

DC Power Systems and Related Products

Hyperride WP10-T10.3 Partner Technical Presentation Series - no.3 **EATON**

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Agenda

- DC Microgrid Laboratory EEIC
- DC Industrie projects
- DC microgrid in Hengelo
- Building as a Grid
- LV circuit breakers
- Breaktor
- xStorage
- Power Electronics for DC Application

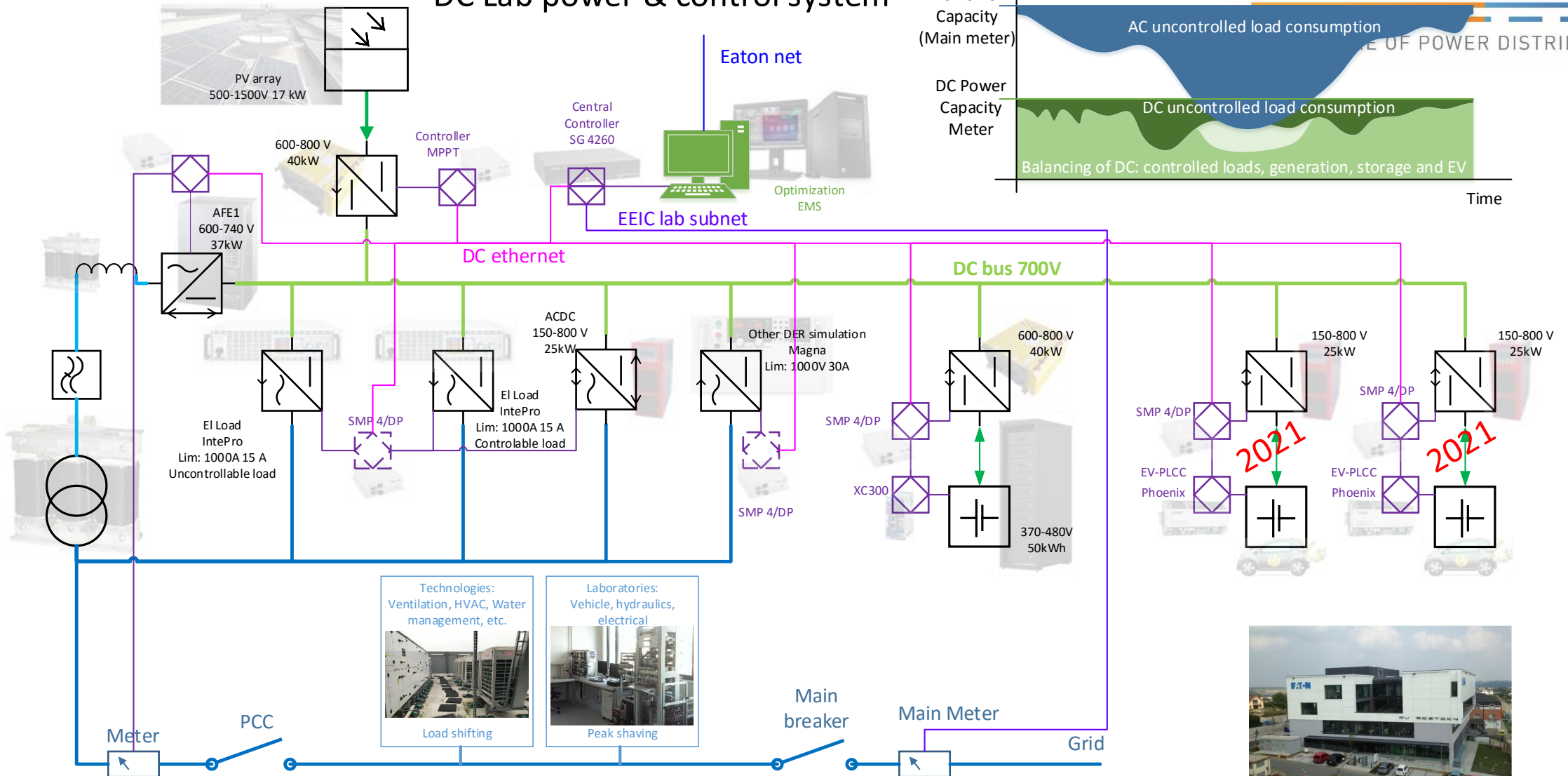


DC Microgrid Laboratory Eaton European Innovation Center (EEIC)




DC Microgrid Laboratory in EEIC

DC Lab power & control system




Technologies:
Ventilation, HVAC, Water management, etc.



Load shifting

Laboratories:
Vehicle, hydraulics, electrical



Peak shaving



Features

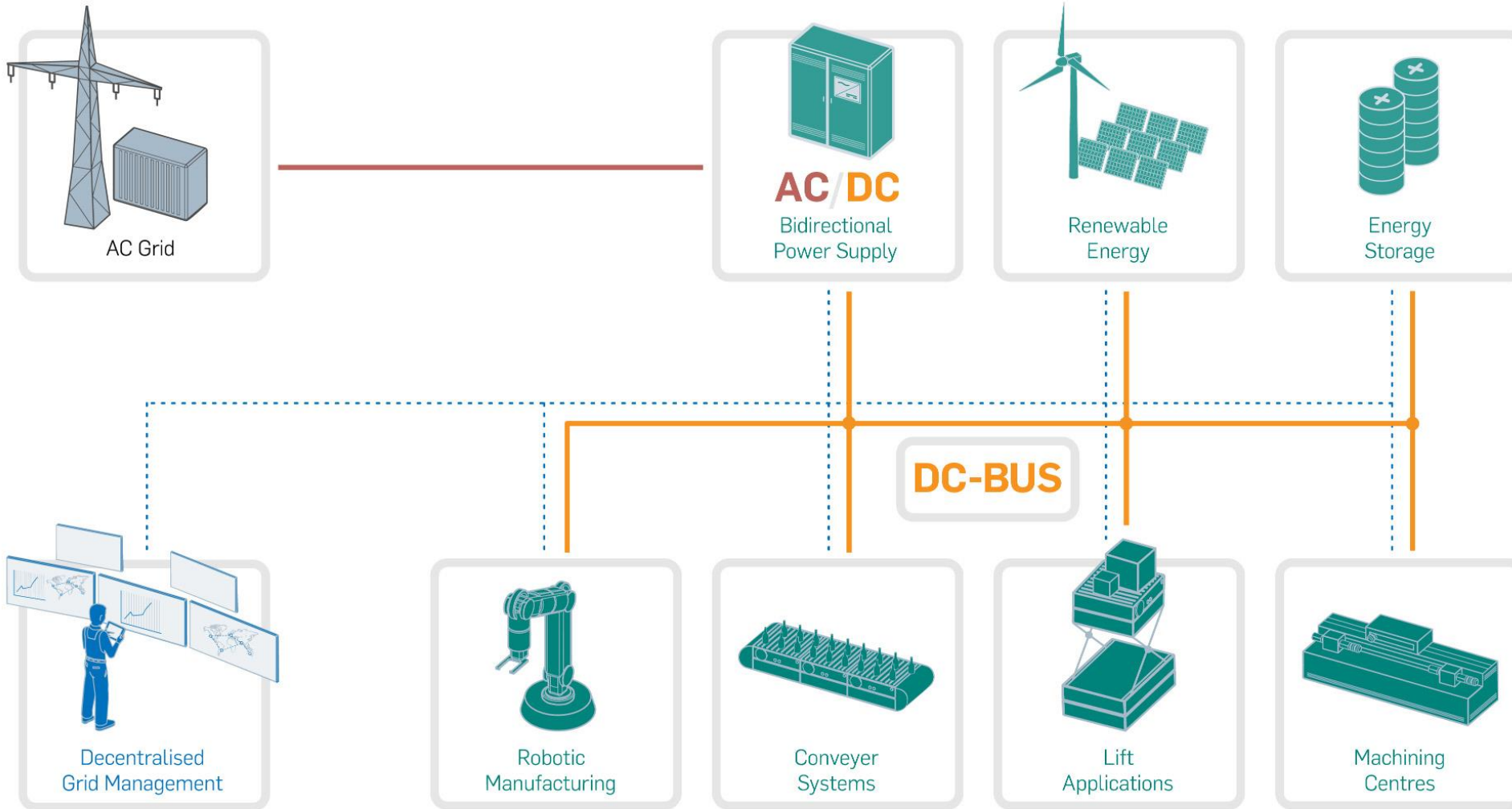
- Behind-the-meter grid: hybrid 240VAC/700VDC;
- PV, xStorage Home, xStorage DC;
- Stability control through droop curves;
- Optimization through central control;

DC grid for industrial applications



German Government funded projects:

- DC INDUSTRIE - Intelligent open DC network in industrial production for highly efficient system solutions with electric drives
- DC-INDUSTRIE 2 - DC for the factory of the future




DC-INDUSTRIE
ENERGIEWENDE TRIFFT INDUSTRIE 4.0

Supported by:

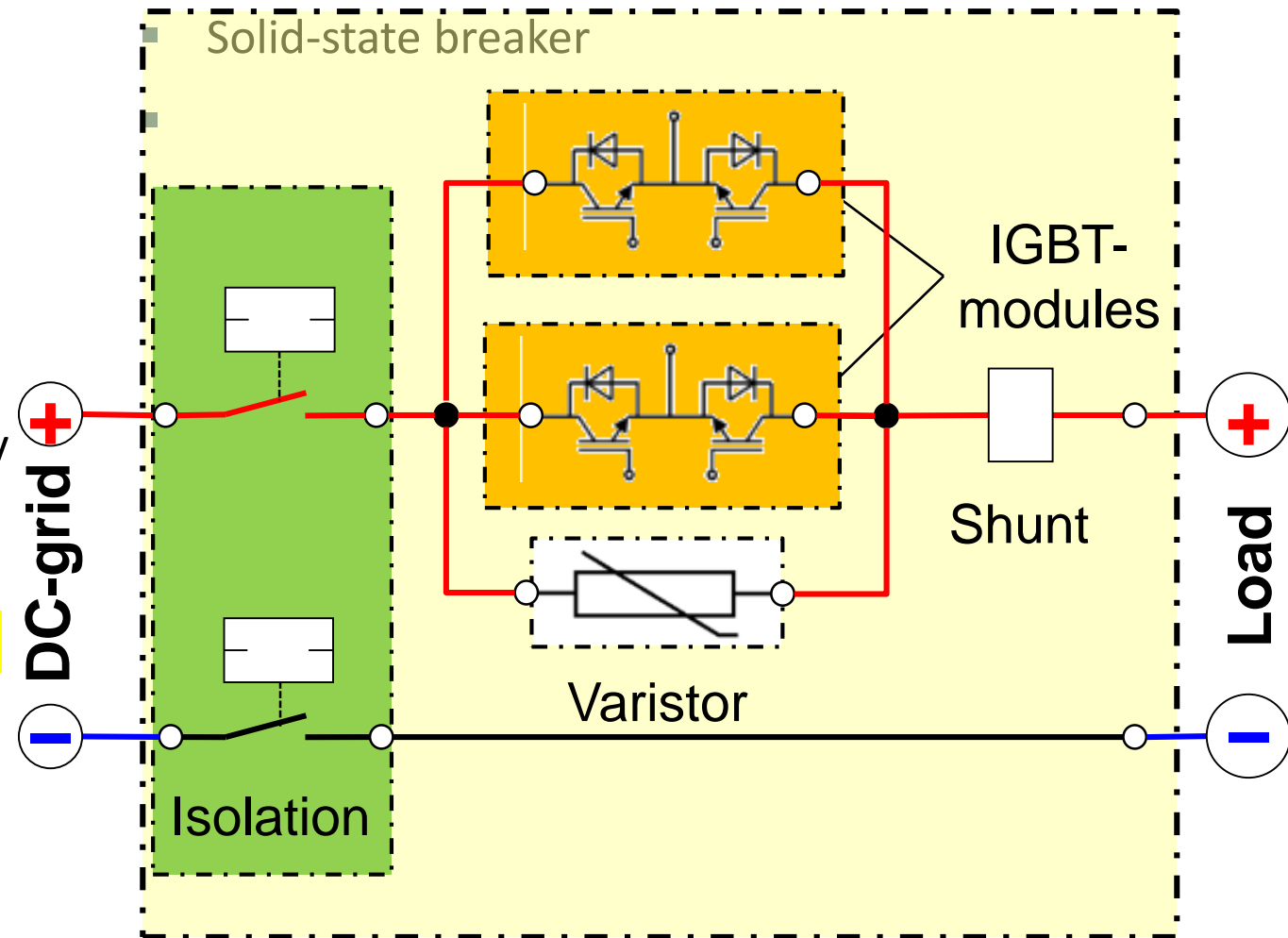


on the basis of a decision by the German Bundestag

-  [Explanatory Video](#)
- [FAQ](#)

- DC power components for industrial application
 - 30 hybrid breakers up to 45 A¹⁾
 - 11 solid-state breakers, 400 A¹⁾
- Reduce feed-in power by 85%
 - From 450 kVA for AC to 50 kVA with DC @Daimler → welding with stored energy
- Breakers successfully tested
 - Normal operation & overload
 - 60 short-circuit tests → no replacement required!
- Selectivity
 - Tests that cannot be done in a lab

¹⁾ Rated current



DC-INDUSTRIE 2

- DC grid for industrial applications
- Automotive, machine manufacturers
- Energy efficiency & flexibility
 - Connect renewables and storage
- Operating voltage
485 V to 750 V
- Apply in six model plants and transfer centers

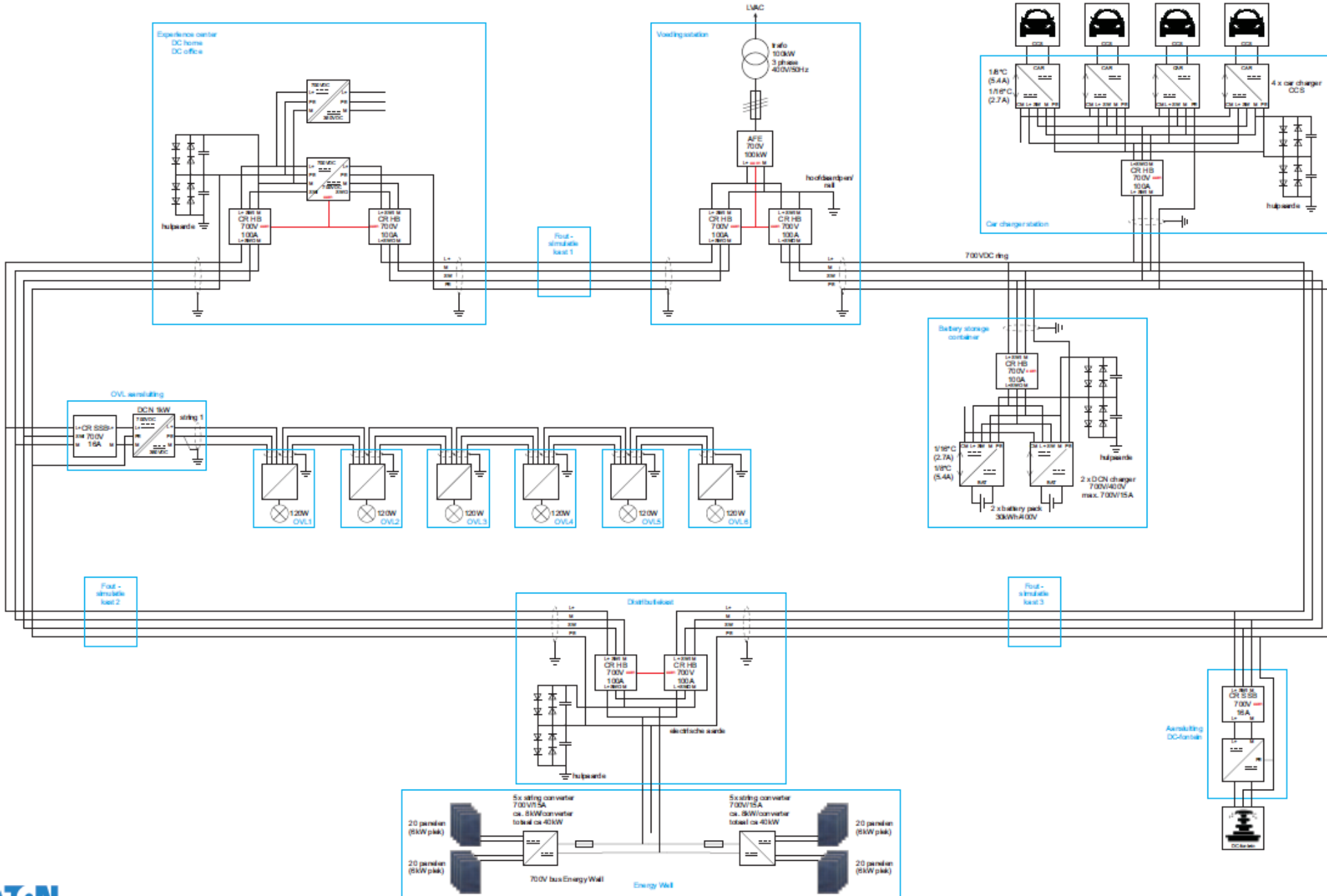


DC microgrid for campus applications Eaton Industry Hengelo

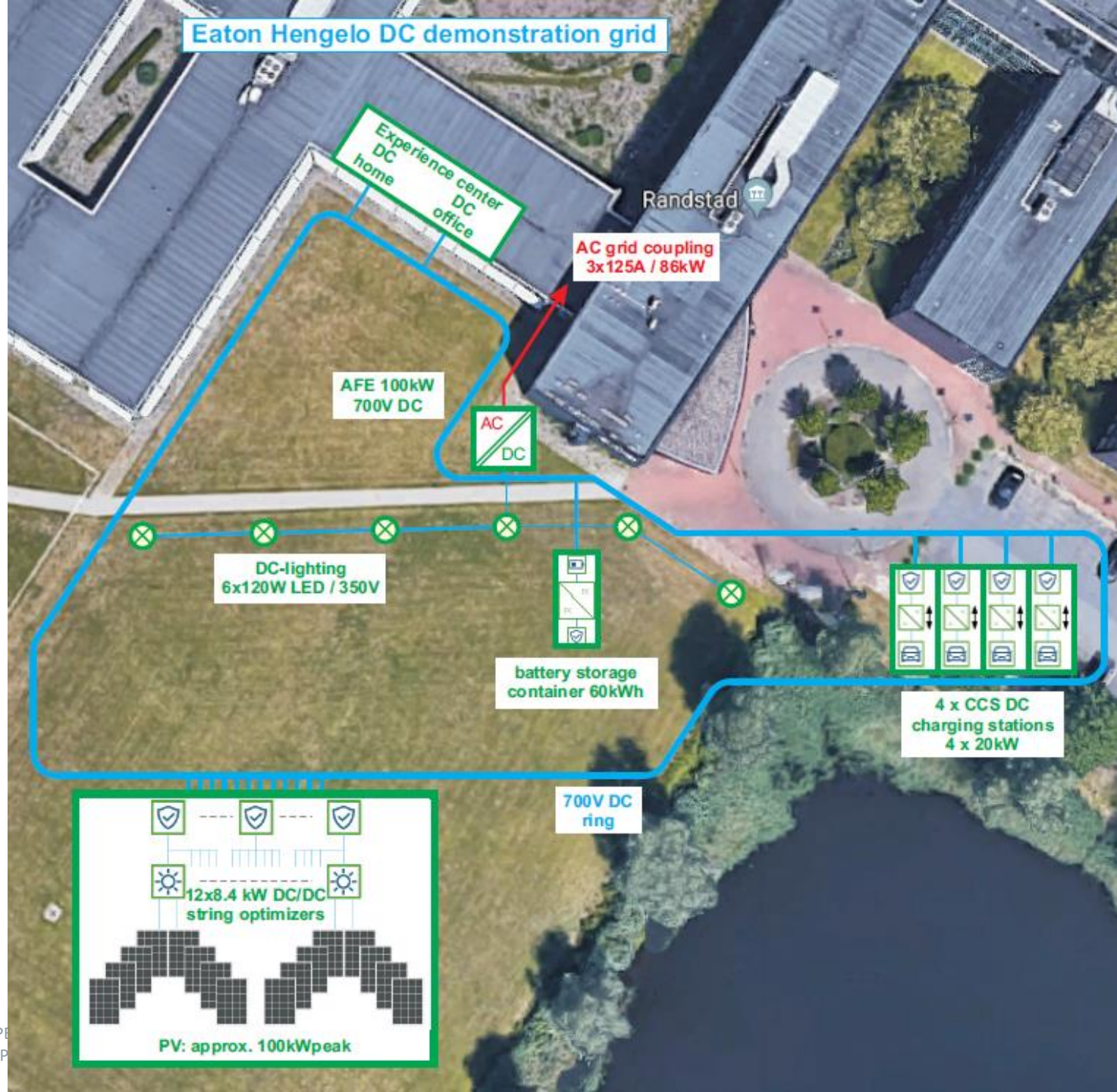


DC Demogrid Eaton Hengelo

Active LVDC grid on **Current OS**



Eaton Hengelo DC demonstration grid



THE FUTURE OF POWER DISTRIBUTION



„Building as a Grid“ Energy Management System



Energy Management System



A multi-objectives smart optimization framework:

- Decentralized architecture;
- Brand/Protocol agnostic (Interoperability);
- Machine Learning techniques;

Functions:

- Maximizing renewable energy;
- Minimizing energy cost;
- Maximize Auto Consumption;
- EV Load Balancing;
- Peak Shaving;
- Energy Arbitrage, thus minimizing the grid reinforcements.





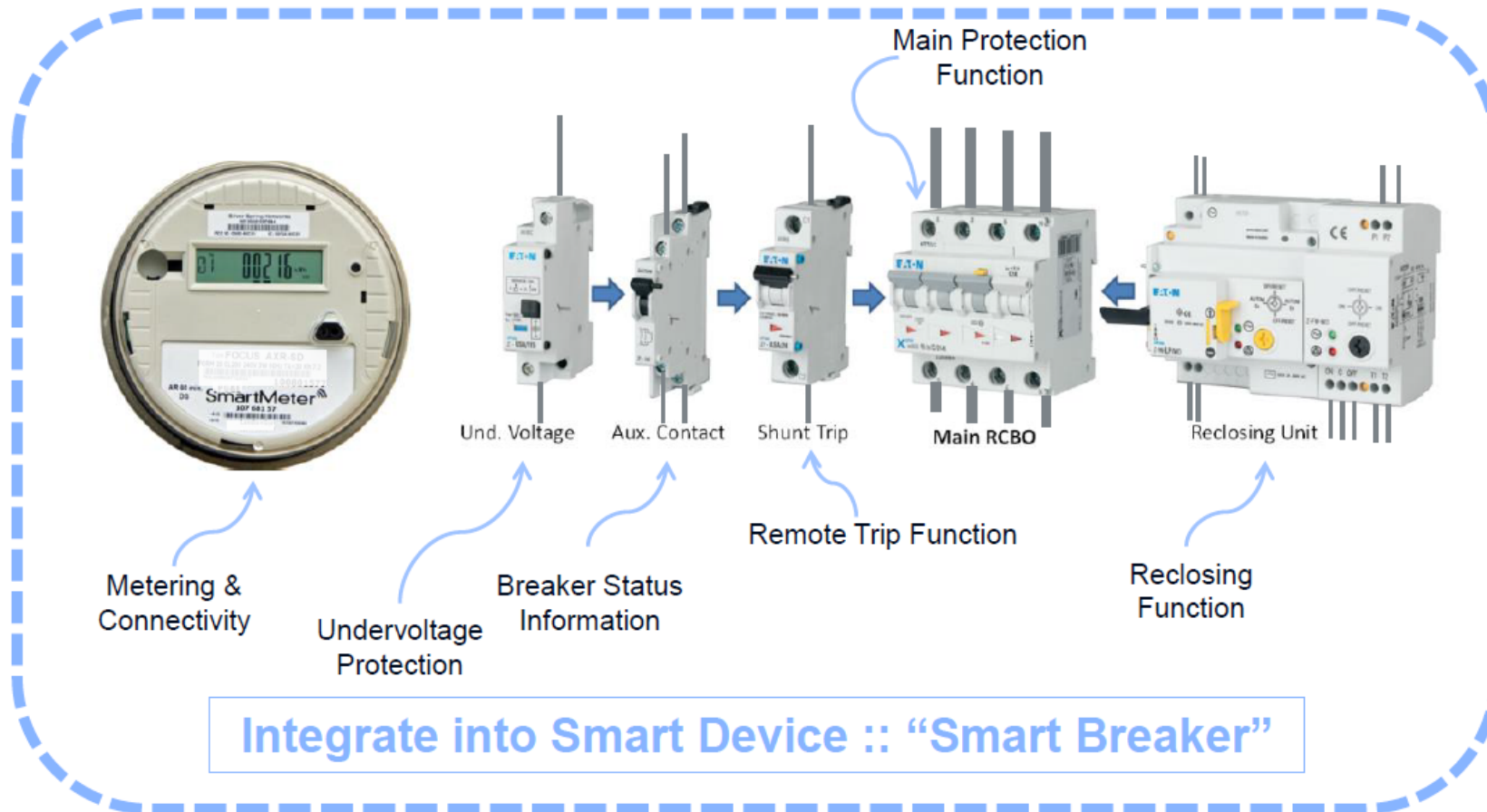
LV circuit breakers Eaton Vienna



Innovative Sensor and Actuator Components

The Starting Point :: State-of-the-Art Circuit Breaker Technology & Solutions

Active components and sensors with existing devices



xStorage



Second life (Nissan) and new batteries



xStorage Home

HYBRID INVERTER: PV 4kW, battery, critical loads
POWER 3.6kW - 6kW
CAPACITY 4.2kWh - 10.08kWh



xStorage Buildings

POWER: 10 kW - 5 MW+
CAPACITY 20 kWh - 5 MWh



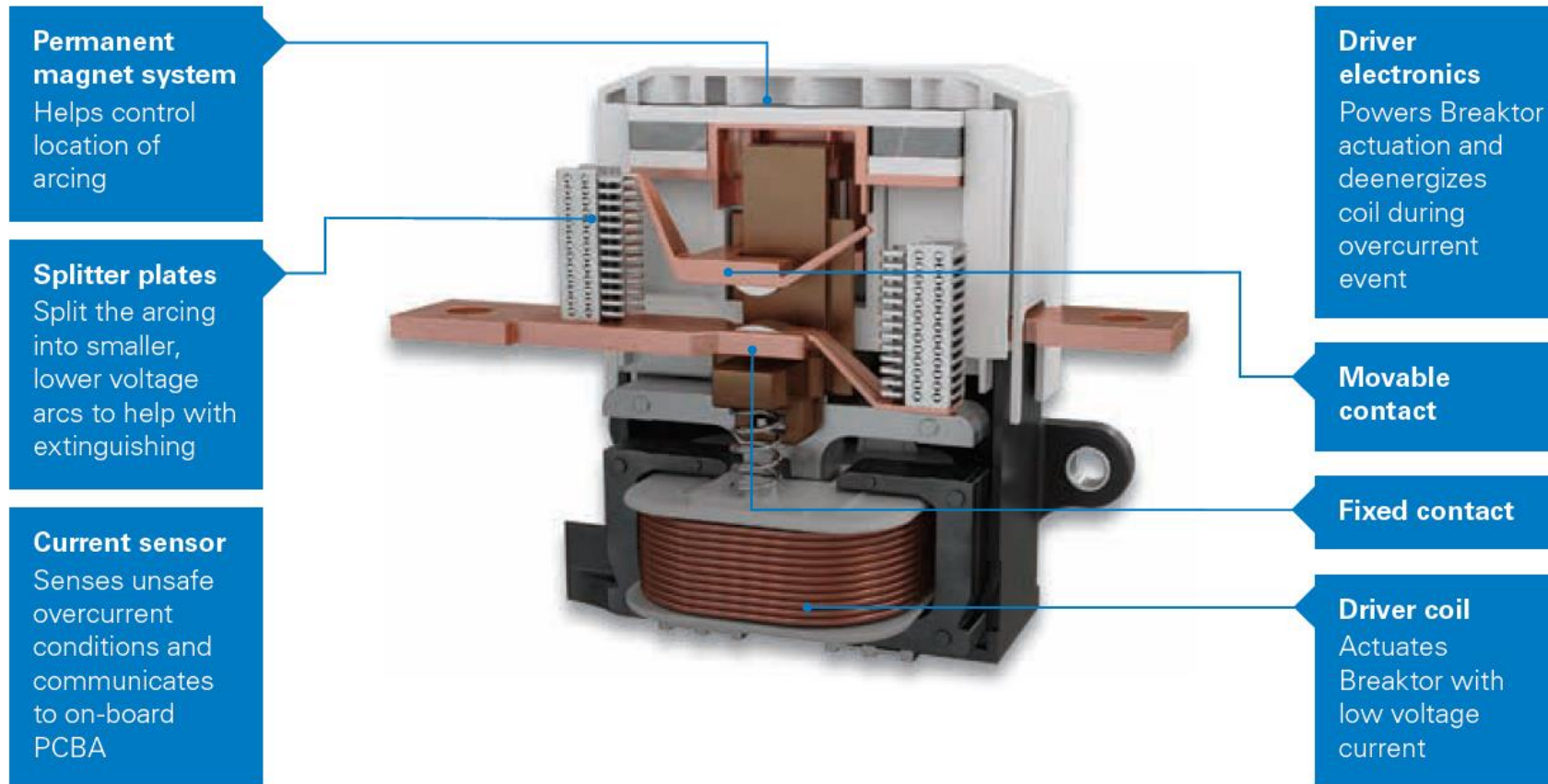
xStorage Compact

Energy management system
EV charging station integration

Breaktor



Breaktor key features



- Less than 4-millisecond actuation for short circuit faults up to **900 volts** and **25,000 amps**
- **Resettable** like a circuit breaker



Breaktor specifications

General

max. operating voltage	2 x 450/425V d.c.	900V / 850V d.c.	500V / 480V d.c.
contact configuration	2 NO	1 NO	
rated current (continuous load, thermal)	350A		
lifespan operations @30A	100.000		

Main Terminals "HV"

max. switch on current	Approx. 1,7kA(+/-20%)
max. cross area busbar	$\leq 150\text{mm}^2$
rated isolation voltage between main terminals and coil	$\geq 2,15\text{kV}$

(autonomous) Overload Protection

overload current threshold	Approximately 1,7kA(+/-20%)
max. overload switch off current	25kA
overload switch off time	up to 4kA < 7ms 4 – 10kA < 6ms 10 – 25kA < 4ms
max. let-through energy	about 400.000A ² s

Power Electronics

Aerospace/ eMobility / Residential

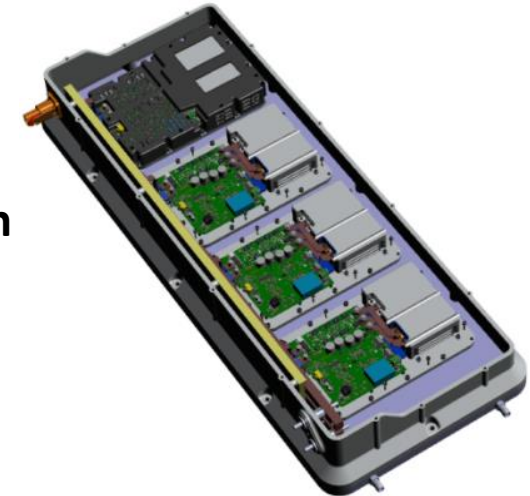
Example #1: 4kW 675V/28V SiC DC/DC isolated resonant converter module



Description

SiC-based isolated DC-DC converter platform with configurable modular design allowing

- ✓ Higher efficiency and high power density
- ✓ Expansion to high power/voltage ratings via **module parallel and series connection**



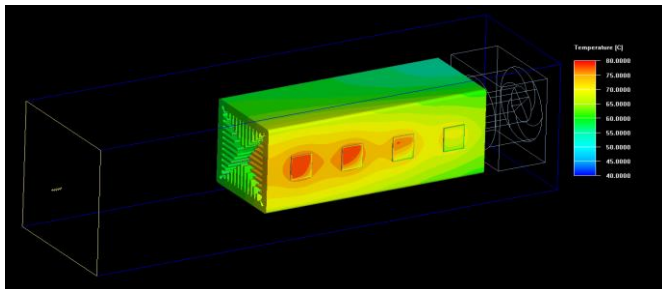
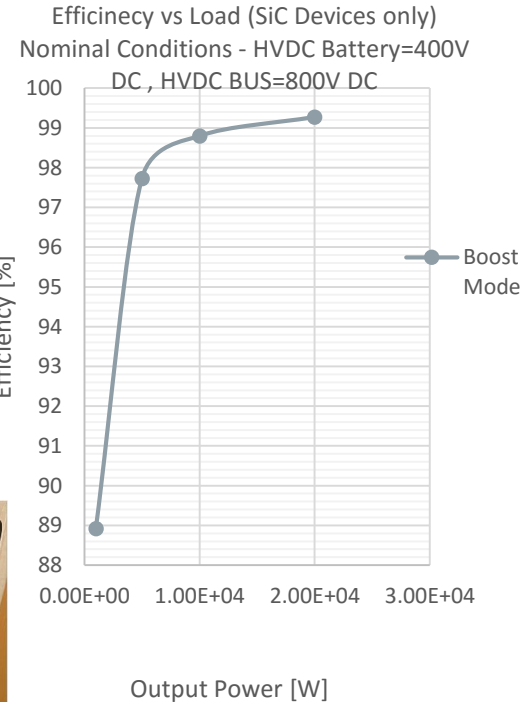
Aerospace

Example #2: 20kW(30kW) 300-650V/600-850V SiC DC/DC non-isolated converter module

Description

SiC-based non-isolated DC-DC converter platform with configurable modular design allowing

- ✓ Higher efficiency and high power density
- ✓ Expansion to high power/voltage ratings via **module parallel and series connection**
- ✓ **ZVS**



Non-road Mobile Machine (electric excavator)



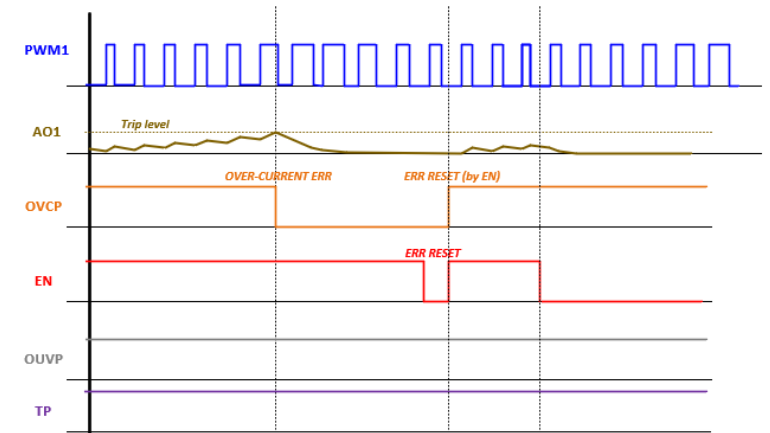
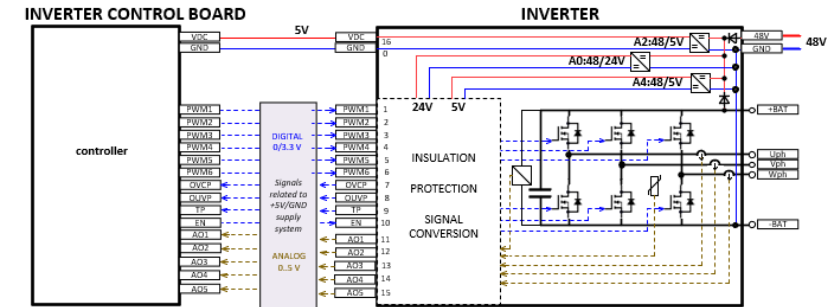
Example #3: 20kVA, 48VDC 3-phase inverter

Description

0...72VDC, 400Arms inverter platform with high application variability

- ✓ Solution covers appropriate optional PDU (power distribution unit)
- ✓ Ceramic power module approach
- ✓ Integrated protective functions
- ✓ Simple, universal control interface
- ✓ Variable cooling systems
- ✓ Easy stacking in multidrive systems
- ✓ Design considers both stationery and vehicle/aircraft applications

Under development



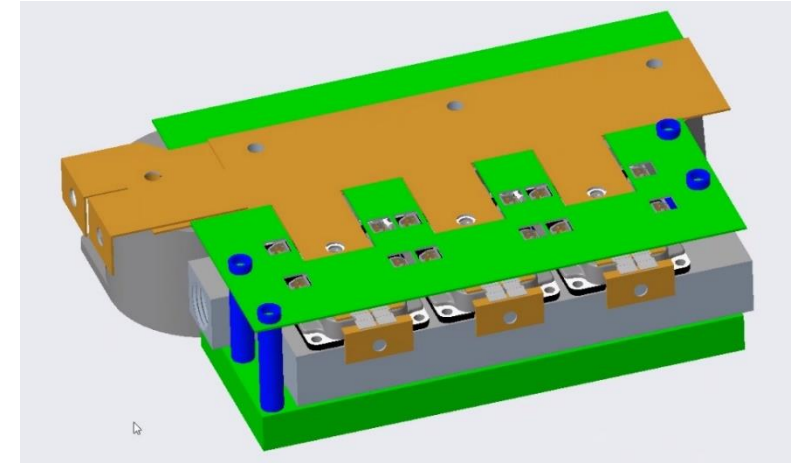
eMobility / Aerospace

Example #4: 200kVA, 800VDC WBG 3-phase inverter

Description

650...900VDC, 400Arms inverter platform with high application variability

- ✓ Targeting 135kW/litre (variant A)
- ✓ SiC high-efficiency solution, cutting-edge components
- ✓ Liquid cooled systems
- ✓ Integrated control and protective functions
- ✓ Easy stacking in multidrive/multiphase systems
- ✓ Design considers both stationery and vehicle/aircraft applications



Under development



Thank you!

