Konference
Energetické Rušení 2024

ERU

Importance and relevance of the power quality in the new era of power systems

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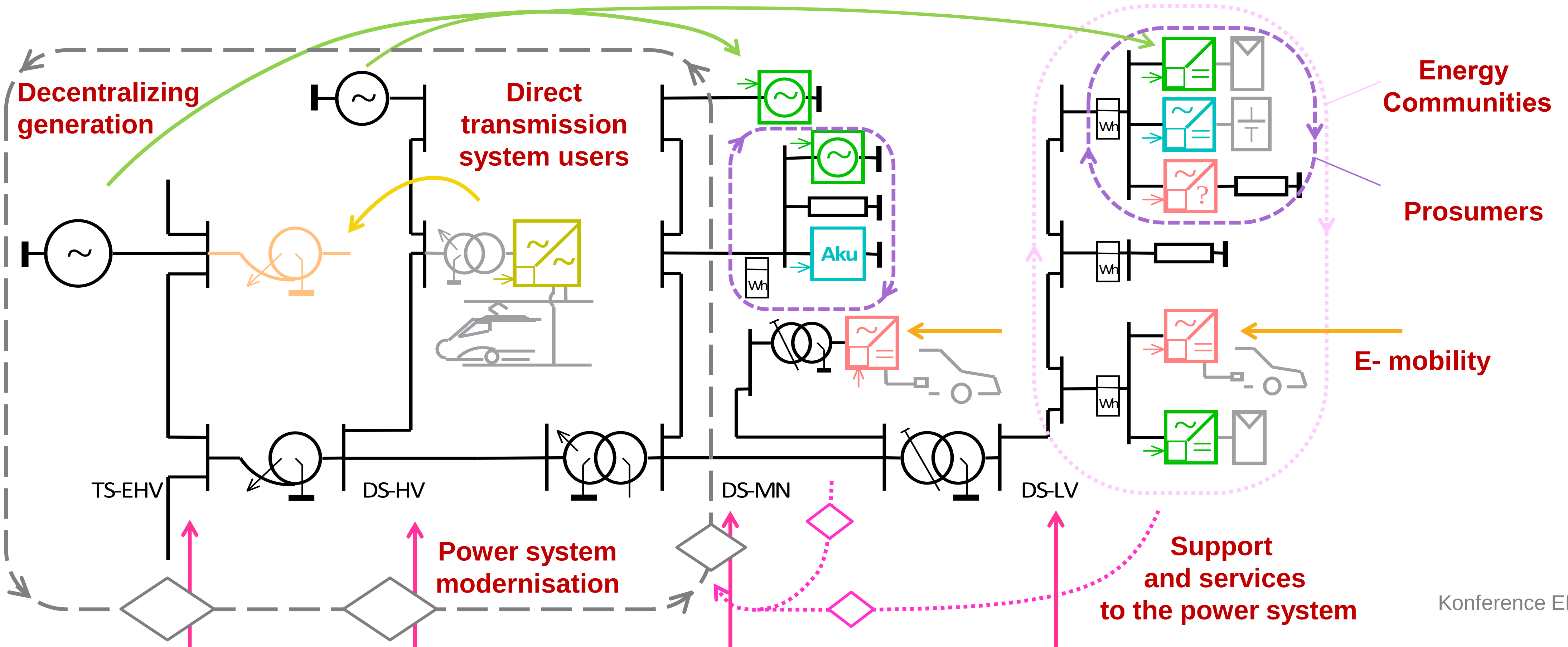
Retrospective of the ERU 22

Power system (PS) transition challenges for power quality | The transition format
- Internal vs. external stimuli and motivations



Retrospective of the ERU 22

Power system transition challenges for power quality | The transition aspects

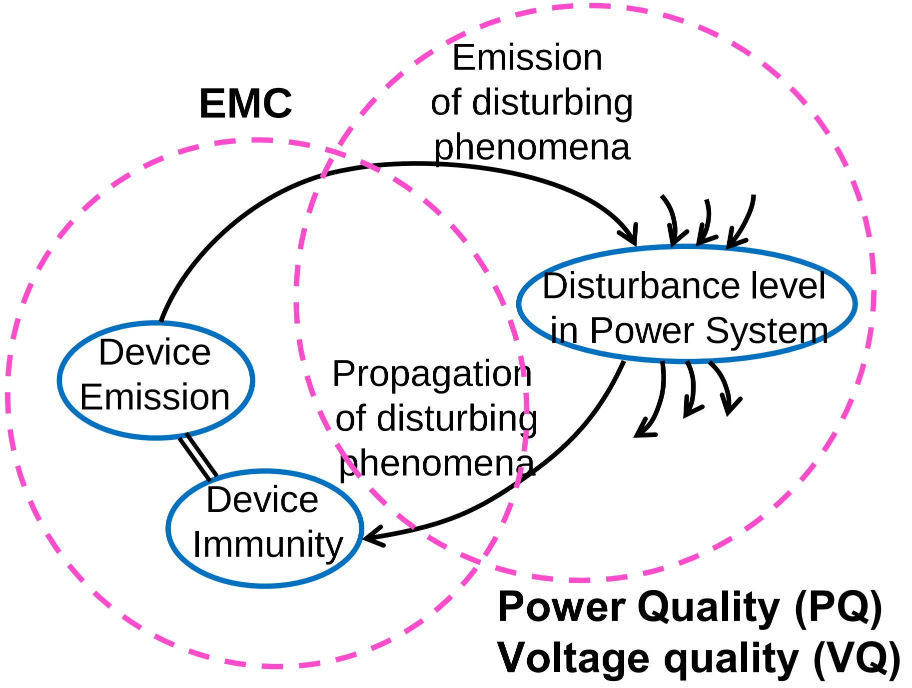
- Decentralized generation
- „New“ power system equipment
  - Generation (technologies)
  - Accumulation (technologies)
  - Controllable loads
  - E-vehicle charging systems (inc. V2G, etc.)
  - Dedicated measuring, control and communication equipment
- "New" ways/dimensions of operation/management of sub-systems
  - Prosumers (LV), Industry energy management
  - Energy communities
  - Decentration of services to the power system

- Power system load pattern development (TS,DS)
- Load character development
- „New“ phenomena – disturbances accompanying electricity cycle
- "New" aspects of equipment emissions
- „New“ aspect of equipment immunity

- Safety
- Reliability
- Resilience
- EMC
- Power quality (PQ)
- Voltage quality (VQ)

PQ importance and relevance

- **Traditionally, Power Quality (PQ) means**
  - Reliability and Voltage Qaulity (VQ)
  - and is strongly related to Electromagnetic Compatibility (EMC)
- **PQ and EMC aim to**
  - Maintain reliability and VQ in power system
  - Therefore **maintaining the power system operability**



- **PQ and EMC sector is seen by Electricity Industry as**
  - Less profitable and outside the mainstream business
  - Imposing obstacles to the mainstream business of the electricity industry

🤔 **HOWEVER!** ☝

PQ importance and relevance

- **Proper operation of the power system is in the best interest of all stakeholders**
- **A reasonable balance between business and technical aspects must be found and maintained**

Electricity bussiness actors

Power system Operability/PQ and EMC keepers

- **Power system sector transition (including PQ and EMC perspective) raises the need for**
  - new technical regulations
  - new technical designs/solutions
  - new technical resources (measurement, control, actuators, ...)

- **What are the challenges and where are we in addressing them?**

Challenges recap

From the perspective of PQ and EMC

- Mapping of new (sources of) disturbances and their incorporation into the concept for EMC and power quality assurance
- EMC and VQ coordination in the power system
  - Allocation of emissions to the power system users (at DS as well as TS level)
  - Power/voltage quality in Energy Communities
- Securing EMC (emission/immunity) of existing and new types of devices/equipment
- Proper integration of dispersed generation (DG) and accumulation (i.e. BESS)
  - Ensuring conformity and compliance with requirements
  - Inverter-based generation plants with voltage control emulating synchronous generator behaviour (grid forming inverters)
- Extension of mandatory network support to extensively- employed equipment: G2V, V2G, G2F (V – Vehicle, G – Grid, P – Power, F – Fuel)
- Adaptation of mitigation techniques and measures
- Innovation and standardisation of electricity parameters and indicators measurement
  - Measurement uncertainty of monitoring and/or control instruments - data quality improvement
  - Advanced power quality management tools
- …….

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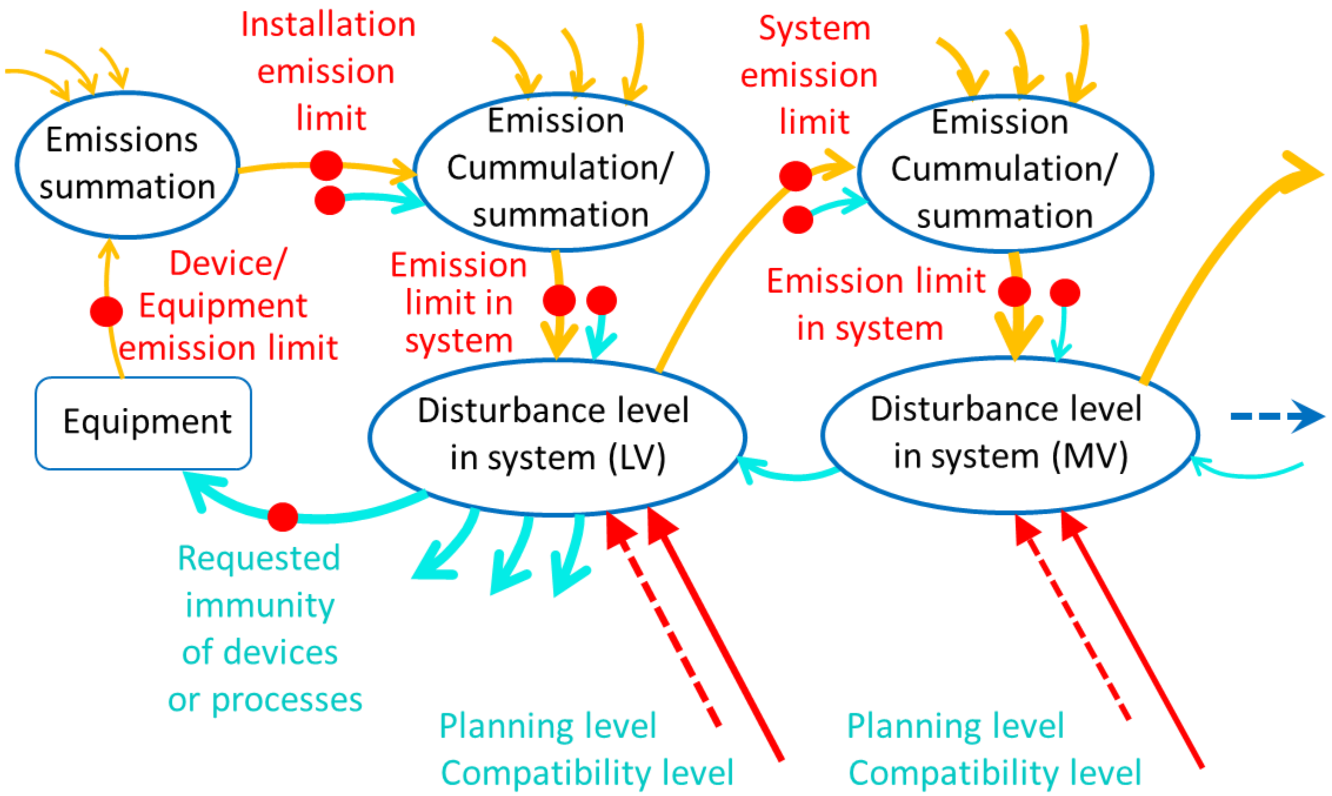
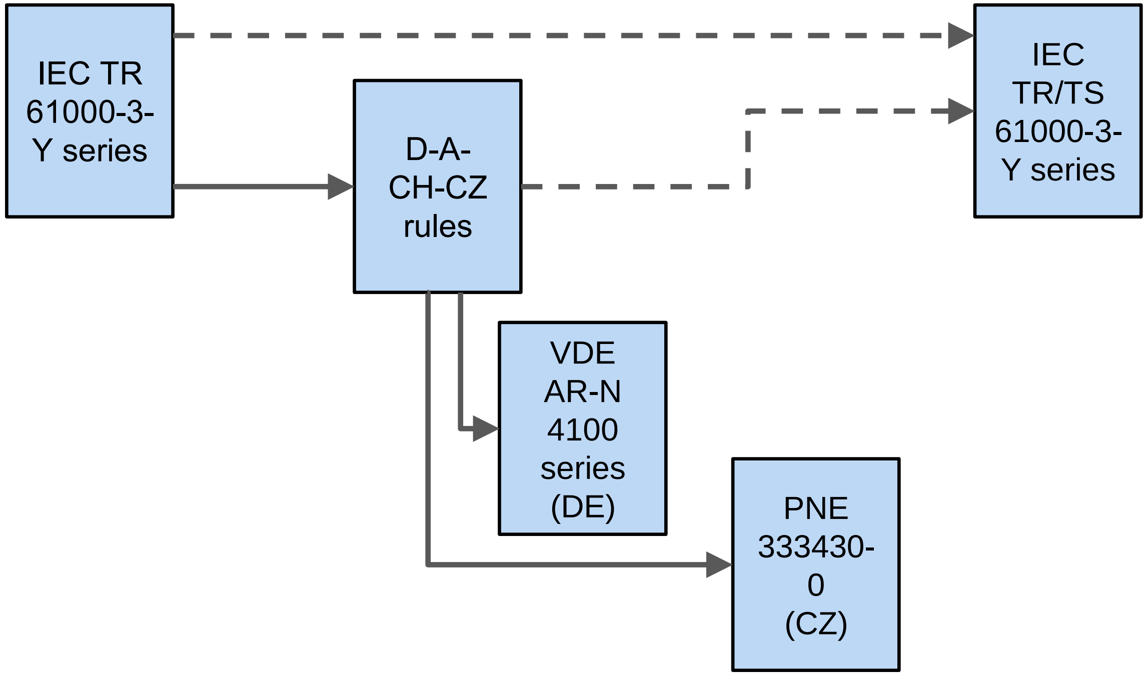
EMC coordination

- **In order to ensure compatibility levels at MV and mainly LV level for mass market devices, coordination across entire PS has to take place**
- **Resulting in**
  - Planning levels adjustment
  - Allocation of emission limits for PS voltage level
  - Allocation of emission limits for individual PS users
- **Aiming to keep disturbance levels, i.e. voltage quality in limits**



EMC coordination

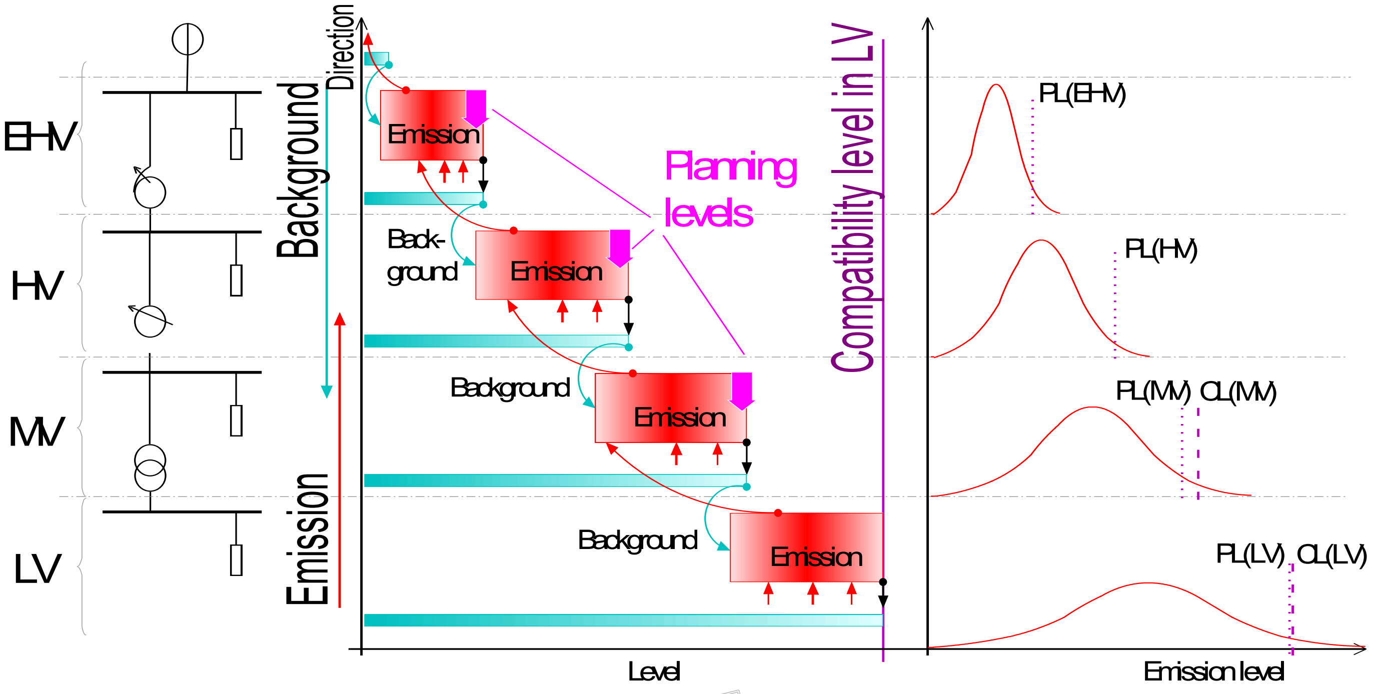
- **The concept was established by IEC SC77A in IEC TR 61000-3-Y series (-6, -7, -13, …)**
- **Recently further developed by the D-A-CH-CZ WG in DACHCZ technical rules ed.3:2023**
- **Adopted in VDE AR-N 4100:2018 series (DE)**
  - **by means of individual emission limits**
  - **4100 – LV, 4105 – LV/generators, 4110 – MV, 4120 – HV, 4130 - EHV**
- **Adopted in PNE 333430-0 ed.6:2024 standard (CZ)**



EMC coordination

PNE 333430-0 ed.6:2023

- Applies to the connection of users‘ **consumption** and **production** equipment and installations
- to the **LV**, **MV**, **HV** and **EHV** networks
- Indicating **planning levels**
- Allocating **individual emission limits**
- Introduces voltage and **current** emission limits
- **Application:**
  - **Pre-connection:** Determination of individual emission limits and compliance assessment
  - **Post-connection:** Verification of compliance with limits by measurement



Flexibility
Re-allocation

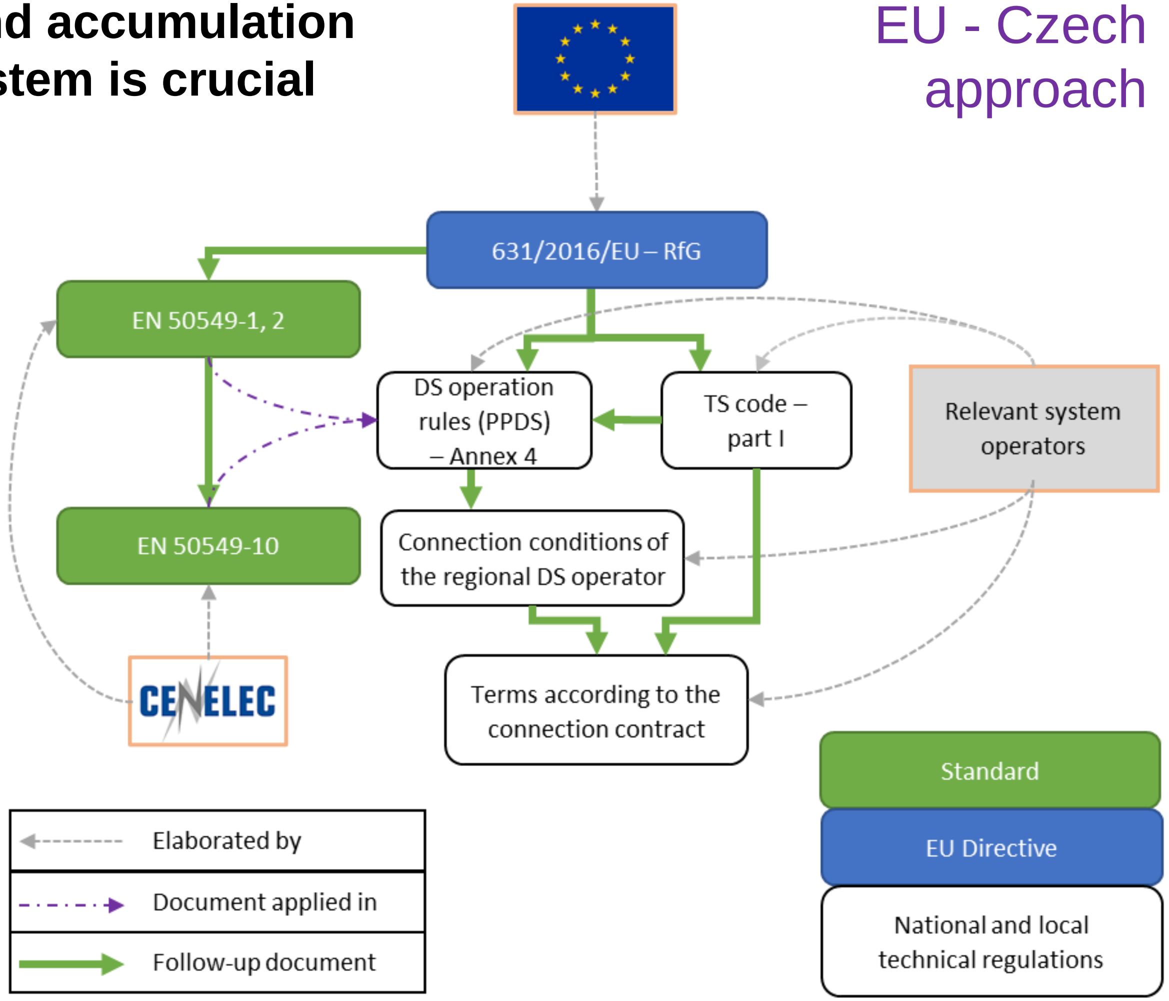
Further development
in progress

DG integration

- **Proper integration of dispersed generation (DG) and accumulation (i.e. BESS) sharing responsibility for the power system is crucial**

EU - Czech approach

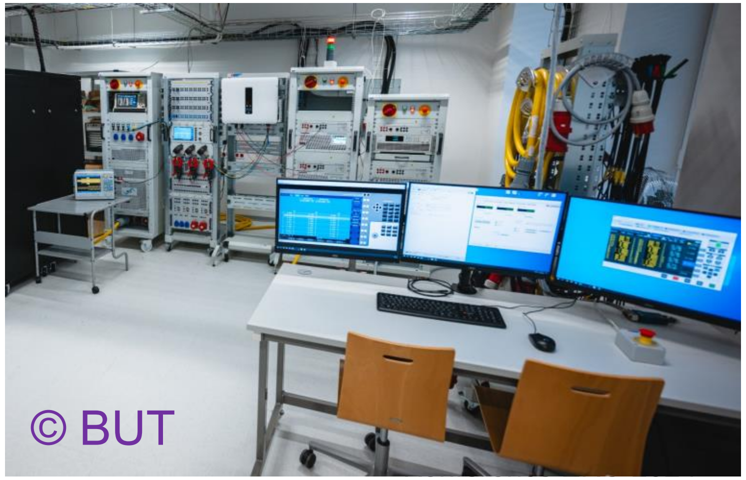
- Requirements set by connection codes
  - Transmission system (TS) level network code
  - Distribution system (DS) level network/grid code
  - Requirements on:
    i) interconnection, ii) interoperability
    a) operation modes, b) minimal immunity,
    c) static support, d) dymanic support, ….
- Compliance verification
  - Testing
  - Simulation
  - Monitoring



DG integration

Joint initiative of DSOs (EG.D, ČEZ Distribuce) and Brno University of Technology (BUT)

- ☑ Establishment of test laboratories for testing components of power generating modules (PGMs), e.g. inverters/ converters, protection terminals, control units;
  Size:
  - ČEZ Distribuce: 15 kVA system (on going project for extension to 50/100 kVA)
  - EG.D: 30 kVA system
  - BUT: 50/100 kVA system (incl. PHIL simulations)
- ☑ Development of a methodology for verifying and demonstrating compliance with requirements
- ☑ Development of a methodology for component compliance testing of components for category A inverter-based PGMs (up to 100 kW)



DG integration

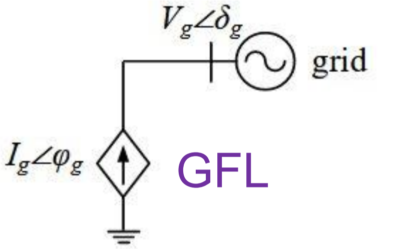
- **BUT test laboratory in cooperation with SZU has been accredited by the national authority for compliance testing of inverters for PGM of category A** ☑

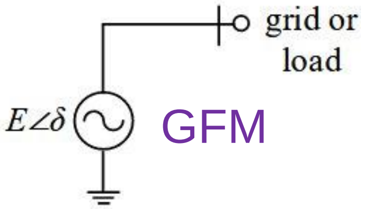
- **Further development challenges and opportunities**
  - Methodology for compliance verification of components for category B inverter-based PGMs
  - Compliance verification scheme by means of accredited inspection body
  - Simulated input testing approach for large scale PGMs
  - Compliance monitoring

  - Inverter-based resources (IBRs) – from grid following (GFL) to grid forming (GFM) - **CONTROL**

STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV

FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ





Something to think about

- The power system faces increasing variability in operation, both in the short and long term

- As the rate of active independent interactions with the power system is rising, making its behavious less deterministic and more stochastic,
does it make sense to
  - apply less deterministic and more probabilistic approaches to planning, design and evaluation stages?
  - implement more distributed and autonomous control?

- Is it time to
  - incorporate machine learning?

- Is it acceptible?

Thank you for your attention!

Přeji konferenci ERU 2024 úspěšný průběh!

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