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Smart grid projects in Europe

Smart Grid-Projekte in Europa

Projets de réseaux intelligents en Europe

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Projets de réseaux intelligents en Europe

Smart-Grid-Projekte in Europa

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CENELEC
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Foreword

This document (CLC/TR 50608:2013) has been prepared by CLC/TC 8X "System aspects of electrical energy supply".

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Introduction

Worldwide interest in reducing the emission of greenhouse gases associated with the production of electrical energy has promoted a growth in distributed energy resources and renewable generation. A significant proportion of the electrical distribution infrastructure in Europe is reaching an age where it warrants major replacement or refurbishment. In considering such a major programme for asset replacement, it would seem sensible to look at the design and operation of the distribution infrastructure to make sure that the new networks make best use of available technology to address environmental concerns, for example minimising network losses and encouraging the connection of distributed generation. These considerations have given rise to the term ‘Smart Grids’. There are now a number of trial projects being conducted across Europe, and other parts of the developed world, to investigate the potential benefits of Smart Grids. To support the development of Smart Grids it would be advantageous if there were a suite of technical standards that described the various components that make up the Smart Grid and how these components operate in concert to deliver the benefits of improved network operations and reduced environmental emissions.

This Technical Report is based on the descriptions of 32 Smart Grid projects in seven countries. By collating the experiences of these early Smart Grid projects, it is intended that Cenelec will be able to identify those areas that would benefit from standardization.

1 Scope

This Technical Report provides an overview of the technical contents and regulatory arrangements of some 32 of the many Smart Grid projects that are currently in operation, or under construction, within Europe [1]. This Technical Report is intended to provide useful information to those organisations and individuals that are currently engaged or about to become engaged in developing Smart Grids. It is also intended that this Technical Report will be used to support the development of relevant standards by presenting the key learning points from early Smart Grid projects – it is widely accepted that the publication of relevant standards will accelerate the development of Smart Grids. It is recognised that this Technical Report only covers a sample of the Smart Grid projects within Europe; it would be impractical to attempt to include every project. It is assessed that the 32 projects shown in this Technical Report are sufficiently representative to provide information and draw early conclusions. Clause 2 of this Technical Report provides a brief overview of all 32 projects, Annex A contains details of the 32 projects as supplied by the countries that participated in the drafting of this Technical Report.

NOTE 1 In order to avoid losing potentially useful information, the details presented in Annex A are very close to the raw data provided by the different countries, with only minor editorial amendments made in the drafting of this Technical Report.

One of the key objectives of this Technical Report is to identify the learning objectives for each of the Smart Grid projects, i.e. why is the project is being carried out and how the success of the project in meeting these objectives will be determined.

NOTE 2 It is intended that the learning contained in this Technical Report, in particular the learning around what type of standards are required to support the development of Smart Grids, will provide useful input to the joint CEN/Cenelec/ETSI Smart Grid Co-ordination Group (SGCG). The SGCG has been established to support the requirements set out in the European Commission Smart Grid Mandate M/490, March 2011.

NOTE 3 In drafting this Technical Report the working group were made aware of a report with a similar scope to this Technical Report that was being produced by the European Commission's Joint Research Centre (JRC) [2]. The JRC report is now published and publically available. It is assessed that this Technical Report and the JRC report are complementary documents; the JRC report provides a high-level view on 220 projects that are being conducted across Europe whereas this Technical Report provides more detailed information on 32 projects.

This Technical Report presents the situation for the 32 projects as they are at the time of writing; as time moves on, it might be necessary to update this Technical Report or to produce a second edition containing information on more recent projects and learning from existing projects, such as those documented in this Technical Report.

2 Project overview

2.1 Rationale for developing the Smart Grid

All of the projects described in this Technical Report are taking place on electricity distribution networks; these networks are owned and operated by distribution system operators (DSO's), sometimes referred to as distribution network operators (DNO's).

1) All Cenelec member countries were invited to submit example projects for inclusion in this Technical Report, the 32 projects presented in this Technical Report represent the sum total of all projects that were submitted for consideration.

2) JRC Report, June 2011: *A view on Smart Grid projects in Europe: lessons learned and current developments*.

From the 32 Smart Grid projects described in this Technical Report, it is possible to determine a number of areas of common interest; however, there are also some significant differences. One common theme behind all projects is the need to try new technology in order to evaluate the potential benefits. Most of the projects are focussed on solving potential network problems rather than solving actual problems that exist on these networks now. The capacity of the low-voltage network to accommodate increasing levels of micro-generation, electric vehicles, heat pumps and other technologies is one of the most common potential problems that the Smart Grid trial is looking to address. A significant number of the trials are looking at the potential for networks operators to utilise controllable demand and network monitoring in order to accommodate more renewable generation connected to the MV network, this inevitably means a major requirement for customer interaction.

2.2 Costs and funding

The total cost of the 32 projects is approximately 516 M€ with a range from under 1 M€ to just over 60 M€, most projects sit in the range 2 M€ to 20 M€.

Only five of the 32 Smart Grid projects are funded entirely by the network operator i.e. there is no regulatory allowance for this expenditure, although some have received a contribution from other businesses with an interest in developing a Smart Grid. The remaining 27 projects receive a contribution to the overall project funding that comes from either central government or from regulated income, which comes from the electricity customers. The use of external funding is seen as incentivising network operators to conduct trials of new technology that might not be the most cost effective solution to a network constraint.

2.3 Duration

The typical duration of the Smart Grid projects described in this Technical Report is 3 years to 4 years. There is one project, NO-2 (see Table A.10), that has a duration of ten years, the reason for this is that Norway intend to use this project as a “national laboratory” to trial different use cases [3] over the ten-year period.

It is assessed that year one of the Smart Grid trial will be associated with planning, constructing and commissioning. Customer engagement will take place throughout the project, most significantly at the planning stage where customer support is essential. Once the Smart Grid is operational, performance will be monitored and trial objectives evaluated. It is assessed that the minimum monitoring period to give robust results is one year; a monitoring period of two years would increase the confidence in the results. Therefore, a trial period of 3 years to 4 years would appear to be the optimum time over which to implement and robustly evaluate a Smart Grid trial.

The majority of the projects described in this Technical Report, 27 out of 32, are designed to be permanent installations, with the intention of taking the Smart Grid from the status of proto-type to business as usual. Of the five non-permanent installations, for all but one it is intended to leave some of the Smart Grid infrastructure in-situ permanently. The clear intention is for the Smart Grid trials to set the design specifications for future networks.

Info will come out during the course of the project that can be fed into other projects and/or fed back into the project where the learning was developed, all aimed at improving the benefits that can be derived from the Smart Grid.

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3) The term “Use Case” refers to the use of a particular type of technology or system within a smart grid. The term "Use Case" has arisen during period when this Technical Report was being drafted. There is work going on within Cenelec and IEC to collect and catalogue generic Use Cases.

2.4 Project status

Nine of the projects described in this Technical Report have progressed to the development stage; 22 projects are still at the planning stage and one project is un-defined. The design and operation of electricity distribution networks has remained largely unchanged for decades and the vision of a Smart Grid requires significant investment in equipment and skills to make it a reality. Therefore, it should come as no surprise that it has proved a slow process to move from planning to development.

2.5 Stakeholders

In addition to the DNO's / DSO's who own and operate the distribution networks 4) there are a host of other parties (stakeholders) who have an interest in Smart Grids, including Regulators, Customers, Government bodies, Academia, Equipment suppliers and Consultants; all parties are having to adapt to a changing approach to designing and operating electricity networks. A common theme from all of the projects described in this Technical Report is the pivotal role that customers will need to play if the Smart Grid trial is to become a success. A number of the projects are investigating the potential to influence and/or rely on customer behaviour in order to optimise network capacity in terms of the ability to accommodate new generation and/or demand.

2.6 Networks and components

The questionnaire sought to gain information on the types of networks that have been chosen for the Smart Grid trials and information on the type of new technologies that are being trialled. The intention of the questionnaire was to gain an understanding of the rationale behind the selection of a particular network and the particular suite of Smart Grid components; and to identify if there are common areas that would benefit from a standardized approach to design / connection / operation.

The majority of the projects described in this Technical Report are focussed on the low voltage network, with a heavy emphasis on customer engagement via the use of smart meters. There is a mixture of area types from urban all underground cable networks to mixed overhead line and underground cable networks in suburban and rural areas. Network operators appear to be keen to investigate the potential viability of Smart Grids across the full range of area and network types, although the majority of the projects are based in urban and suburban areas in order to take advantage of the higher customer population and therefore the greater learning opportunity for the projects.

A common theme across all projects is the desire to identify how much extra capacity can be extracted from the existing networks by optimising the use of demand and generation. To achieve this optimisation a number of the projects plan to employ smart meters with the associated communication infrastructure. In addition, some projects are trialling the use of generation to support network voltage control by control the power and reactive power of the generation.

A large number of the projects include the provision of supplies to electric vehicle (EV) charging points; at least two of the projects are associated with major EV initiatives. Network operators are keen to understand the impact that EV charging will have on the distribution network, what will be the daily, weekly, annual charging regimes and what will be the diversity between users. Some projects are investigating the potential for intelligent charging, where the charging of EV's is aligned with the output from wind turbines connected at HV or above.

Heat Pumps (HP's) feature in some projects. As with EV's the network operators are keen to understand the impact that HP's might have on the low voltage network, in particular the operating cycles and how customer usage might be influenced by providing the customer with information via smart meters and the by the use of innovative tariffs.

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4) There are cases where DNOs/DSOs are operators but not owners of a distribution network.

Battery energy storage features in ten of the projects. Some projects are planning to install standalone battery storage units, ranging in size from kW to 2,5 MW. In all cases it appears that the intention of including storage in the trial is to investigate the potential for batteries and other storage media (hot water heating in one project and cold stores another project) to support network optimisation by absorbing surplus generation and/or to reduce peaks in demand. Although some of the responses have made reference to electric vehicle (EV) batteries in response to the question on storage, it has been confirmed that there is currently no intention for these projects to investigate the potential for the batteries in EVs to act as an energy storage component that can be called upon to support the network.

2.7 Generation

The questionnaire asked for information on the number, size and type of any generation installed within the Smart Grid trial:

It has been reported that all projects include generation connected to the distributed network (distributed generation). There is a range of generation types and sizes ranging from kW photovoltaic generation connected at LV through to 10's MW Wind, Hydro, Biogas, CHP connected at MV / HV. In most countries, there are financial incentives that encourage the connection of renewable generation. These incentives have accelerated the growth of distributed generators seeking connection. The Smart Grid trials are investigating the opportunities for connecting more generation to existing networks by optimising the use of both demand and generation, which is reliant upon information and communications in order to dynamically permit or constrain operation of the demand and/or generation. Some projects are investigating the use of dynamic thermal ratings of overhead lines in order to determine the dynamic capacity of the line, which in turn will permit / constrain the generation connected to the network.

2.8 Customers

A major requirement for the Smart Grid is customer engagement: if customers cannot be influenced to modify their demand, either actively or passively, it will limit the opportunities for network optimisation.

The projects described in this Technical Report are mainly concerned with customers connected at LV, typically residential (domestic) customers. Two projects are looking at the role that can be played by larger customers in managing their demand in response to signals from the network operator, again these projects are aimed at optimising the operation of the network, in these cases it will be the HV and EHV networks.

2.9 Standards

As described in the Scope, it is intended that the learning contained in this Technical Report, in particular the learning around what type of standards are required to support the development of Smart Grids, will provide useful input to the joint CEN/Cenelec/ETSI Smart Grid Co-ordination Group (SGCG). The SGCG has a sub-group that is tasked with identifying a "first set of standards" for Smart Grids.

A small number of project descriptions have suggested that there is a need for standards in the areas of Interconnection, Interoperability (between smart appliances and smart network components) and the connection of electric vehicles. Other projects have suggested that no new standards are required for the Smart Grid trials to take place; and some project descriptions have suggested that it is too early to decide which areas require new standards.

One country has identified the potential need for interface standards between Smart meters and external equipment such as displays and smart house control equipment including also dynamic price/tariff information. This suggestion comes in recognition that customers might wish to respond to changes in electricity pricing throughout the day. Although this potential requirement has been identified and the responder is aware that some progress is being made in this area, it is not being studied in detail within their project.

Annex A
(informative)

Smart grid project descriptions

Annex A contains a non-exhaustive list of Smart Grid projects that are currently in planning or under construction in Europe. The project descriptions were provided by the members of CLC/TC8 X, Working Group 5.

Austria	AT 1 – 9 (see Table A.1, Table A.2 and Table A.3);
Denmark	DK 1 – 4 (see Table A.4 and Table A.5);
France	FR 1 – 4 (see Table A.6 and Table A.7);
Germany	DE 1 – 4 (see Table A.8 and Table A.9);
Norway	NO 1 – 2 (see Table A.10);
Spain	ES 1 – 3 (see Table A.11);
United Kingdom	UK 1 – 6 (see Table A.12 and Table A.13).

Table A.1 — AT 1 – 3

Austria	AT1	AT2	AT3
Title	DG DemoNet - Smart LV Grid Control concepts for active low voltage network operation with a high share of distributed energy resources	DG DemoNet Validation Active operation of electricity distribution networks with a high share of distributed generation – Validation of voltage control concepts	E-Mobile Power Austria (Lighthouse Project of Austrian Mobile Power) Control concepts for active low voltage network operation with a high share of distributed energy resources
Country	Austria	Austria	Austria
Value (Euros)	~ 2,2 M€	~ 1 M€	21 M€
Funding mechanism / Regulatory Arrangements	The project is funded by the Austrian Climate and Energy Fund (http://www.klimafonds.gv.at)	The project is funded by the Austrian Climate and Energy Fund (http://www.klimafonds.gv.at)	The project is funded by the Austrian Climate and Energy Fund (http://www.klimafonds.gv.at)
Scope (Brief description)	Following this paradigm shift, the project "DG DemoNet – Smart LV Grid" searches for solutions for an active network operation at the low voltage level. The project develops and evaluates smart planning, monitoring, management and control approaches for the system integration of local energy production and flexible loads (e.g. heat, e-mobility) in low voltage networks.	In the rural distribution network structures, typical for Austria, the increase of voltage through the feeding in of decentralised energy generation plants has turned out to be the most important system limitation when integrating the generation units. The main project target is to integrate a maximum of decentralised generation units based on renewable energy resources into the electric distribution network (medium voltage networks) without reinforcement of the network.	Within the framework of the project, an integrated system solution for electric mobility will be developed and implemented for the first time in close collaboration with all partners from the automobile industry, infrastructure technology, energy supply and science sectors. On the one hand, methodology will be based upon findings concerning the requirements and expectations of users from existing and new electric mobility model regions; on the other hand, integrated and standardized system architecture, as well as a road map, will be developed in a broad, joint examination of requirements and solution options.

Austria	AT1	AT2	AT3
Selection criteria and Objectives (learning outcomes)	The project aims to enable an efficient and cost effective use of existing grid infrastructures based on a three-step concept: intelligent planning, on-line monitoring, and active LV grid management. Communication-based systems for automatic control concepts for low voltage grids will be developed and evaluated by putting them into practice. In the project, real tests of solution approaches for central and distributed monitoring, management and control concepts will be performed.	In the project DG DemoNetz-Validierung, the voltage control concepts for medium voltage networks developed in the former projects DG DemoNetz-Konzept and BAVIS will be implemented in reality in the analysed grid sections in Vorarlberg and Salzburg by using test platforms. This will allow validating the simulation results from the projects DG DemoNetz-Konzept and BAVIS in a field test. The detailed results of the project are: • Development of a technical solution (ICT & ET) that complies with the requirements of the developed control concepts. • Examination of the general applicability of the results. • Compilation of an operational concept • Analysis of the long-term cost savings, compared to traditional network planning concepts	Following an integrated demonstration run, a national implementation of the central infrastructure components will be established for Austria. The developed standards and technologies are available for the application of electric mobility in the model regions.
Timetable (Start and Finish)	2011-2014	2010-2013	2010-2013
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	The equipment will be permanently installed	Permanent installation because special measures are already needed to integrate more distributed generation into the network.	
Current status and results	The project is currently in the planning phase (network selection, network user recruitment)	• Final development of the central voltage control unit • Installation of the equipment • Contracts with generator owners	

Austria	AT1	AT2	AT3
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• DNO • Equipment manufacturer • Regulator • Customers	• DNOs • Equipment manufacturers • Regulators	• DNOs • Equipment manufacturers (automotive and electrical industry) • Investors
Generation	Photovoltaic generators (hundreds) from a few kW to a few tens of kW	• About five controlled generators per region • Mainly small hydro (but also PV and biomass, currently not controlled) • A few hundreds of kW to a few MW	
Network	• LV network (0,4 kV) • Rural / suburban • Underground / overhead	• MV network (30 kV) • Rural network • Mixed over-head and underground	• LV network • Urban and suburban
Demand	• E-vehicles • Heat-pumps		• E-vehicle
Customers	• Smart meters will be used as distributed sensors and gateways will be used to interact with customers equipment	• Generator owners are actively involved through bilateral contracts	• Smart Metering
Communications	PLC for smart metering	• Radiofrequency • PLC • SCADA system	• Under development
Storage	Storage from e-vehicles will be used		
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Interconnection standards need to be adapted to allow the participation into the network operation	• Communication standards for PLC are partly missing for the intended use. • Standardized interfaces are also missing • Interconnection standards need to be adapted to allow the participation into the network operation	• Standards in the field of e-vehicle are missing

Austria	AT1	AT2	AT3
Was there a need to solve interoperability problems? If so how was this done?	Yes, still under process	Yes, still under work	
Information sources (public domain)	Not yet	Smart Grids Projects in Austrian R&D Programmes 2003-2010 http://www.nachhaltigwirtschaften.at/edz_pdf/1016_smart_grids_projects.pdf	www.austrian-mobile-power.at
Any other comments / observations			