ENG52: SmartGrids2
“Measurement Tools For Grid Stability and Quality Management”

M18 Workshop, 3rd February 2016.

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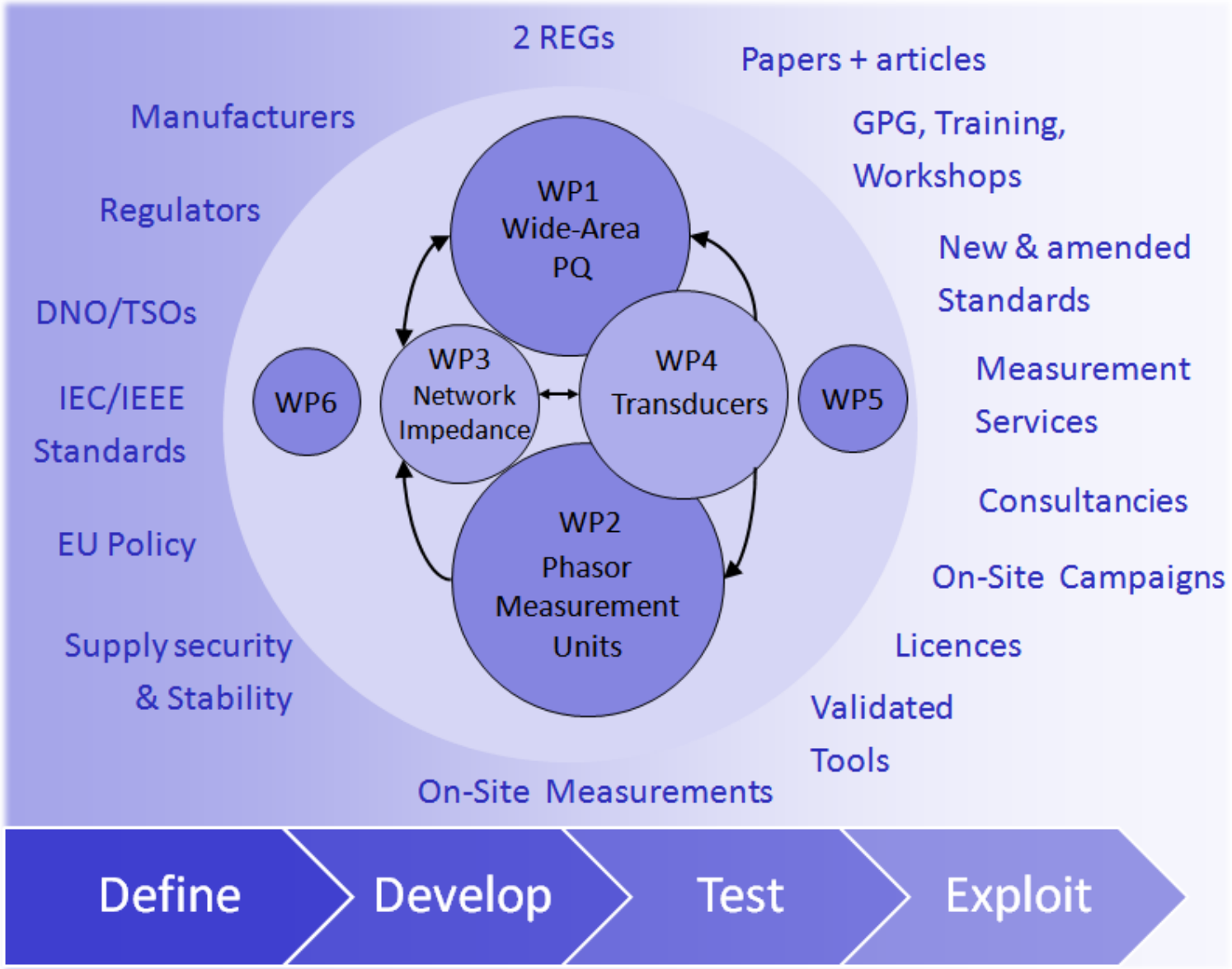
Aim: *"to develop, demonstrate and validate new measurement tools for network operational stability and power quality".*

Objectives:

Early warning of Instability – detect the onset of instability in areas of the grid– prevent cascading failures and blackout.
A "life support monitor" for Smart Grids - Phasor Measurement Units (PMU), to be used in multiple locations to manage stability.
Power Quality (PQ) Disturbances – assess grid impact - plan /defer new connections, reinforcement and mitigation.
PQ Disturbance "radar" – locate major sources of poor PQ for mitigation and enforcement.
Grid topology and impedance - analyse, plan and mitigate for instability, resonances and PQ disturbances.
Transducers – Accurate level transformation without disturbing the grid, essential for the PMUs measurement chain.

SMART GRID METROLOGY

JRP Structure



18 Partners (3 REGS)


NPL
National Physical Laboratory

Achievements WP1: Power Quality Propagation

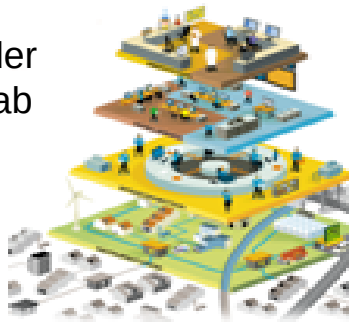
Challenges:

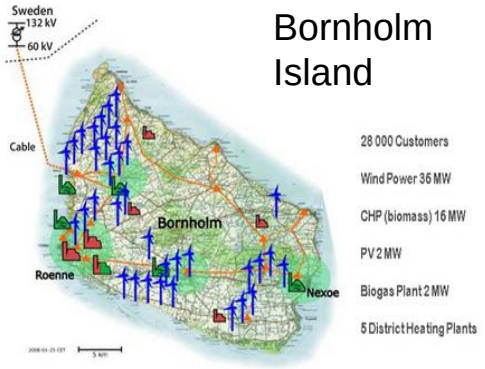
- How do PQ disturbances propagate through networks ?
- Reconcile modelling with PMU/PQ measurements to understand attenuation & resonant characteristics.
- Develop a PQ disturbance location method A “PQ Radar”.

M18 Summary:

- Organised measurement campaigns in a variety (4) Smart Grids
- Identified data and Modelled grids, selected measurement sites.
- Obtain, calibrate and Install instrumentation and transducers.
- Write data collection and analysis software.

Alliander LiveLab





Bornholm Island

Achievements WP2: Phasor Measurement Units (PMUs)

Challenges	M18 Summary
Confidence - how do we know PMUs are right? - Interoperability between vendors? - Commercial PMU calibrators need calibrations…	• Develop a PMU calibrator. • 10X improvement on state-of-art. • On-site calibrations against “gold standard” PMU, Reference PMU development in progress.
Dynamic signals in real networks (varying amplitude and phase signals)	• New algorithms (reviewed implemented and compared).
Can PMU be used in distribution networks ?	• Improve algorithm immunity to power quality disturbances. • Better phase sensitivity for more localized use (calibrator phase)

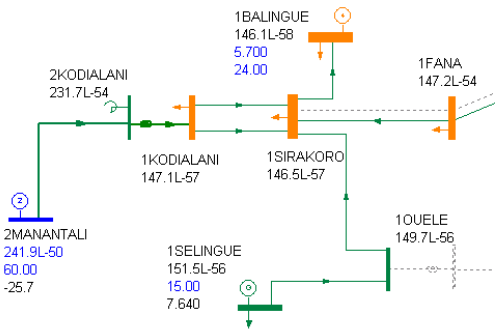
Achievements WP3: Network Impedance

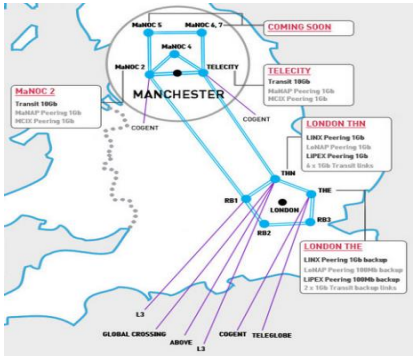
Challenges:

- Multiple PMUs to measure impedance on sections of network.
- Extend to harmonic frequencies.
- Application to harmonic mitigation, improved planning and dynamic rating.
- Relate line resistance to temperature – Dynamic rating

M18 Summary:

- New algorithms developed tested for impedance measurement.
- Tested in in simulation and using lab transmission line setup.





Achievements WP4: Transducers

Challenges:

- Transducers (VT/CT) are the source of biggest error in the PMU,
- They have a complex frequency response that causes waveform distortion.
- It is rarely possible to remove and characterise CT/VTs.

M18 Summary:

- Split-core rigid and flexible Rogowski coils have now been characterised, assessing their performances before start of the optimisation phase,
- The first complex frequency characterisation at rated voltage (up to 20 /√3 kV) of commercial measurement VTs up to the 50th harmonic.
- Developed a real-time compensation method for VT using a digital filter.
- A software model for the analysis of uncertainty propagation in the PMU measurement chain.

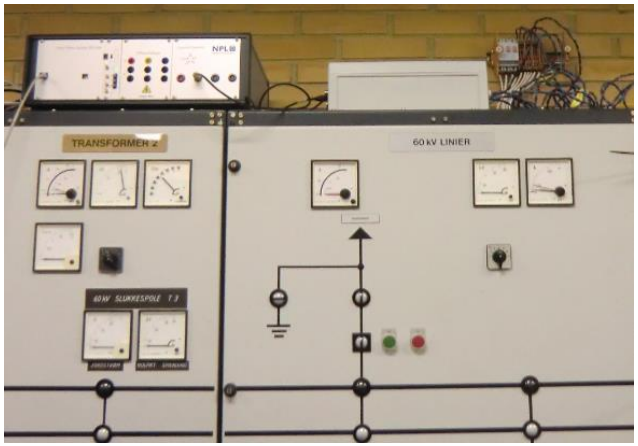
Impact of The JRP

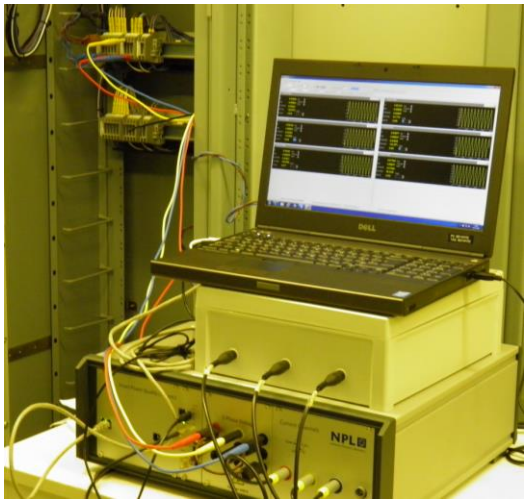
- The impact of the electricity supply system has an extremely high economic and societal impact (everything fundamentally depends on it!).
- RES will have a profound effect on the integrity of this supply and political factors threaten its security.

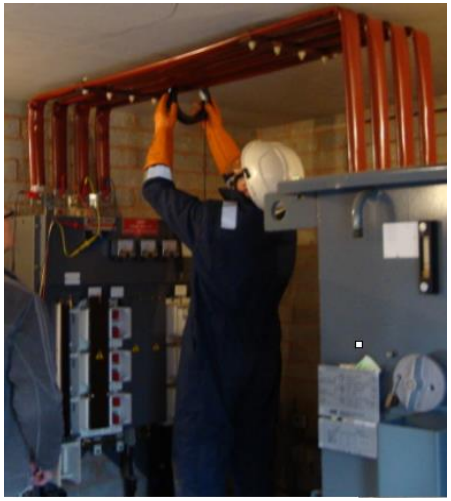
Realisation of Impact in this JRP

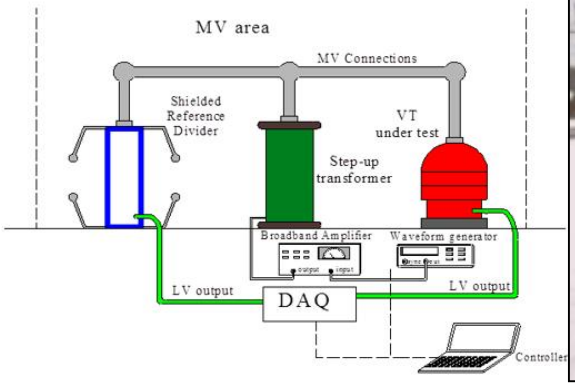
- 33 Stakeholders support this JRP, 13 actively collaborating.
- High Profile smart grid test sites including the Alliander LiveLab, Bornholm Smart Island and EDFs new Concept Smart Grid.
- Measurements campaigns (at least 7) working with network engineers *the best route to dissemination*.
- Normative Standards engagement through 14 inputs to standards activities.
- 26 Publications, 19 Conferences at M18

Summary









Smart grids are essential to manage this future electricity system and the tools and techniques developed in this JRP will be an essential contribution.