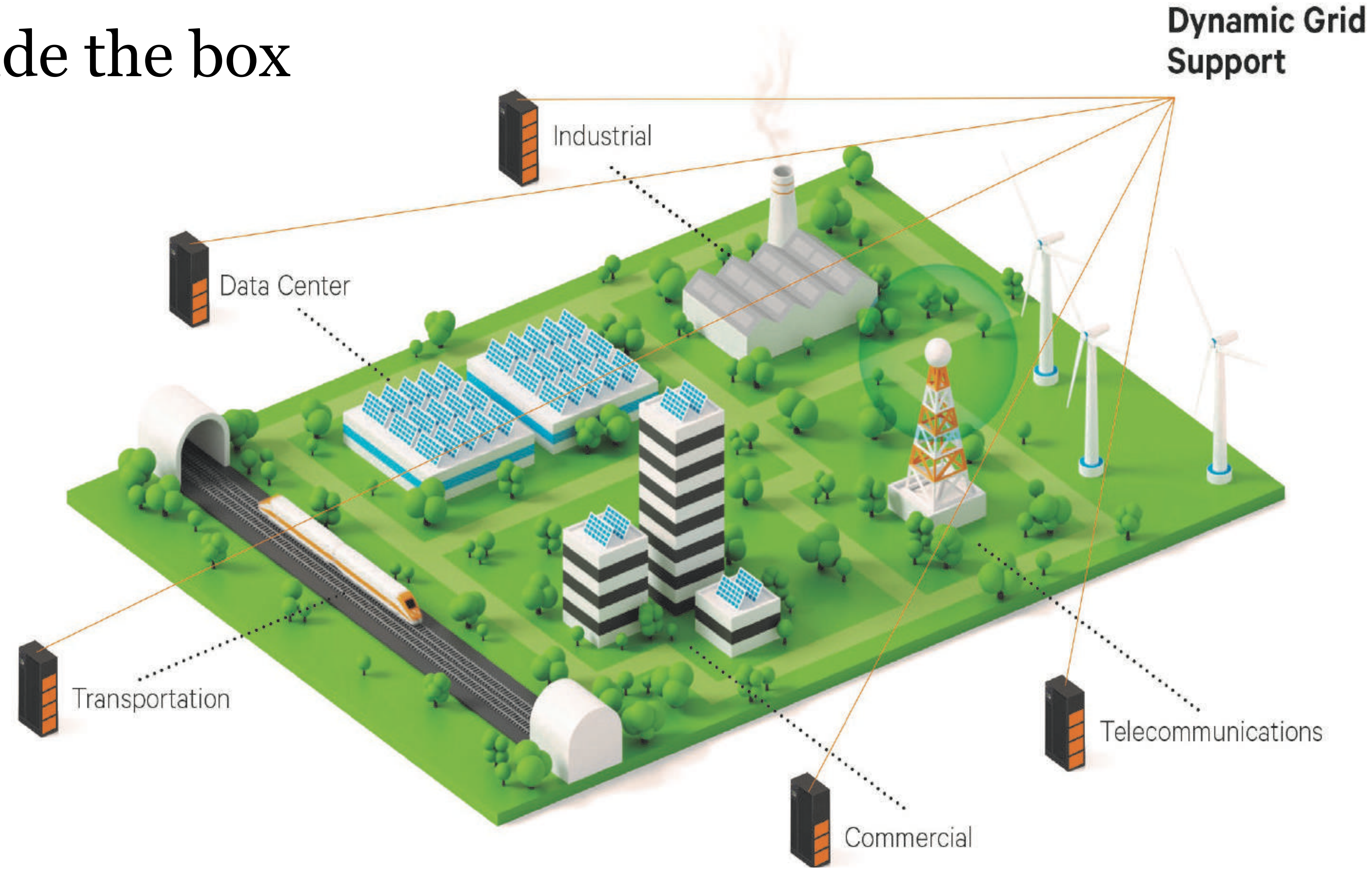
Energy management and storage

Renewable energy

Intelligent heat recovering

Giga-connectivity with low latency

Close to the ‘consumer’ computing



Smart, intelligent energy-district heating-connectivity hubs

Frequency Response

- What is Frequency
  - Frequency in a power system is a real-time changing variable that indicates the balance between energy supplied by the grid and energy demanded by consumers.
- Why is Frequency Response needed?
  - Increased renewable generation from wind and solar poses significant challenges to its grid stability. As a result, there is an increased likelihood of frequency deviations

Source: EnelX

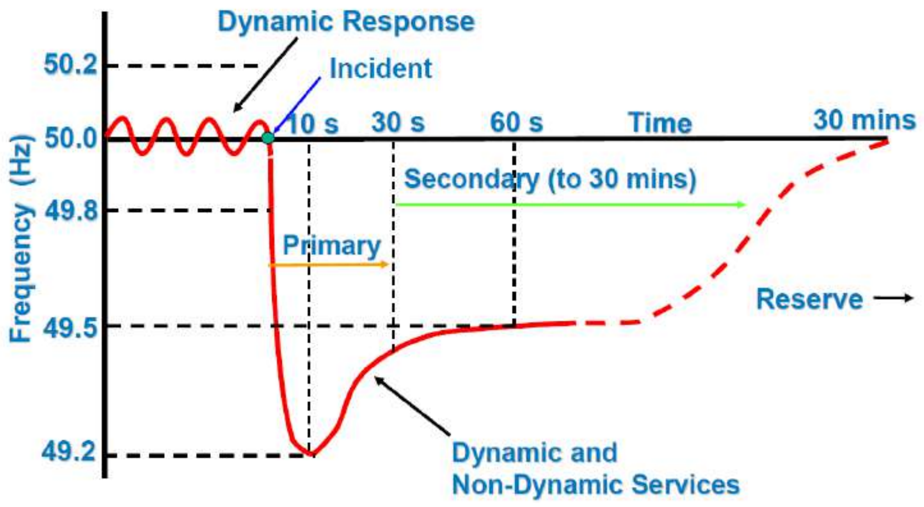
Grid Services Opportunities

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

Frequency Management

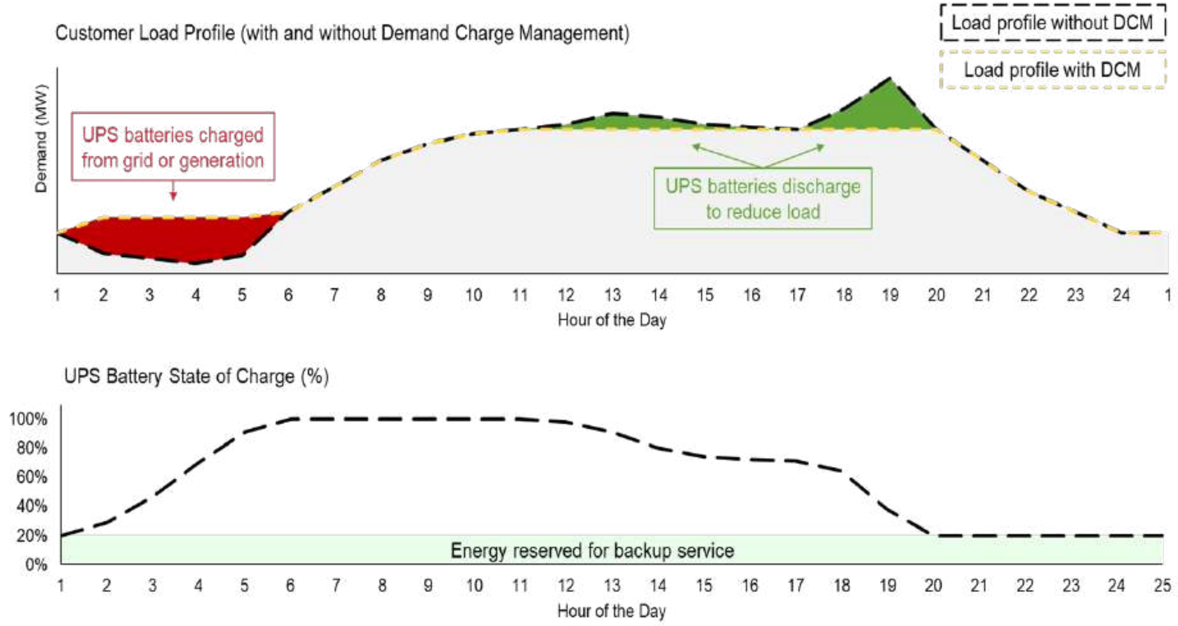
A **fast-acting balancing system** is needed to provide a quick response to sudden frequency variations and increase or reduce the electricity demand within a few Seconds (**fast frequency response** and primary reserves) or minutes (secondary reserve).

The faster the response, the higher the revenue opportunity.



Demand Management (Peak Shaving)

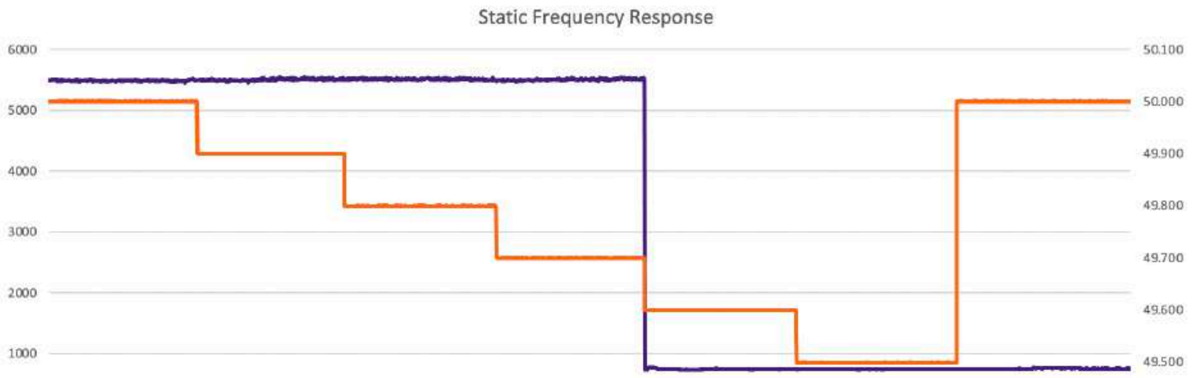
In times of low demand or high supply, energy is fed into storage, from which it is released at times of high demand or low supply. Alternatively, consumers adjust their energy consumption according to the changes in electricity market price or management of different auxiliary power sources.



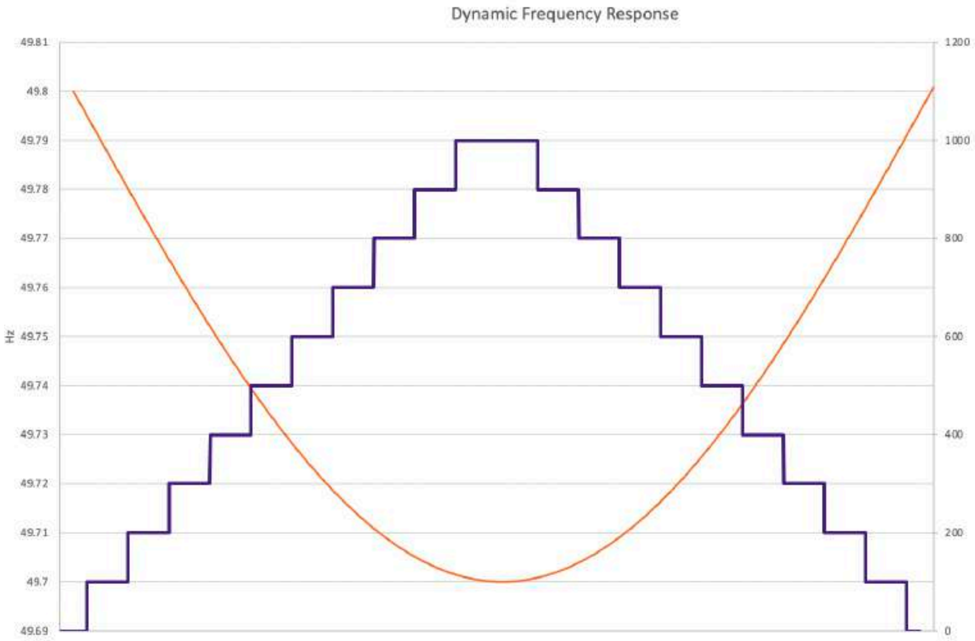
Grid Services Opportunities

Static & Dynamic Frequency Response

Static frequency response is **a digital type response** where a site reduces its electrical consumption based on one frequency setpoint.

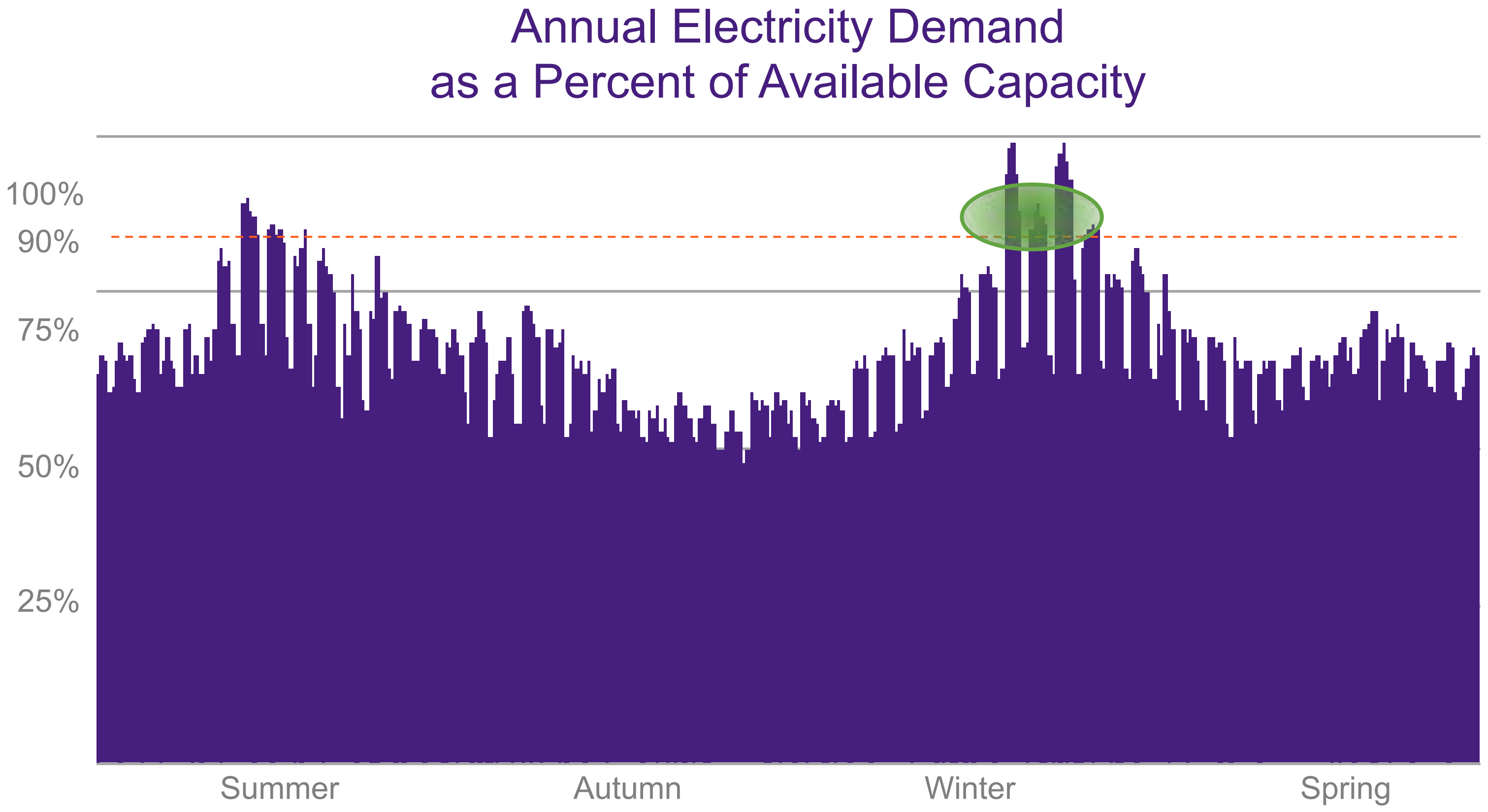


Dynamic frequency response is **an analogue type response** where a site tracks the grid variations and reduces/ increases its electrical consumption based on the frequency.



The Value of Grid Support Services

- More than 10% of grid infrastructure costs are spent to meet peak demand that occurs less than 1% of the time.
- Building a new power plant for that 1% of the time is incredibly expensive.
- Demand response is a fast and cost-effective way to meet peak electric demand.



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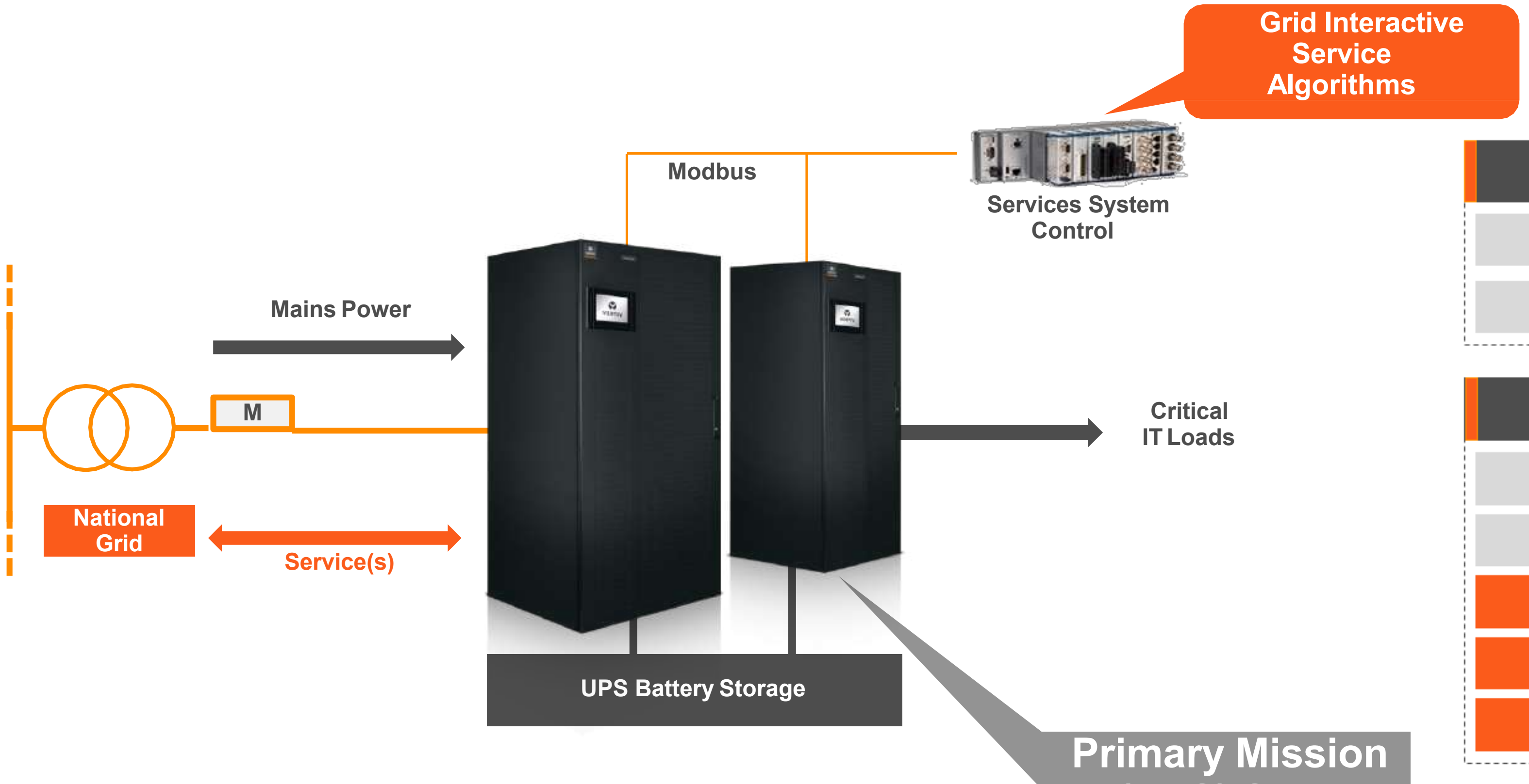
Source: EnelX

UPS With Grid Support Capabilities As An Intelligent Power Converter

DATA CENTER «ACTIVE CONSUMER»

Liebert® EXL S1

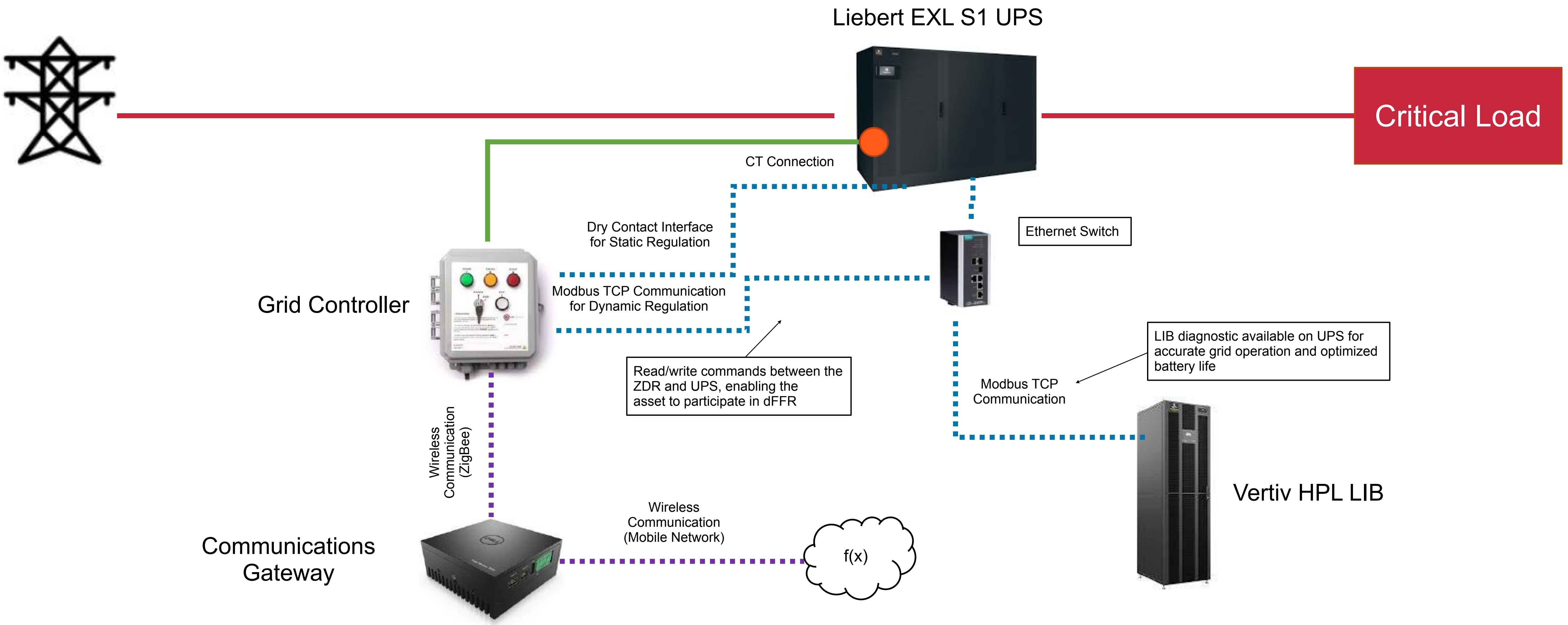


Traditional UPS Services
- Backup Power
- Power Quality

Grid Interactive UPS Services
- Backup Power
- Power Quality
- **Demand Management**
- **Fast Frequency Response**
- **Grid Services***

* Frequency Regulation, Synchronous Reserve, Resource Adequacy, Reactive Power, Flexible Ramping, Demand Response

Fast Frequency Response: Static and Dynamic Frequency Regulation



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

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Application case: Battery sizing for DGS in Ireland

The battery backup time for Liebert **EXL S1 1.2 MW** UPS for a data center is **1 minute**.

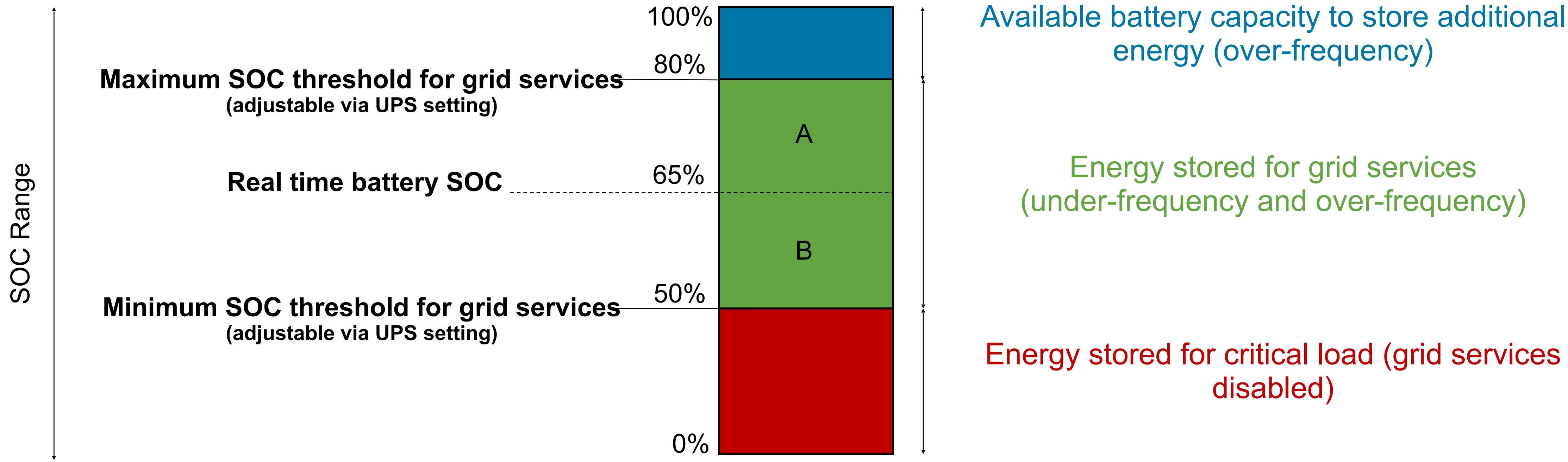
By adding to the existing capacity an extra investment in terms of energy storage of **5 minutes**, the user can benefit of this additional storage for grid support, gaining in both resiliency and revenues.

Sizing with HPL batteries:

- **6 battery cabinets** for 1 minute backup time
- **8 battery cabinets** for 6 minutes battery runtime (1min backup time + 5min dynamic grid support)

Revenues generated when customers are participating to Ireland's DS3 programs: FFR, POR, SOR, TOR1.
At present, an asset with 1 MW capacity could earn **~€100,000** (90k operation + 10k bonus bundle) per year.

Battery SOC Management for Grid Services



NOTE: Maximum SOC threshold for grid services is used to keep battery at partial SOC to prolong battery life. Reserve energy space can be used to manage over-frequency conditions.

Battery Sizing For Dynamic Grid Support Applications

1) What grid service do we need to target?

The most lucrative services are related to **fast frequency response**, requiring reaction time of 500ms to 1s in response to over/underfrequency detection. The UPS is expected to discharge/recharge the batteries with a demand response duration in the order of **minutes**.

2) How will this impact battery life?

In **traditional back-up** applications, life projections are mainly based on calendar effects.

In a **grid service** application, cycling degradation will add to the calendar degradation

3) How to properly size the batteries for grid services?

Number of Battery Strings Affects Many Parameters. Adding battery capacity increases initial battery cost but substantially increases grid service duration and mitigates the life impact of grid service operation.

Grid Service Power	1200 kW		840 kW	
# of HPL Racks	8	12	8	12
Grid Service Load per Rack	150 kW	100 kW	105 kW	70 kW
Total Usable Energy	75%	88%	87%	89%
Total BOL Capacity	304 kWh	456 kWh	304 kWh	456 kWh
Reserve Energy*	20 kWh	20 kWh	20 kWh	20 kWh
Demand Resp. duration**	~10 min	~19 min	~17 min	~27 min
Eff. Discharge Rate (C)	3.94	2.62	2.76	1.84
Battery Life Impact	Critical	Severe	Severe	Significant

* Assumes 60 seconds of outage protection at 1200 kW, excludes UPS overload condition

** Estimated at beginning of life

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Takeaways

1) Datacenters contributes to a significant amount of the worlds total energy consumption
Dynamic grid support positions you well for future regulations and contributes positively to the energy system and society.

2) Commercial attractive
Small additional Capex vs standar UPS & batteries

3) Dynamic grid support is here to stay
It is not any longer a powerpoint product, it is being applied on a broad commercial scale.