Study Committee C5

Electricity Markets and Regulation

Paper C5_307_2018

Smart TSO-DSO interaction schemes and ICT solutions for the integration of ancillary services from distributed generation

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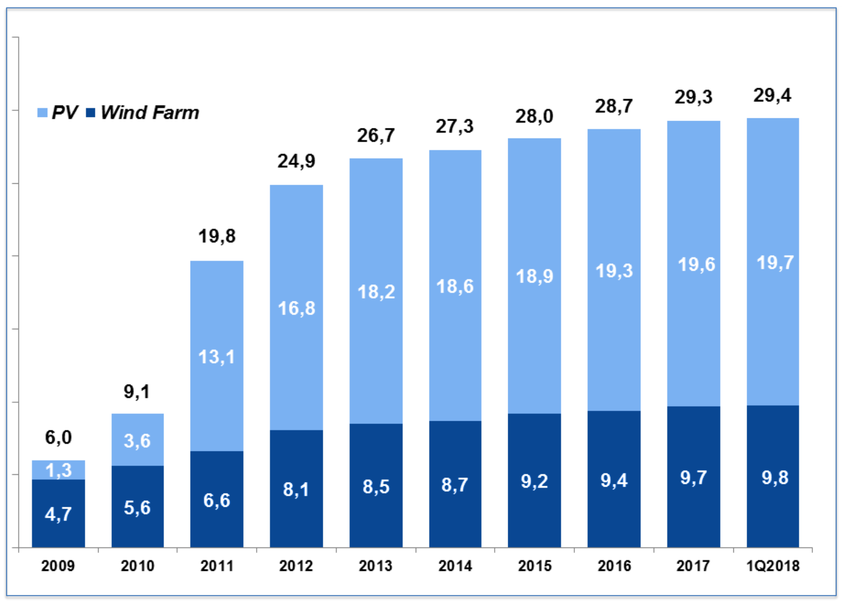
Motivation

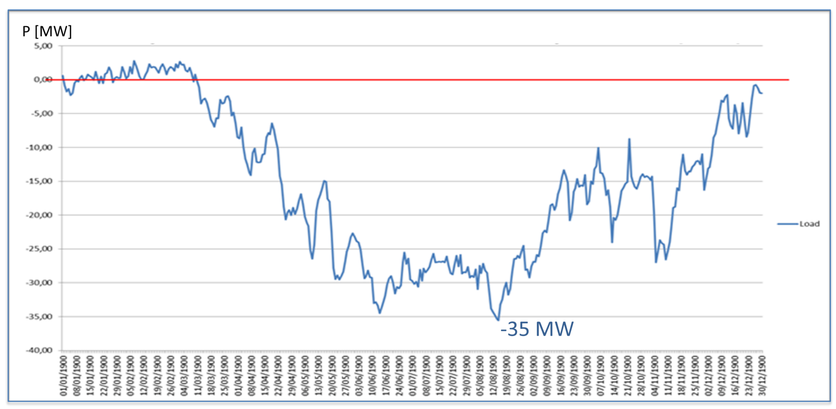
- During the recent years there has been a rapid increase in the number of generators based on **renewable energy sources**
- The spread of generation units located at distribution level leads the energy framework to move from a power park module characterized by few traditional plants connected to HV grid to an energy context composed by numerous small-sized generators connected to MV and LV levels.
- This new configuration of the system can lead to **reverse power flows** in case of local oversupply at distribution level
- The increase of distributed generation, based on renewable sources, entails to improve the infrastructure for **monitoring and control** of MV and LV levels.

Objective:

The Italian pilot project aims to demonstrate the technical feasibility of the **observability** of DSO network and the use of **flexibility** from Distribute Energy Resources (DER) and Renewable Energy Sources (RES).



Renewable Sources in Italy– Installed Power



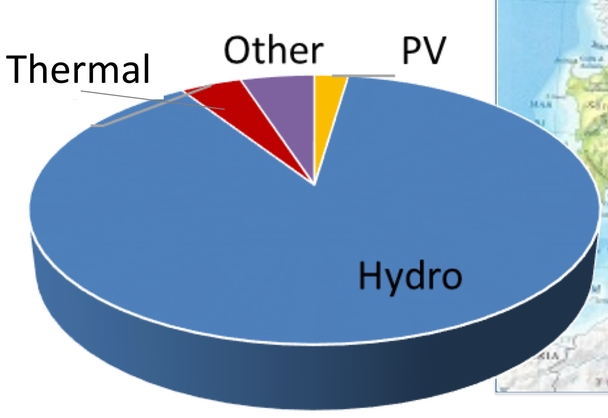
Daily medium load TR Molini di Tures - year 2014

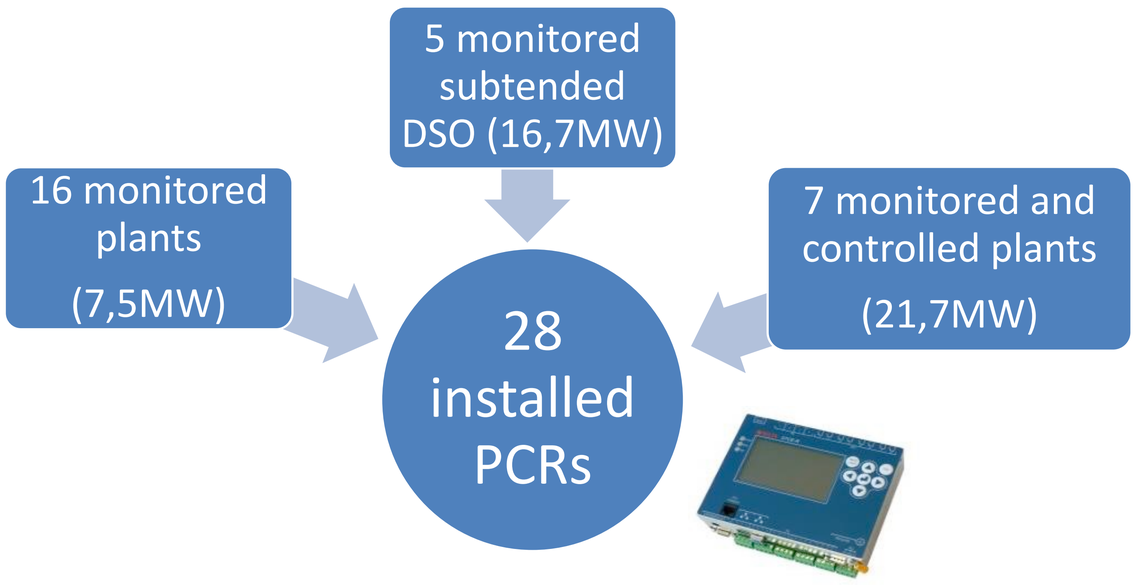
The grid involved

The pilot is located in the area of Ahrntal valley, in South-Tyrol, at the border with Austria, a portion of grid characterized by a large presence of hydro power plant.

This location provides the opportunity to involve generating modules of **different sizes** connected to **all voltage levels**:

- **HV:** the project involves **two hydro power plants** connected to TSO HV substation (Molini and Lappago - 43 MW in total).
- **MV:** the project involves the MV grid powered by the DSO primary substation "Molini di Tures"; there are **23 producers**, with an installed power of 29 MW (27.7 MW of run-of-river, 1.5 MW of biomass, 0.2 MW of PV), and **5 local DSOs** that are characterized by a small number of customers fed by one or more hydro power plants.





Installation of Plant Central Regulators (PCRs)

- to monitor interconnection points
- to monitor and control plants involved in voltage and aFRR* regulation

*aFRR: automatic Frequency Restoration Reserve

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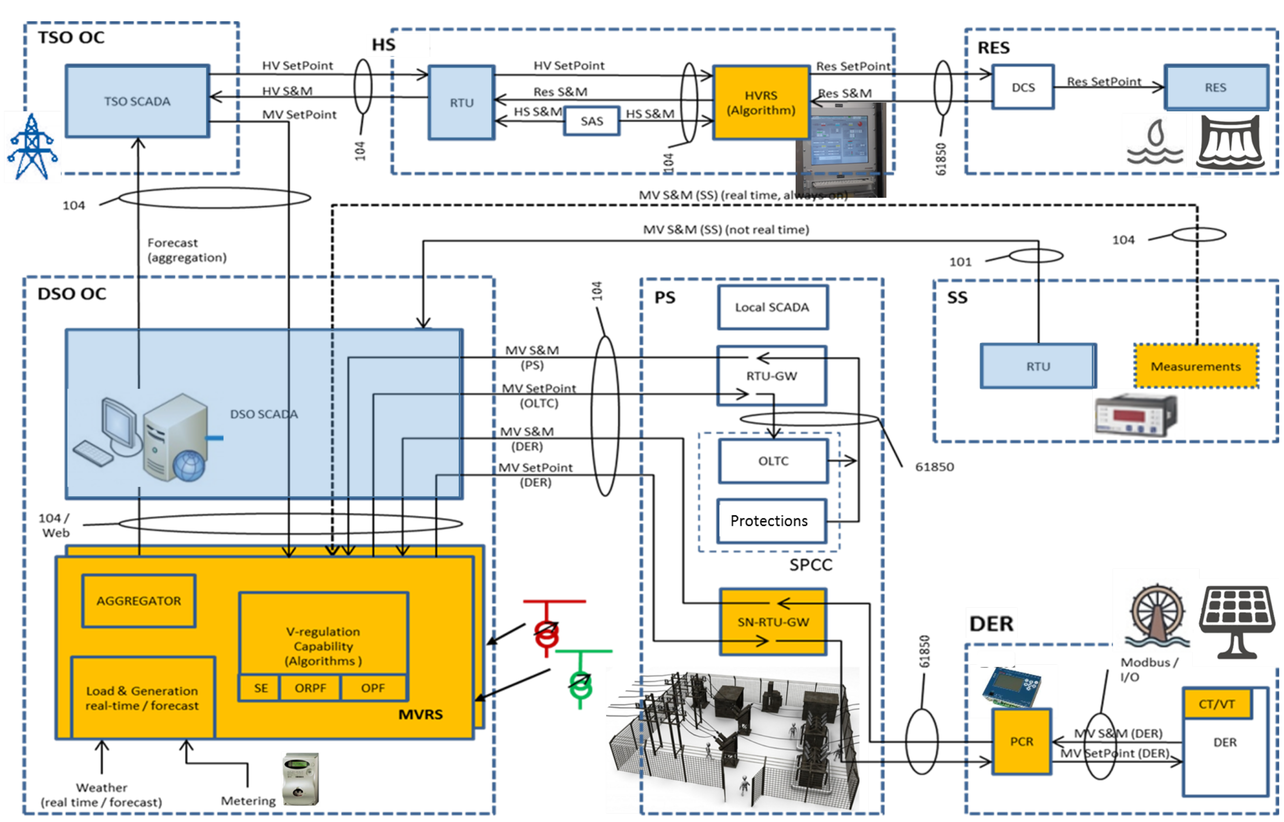
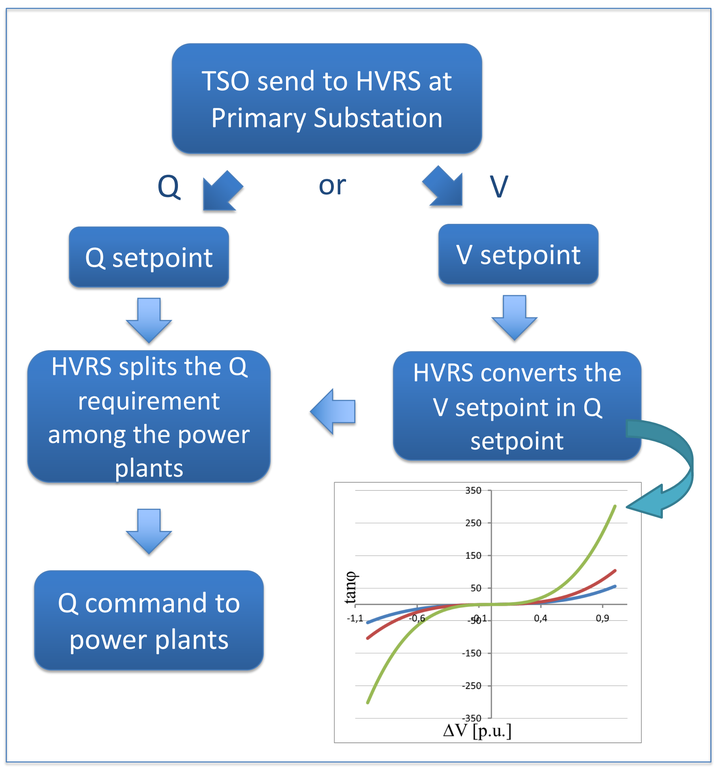


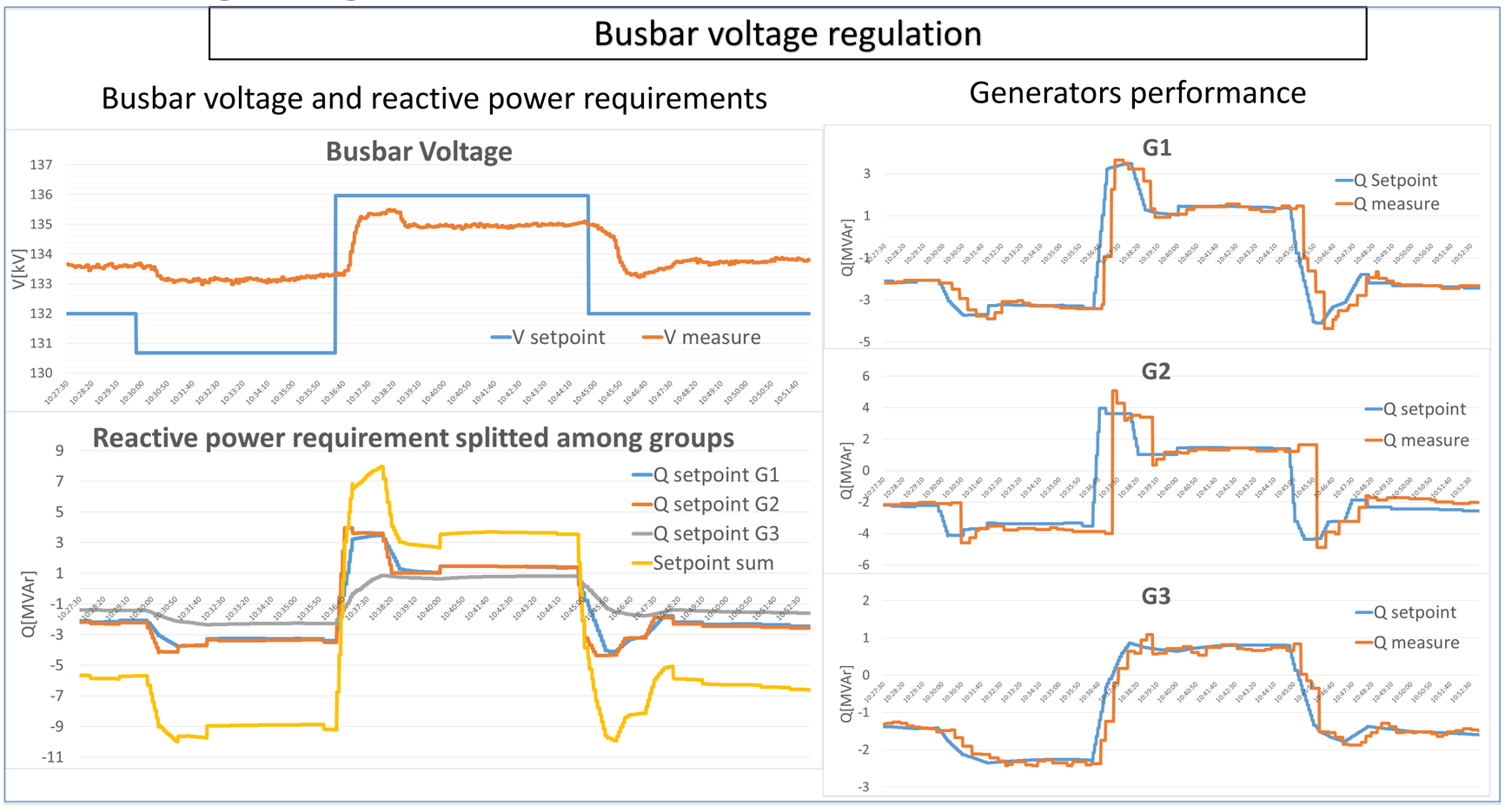
Architecture

Devices and functionalities implemented

- **High Voltage Regulation System** (HVRS) installed in the HV substation – main functionalities:
  - To **aggregate** and send to the TSO the reactive power information of controlled plants
  - To provide **hierarchical coordinated** voltage regulation by multiple HV connected renewable generating modules
- **Medium Voltage Regulation System** (MVRS) installed in the DSO control room – main functionalities:
  - To collect and provide to the TSO the **aggregated** information to determine the system state and to improve the grid observability
  - To provide **voltage regulation by distributed generation**
  - To provide **aFRR by aggregated distributed generation**

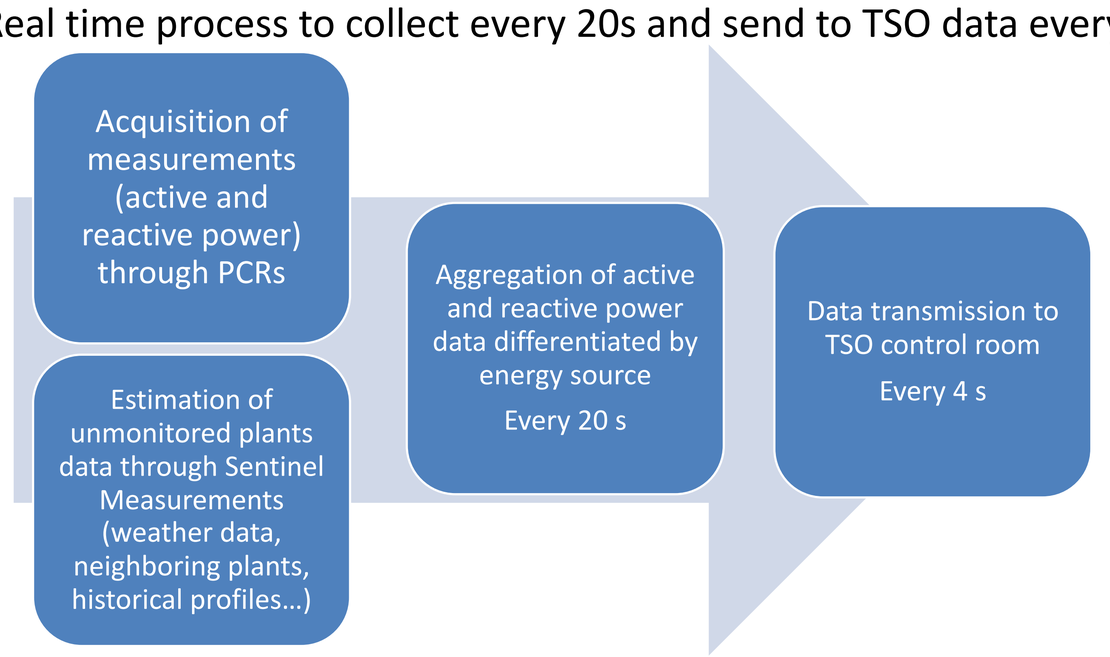
HVRS: Hierarchical Coordinated Voltage Regulation





MVRS: Observability of DSO grid

Real time process to collect every 20s and send to TSO data every 4s



The observability algorithm shall respect a **minimum accuracy** in order to provide to the TSO a **reliable real-time representation** of the DSO embedded generation and load. The respect of a minimum accuracy is of utmost importance to allow the integration of observability information in the TSO's SCADA system. In the SMARTNET project most of the hydro power plants are provided with measurements (through the PCRs): this allow to ***reverse engineering*** the algorithm and check how many power measurements are needed to achieve the required accuracy (10% in terms of real-time power, checked against 15min energy measurements). It is evident the dependence on the type of source; the first results highlighted that for **hydro power plants about 60% of installed power has to be measured.**

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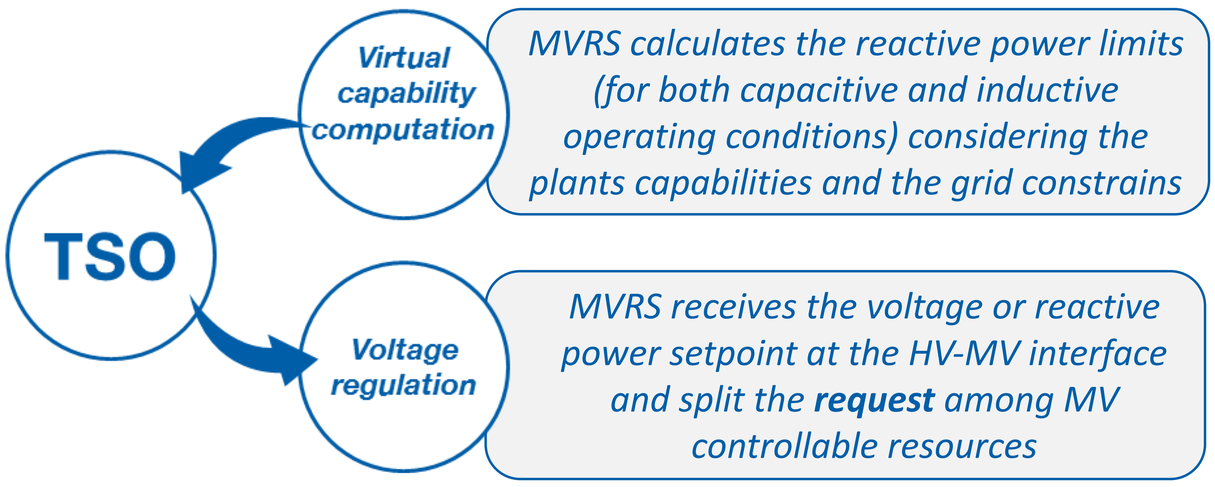
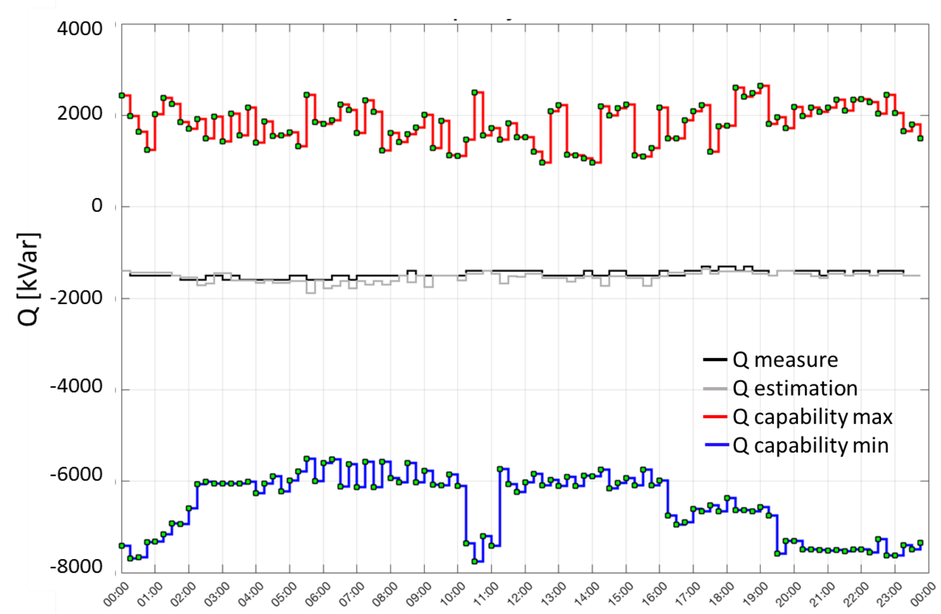
MVRS: Voltage Regulation



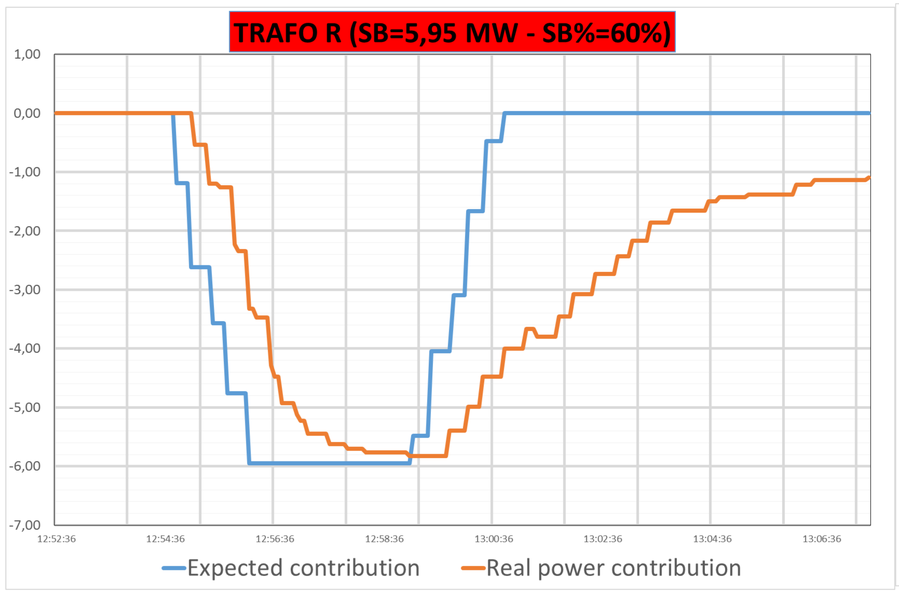


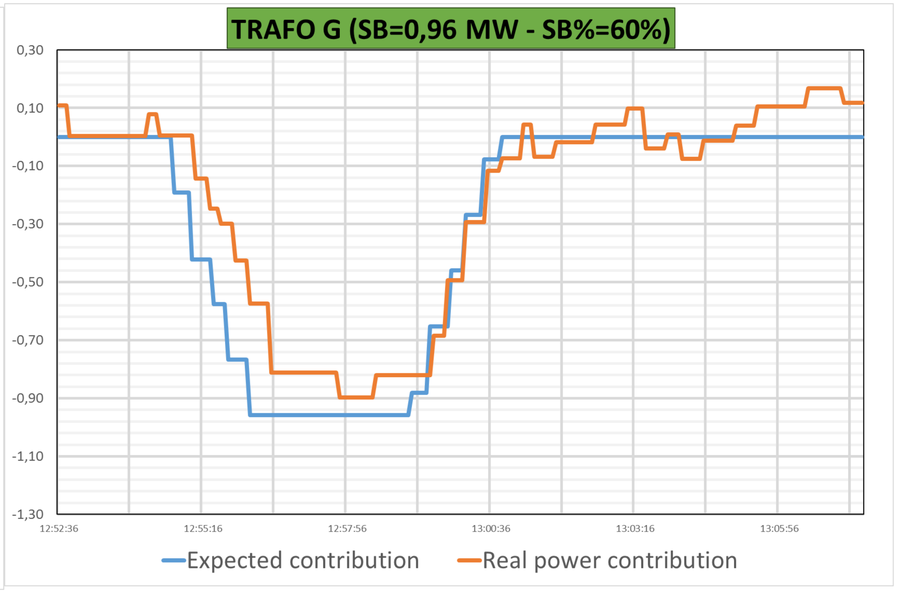
Virtual capability computation

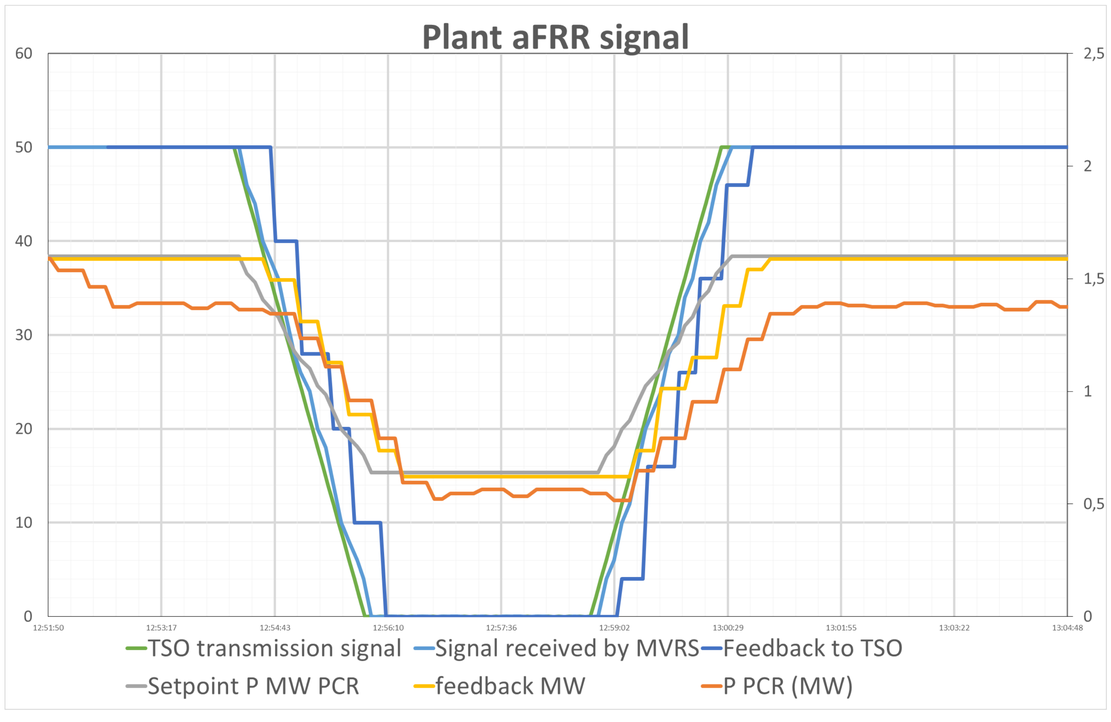
MVRS: aFRR Regulation

- The MVRS calculates the **aggregated dynamic active power capability**, considering all the available data (topology, measurements, constrains, etc.)
- The MVRS sends to the TSO the range of the **available active power** for the regulation of the **virtual plant**
- The aFRR loop controller sends, every 8s, a setpoint (signal level between 0 and 100%) to the virtual plant
- The MVRS calculates the corresponding active power and split the request among the DG plants involved in the regulation, taking into account the specific capability and the **grid constraints**

aFRR tests: power ramps at the primary substation of 6.91 MW







Conclusion

- HVRS and MVRS have been successfully developed and installed by technological partners, demonstrating the feasibility of all the functionalities foreseen by the pilot project.
- With the implemented observability algorithm it has been possible to check how many measurements are necessary to achieve the required accuracy. It is evident the dependence on type of source. The first results highlighted that for hydro power plants about 60% of installed power has to be measured.
- The calculation of active and reactive power limits lead to know the available DG contribution in both voltage and frequency regulation taking into account DSO grid's constrains.
- The pilot will collect a large amount of data useful to deepen the flexibility available from renewable generation (HV and MV connected). This also allows to learn how to better setup power plants to improve active and reactive power response.