Fraunhofer IEE

Need for grid-forming units in the distribution grid and their impact on protection, automation and control

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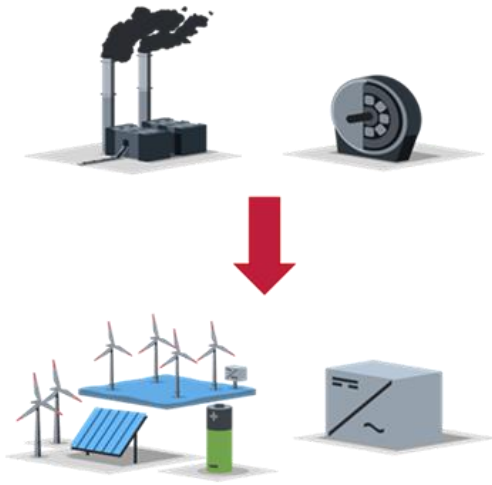
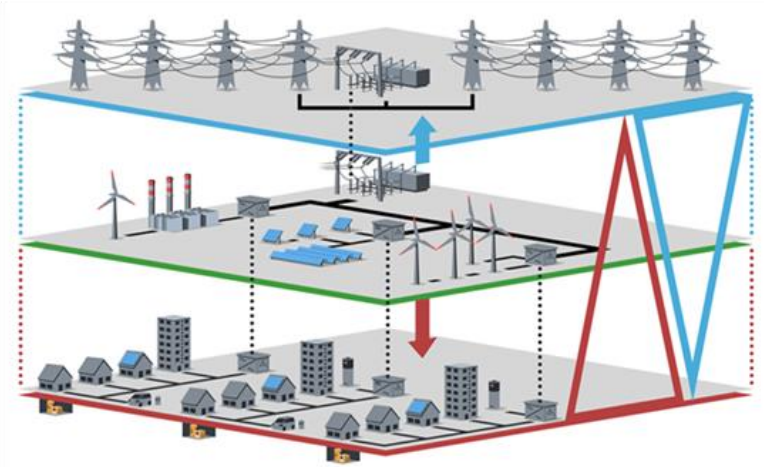
Carbon-neutral stable power system





- Substitution of conventional power plant
  - Inverter-based renewable generation
  - Decentralized generation
  - Grid-forming inverter

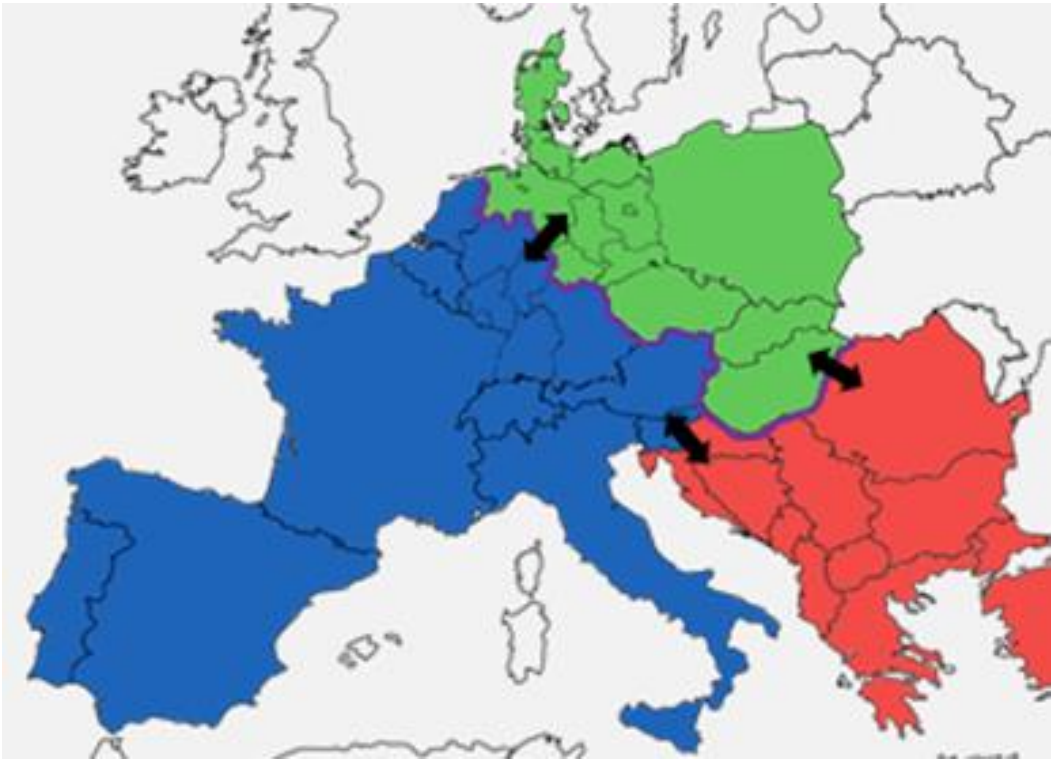
Challenges of the future power system

- Voltage support during faults
  - Provision of a high current (active/reactive)
    - Inverters provide limited currents (1.0 – 1.5 p.u.)
- Frequency stabilization
  - Provision of inertia
    - Grid supporting inverters provide only frequency response
    - Grid-forming inverters can provide inertia
    - Market procurement open to units of all voltage levels?

Demand of frequency containment

- System split as design case
- Up to 45 GW of power imbalance (2035)

- Demand of inertia also from the distribution grids



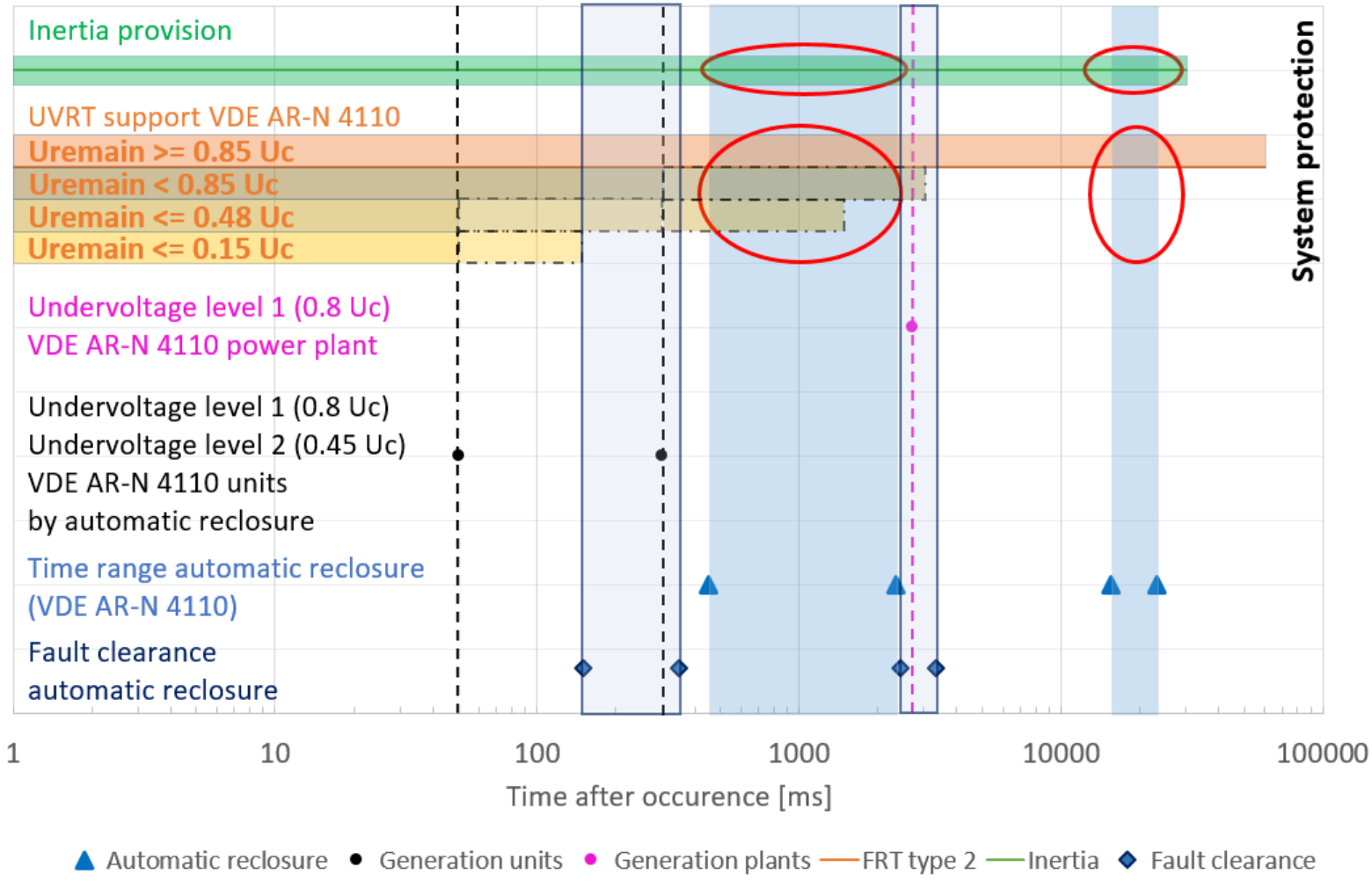
- T. Hennig (2022); Zukünftige Systembedarfe an Momentanreserve und Anforderungen an netzbildende Umrichter; Project Netzregelung 2.0 Final Conference, Kassel, Germany, July 2022

Protection aspects

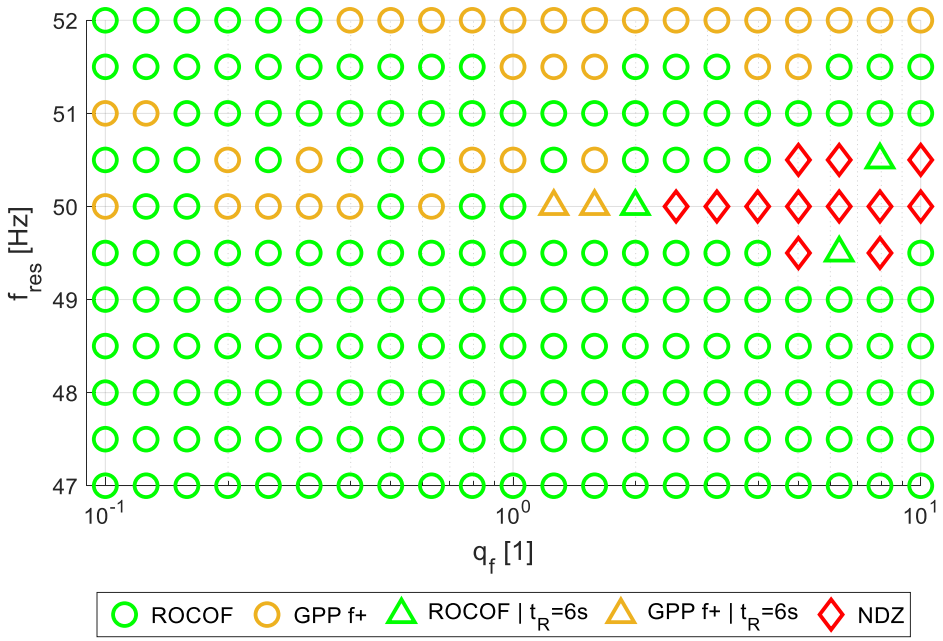
- Line and plant protection (ms – sec)
  - Fast and selective disconnection
  - Protection of operating equipment
- System protection (zero up to min)
  - Keep Frequency and Voltage in normal operation range
    - Support for some time

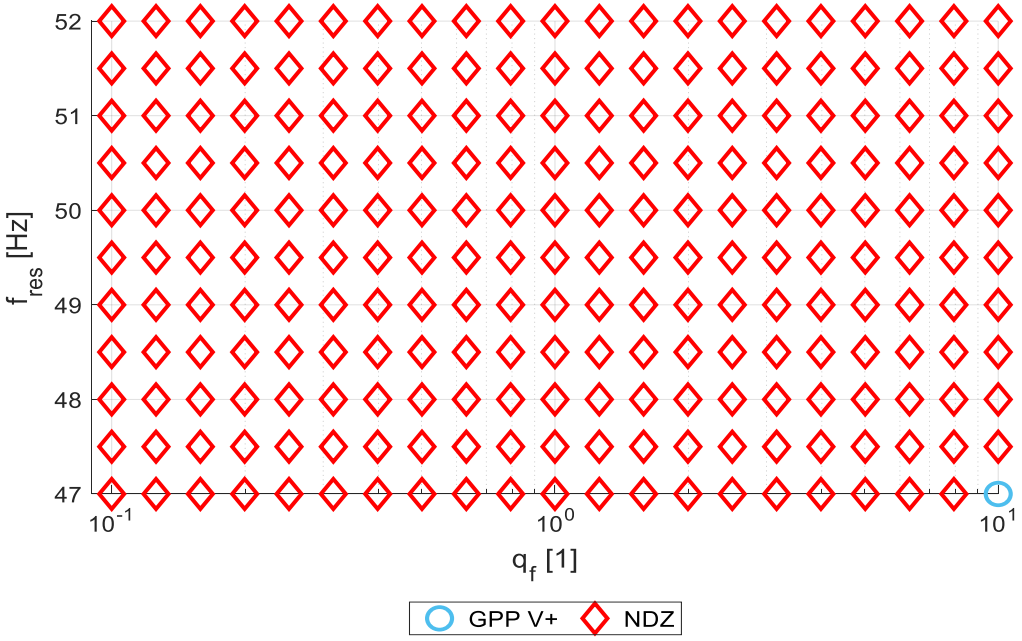
Possible conflicts – Distribution grids

- Overlapping of measurement times of protection goals
- No system support from disconnected units



Island detection with grid-forming inverter





– Without GFM

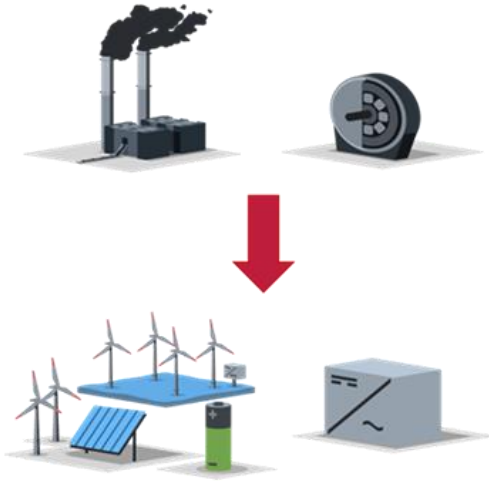
With GFM

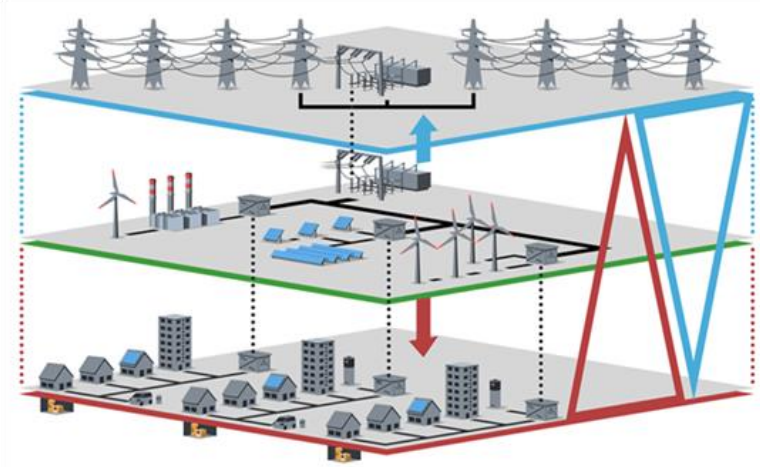
- Non detection zone (NDZ) increases with grid-forming inverters

Summary

- Technology change leads to more decentralized support
- Line protection and system protection overlaps
- Loss of support for voltage and frequency
- Use of Grid-forming inverters bear the risk of unintentional islanding
  - Improvement of islanding detection needed
- Risk of asynchronous reconnection with unintentional islands
  - Impact on automatic reclosing

Verteilnetz 2030+





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