Smart Integration of Renewable Energy

Ultracapacitors as backup for industrial production processes and grid services

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Content

- Freqcon
- Grid services
- Industrial applications
- Projects

FREQCON German Engineering
to energize the World

- 1988: Engineering of converter systems and pitch control for 50 kW wind turbine
- 2000: First pitch control system with ultracapacitor back-up
- 2009: More than 10.000 pitch system with ultracapacitor back-up in the field
- 2014: German Renewables Award for the Multi-Source-Converter (MSC)
- 2016: German Renewables Award for Ultracapacitor Grid Stabilizer (UGS)
- Today: 3.300 m² production space, 90 people, > 10 Mio. € annual turnover

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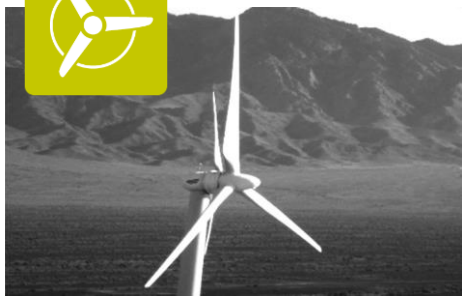
FREQCON Grid and Offgrid Solutions



Wind Energy

- Centralized Control System
- NGC Power Converter
- MSC Power Converter
- Certified Safety System
- Ultracapacitor Pitchsystem

Solar Energy

- MSC Power Converter
  - Solar + Battery

Grid & Storage

- Battery 2 Grid Power Converter
- STATCOM Converter
- MSC Power Converter
  - Flywheel + Battery
  - Ultracapacitors + Gensets
- Ultracapacitor Grid Stabilizer
- Ultracapacitor UPS System

Microgrid

- MSC Power Converter
- MSC System
- Mini-MSC-Converter
- Mini-MSC-System

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Change in energy supply

Current grid situation

- High share of renewables in public grid
- Reduction of conventional power plants (nuclear and cole)

Consequences

- ➢ Instabilities in public grid (frequency fluctuation)
- ➢ Less rotating mass for compensation
- ➢ Especially problematic for island grids (Ireland, Sardinia, Canaries)

Solutions

- ✓ Energy storage for primary power regulation and fast frequency response (mostly battery applications)
- ✓ **Artificial interia (Ultracapacitors, fly-wheels)**

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Replacement example

Traditional power plant generator

- Power: 1,5 GW
- Diameter and mass: 2 m and 200 t
- Rotation: 1.500 rpm
- Grid frequency: 50 Hz
- Energy content: 1,2 GJ
- Compensation capability for a change of 1 Hz: approx. 48 MJ

Requirements for replacing this generator

- Quick and precise measurement
- Converter system capable of a phase synchronous supply of 24 MJ for 2 s from standby within a few milliseconds
- Energy storage of 48 MJ for a few seconds

Ucaps: 1 MW for 2 s

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Freqcon Ultracapacitor Grid Stabilizer (UGS)

- Very compact energy storage
- Frequency measurement within one millisecond
- High precision with a resolution of 1 mHz
- High voltage range on DC bus connection
- Grid conformity (MV-regulations and transmission codes)
- Integration in wind and solar converter systems
- Communication to overlying systems: 250 µs
- Parallel functions: “Fast Frequency response” and “Dynamic Reactive Response”

GERMAN RENEWABLES 2016 AWARD
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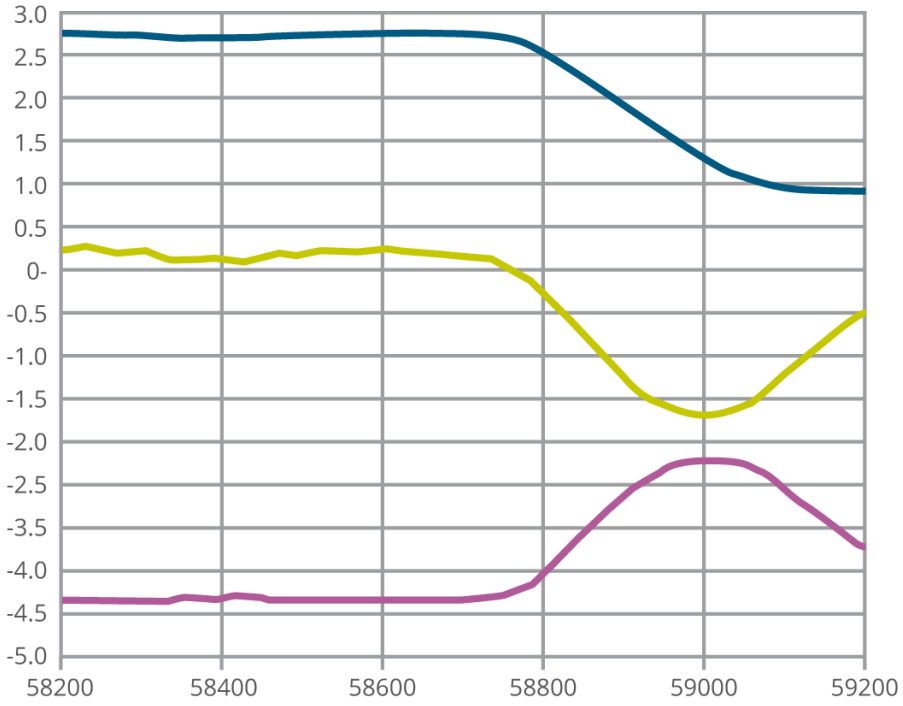
Active Power Grid Support

ROCOF-Support (Rate of Change of Frequency)



Frequency: Drop from 50Hz to 49,3Hz

ROCOF: -2Hz/sec

Response of Converter System:
differential response, promptly active power support

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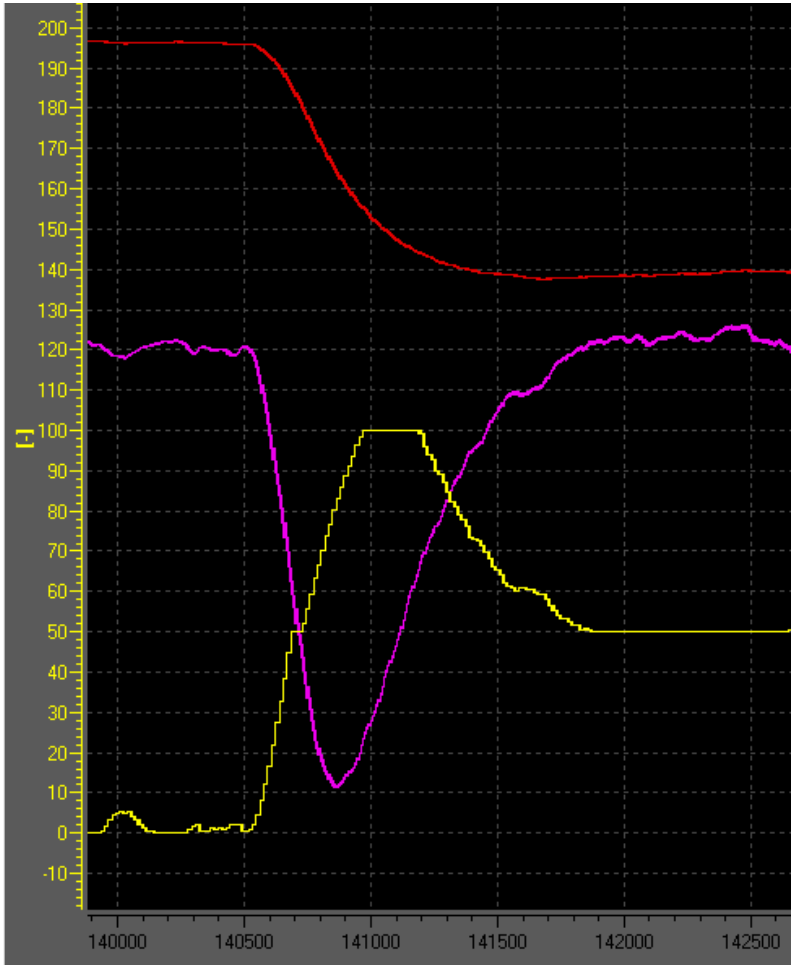
RoCoF and Fast Frequency Response simulation



<- 2.5 sec ->

Frequency: Drop from 50Hz to 49,9Hz

RoCoF: -2Hz/sec

Response of Converter System:

RoCoF and linear frequency response

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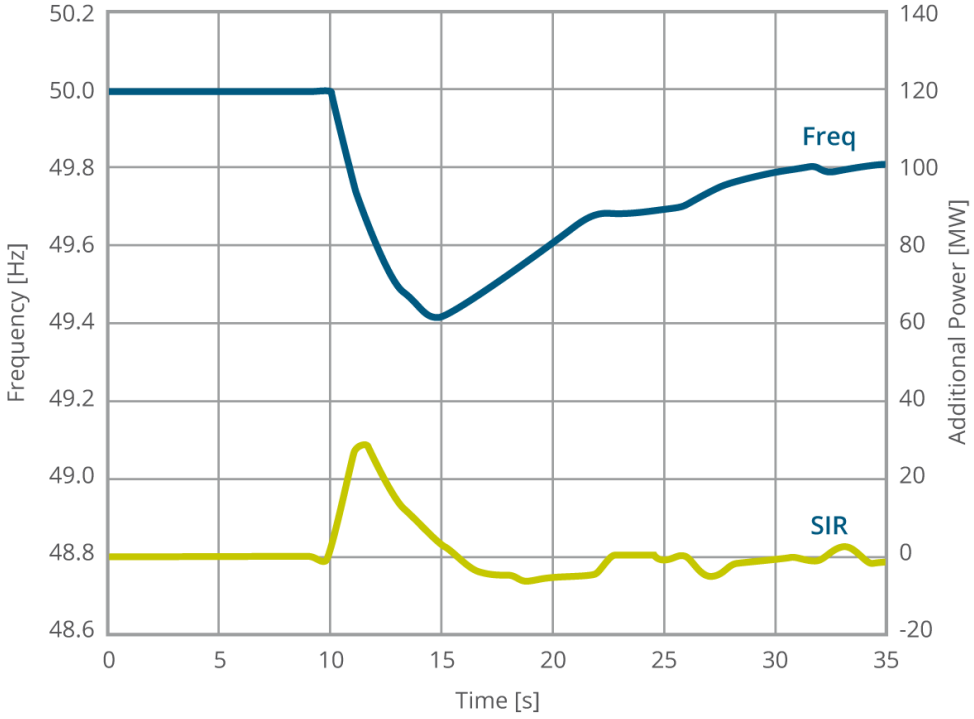
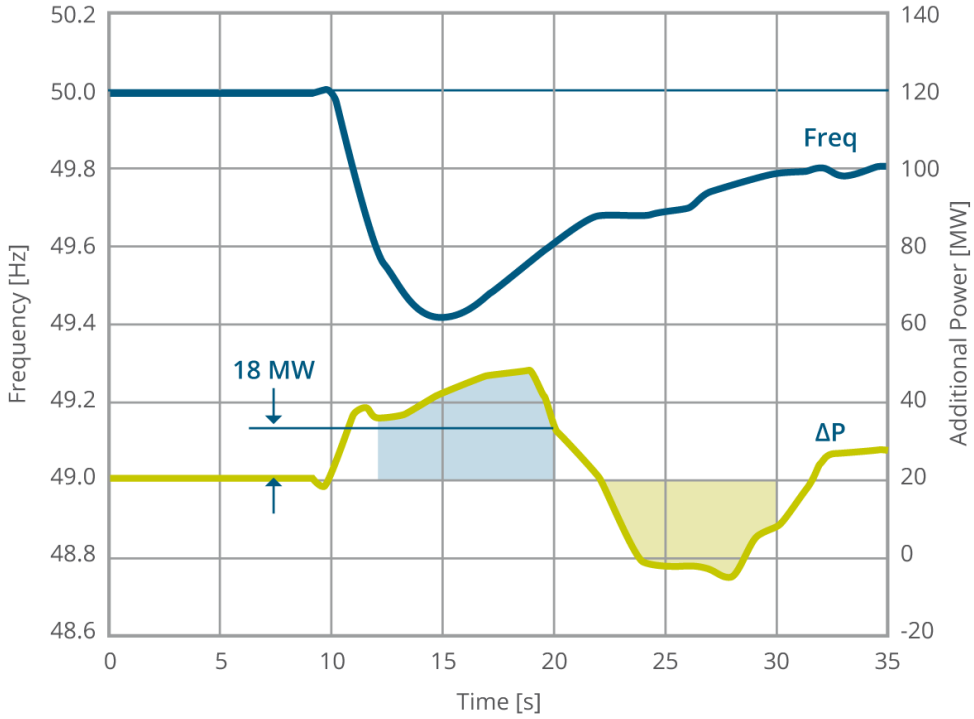
Active Power Grid Support

Synthetic Inertial Response



Fast Frequency Response



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Industrial applications of ultracapacitors

Current grid situation

- Voltage dips as result of switching between transmission lines
- Very common in Italy due to geographical set-up of transmission grid

Consequences

➢ Faults on sensitive machinery (eg robots in automated production processes

Solutions

✓ Ultracapacitor system with fast grid disconnector (U-UPS) to compensate voltage dip
✓ Measurement: within 10 ms
✓ Compensation: within 20 ms up to several seconds

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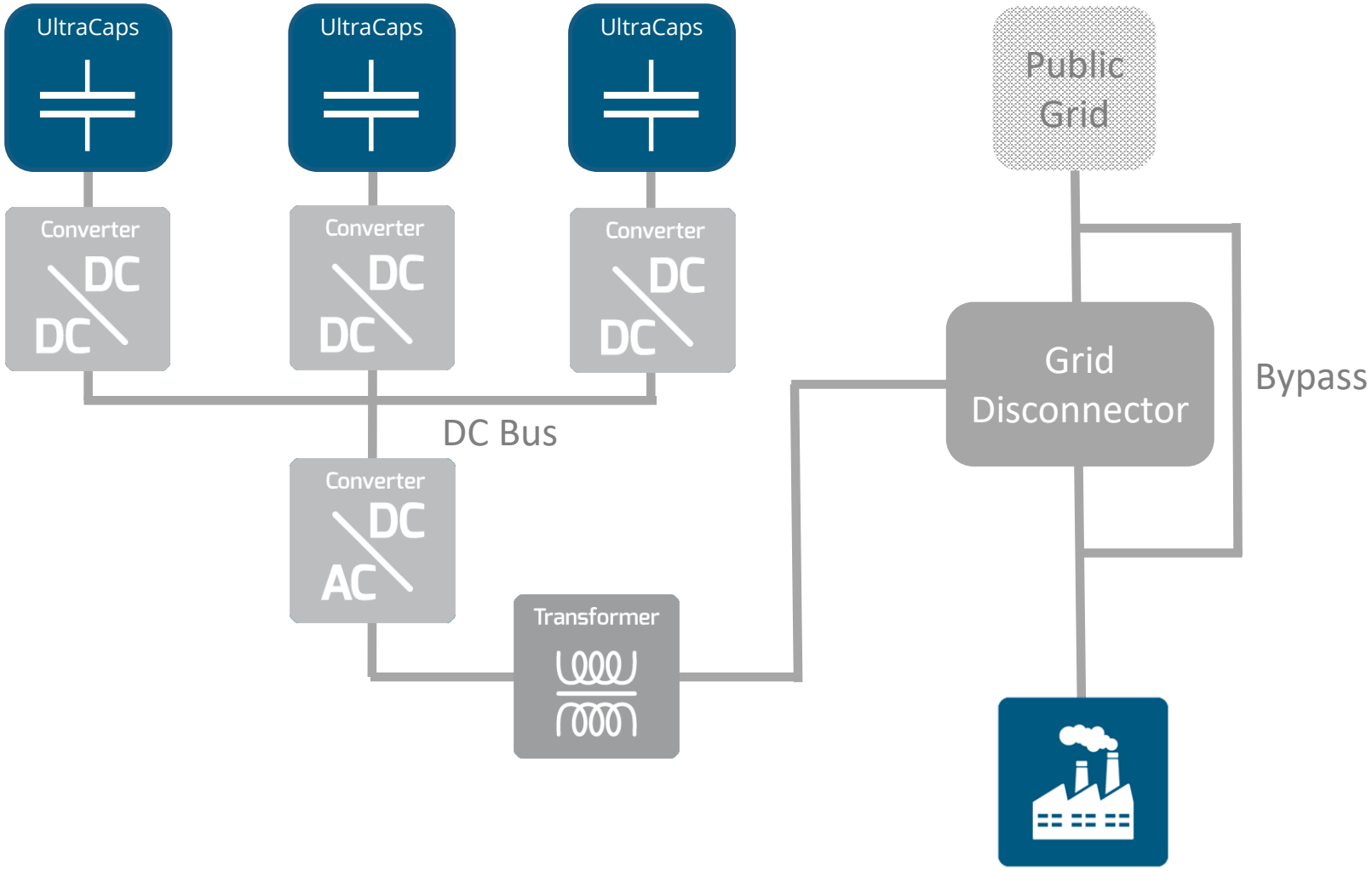
Industrial applications of ultracapacitors



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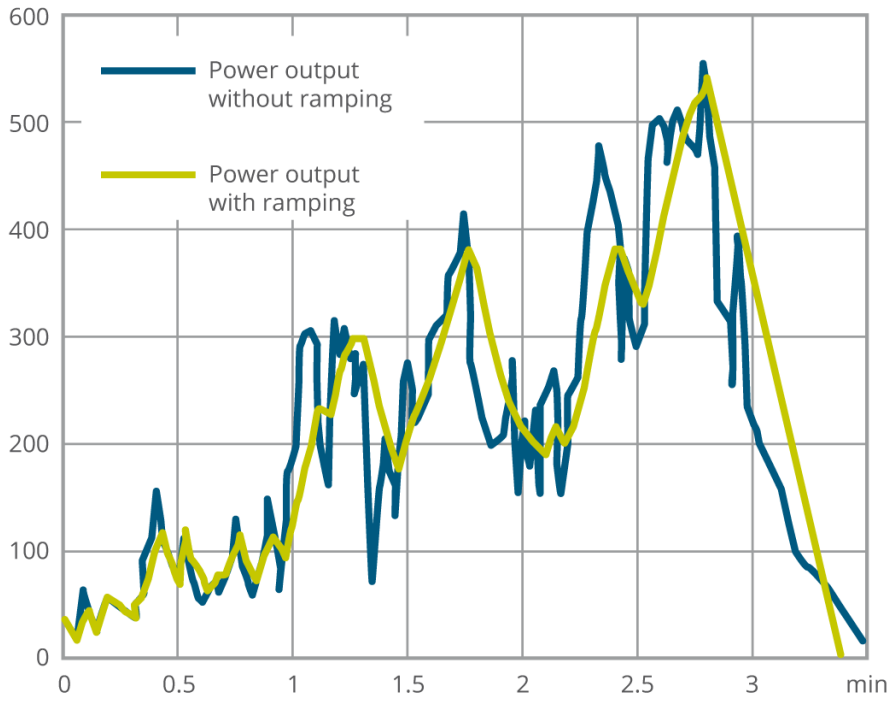
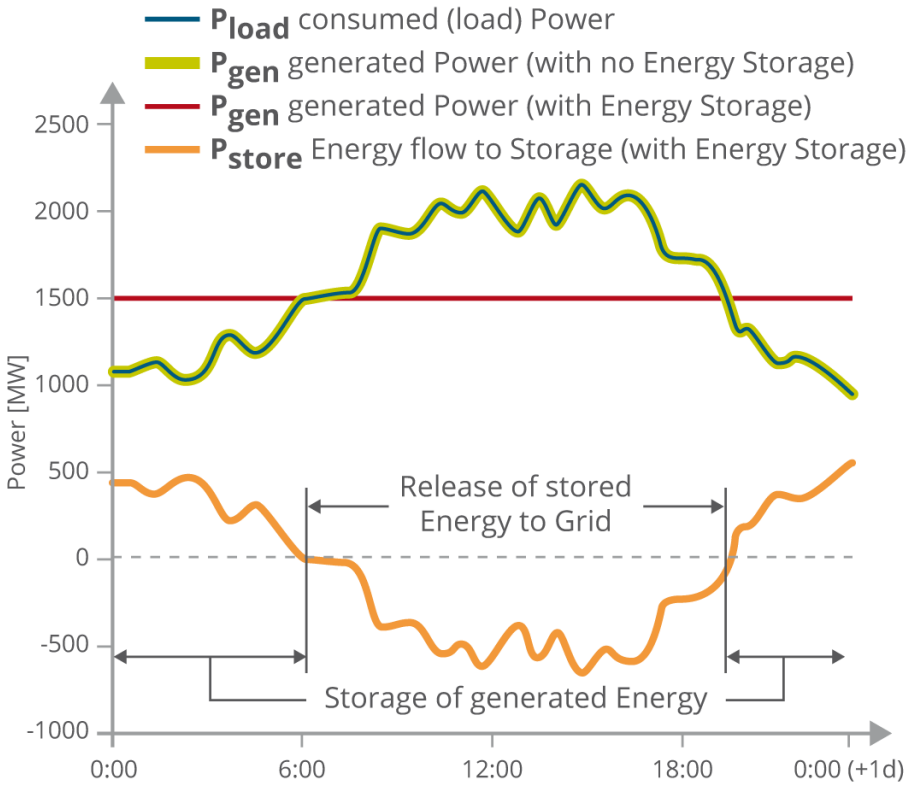
Grid Support by Ramping & Peak Shifting

Ramping



Peak Shifting



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Reference Projects:
Grid & Storage

Reference Projects Grid & Storage

2014

MEGA MSC

MEGA (Micro Electricity Generation Association), Ireland

- Design and delivery of 300 kW / 150 kWh electrical energy storage system.
- DS3 Grid Services and UPS
- Hybrid System:
  - 100 kWh Litium-Ion
  - 50 kWh Lead-Carbon
  - 50 kW-10sec Ultracapacitors

2017

Kilpaddoge MSC

2.0 MW DS3 Power Park Module Kilpaddoge, Ireland

- Ultracapacitors for Fast Frequency Response
- Diesel Gensets for Operating Reserve + Ramping

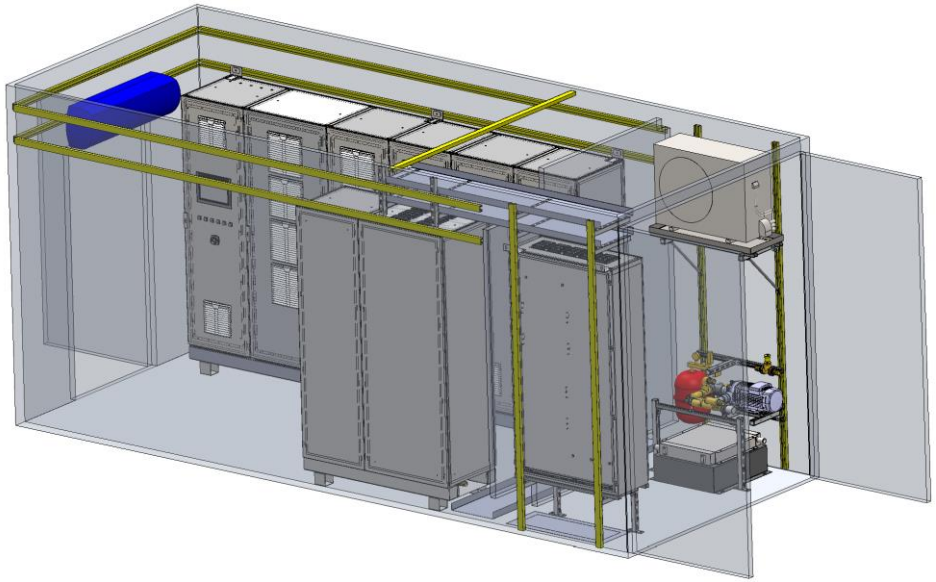
Reference Projects Grid & Storage

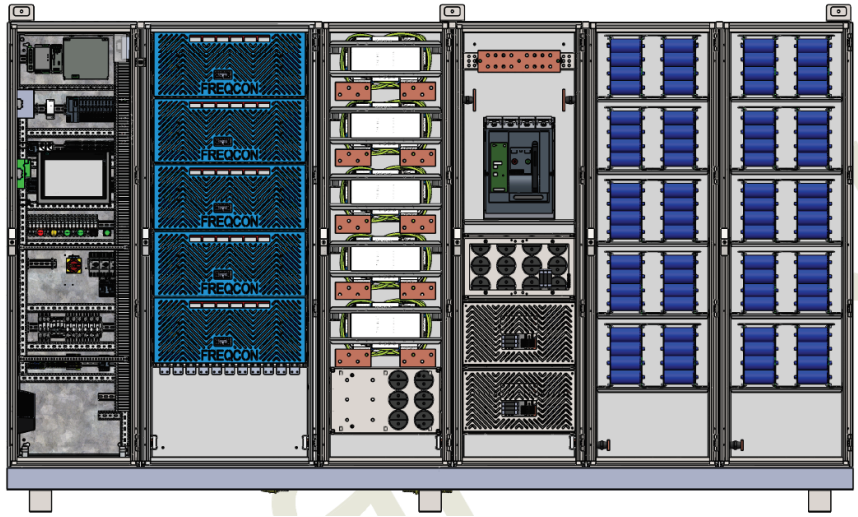
2018

Mlada Boleslav UGS

Siemens/e.ON/Skoda, Czech Republic

- Design and delivery of 1 MW / 1,5 s UGS
- Voltage dip compensation for automobile production
- 20“ Container





Thank you very much for your attention.

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