GRID4EU DEMO2 - LV NETWORK MONITORING AND CONTROL

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ABSTRACT

GRID4EU is a large-scale research and development project of advanced future Smart Grid solutions, with the purpose to evaluate and analyse the project results delivered by different demonstration projects. The results will be used to study the replication and scalability potential for the entire Europe. GRID4EU is partly funded by EC FP7 including 27 partners and 6 demonstrator sites. The GRID4EU project commenced in November 2011 and will continue through January 2016.
Vattenfall Distribution Nordic is governing and coordinating one of the GRID4EU demonstrators at Uppsala, Sweden, called Demo2, including approx. 10 000-15 000 smart meters at customers' premises and approx. 110-120 secondary (10/0,4 kV) substations.

In the Demo2 demonstration Vattenfall and its partners ABB, Siemens/eMeter, Schneider Electric and KTH (Royal Institute of Technology) will show how to monitor and control the low-voltage (LV) network by utilising the existing smart meters in combination with information collected from secondary substations.

The project system architecture will involve Schneider Electric Titanium advanced metering management (AMM) system used for data collection from the smart meters and ABB MicroSCADA Pro and DMS (distribution management system) for the collection of information from remote terminal units (RTUs) in the secondary (10/0.4 kV) substations. These systems will be integrated with Siemens/eMeter EnergyIP Meter Data Management System (MDMS) for providing complete system integration for Smart Grid utilisation at the LV network level.

Similar systems as the ones utilised in the Demo2 test are presently run by several distribution system operators (DSOs) in their ordinary operational business, e.g. Vattenfall, but the systems are up to now managed as separate entities. The Demo2 demonstration will combine the use of the systems and integrate the needed information in order to gain a dynamic tool for fast and reliable power quality analyses as well as improved service to the customers.

Field installations for Demo2 commenced in 2013 and will be finalised during the spring of 2014 when the operational test and monitoring phases start and continue through 2015.

GRID4EU

The GRID4EU project is a large-scale demonstration of advanced Smart Grid solutions with wide replication and scalability potential for Europe. The project, which has received funding from the EU FP7, is including 27 partners and six demonstrators, which are tested in six different European countries. See Figure 1.

Figure 1. GRID4EU partners and demonstrators

The GRID4EU project, commenced in November 2011 and continues through January 2016, is the biggest Smart Grid project to be funded by the EC. The project is led by six European electricity Distribution System Operators (DSOs) from Czech Republic, France, Germany, Italy, Spain and Sweden.

DEMO2 - LV NETWORK MONITORING AND CONTROL

Vattenfall's demonstrator in the GRID4EU project, Demo2, aims at validating that monitoring and control of low-voltage (LV) distribution networks using Smart Grid and AMM technology allow for improving customer power quality by improving outage management and power quality monitoring. In the Demo2 demonstration, Vattenfall, ABB, eMeter/Siemens, Schneider Electric and KTH will show how to monitor and control the LV network by utilising existing smart meters combined with information collected from secondary (10/0,4 kV) substations.

The demonstrator will be located at Uppsala located about 70 km north of Stockholm in Sweden. See Figure 2 below. The test site will mainly be split between two 70/10 kV primary substations Gränby and Fyrislund, but other areas of the LV network will be covered as well.

In total the demonstration will include 110-120 secondary substations in the Uppsala area, depending on the technical conditions. In the pre-selection phase already about one-third of the secondary substations had to be disregarded mainly due to various technical inadequacies. The number of meters at the customers' sites included in the Demo2 tests will be 10 000 - 15 000 depending on possible final configuration.

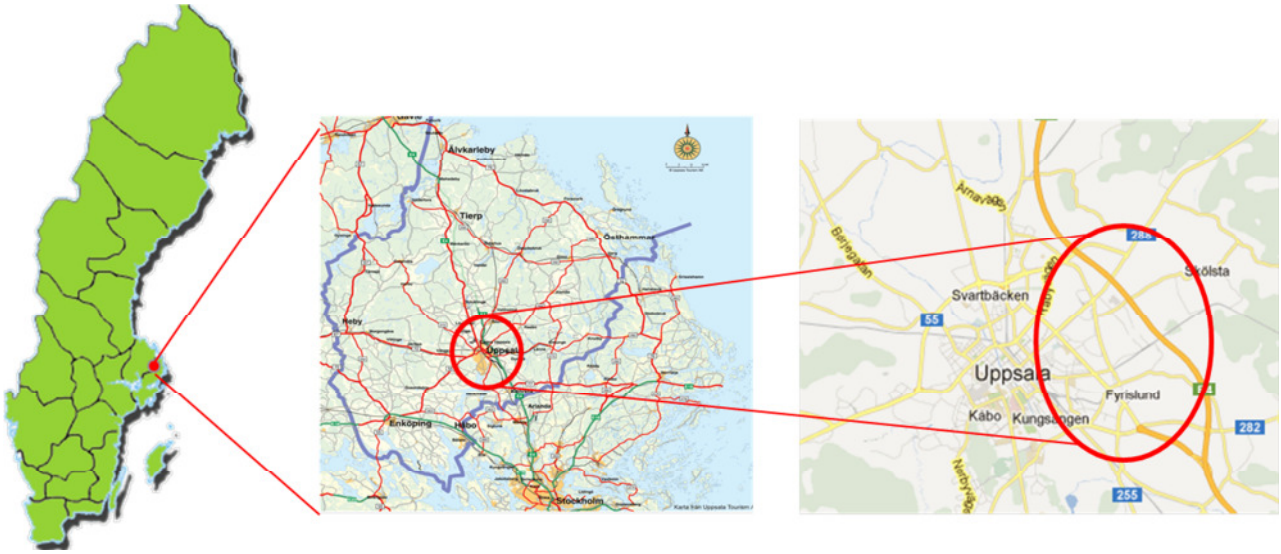

Figure 2. Location of demonstrator.

Demo2 system architecture

The project system architecture will involve Schneider Electric's Advanced Meter Management (AMM) system used for data collection from the smart meters and ABB's Supervisory Control And Data Acquisition (SCADA) system and Distribution Management System (DMS) for the collection of information from the secondary substations. These two systems will be integrated with eMeter's Meter Data Management System (MDMS). See Figure 3.

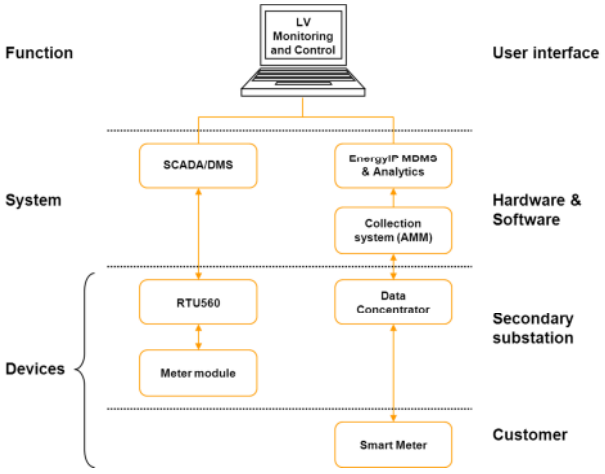

Figure 3. Schematic image of system architecture of Demo2

The ordinary system in operation within Vattenfall will be the backbone of the project IT infrastructure. The smart meters are communicating through the 400 V network, using Power Line Carrier (PLC) technique and data concentrators (DC). The DC is collecting metering data from the meters being installed on the same power line structure as the DC. The DC is in turn connected to the overlying collection system via GPRS. The data traffic uses common standards and passes the telecom operator Maingate communication platform and servers before being exported to the Titanium server through VPN (Virtual Private Network) integration.

The second stream of information to be used by Demo2 will originate in the devices deployed in the secondary substations. This system is not in operation within Vattenfall today and will be one of the main purposes to test in this demonstration. The system principle follows the same logic as for the smart meter information stream, except that there is no PLC connection between the meter module, connected to the outgoing feeder, and the RTU (Remote Terminal Unit) at the secondary substations. This communication is through cable between meter and RTU, using Modbus as the communication protocol.

Figure 4 below shows a simplified description of the anticipated system environment together with the project system interfaces.

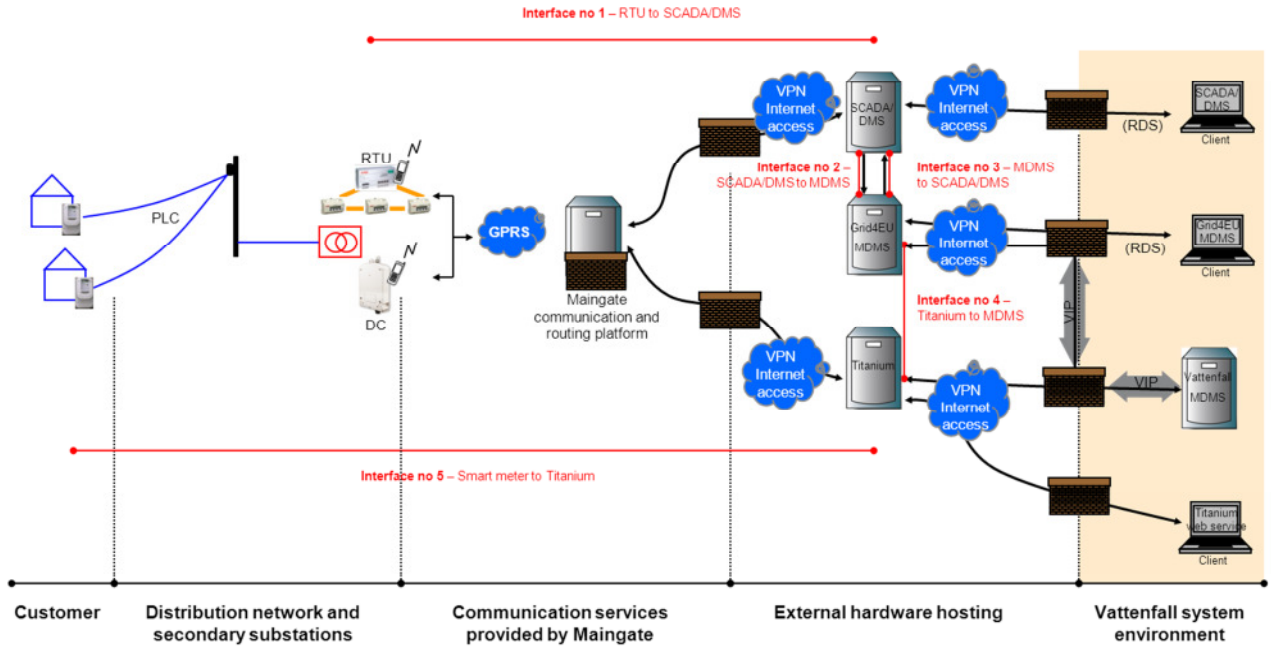

Figure 4. Anticipated system environment of Demo2

Demo2 systems

The SCADA system solution chosen for Demo2 is ABB MicroSCADA Pro and DMS. The MicroSCADA Pro will handle data management and construction of reports based on the data transmitted from the RTU's in the secondary substations. DMS is a visualization tool that receives data from the SCADA program and the MDMS. Using this data it constructs images showing network layouts, reported problems and graphic fault identification at the level of secondary substations. MicroSCADA Pro can be used either as a local or a centrally located control system for different applications. It works in a hierarchy. At the RTU level located in the secondary substations, it converts discrete signals to a communication protocol and transmits them to a centrally located SCADA server.

Siemens/eMeter EnergyIP is an enterprise software platform that brings together new information sources and remote operational capabilities with existing and new business applications to better serve energy consumers, suppliers, and distributors. The role of EnergyIP MDMS for the Demo2 is to serve as a platform to validate incoming measurement data and events based on defined configuration rules as well as to publish validated data to SCADA/DMS for further analysis.

EnergyIP will process meter data and events from the AMM system and data collected by the SCADA/DMS RTUs in selected secondary substations and will additionally gain insight into customers' usage, the data infrastructure status and transformer loading management studies.

Schneider Electric's meter data collection system Titanium is an AMM platform that aims to manage the rollout of an AMI system, as well as to operate and maintain it. The functionalities that Titanium will offer for the purposes of Demo2 are grouped in several categories: (1) Device installation management, (2) Data collection, (3) Reporting capabilities and (4) Incident handling & support. The data collection process is the main focus of the data collecting system. These capabilities are focused on retrieving and analysing the collected meter values, alarms and events to create value for the operation, and how this information is eventually exported to other utility's systems.

Final configuration of Demo2

The final configuration of the innovative solution is to make use of the delivered technological platform, as depicted in Figure 5 below. The equipment and system applications have the potential to be used in multiple ways and support different purposes. Vattenfall has the responsibility for specifying the final configuration of the innovative solution requirements.

The configuration will focus on the topic around power quality. Each Demo2 system will support the analysis of power quality areas, with some overlapping. The project has defined the areas of interest to be the following, though the focus for the analysis and presentation of results will be the areas related to the defined Use Cases and KPI's for Demo2: (1) Monitoring and Control, (2) Power Outages, (3) Power Quality and (4) Power Control.

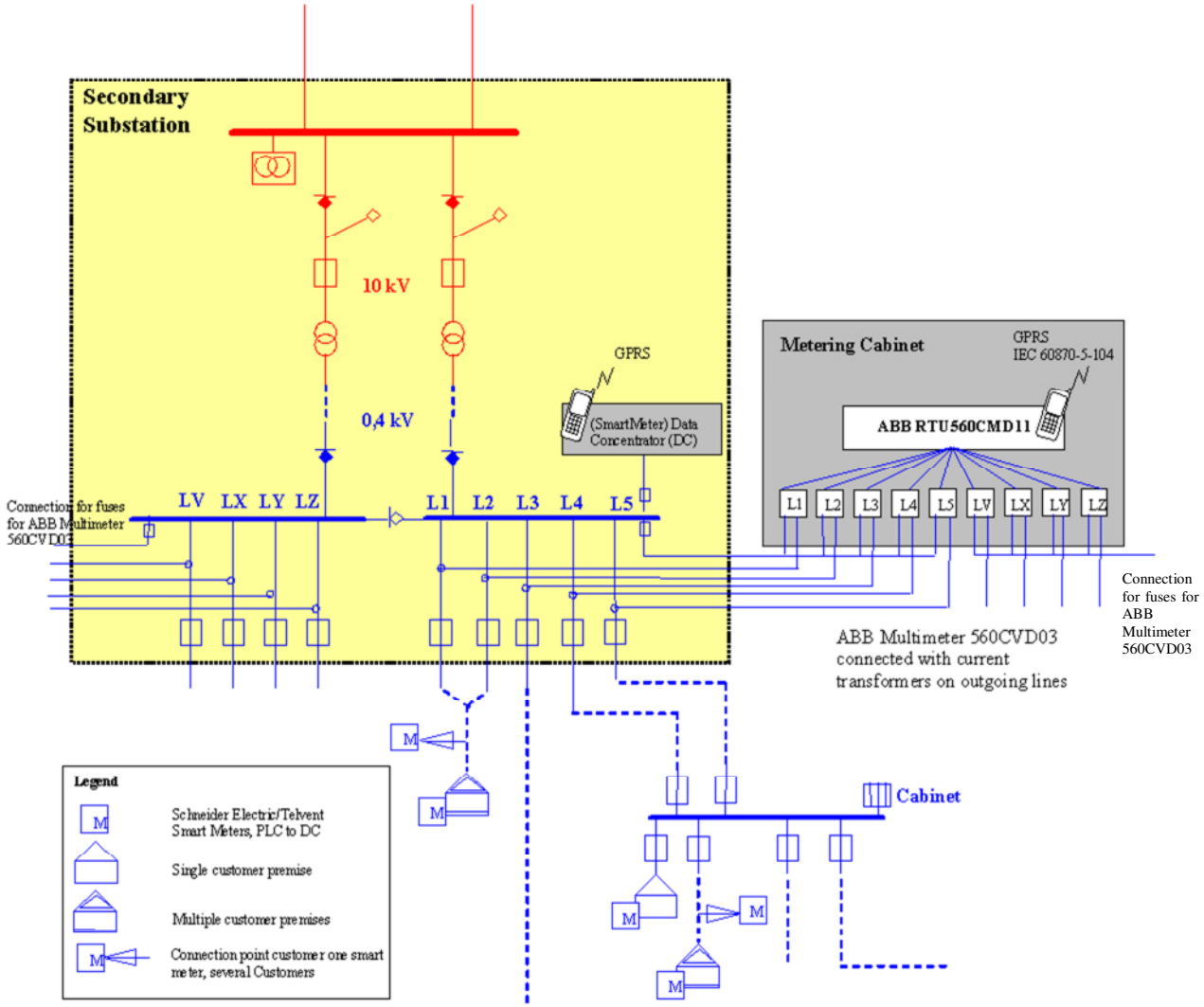

Figure 5. Tentative final configuration of Demo2

Time schedule

The GRID4EU project commenced in November 2011 and will continue through January 2016. Planning for Demo2 was carried out during the first project year and technical specifications during the second. Field installations for Demo2 commenced in 2013 and will be finalised during the spring of 2014 when the operational test and monitoring phases start and continue through 2015.

Benefits of Demo2

Similar systems as the ones utilised in the Demo2 test are presently run by several DSOs in their ordinary operational business, e.g. Vattenfall, but the systems are up to now managed as separate entities. This demonstration will combine the use of the systems and integrate the needed information in order to gain a dynamic tool for fast and reliable power quality analyses as well as improved service to the customers.

Some of the benefits anticipated to derive from the Demo2 tests are indicated in Figure 6.

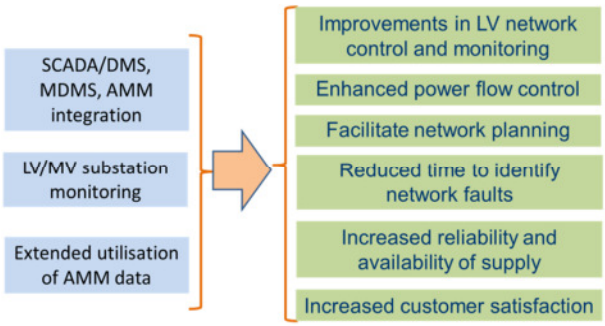

Figure 6. Anticipated benefits of Demo2

Vattenfall has introduced several development steps during the past two decades, e.g. previous introduction of AMM and now Smart Grids. Each step has elevated the technology level for higher automation in the operational processes and thus improving the network business concept. This second technology step of a Smart Grid solution is necessary for the smart energy enabler platform. The LV network monitoring and control technology allow for improving customer power quality by improving outage management and power quality monitoring but will also support the development towards more micro-scale production, smart homes, electric vehicles, reduced CO2 emissions, etc. The Demo2 Use Cases will analyse the potential for this LV network technology.

This demonstration has defined the purpose to test the Use Cases to monitor the power quality in the low-voltage network and to improve the outage detection by advanced technology for smart automation in the secondary substations. The Demo2 partners are convinced the chosen technology solution will show business beneficial values in relation to the system set up cost, which anticipates being manageable with reasonable effort in deployment and system monitoring.

REFERENCES

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