MED POWER 24
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Royal Olympic Hotel

Panel 4. Advanced simulation and laboratory methods in power systems

ERIGRID 2.0
Connecting European Smart Grid Infrastructures

From ERIGrid to ERIGrid 2.0: Innovations in Research Infrastructures for Sustainable Energy

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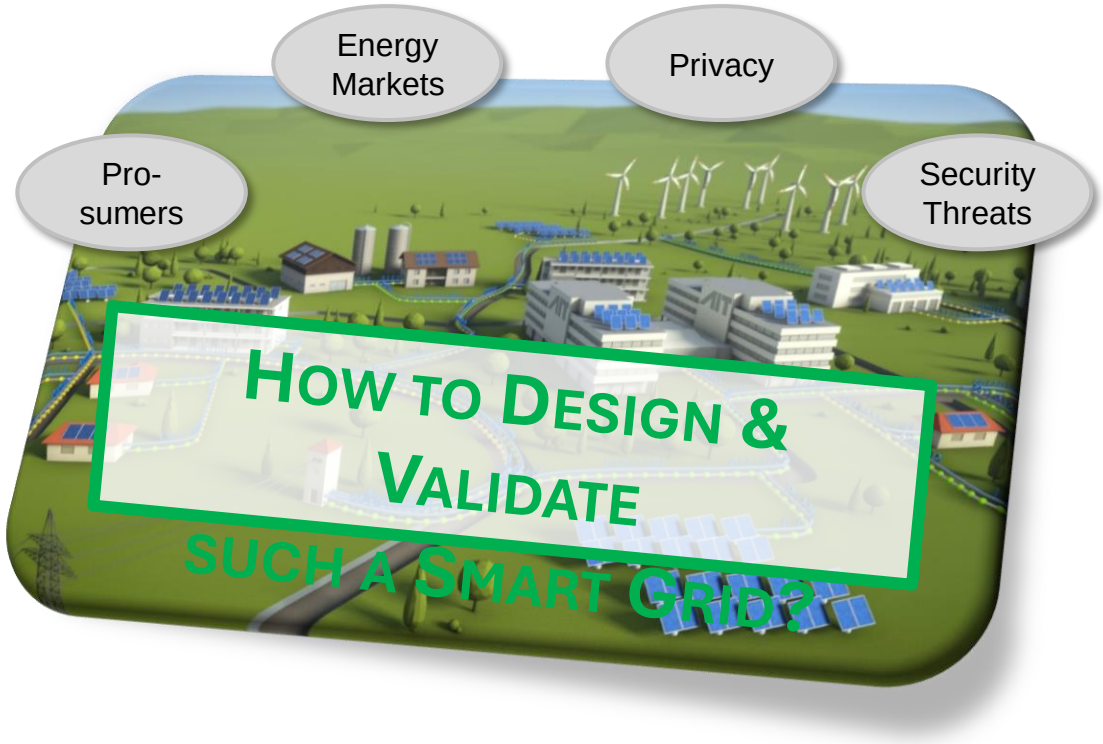
Background and Motivation

- Planning and operation of energy infrastructure becomes more complex
  - Large-scale integration of renewable sources (PV, wind, etc.)
  - Controllable loads (batteries, electric vehicles, heat pumps, etc.)
- Trends and future directions
  - Digitalisation of power grids
  - Deeper involvement of consumers and market interaction
  - Linking electricity, gas, and heat grids for higher flexibility and resilience

→ ***Smart Grid or Cyber-Physical Energy Systems***



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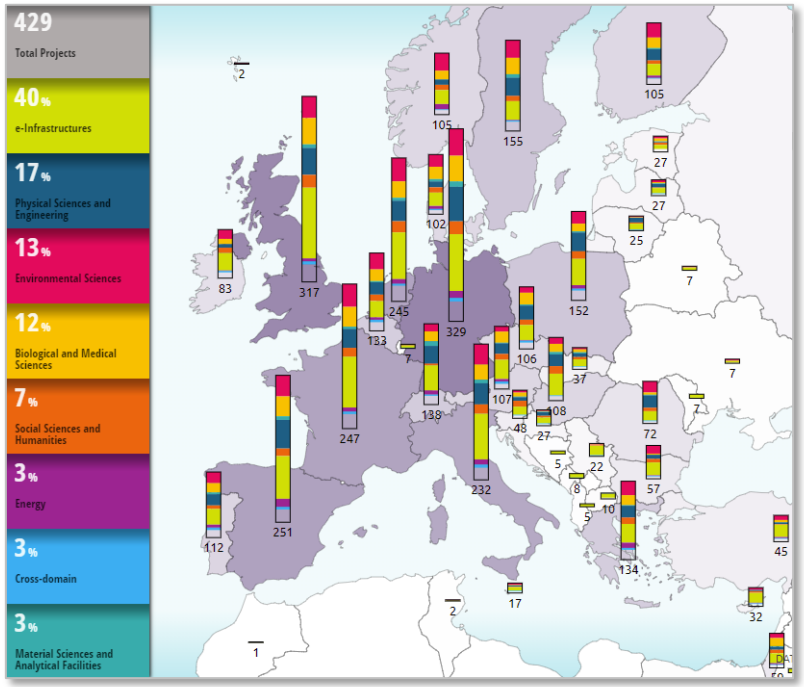
European Research Infrastructures (RI)

- Provide resources (major scientific equipment) and services to communities
- Conduct research and foster innovation
- Are strategic investments in scientific and technological excellence
- Act as knowledge and innovation hubs (collections, archives or scientific data)
- Essential pillar of the European Research Area



Source: European Commission & RICH2020

→ ***Only a few cover energy-related topics***

→ ***Almost no one covers power system/smart grid topics***

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Integrated Smart Grid and Energy Systems RIs

- Long-term, Pan-European cooperation
- Advanced community

Legend:

DER … Distributed Energy Resource
RI … Research Infrastructure
TNA … Trans-national Access
VA … Virtual Access
NoE … Network of Excellence

2005

DERlab
European Distributed Energy Resources Laboratories

- GA-ID 5189299
- FP6 NoE (11/2005-10/2011)
- Coordinated by FhG
- 3 Mio EUR funding
- 12 partner
- Networking of DER labs, pre-standardization

DERri
Distributed Energy Resources Research Infrastructure

- GA-ID 228449
- FP7 RI IA (09/2009-12/2013)
- Coordinated by RSE
- 5 Mio EUR funding
- 16 partner from 12 countries
- TNA to DER labs, pre-standardization

ERIGRID
Connecting European Smart Grid Infrastructures

- GA-ID 654113
- H2020 RI IA (11/2015-04/2020)
- Coordinated by AIT
- 10 Mio EUR funding
- 18 partner from 11 countries
- TNA to Smart Grid and DER labs, pre-standardization

ERIGRID 2.0
Connecting European Smart Grid Infrastructures

- GA-ID 870620
- H2020 RI IA (04/2020-04/2025)
- Coordinated by AIT
- 10 Mio EUR funding
- 20 partner from 13 countries
- TNA & VA to Smart Grid, Smart Energy Systems and DER labs, pre-standardization

2028

RISEnergy

- GA-ID 101131793
- HORIZON RI SERV (03/2024-08/2028)
- Coordinated by KIT
- 14.5 MIO EUR funding
- 54 partners (17 core institutes)
- TNA & VA to renewables and energy systems

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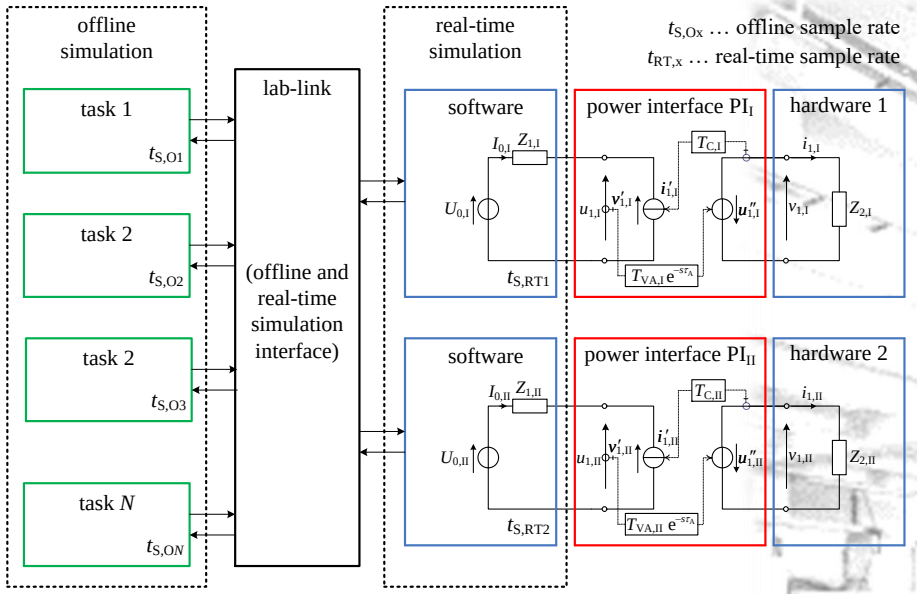
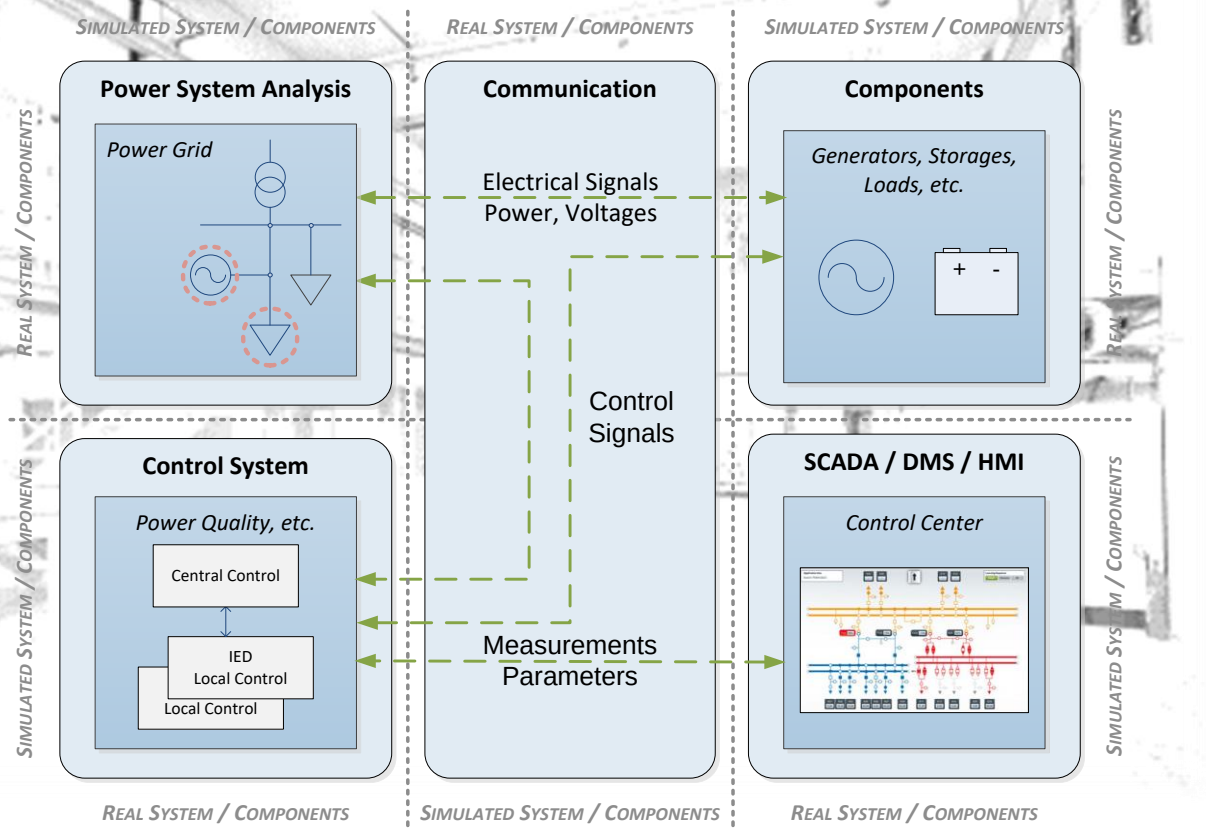
Selected Results ERIGrid





Advanced testing methods and tools

- Co-simulation and Hardware-in-the-Loop (HIL) based system-level testing
- Functional Mockup Interface (FMI)-based simulation library

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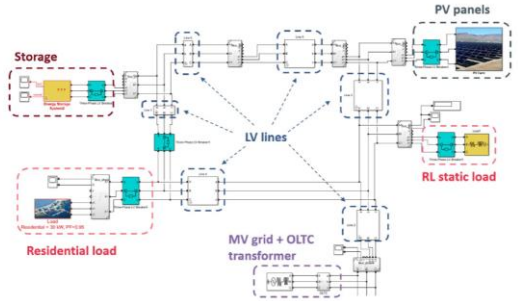
Selected Results ERIGrid 2.0

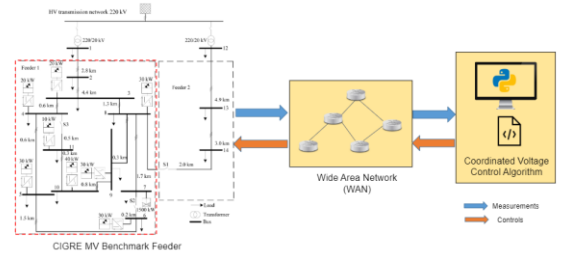
- Enhanced validation methods
  - Development of benchmark scenarios/models for different testing setups
  - Developing guidelines for test reproducibility and representation of data and uncertainty
  - Developing methods for test upscaling and domain extension

Name	Domain	Simulation Environment
Electrical Network	Electrical	MathWorks MATLAB/Simulink
Multi-Energy Networks	Electrical, Thermal	pandapower, Modelica, Python
ICT-Enhanced Power Systems	Electrical, ICT	DIgSILENT PowerFactory, Mininet

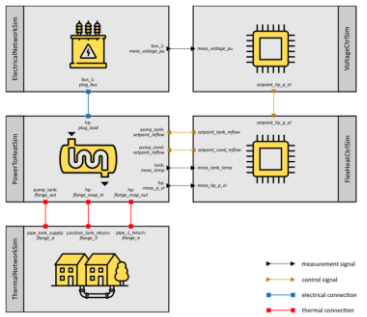
Electrical Network Benchmark



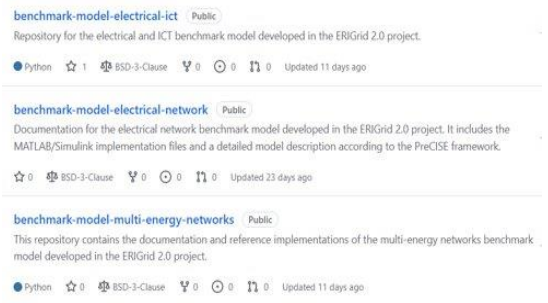
ICT-enhanced Power System Network Benchmark



Multi-Energy Network Benchmark



Documentation in GitHub



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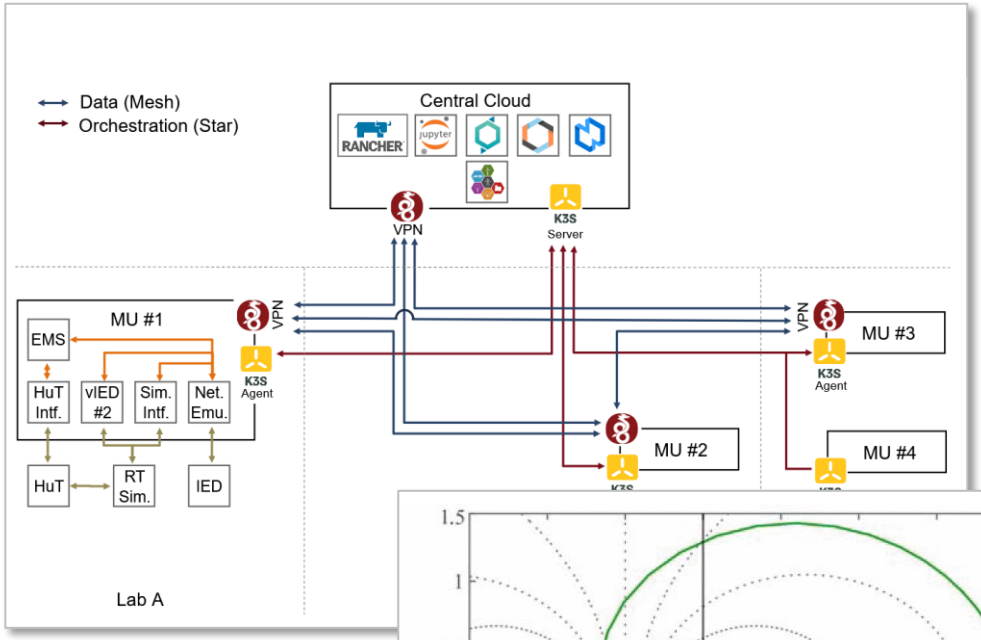
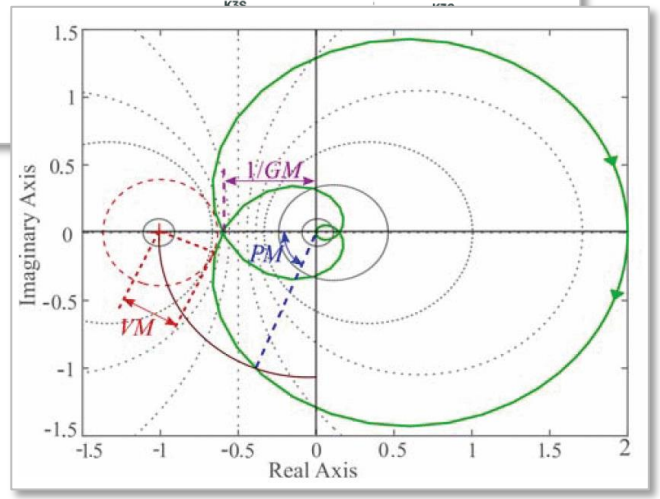
Selected Results ERIGrid 2.0

- Improved and extended tools
  - Coupling multiple instances of non real-time with real-time simulators, HIL components, and lab equipment (RiasC approach)
  - Multi-domain co-simulation of physical infrastructures at multiple time scales
  - Methods for the coupling of real-time simulators with co-simulation and HIL
  - Sensitivity analysis of HIL experiments
  - Support distributed and remote experiments





G. Lauss et al., "A Framework for Sensitivity Analysis of Real-Time Power Hardware-in-the-Loop (PHIL) Systems," in IEEE Access, vol. 10, pp. 101305-101318, 2022, doi: 10.1109/ACCESS.2022.3206780.

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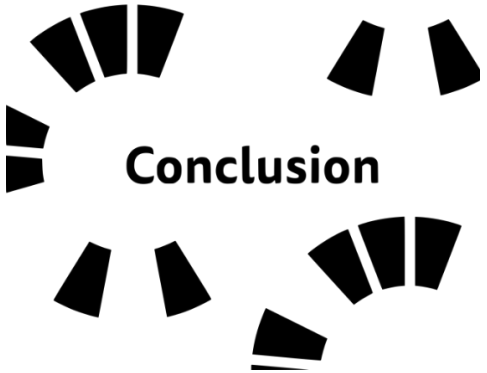
Lessons Learned

- Future large-scale rollout of smart grid and energy solutions expected
- New technologies and methods needed for system analysis and testing
- Promising integration of simulations, HIL, and lab testing
- Important to develop system validation procedures and benchmarks
- Open research results (open access, data, publications) drive innovation
- Lab-based research infrastructures are crucial for the energy transition
- Multi-domain education and training essential
- Collaboration on an international basis is important and beneficial



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Outlook

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www.erigrid2.eu

@ERIGrid 2.0 Project

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