Smart TSO-DSO interaction schemes, market architectures and ICT Solutions for the integration of ancillary services from demand side management and distributed generation

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Results for the three project pilots

Carlos Madina (Tecnalia)

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Aims and goals of WP5

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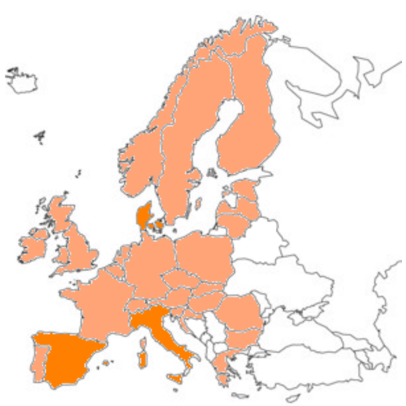
Realisation of three complementary pilots to evaluate the performance of different TSO-DSO interactions under different market structures.

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



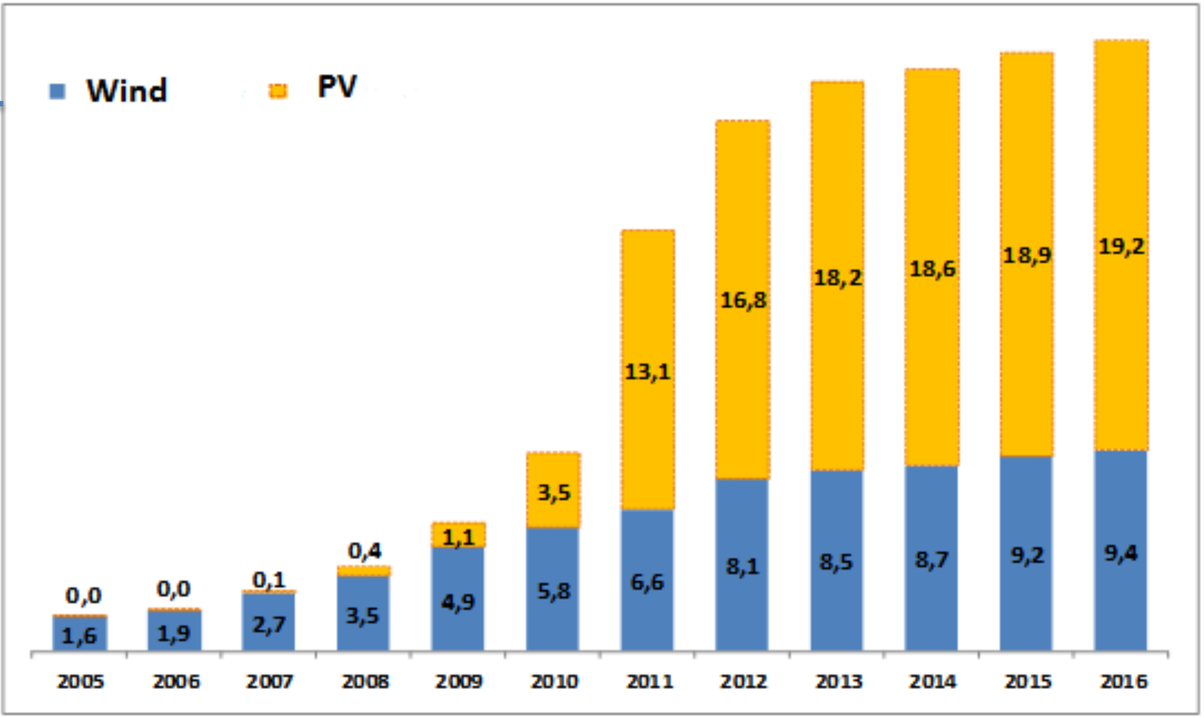
Identify & remove barriers to facilitate the way to the pan-European market for ancillary services.

Status of the pilots

Centralised TSO control in high-DER area

Italian context: Energy situation

Large increasing of RES in the last 10 years



New issues in terms of power management of the electrical grid

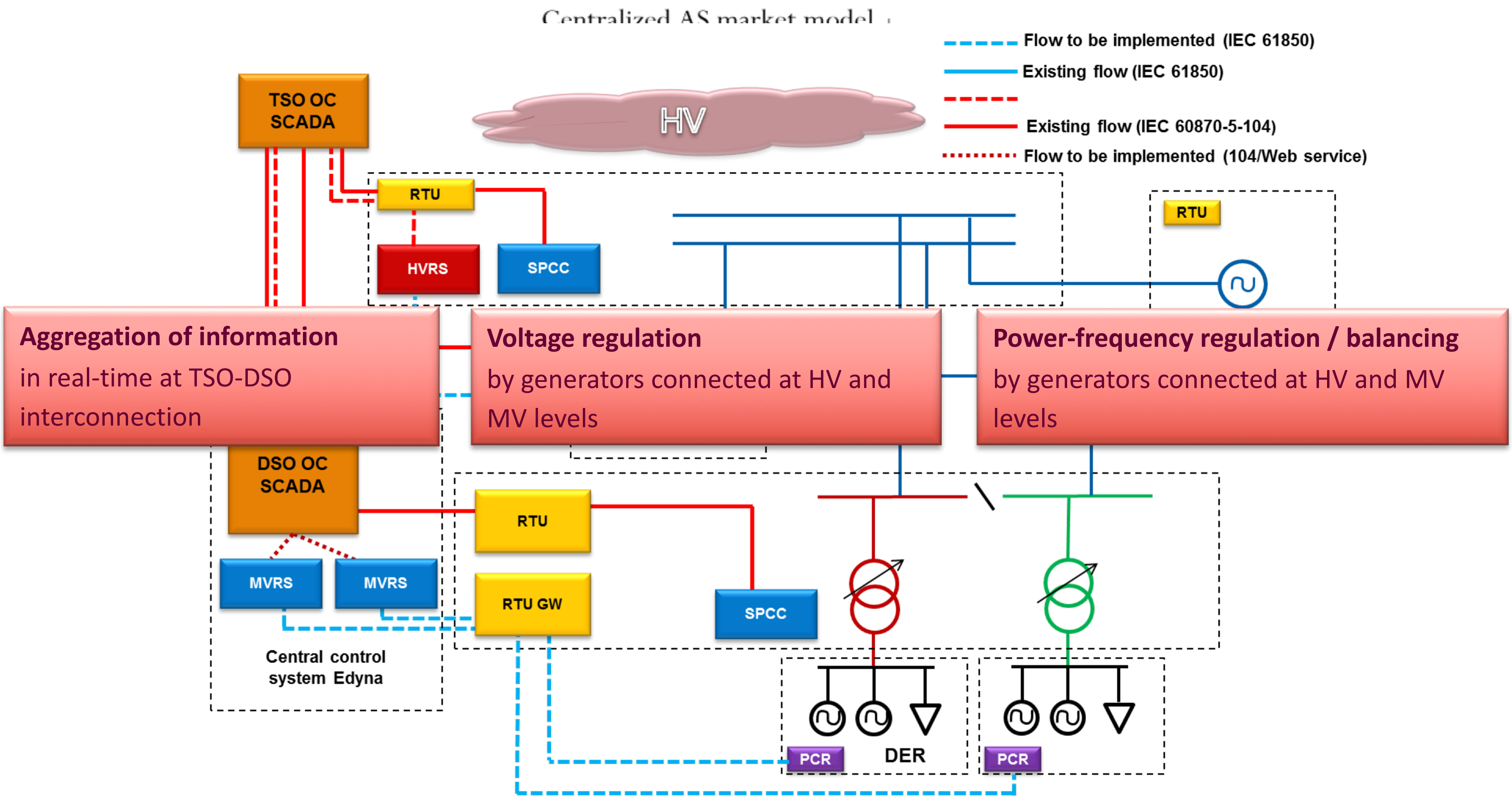
Active power rise from MV up to HV grid

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

Pilot A: Centralised TSO control in high-DER area



Aggregation of information
in real-time at TSO-DSO interconnection

Voltage regulation
by generators connected at HV and MV levels

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

Pilot A: Centralised TSO control in high-DER area

Aggregation of information
in real-time at TSO-DSO interconnection

Acquisition of measurements (active and reactive power) through PCRs

Estimation of unmonitored plants data through Sentinel Measurements (weather data, neighboring plants, historical profiles…)

Aggregation of active and reactive power data differentiated by energy source

Every 20 s

Data transmission to TSO control room

Every 4 s

TSO

Virtual capability computation

MVRS calculates the reactive power limits (for both capacitive and inductive operating conditions) considering the plants capabilities and the grid constrains

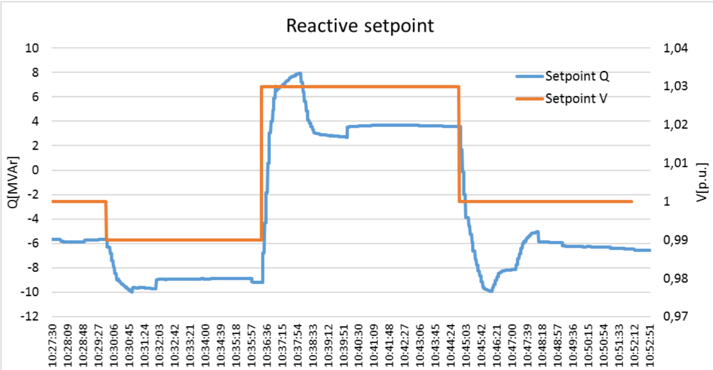
Voltage regulation

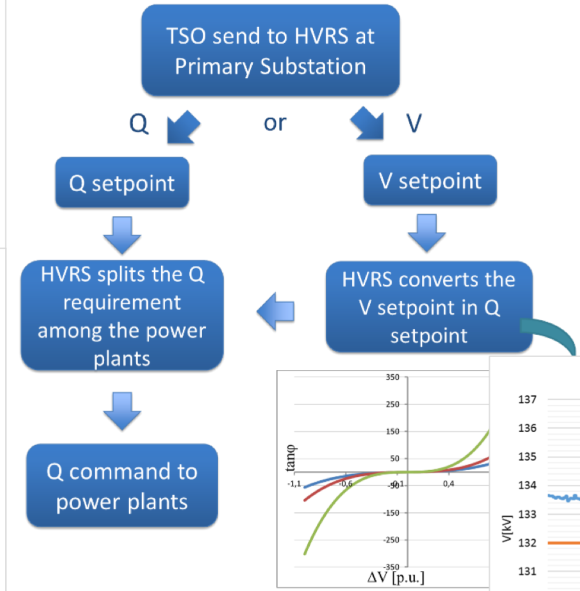
*MVRS receives the voltage or reactive power setpoint at the HV-MV interface and split the **request** among MV controllable resources*

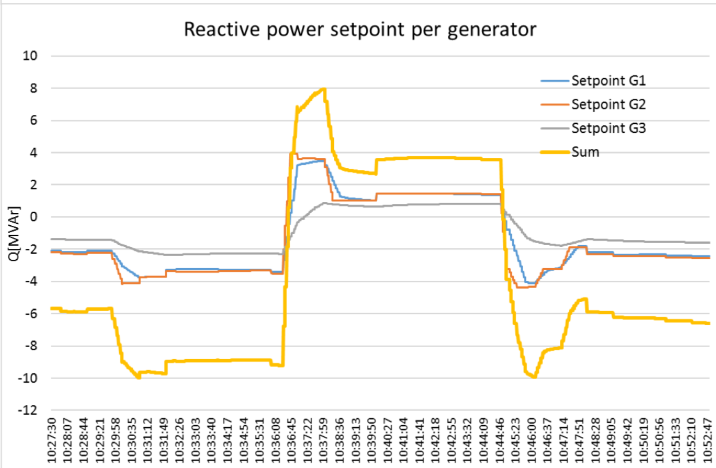
Pilot A: Centralised TSO control in high-DER area

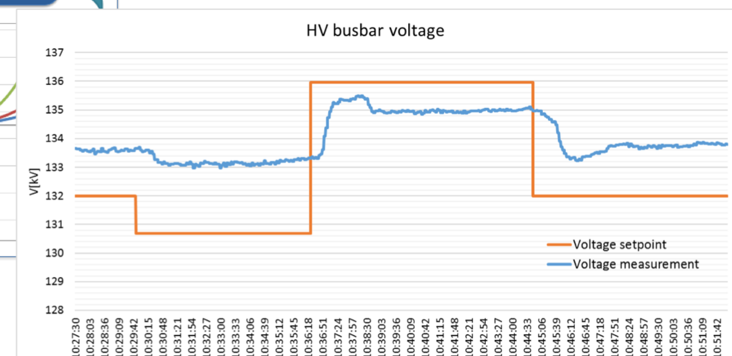
Voltage regulation

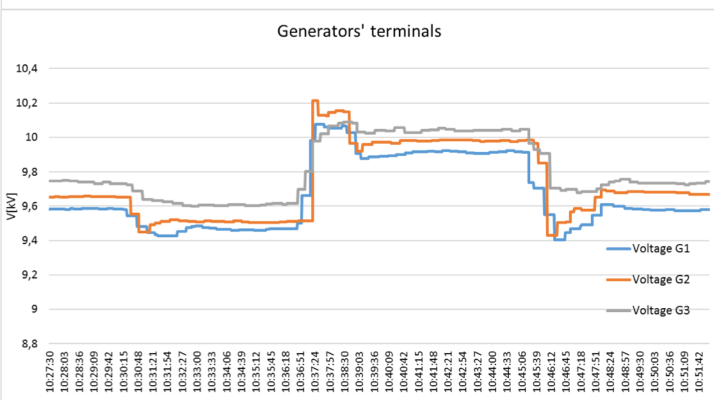
by generators connected at HV and MV levels

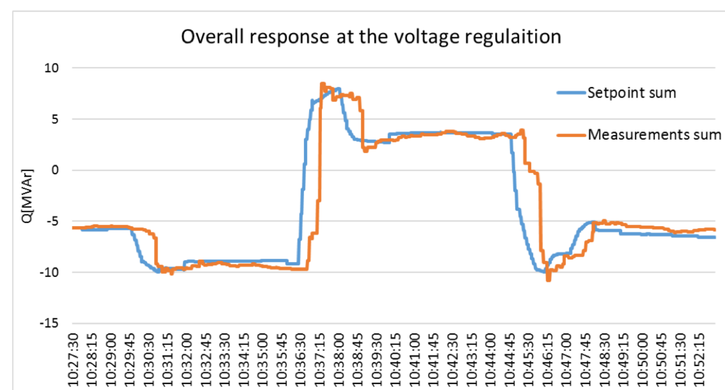








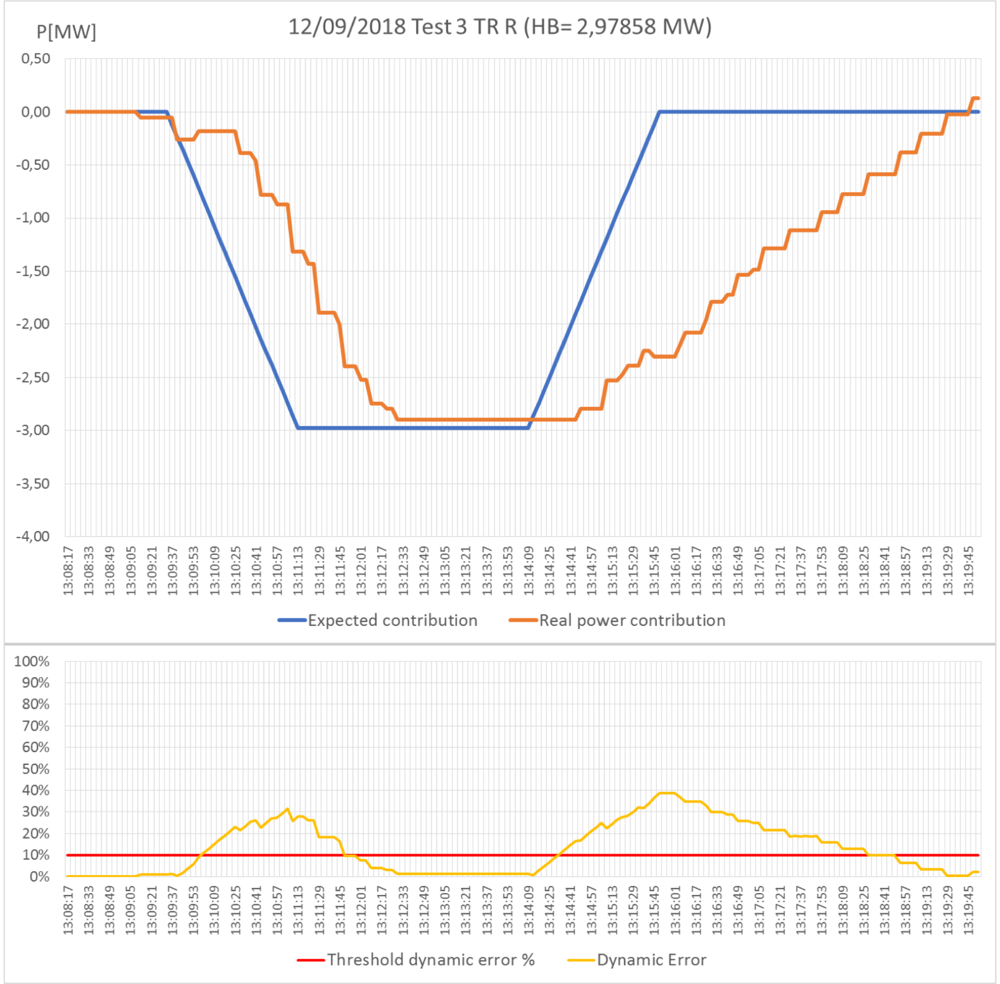




Pilot A: Centralised TSO control in high-DER area

Power-frequency regulation / balancing

by generators connected at HV and MV levels

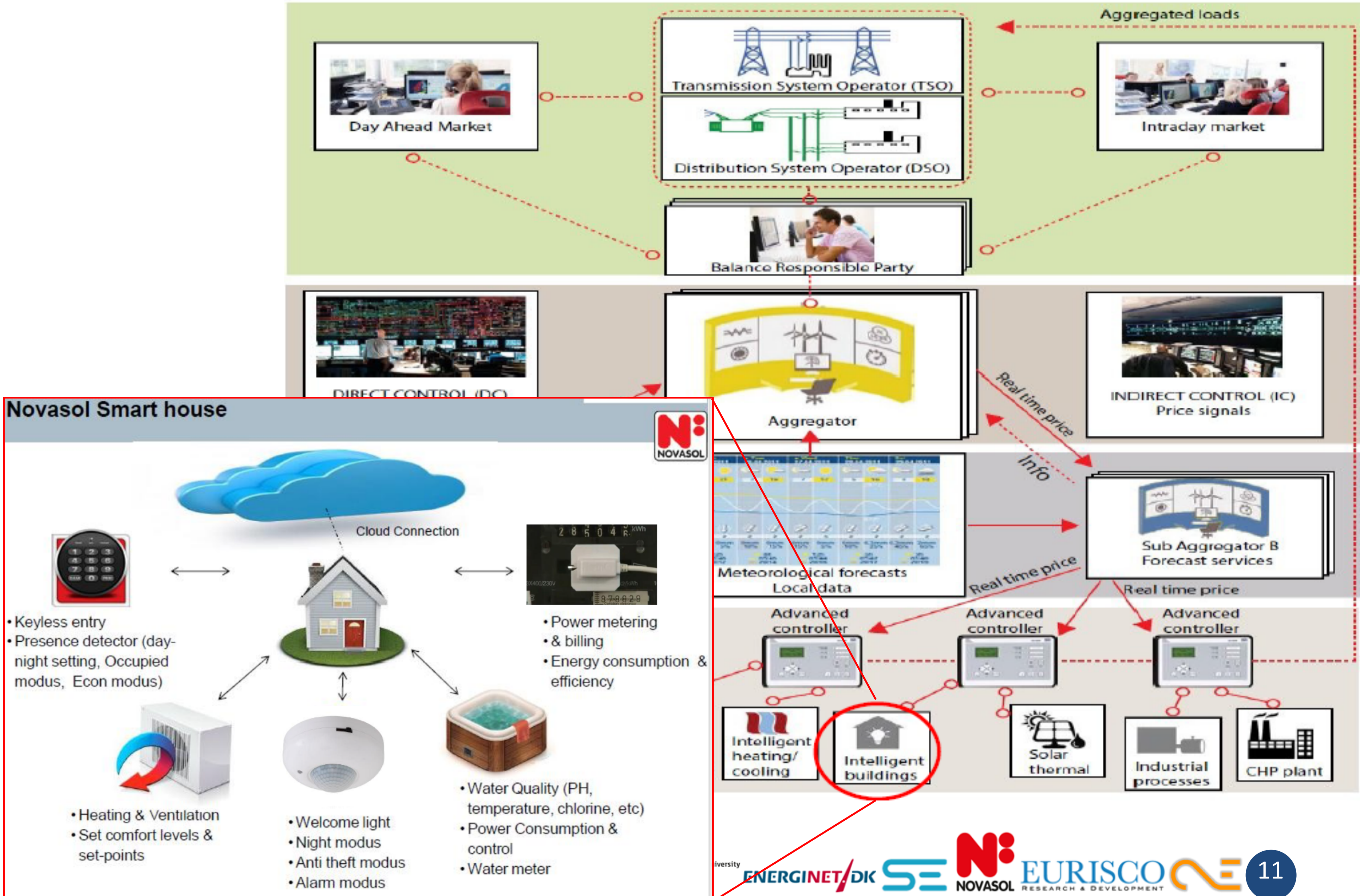


Pilot A: Centralised TSO control in high-DER area

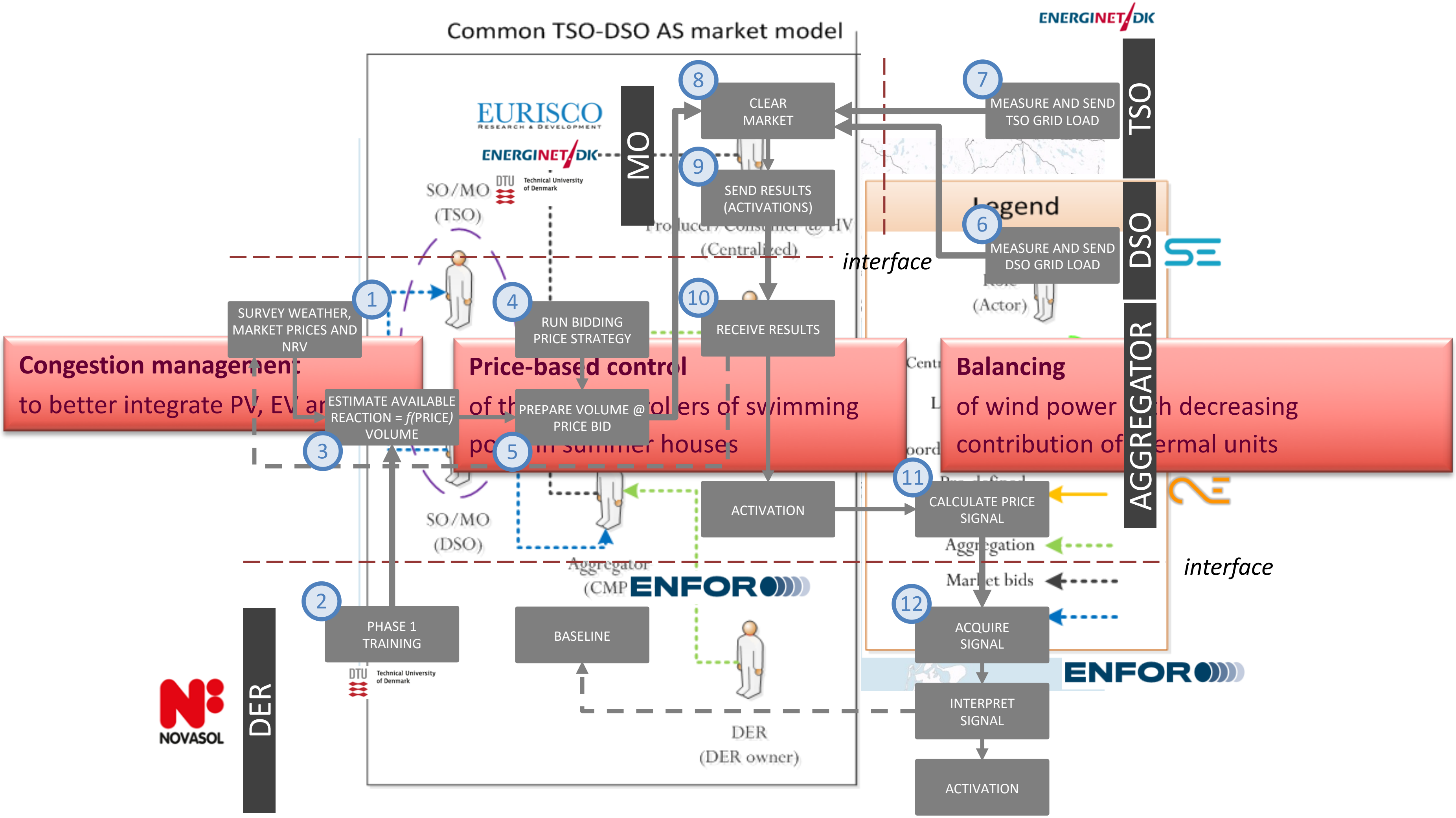
- Observability function: OK
- Voltage regulation:
  - HVRS: OK (lower impact than big power plants and small delays)
  - MVRS:
    - OK for distribution
    - Very low impact at transmission
    - Good to avoid reactive power loops which waste resources
- Frequency regulation:
  - RES were able to provide downward balancing
  - But they could not follow aFRR control signal (they may for mFRR)

Common TSO-DSO market with pool flexibility

Smart Energy Operating System (SE-OS)



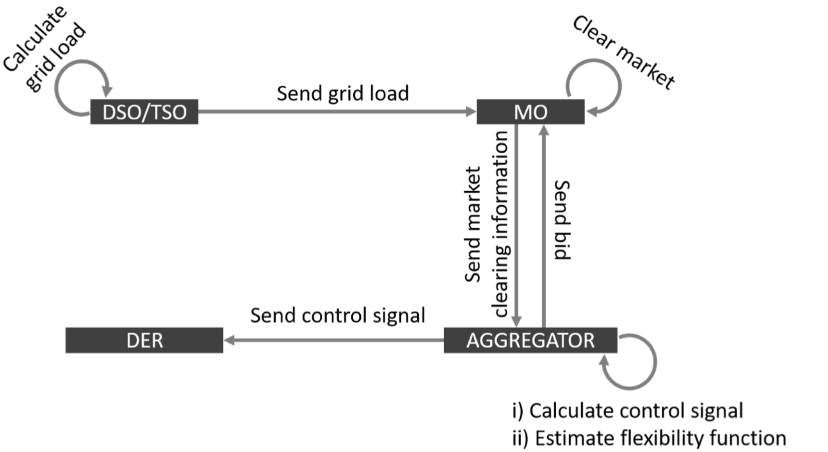
Pilot B: Common TSO-DSO market with pool flexibility

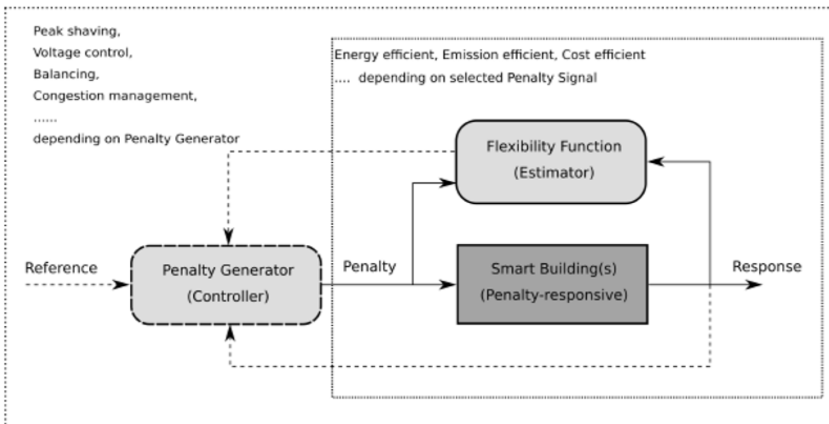


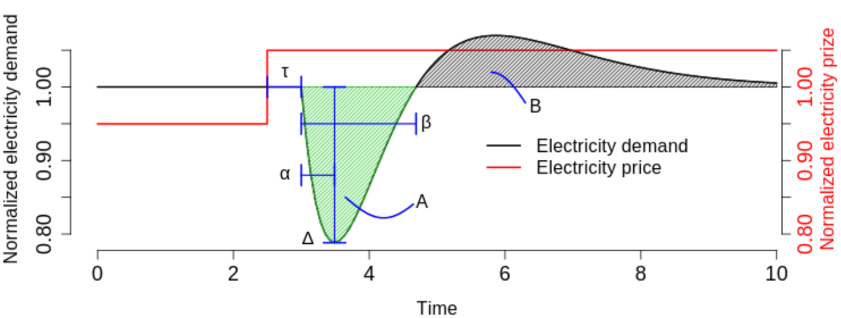
Pilot B: Common TSO-DSO market with pool flexibility

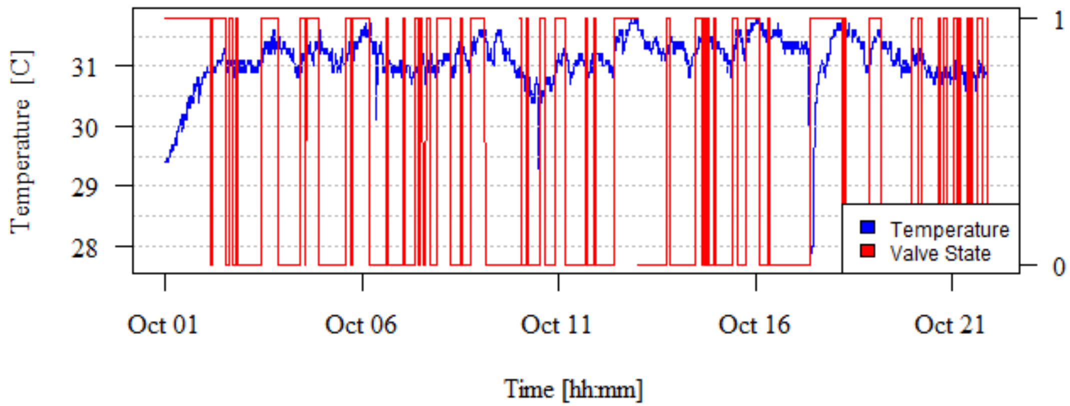
Price-based control

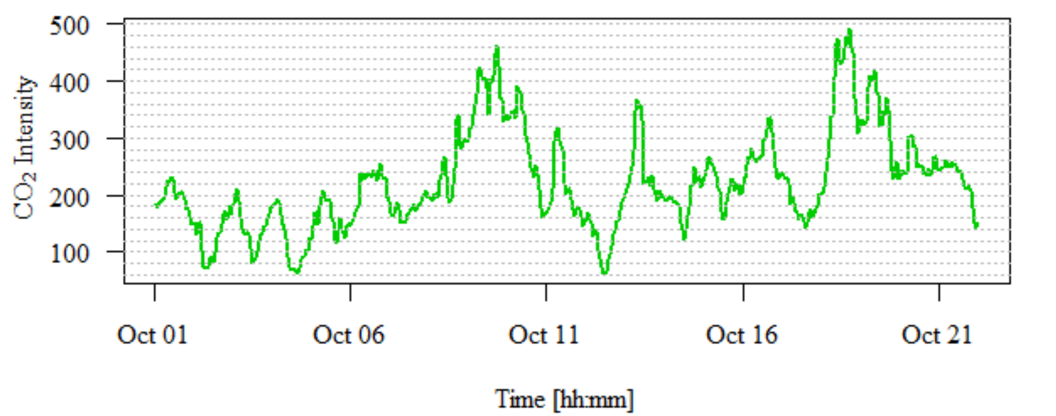
of thermal controllers of swimming pools in summer houses











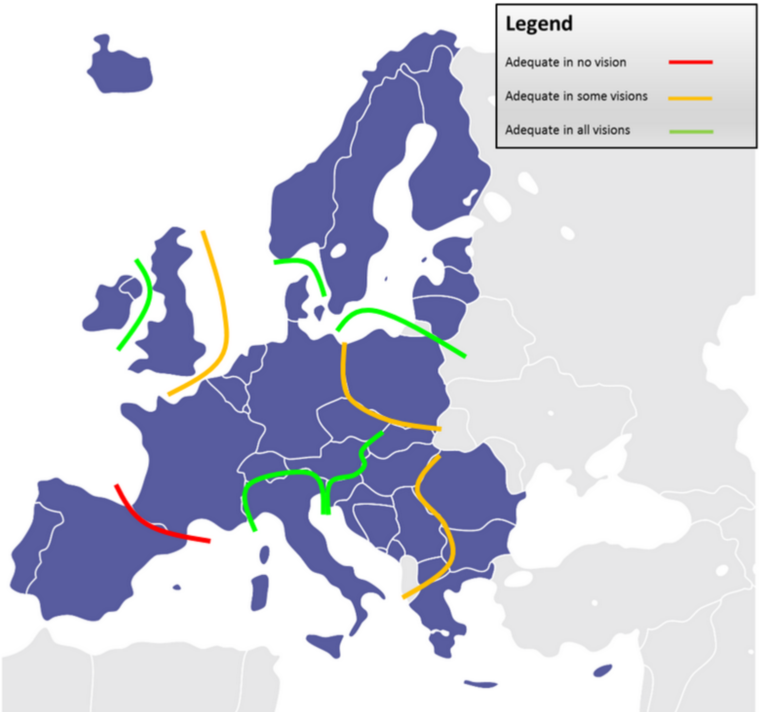
Pilot B: Common TSO-DSO market with pool flexibility

- Indirect control is useful for controlling DER
- Indirect control can be based on prices or other penalties, such as CO_2-content
- Challenges in estimating flexibility function, but lightweight approach
- Need to have a strong communication network → Focus on urban areas

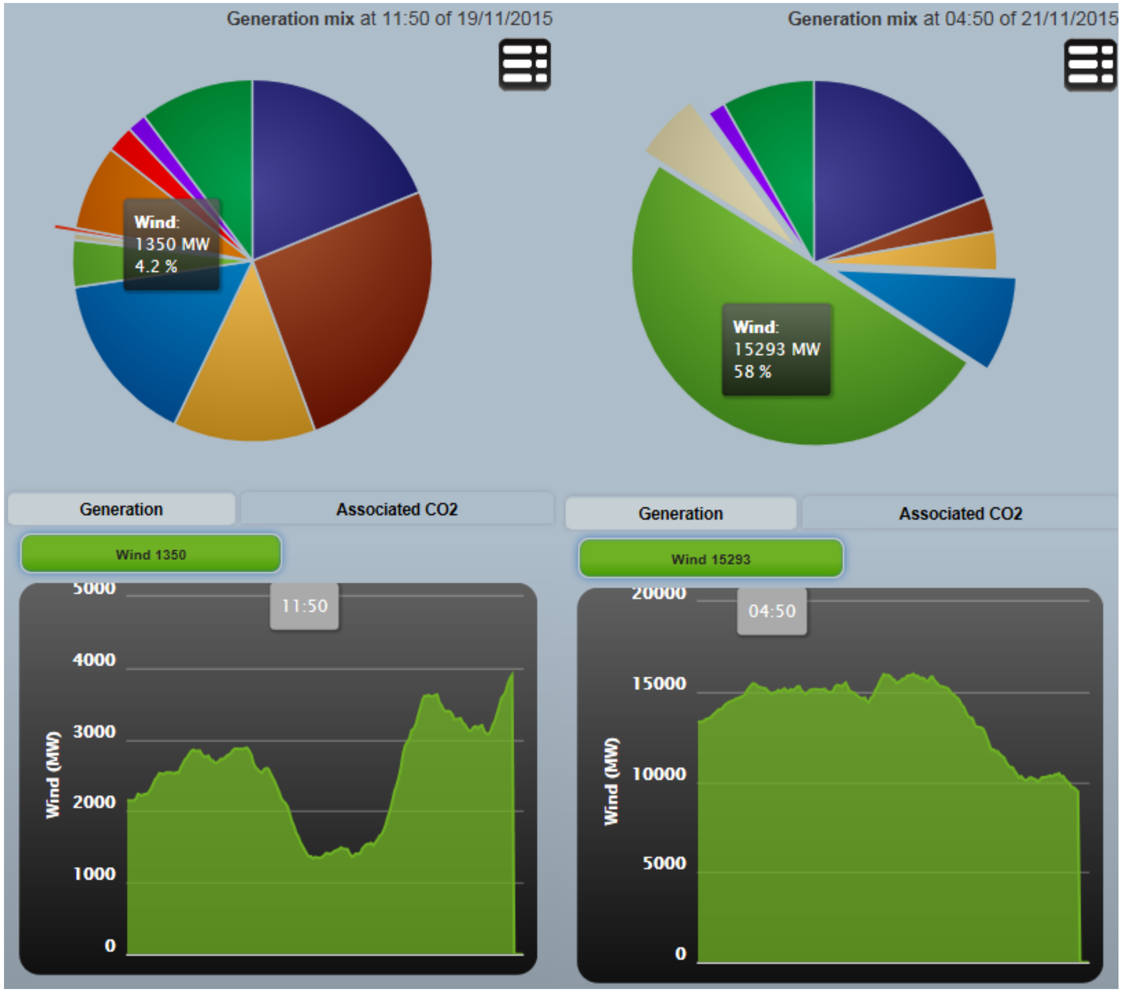
Status of the pilots

Shared responsibility with base station flexibility

Spanish context



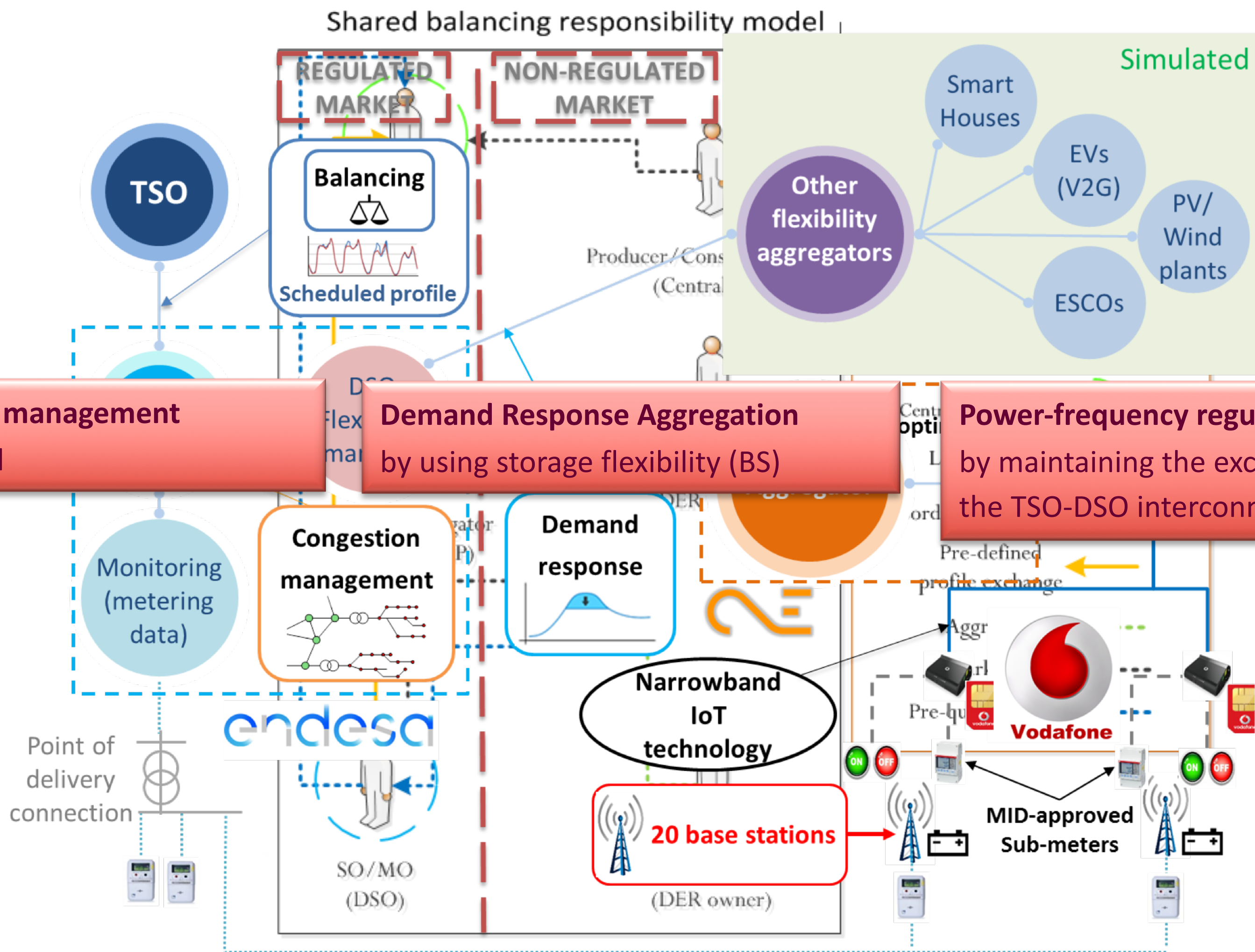
2030 Transmission adequacy (TYNDP'16)
http://tyndp.entsoe.eu/exec-report/



Poor interconnections

Big contribution by highly-variable RES production

Pilot C: Shared responsibility with BS flexibility



Congestion management
at DSO level

Demand Response Aggregation
by using storage flexibility (BS)

Power-frequency regulation / balancing
by maintaining the exchange program at the TSO-DSO interconnection

Pilot C: Shared responsibility with BS flexibility

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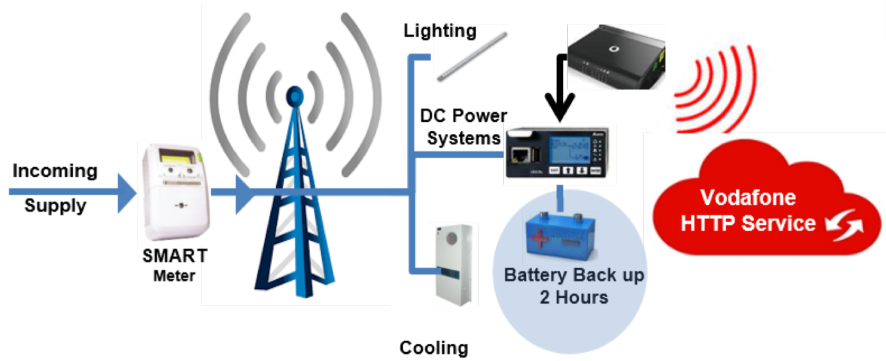
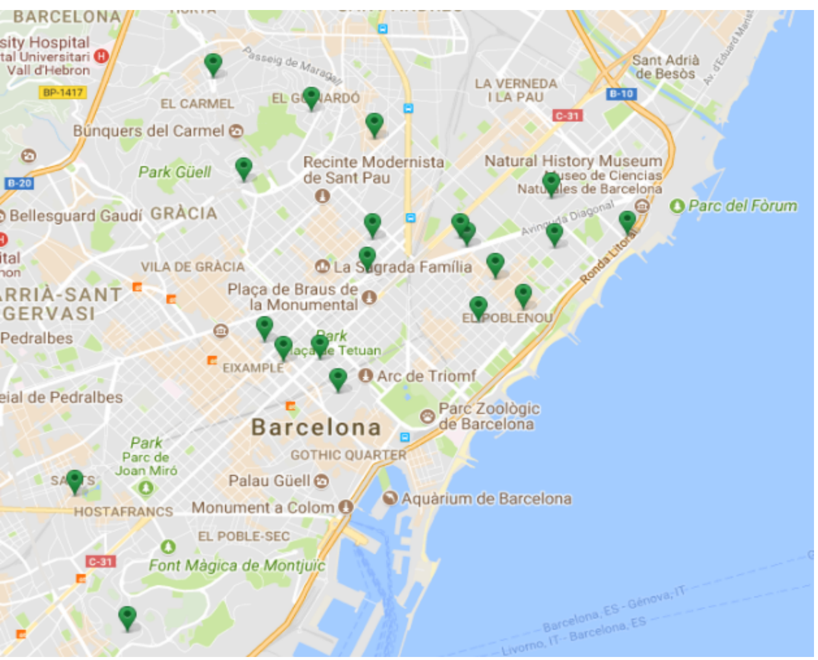
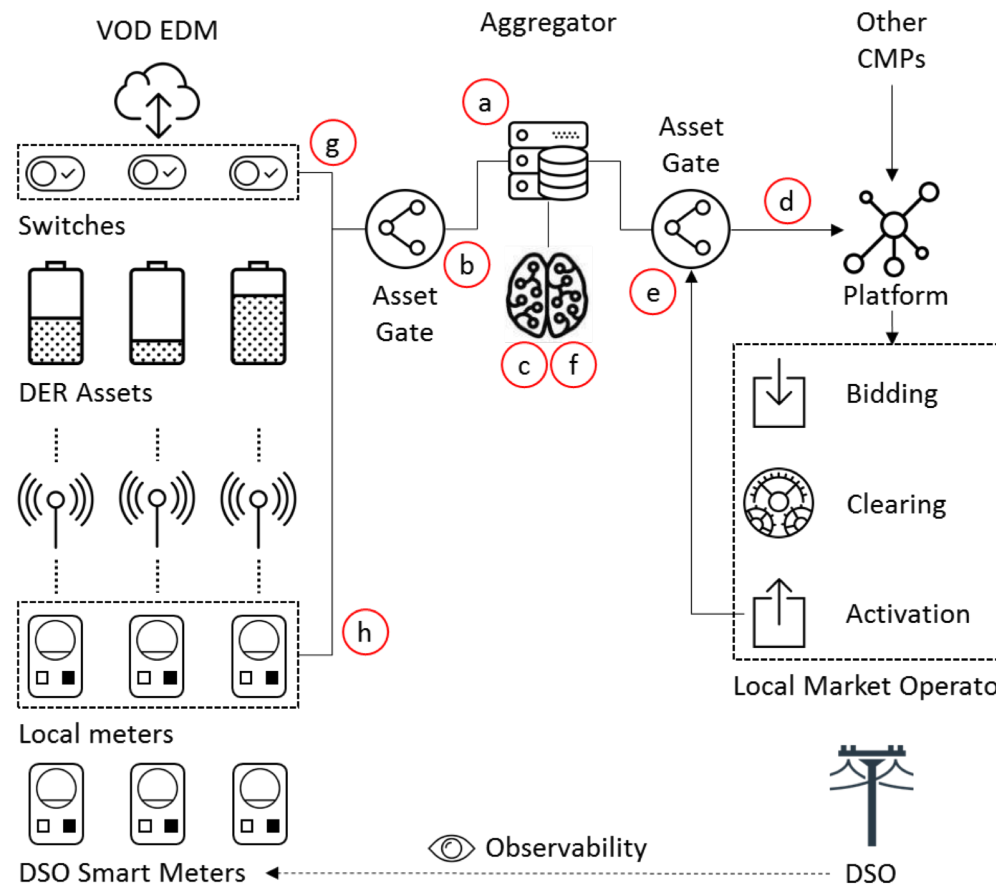




Demand Response Aggregation

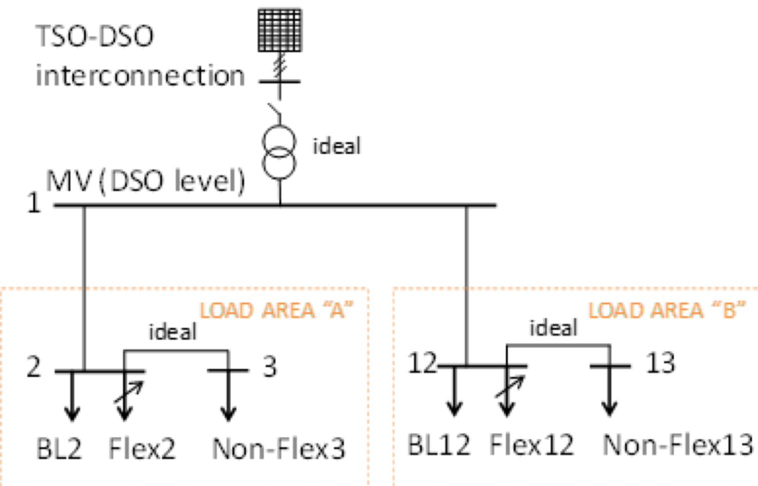
By using storage flexibility (BS)

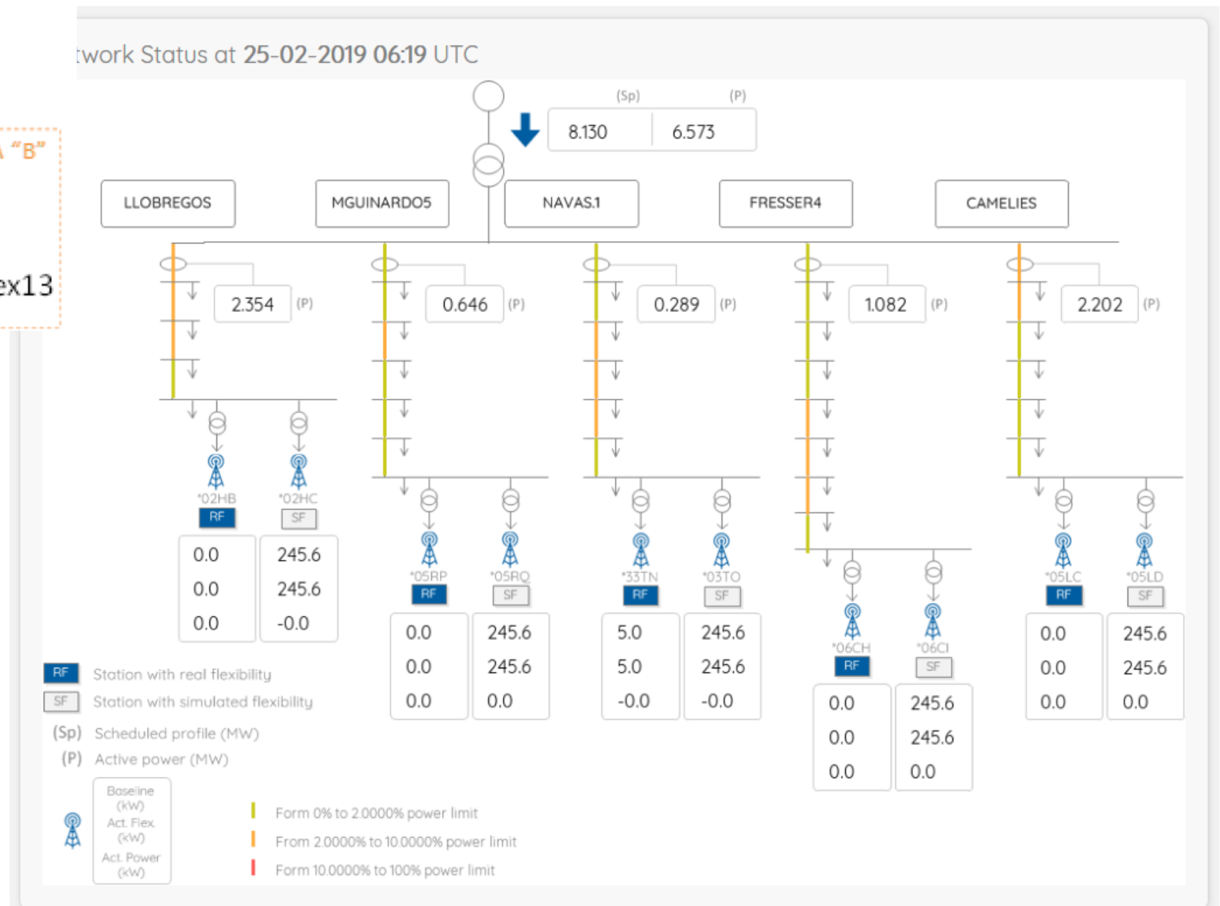


Pilot C: Shared responsibility with BS flexibility

Congestion management

at DSO level

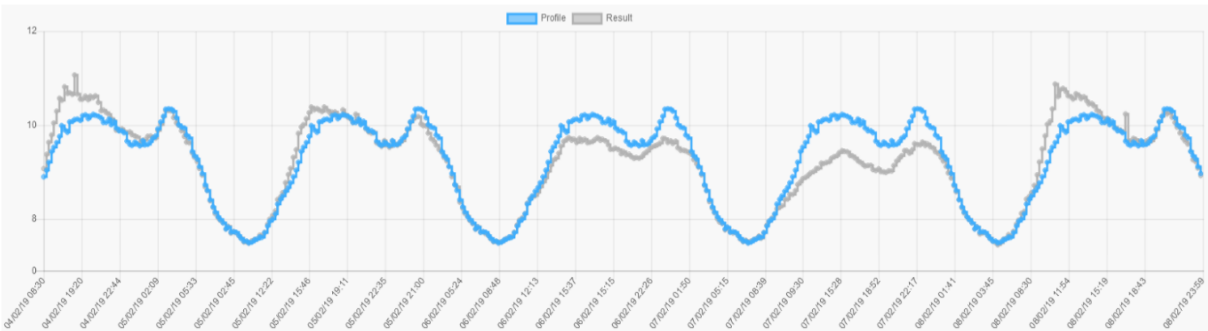


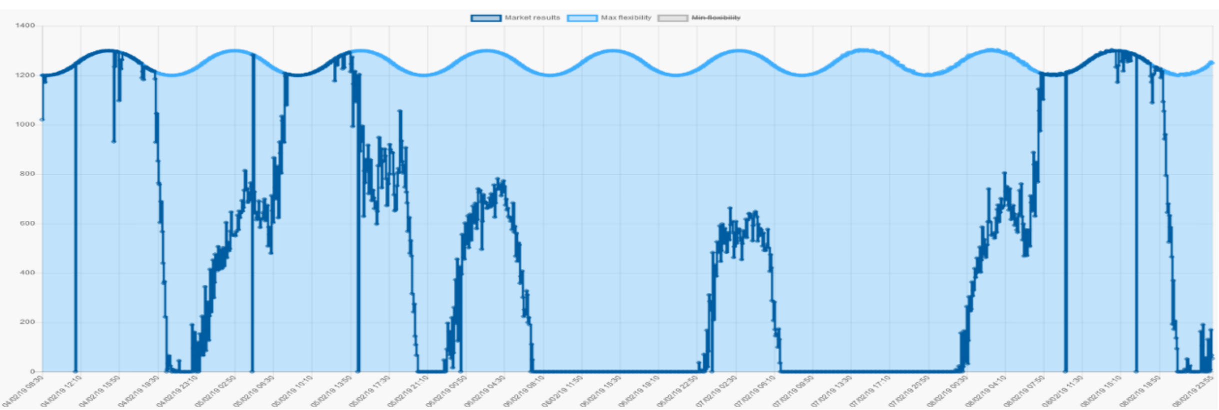


Pilot C: Shared responsibility with BS flexibility

Power-frequency regulation / balancing

by maintaining the exchange program at the TSO-DSO interconnection





Pilot C: Shared responsibility with BS flexibility

- DSO can operate local markets to avoid congestions and maintain scheduled profile:
    - Perfect matching between real exchange and scheduled profile, except:
        - When downward balancing was needed
        - There was not enough flexibility available
- CBA shows CS C as the least efficient one. However, from a practical point of view, it worked.
- No impact on Vodafone’s service
- High replicability: More than 250 MW available on Vodafone’s sites across Europe

SmartNet-Project.eu

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Thank You

Carlos Madina

tecnalia

Contact Information

Affiliation: Tecnalia

Phone: +34 667 165 473

Email: carlos.madina@tecnalia.com