Power System Testing

Testing requirements in smart systems

Annex 5:
Smart Grid International Research Facility Network (SIRFN)

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Power System Testing

- Motivation
- Objectives
- Approach
- Planned outcome

Motivation

- Challenges in the transition from a passive distribution grid to an integrated, smart system
  - Growing complexity in grid operation
  - Interdependencies of market roles and power/ ICT convergence
  - Multiple actors and objectives in grid operation
- How can risks minimized and safe system operation verified?

Growing Complexity

Type	Number of units	Installed power
PV in Germany	about 1.100.000	ca. 36 GW
Wind in Germany	about 24.000	ca. 35 GW

Status 2014-12

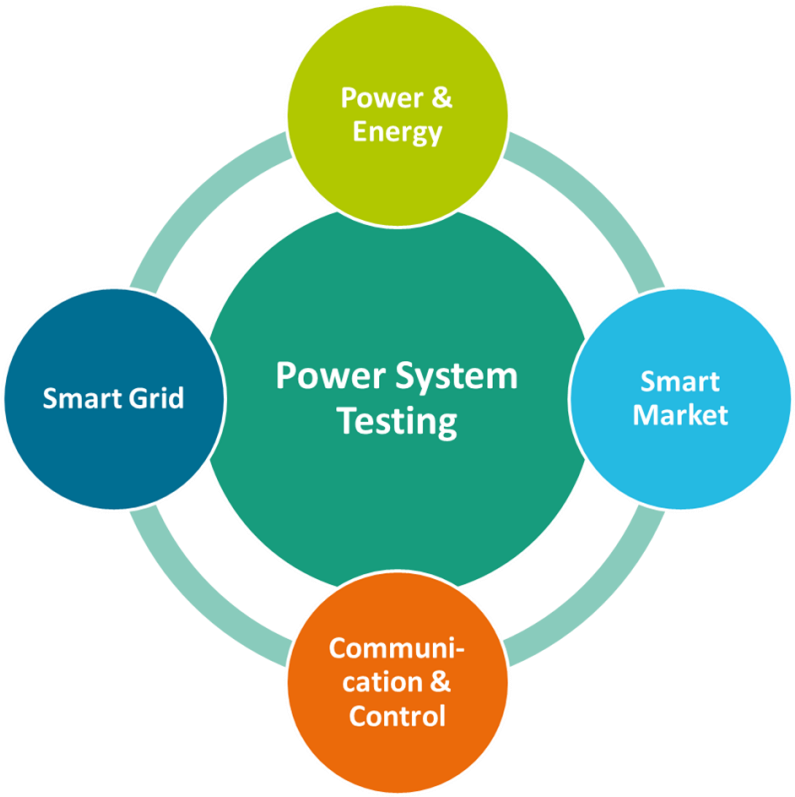
- Growing number of generators
- Growing variability of power production
- Growing number of actors
  - Grid operator, energy supplier, ESCOs (metering service, load aggregators, generation aggregators, …)
  - Prosumers, demand-side-management
- Growing number of storage systems (large scale and household scale, electric vehicles)
- Growing number of automatic control strategies and functionalities
- Bi-directional power flow

Interdependencies in power system control

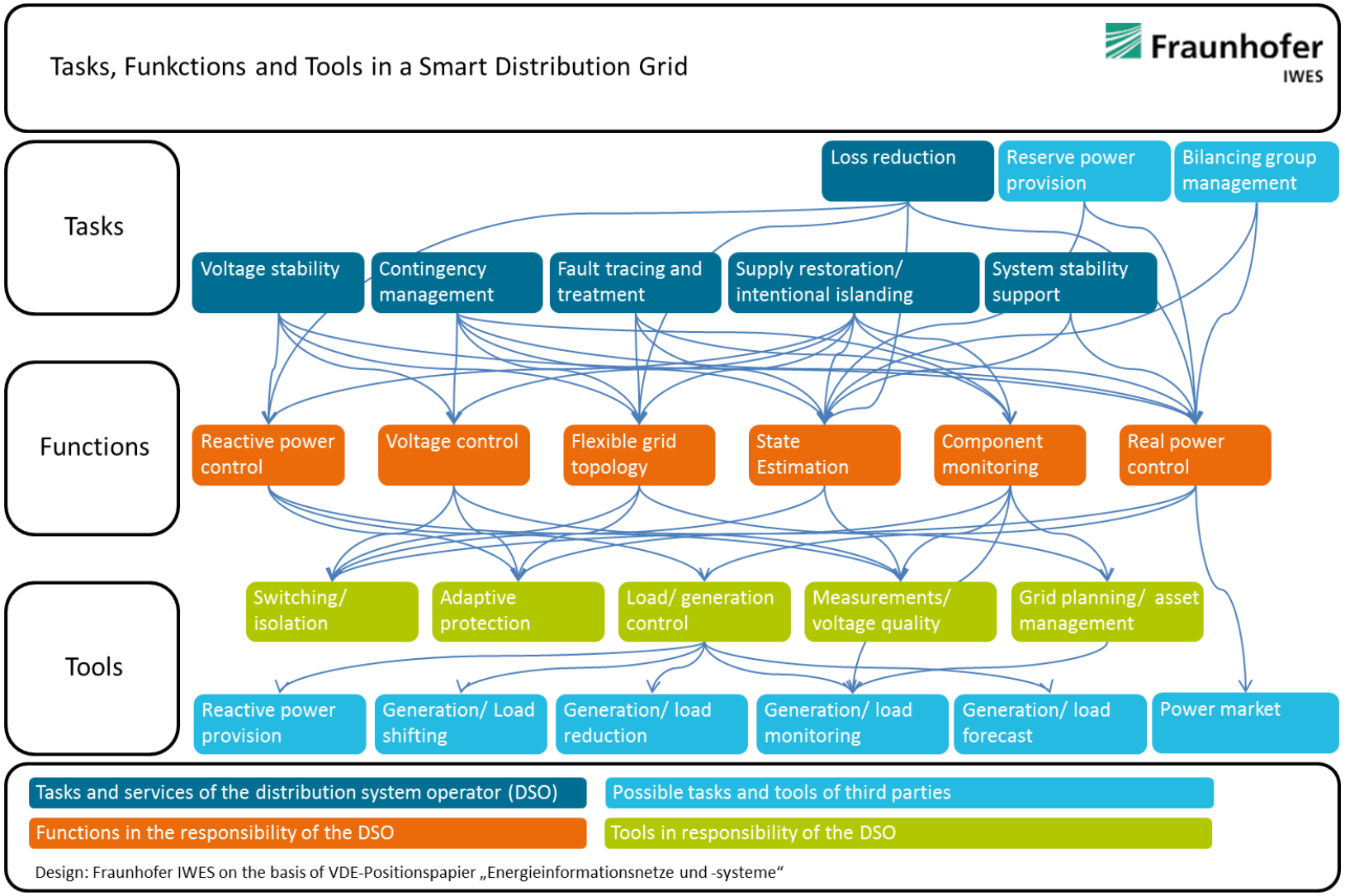
System control by

- Market mechanisms
- Interaction between market and direct actions
- Emergency actions

(German „BdEW-traffic lights“)



Multiple actors with possible divergent objectives



Classical approach and questions raised: component and field testing

- Component testing for grid code compliance
  - Behavior of a single device under standardized grid conditions
    - How to test interaction and interoperability?
    - How to consider high penetration scenarios?

- Field testing
  - Testing under normal operation with given use patterns
    - Testing of a variety of use patterns possible only for a variety of different test locations
      ➔ very costly and time demanding
    - Testing of failures or extreme situations is difficult, if not impossible

Objectives, approach and outcome

Objectives

- Categorize testing tasks in future power systems
- Map testing tasks to existing testing capabilities and facilities
- Define the needs for development

Approach

- Select a set of relevant use cases
- Specify the testing needs
- Describe the testing activities/ procedures
- Derive the necessary testing capabilities
- Map the capabilities to state-of-the-art testing facilities
- Describe possible gaps

Out-come

- Common view on future testing needs in power systems
- Guideline for laboratory developments

Testing environments

Use case XY	Simulation	Laboratory testing	Training simulator	Field test
Performance				
Require-ments				
System				
Subsystem				
Component				

Use Case Classification

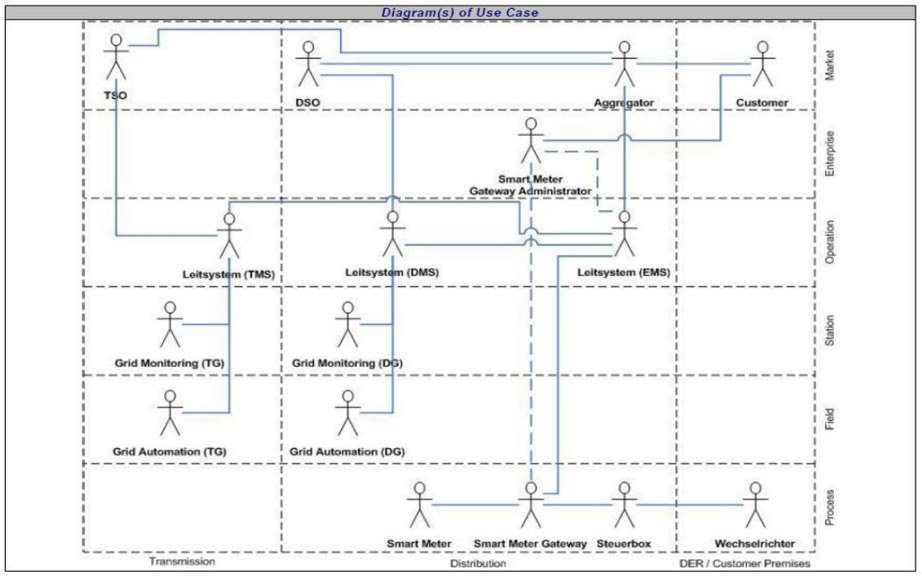
- Possible classification criteria
  - Power rating and time scale/ dynamics
  - Interoperability
    - Technical communication (syntax), general communication (semantic/ language)
    - Power network influence
  - Required modelling
    - Devices, communication/ communication path, needs of model validation
  - Required specification
    - Level of detail

Use Case Classification - Details

- Power rating
  - 10/ 100/ 1000 kW
- Time scale an dynamics
  - a few cycles up to 2000 ms
  - 1 to 10 minutes
  - 10 minutes to several hours
- Interoperability
  - Technical communication (syntax)
  - General communication (semantic/ language)
  - Power network influence
  - Interdependencies of functionalities

Use case: provision of flexibility to the grid (voltage, frequency)

- What has to be tested? What are the requirements?
  - Completeness and update process resources database
  - Technical communication between stakeholders
  - Monitoring grid status
  - Response to requests
  - Interdependencies between regional markets (e.g. Regioflex, FLECH) and global markets (e.g. reserve capacities requested by TSO)

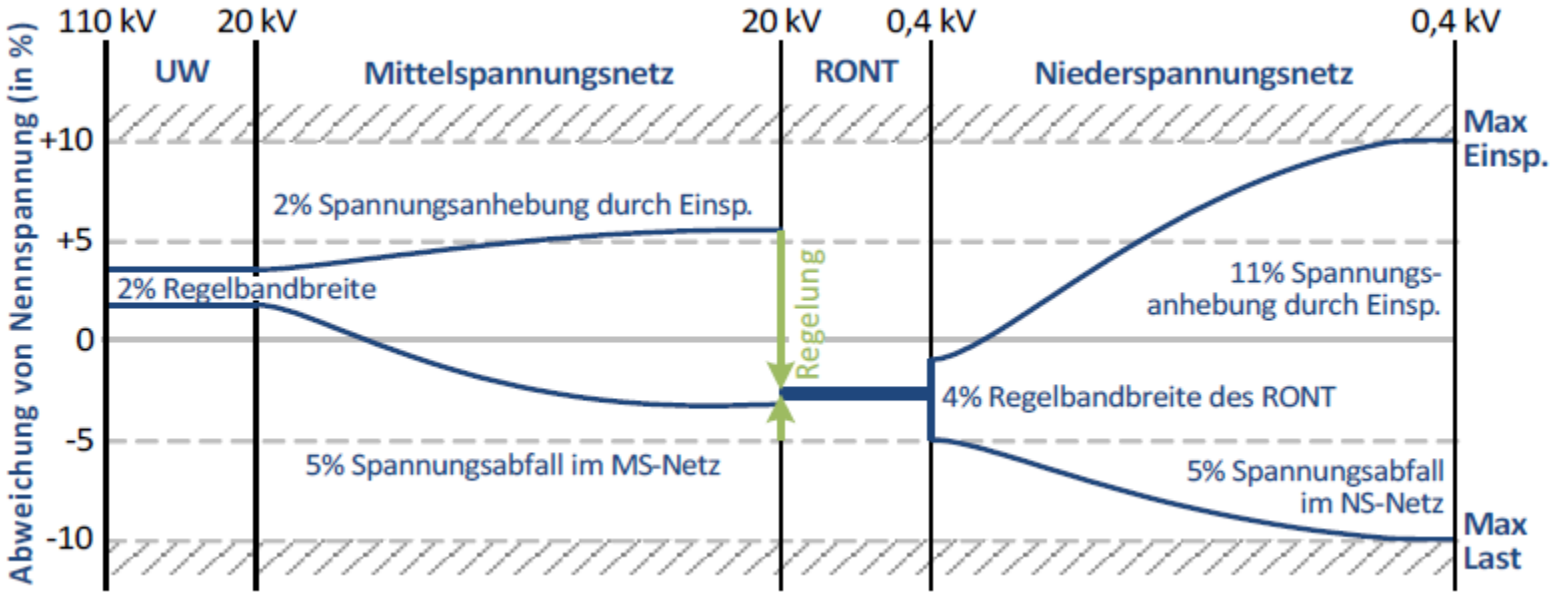


Example from FNN Use Case Grid Supporting Control (non-regulated)

Use case: massive OLTC MV-LV transformer deployment

- Deployment of OLTC MV/LV transformers, electrically near

Voltage band (±10%) usage <u>with</u> OLTC MV/LV transformer



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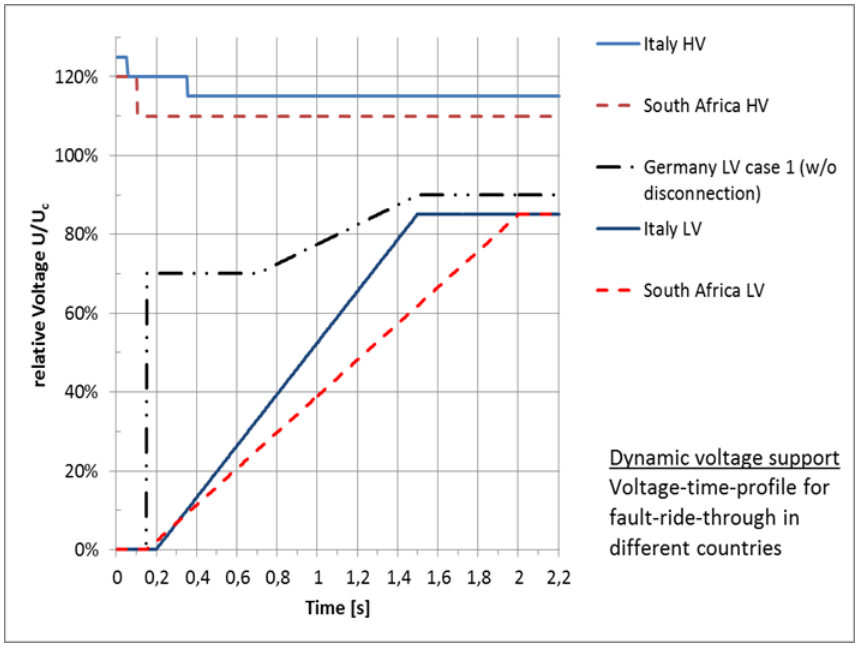
Use case: Dynamic grid support (voltage, frequency)

- Dynamic voltage support and network protection/ fault detection
  - Are the DSOs happy to support the TSOs?



Use case: High penetration of power electronics

- System behavior facing a high penetration of power electronics
  - TSO and DSO level
  - Power quality
  - Network stability
  - Protection

flicker, harmonics, inertia, synchronizing torque, short circuit capacity, ...

Looking for your expertise

- Engage in SIRFN
- Power System Testing Workshops
  - 25 June 2014 (online)
  - 16 October 2014 (online)
  - November 2014 (Kyoto, Japan)
  - 19 March 2015 (Les Renardieres, France)
  - Next planned for April (online)
- Get in touch for more information

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