



**Transnational CLOUD for
Interconnection of
Demonstration Facilities for
Smart GRID Lab Research & Development**

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ETIP SNET's Northern Region Workshop

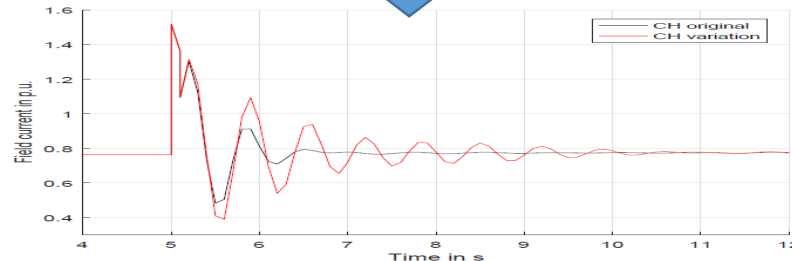


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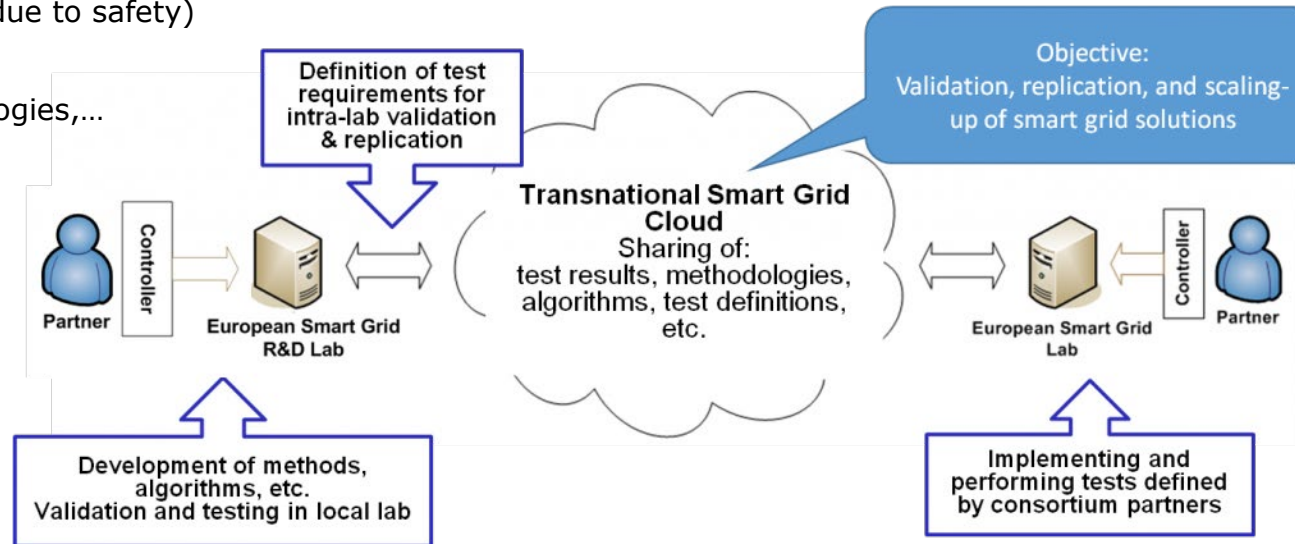
Research Goal

Provide recommendations and strategies to **meet the challenges** of the future power system, to facilitate larger amount of **intermittent renewable generation** together with **less nuclear** production while providing a **secure and reliable electrical power supply**.



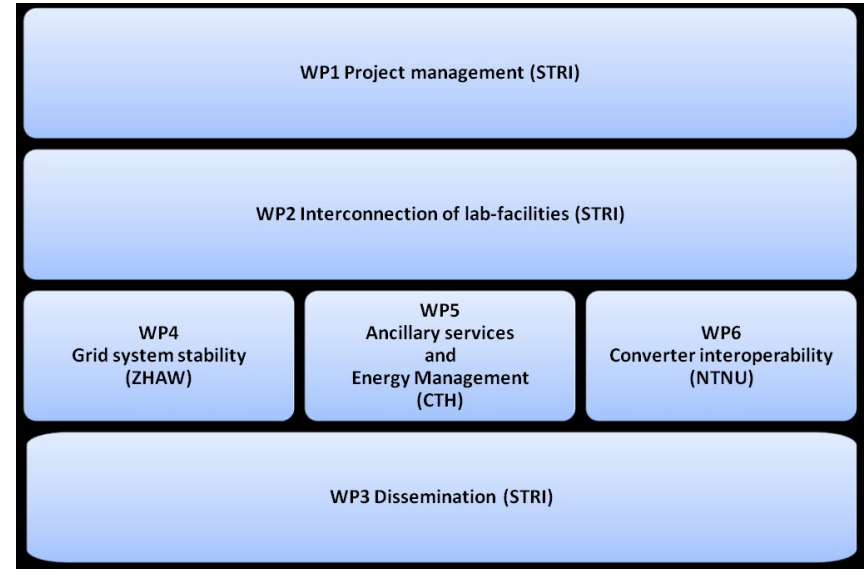
Research Methode: Transnational Smart Grid Cloud

- Physical layer
 - Use and control of equipment (somewhat restricted due to safety)
- Information layer
 - Test results, methodologies,...
 - Historical data
 - Live feed
- Personal / human layer
 - Exchange of resources



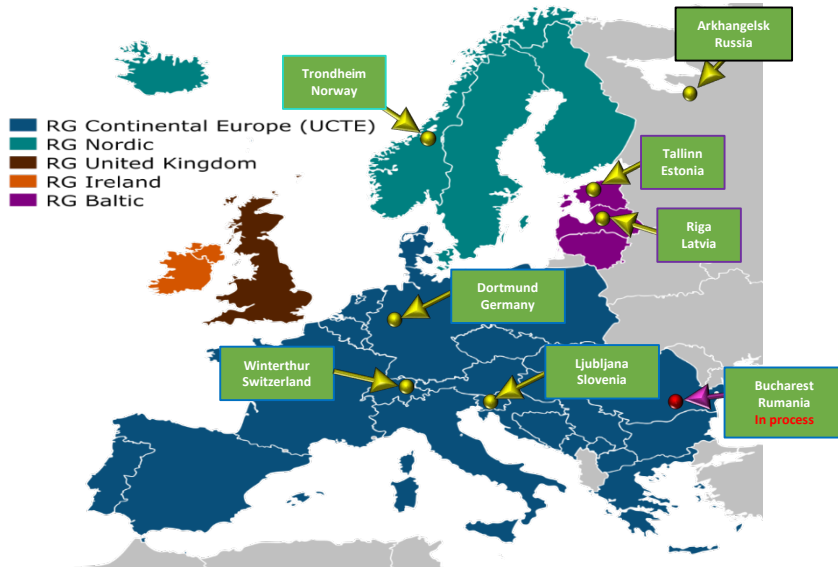
Project Status

- Project kicked off in March 2016, and is to finish in March 2019
- 3 technical work packages, 3 support work packages
- 5 project partners, more than 20 publications (and more on the way)



Results: Scientific Results & Solutions WP2 – Interconnection of Lab Facilities

Example of Available Measurements Exchange Europe



Interconnection of Labs Phasor Measurement Exchange

Real Time Monitoring: Use of professional visualization tools

Fast Data Collection: 50 samples/sec

Large Storage Required: 250 MB/h, 150 GB/month



Results: Scientific Results & Solutions

WP5: Ancillary Services and Energy Management

Development of ASBRA

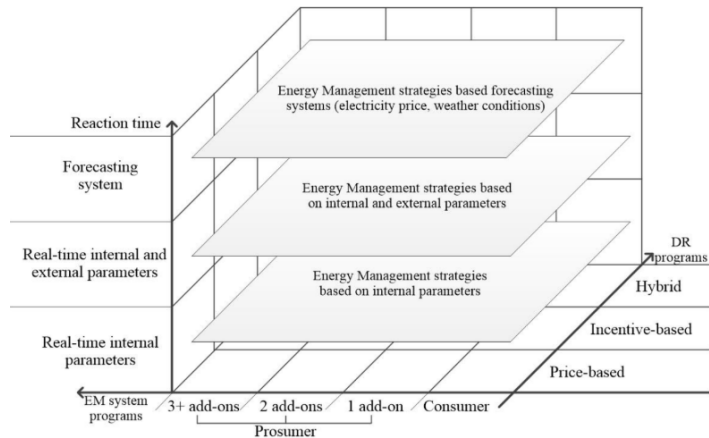
Ancillary Services Benefit and Risk Assessment

- A first evaluation of a suppliers possibilities to supply ancillary service(s)
- General for all but needs to be adapted to each service and supplier
- Includes the impact to supply multiple ancillary services
- Can also be used to determine penalties systems is applicable.

Results: Scientific Results & Solutions

WP5: Ancillary Services and Energy Management

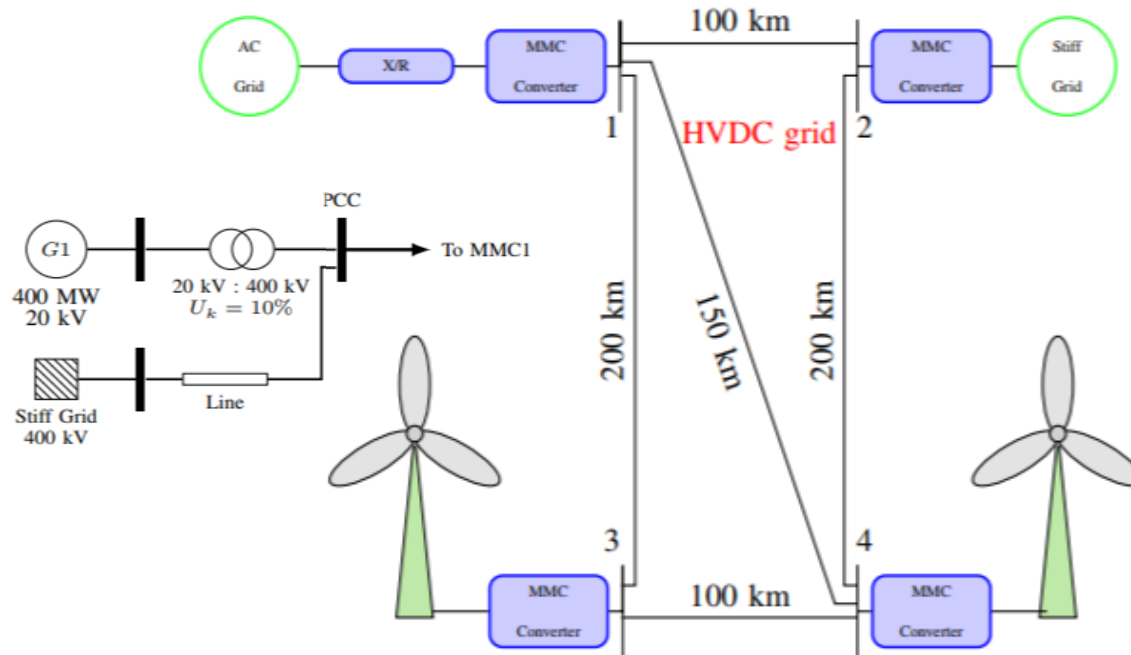
- Tested a large number of Energy Management Services (EMS) in the lab
- Also evaluated EMS extensively based on three differentiation axis



	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	Internal	Internal & External	Forecasting	
EMS	PV	WIND	EV	Storage	PV + EV	PV + STORAGE	WIND + EV	WIND + STORAGE	EV + STORAGE	3 and more												
Criteria																						
SS use impact	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red
Can user behaviour changes influence the system?	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red
Profit gain stability	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red
Range of work	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red
Can Over-generation be avoided?	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red
Synergy of the system components	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow	Green	Red	Yellow

Results: Scientific Results & Solutions

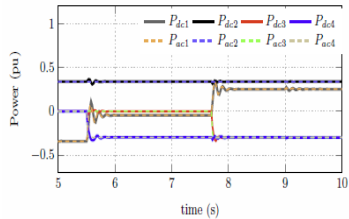
WP6: Converter Interoperability



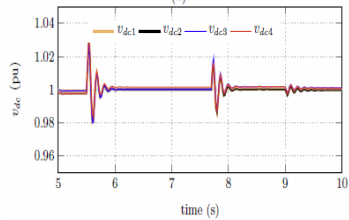
Results: Scientific Results & Solutions

WP6: Converter Interoperability

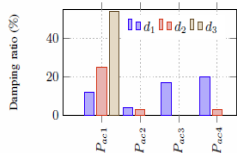
Normal operation



(a)

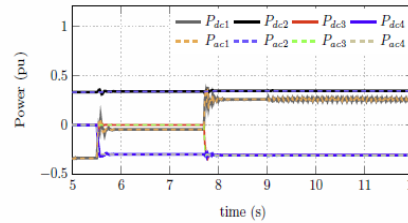


(b)

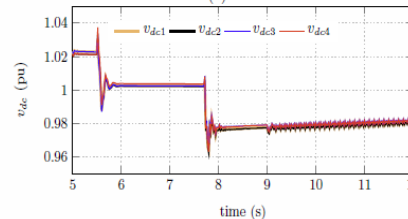


Index: Damping

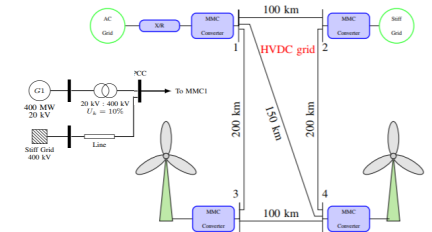
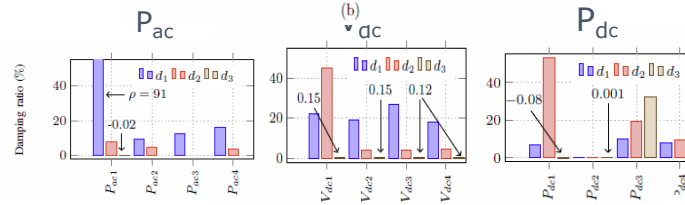
Abnormal operation



(a)



(b)



Some learnings from the project

- The cooperation between labs has made it possible to perform tests and analysis that would not be possible stand-alone. This has been done through use of equipment in others' labs, sharing of data/methods/results, and sharing of resources / knowledge
- Labs are not straight forward to connect;
 - Challenges with regards to Firewalls
 - Limitations on how and what you can control in others' labs due to safety
 - Large data sizes when doing measurements can make the data difficult to store and share (e.g. 150 GB / month in frequency data only)
- Can be challenging with technical definitions - e.g. Interoperability
 - The ability of two or more networks, systems, devices, applications, or components to interwork, to exchange and use information in order to perform required functions
 - How the operations of one system/component (indirectly) affect the operations of other components in the network

Barriers to innovation

- In general, the industry seems to have a limited understanding of ancillary services, and especially on aggregation of ancillary services
- Lack of regulations and/or possible ways to capitalize on ancillary services
- Limited regulations related to DMS (local incentives, etc) (e.g. appliances should be able to interact with grid on a more automatic basis)
- Lack of commercial reasonable (low cost) Smart Socket products for DMS, which both measures the energy consumed and allows control

The results include among other

- Recommendations on the modelling of grids
- ASBRA - suggested approach for evaluating ancillary service business models
- SmartSocket prototypes
- An improved understanding of the advantages of hybrid AC/DC systems
- Creation of an early version of pattern recognition for "abnormal operations in a hybrid AC/DC system"

Ideas for further research

- There is a lack of analytical tools to train the algorithms to monitor and detect abnormal grid operation for the benefit of TSOs and DSOs.
- We are in need of a more complete understanding, analysis and modelling approaches for hybrid HVAC/HVDC systems, with particular emphasis to the dynamics arising from their interconnection.
- Potential commercializing of affordable smart sockets
- Further investigate the implications of aggregated ancillary services (providing multiple services)



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