Required Technologies for Grid Integration of Charging Infrastructure

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ENERCON
ENERGY FOR THE WORLD

AGENDA

1. Motivation
2. State of the Art Grid Integration
3. Expected Levels of Grid Integration
4. Behavior of EVSE and EV in case of grid faults
5. Summary and Outlook

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Motivation

- Climate goals require CO_2 savings in all sectors: Energy, Heat, Mobility
- E-Mobility is a big part of the solution

- Study* analyzes the future energy system of Germany which would be needed to achieve the two-degrees target (≠100% EV)
  → determines a future electricity demand for the transportation sector of 120 TWh per year in Germany = "100% scenario"
  → average power consumption of 13.7 GW in Germany caused by e-mobility
- Synthetic load profile:
  - peak demand of 28.8 GW for 100% scenario
  - Minimum demand of 550 MW for 10% scenario
- Today's primary control reserve in the German regulation zone is 620 MW
- E-Mobility will play an important part for the power system

*Fraunhofer IWES, „Geschäftsmodell Energiewende", 2014

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State of the Art Grid Integration

- In most countries, the Grid Codes refer to EVSE* as normal loads
  - No control of the EVSE behavior depending on the actual situation of the grid
- Some countries introduce the concept of controllable loads → Smart Charging
  - Charging process can be shifted in time to prevent high demand peaks

But EVSE are not just necessarily an additional load, they could also actively support the grid!

*EVSE = electrical vehicle supply equipment ≈ charging stations

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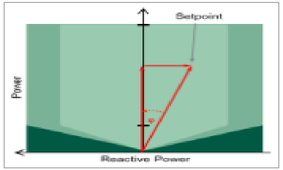
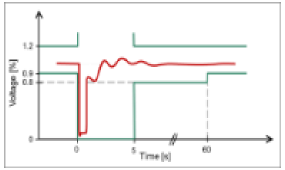
Expected Levels of Grid Integration

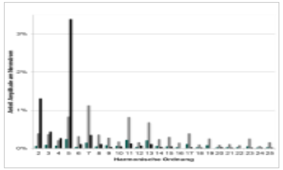
- EVSE are connected to the grid via power electronics – similar to RES
- Requirements for generators like wind turbines that are perceived to be standard in modern grid codes are e. g.



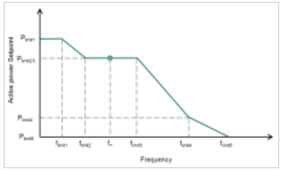
Reactive Power for Voltage Stability & STATCOM



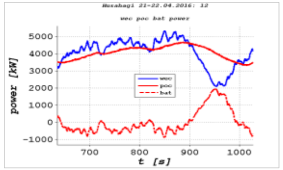
Fault Ride Through (FRT) Capability



Power Quality Optimization / Minimized Harmonic Currents

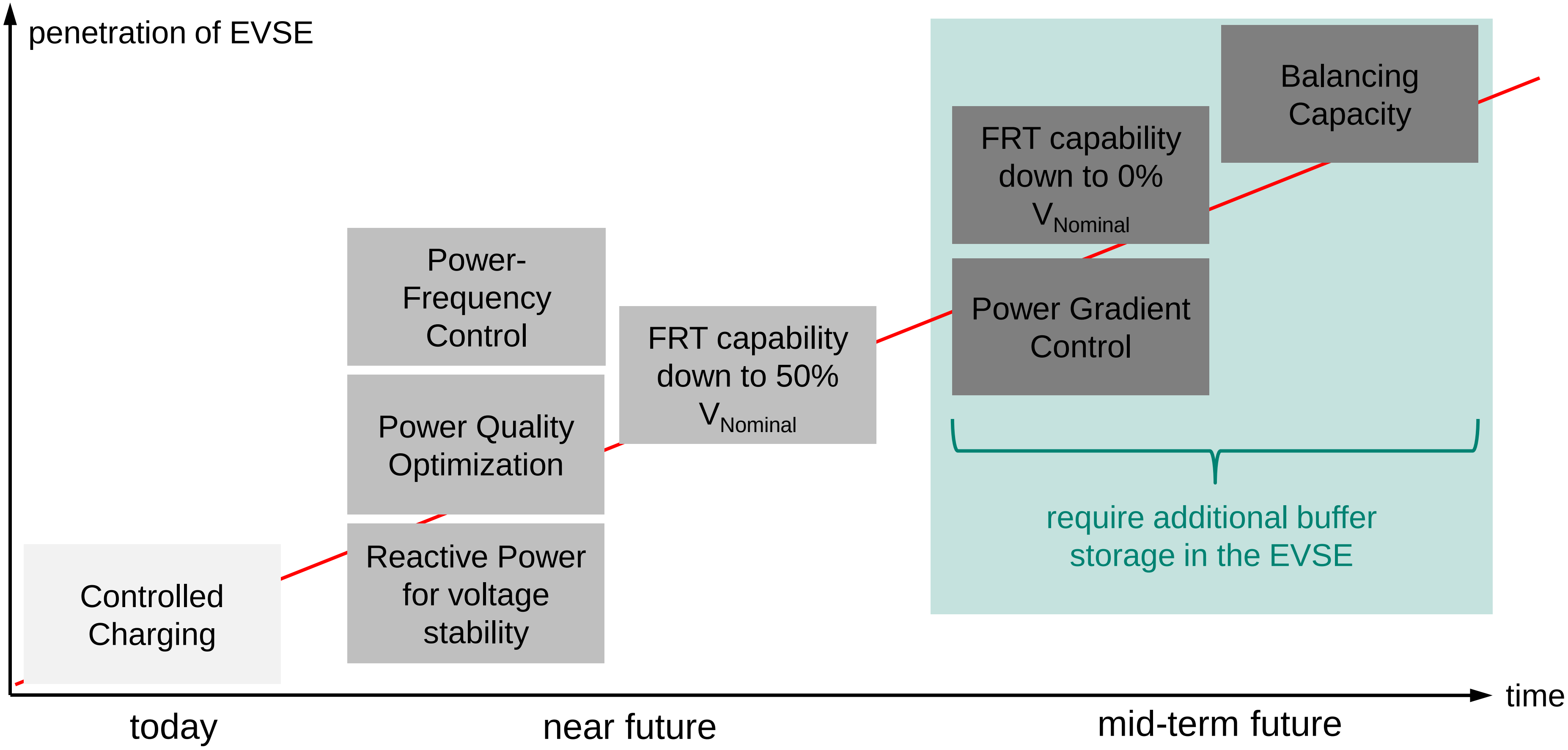


Power-Frequency Control P(f)



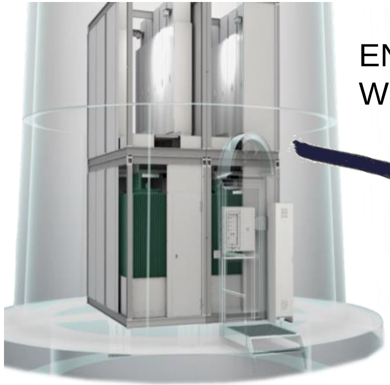
Optional Gradient Control

Expected Levels of Grid Integration



Expected Levels of Grid Integration

ENERCON‘s answer to future requirements:



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WEC

SYNERGIES

- Re-use of proven power electronics as well as low voltage components
- Leading grid integration technology
- Built-in ancillary services

ENERCON TECHNOLOGY PLATFORM

- Scalable power electronics
- FACTS 2.0
- Proven grid integration technology
- Compliant with grid codes world-wide

E-CHARGER 600

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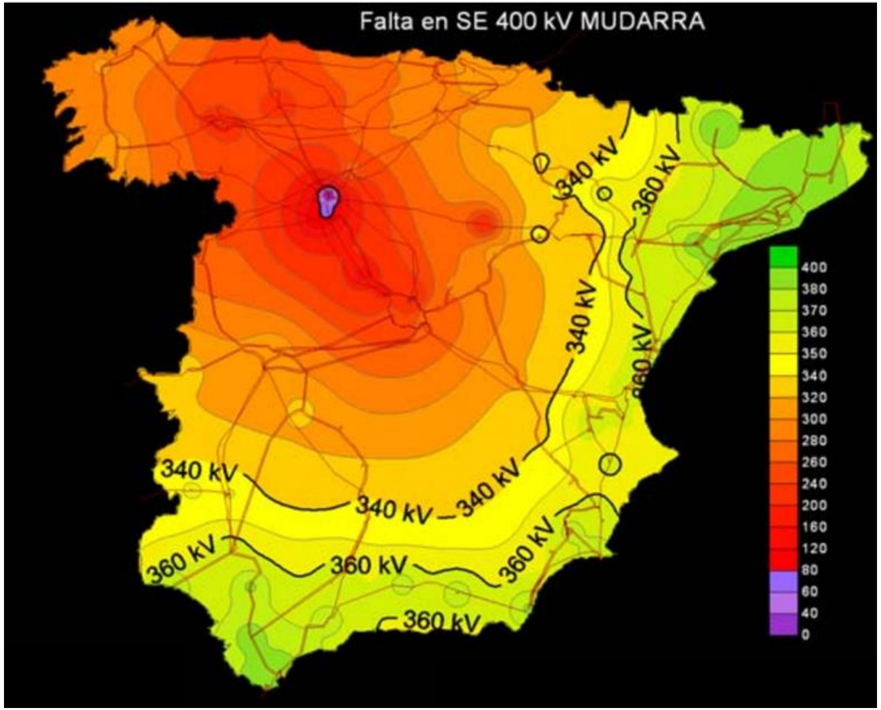
Behavior of EVSE and EV in case of grid faults

- Voltage dips in the transmission system can have a spread of several 100 km
- Example: fault in Spanish transmission system



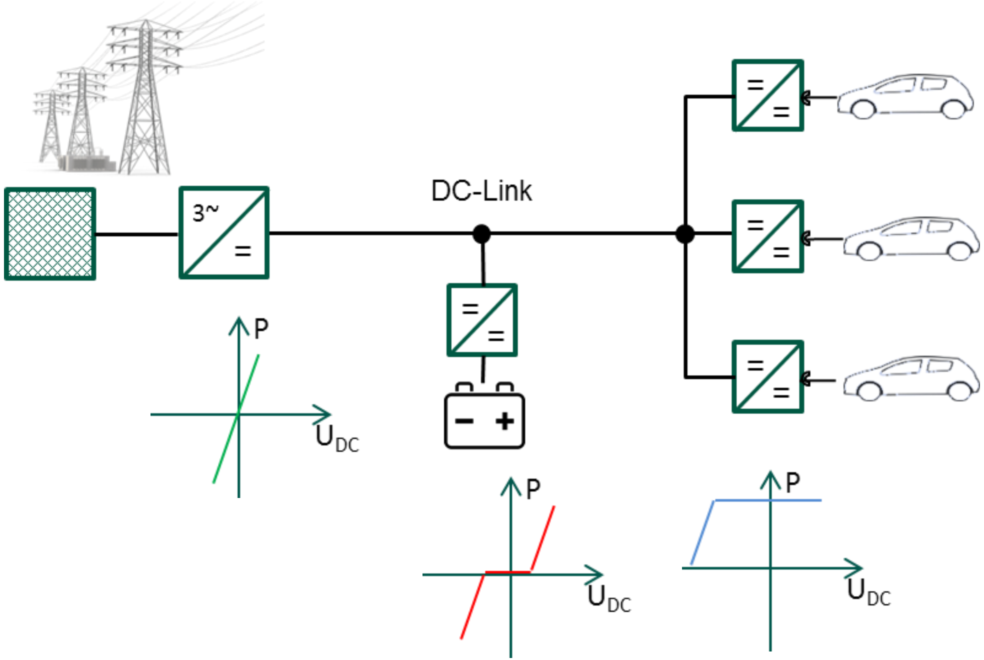
- Short circuit location in the north of Spain: 3-ph fault at 400 kV substation
- Voltage collapses around fault location
- Most of the system affected by voltage drop of >10%

Source: RED Eléctrica de Espana

Behavior of EVSE and EV in case of grid faults

- In fault situations grid voltage suddenly dips
  → possible power exchange with the grid is massively reduced
  → disruption of the charging process due to power shortage in the EVSE DC link

- Possible technical solutions:
  a) Fast reduction of charging power
  b) Storage implementation



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Summary and Outlook

- Expected ramp-up of EVs, with the corresponding expansion of charging infrastructure will have a significant impact on the electricity grid
- Today’s standards do not define a desired behavior of EVSE in case of grid faults
  - Risk that grid faults lead to critical post-fault imbalances between generation and load
  - a defined FRT behavior should be required for EVSE
- Advanced grid integration technologies for EVSE can be achieved easily by using the same features that are already well known from RES
- Any equipment that is installed today will influence the grid for at least 10 years
  → requirements for grid integration technologies of EVSE should be introduced in modern Grid Codes
- buffer storage inside EVSE can have several benefits, depending on the dimensions of the storage:
  - help to avoid peak loads
  - enable FRT down to 0 % of the nominal grid voltage
  - used as balancing capacity

THANK YOU FOR YOUR ATTENTION

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