The Important Role of Research Infrastructures in Context of Smart Grid Technology Development, Validation, and Roll-Out

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Outline

- Motivation
- Status Quo in Validation
- Future Needs
- The ERIGrid Approach
- Validation Example
- Conclusions

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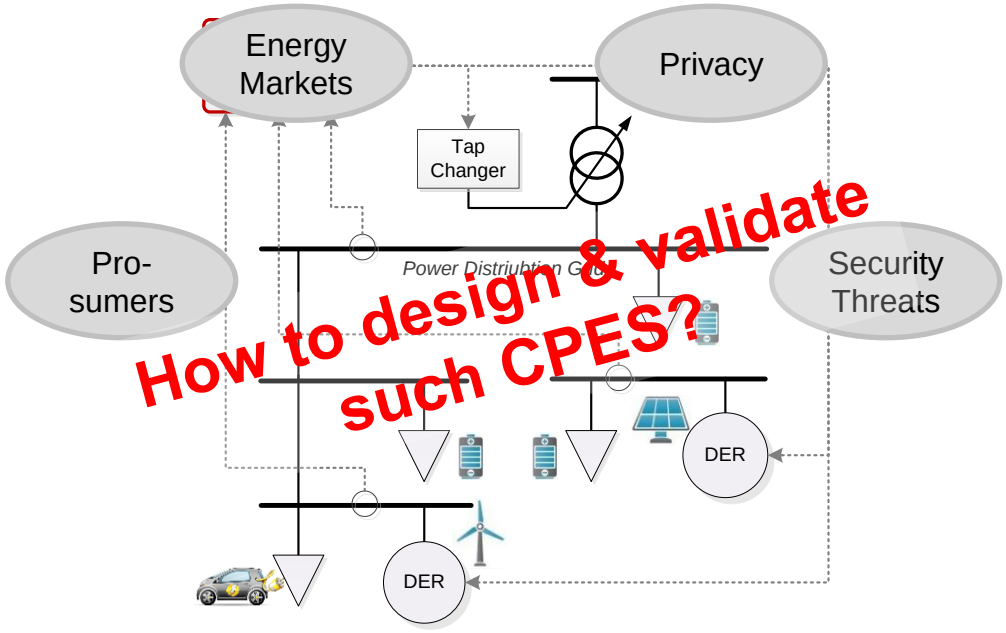
Background and Motivation

- Planning and operation of the 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



→ *Cyber-Physical Energy System (CPES)*

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Status Quo in Validation

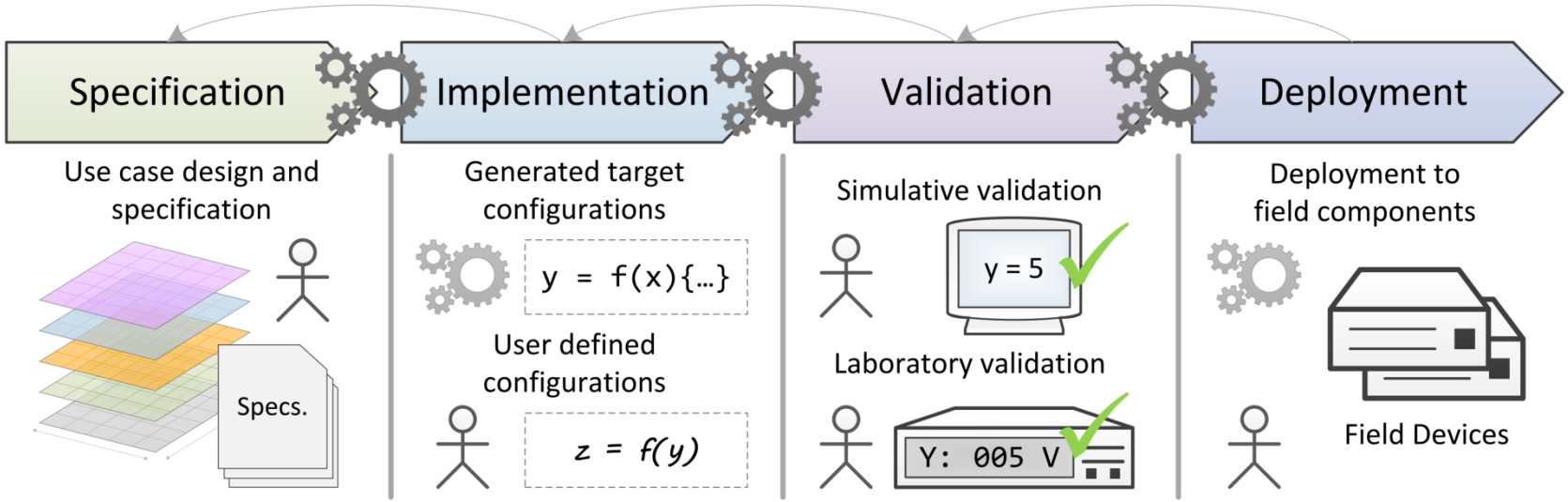
- In the past individual domains of power and communication systems have been often designed and validated separately
- Available methods and approaches are

	Req. & Basic Design Phase	***Detailed Design Phase***	***Implementation & Prototyping***	***Deployment / Roll Out***
Software Simulation	+	++	O	-
Lab Experiments and Tests	-	-	++	+
Hardware-in-the-Loop (HIL)	-	-	++	++
Demonstrations / field tests / pilots	-	-	-	++

Legend:
- … less suitable, o … suitable with limitations, + … suitable, ++ … best choice

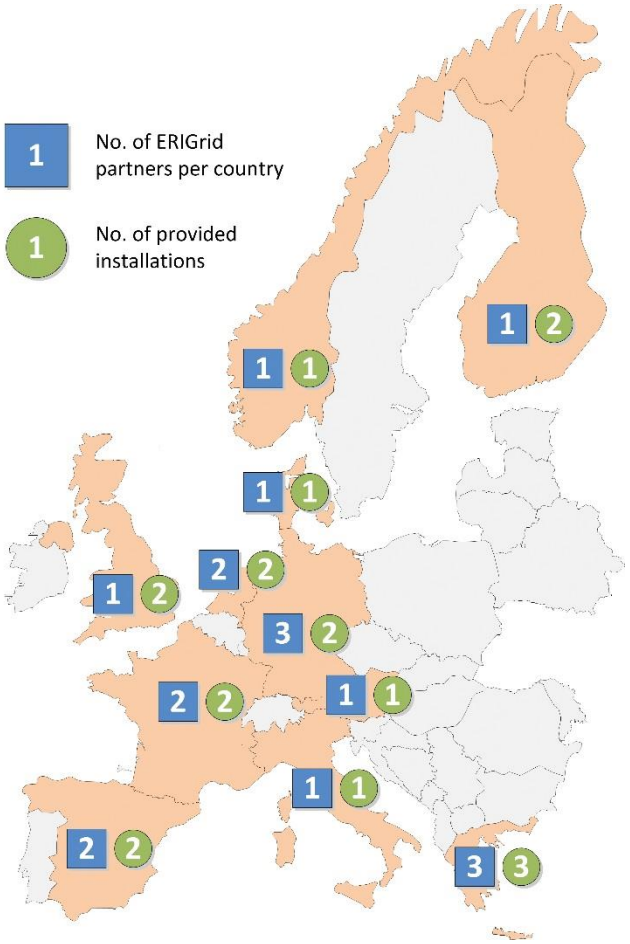
Future Needs

- Vision: *"Providing support from design to implementation & installation"*
  - Integrated system design
  - Validation and testing
  - Installation and roll out



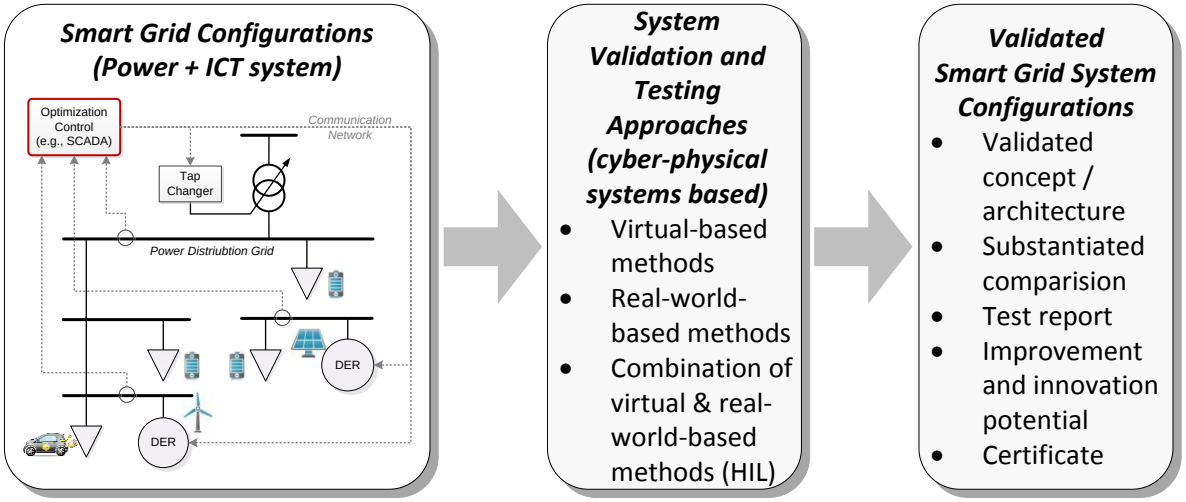
The ERIGrid Approach

- H2020 INFRAIA-1-2014/2015 call
  - Integrating and opening existing national and regional research infrastructures of European interest
- Funding instrument
  - Research and Innovation Actions (RIA)
  - Integrating Activity (IA)
- 18 Partners from 11 European Countries
- Involvement of 19 first class Smart Grid labs
- 10 Mio Euro Funding from the EC (~1000 Person Month)



The ERIGrid Approach

- Development of a holistic validation framework and the corresponding research infrastructure with proper methods and tools

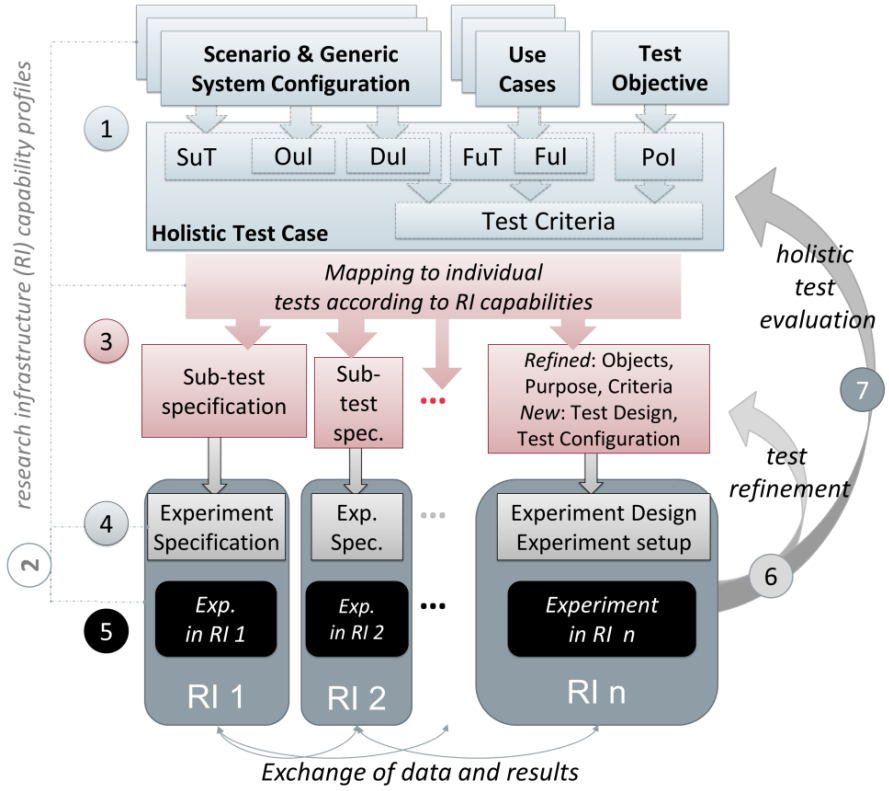


- Improved simulation and lab-based validation approaches
- Harmonized and standardized evaluation procedures
- Provision of training and education material

The ERIGrid Approach

- Towards formalized validation

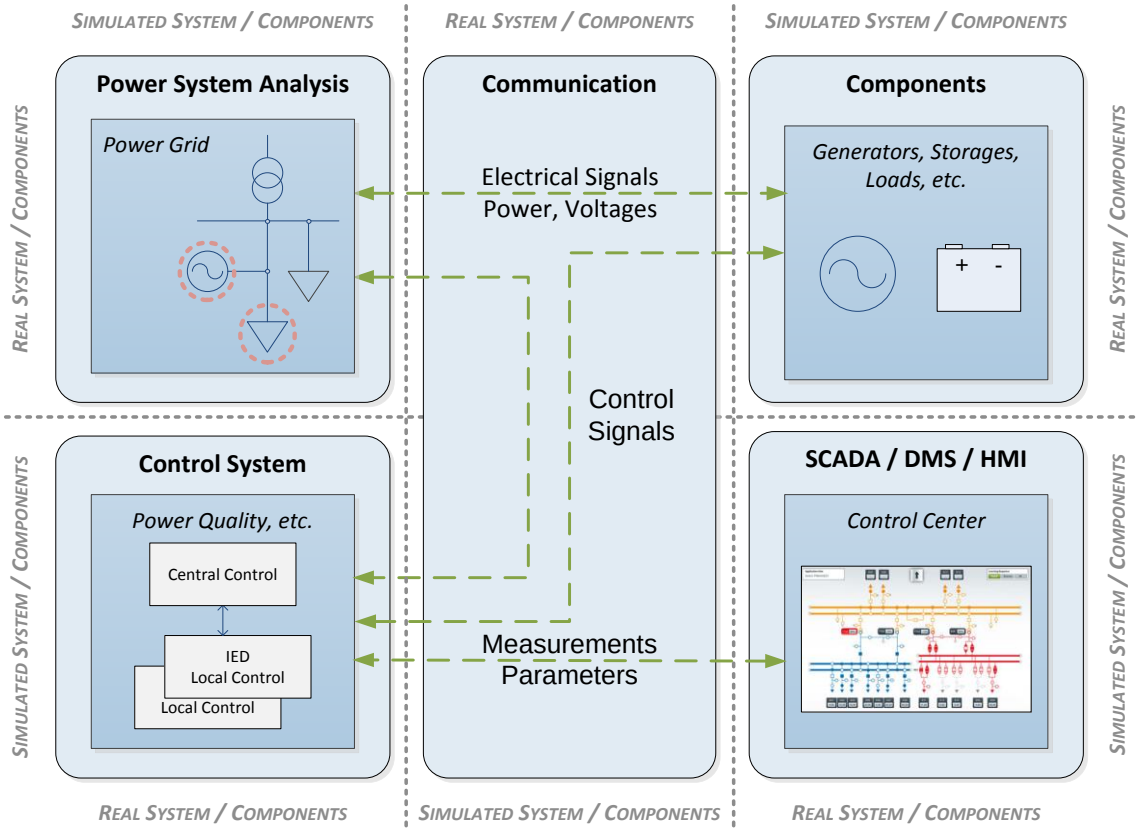
"From validation needs to evaluated integrated Smart Grid Configurations"



Legend:
- System under Test (SuT)
- Object of Investigation (OuI)
- Domain under Investigation (DuI)
- Function(s) under Investigation (FuT)
- Function(s) under Test (FuI)
- Purpose of Investigation (PoI)
- Research Infrastructure (RI)

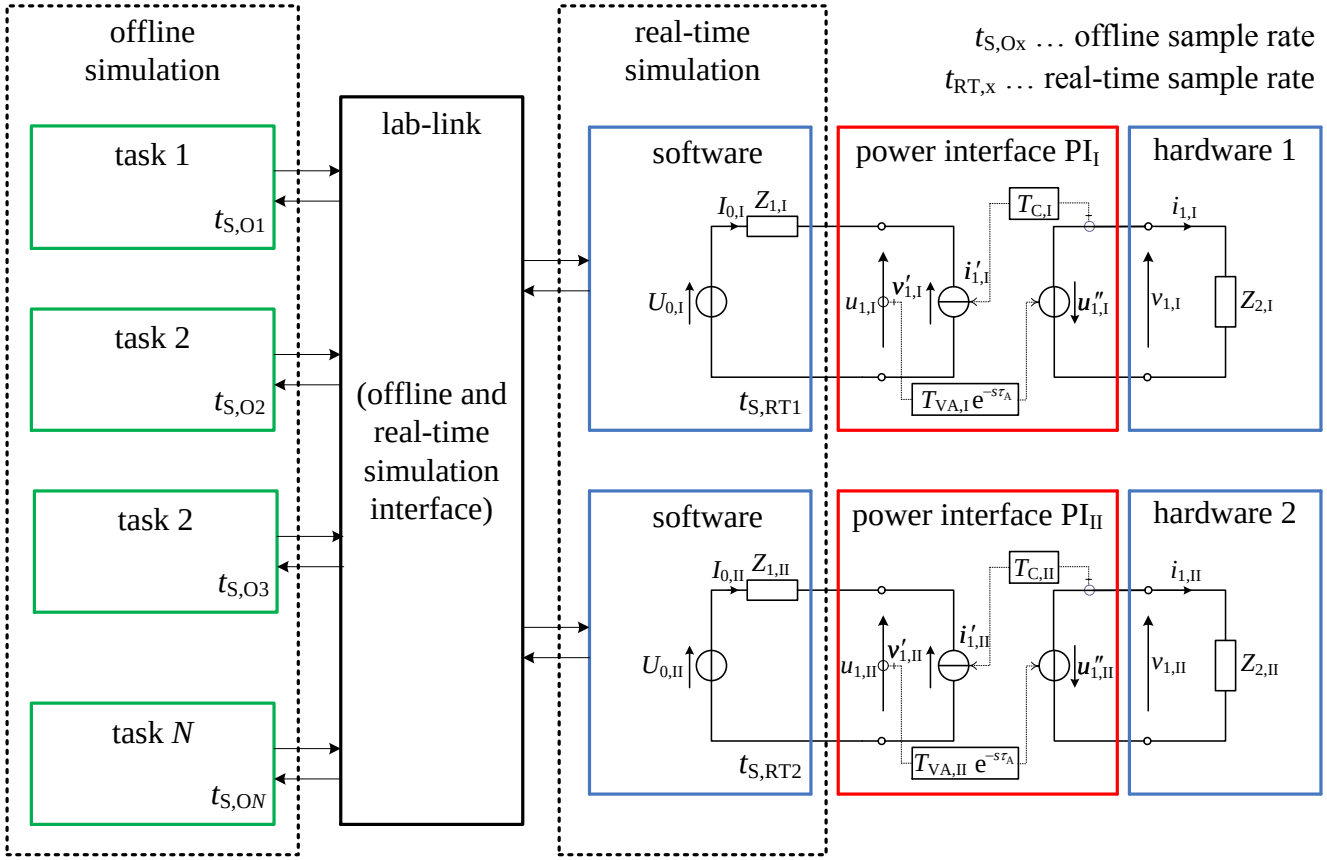
The ERIGrid Approach

- Cyber-physical (multi-domain) approach for analysing and validating Smart Grids on system level



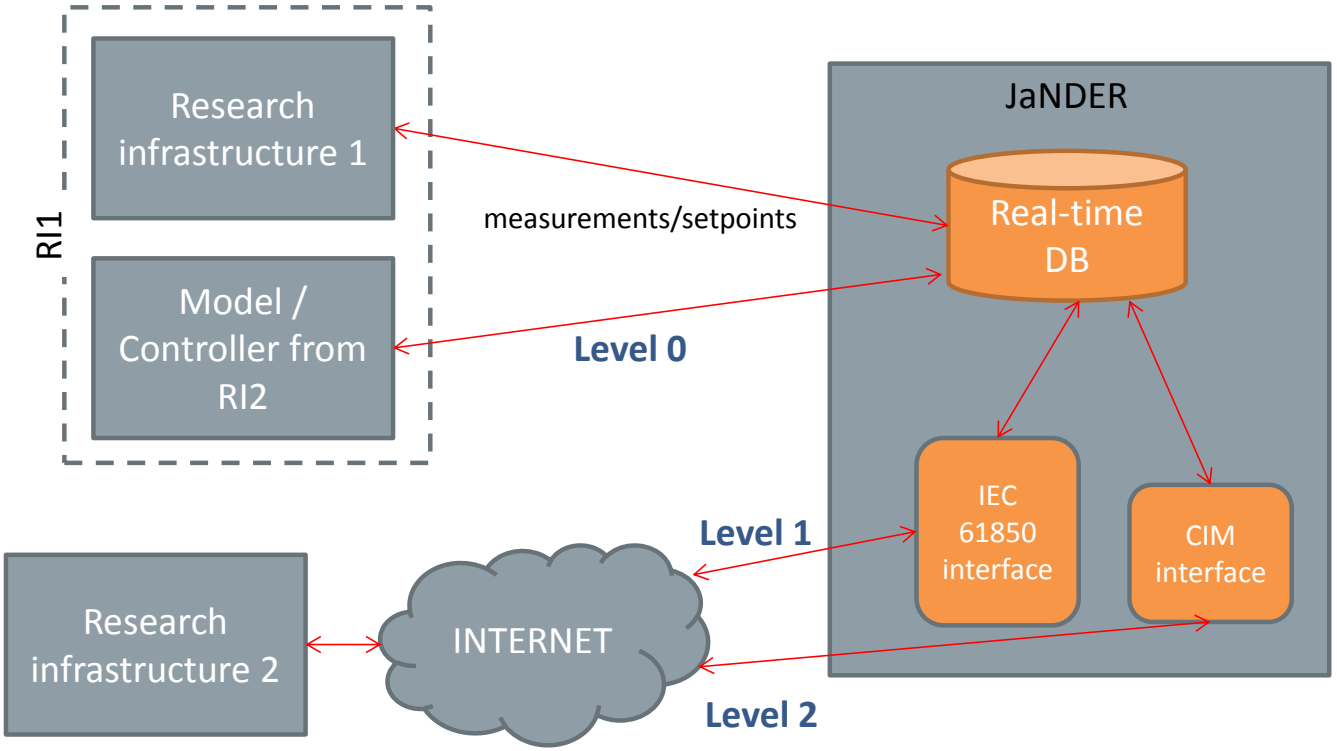
The ERIGrid Approach

- Improved validation and testing methods: focus on co-simulation and HIL



The ERIGrid Approach

- Coupling of Research Infrastructures for integrated and joint testing (multi-lab)



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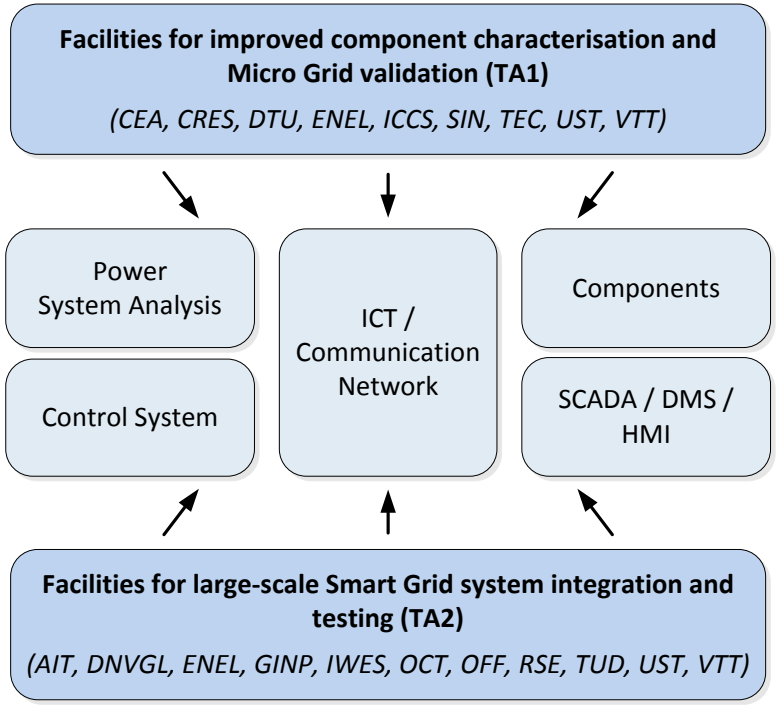
The ERIGrid Approach

- User access to European Smart Grid Research Infrastructures

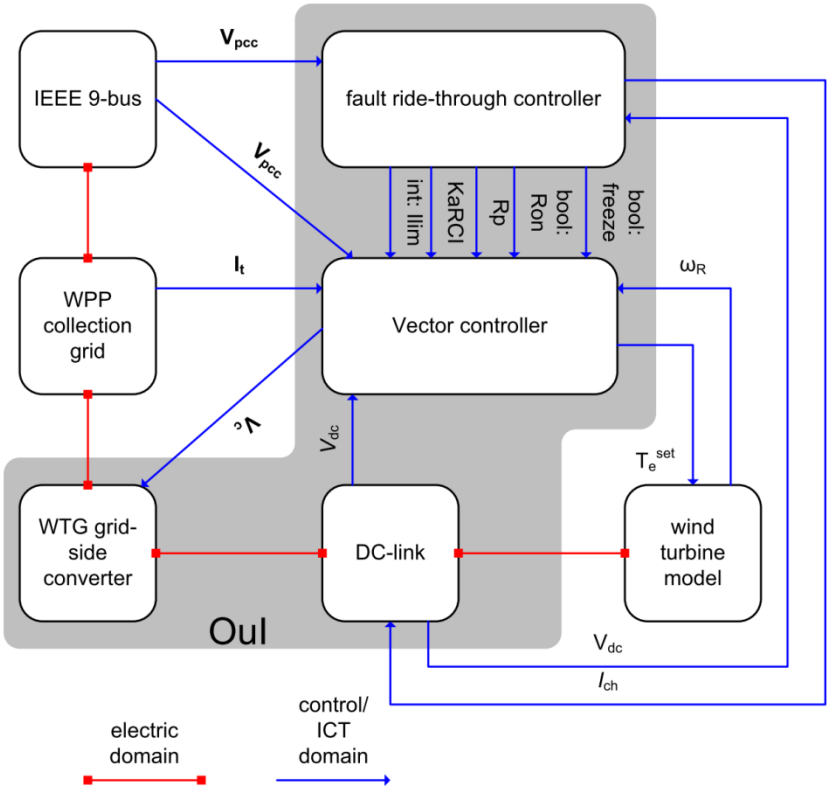


R&D topic	Provided services to external users
DER components	• PV-inverter tests (component, integration) • Storage, charging devices test (component, integration) • …
Development of new network components	• Test of new component concepts • Validation of advanced control methods for components • …
Smart Grid ICT / Automation	• Valdiation of controller implementation and integration • Validation of communication protocols • Test of SCADA system developments and integration • Cyber-security assessment • …
Co-simulation	• Co-simulation tests power grid ↔ communication network • Co-simulation tests power grid ↔ components ↔ communication network • …
Real-time simulation and HIL	• Integration tests for inverter-based devices • Validation of new power electronic component topologies • …
…	…

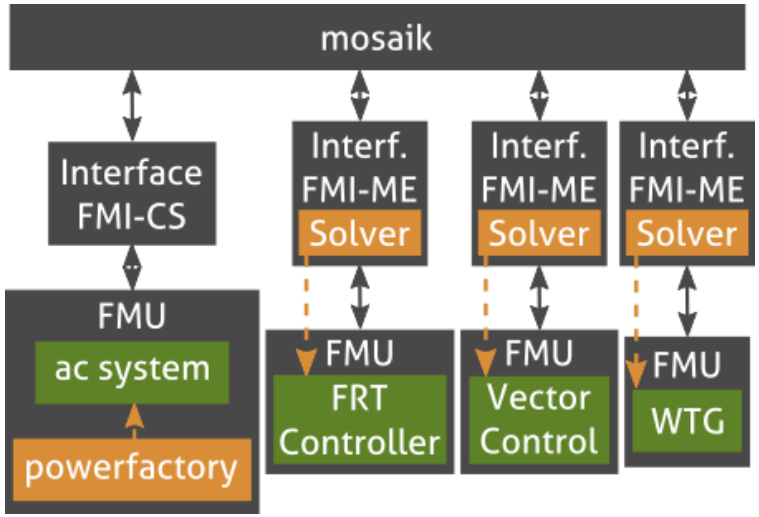
Validation Example

- Validating Fault Ride Through (FRT) controller of a Wind Power Plant (WPP)

Test System Configuration



Co-Simulation based Validation (using FMI)



Conclusions

- A large-scale roll-out of Smart Grid solutions is expected in the near future
- New approaches and methods are required to support system analysis, evaluation and testing of integrated approaches
- Advanced research infrastructures are still necessary
- A Flexible integration of simulation methods, hardware-in-the-loop approaches, and lab-based testing looks promising to overcome today's shortcomings
- Future activities and research should focus on
  - Integration of design and validation tools from different domains
  - Development of system level validation procedures and benchmark criteria
  - Improvement of research infrastructures supporting system level validation
  - Education/training and harmonization (standardization) of validation methods

Free Access to European Smart Grid Labs
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ERIGrid calls for free transnational access:

1st call: 15 September - 15 December, 2016
2nd call: 15 March - 15 June, 2017
3rd call: 15 August - 15 November, 2017
4th call: 15 February - 15 May, 2018
5th call: 15 August - 15 November, 2018
6th call: 15 February - 15 May, 2019

erigrid.eu/transnational-access

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