DEMONSTRATION OF THE TECHNICAL AND COMMERCIAL VPP CONCEPT: SLOVENIAN DEMO IN THE INTEGRID PROJECT

Ursula KRISPER
Elektro Ljubljana, d.d., Slovenia
Ursula.krisper@elektro-ljubljana.si

Boris Turha
Elektro Ljubljana, d.d., Slovenia
boris.turha@elektro-ljubljana.si

ABSTRACT

InteGrid's vision is to bridge the gap between citizens, technology and the other players involved in the energy sector value chain. Elektro Ljubljana, d.d. one of five Slovenian electricity distribution companies is facing with the increased share of RES, especially PV systems, charging stations for electric vehicles and customers' higher connection power applications-request. All these new age but operating facilities are already connected at LV (low voltage) network level.

Slovenian demo will cover the operation and possible interaction between Advanced Metering Infrastructure, Demand Response, electric vehicles charging system, small scale LV energy storage and the DSO Supervisory Control and Data Acquisition (SCADA) system. All these components shall be intelligently integrated into a holistic solution. New possible services dedicated to fulfil the DSO needs will be unlocked and new tools for DSOs developed with the aim to prove on the small scale demo the general concept and approach to significantly improve the network operation. This way, the DSO might become a self-sustainability facilitator. DSO's VPP- "technical VPP" - will be established for participating on the active DSO management, with the activation of flexible power of distributed resources. The approach of concentrating all flexible facilities related information under the common Grid and Market Hub platform will enable them to operate in a neutral and standardized way. A special validation module - the Traffic Light System - will define their activation.

Small scale demo in Slovenia will enable the development of new services for the DSO. The Slovenian regulatory environment analyses, together with forthcoming changes of services and tariffs, will significantly influence on the acceleration of changes by the National Energy Agency, Market Operator, TSO and finally by the DSO.

ABOUT THE INTEGRID AND THE CALL IN 2016

Integrid is a positive answer on a call under the H2020 "Secure, clean and efficient energy" with the topic "LCE 2 - 2016: Demonstration of smart grid, storage and system integration technologies with increasing share of renewables: distribution system". The project is a HORISON 2020 approved, funded by the European Commission and started in January 2017.

InteGrid envisages the development of an integrated EU energy system. During four years, the project will apply an innovative approach to move from single solutions for involved actors and stakeholders to an integrated management at a higher scale while focusing on the scalability and replicability considering current market conditions. Under the market are meant the real energy market services and also the services for more innovative market, services for the distribution power network.

Project will address the regulatory and policy frameworks for the solutions proposed in the demonstrations. Throughout the project the aspects that most influence the success of tested solutions will be identified and recommendations will be put forward. Mature solutions will be based on existing standards.

Within one of the working parts, the innovations will build on an overall security architecture that covers the whole communication chain for a trustful ICT environment that is resistant to cyber frauds and attacks (including the analysis of standard communication protocols and associated security solutions).

Scalability and replicability analysis will be conducted as well as a CBA. Also, a replication plan will be developed targeting all different stakeholders. Industrial partners will develop a business plan for the solutions demonstrated.

PROJECT OBJECTIVES

InteGrid main objectives are to demonstrate:

- how the Distribution System Operators (DSOs) will enable the different stakeholders to actively participate in the energy market and how to develop and implement new business models, by using new data management and consumer involvement approaches;
- the scalable and replicable solutions in an integrated environment that enable DSOs to plan and operate the network with a high share of distributed renewable energy sources (DRES) in a stable, secure and economic way, using flexibility inherently offered by specific technologies and by interaction with different stakeholders.

PROJECT'S CONCEPT AND APPROACH

The concepts and approaches have the basis on the following:

1) DSO as system optimizer and as a new market facilitator and

2) integration of existing demonstration activities in three different regions allowing to move from single solutions to an integrated management at a higher scale while focusing on the scalability and replicability considering current market conditions.

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The three conceptual pillars – proactive operational planning with distributed renewable energy resources (DER), business models for flexible DER, information exchange between different power system actors – offer an opportunity to maximise the economic, societal and environmental gains from the combined integration of DRES and flexible DER.

THE ROLE OF THE DSO AND INTERPLAY WITH OTHER STAKEHOLDERS

The background and needs for the MV and LV grid, considering the increasing share of renewables and flexibility, reflect in the novel need for the innovative and predictive management strategies with emerging business models related to storage and consumers flexibility.
The DSO must provide the increasing share of renewables and to enable the various stakeholders to make use of flexibilities in the system. Access to information on the state of the system for all market parties is crucial and needs to be facilitated by the DSO. Following this, communication, information and coordination of actions are of high importance. To ensure the stability of the grid, the DSO must have visibility of aggregation actions connected to its network. As the data managing party, the DSO guarantees the information flow between the various parties of the energy market and provides a level playing field where information is available to all parties of the energy market in a transparent, independent and non-discriminatory way.
The DSO will operate as a system optimizer and market facilitator for flexibility products by exchanging technical and commercial information collected from the grid and performing technical validation of flexibility activation. Moreover, the market hub will be a marketplace for "regulated" flexibility and responsible for the interface between flexible grid users and DSO.
The selected demonstration sites form an important part of InteGrid's demonstration system. The project will build up and analyse 3 different pilots, the first will be in Portugal, second in Sweden and the third in Slovenia.

ARCHITECTURE OF THE SLOVENIAN DEMO

At the very beginning of the project the architecture of the Slovenian demo had been defined, which is shown in the Figure 1.

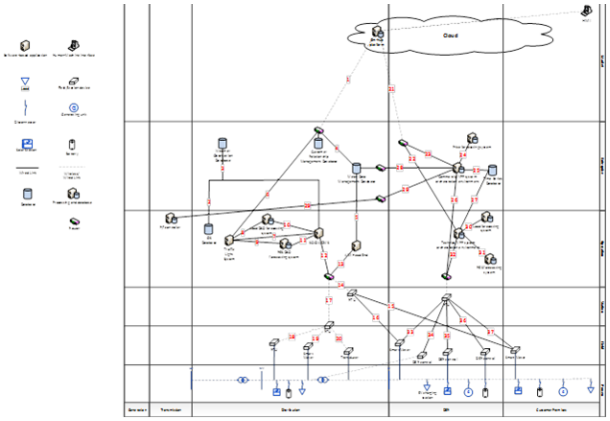

Figure 1: Slovenian demo architecture and components

In Slovenian demo, the existing systems and all the components Figure 1 are: Advanced Metering Infrastructure (AMI), DSO's SCADA (data), virtual power plant (VPP), customers with flexibility, small scale energy storage and EV charging stations.
Advanced Metering Infrastructure consists of smart meters and the supporting system for metering data collection. The commercial VPP, managed by supplier, will be capable to offer the ancillary service to the TSO. The selected service is going to be the manual frequency reserve restauration (mFRR). mFRR is already offered on the Slovenian market of ancillary services (balancing) by several suppliers. The recharging stations for EV are going to be incorporated in the management structure via their own, separate operating management system (the name of this supervisory system is SUPP). Finally the small scale energy storage installed at the end customer-prosumer will serve as a supporting unit for charging and peak shaving. Charging station and storage represent together with the rest of the load a micro grid structure. With the demo at the micro level, we can present the behaviour of consumption and generation in a way, and this last will come from the storage device. The necessary information exchange shall be established.
New tools which will be developed and later also used are going to be the forecasting, power flow and estimation, in parallel directly incorporated into the VPP concept the traffic light system as a supporting part of the VPP and on the highest level the "gm-hub" platform shall be established.

OPERATION OF EACH ELEMENT IN SLOVENIAN DEMO

An overview of the HLUC

From the architecture and basic components out, the use cases were defined. It is important to mention, that all partners defined and decided in for 12 high level uses cases (HLUC), which are shown in Figure 2. All of them reflect the basis of the real environment of the demos. Also the possible interactions between each HLUCs had been foreseen, partners have defined the gaps and also have proposed approaches how to overcome them.
For each HLUC the leader is defied; leader is the full demonstrator of the use case. Further, beside leaders

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also the listeners and learners are defined. Learner demonstrates only part of concept, which will be fully demonstrated by the leader in another demo. Listener analyses the information and checks the results provided by leaders and learners whether the implementation of a new function in the future is viable.

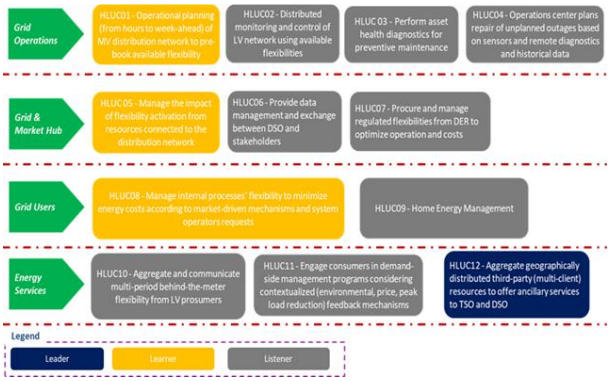

Figure 2: The HLUC scheme

HLUCs enable the improvement of existing knowledge and experiences, exchange of it between the partners and are a real added value for all of them. The HLUC12 is the core activity which will be proven during the Slovenian demo. Through these cases other partners have an opportunity to learn, to follow and to analyse the possibility of integration of it into their own systems. On the other hand, the Slovenian partners are also learners, listeners, which mean that they are going to be involved in these HLUCs.

Slovenian demo

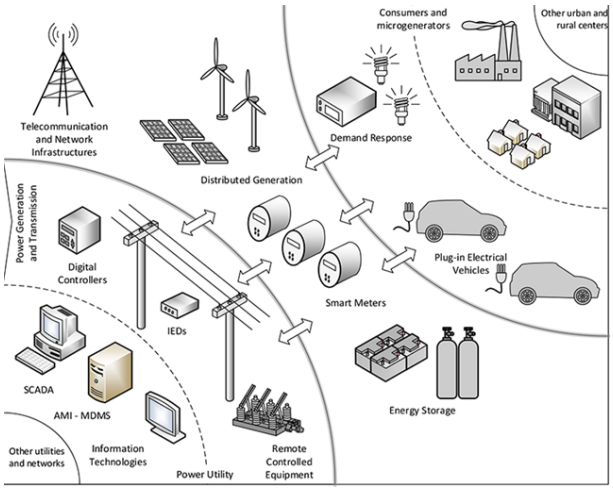

Figure 3: Schematic view of all involved elements and interactions

Demo will follow the obligation of establishing the aggregated flexible power enabled by the interested end customers. In case of Slovenian Demo only the business-commercial customers will be involved and observed. This demo is not dedicated to observe the behaviour of domestic customers, no households shall be included. The core is going to be the observation of demand response and generation. All interested customers will be participating with their adjustment of active power, and shall be recognized as potential flexibility units. The activated flexible power will be resulting in lowering or increasing the customer's basic load.

HLUC 12- flexibility and aggregation

The VPP will be established and serving as an aggregation tool. This platform will be capable to summarize the flexibilities but in this project it is going to be used for two main purposes: for the market-commercial VPP and for the grid, technical VPP.
The VPP as a tool with its internal functions (aggregation, availability of separate flexible units, aggregated and separated per each customer available power, prices…) will be supported by the traffic light system (TLS) approach. TLS will be given for a use by one of the partners working in the project. TLS will serve as an indicator of activating or not activating the flexibilities. The general description of the actions of the VPP is as follows:
The aggregator or the flexibility operator schedules the flexibility units registered in his portfolio according to the volume and bids on the balancing market shall be provided. The TLS executes a Load-Flow or a Multi-Period optimal power flow (OPF) to evaluate the impact of the flexibility programs on the state of the MV network or in order to take the decision to solve the eventual constraints detected. The evaluation of the upwards and downwards flexibility programs is the result of the TLS and the situations are describe with the colours: Green Phase, the entire amount of flexibility proposed by the aggregator is accepted; the Orange Phase, the program is partly rejected, (similar as the curtailment of the power, TLS will indicate the units which are allowed to participate) and the last is the Red Phase, the flexibility program is entirely rejected in case constraints cannot be avoided by any mean (even by using the network devices or the commercial flexibility). With the multi-Period OPF, the TLS is capable to provide a traffic light for submitted programs up to 24 hours in advance (hourly period).
TLS communicates the results to the Grid-Market Hub. Results must be available on the gm-Hub with enough time in order to enable the aggregator to consider them in the bidding strategy. The information provided to the DSO are the new planned set points of the flexible units for a given network operation time frame. The gm-Hub platform is for the aggregator the information exchange where to get the results of the of the TLS evaluation.

HLUC1 aspect- learning the experiences

In Slovenian demo also other developed tools shall be tested. The technical established VPP will use them. The technical VPP will satisfy the DSO needs and will be upgraded with MV optimization (multi-period optimal power flow), estimation (load allocation) and forecasting algorithms. Envisaged is the active management of MV distribution grid.
An alarm signal from SCADA system will trigger the technical VPP flexibilities at specific troubled location to restore secure and reliable operation.
For testing the tools the necessary preparations shall be done:

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- A network topology; a processer is necessary to convert the geographical data of the network into a readable format.
- To select the area of the grid with enough high ratio of installed smart meters (active and reactive power measurements from HV/MV and MV/LV substations with 15 minutes intervals). Desired are two year historical data for the HV/MV substations and one year for the MV/LV substations.
- The access to other IT systems or data is necessary. The required data are the "normal" grid topology; grid measurements; OLTC tap position. Pre-processing methods developed by Elektro Ljubljana to gather and clean information from these different systems will be necessary, as well as a validation of the file formats.
- A short-term forecasting tool-system for the net-load will be operational before the start of the demonstration phase. It will be capable to prepare the forecasts for each node, load and generation units of the tested grid. The performance will depend on the quality of the measurement data and the availability of the historical.
- A fact is that the data from the HV/MV substations are collected every hour, the data from the MV/LV substations only one time per day, it must be reached the update of the network operating conditions with an hourly rate. The conclusion is that the MV Load Allocation tool will need to be installed to overcome this limitation in information acquisition.
- The interface must be comprehensive enough to be used by DSO grid operators in the control center. A preliminary assessment will be conducted. (HTML reports will show such information to human operators).
- The gm-hub will be used to support flexibility data exchange between the DSO and the technical VPP. The JSON object format will be used to allow the communication between independent language systems, too.

CONCLUSION

In the demo it is going to be proven the novel approach with the aggregated, market dedicated flexibilities. The facilities will first consider the grid status and will respect the DSO requirements or limitations. Only with the conformation of the DSO the aggregator will be allowed to operate them.
The result and the benefit of this project is to study, to test and to propose new services for the DSO. The explanation is in a fact, that the DSOs are daily facing with the changes and new requirements of the customers connected to the grid, so the need to develop of new services is coming spontaneously. We should not deny that the legislation must also follow the changing environment, on the local and even on the international level. Proposals for upgrade of the legislation must become a part of normal development cycles.

REFERENCES

[1] Integrid partners, 2016, H2020 Call; Proposal: "INTEGRID", Demonstration of Intelligent grid technologies for renewables Integration and Interactive consumer participation enabling Interoperable market solutions and Interconnected stakeholders

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