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

WP5 – Task 1 - Italian pilot project

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Summary

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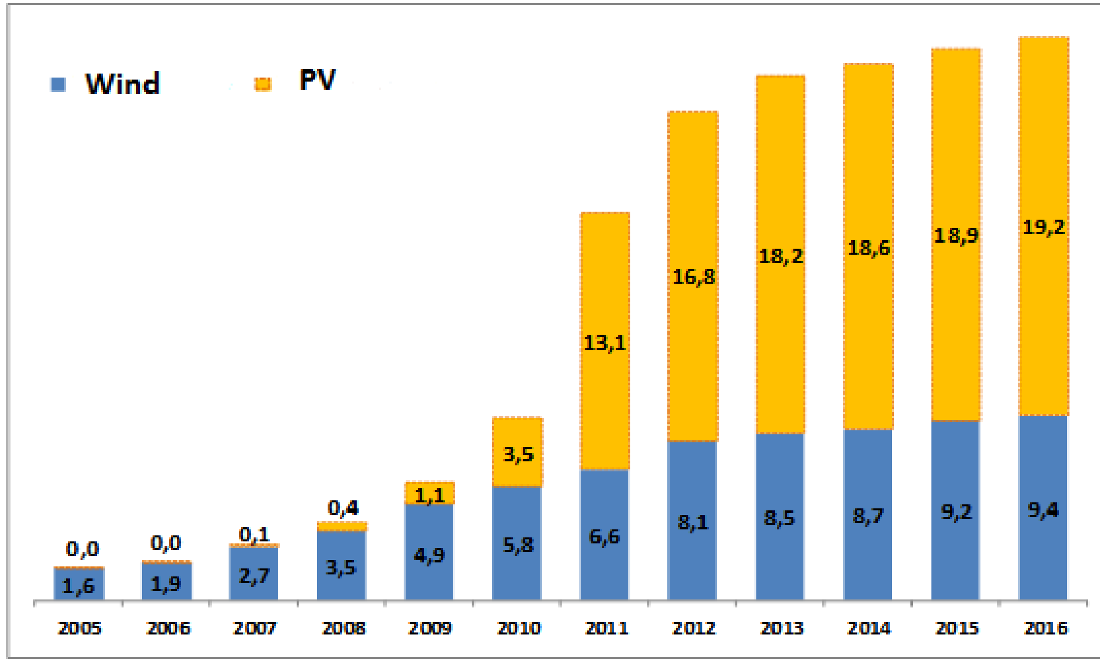
- New approaches
- Goals of Italian Pilot A
- Main functionalities
- Italian Pilot Project - Field implementation
- Aggregation of information
- Virtual Capability
- Voltage regulation
- Power/Frequency regulation
- Conclusions

Italian context

Energy situation

Large increasing of RES in the last 10 years

New issues in terms of power management of the electrical grid



NEW CHALLENGES

- Active Power rise up from MV to HV grid
- Unpredictability of RES
- Needs to improve the infrastructure for monitoring and control of MV and LV levels

New approaches

A smart management of the electrical grid, by all the actors involved, could help to face the new challenges

Interaction and **collaboration** between TSOs and DSOs

- It could provide a better **observability** and allows to take advantage from electrical resource.
- The electrical system could be **more flexible**

Goals of Italian Pilot Project

Goals and solutions

The italian pilot project would like to implement new features for an innovative experimentation in field

Aggregation of information
in real time at the interconnection point between TSO-DSO (HV/MV transformer).

Voltage regulation
development of an architecture and implementation in field of a system for the voltage regulation by generators connected to HV and MV levels

Power-frequency regulation / balancing
development of an architecture and implementation in field of a system for the power-frequency regulation by generators connected to HV and MV levels

Italian Pilot Project - Implementation in field

Details about implementation in field

The part of distribution network involved, substations and generation units have been selected in order to have a **complete system to test several functionalities with different devices** to guarantee interoperability using the standard protocol IEC 61850.

The equipment to be installed on the EDYNA MV network will provide from a single manufacturer, SELTA.

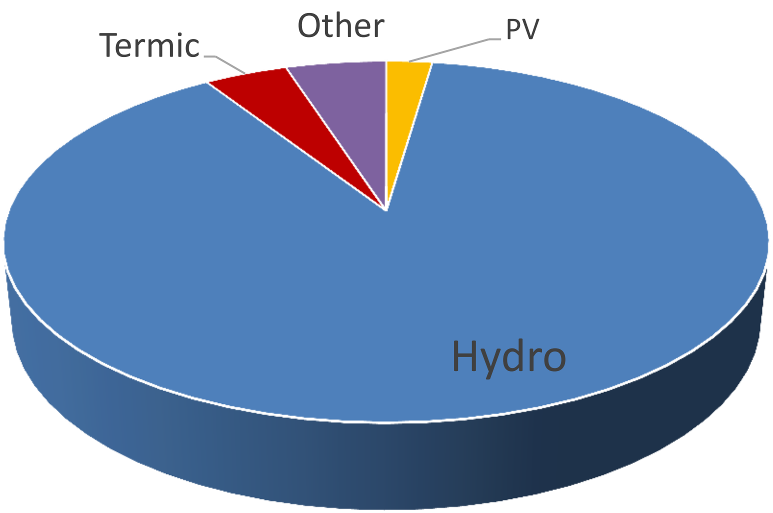
Valley of Ahrntal, in South-Tyrol, Italy

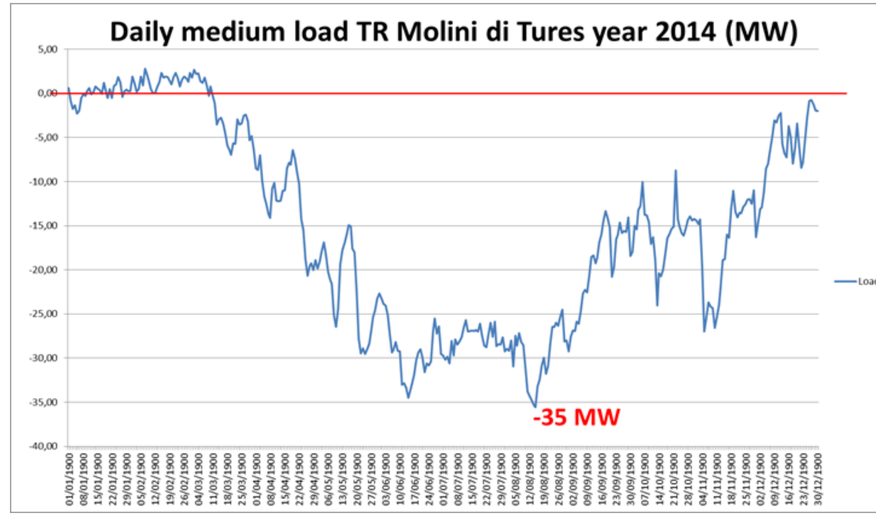
Molini di Tures Primary Substation

1 HV hydraulic generation and many MV generators (Hydro, thermo and PV)

Italian Pilot Project - Implementation in field

HV grid around Molini di Tures





- **HV** Generation:
  2 Hydraulic PGM of **20MW** each.
- **MV** and **LV** Generation:
  More then 30 PGM with more than **40MW** of total nominal power (Hydro, termic and other)

Requirements

In order to **control the system in real time** it is necessary to have an high **ACCURACY** in terms of observability. In fact this is fundamental for improving some **important algorithms** for TSO's activities (state estimation, load flow, dynamic stability assessment).

Examples of actual characteristics of existing TSO's systems and accuracy requirements

SCADA (Supervisory Control And Data Acquisition) and EMS (Energy Management) systems

- Data acquisition and elaboration: 2''-4''
- Level of aFRR regulation: 8''
- State estimation: 1'
- Security evaluation: 5'
- Dispatching orders: 5'-15'
- Dynamic analysis: 15'

Central system for defence plan

- Central system elaboration (configuration): 4''
- Data acquisition: 4''
- Orders on event: ~300-400 ms

Functionalities

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).

Aggregation of information

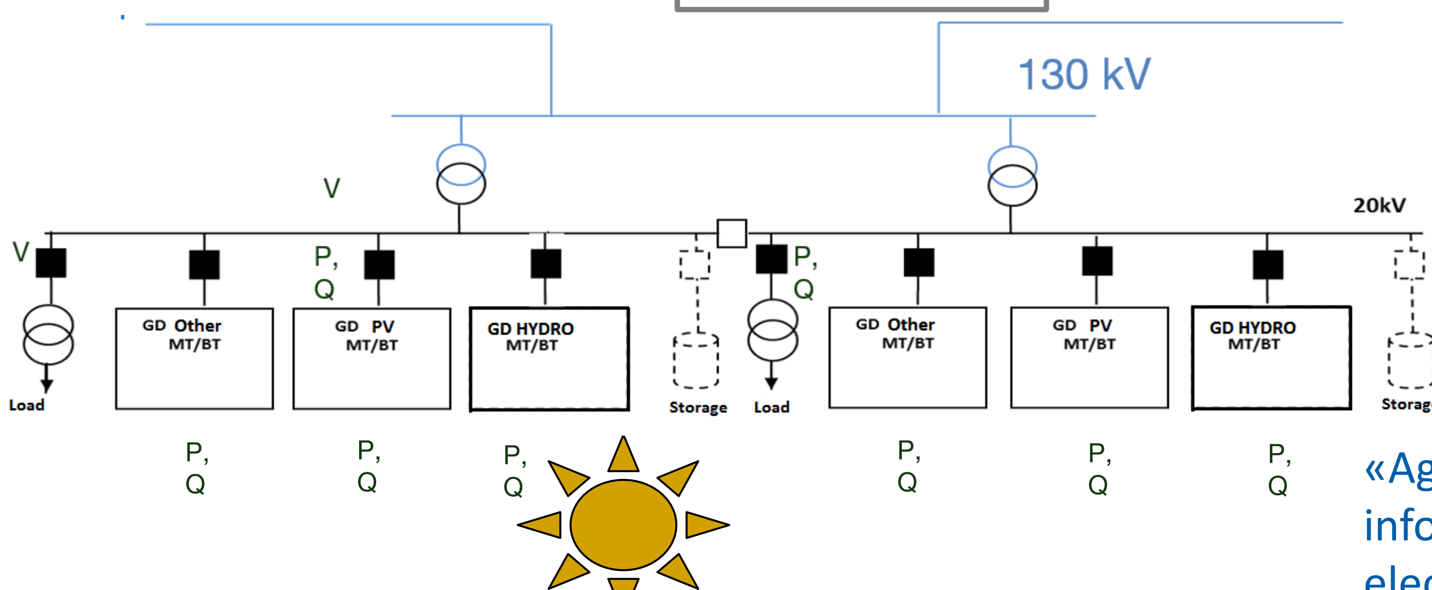
Implementation in pilot project

Data to be included in the aggregation

Nominal data
Total power installed

Load and generation
Real time data in terms of P and Q for all the sources

Forecast Data
P for all the sources

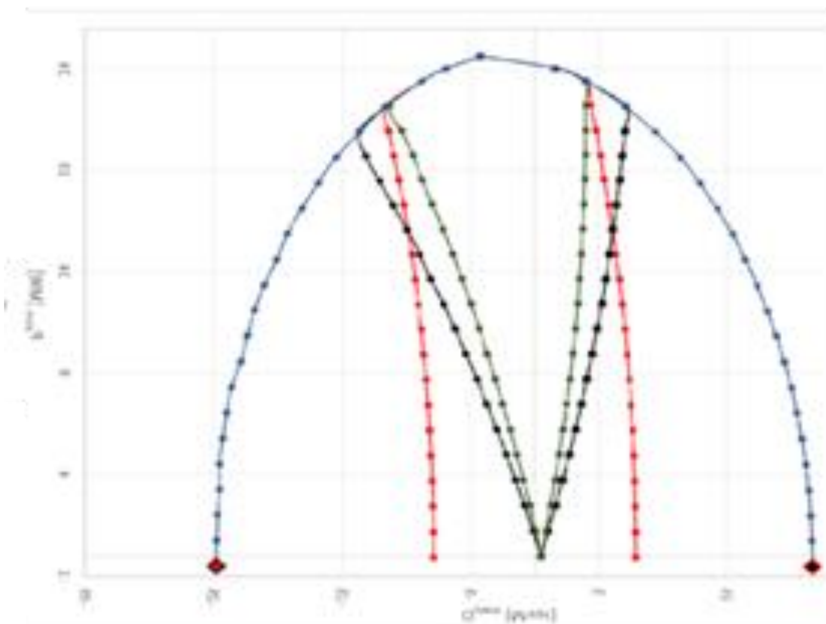


70 power generation modules «hidden»

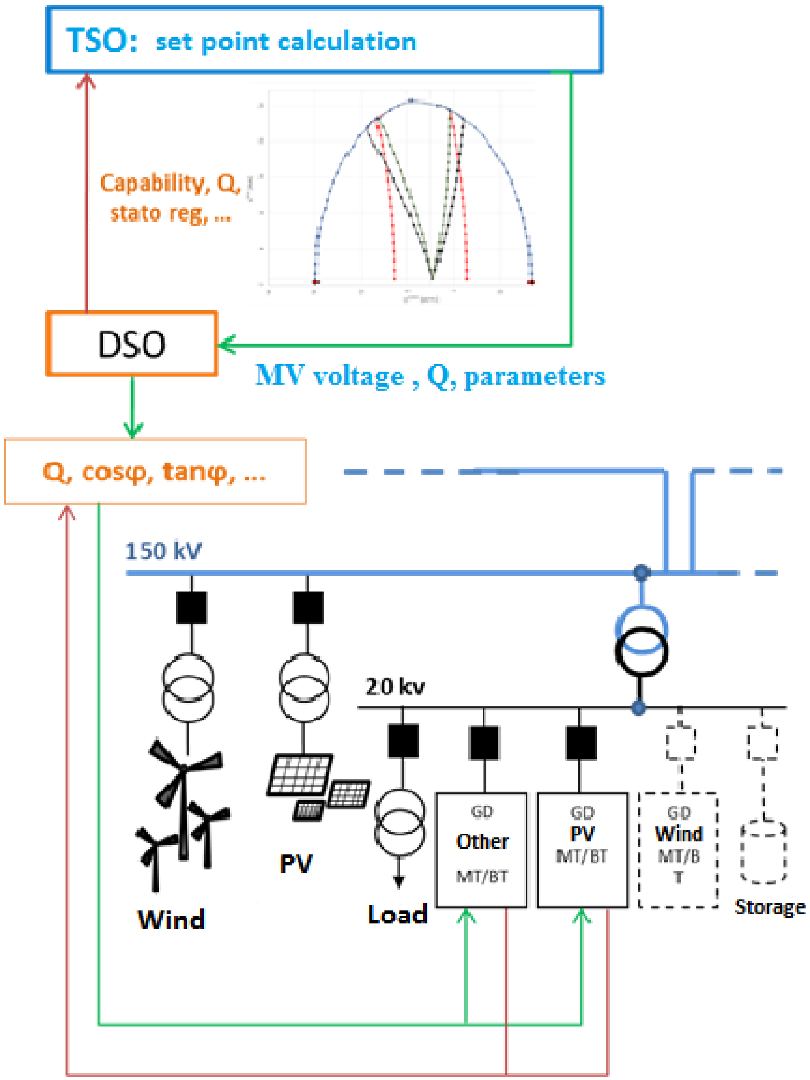
«Aggregate» of information at electrical node level

Virtual Capability

Virtual capability: it represents the **operational limits** in terms of P and Q, updated also considering the **operation point in real time** at the interconnection point. The construction of virtual capabilities is carried out by the DSO, because the limitation consider also **information about the topology** of the distribution network.



Voltage regulation

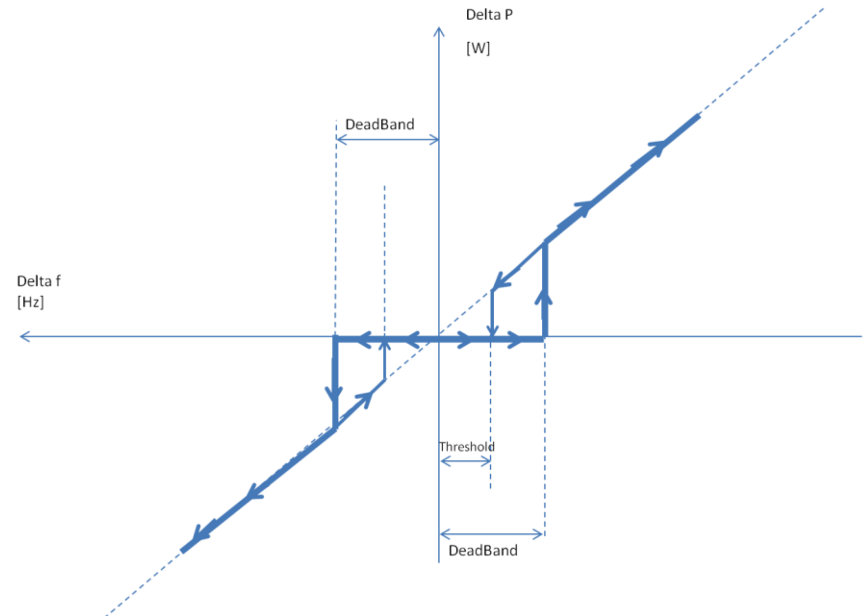


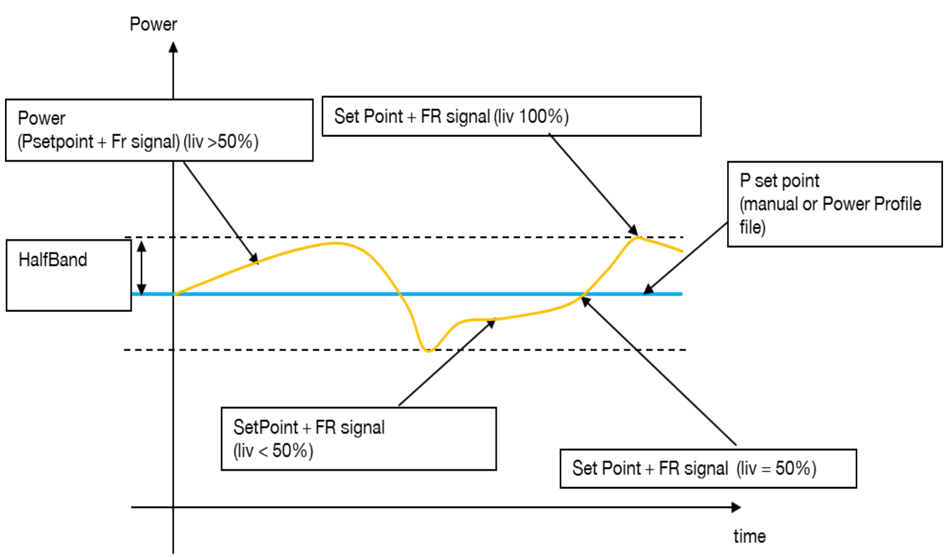
- DSO provide **virtual capability** at the interconnection with TSO, so that the TSO can provide a **voltage set-point** or a **reactive power level** fitting with available capability.
- The voltage set-point is calculated by an **algorithm of optimisation for the whole high voltage grid**, considering the TSO-DSO connection point as a virtual resource.
- The DSO receives the set-point (V or Q) and **instructs connected resources**, throughout the conversion to **orders set-point.**
- The management of distributed generation must be compatible with hierarchical regulation on HV networks **in terms of time of regulation**. MV generation regulation must be decoupled from HV regulation **(slower)**.

Power/Frequency regulation

The power/frequency regulation FRR is carried out by the **modulation of the injected active power**, around the scheduled value.

A new device will be developed and installed the primary substation, for receiving the TSO set point and deliver it to controllable MV generators. A IT architecture to exchange data with the required availability/thoughput/latency will be designed accordingly.

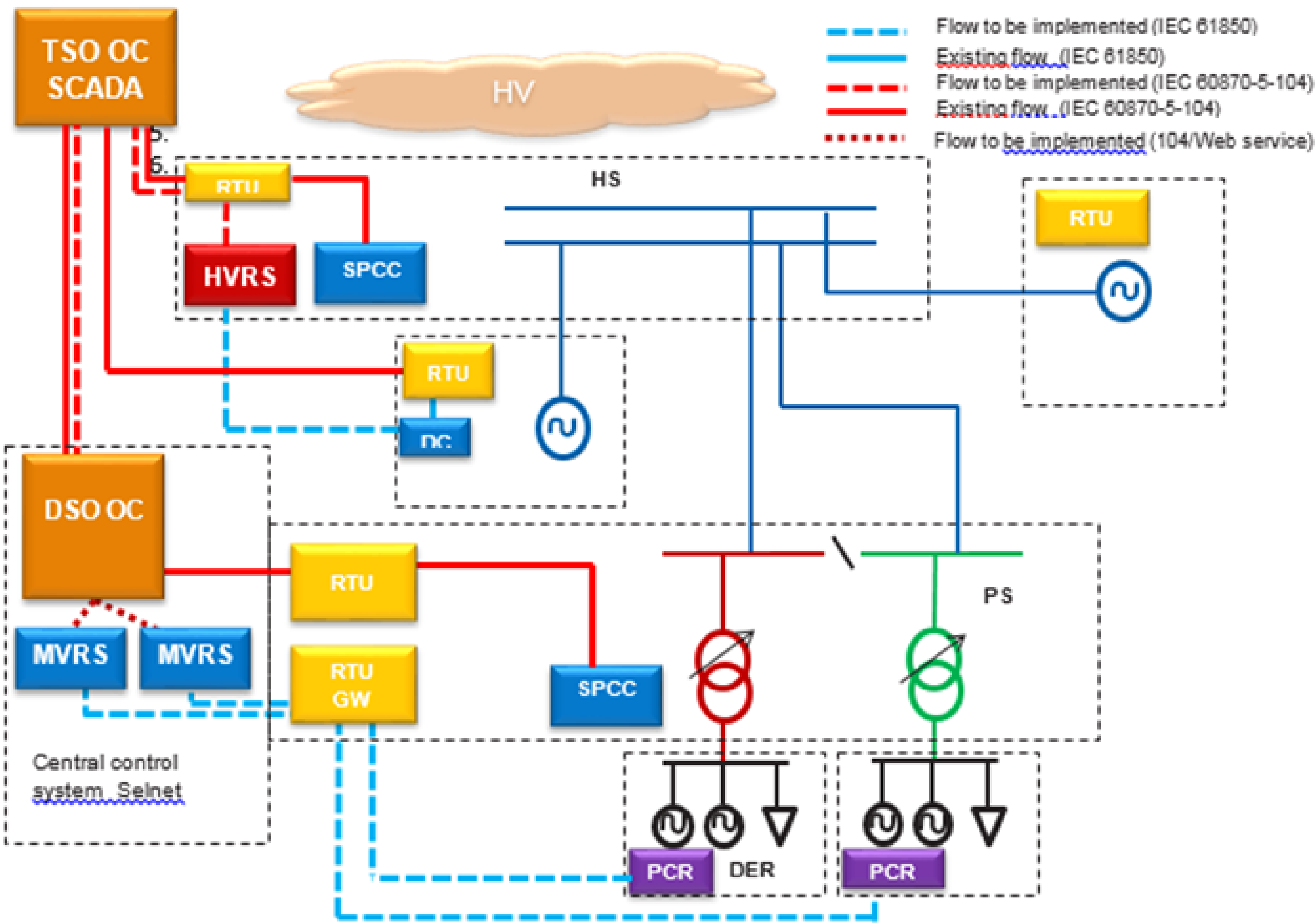




- **FCR** process is a power variation with a droop response (local regulation).
- **FRR** process is the power variation, around a program level, following a set-point sent by the TSO.

The typical timing for P/f regulation is in order of seconds!

System architecture



System architecture

Legend

TSO OC	TSO Operation Center
DSO OC	DSO Operation Center
HS	HV Substation
PS	Primary Substation
SS	Secondary Substation
RES	HV Generation/Customer
DER	MV Generation/Customer
SPCC	local protection, command and control system (system installed in substation for the protection, command and control functions at local level)
OLTC	On Line Tap Changer
PCR	Plant Central Regulator (device to interface the power generation module control system to the MVRS)
HVRS	High Voltage Regulation System (device which performs functions and algorithms for the aggregation and the control of generation at high voltage level)
MVRS	Medium Voltage Regulation System (device which performs functions and algorithms for the aggregation and the control of dispersed generation)
S&M	State & Measures
CT/VT	Current/Voltage Transformers

Conclusions

Pilot expectations

TSO will receive aggregated data not only for control but also in order to manage the allocation of services.

Aggregation must be done by DSO, but others parties could provide aggregation service as well. It is very important to define the *virtual capability*.

A new device will be installed at the interconnection point TSO/DSO and it will collect all the data described. It will also make available the information to TSO. A specific functionality will transform all data in aggregated data, in order simulate a virtual power plant.

The virtual power plant will be described by information in terms of P and Q and by forecast data, fundamental for calculations in order to request ancillary services.

The functionality will provide, for each virtual power plant, limit of P and Q (virtual capabilities) that may be used in TSO's algorithms for active and reactive power dispatching.

Italian Pilot Project in brief…

Main activities and tasks assignment

Here following are listed the main activities and the corresponding partner leaders:

1. Site inspection and identification of HV station suitable for the project: **EDYNA (collaboration: all partners)**
2. Identification of MV station suitable for the project, power generation involvement and first feasibility evaluation: **EDYNA**
3. Site inspecition on MV station: **EDYNA (collaboration SELTA)**
4. Functional specification of the three project tasks**: TERNA (collaboration: all partners)**
    1. Aggregation;
    2. Voltage Regulation;
    3. FRR regulation.
5. Detailed project specification**: SIEMENS/SELTA (collaboration: all partners)**
6. NRA involvement/ information sharing: **TERNA (collaboration: EDYNA)**
7. Algorithm implementation of the three project tasks: **SIEMENS/SELTA**
8. DSO control system updates (if needed): **EDYNA (collaboration: SELTA)**
9. Data flow implementation: **TERNA (collaboration: EDYNA, SELTA, SIEMENS)**
10. Supply of equipments to be installed at the power generation facilities: **SELTA**
11. Supply of equipments to be installed at DSO station: **SIEMENS/SELTA**
12. Test and commissioning: **TERNA/EDYNA (collaboration: all partners)**
13. Operational experimentation : **TERNA/EDYNA**
14. Experimentation reporting: **all partners**

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Thank you for your kind attention!

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