



Super Capacitors Business Cases for Industrial & Utility Applications





- I. Stationary Energy Storage Fundamentals
- II. Supercapacitors vs. Batteries
- **III.** Supercapacitors application in ESS
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I. Stationary Energy Storage Fundamentals



C-Rate: Charging and Discharging rate of a storage device (Super caps/Batteries) compared to the total stored energy content.

1 MWh discharged / charged in 1 hour = 1 C	1 MW
1 MWh discharged / charged in 0.5 hour = 2 C	2 MW
1 MWh discharged / charged in 1 minute = 60 C	60 MW

Energy Density: Energy density is the measure of how much energy a battery contains in proportion to its weight. (Wh/Kg) (Typical range 5 Wh/kg to 220 Wh / kg)

Cycles life: Number of cycles (from full charge to full discharge to full charge) a storage device can provide in its designed life in order to reach 20% to 30% of its capacity compared with its beginning of life capacity. (Typical range 1,000 to 1,000,000)

Power Delivered



Supercaps vs. Batteries



Ι.



I. Supercaps Applications in ESS



Short-term (1 sec to 30sec) power supply for

- 1. Voltage dips & Micro interruptions mitigation (1 sec)
- 2. Genset bridging systems (8 sec to 16 sec)
- 3. Grid Stabilization (FCR) in combination with Hydro power and Gas (30 sec to few minutes)
- 4. Peakshaving for huge starting loads

I. Voltage Dips and Micro Interruptions



- Voltage dips are disturbances characterized by a sudden decrease in amplitude between 90% and 1% of nominal voltage
- Although followed by immediate restoration they are transferred without attenuation from high voltage level to medium and low voltage level
- Duration: 90% of the events are between 10 1000 ms



Scatter plots for all qualified dips

I. Voltage Dips and Micro Interruptions





Average annual cost (€/year)

Weldemariam, L. E. (2017). Monitoring and regulation of voltage dips in the distribution network. Technische Universiteit Eindhoven. https://pure.tue.nl/ws/portalfiles/portal/74678080/20170911_Weldemariam.pdf







ENTSO-E – European Network of Transmission System Operators for Electricity

FCR – Frequency Containment Reserves FRR – Frequency Restoration Reserves

EFR – Enhanced Frequency Response EFCC – Enhanced Frequency Capability Response FFR – Fast Frequency Response

PRL – Primärregelleistung SRL – Sekundärregelleistung







- 1. Supercaps + Batteries
- 2. Supercaps + Generators
- 3. Supercaps + Slow Powerplants e.g. Hydro, Gas etc.

I. Short-term back-up power FREQCON U-UPS



Year	2020
Country	Italy
Field	Industry

Scope of delivery

- 1.0 MW Ultracapacitor Uninterruptible Power Supply (U-UPS) for up to 1 second delivered in 20 ft. Container



Project description

Uninterruptible high quality power supply in the plastic bag production industry.

Compensation of grid failures eliminating equipment loss, downtime resulting in cost savings.

II. Solution automotive industry FREQCON U-UPS



Year	2018
Country	Czech Rep.
Field	Industry

Scope of delivery

- 1.0 MW Ultracapacitor Uninterruptible Power Supply (U-UPS) for voltage dips up to 1.5 seconds delivered in 20 ft. Container



Project description

Design and commission of a turnkey container solution consisting of MSC-Converter ultracapacitor storage for a Czech car manufacturer's production site. Ultracapacitors are charged by the public grid during normal operation. U-UPS automatically responds to voltage dip and micro-interruptions. It takes over load supply in < 10 ms. ROI 2.5 mths.

III. Ultracapacitors+Diesel Gensets FREQCON UGS



Year	2017
Country	Ireland
Field	Grid Service

Scope of delivery

- 2.0 MW Ultracapacitor Uninterruptible Power Supply (U-UPS) for up to 12 second delivered in 40 ft. Container



Project description

To combine fast-acting frequency response services and ramping services the project consists of 5 diesel generators plus ultracapacitors, connected to the grid via our MSC-Converter with 5 diode rectifiers and multiple DC-inputs. This setup allows the customer to harvest income streams from DS3 services as well as capacity payments.

IV. Ultracapacitors + Hydro Poweplant Freqcon UGS



Year	2022
Country	Finland
Field	Grid Service

Scope of delivery

- 3.0 MW Ultracapacitor Uninterruptible Power Supply (U-UPS)
for up to 30 second delivered in 2 x 40 ft. Container

Project description

- The customer operates several hydropower plants. To stabilize the frequency at the grid, an ultracapacitor bank from shall be used.
- The project shall make an important contribution to frequency stabilization in the Nordic market.





- Supercaps have more power density than batteries but less energy density
- Supercaps are many times expensive than batteries when compared at Euro / kWh price
- Supercaps are ideal and become economical for applications with small time duration , high power and many cycles (1 sec to 30 sec)
- Supercaps can be combined with batteries, Gensets and big powerplants for making a better business case
- Power conversion systems (Inverters) should be flexible enough to incorporate other storage systems at later stages e.g. Batteries etc.





THANKS