SmartNet Pilots: The demonstration of the different TSO-DSO coordination schemes and market structures

Carlos Madina (Tecnalia)

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 691405
Agenda

- Aims and goals of the pilots
- Timeline
- Presentation of Italian pilot
- Presentation of Danish pilot
- Presentation of Spanish pilot
- Key results
Aims and goals of the pilots

Realisation of three complementary pilots to evaluate the performance of different TSO-DSO interactions under different market structures.

Coordination with laboratory simulations to bridge the gap between present real-world implementation and the opportunities envisaged for the future.

Identify & remove barriers to facilitate the way to the pan-European market for ancillary services.
Timeline

Jan 2016 (start) to Oct 2018

SmartNet Project

Coordination of pilots

Realisation of Pilot A (Italy)

Realisation of Pilot B (Denmark)

Realisation of Pilot C (Spain)

- Functional specification
- Technical specification
- SW & HW development
- Installation & testing
- Execution
- Reporting

31 Dec 2018 (end)
Centralised TSO control in high-DER area

Description of the pilots
Energy context

Large increasing of RES in the last 10 years

New issues in terms of power management of the electrical grid

Active power rise from MV up to HV grid

Difficulty to predict RES production

Italian NRA is opening the market to DG and DR through aggregators and requiring the DSO to improve observability for the TSO

Needs to improve the infrastructure for monitoring and control of MV and LV levels
Centralised TSO control in high-DER area

Aggregation of information in RT at TSO-DSO interconnection (HV/MV transformer)

Voltage regulation by generators connected at HV and MV levels

Power-frequency regulation/balancing by generators connected at HV and MV levels

Centralised TSO control in high-DER area
Implementation in field

- **HV Generation:**
  2 Hydraulic plants of **20MW** each.

- **MV and LV Generation:**
  More than 30 plants with more than **40MW** of total nominal power (Hydro, thermal and other)
1) **Aggregation of information in real-time** at the interconnection point TSO-DSO (HV/MV transformer).
   Exchange of distribution data with the TSO:
   - Load (total load, gross amount of load compensated by distributed generation);
   - Total distributed generation at the interconnection point, differentiated by source (PV, rotating, etc.).

2) **Voltage regulation** - development of an architecture and implementation of a system for the HV voltage regulation:
   - One generation unit connected to HV grid;
   - One or more generation units connected to MV grid;
   - A device for each power plant in order to receive command from the TSO through the DSO.

3) **Power-frequency regulation** - development of an architecture and implementation of a system for the power-frequency regulation:
   - One generation unit connected to HV grid;
   - One or more generation units connected to MV grid;
   - A device for each power plant in order to receive command from the TSO through the DSO (FRR).
Expected results

- TSO will receive aggregated data for control and to manage the allocation of services.

- Data must aggregated by DSO, but other parties could also provide the aggregation service.

- The VPP is defined by P, Q and forecast $\rightarrow$ Needed for AS allocation.

- New device installed at TSO-DSO interconnection to collect data and make it available to the TSO (VPP).

- TSO will know, for each VPP, the limits for P and Q (virtual capability) that may be used when activating AS.
Description of the pilots

Common TSO-DSO market with pool flexibility
Congestion management to better integrate PV, EV, and HP

Balancing of wind power with decreasing contribution of thermal units

Price-based control of thermal controllers of swimming pools in summer houses

Common TSO-DSO market with pool flexibility
Implementation in field
Price-based control

Advantages
- Highly scalable
- No data safety issues
- Very low transaction costs

Disadvantage
- Application to all demand vs. to the provided flexibility
- Estimation of reaction curve
Expected results

- Demonstration of aggregation service in 30 rental houses (10 + 10 +10)
- Implementation in field of ICT to exchange data: TSO-DSO-Aggregator-DER
- On-line services for price & load forecasting + model predictive control
- Development of an architecture for AS provision by DER through aggregation
- Estimation of DER reaction curves + unidirectional signals to gather flexibility
Description of the pilots

Shared responsibility with base station flexibility
Energy context

2030 Transmission adequacy (TYNDP’16)
http://tyndp.entsoe.eu/exec-report/

- Poor interconnections
- Big contribution by highly-variable RES production
Shared responsibility with BS & EV flexibility
Implementation in field

More than 400 Base Stations just in Barcelona

Contracted power of each one from 5 kW to 15 kW
Software Flexible Tool for the DSO

Balancing. Time plot of active power exchanged at TSO-DSO interconnection points

Flexibility. Time plot of total flexibility volumes per market session at each TSO-DSO interconnection point (kW)

CMPs. Time plot of aggregated load of customers’ portfolio of each CMP.

Market prices. Time plot of the clearing price per market session at each TSO-DSO interconnection point

Market results. Table of dispatched flexibility volumes per CMP per market session and node at each TSO-DSO interconnection point (kW)

Network Status. Diagram of the distribution network downstream each TSO-DSO interconnection point:
Expected results

- Demonstration of DER aggregation service in 20 mobile phone base stations
- Creation of AS local market to solve DSO’s congestion issues and to share balancing responsibility
- Development of tools for DER aggregation and for bidding to DSO-managed local AS markets
- Development of tools for determining DSO’s balancing and congestion management needs
Key results

Validated TSO-DSO interactions (technical + operational)

Demonstrated interoperability and scalability to the whole European system.

Identified barriers for real implementation and regulatory proposals

Guidelines on best practices to implement the considered TSO-DSO schemes
Thank You

Carlos Madina

Contact Information

Affiliation:  Tecnalia
Phone:  +34 667 165 473
Email:  carlos.madina@tecnalia.com
Pilot A: Back-up slide

Aggregation of information in RT at TSO-DSO interconnection (HV/MV transformer)

Voltage regulation by generators connected at HV and MV levels

Power-frequency regulation / balancing by generators connected at HV and MV levels
Pilot B: Back-up slide

Receive Grid Load

1. Market Management System
   - Day-ahead
   - Intraday
   - Real-time
   - MO

2. Calculate residual capacity
3. Receive bids
4. Clear market
5. Activate bids
6. CMP Trading System
   - Day-ahead market
   - Intraday market
   - Real-time market

7. DER aggregator
   - DER services
   - Value-added services
   - EMS-SCADA

8. TSO
   - Trading System
   - EMS-SCADA

9. DSO
   - Trading System
   - EMS-SCADA

Ancillary services
- TSO Trading System
  - Frequency control
  - Congestion management
  - Voltage control
- DSO Trading System
  - Local Frequency control
  - Local Voltage control
  - Congestion management

Energy Trading

- CMP
- EMS-SCADA

- Technical aggregation
  - DER services
  - Value-added services

Setpoint

Measurements

- DER gateway
- DER trading system

Congestion management
to better integrate PV, EV and HP

Price-based control of thermal controllers of swimming pools in summer houses

Balancing of wind power with decreasing contribution of thermal units