Use Case Summary – External Generation Site

With the anticipated increase in small decentralized energy resources from primary wind and photovoltaic (PV), the low voltage (LV) grids are exposed to new load scenarios than originally designed for. Further, new high consumer demands from Electrical Vehicle (EV) mobility and heat pumps challenge existing LV grid infrastructures additionally. As a result, there is an increased interest in technologies to improve the LV grid operation. These mainly entail: local energy storage, active control of energy fed in electrical grid, flexible demand control (entailing both end-user managed demand response and autonomic demand control) for house-holds and EVs. This use case covers the automation and control techniques required for future LV grids and enables the DSO to utilize the flexibility of the LV grid assets. All this happens over an imperfect communication network which poses challenges to the operation of the grid. Therefore, the objective of this use case is to demonstrate the feasibility of controlling flexible, distributed loads and renewable energy resources in LV grids over an imperfect communication network. Flexibility of LV grids for upper hierarchical control levels is also investigated.

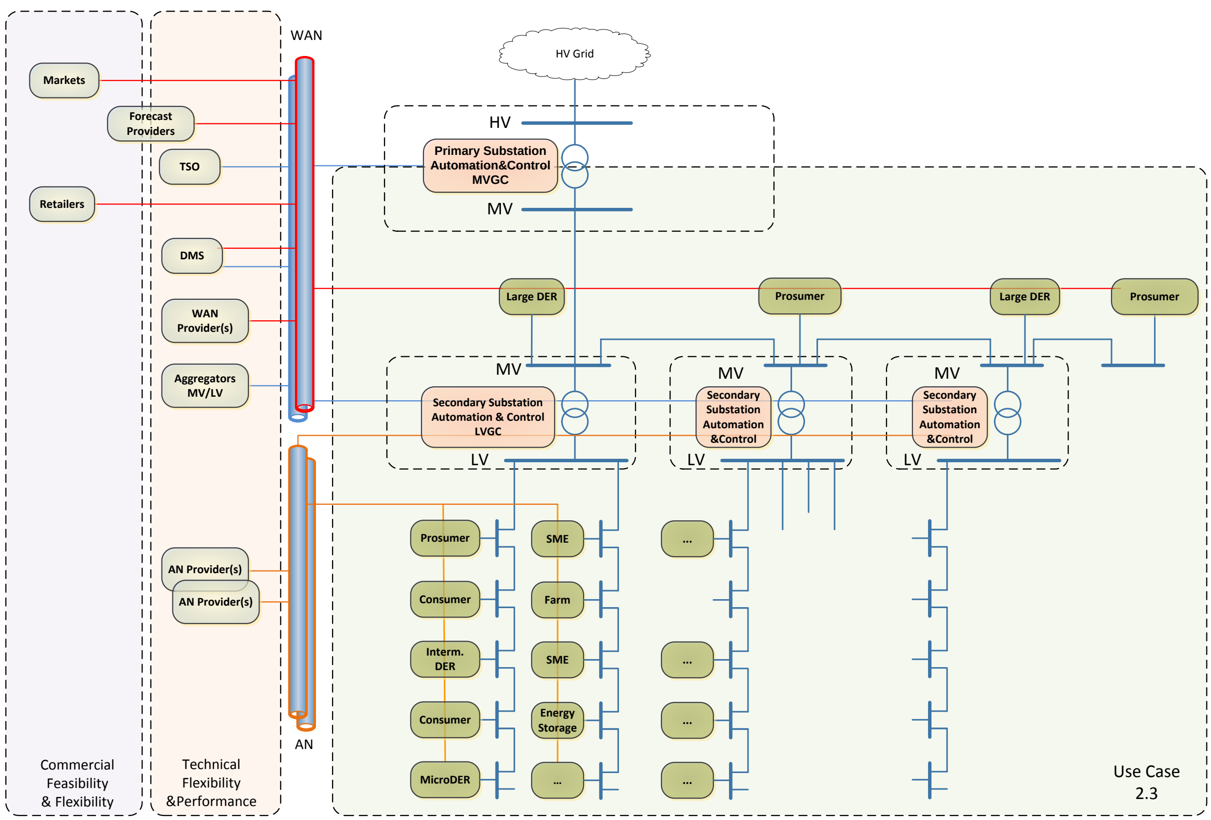

Figure 1 Overview of External Generation Site Use Case

The reference scenario for this use case consists of a MV and LV grid shown in Figure 1, contains: 1) fixed and shift-able energy consumption from households, small enterprises and EVs, 2) production from PVs and wind turbines, 3) Energy storage. Hierarchical controller architecture is utilized, where a distribution management system (DMS) is at the upper most level. This provides commands to the MV grid controller, which sends commands to the LV grid controllers as well as flexible generation and consumption in the MV grid. Finally, the LV grid controller sends commands to flexible assets in the LV grid. The LV grids are connected to the MV grid via a controllable transformer station with an online tap changer (OLTC).

It is considered that all components in the architecture are connected with a communication network providing monitoring data from and control of the individual components. The LV grid implements its own control mechanisms which are responsible for: a) maintaining an acceptable voltage profile, security and safety, b) balancing available power resources (energy storage and generation) with the (flexible) demand, and c) handling the interactions between a) and b). The control infrastructure is managed by one or more dedicated LV grid controllers which provide functionality to support the sub-use cases introduced in the following sections. This Use Case is considering only faults and performance degradation within the public communication network, and the system's overall ability to perform normal grid operation even during network faults and performance degradation.

With the introduction of significant decentralized energy production from wind and photovoltaic plants in the LV grid along with energy storage as illustrated in Figure 1, new problems arise. In this setting the low voltage grid control should preferably be able to: 1) control the voltage profile along the low voltage feeders, 2) optimize MV grid losses; 3) optimize energy cost; 4) aggregate the flexibility of LV and MV assets that can be used as an input to the MV control and distribution management system (DMS). The grid operation should in this matter be resilient to faults and performance degradation in the public communication lines between the low voltage grid controller and the assets in the electrical grid with special focus on the low voltage side, hereby limiting the effect of changing network conditions on the electrical grid performance. This means that the use case also includes mechanisms for adapting the communication to events in the network that challenge the communication and the quality of the data exchanged between the controlled and controlling entities.

Under these settings, two focus points are defined as to show the above characteristics:

- **Technical flexibility and performance**: Resilience of control towards faults and congestions in communication networks.

- **Commercial feasibility and flexibility**: Aggregation of generation and demand (abstraction of models).