SmartNet

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

External Workshop | June 20th, 2018 - Brussels

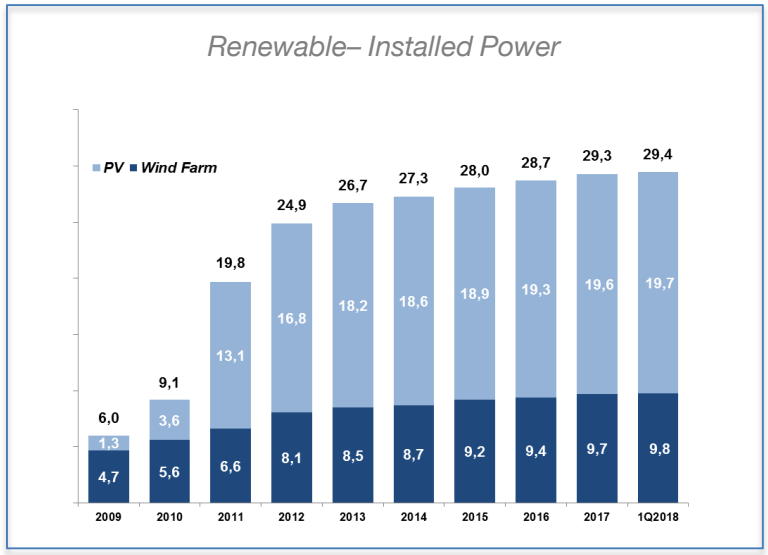
WP5 – Italian pilot project

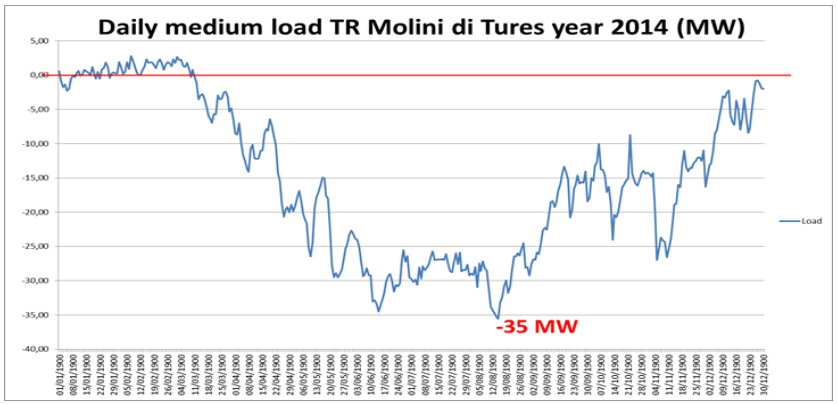
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691405

Italian energy framework

Large increasing of RES in the last 10 years and of DG connected at distribution grid

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**

Goals of Italian Pilot A

The Italian pilot project aims to implement new features for an innovative experimentation in field

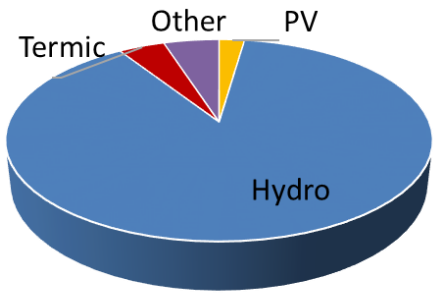
Aggregation of information
in real time at the interconnection point between TSO-DSO (HV/MV transformer).

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 MV levels

Italian Pilot Project - Implementation in field

Valley of Ahrntal, in South-Tyrol, Italy



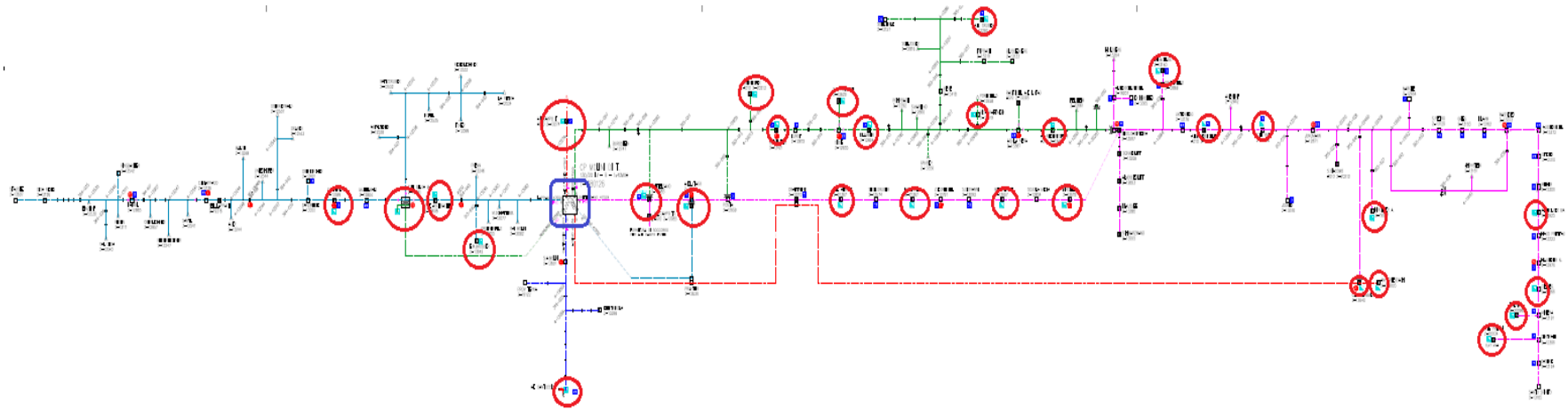
Substation of Molini di Tures: 2 HV hydroelectric generators (20MW), 2 x TR 40 MVA 132/20 kV, 6 feeders.

MV generation: 33 generators with 43,5 MW of power (41,7 MW hydro, 1,5 MW thermo, 0,2 MW FV).

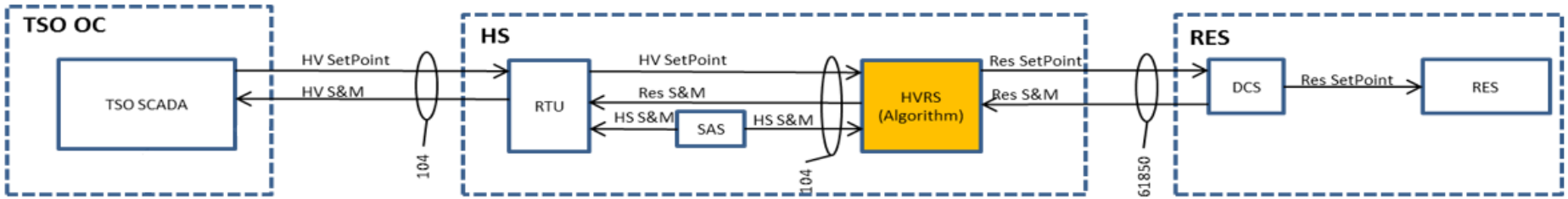
Others 0,85 MW of generation in LV (0,73 MW FV).

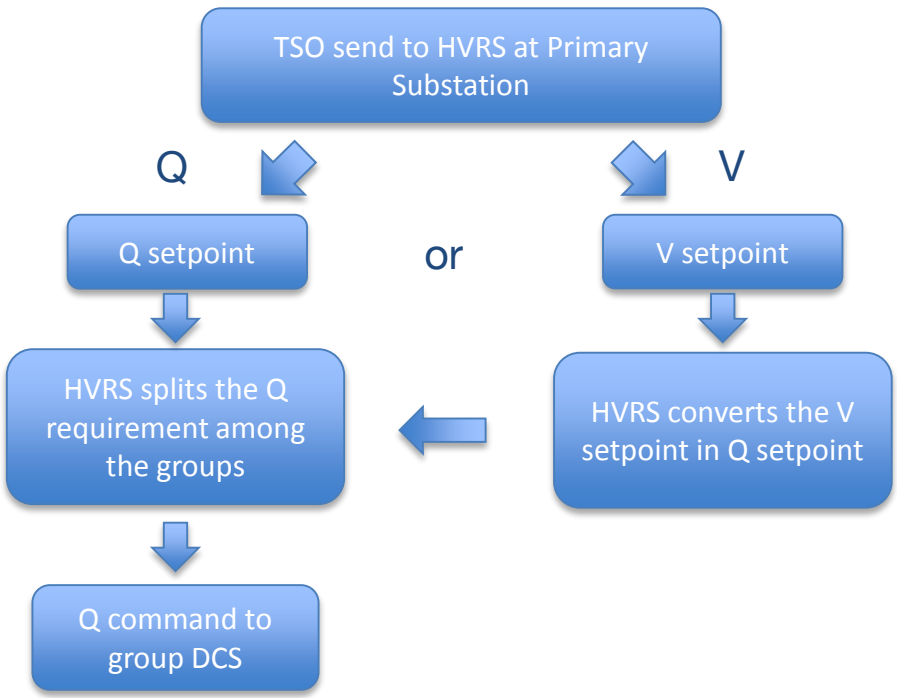
Also there are 9,6 MW of generation waiting to connect to the grid.

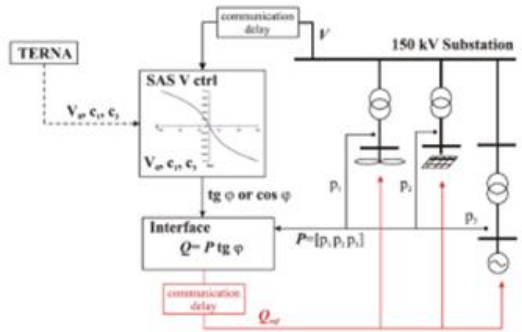
Feeders without reverse current feeding

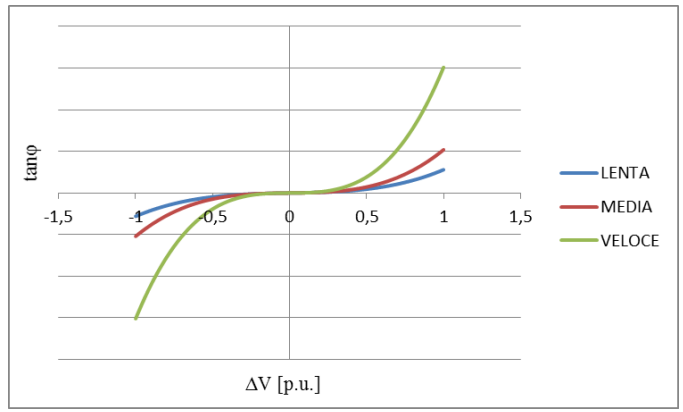


HVRS Voltage Regulation





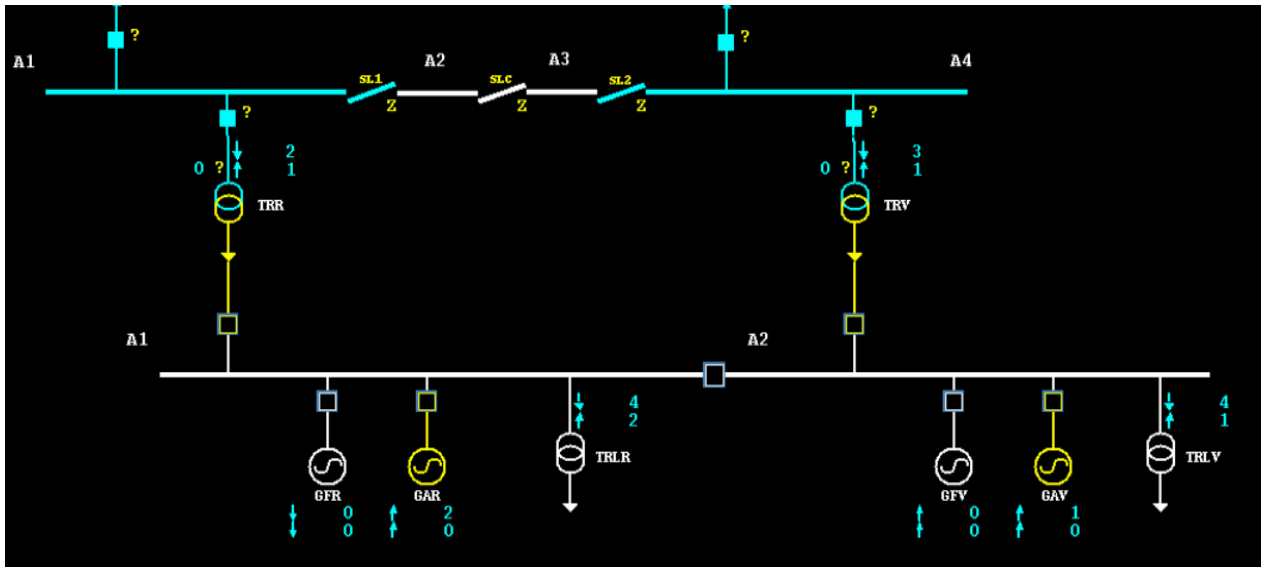




MVRS functionalities

Observability and aggregation of data of distribution grid

Aggregation of information in real time at the interconnection point TSO-DSO (HV/MV transformer) differentiated by load and energy sources. Aggregations are composed by measures and estimations.

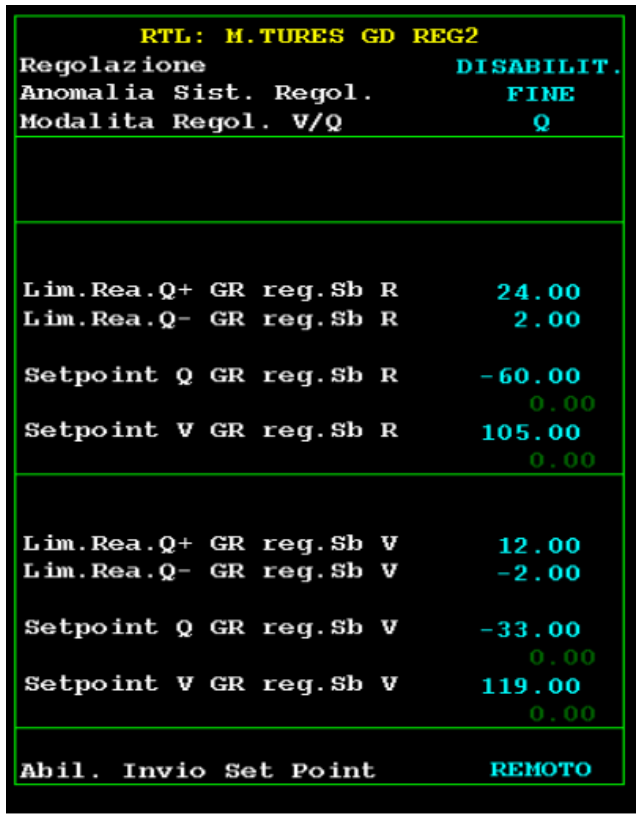


Interface of TSO Control System

Functionality in operation:
P and Q values of the aggregations are automatically updated every 20s and sent every 4s

MVRS functionalities

Voltage regulation



Interface of TSO Control System

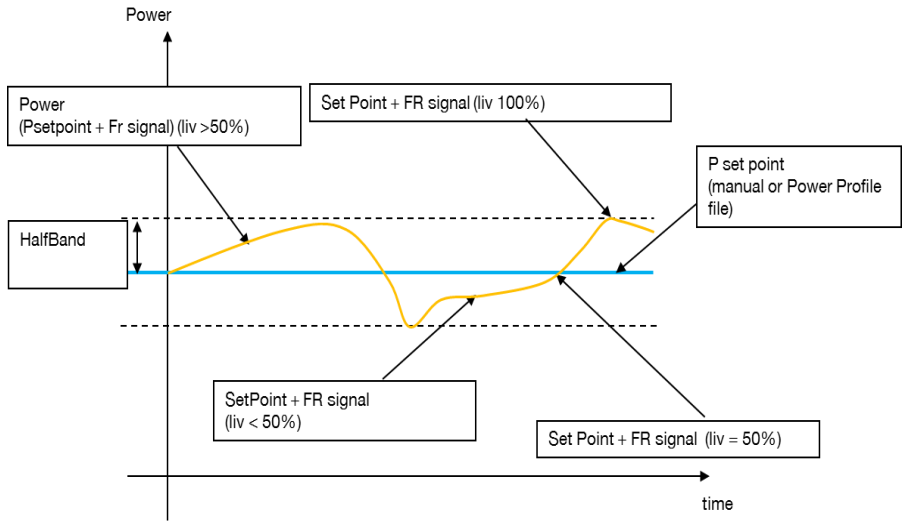
- MVRS provides **the reactive power availability of the virtual plant** at the interconnection with TSO, taking into account the single generators capabilities and the DSO grid constrains
- TSO can provide a **voltage** or a **reactive power setpoint** fitting with available capability considering the DG as a virtual plant
- MVRS receives a unique setpoint and splits the command among the DG taking into account the distribution grid constrains
- The plant receives the command through PCR (Plant Central Regulator) and provides its contribution.

MVRS functionalities

P/f regulation

- MVRS calculates the program and the half band available for the active power modulation at the interconnection point considering all the controllable DG and sends the values **of the virtual plant** to the TSO
- National regulator sends automatically an active power level signal every 4 s that is a percentage of the band
- MVRS receives the level and splits the command among the DG involved in the regulation

Ad hoc test with volunteer hydroelectric plants' owner connected at MV grid adopting ramps similar to the tests used for the participation of traditional plants in aFRR service

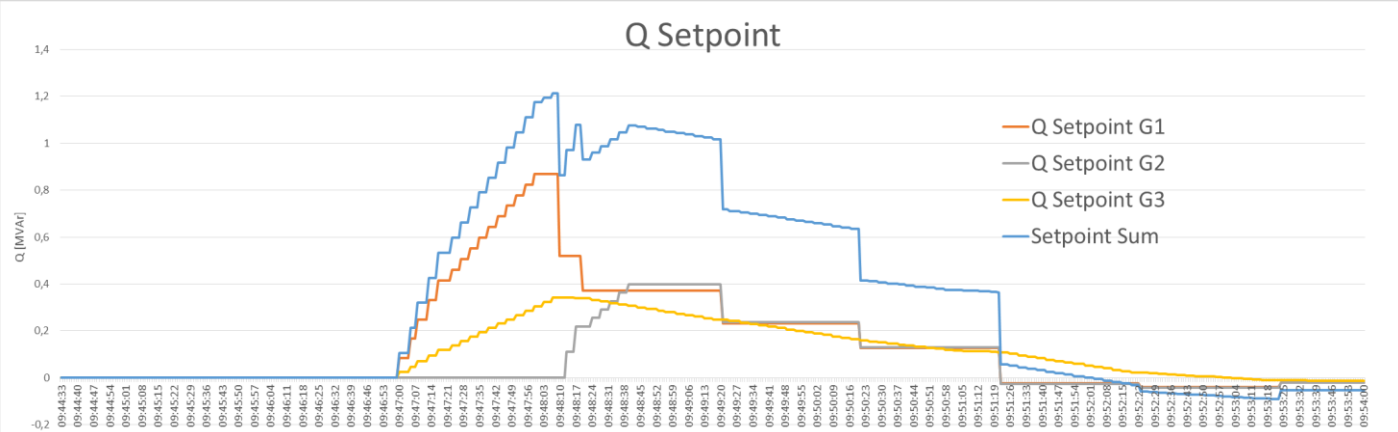


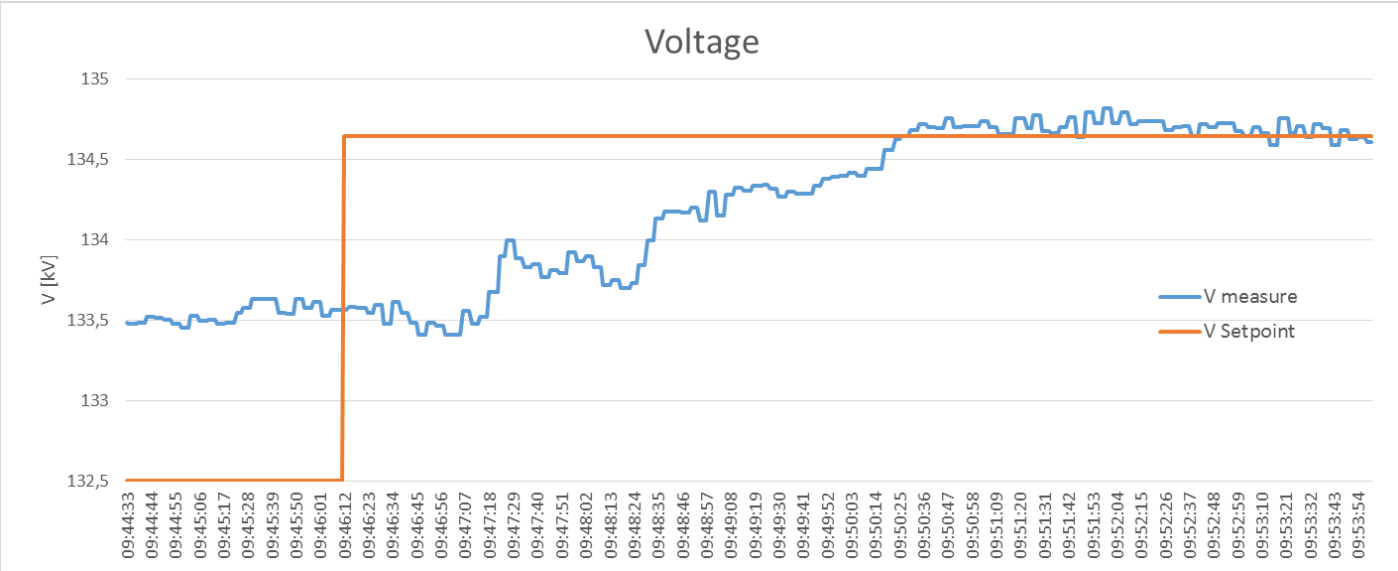
aFRR process is the power variation, around a program level, following a setpoint sent by the TSO.

Siemens HVRS Preliminary Results

HVRS – Voltage regulation results

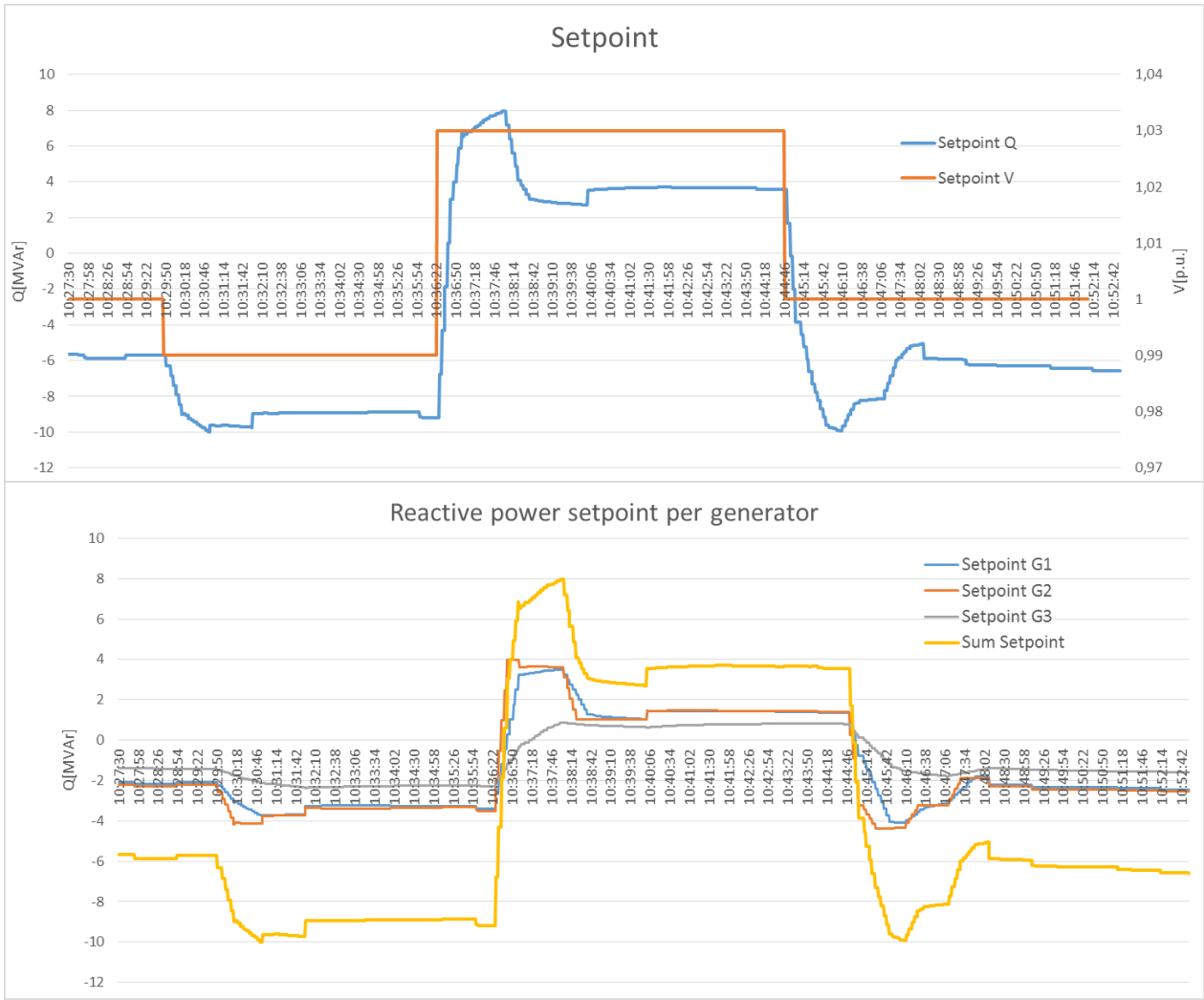
HV Busbar Voltage Regulation – Example #1





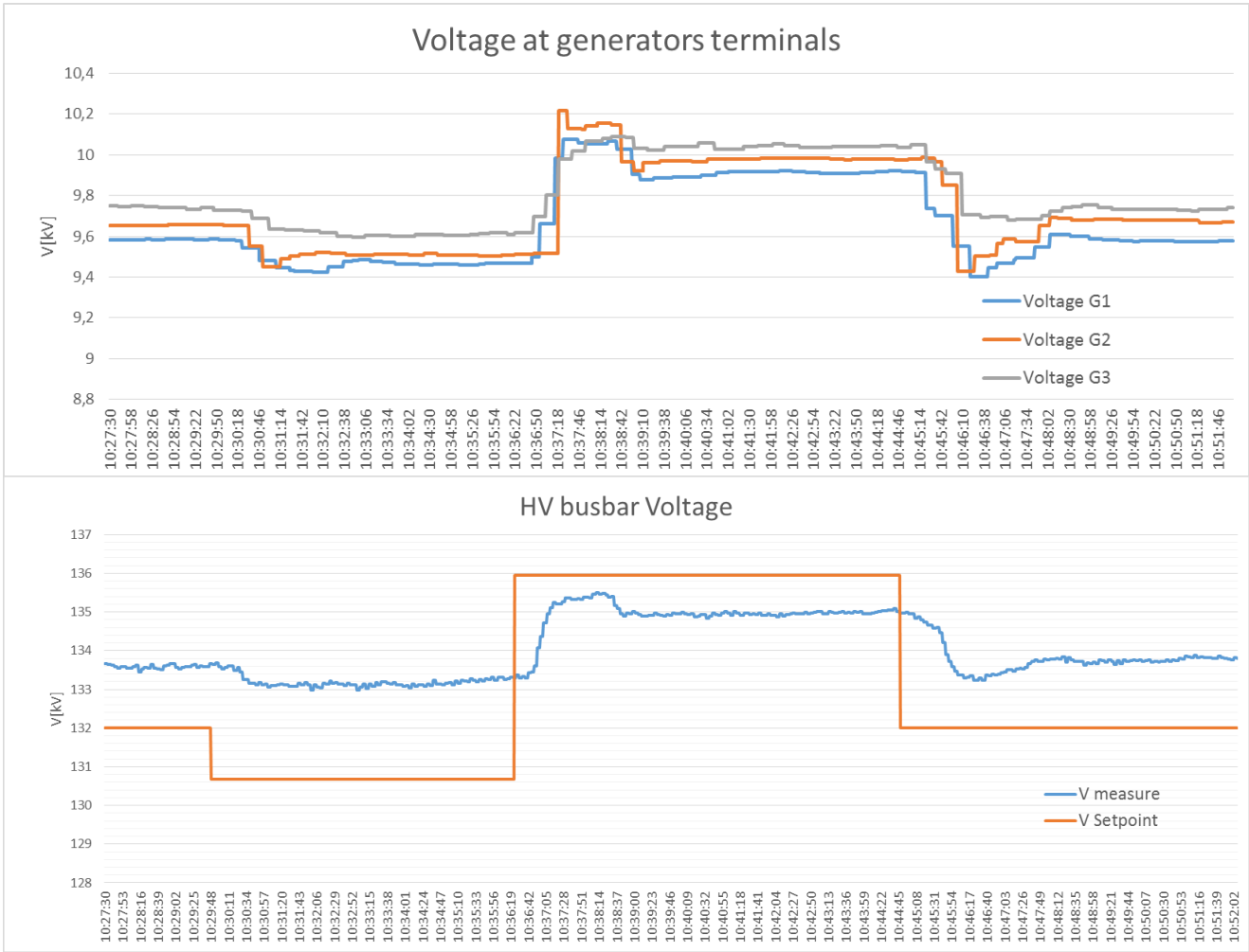
HVRS – Voltage regulation results

HV Busbar Voltage Regulation – Example #2

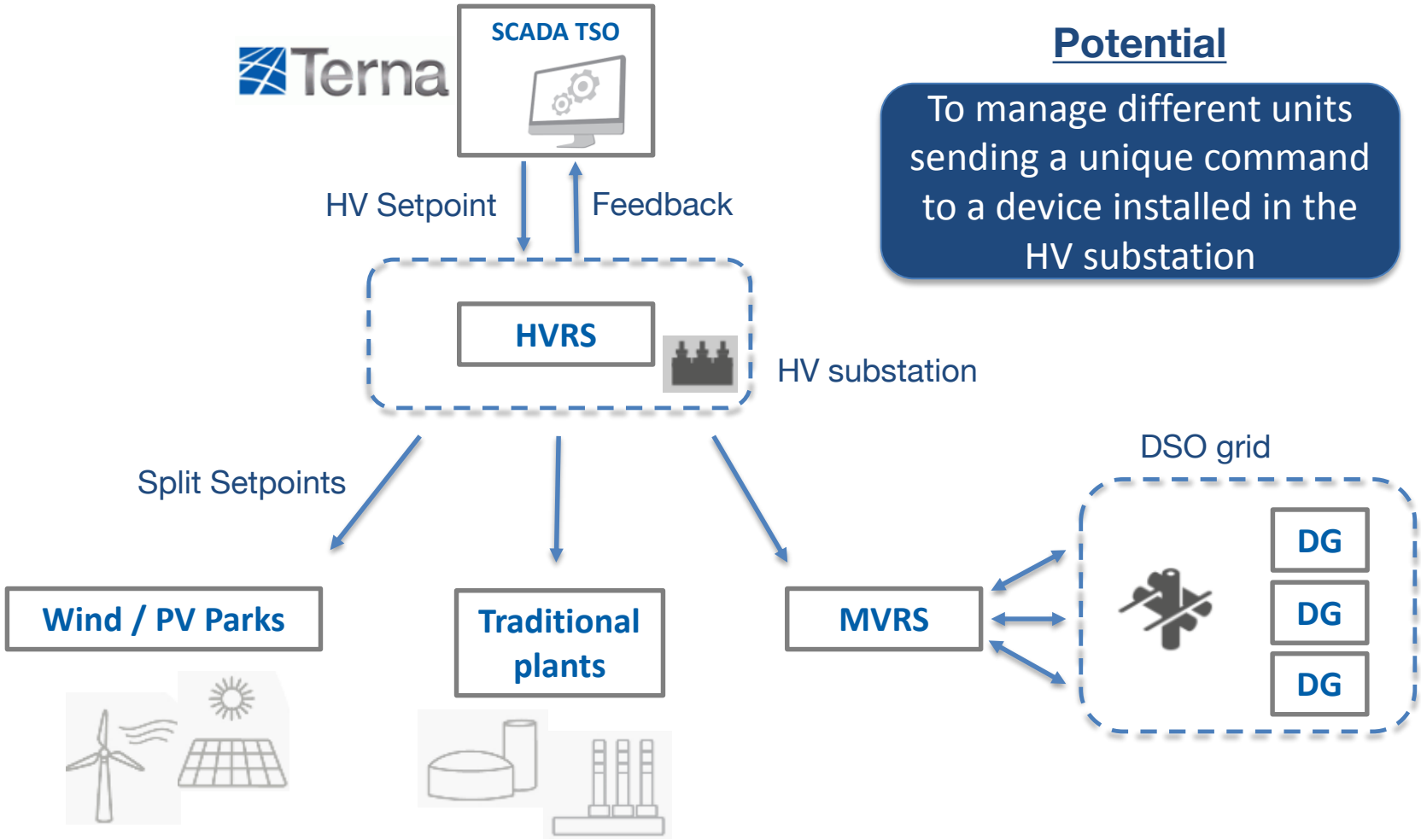


HVRS – Voltage regulation results

HV Busbar Voltage Regulation – Example #2



HVRS – Possible exploitation



Potential

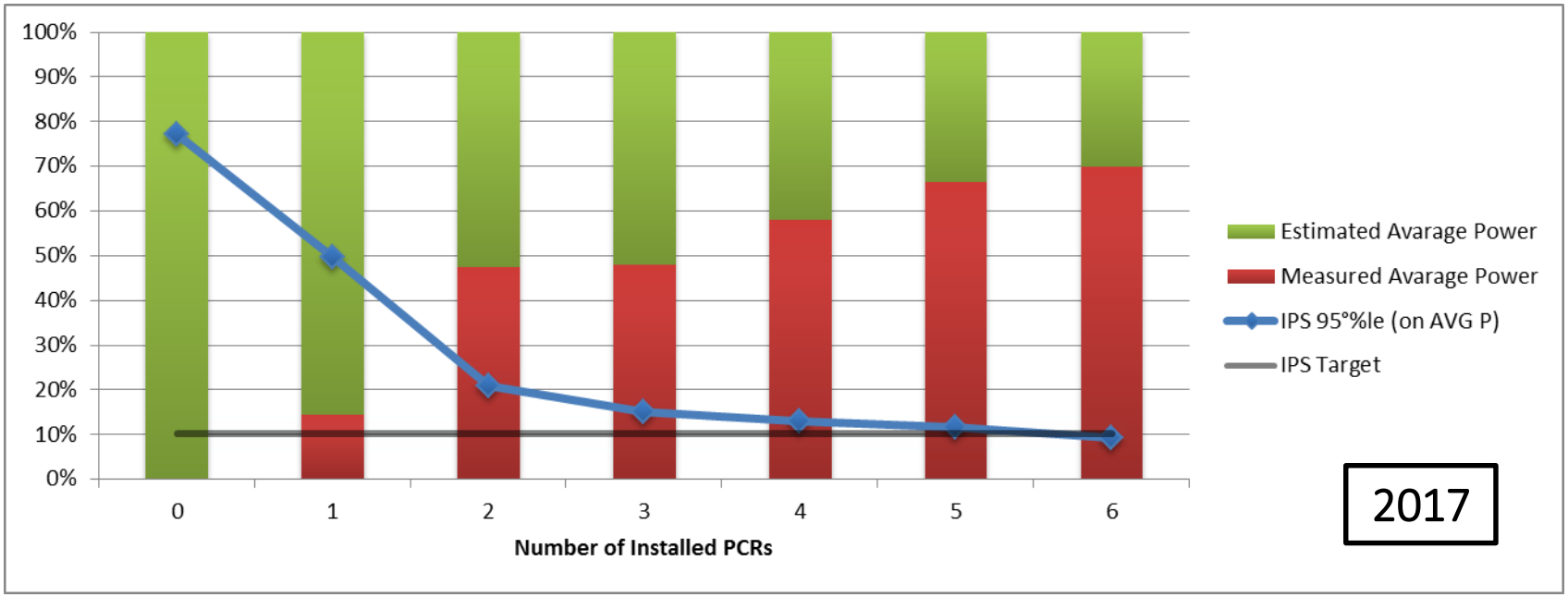
To manage different units sending a unique command to a device installed in the HV substation

Selta MVRS Preliminary Results

SELTA MVRS: Observability Module

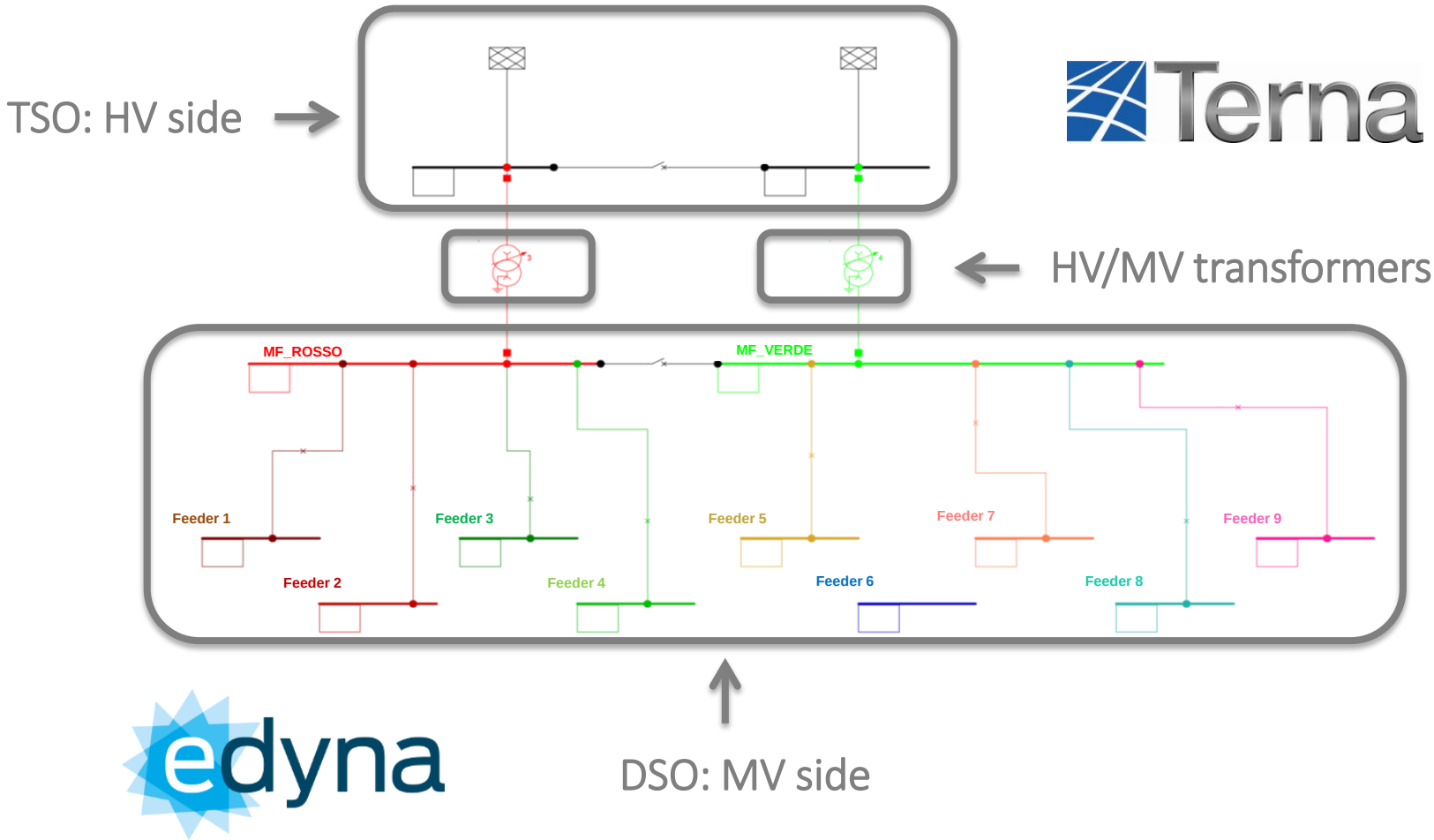
How many PCRs are they needed?

AGGREGATE DETAILS:		
Total Nominal Power	**26.140**	kW
Total Avarage Power	**9.829**	kW
Number of MV Plants	**19**	
Hydroelectric Plants	**17**	
Photovoltaic Plants	**1**	
Biomass Plants	**1**	

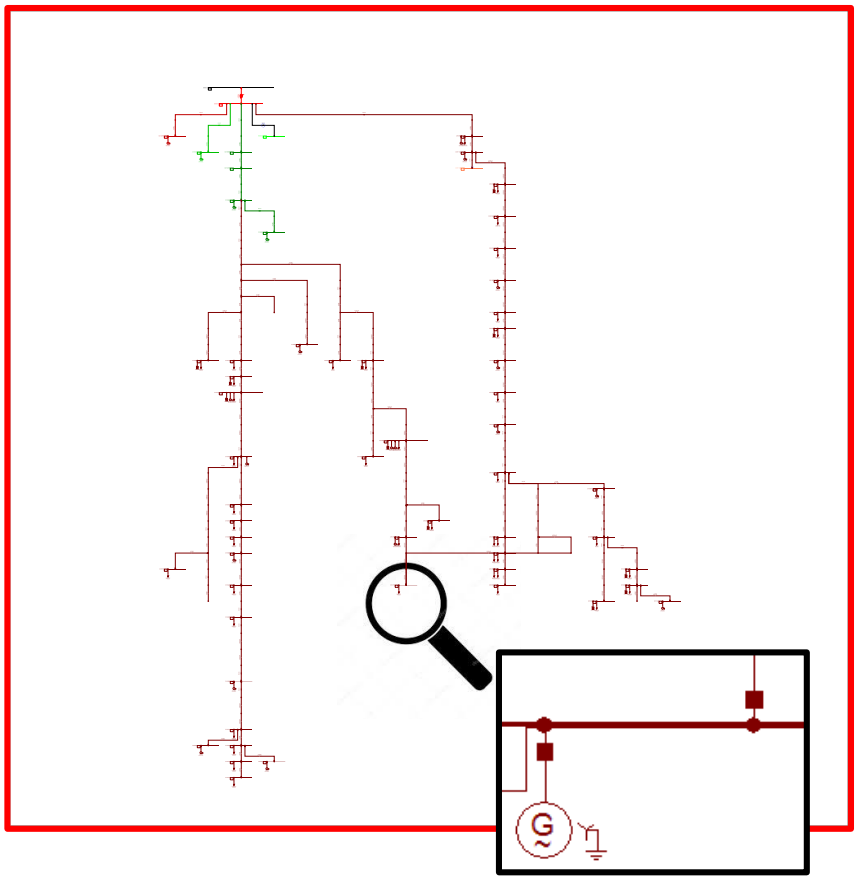


IPS Target = 10%

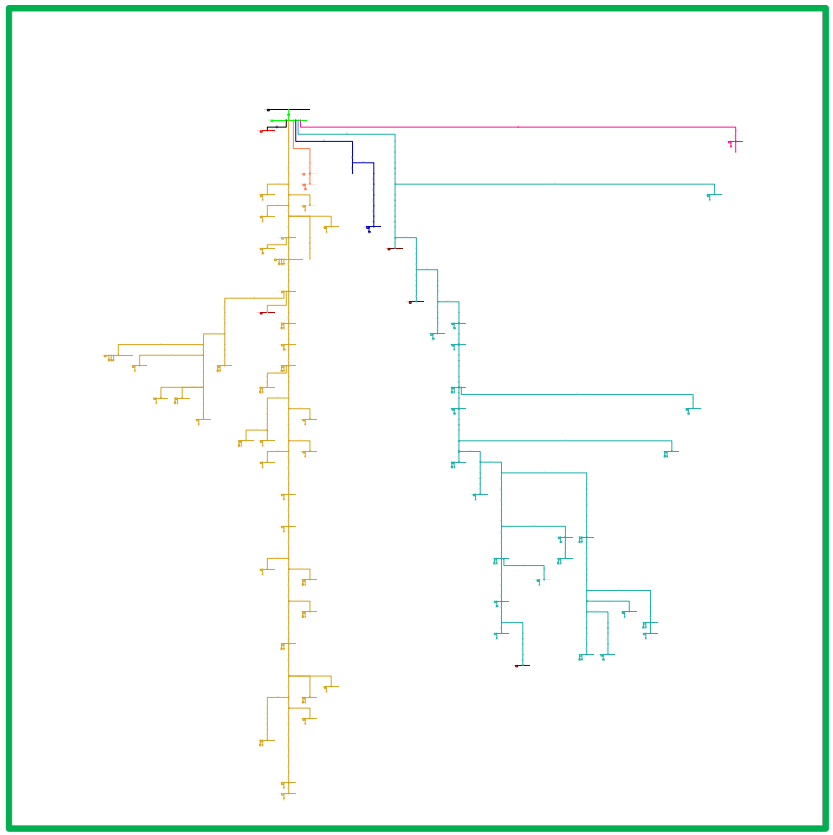
SELTA MVRS: Distribution State Estimation



SELTA MVRS: Distribution State Estimation



RED Macro Feeder

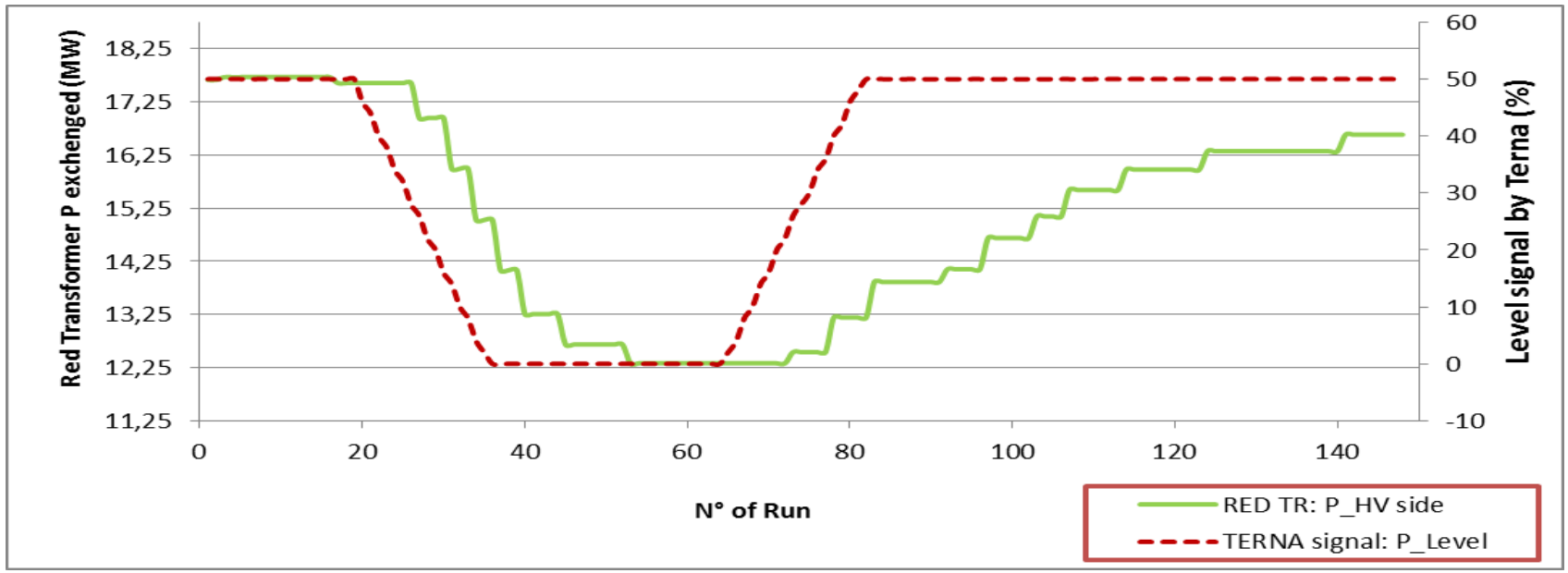


GREEN Macro Feeder

TEST 7/6/18

SELTA MVRS: Power/frequency regulation

- RED Transformer:
  - ✓ 2 controlled DGs (DG_R1 , DG_R2)
  - ✓ Total controlled Power = 5,9 MW



Each run corresponds to 5 ÷ 6 seconds

TEST 7/6/18

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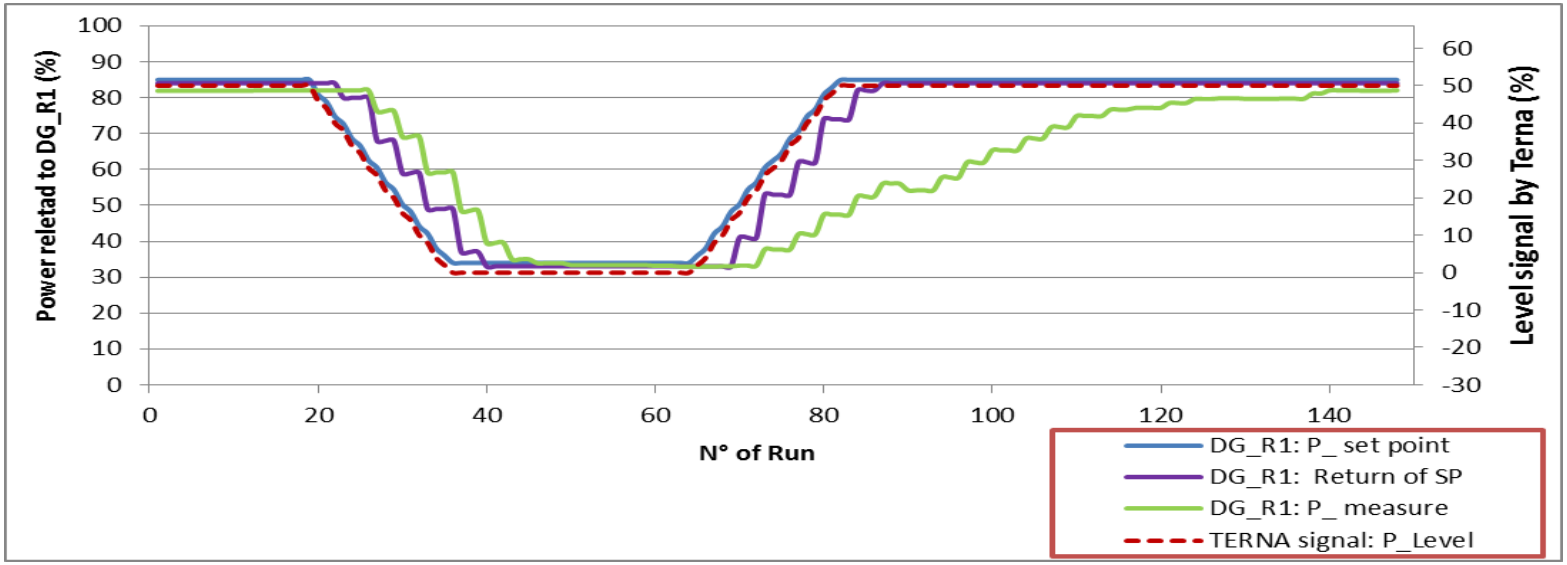
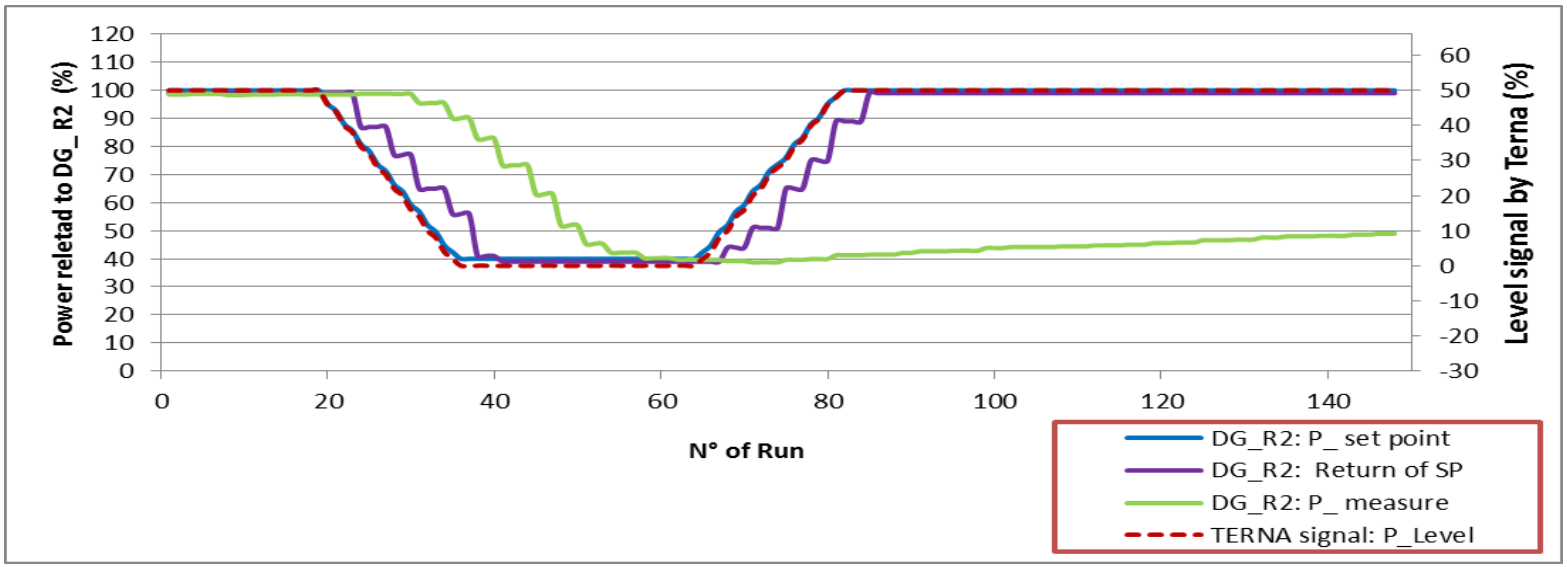
SELTA MVRS: Power/frequency regulation

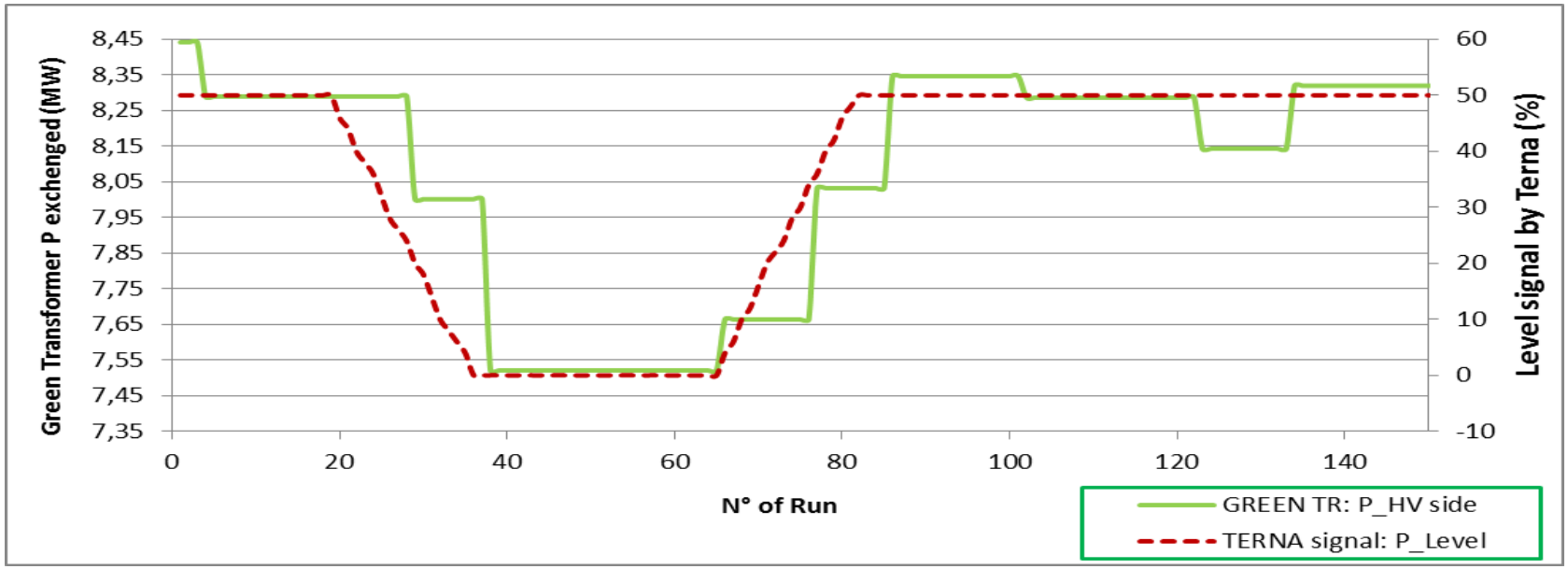




TEST 7/6/18

SELTA MVRS: Power/frequency regulation

- GREEN Transformer:
  - ✓ 1 controlled DG (DG_V1)
  - ✓ Total controlled Power = 0,9 MW



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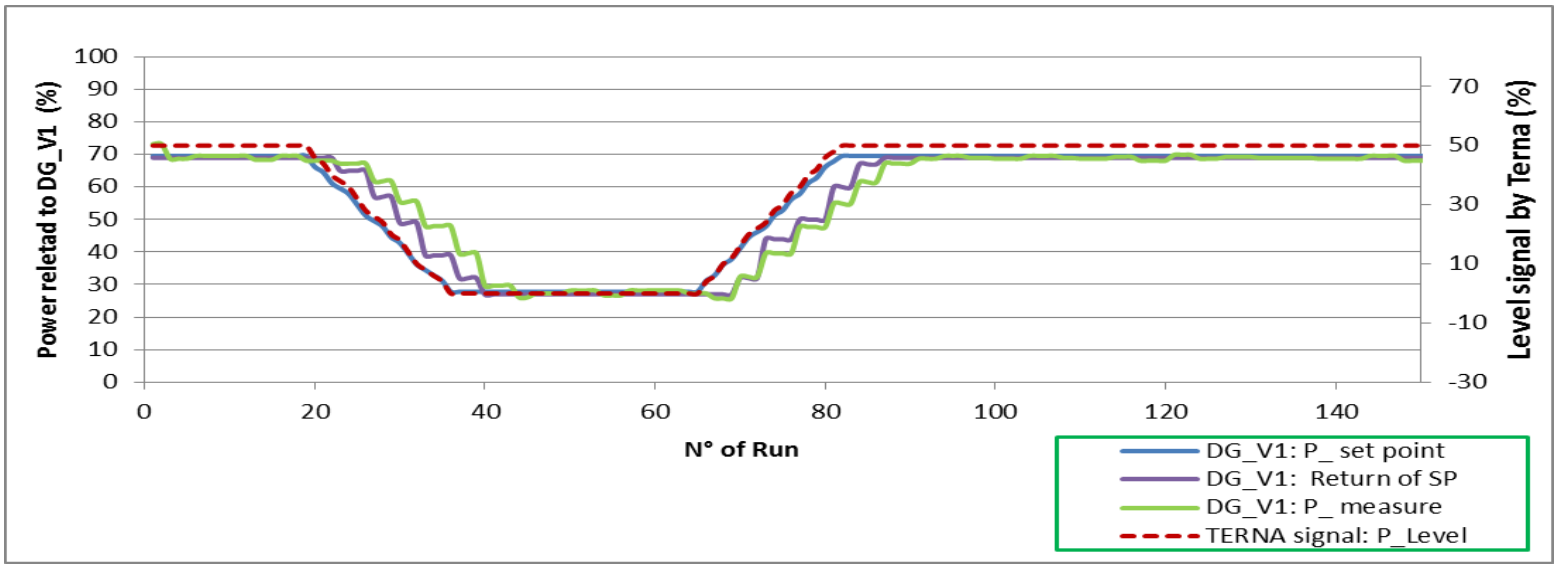
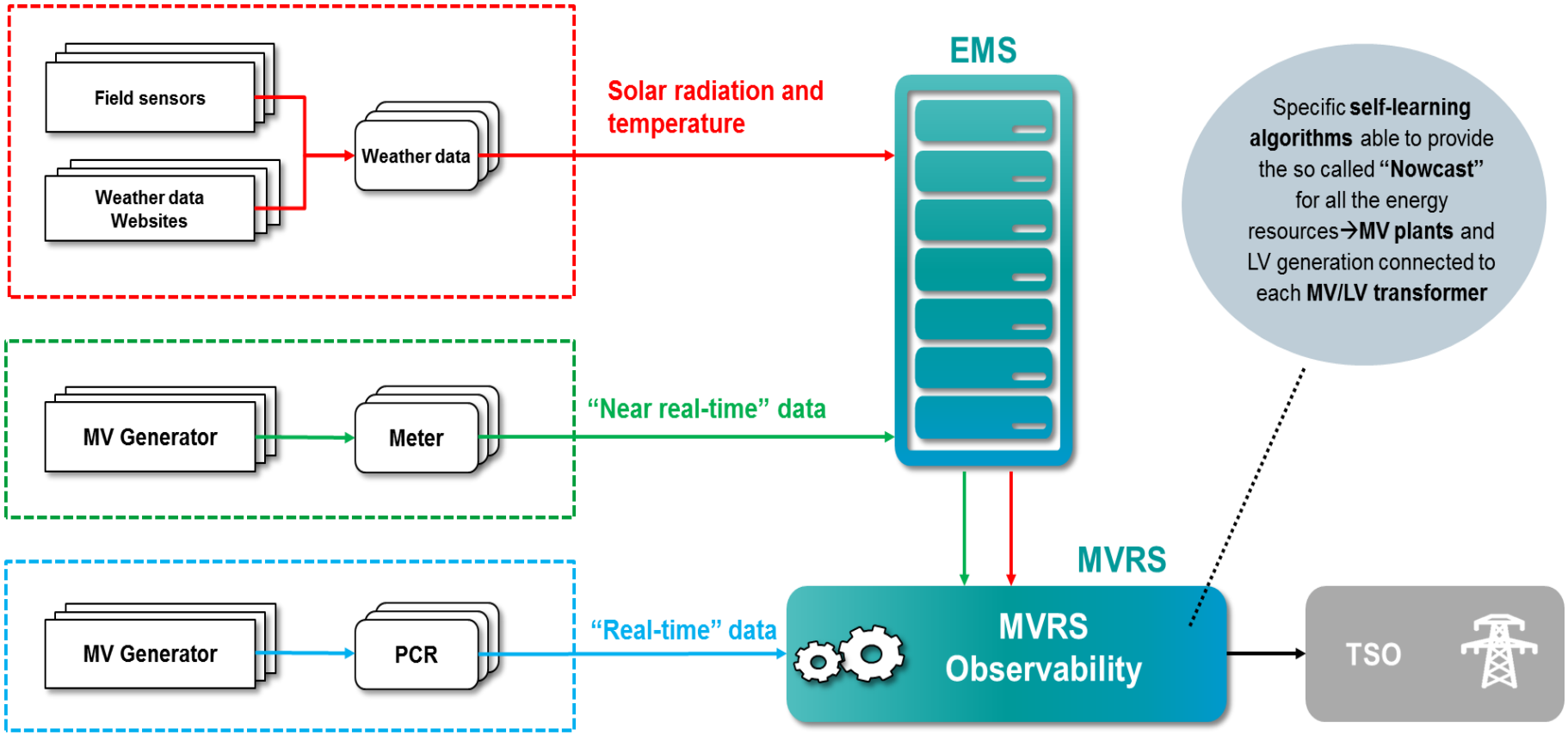


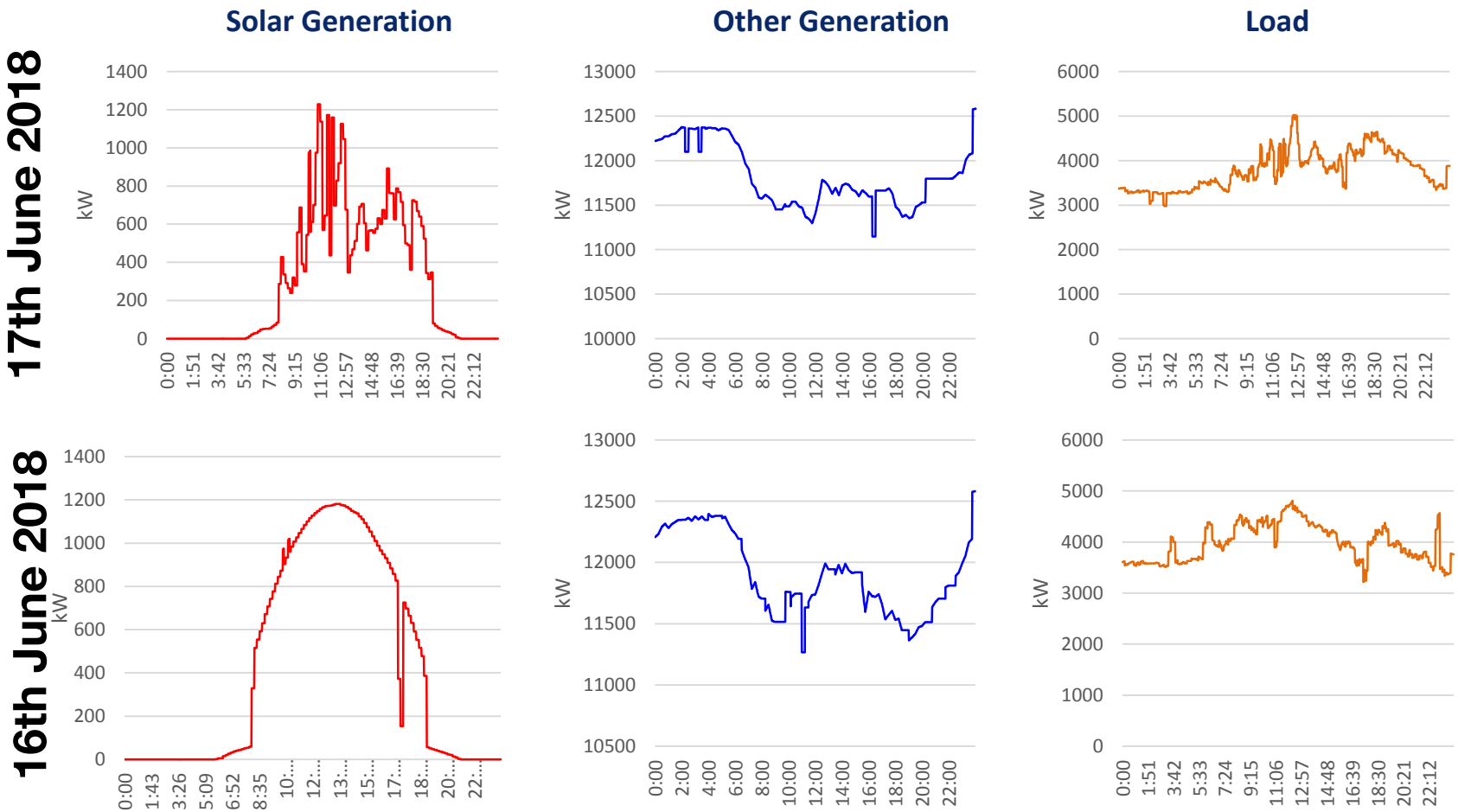
Siemens MVRS Preliminary Results

Observability function



Observability function

Preliminary results



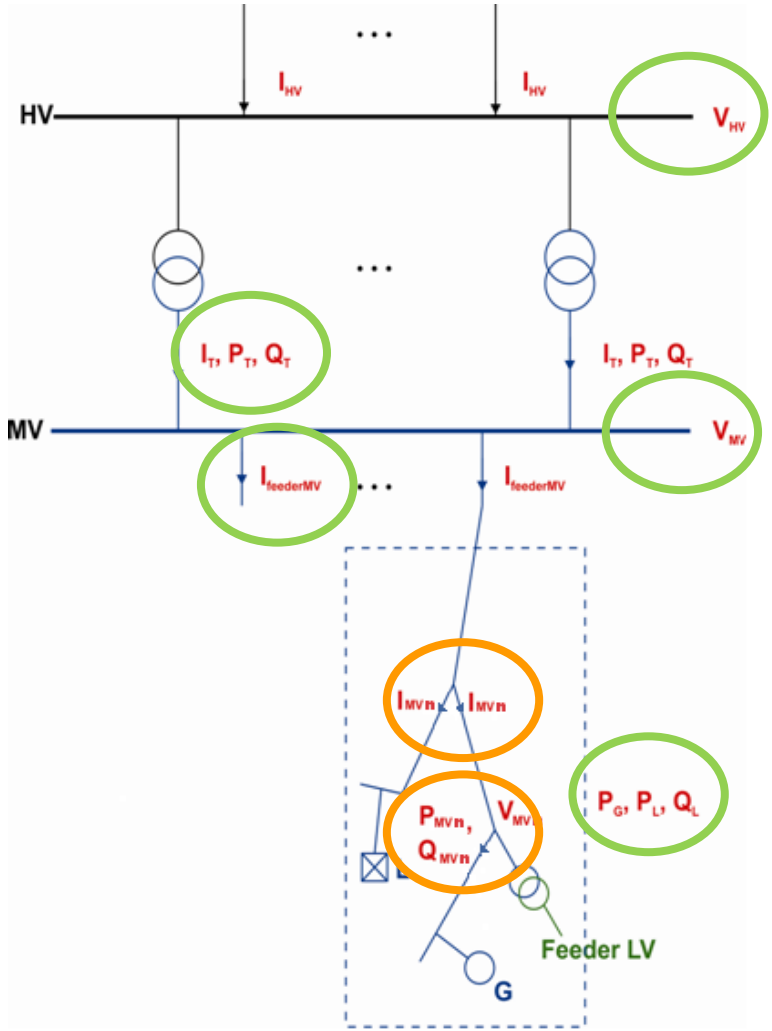
Capability & Voltage Regulation function

MV State Estimation

The **Complete State Estimation** algorithm uses:

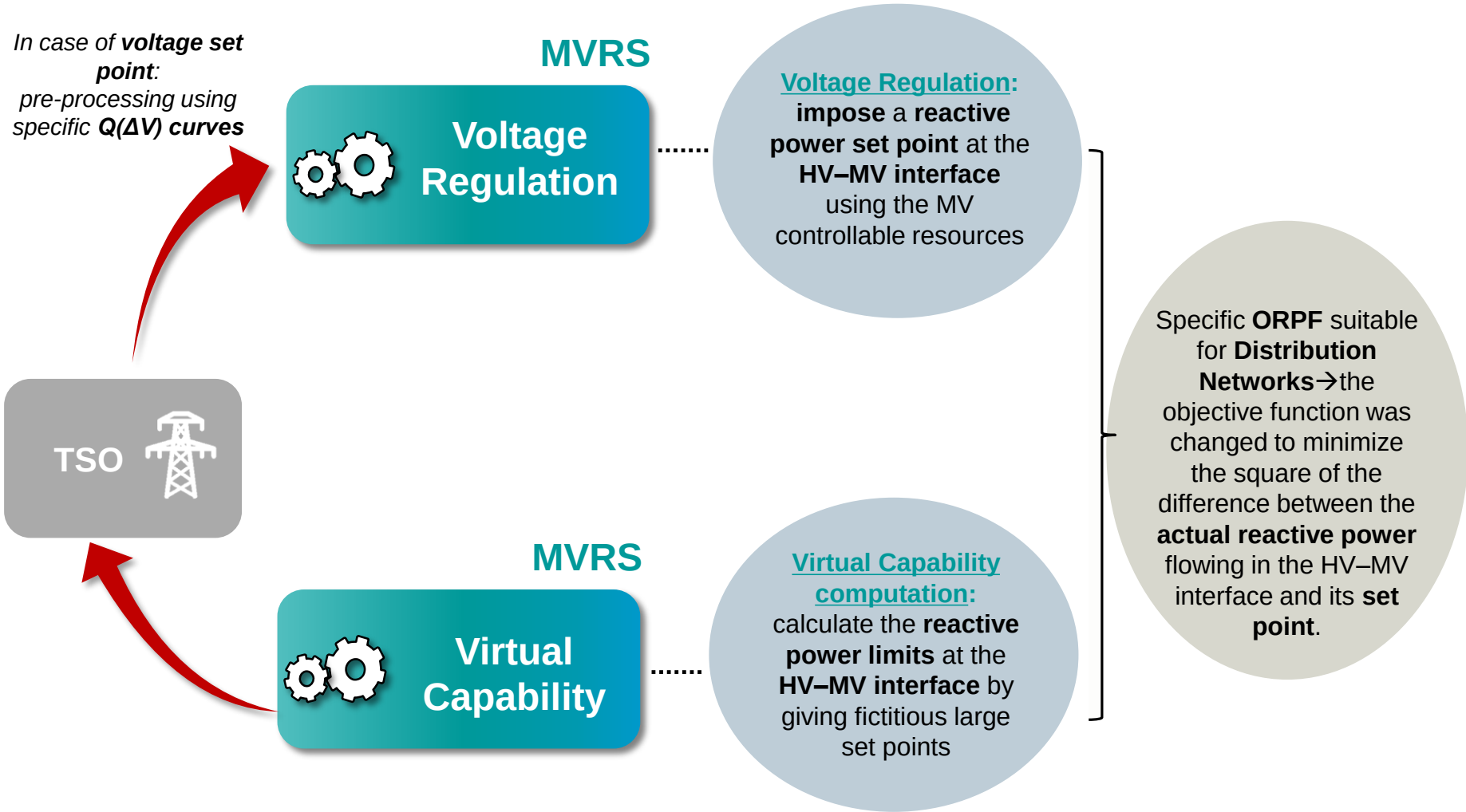
- V_{HV}
- I_T, P_T, Q_T
- V_{MV}, $I_{feederMV}$
- I_{MVn}, V_{MVn}, P_{MVn}, Q_{MVn}
- Load and generation data (P_G, Q_G, P_L, Q_L)→**<u>Nowcast</u>**

✓ I_{MVn}, V_{MVn}, P_{MVn}, Q_{MVn} are **real-time measurements** provided by smart devices (**PCR**) installed on the MV network



Capability & Voltage Regulation function

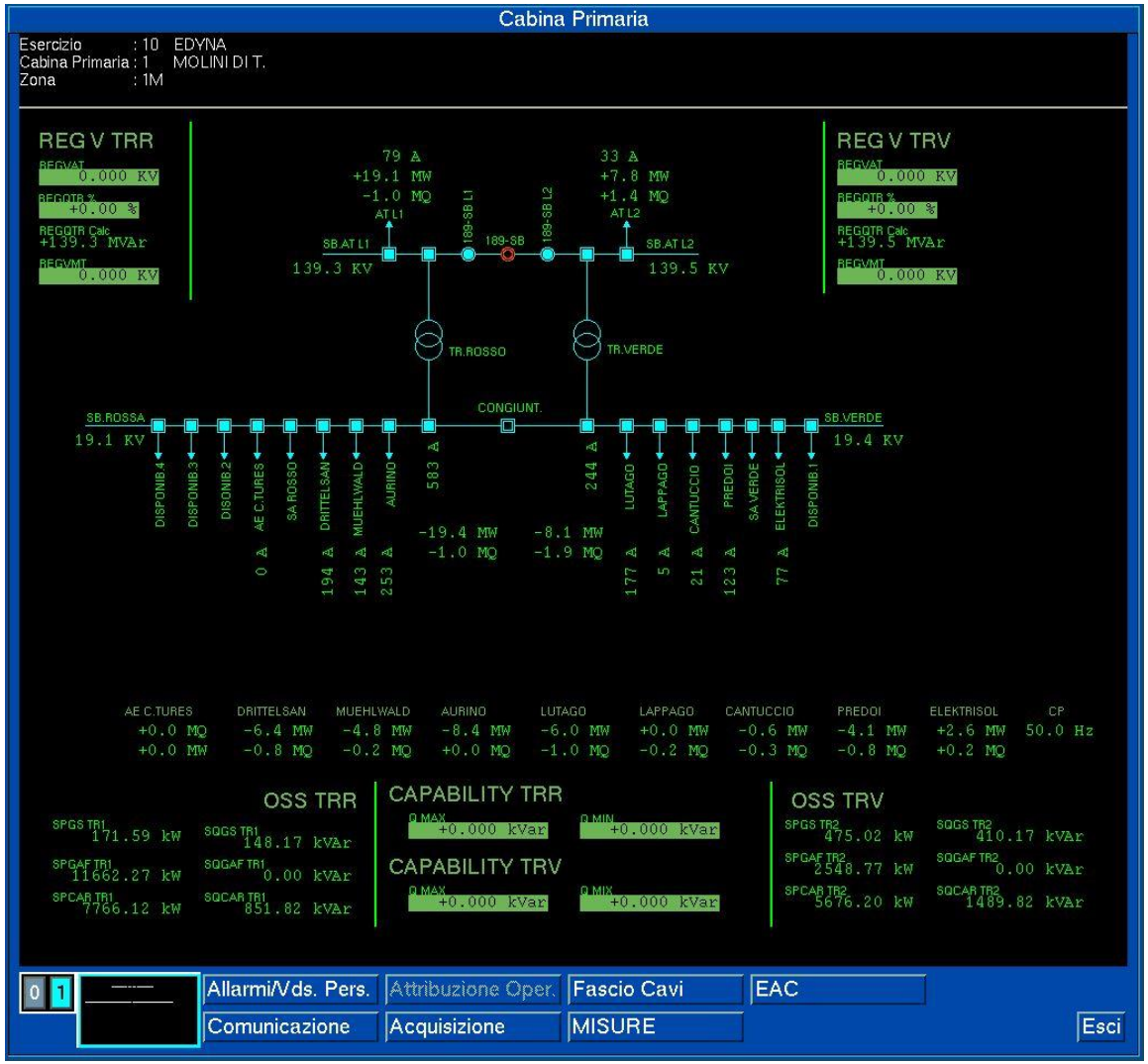
Control loop



Capability & Voltage Regulation function

Preliminary results

MVRS real-time operation



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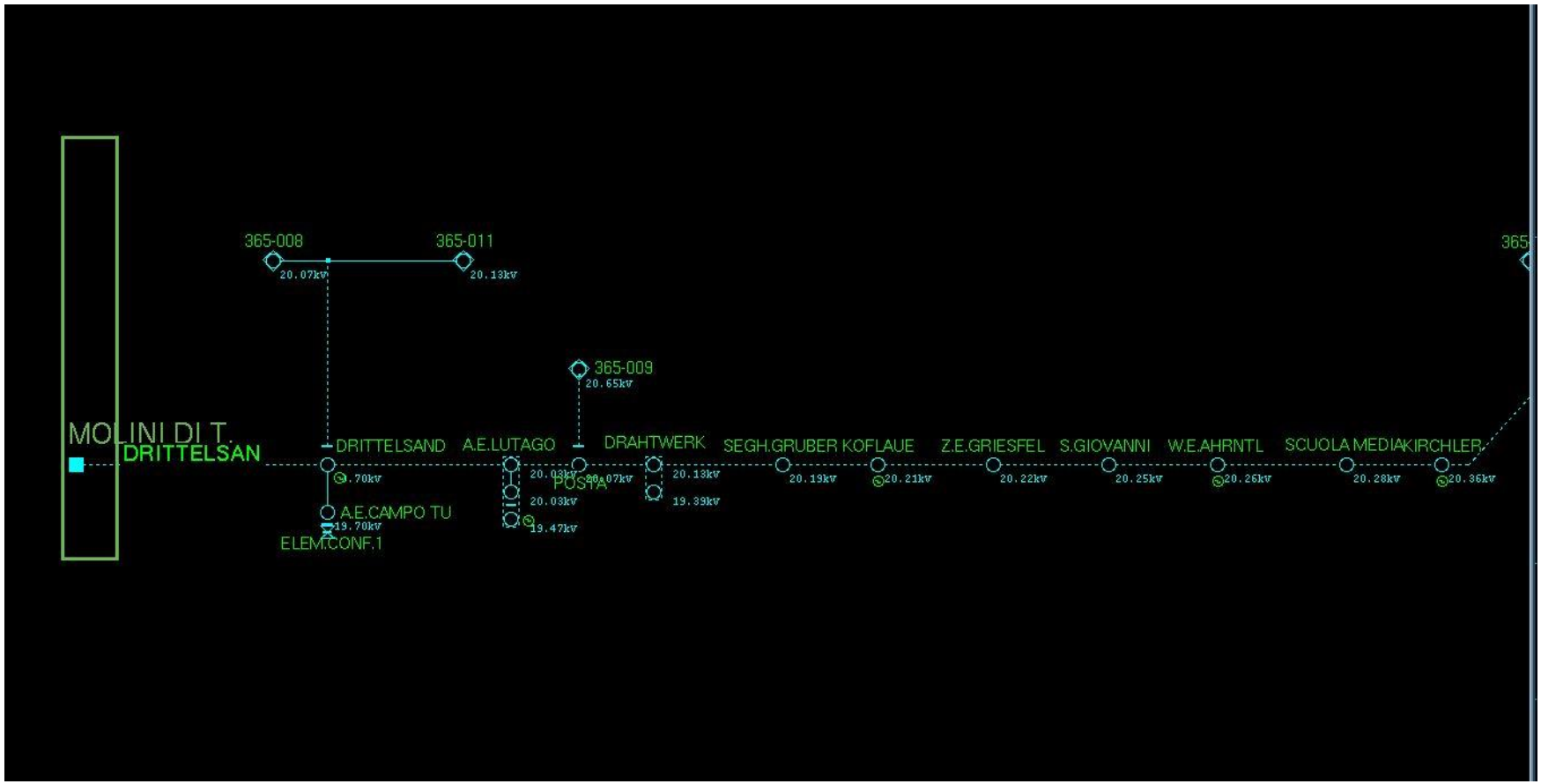
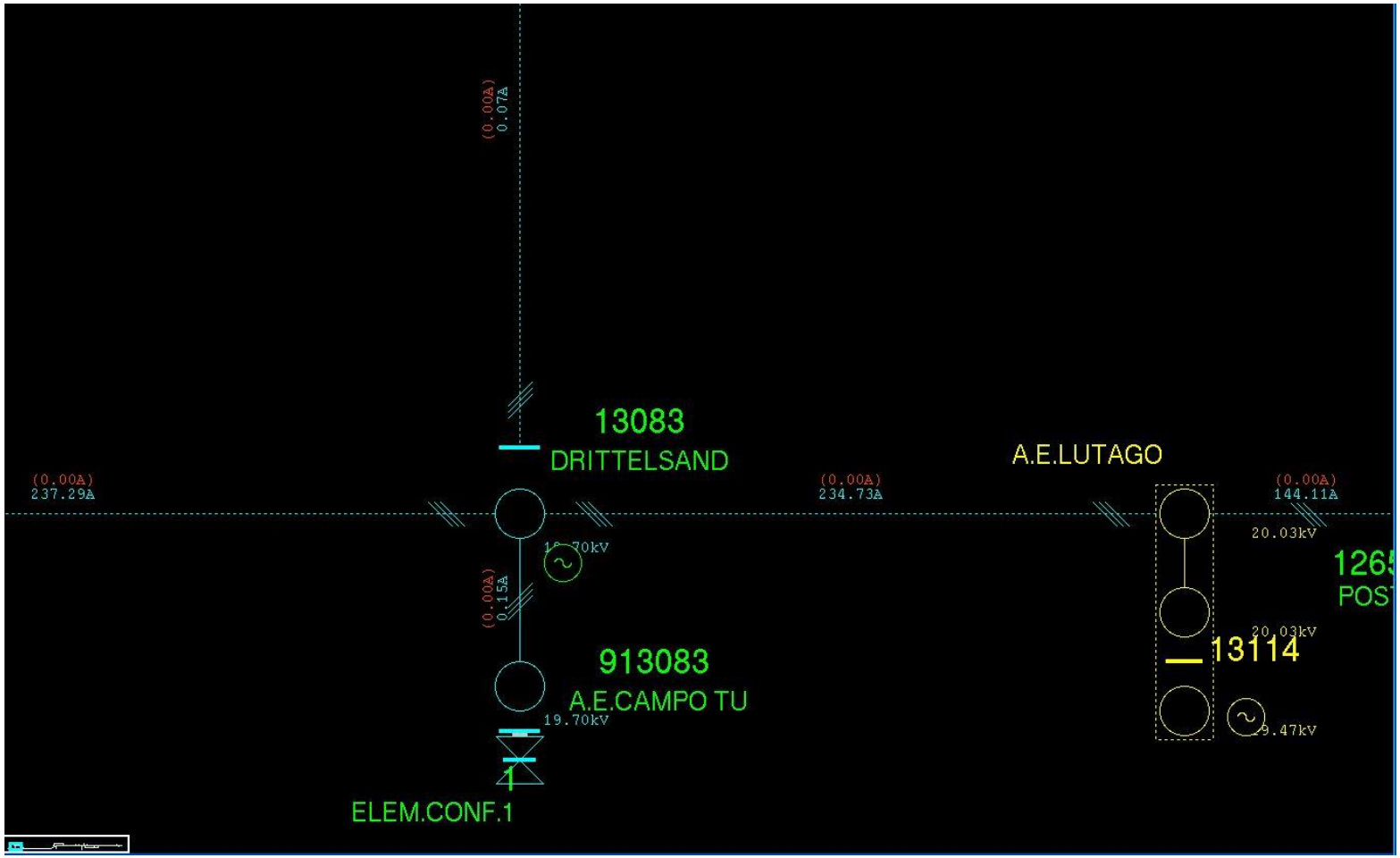
Preliminary results



MVRS real-time operation

Capability & Voltage Regulation function

Preliminary results



MVRS real-time operation

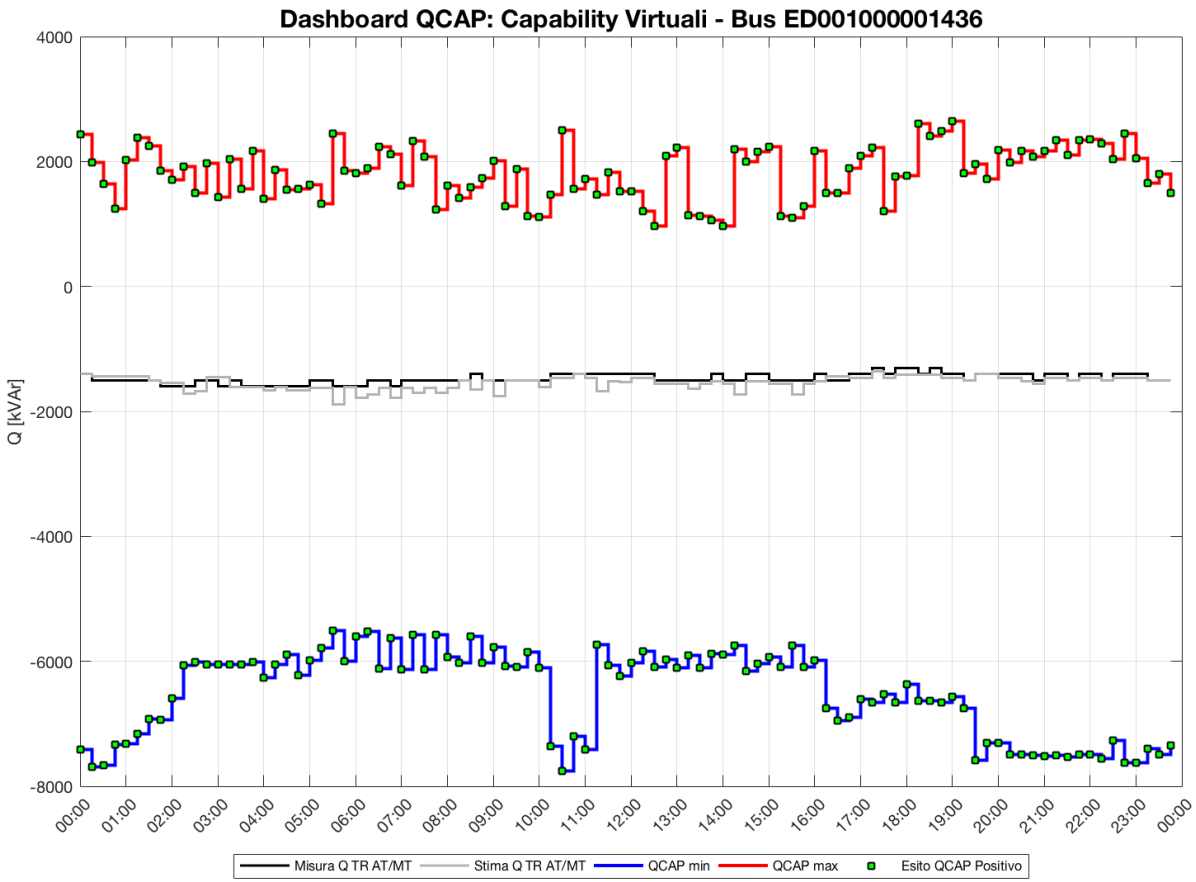
Capability & Voltage Regulation function

Preliminary results

Capability estimation

(17th of June)

Red Transformer



Capability & Voltage Regulation function

Preliminary results

Voltage Regulation

(17th of June)

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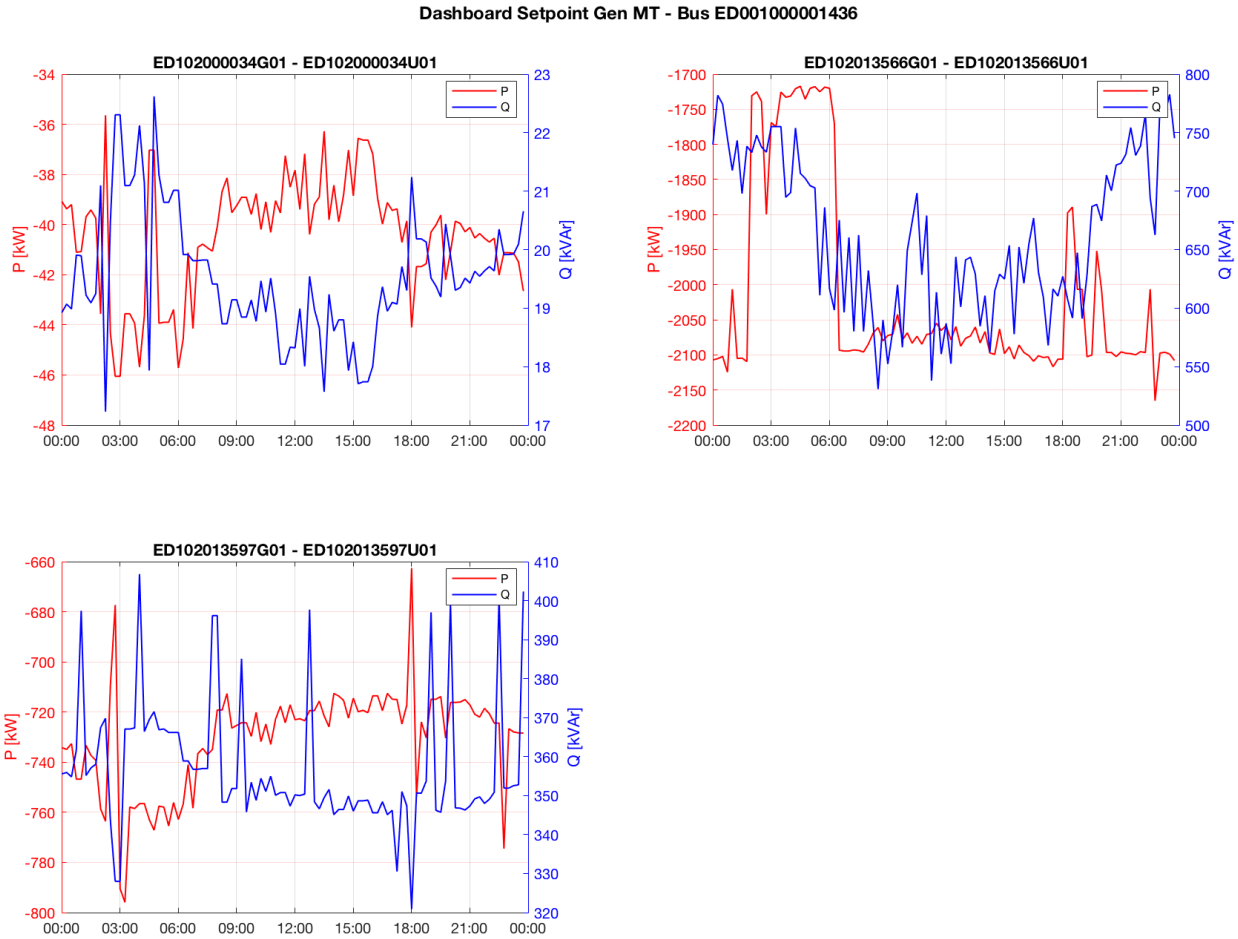

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Thank you for your kind attention!

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