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

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SUMMARY

The energy power systems are facing major challenges as fossil fuel generation is replaced with renewable generation, which is often characterised by variable behaviour. This increases the need for resources to be used to guarantee voltage and frequency stability, to deal with congestion management and to ensure the compliance with power quality standards. At the same time, there is an increasing number of local, small-sized generation, flexible demand and storage systems that are often located at distribution level. These resources could potentially be able to provide network services if they are aggregated effectively. However, to achieve this, the roles of the diverse network stakeholders – transmission systems operators (TSOs), distribution systems operators (DSOs) and aggregators – should be reshaped. In tandem with this, the way real-time electricity markets are organised also needs to be adapted to reflect the new operating paradigm.
The SmartNet project (http://smartnet-project.eu/) aims to investigate different solutions to optimise the coordination between TSOs and DSOs with the purpose of improving the grid monitoring and the participation of resource located in the distribution grid in ancillary services.
Within this project, three physical pilots are implemented in Italy, Denmark and Spain to determine new practical solutions.
The subject of this paper is the Italian pilot, realized by a consortium composed by RSE, Terna (TSO), local DSO Edyna, Siemens and Selta in order to develop, implement and test in field technological devices to demonstrate that a smart management of the entire electrical grid, with the coordination of all the actors involved, could help to face new challenges.
In particular, the interaction and the collaboration between TSO and DSO could improve the observability of the grid and allow investigating and defining needs, opportunities and feasibility to employ the potential contribution from all the resources connected in the transmission and distribution grid. In this way, the electrical system could be more flexible and more optimizable.

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In terms of technology, the Italian pilot project aims to implement new devices in order to improve the observability of the DSO's grid and to enable flexible generation to provide system services. In particular, the main functionalities regard:

- The acquisition of real time information about the operational state of the power plants located at distribution level
- The estimation of the production fed into the power grid by unmonitored plants
- The aggregation of real time data at the interconnection point MV/HV provided by the DSO to the TSO
- The voltage regulation by generators connected to HV and MV levels
- The power/frequency regulation (Automatic Frequency Restoration Reserve – aFRR) by generators connected to MV grid

The purpose of the present paper is to submit the achievements of the demonstration project realized in Italy during the first two years and to describe the ICT solutions developed by Siemens and Selta in order to fulfill the above functionalities.

KEYWORDS

Ancillary services markets, Observability, Voltage regulation, frequency/power regulation, distributed generation, DER, RES

INTRODUCTION

The Italian energy context, as the European one, is undergoing important changes. During the recent years there has been a rapid increase in the number of renewable energy sources also due to government incentives: 5,6 GW of wind power capacity and 18,5 GW of solar power capacity has been installed since 2008

An important consequence is the spread of generation units, in particular photovoltaic panels, located at distribution level. The energy framework is moving from a power park module characterized by few traditional plants connected to HV grid to an energy context composed by numerous small-sized generators spread at MV and LV levels. Only Italian photovoltaic installations amount to 50 traditional plants of 320 MW each, but located at distribution level.

This new configuration of the network can lead to reverse power flows: in case of local oversupply, when the amount of locally generated power exceed the local load, the active power can rise up from distribution grid to upper grid level. In the future, it could influence the voltage and frequency regulation also in the transmission grid.

Furthermore, due to the unpredictable nature of the renewable energy resources, a future increase of renewable penetration will lead the needs to improve the infrastructure for monitoring and control of MV and LV levels.

Within this context, the Italian pilot project of SmartNet aims to demonstrate the advantages of improving the observability of the grid and using the flexibility from Distribute Energy Resources (DER) and Renewable Energy Sources (RES) in the ancillary services; in the future both transmission system operators and distribution system operators could benefit from these types of flexibility.

With these opportunities, the technological partners, Siemens and Selta, have developed devices that are able to implement the functionalities necessary for the scope.

Siemens has realized the HVRS (High Voltage Regulation System) that implements the algorithms to perform the function of the reactive power information aggregation and to control the high voltage generation to achieve the voltage regulation.

Selta and Siemens have realized, with two different ICT solutions, the MVRS (Medium Voltage Regulation System), which aims to perform information aggregation and also to control the MV generation to achieve both the power/frequency and the voltage regulation.

This paper illustrates in details the architectures and the functionalities implemented.

THE GRID

In the following, the grid under investigation, where the SmartNet project has been realized, is briefly descripted.

The pilot is located in the area of Ahrntal valley, in South-Tyrol, alpine Italian region, at the border with the Austria (Figure 1 – left side).

The orography and the climate of this region has always been favourable for the exploitation of water power to product energy: the abundant winter snowfalls give rise to abundant and numerous water flows during the summer.

The choice of this location is due to the availability of several generating modules of different size connected to all levels of voltage.

On one hand, regarding the HV part of the project, the subject of study is the TSO HV substation, where due hyroelectric plants are directly connected to TSO’s grid (Molini and Lappago of 43 MW total).

On the other hand, part of the project involves the DSO grid. As indicated in Figure 1 (right side), the MV grid of this area is powered by the primary substation “Molini di Tures” of EDYNA characterized by 2 transformers HV/MV (132/20 kV) of 40 MVA each. There are 9 MV feeders outgoing from this substation: 3 of them feed distributed load at LV level (mainly domestic consumers, toursitic load and small-sized industry) and the other 6 are dedicated to MV producers or local DSOs.

For the characteristics of the area, these feeders are very long and without connections with others feeders; the same substation Molini di Tures has only one possible MV connection with another HV/MV substation (Brunico).

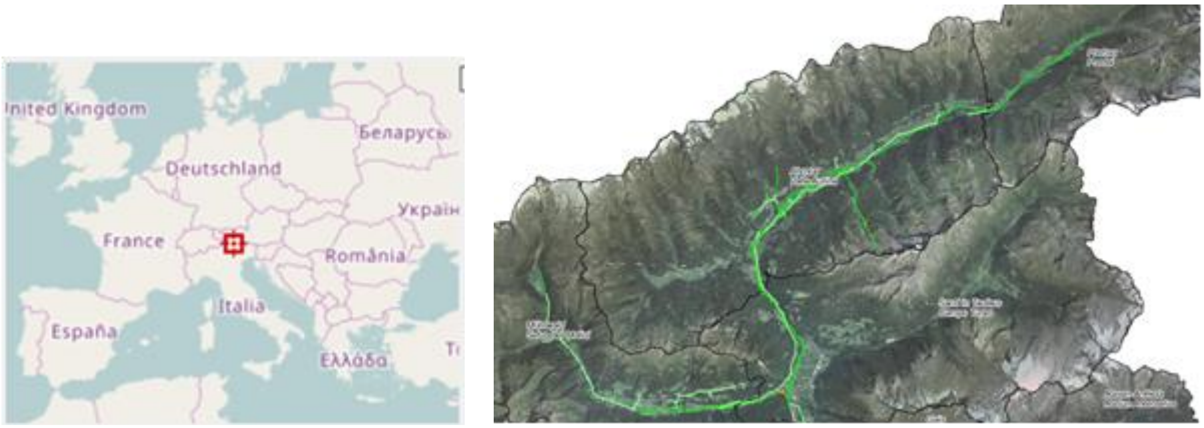

Figure 1 The Arnhtal valley in Europe (left side) and EDYNA MV grid of Molini di Tures (right side)

At the MV grid, there are connected 23 producers, with an installed power of 29 MW (27.7 flowing hydroelectric, 1.5 biothermic, 0.2 PV) and 5 local DSOs that are characterized by a small number of costumers fed by one or more hydroelectric plants. For this reason, these interconnection points with DSO grid are comparable to big prosumers with 17 MW of total power consumption in the interconnection points. There are also 0.85 MW of production in LV (0.73 PV).
The consequence of this installed production at MV and LV levels is that for almost the whole year in the interconnection point between TSO and DSO the power rise from MV to HV, with a peak higher than 30 MW in summer, as depicted in Figure 2 This characteristic makes this grid suitable to implement the project.

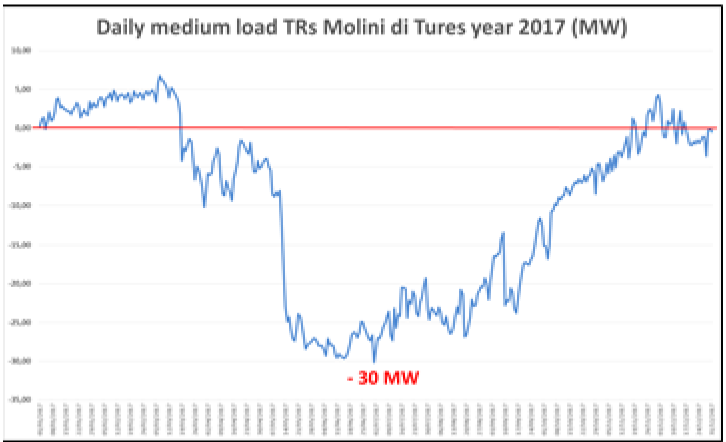

Figure 2 Average load in Molini di Tures (year 2017)

In order to realize the project, Selta has installed the Plant Central Regulator (PCR): all the 28 interconnection points are monitored by this device and 7 of the biggest hydroelectric plants, of 22 MW total, are also controlled by the PCRs to obtain the voltage and the frequency regulation.
PCR is an integral part of Selta's solution for DSO and it represents the most peripheral device in the communication chain. It plays an essential role for observability of the DSO grid, for the Voltage Regulation and power/frequency Regulation purposes. It allows the monitoring and the control functions of the MV DERs. Indeed, when PCR interfaces a controllable DER, it makes available the functions of reactive power and *cosphi* modulation in V Regulation and active power modulation in the P/f Regulation.
PCR can offer protocol or physical I/O interface modalities, according to the equipment of the interconnected plant. Furthermore PCR is able to adapt itself to plant configuration and, at the same time, it allows to monitor measurements from generators, storage systems, adjustable loads and from connection points on the grid. Its architecture integrates also 3G/4G, Distribution Line Carrier (DLC)

and optical fibre technologies, leading to a safe and reliable communication service. PCR is considered the prototype of Italian CCI (Controllore Centrale d'Impianto), promoted and required by CEI 0-16 to control and to measure DERs in MV grid. Furthermore it has already been tested in other practical applications and experiments. [12]

OBSERVABILITY

The widespread presence of non-programmable energy sources creates the opportunity to develop innovative strategies to increase the monitoring and the control of the grid. With this purpose, the Italian NRA's (ARERA) resolution 646/2015/R/eel [2] aims to promote the implementation of services to allow a reliable and effective management of distribution grids characterised by a high penetration of Distributed Generation (DG). It defines incentives in favour of DSOs to stimulate the investments focused on the observability of the DG (power flows and states). Within this resolution, the Authority has defined two types of MV observability functionalities, characterized by different level of complexity: OSS-1 to send to the TSO data e measures of the renewable generators and OSS-2, which requires a more complex architecture, to send also the estimated values of generation and load.

An important aspect of the observability is the aggregation function that consists of obtaining equivalents of the generation and the load on the HV/MV transformer: the real time information at the interconnection point between TSO and DSO are collected and aggregated by the DSO. The nodal equivalentation allows the TSO to have a better observability and transparent access to the underlying resources to ensure a safe use of this type of resources. In fact the possibility for the TSO to know the total amount of the generation, by type of energy source, and of the load at the HV/MV substation at all times allow the TSO to have:

- Better perception of the production location and the actual load supplied
- Better knowledge of the actual absorption to restore the service after the disconnection at the station
- Better assess the N-1 security of the grid
- Better realize dynamic evaluation to individuate critical constrains
- Better manage the Defence System

The data transmitted by the DSO to the TSO are:

- Total generation power installed differentiated by source, i.e. PV, rotating machine etc.
- Total load, understood as gross amount of load compensated by distributed generation
- Real time values of the active and reactive power flows every 20 seconds, differentiated by load and generation source.

The first goal of the Italian pilot is the development of the functionality to obtain an accurate observation of the MV an LV sources real time.

MVRS represents the application software that, together with SCADA system, constitutes the Advanced Distribution Management System (ADMS) solution for Smart Grids. Therefore, MVRS is considered as added value for a traditional SCADA system, especially for electrical grid characterised by the presence of Distribute Energy Resources (DERs). A key point of the overall system is that MVRS can manage whatever kind of energy source (renewable energy resources, storage systems, adjustable loads) and it is extremely flexible to the grid configuration. ADMS obtains real time field information via multiple stack interactions (IEC-61860, IEC 6870-5-104, Web Services, IOT systems). In this innovative solution, the communication between MVRS and SCADA takes place through tele-control protocols and inter-process communication solutions, by allowing technological distributed architectures.

Acquisition of measurements, collection of nominal data, estimation about DERs power (now cast and forecast), grid reconfiguration and aggregation of information are the main tasks of the observability module, implemented by real time processes. Powers, voltages and weather data are just some examples of exchanged variables used for the observability of the Distribution grid.

Aggregation of real time information is based on power measurements from the field along with power estimations. The final result wants to be the creation of power aggregates, divided according to

energy source, referring to distributed resources available in the part of grid under examination. For the purpose of responding to ARERA resolution 646/2015/R/eel, the aggregation is composed and sent to the TSO every 20 seconds.
Estimation of power generation is necessary for the unmonitored MV DERs and for the whole LV production, whose measure is usually not available in real time for technical and economic reasons. Because of nature of renewable energy sources, appropriate methods have to been carried out for power estimation.
In the following, we will describe in detail the two different approaches developed by Siemens and Selta in order to compute estimations based on a limited set of measurements on the network.

The Selta now-cast estimation algorithm is based on the concept of Sentinel Measurements (SMs). The SMs can consist of real time power measurements related to plants monitored by PCRs, of historical power profiles acquired by energy meters or of real time weather data (e.g. solar radiation, air temperature or river flow). Taking into account the historical data, it's possible to calculate the correlation coefficients between the unmonitored DER and the SMs. This off-line evaluation allows to find out the relationship between neighbouring plants of the same energy resources (e.g. hydroelectric generators) and to assess the impact of weather variables (in particular for the PV plants). Therefore, the best SMs (3 SMs in practical applications) are selected for each unmonitored DER and appropriate weights are generated.
In order to follow the seasonality of the power generation, for each month the set of SMs is updated and the correlation coefficients are evaluated. The real time estimation of DER power amount is based on the weighted average of the selected SMs, correlated by the respective coefficient.
A different approach is carried out as regards the estimation of reactive power exchanged by the unmonitored plants. Considering the historical metering, the average value of *cosphi* is calculated for every generators. Therefore, the on-line evaluation of reactive power is computed as directly related to the estimation of active power through the corresponding *cosphi*.

The Siemens solution is based on an integrated architecture that is able to elaborate and combine non-homogenous raw data. To estimate the real and reactive power amount for each unmonitored MV plant and each MV/LV Secondary Substation transformer, the system is able to consider real-time weather data (solar radiation and temperature), "near real-time" data registered by energy meters for MV plants (on 15 minutes basis, originally used for billing purposes) and real-time data acquired by PCR.
The weather data are processed by a specific Siemens application based on a self-learning algorithm that, considering the geographical location and the physical characteristics of each plant, is able to provide the so called "nowcast" for all the PV plants connected to the DSO electrical network (MV plants and LV generation connected to each MV/LV transformer). All the other energy resources (i.e. non-renewable or hydroelectric) are estimated processing the combination of historical data and available "near real-time" data registered by energy meters. All the "nowcast" data is then transferred to the Siemens monitoring&control system that carries out the selection and combination of this data with the real-time measurements coming from the field (PCR) to obtain the aggregated real and reactive power (HV/MV transformer level) ready to be sent to the TSO.

In order to evaluate the aggregation functionality and assess the accuracy of the algorithms implemented, an ex post analysis evaluates the Estimation Precision Index (EPI): it relies on the comparison of monthly metering and the corresponding estimation. In particular, it's subject of study the determination of the amount of measures of monitored DER necessary in order to obtain the requested accuracy

VOLTAGE REGULATION

Another consequence of the growth of the importance of the renewable generation and of the small-size plants connected to distribution grids is the necessity of an improvement of the reactive power management.

The ARERA resolution 300/2017/r/eel [3] is an important step in this direction because it proposes to realize pilot project about modalities for the remuneration of ancillary services currently non-remunerated as the voltage regulation. The aim is to collect useful elements for the reform of the dispatching market.
For this reason, the project aims to preempt future evolution of the regulatory framework, with a view to a possible opening of the reactive power market, realizing devices able to modify the reactive production/absorption of the users controlled.
In detail, on one side, Siemens' HVRS has been installed in Terna's substation to control the reactive power of hydroelectric plants connected to HV grid, which currently are only involved in the primary voltage regulation.
On the other side, MVRS devices perform similar functions to manage the reactive power contribution of distributed plants at MV level; the purpose is to run the Primary Substation like a virtual generation plant able to exchange data and interact with the TSO like a traditional HV plant (VVP Virtual Power Plant). On the basis of the grid configuration and plant's conditions, they compute the virtual capability to determine the reactive availability and exercise control actions in order to comply the TSO's command.

HVRS voltage regulation [11]

The evolution of electric system scenario introduced above will benefice by the involvement of non-programmable renewable generating facilities in the operation of electric power system to maintain and, where possible, to increase the margins of security and reliability of transmission and distribution systems.
Today, only conventional large power plants are equipped with specific devices to participate at the hierarchical control voltage and one of the goals of the SmartNet project is to implement and test an innovative tool to enable the involvement of RES in dispatching function, such as photovoltaic plants, wind farms and small hydroelectric plants.
In SmarNet application, the HVRS device aims to smooth the voltage fluctuations measured in the 132 kV Molini di Tures substation by means of the reactive power exchanged by the two hydro power plants "Molini" and "Lappago", connected at this substation (two synchronous generators for each power plant). The HVRS cubicle is designed as a SAS (Substation Automation System) functional unit [10], so enabling an easy integration in the TSO substation automation architecture. The HVRS algorithm measures the HV busbar voltage and real power generation of the hydro plants and coordinates the reactive resources directly connected according to a control law that links the voltage error (namely the difference between the measured and optimal voltage) and generator reactive power contribution, (reactive power injected/absorbed, power factor or *tanphi*, as depicted in Figure 3.a, left side). The calculated set point is compliant with the generators capability charts, parametrized in the HVRS database and sent to the TSO. The busbar voltage/power factor control law must be robust with respect to all different operating points and resilient against contingencies and large perturbations: it represents an evolution of the regulation algorithm proposed in [11]. The proposed control law is depicted in Figure 3.b (right side): a continuous control centered in the voltage reference optimal set point (the sample value, 1.02 pu, can be remotely updated by the Terna EMS) and a cubic correlation between the voltage error and generators power factor is adopted. Such a control law can be changed parametrically: Figure 3.b depicts three different control laws, increasing the control effort moving from the violet to the blue one. In particular, the cubic correlation has been introduced to obtain a flexible control of the reactive resources.
The HVRS send to each control system of the generators the reactive power set-point which is implemented by varying the voltage set-point of the generator in order to obtain the request amount of reactive power. The reactive power control loop is slower than the voltage control loop, and this allow to guarantee a fast response of the generator in case of sudden change in the network operation (e.g. short circuit).
The HVRS track the voltage error (the difference between the voltage set-point and voltage measurement); at first instance the generators will react to the voltage error and then the HVRS will send a reactive power setpoint proportional to the voltage error following the law described in the

diagram figure 3.b. The change of reactive power exchange of Molini di Tures and Lappago power plants make the error smaller and then a smaller requirement of reactive power variation will be send to the generators control systems of the power plants. If the needed reactive power exceed the available amount the request will not be augmented anymore. If it is not the case then the HVRS will allow with intermediate steps to reach the HV voltage setpoint with accuracy less or equal to the voltage error deadband.

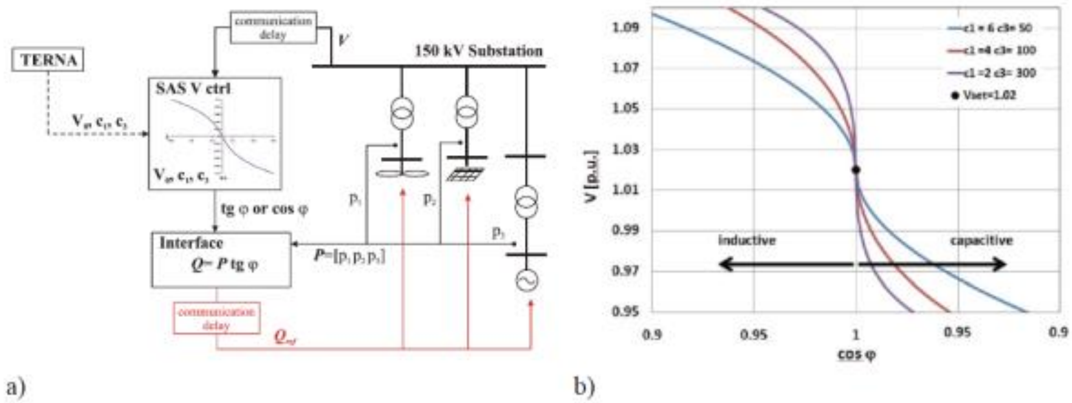

Figure 3 Proposed substation voltage control structure (left side) and control law (right side)

On a higher level, the TSO could adopt the proposed architecture to control the subtransmission network; as a matter of fact, the TSO should define, for each SAS, a voltage set point and a regulation “strength” (i.e., a control law) in order to coordinate a large number of RES generators by means of few signals. In operational terms, on the basis of the operational state of the plants, the HVRS is able to supply to the TSO the current availability of reactive power and to split the command amongst the controlled generators in order to obtain a homogenous division of the efforts and avoid undue reactive power flows between providers in the same electrical area.
In Figure 4 the HVRS main HMI is represented: in the upper part the regulation parameters are summarized, while the orange boxes resume the regulation operating status and the calculated set point. The single line diagram of Molini di Tures substation is then reported, together with the active/reactive power and voltage measures.

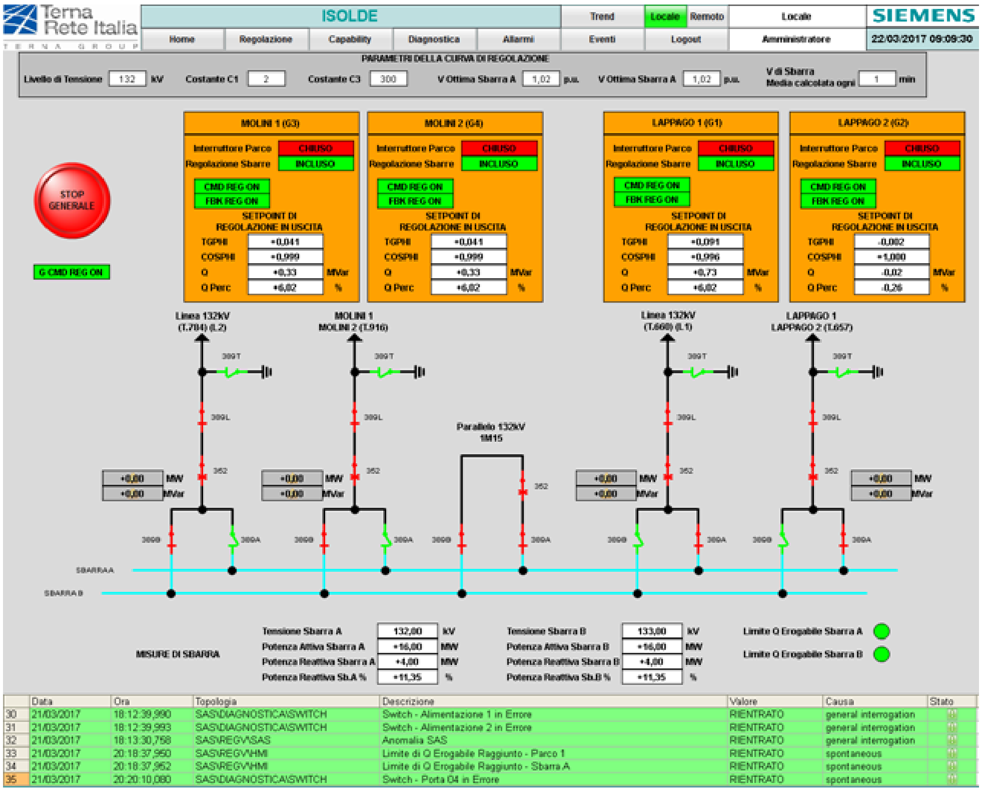

Figure 4 Main HMI of HVRS device

MVRS voltage regulation

In order to further increase the amount of reactive power reserve, for the benefit of DSO and/or TSO, SmartNet project aims also to involve DG in the voltage regulation ancillary service.
With this purpose, the second functionality implemented in the MVRS is the voltage regulation through units connected at distribution level which define the Virtual Power Plant (VPP): the task of the Advanced DMS is to realize a control loop to fulfill the TSO set points on the TSO-DSO interconnection point (HV busbar voltage set point or reactive power set point). The entire control process takes into account primarily all the technical constraints on the DSO network: in fact it defines the reactive power dynamic capability considering under and over excitation limits dictated by DSO's grid constrains and then it realizes the TSO set points in order to solve/avoid violations on the MV network. For these purposes, the Advanced DMS considers both the regulation of the HV/MV transformer On Load Tap Changer (OLTC) and the DERs reactive power.
In this paragraph, two technical solutions, implemented by Siemens and Selta, will be described.

Voltage Regulation, implemented by Selta, works with a continuous time constant cycle and it consists in a multi-stage algorithm. First step is characterized by the state estimation of the electrical parameters of the Distribution grid model, corresponding to the controlled portion. Measurements from SCADA, power estimations and load flow calculation contribute to the smart allocation of unmonitored loads, feeder by feeder. The on-line evaluation allows to check out the nodal voltages value at any time. Considering a normal operating range in ±5% of nominal voltage, second step includes the voltage regulation by OLTC and/or by DERs reactive power in order to fix possible nodal voltage violations in the MV grid. This preliminary regulation takes into account the DERs' sensitivity to the node in violation and it tries to avoid the misuse of OLTC. The specific calculated set points are sent to the involved controlled resources. Until the violation persists, VPP is declared unavailable to participate in the ancillary services requested from TSO.
If program does not detect any violations, the evaluation of VPP reactive power dynamic capability represents the next step. In this part of the algorithm, a series of load flow are run in order to evaluate the maximum available capability of the VPP in under and over excitation. The calculation includes checking of possible nodal voltage violations; where necessary the capability is reduced by DERs

sensitivity method. Reactive power virtual capability and operation point at the HV side of the transformer are sent to TSO, on the basis of set up and topology of the DSO network.
According to VPP capability, the TSO requires ancillary services to regulate high side voltage value at TSO/DSO grid interconnection point. MVRS can receive a percentage of reactive power referred to the last capability sent. In other cases, voltage set points are received and appropriate Q(ΔV) tables convert them in reactive power ones.
The goal of the regulation algorithm is chasing and keeping set point requested, adapting decisions to changing field conditions. Therefore, a smart splitting of reactive power set point is implemented according to single DERs capability. The MVRS closed loop control system finds a solution for the simulated model and the set points are sent towards MV DERs, available and controllable. This regulation step is repeated only after the real settling of the plants, working as external closed loop control.

The Siemens MVRS implements a control loop based on the evolution of some functionalities of the Siemens Smart Distribution Management System [4] [5]; in detail, to realize this SmartNet functionality there are three algorithms that provide the MV network State Estimation, the reactive power Virtual Capability and the Voltage Regulation.
In case of receiving from the TSO a voltage set point (for the Primary Substation HV busbar), the MVRS pre-processes the data using specific Q(ΔV) curves (implementing the same approach used in the Siemens HVRS); thanks to this elaboration, the Voltage Regulation algorithms are always run with a reactive power constraint assigned to each HV/MV transformer.
Regarding the State Estimation, this process represents the first step to manage the Distribution Network in real time, before taking any control action. In Distribution Networks the application of classical state estimation methods is impossible mainly due to the reduced number of available measurements and, hence, the lack of redundancy. Therefore, depending on the available measurement points various specially designed State Estimation techniques have been implemented: (i) simplified algorithms when only the primary substation measurements are available [6][7] and (ii) advanced algorithm when both primary and secondary substation measurements are available [8].
About the control step (Virtual Capability computation and Voltage Regulation), this part of the functionality aims to apply an imposed reactive power set point on the HV–MV interface (the HV–MV transformer) by optimally dispatching the reactive resources available at the MV level and assuring the operational constraints of the network.
Originally, an optimization problem was designed by adapting the traditional Optimal Reactive Power Flow (ORPF) problem [9] to an ORPF model suitable for Distribution Networks [5]. Here, the goal of the ORPF was to minimize the real energy losses in the Distribution Network subject to the following constraints: (i) power flow equations; (ii) generating units capability constraints; (iii) nodal voltage operating limits and (iv) branch current limits. To realize this specific SmartNet goal, the objective function of the ORPF [5] was changed to minimizing the square of the difference between the actual reactive power flowing in the HV–MV interface and its set point; ideally, this is null, but if constraints are at limit then the minimum possible deviation from the set point is achieved.
With this new algorithm, it is possible to: (i) calculate, at a given moment in time, the reactive power limits at the HV–MV interface by giving fictitious large set points (above the sum of the capabilities of the generating units) for both capacitive and inductive operating conditions (i.e. Virtual Capability computation) and (ii) impose, in real time, a reactive power set point that lies inside the previously computed limits (i.e. Voltage Regulation).

FREQUENCY/POWER REGULATION

The last functionality implemented in the MVRS is the frequency/power regulation through DG. Since the Authority, within the resolution 300/2017/R/eel, has open the dispatching market to aggregation of non-relevant units and of loads, this innovative implementation has become a very topical issue.
Regarding this functionality, the main task of the MVRS is to receive a level command by the TSO and act an active power variation of the VPP in order to modulate active power fed into the grid complying with the TSO requirement.

In practice, the MVRS, considering all the available data (topology, measurements, etc.) characterizing the MV electrical network, calculates an aggregated dynamic real power capability (i.e. the real power range available for the TSO to provide the power/frequency regulation).
Each MV generator included among the plants that are available for this kind of regulation, is characterised by two real power regulation ranges: one for real power increasing and one for real power decreasing. The preliminary computing on these data are performed in different ways by the two MVRS: in Siemens solution, the real time regulation ranges for each MV plant are pre-processed considering equivalent generators (the individual physical generators are clustered considering homogenous primary energy source and nominal power); in Selta approach, the pre-processing is done considering the actual state of each switch available in the plant for the single physical generators. After this step, the MVRS aggregates the single real power regulation ranges to describe the virtual generator (i.e. the Primary Substation).
The activation of the power/frequency regulation starts an open loop real power regulation where the set point sent by the TSO (0-100 % format) has to be processed by the MVRS firstly to calculate the necessary total real power and then to split it according to each unit capability. The final real power set points are sent to each PCR installed on field to actuate the power regulation. As required by the TSO, the entire control loop considers very strict time requirements: provide to the TSO actual regulation ranges with a 4 seconds schedule and process/send to the field the set points with a 8 seconds schedule; from this point of view, besides the data processing speed, the communication channel between the TSO/DSO and to the PCR on field plays a fundamental role.

CONCLUSION

The paper presented in detail SmartNet pilot project realized in Italy, highlighting the advantages of an integration of renewable energy sources and distributed generation into the system. In particular, the devices developed by Siemens and Selta allow to obtain an improved monitoring of the grid and to exploit the potential of the resource that could not participate in system services until recently.
As shown above, the regulatory framework is taking in account the evolution of the energy system and it is moving in this direction in order to encourage the development of a smart management of the grid. In this context, the project represents an innovative study that will provide important information, also through the forthcoming execution phase, in order to collect elements to allow in the future the improvement of the grid management for the benefit of the TSO and the DSO.

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