October, 2017

USE CASES FOR THE ADOPTION OF 5G TELECOMMUNICATIONS WITHIN THE OPERATIONS OF ELECTRIC UTILITIES.

Background

One of the main objectives of the European Utilities Telecommunications Council (EUTC) is the analysis of any new telecommunications service that could introduce additional efficiency into the operations of its utilities affiliates.

Being sure that the most efficient solution for the telecommunications needed by utilities will have always a certain component of services provided by the telecommunication operators (TO), EUTC has always promoted a continuous attempt to achieve the appropriate relationship with them so as to facilitate the common understanding of our utilities needs as well as of their provided services capabilities.

In this regard, several workshops have been done in the past years with the intervention of main European TO updating both needs and solutions. It is important to remind that in all these workshops, EUTC has been supported by officers of the European Commission well conscious of the advantages for a better understanding between both sectors.

Nowadays most utilities are using services from TO, such as 3G and 4G, with known limitations for some of the utilities requirements, fully proving that a future improvement is needed.

On September 11th, 2017, EUTC and EDSO4SG (the Association of European Distribution System Operators), by the invitation of EC DG Connect, held a meeting in Brussels to analyse in detail the use of 5G technology/services by the future operations of utilities. This was done within the framework of the activities envisioned by the PPP 5G to address the use of this technology in several vertical sectors.

5G Telecommunication services.

EUTC has collaborated actively in the preparation of the White Paper "5G and ENERGY" as well as maintaining several contacts with the PPP 5G, which, as stated in the September 11th meeting, did not produce major advances in the common needed effort.

By one side, utilities are embarked in a digitalization process where the telecommunication services will play a fundamental role to access with enough capability and reliability a massive amount of network devices. Only with this digitalization the grids will become as smart as needed for allowing the customers the active role they are claiming for its energy involvement (use and production). By other side, 5G are being announced as the solution for the Internet of Things and TO are expecting its intensive use by vertical sectors as Energy and, very particularly the electrical subsector.

5G Use cases

Therefore, the better common understanding of the future will represent more accuracy in the planning, development and final provisions of the requested services. This was one of the fundamental conclusions within the September 11th meeting and along it, there was asked by the EC, and committed by EUTC, the description of some **use cases** where utilities might think 5G will be introducing efficiency for the overall system, while complying with the utilities requirements.

The focus of this paper lies on 2 use cases**: Enabling Local Energy Networks**, which describes the need for telecommunications of highly digitalized network, where medium and low voltage networks play a fundamental role in the integration of a massive amount of distributed energy resources; and **Enabling Flexibility Management,** where the network is only a part of the case, including the very important role of the prosumer.

1. USE CASE – Enabling local Energy Networks

1.1 The legacy of the energy system and the control of energy networks

In the past, the Energy system relied on central generation units. Consequently the Energy Network was built to meet the requirement for energy transport and energy distribution from the central generation sites to the regional and local customers.

Along with the energy network, the communication system for control was build up with the same structure in mind.

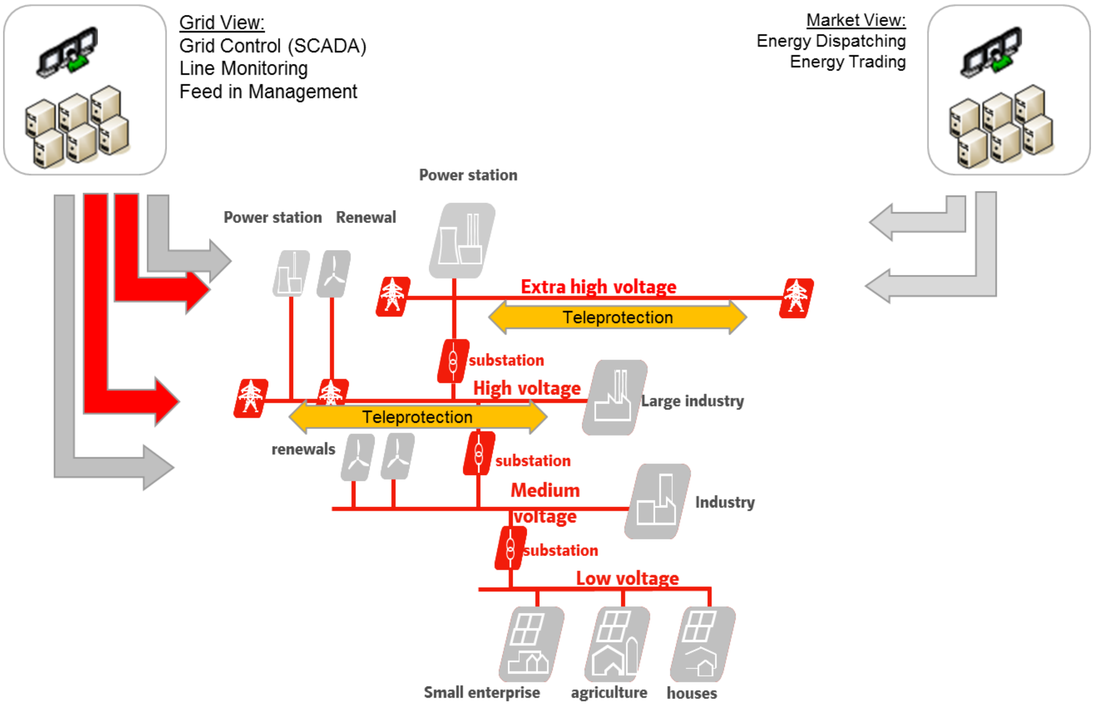

Figure 1: Energy Network Control today

1.2 Challenges for the energy system in the future

Due to the massive expansion of renewable energies, the requirements on the electricity grid are changing fundamentally. The increasing volatility and decentral energy generation increases the complexity and requires a higher flexibility of the networks, as well as an adapted control logic. The increased use of ICT will play a key role for the set-up of smart grids and the success. The electricity demand of all consumers has to be intelligently estimated/measured and forecasted. The generation and supply of the electricity will be dynamically steered. (matched?). This enables flexible business models and dynamic offers, which leads to changes in the consumer's consumption pattern.

The following megatrends will lead to a clear decentralization of the energy networks:

- The massive expansion of small-scale renewable energy sources
- Decentralization of energy production with high volatility
- The dynamic development of electro mobility
- The controllability of local consumers (e.g. heat pumps, night storage heater, V2G)
- The economic availability of local storage (battery, heat, cold)
- The implementation of climate change in Europe and the phasing-out of nuclear power in different member states (e.g. Germany)

So far centralized systems have used a few sensors and actuators for forecasting and operation of the grid. In the future decentralized systems at local level with a high degree of networking will determine the architecture. The aim is to optimize the local and regional energy distribution networks by implementing the dynamic control of producers, loads and storage in a way that they are in an energetic equilibrium. For this purpose, communication connections in local and regional structures with very low latency (short control time constants due to the lack of inertia of large machines in the energy system) are necessary. Direct interaction between loads and producers without using the core infrastructure of the 5G network must also be ensured (Device 2 Device Communication). For this purpose, both mechanisms for peer to peer communication (unicast) as well as for mass communication (broadcast) will be used.

1.3 Challenges for the energy system in the future

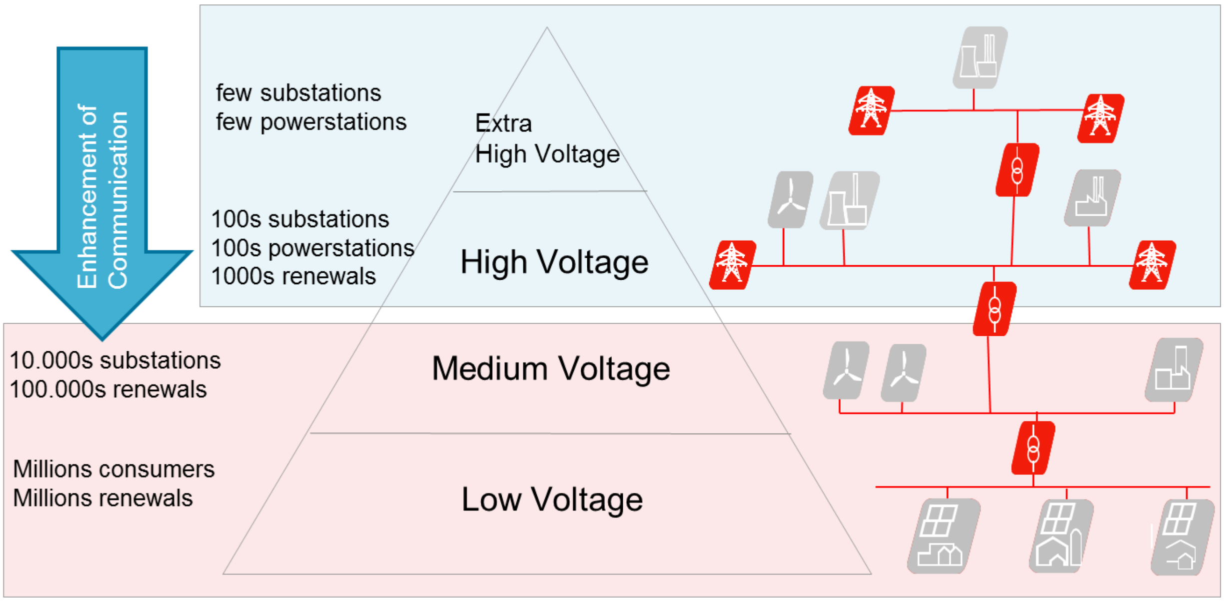

Figure 2: Challenge for communication in the future

Utilities have to enhance their telecommunication infrastructure into the medium – and low voltage networks. In parallel, the supervision and control of the energy networks have to be moved from a central to a decentral approach:

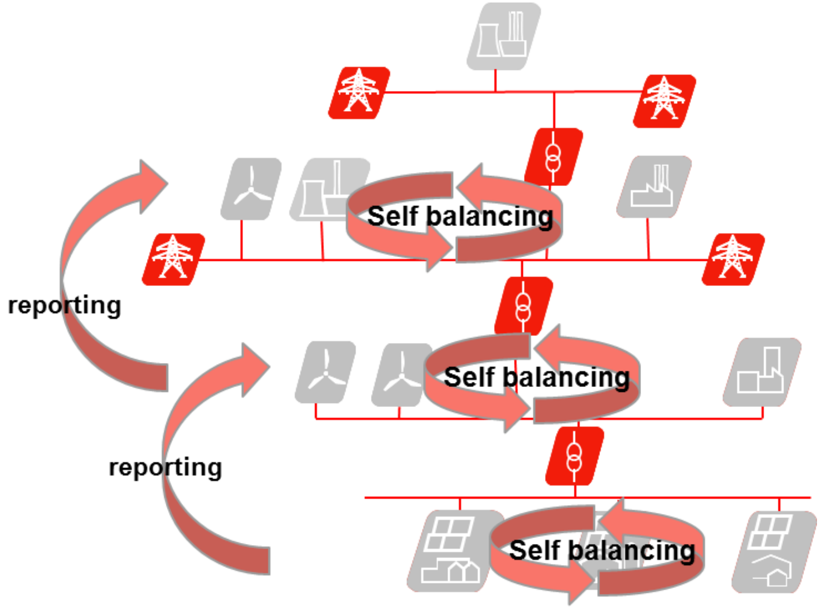

Figure 3: decentralised network balancing

1.4 Interaction between home automation systems, industrial control systems and local energy distribution networks

To implement these local energy networks, a seamless interaction between the power distribution network and the control systems of industry (SmartFactory) and houses (SmartHome) is indispensable. Only in this way it will be possible to establish a regional balance between energy consumption and energy production without having a loss in the supply quality of the electrical energy. Both the Smart Home and the SmartFactory or SmartBuilding rely on the robust, fast, cost-effective and secure exchange of a large amount of data. The main applications in the field of energy data, monitoring of energy consumption and performance vary between a data granularity of 1Hz up to 1kHz in average, with peaks up to 1Mhz for disaggregation of consumptions). These data must be exchanged between potential market participants via the communication infrastructure locally or regionally. In particular, with the requirements of virtual power plants as well as load control (demand side management), these data have to be available in near real-time. The requirement on the availability of 5G includes not only coverage but also the availability of the service in buildings (deep indoor coverage). In addition to this, combinations with other services such as building security and comfort are making latency increasingly important.

These overall requirements, particularly in the case of end users, are concurrent with the low cost requirements, both in terms of the cost of the infrastructure and the cost of the transmitted data. This is only way to realize a comprehensive use of 5G in the end customer business.

1.5 Blackstart from islanded local energy networks

As a result from moving generation, storage and demand into the distribution networks, the concept of blackstarting (start of the energy network after a blackout) has to be adapted.

The megatrend decarbonisation will lead to a shutdown of fossil generation in the extra high voltage and high voltage networks. Moreover, the shutdown of nuclear generation in different European member states will increase the lack of big generation facilities. The only option for blackstarting the energy network will be to make use of the renewal generation and decentral energy storage in the distribution networks.

As a consequence, it must be possible to operate local and regional energy networks independently from the transmission network.

The coordination and balancing of these local energy networks will only be possible, when all participants communicate with one another and have a communication with a local control instance. Moreover, market mechanisms have to be postponed in a case of islanded operation.
The local communication has to be available, even when the backbone –network of the telecommunication provider is not available.
5G technologies, with following functionalities may facilitate this approach:

- device 2 device communication
- network slicing
- ultra low latency
- massive M2M

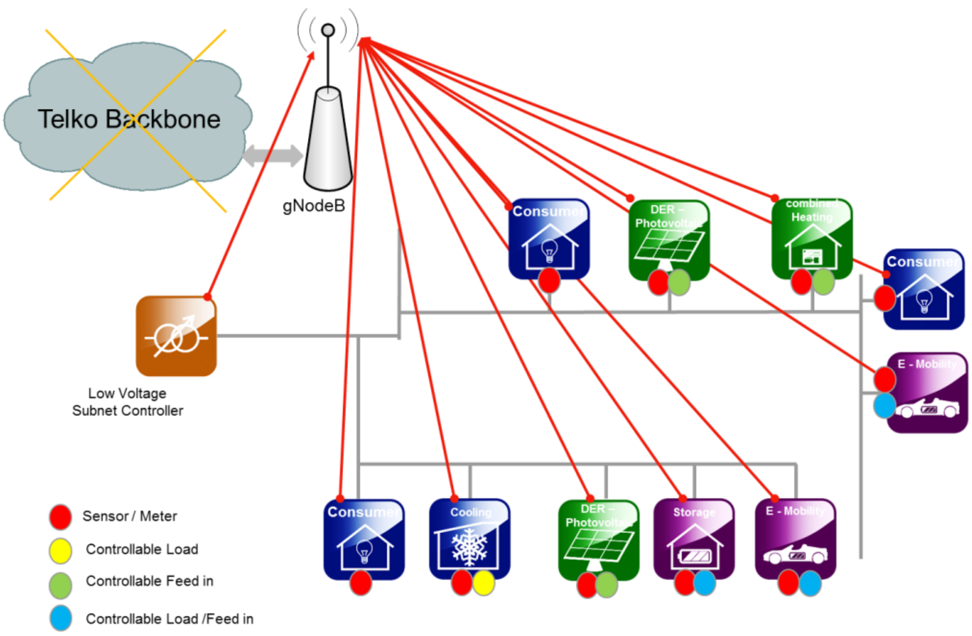

Figure 4: Local energy network

2. USE CASE – Enabling Flexibility Management

2.1 The changes in consumption/injection of electrical power from/to the power system from their current/normal patterns in response to certain signals, either voluntarily or mandatory (SG-CG/M490/L)

The European Union policy on energy entails the development of secure and competitive energy supplies, within a sustainable and decarbonized Energy System, meeting the climate change targets of 2020 and beyond, for which the development and integration of large scale Distributed Energy Resources (DER) based on renewal energy sources and Demand Side Flexibility, and intelligent flexibility management will be fundamental System's components.

From a broad conceptual viewpoint, not constrained by market design and regulated actors, Real-time (micro-second) orchestration of supply-demand for efficiency maximization and system stability will be definitively achieved by advanced analytics, distributed computing and adequate communications between actors.

The DSO will have a decisive role in System stability and optimization, participating in flexibility orchestration, directly or by interacting with other market stakeholders, contributing with Grid topology context, including results of advanced management of Grid condition, reliability and capacity.

This embodies the Digitalization of the Energy System, for which special arrangements shall apply, besides functional requirements also the ones concerning safety and business continuity, demanding the adequate use of private dedicated technologies and market ICT services, for which 5G is recognized as a decisive contribution for fixed mobile convergence namely by offering homogenous capabilities on segmentation, bandwidth and QoS differentiation.

The present use case depicts 5G as a potential ubiquitous connectivity enabler matching the requirements for massive volume of connection points, segmenting and managing networks to several stakeholders, assuring the adequate service QoS, security and reliability.

Within the Smart Grid conceptual model of Flexibility Management, DSO (Grid Operations) are fundamental to take active control decisions upon real time condition and topology of the Grid (LV/MV), driving efficiency and quality stability, contributing to economical Distribution Network dimensioning by avoiding worst case capacity scenarios that would require additional capital expenditure

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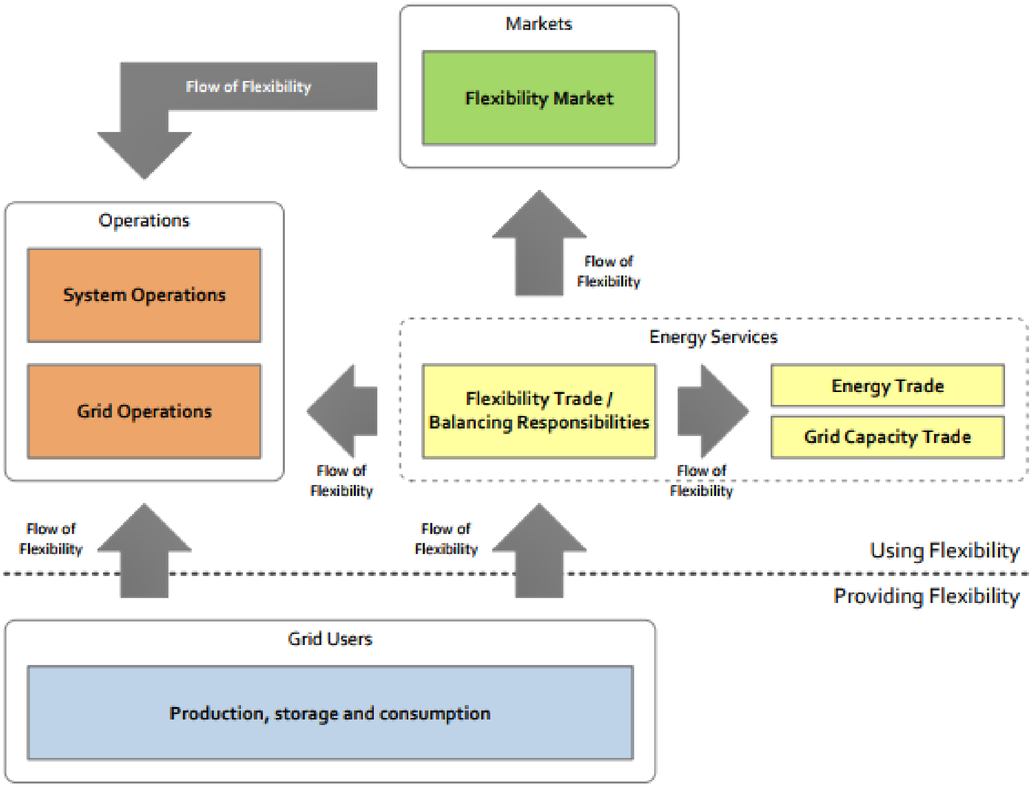

Figure 5: Flow of Flexibility plotted son Conceptual Model, from Providing to Using Flexibility
***Source**: Smart Grid Coordination Group Document for the M/490 Mandate Smart Grids Methodology & New Applications - SG-CG/M490/L*

2.2 Use Case description

To fulfill its role, DSO are evolving their SCADA into advanced distribution management systems, that imply further sensing and distributed automation requiring for stringent control and supervision functions connectivity services under 10ms RTT and better than 99,99% availability, enabling functions that accomplish fault location, isolation and restoration, volt/volt-ampere reactive optimization, conservation through voltage reduction, peak demand management, support for microgrids, in a dynamic DER and Prosumer environment (electric vehicles, solar panels, storage, …).

DER and flexible consumer appliances will conceivably evolve to cope with standardized communication and management logic, fostering smart contracts that can be managed by adequate market participants but will also cascade the necessary digital bond with the Grid Operations role, allowing dynamic flexibility models.

DSO can actively send requests procuring flexibility services for stability reasons as can provide correction signals or direct command in case of emergency action, actions that should be first explored within the contractual technical allowances.

In this evolved model, connectivity services supported by communication networks are key, and an audit and accountability process should be in-place as a default rule, since a communication outage can isolate a System actor, with resulting economic loss (example: a solar panel could be switched off by lack of authorized/registration/… due to communication loss, a load or source could be curtailed caused by a command failure due to communication impairment).

In this evolved environment, high usability should be granted to DER and prosumers who will focus on their contractual relations, SLA definitions for their energy transactions, not having to engage in complex connectivity setups.

2.3 Network and connectivity

Considering the anticipated massive number of connected actors, scaling considerations and other relevant conditions should be anticipated:

- Devices should register and authenticate through automated kind of plug & play functionality for network access and connection to their application servers;
- Standardization of network capabilities applicable to end-devices (customer, DER, network sensors or appliances, …)
- Smart grid traffic should be supported in "Private Virtual Network" context, with adequate resourcing and priority definitions, ensuring no impact or access from other sources or disturbances within the global network infrastructure;
- Network slicing/virtualization should also promote better delimitation and access control for Operation's personnel (Configure, Change, ….) to improve overall system security;
- The need for high priority traffic with deterministic latency requirements. To further guarantee the stability of the smart grid (mission critical application), this information must be transported with highest priority or via reserved communication channels for reducing the latency from submitting the message until receiving it.
- Latency requirements should match new SDN capabilities combined with cloud and edge computing that will further foster DSO technical use cases and their geographical distribution;
- Field devices shall by design and architecture meet relevant functional, security and environment conditions, ensuring their high functional availability but also their remote serviceability accounting for a required extended life-cycle;
- Contractual models for Pre-provision of appliances to support authentication, match service profile, auto-test and Network selection;
- Orchestration entities should be able to manage the connectivity, obtaining relevant information from networks on quality of service to drive network reselection as needed
- Density limits for always-on terminals/services requiring very low latency should be accounted
- Cold restart of connected devices

2.4 Public Service offer / Network-as-a-Service (MNO)

As per current MNO and other public connectivity offers, besides strict technical capabilities of underlying technologies and resulting service definition, it's equally important to develop a framework for governance, security, business continuity and Responsibility (accountability & Liability).

The connectivity systems used as part of a smart Grid dynamic balance between its stakeholders will require adequate formulation of its integrity, security and continuity of operations, leading to eventual regulation of private held companies and their respective licenses, developing a reliable and manageable enforcing model through which regulators can derive accountability for System performance and adequate response to society and to the economy.

- Network Slicing within a multi MNO environment, assuring E2E consistency across MNOs and private infrastructure, permitting service portability and private addressing space;
- Switching through available networks for connectivity resilience and availability;
- Transparency and framework for Risk Management and Business continuity practices for companies operating the connectivity Systems;
- The segmentation of Networks for Smart Grid Vertical should be market defined to ensure no lock-in and the possibility to switch;
- Capacity management and priority to specific Smart Grid traffic;
- Accountability model and audit framework;
- Service definition and required technical conditions within the "Private Slice" concept shall be maintained by MNO and subjected to coordination by regulation and standardization bodies to account for the Grid and Market appliances ecosystem and their traditional extended life cycle;
- Management functions, namely related to assurance mechanisms that should contribute to the automation of provisioning, authentication and system debug, creating scaling conditions and avoiding total dependence from over the top probes and debugging.

ABOUT EUTC

The European Utilities Telecom Council (EUTC) is a non-profit organization delivering education, collaboration, best practices and thought leadership in telecommunication technology to utilities, other critical infrastructure providers and regulators, ensuring efficient, secure, sustainable and affordable smart infrastructure solutions.

For more information, please visit our website www.eutc.org or contact EUTC via eutc@eutc.org