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Smart grid projects in Europe

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National foreword

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Smart grid projects in Europe

Projets de réseaux intelligents en Europe

Smart-Grid-Projekte in Europa

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

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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).

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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.

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			

Table A.2 — AT 4 – 6

Austria	AT4	AT5	AT6
Title	ISOVLES: PSSA:M Innovative Solutions to Optimise Low Voltage Electricity Systems: Power Snap-Shot Analysis by Meters (PSSA-M)	metaPV – Metamorphosis of Power Distribution Dis	More PV2Grid More functionalities for increased integration of PV into grid
Country	Austria	EU	Austria
Value (Euros)	~ 700 k€	> 9 M€	~ 350 k€
Funding mechanism / Regulatory Arrangements	The project is funded by the Austrian Climate and Energy Fund (http://www.klimafonds.gv.at)	EC FP7	The project MorePV2Grid is funded by the Austrian Climate and Energy Fund (http://www.klimafonds.gv.at)
Scope (Brief description)	The existing low voltage networks in their traditional form are not rated for integrating a high number of renewable electricity producers. Today, the relevant decisions on connecting decentralised energy plants in low voltage networks are based on calculations related to estimated peak demands in single line sections. For this reason, during the planning, high safety margins have to be considered in addition. This is consequently restricting the capability of connecting distributed generation plants.	MetaPV will provide the scientific basis for transforming photovoltaic from a troublesome and variable source of power to active support for a more intelligent grid. Amidst growing concerns regarding the capacity of the grid to support large-scale integration of renewables, MetaPV is a first step towards a reliable solution for PV integration. Instead of creating new grids or reinforcing the current one to increase capacity, it is possible to opt for a more evolutionary approach. Putting to use both advanced new communication technologies and the possibilities of PV itself, will enable an increase in grid hosting capacity at a lower cost. More PV can help improve power quality, safety and security of supply.	A concept for local autonomous voltage regulation at distributed small photovoltaic-plants will be evaluated within field experiments in the project morePV2grid. Reactive power and power injection are used to increase or decrease voltage. Thus PV-plants could develop from ”Troublemakers“ to ”Troubleshooters“ and an increased penetration of DG would be possible.

Austria	AT4	AT5	AT6
Selection criteria and Objectives (learning outcomes)	The objective of the project ISOLVES:PSSA-M is to define and develop the required technical foundations to enable an increasing number of distributed energy feed-in opportunities in low voltage networks. For this purpose, a method is developed to take an instantaneous image of the network, the so-called "Power Snap-Shot Analysis by Meters" (PSSA-M), and will be applied together with the smart meters to be adapted in the framework of the project. The following possibilities offered by an analysis of the instantaneous image of physical parameters in a low voltage network will be used: load flow and load distribution, critical voltage states, fault location, etc. By analysing the obtained measurement data of up to 100 different low voltage networks (including those with urban and rural structures) low voltage networks models can be developed and validated more precisely which leads to an essential improvement of network planning and network operation in distribution networks. The developed grid models and measured loads can be used to simulate future scenarios with high penetration of PV-Systems or loading e-vehicles for single phase or three phase components.	MetaPV is demonstrating for the first time out of the lab and in the real world, on both a technical and financial level, that PV can actively contribute to network operation. The project will focus specifically on quantifying the additional benefits from PV, to provide real insight for future grid developments.	The objective of the project morePV2grid is to develop and validate concepts for controlling the voltage with photovoltaic installations. The concepts allow numerous distributed PV-systems to contribute to voltage-keeping by autonomous adjustment of power and reactive power injection without supervisory system and communication technology. The main result of the project will be a set of validated control concepts with a high potential for wide-scale implementation in low voltage networks (e.g. with a detailed characteristic or control algorithm).
Timetable (Start and Finish)	2010-2013	2009-2014	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?	Permanent installation	Permanent	Permanent

Austria	AT4	AT5	AT6
Current status and results		Planning almost completed; development under finalisation. Demonstration phase started.	• Control under development • Lab tests under development
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• DNO • Equipment manufacturer • Customers	• DNO • Equipment manufacturers • Investors • Regulators	• DNO • Equipment manufacturer
Generation	Small generators (mainly PV), uncontrolled	> 100 installations Installations from a few kW to a few MW. In total more than 6 MW.	Small PV (for households) < 10 kW Less than ten installations on a same LV feeder
Network	• LV network • Rural and Urban • Underground and overhead	• MV and LV • Urban /suburban • Mainly cable network	• LV network • Rural / suburban • Underground / overhead
Demand	• Passive demand (e.g. heat-pumps)		
Customers	Smart metering will be used as a way to gather useful information about the network status		• Smart meters used for validation
Communications	• PLC	• GPRS for monitoring purpose • SCADA	• Communication only used for monitoring and validation purpose
Storage		Some of the inverters (10 %) will feature storage capability (lead-acid or Li-ion battery) Function: voltage control, congestion management, self-consumption	
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 must be adapted Planning practises must be adapted	Interconnection standards must be adapted

Austria	AT4	AT5	AT6
Was there a need to solve interoperability problems? If so how was this done?	Yes, currently under process	Yes, still under progress	
Information sources (public domain)	Andreas Abart et.al, 2011, Power SnapShot Analysis: A new method for analyzing low voltage grids using a smart metering system, CIRED 2011 Frankfurt, 6-9 June, Paper Number 1083	www.metapv.org	Smart Grids Projects in Austrian R&D Programmes 2003-2010 http://www.nachhaltigwirtschaften.at/edz_pdf/1016_smart_grids_projects.pdf
Any other comments / observations			

Table A.3 — AT 7 – 9

Austria	**AT7**	**AT8**	**AT9**
Title	Smart Grid Model Region Salzburg	SGMS – B2G Smart Grids Modellregion Salzburg – Building to Grid	ZUQDE Smart Grids model region Salzburg – Central voltage and reactive power control with distributed generation
Country	Austria	Austria	Austria
Value (Euros)		640 k€	Approximately 600 k€
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)	In October 2009, Salzburg AG submitted together with partners a bundle of projects in the third tender of “New Energies 2020” for the research, development and demonstration of intelligent networks and the integrated concept with the vision of a comfortable, intelligent “Smart infrastructure" with preserved resources and could establish the first Smart Grid model region of Austria in Salzburg. The Smart Grid Model Region Salzburg (SGMS) is supported by an interdisciplinary team of energy industry (Salzburg AG), housing industry (Salzburg Wohnbau), industry (Siemens AG, Fichtner) and top-class research partners (Austrian Institute of Technology, TU Wien, CURE).	In the context of so-called Smart Grids, buildings are expected to integrate in a cooperative manner and to expose their currently unused flexibility of operations (shiftable loads, load shedding, duty-cycling, etc.), supported by building automation and information technology. Building optimisation and grid optimisation, typically decoupled in existing solutions, shall be harmonised. An experiment shall show the potential for grid relief and efficiency improvements of intelligent buildings in a Smart Grid.	In recent years, more attention has been devoted to the computer modelling and analyses of distribution networks. Distribution Management Systems (DMS) with advanced Network Application are now available to facilitate system monitoring and controlling. However, the penetration of DGs and their versatile nature is challenging the relative new software.

Austria	AT7	AT8	AT9
Selection criteria and Objectives (learning outcomes)	The aim of the SGMS is to aggregate different Smart Grid applications and issues in an integrated system and to implement lighthouse projects in the real environment, considering with problems of daily business and addressing specific customer needs. In addition to development and demonstration of technical solutions notably, research and analysis in the field of customer-integration / -acceptance and usability play a central role.	It is the goal of the project to investigate in a series of experiments where the limits of intelligent buildings in a Smart Grid are. For this, a number of generic load models for buildings must be developed and embedded into an interoperable communication infrastructure. The investigated objects will be medium and large size residential and commercial buildings, the test cases will be conducted semi-automatically. Results are figures about the operational potential of "active" buildings and communicable and aggregatable load models, constituting a stepping-stone to the intelligent, smart-grid enabled building.	ZUQDE will develop further the DMS application Volt/var Control (VVC) to keep a certain voltage level in the whole distribution network with a high penetration of Distributed Generation (DG). This will enable three possible actions: changing the reactive power output of DG units, changing transformer taps, switching capacitor banks. The experimental development will be finalised with the closed loop operation of VVC in the network of Lungau, Salzburg.
Timetable (Start and Finish)	2010-…	2010-2013	2010-2012
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Partly permanent, partly removed	The equipment permanently installed.	Permanent
Current status and results	Projects under progress (planning and first steps of implementation)	Load modelling under progress and preparation of the experiments	• Recruitment of generators owners • Upgrade of generators with communication facilities.
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• DNOs • Equipment manufacturers • Customers • Generators	• DNO • Equipment manufacturer • Research • Investors	• DNOs • Manufacturers • Generator owners
Generation	• Hundreds of generators • From few kW to few MW • Small Hydro, PV, biomass…		• About 5 small hydro power (controlled) • Several 100 kW to a few MW

Austria	AT7	AT8	AT9
Network	• MV and LV • Urban and rural	• Voltage level: LV and MV • Urban, suburban	• MV (30 kV and 10 kV) • Rural • Underground / overhead
Demand	• HVAC • Lighting • Heat pumps • E-vehicles	• Private and commercial buildings • Heating, ventilation, air-conditioning (HVAC) • Lighting • Heat pump	
Customers	• Smart metering used		
Communications			• Radiofrequency
Storage			
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?		Existing standards are not sufficient.	• Interconnection standards must be adapted to cover the active participation of generators to the network operation
Was there a need to solve interoperability problems? If so how was this done?	Yes, not fully solved	Yes, this still need to be done.	Yes, currently under process
Information sources (public domain)		Smart Grids Projects in Austrian R&D Programmes 2003-2010 http://www.nachhaltigwirtschaften.at/edz_pdf/1016_smart_grids_projects.pdf	Smart Grids Projects in Austrian R&D Programmes 2003-2010 http://www.nachhaltigwirtschaften.at/edz_pdf/1016_smart_grids_projects.pdf
Any other comments / observations			

Table A.4 — Denmark 1 – 2

Denmark	DK1	DK2
Title	Twenties	Edison
Country	Denmark	Denmark
Value (Euros)	56,8 M€	6,5 M€
Funding mechanism / Regulatory Arrangements	Funding mechanism EU FP7	Funding mechanism National PSO funding (ForskEL)
Scope (Brief description)	Demonstrating by early 2014 through real life, large scale demonstrations, the benefits and impacts of several critical technologies required to improve the European transmission network, thus giving Europe a capability of responding to the increasing share of renewable in its energy mix by 2020 and beyond while keeping its present level of reliability performance	The project will assess the introduction of electrical vehicles in the Danish electricity system and develop frameworks and technical solutions that enable a more wide scale demonstration. The solutions must allow the electrical vehicles to be charged intelligently in terms of system stability and bottlenecks in the local electricity grid.
Selection criteria and Objectives (learning outcomes)	The TWENTIES project is intended to lead to the development of new model tools and operational support tools for a power system with high penetration of power generated from wind farms and their joint operation with thermal plants.	More effort needs to be put in to battery development in order to improve efficiency. Electrical noise is a problem. Cable max. capacity became a problem with many EV in the same area. A further need for development of smart charging of EV
Timetable (Start and Finish)	2010-2014	2009-2011
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	A permanent installation	A permanent installation
Current status and results		A lot of report writing left. The 21.09.2011 press conference. Q1 2012 delivery.

Denmark	**DK1**	**DK2**
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	Universities and research institutions and industrial companies and utilities	Universities and research institutions and industrial companies and utilities
Generation	Wind power and thermal plants.	Wind power
Network	50/10 kV and 10/0,4 kV	60/10 kV and 10/0,4 kV
Demand		A lot of focus on Electric Vehicles
Customers		Only 5 customers with smart meters and Electric Vehicles
Communications		Main standard used EN 61851-1 (EN 61850-7-420)
Storage		Yes, batteries in EV
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Don’t know yet	Need for new standards where a problem, e.g. charging plugs
Was there a need to solve interoperability problems? If so how was this done?	Don’t know yet	
Information sources (public domain)	http://www.twenties-project.eu	http://www.edison-net.dk/
Any other comments / observations		

Table A.5 — Denmark 3 – 4

Denmark	DK3	DK4
Title	iPower	Ecogrid
Country	Denmark	Denmark
Value (Euros)	8 M€	21 M€
Funding mechanism / Regulatory Arrangements	Danish Government. Danish Agency for Science and Technology and Innovation (SPIR)	Funding mechanism EU FP7
Scope (Brief description)	In the iPower project, they will develop and demonstrate solutions that cover all critical aspects of intelligent energy systems with flexible consumption.	The project will be based on a single full-scale demonstration of a complete distribution system covering the Bornholm distribution grid, which is part of the Nordel interconnected system. The Bornholm system has very high penetration of a variety of low-carbon energy resources, including wind power [30 MW], CHP units [37 MW], Biogas units [2 MW], PV units [1 MW growing to 5 MW] (under implementation), active demand [28 000 consumers – 55 MW peak load and 239 MWh annual energy demand] and Electrical Vehicles (under rollout).
Selection criteria and Objectives (learning outcomes)	How to make the shift from consumption-driven power generation to production-driven electricity. How to develop a complete Smart Grid.	Drivers in the project are full-scale deployment and operation of all Smart Grids facilities in a real grid on the island of Bornholm in Denmark. With a real time market, DER, 50 % Renewable energy and prosumers.
Timetable (Start and Finish)	2011-2016	2011-2014
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	It is not decided yet. Some of the installation will only be done in test labs.	A permanent installation
Current status and results	It is in the very beginning the first articles will be available in the end of 2011	It is in the very beginning.

Denmark	DK3	DK4
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	32 partners, universities and research institutions as well as industrial companies	Universities and research institutions and industrial companies
Generation	Wind, PV and power plants	Wind, PV and power plants
Network	50/10 kV and 10/0,4 kV	50/10 kV and 10/0,4 kV
Demand	Direct and indirect control Smart Grid box at the end user. Yes, Heat pumps and Electric Vehicles.	Direct and indirect control Smart Grid box at the end user. Yes, Heat pumps and Electric Vehicles.
Customers	Mostly test facilities. Unknown.	2000 customers 2000 smart meters
Communications		
Storage	Battery storage in test labs.	Heat appliances and batteries of the electric vehicles.
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Don't know yet	Don't know yet
Was there a need to solve interoperability problems? If so how was this done?	Don't know yet	Don't know yet
Information sources (public domain)	www.ipower-net.dk	www.eu-ecogrid.net
Any other comments / observations		

Table A.6 — France 1 – 2

France	FR1	FR2
Title	ENRPool	GreenLys
Country	France	France (Grenoble & Lyon)
Value (Euros)	2,5 M€	40 M€
Funding mechanism / Regulatory Arrangements	ADEME No participation of CRE (French Electricity regulator)	ADEME No participation of CRE (French Electricity regulator)
Scope (Brief description)	To match industrial customers consumption with Wind/PV generation	Automatic Metering Intelligence
Selection criteria and Objectives (learning outcomes)	To reduce peak consumption and to increase consumption during high level of generation	Coherence between aggregator behaviour and local DNO Viability of aggregator
Timetable (Start and Finish)	2011 - 2014	2011 - 2014
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Yes but, linked with funding rules	Yes but, linked with funding rules
Current status and results	Validated but not signed yet	Validated but not signed yet
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	Generator/Aggregator/Industrial customer	DNO/Suppliers/Generators/Equipment manufacturers/Customers
Generation	A few dozens Existing PV/Wind 450 MW	100 kW with Combined Heat Power and PV

France	FR1	FR2
Network	From 400 kV to 20 kV Urban and Rural Overhead and Underground	20 kV and 230/400 V Urban and Rural Overhead and Underground
Demand	Passive No Electric Vehicles	Passive No Electric Vehicles
Customers	Around 10 Smart metering Volunteer	1 000 Smart metering (Linky) Volunteer
Communications	No Communication, manual control	CPL (Linky) and IP for aggregator Yes
Storage	No storage	No storage
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Yes	Yes. The major aspect is related to regulation.
Was there a need to solve interoperability problems? If so how was this done?	No	Several manufacturers to test interoperability
Information sources (public domain)	Partially	Partially
Any other comments / observations	No	No

Table A.7 — France 3 – 4

France	FR3	FR4
Title	Millener Project	NICEGRID/GRID4EU
Country	France (Guadeloupe/Reunion/Corsica)	France
Value (Euros)	30 M€	
Funding mechanism / Regulatory Arrangements	ADEME No participation of CRE (French Electricity regulator)	ADEME
Scope (Brief description)	To support the Island grid. 1 000 house holders with demand response 500 PV systems with storage	Aggregation mechanism of several Distributed Energy Resources in order to balance the demand. Interaction with TSO, DSO, Energy providers
Selection criteria and Objectives (learning outcomes)	Operation of distributed storage and generation	
Timetable (Start and Finish)	2011 - 2014	December 2010, to run for 2,5 years
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Yes but, linked with funding rules	
Current status and results	Project validated and signed	
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	DNO/Suppliers/Generators/Equipment manufacturers/Customers	Supplier, Equipment Manufacturers, Research Center, Academic
Generation	500 PV systems of 3 kW	
Network	230 V – 50 Hz Rural Overhead	Transmission and Distribution

France	FR3	FR4
Demand	controlled	Controlled - Mostly PV, Microgrid
Customers	1 500 Smart metering Volunteers	Involvement regarding generation, load, consumption
Communications	GPRS or IP Scada for manual action on DMS Yes	
Storage	• 500 in total: • 250 x 4,2 kW and 250 x 8,4 kW • Li/ion • Multi function	
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Yes. The major aspect is related to regulation.	
Was there a need to solve interoperability problems? If so how was this done?	Several manufacturers to test interoperability	
Information sources (public domain)	Partially	
Any other comments / observations	No	

Table A.8 — Germany 1 – 2

Germany	DE1	DE2
Title	E-DeMa – development and demonstration of locally networked energy systems to the E-Energy marketplace of the future	eTelligence
Country	Germany	Germany
Value (Euros)	20 M€	Funded by BMWi (10 M€), Budget about 20 M€
Funding mechanism / Regulatory Arrangements	Funded by the German Federal Ministry of Economics and Technology	Funded by BMWi (10 M€), Budget about 20 M€
Scope (Brief description)	A general differentiation is made between those people who generate electricity and those who use it, the customers. E-DeMa does not use the word customer; it is replaced by „Prosumer". This is taken to mean the active customer who both generates electricity and feeds it into the grid (producer) and uses this electricity (consumer). This is one of the most important goals of the project: the encouragement of the end consumer's active involvement and participation in the energy market. The E-Energy Marketplace 2020 to be established within the scope of the project is based on the distribution grid of RWE Deutschland AG; the model regions Mülheim and Krefeld are part of this distribution grid. A key aim is to integrate „Prosumers" by means of IKT gateways which enable both the load management and control of household devices, smart metering as well as the control of local feeders. The benefits are manifold: displayed energy consumptions or price signals for the prosumer, online information for an improved grid management by the network operator. E-DeMa creates an integral infrastructure to control the consumption with an active involvement of the consumer and on the basis of which further energy services can be established.	The idea behind eTelligence is the intelligent system integration of electricity generation and consumption. Here, system integration means that both network and market aspects are taken into consideration. On the network side, we have to ensure that even a large portion of decentralised generation such as wind farms do not jeopardise quality of supply. It is the aim on the market side to have all protagonists involved. Such intelligent system integration can be achieved by means of modern ICT solutions only. In terms of communication, the protagonists have to be involved in order to exchange information on the current state of the system and control optimised operation actively. Thus, a regional market place for electric power is supposed to be developed within the framework of the eTelligence demonstration project. In this connection, integrating all protagonists is important, and hence the definition of market rules, products, and access mechanisms. Small consumers and producers are integrated via tariffs and incentive programs, since these make little demands to communicational integration. Contrary to this, larger units have to be controlled in real-time, for which reason the development and proving of direct control systems is required. The intended solutions are supposed to be implemented at large scale. Scalability and exploitation are allowed for by employing international standards.

Germany	DE1	DE2
Selection criteria and Objectives (learning outcomes)	In future the customer should be able to organise his electricity consumption on when the price is cheapest during the day The consumer/customer should be able to act as a provider on the energy marketplace The low supply amounts of individual households can be concentrated by the energy marketplace	Expected benefits: • Increase market transparency via an internet based and standardized business platform • Increase market participation via an open energy market especially for small generators • Increase energy efficiency via roll out of smart meter and feedback system • Increase cost effectiveness via for example reduction of communication costs • Ensure security of supply via a regional matching of generation and supply • Reduce environmental pollution via improved integration of renewable energy • Analyze political and regulatory burden which can be a showstopper for the new energy system
Timetable (Start and Finish)	November 2008 – December 2012	November 2009 – October 2012 (4 years)
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	The project is a trial, most of the equipment will be removed after the trial period	eTelligence field tests new technologies, therefore we have to remove most of these prototypes after the project. After the project, the new smart meter at the households will be of no use for the tester, so we have to change the systems. The technologies at the industrial tester and the grid equipment will be used after the field test – if possible - and the technologies are still working stable.
Current status and results	• Most of the theoretical work has been completed including simulation models and pricing models/products for the marketplace • Required subsystems have been developed and are currently tested • System integration test will start Q4 2011 • Preparation of field trials for Q2 2012 started	Since 01.2011, the local eTelligence market works and the market participants trade their energy with respect of real money. Sind June 2011, 650 households in the test region use new smart meter, feedback systems and traffics.

Germany	DE1	DE2
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• Customers • Generators • DNO's • municipal utilities • Equipment manufacturers • Service providers	DSO, Supplier, Generators (wind, PV, biogas), industrial consumers, households Contact to German politic and regulator
Generation	12 Combined heat and power (CHP), 1 kW	• 2 micro CHPs (0,23 MW_{el}, 0,36 MW_{th}) • 1 micro-CHP 0,06 MW • 1 photovoltaic 0,08 MW_{el} • 1 wind farm, 0,60 MW_{el} • 2 cold storage houses (0,26 MW_{el} and 0,25 MW_{el})
Network	• 400 V • Urban • Underground cable	• Low and medium voltage level • Urban (small city) • Underground
Demand	Integration of smart-enabled appliances like dryers or washing machines	• Controlled demand of industrial consumers • Passive demand of households via tariffs
Customers	Planned 1 610 customers in field trial Smart metering and regional energy marketplace	• 650 • Smart Meter • Passive demand of households via tariffs • Use of new feedback systems
Communications	• Smart meter communication: M-Bus (local) and GSM (wide area) • Market place communication via DSL	• use of existing DSL or UMTS • secure channels
Storage	No storage devices used in the project	Two cold storage house, used to smooth incorrect prediction of wind- and PV-production

Germany	DE1	DE2
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	Implementation of open standards for smart appliances and smart home controllers are	eTelligence uses – as far as possible – existing standards such as EN 61850 or the Common Information Model (CIM). To communicate with new market participants, e.g. cold storage house, the project adjusts these standards.
Was there a need to solve interoperability problems? If so how was this done?	Yes, the integration of smart appliances was done via protocol converters Standardization and interoperability of communication protocols for smart appliances are still missing	Problem: ensure the interoperability of different participants like micro-CHP or cold storage house to realise a local market. Solution: Using and adjusting given standards (EN 61850, CIM)
Information sources (public domain)	http://www.e-dema.com/en/	www.etelligence.de
Any other comments / observations		-

Table A.9 — Germany 3 – 4

Germany	DE3	DE4
Title	E-Energy project “Model City Mannheim”	Regenerative Modellregion Harz, short “RegModHarz”
Country	Germany	Germany
Value (Euros)	Budget 20,8 M€	Circa 17 M€
Funding mechanism / Regulatory Arrangements	Funded by the German Federal Ministry of Economics and Technology	Funding 10 M€ by the federal ministry for the environment
Scope (Brief description)	The Model city of Mannheim project concentrates on an urban conurbation with a high penetration rate in which renewable and decentralised sources of energy are used to a large extent. Within the framework of the E-Energy project, a representative large-scale trial is being conducted both here and in Dresden to demonstrate the project can be applied and translated to other regions. The trial uses new methods to improve energy efficiency, grid quality, and the integration of renewable and decentralised sources of energy into the urban distribution network. The focus is on developing a cross-sectoral approach (involving electricity, heating, gas and water) to interconnect the consumption components with a broadband power line infrastructure. Electricity is offered to customers close to the point of generation and directly when the power is generated. This avoids transporting power (and associated power loss), and includes the use of decentralised energy storage units. Proactive users in the energy market ("prosumers") can gear their power consumption and their power generation towards variable pricing structures. Furthermore, real-time information and energy management components also aim to help the customer contribute to even greater energy efficiency.	The project has three main goals 1. Construction of a vpp for monitoring and controlling of DER 2. Investigation of different business models for the vpp 3. Support of network operation by network monitoring and provision of ancillary services
Selection criteria and Objectives (learning outcomes)	Enabling the network to integrate users with new requirements, Enhancing efficiency in day-to-day grid operation Ensuring network security, system control and quality of supply Improving market functioning and customer service Enabling and encouraging stronger and more direct involvement of consumers in their energy usage and management	See above

Germany	DE3	DE4
Timetable (Start and Finish)	November 2008 – October 2012	November 2008 – October 2012
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Integrated System (pilot project which focuses on the integration of different Smart Grid technologies and applications, e.g. smart meter, demand response, grid automation, distributed storage, renewables, etc.)	The equipment is removed because in research projects it is not possible to produce commercial products. Of course, the industry partners will use the knowledge made in the project for the development of their products.
Current status and results		In the project, we defined seven ShowCases. With these ShowCases, we will demonstrate the most important project results. A description of the ShowCases can be found on the project homepage (www.regmodharz.de). All ShowCases are still under construction, but we were able to show pre-versions of the ShowCases on different events. At HMI (Hannover Messe Industrie) in April 2011, we were able to demonstrate a first prototype of the virtual power plant control centre.
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	Households and DNO	We have circa 20 project partners. (TSO, DSO, energy provider, research institutes, consultants, wind farm operator,...)
Generation	Co-generation (simulation only)	For the ShowCases, different generators in the district Harz will be connected to the vpp. A wind farm (62 MW), biogas plants (~ 2 MW), solar generators (~2 MW), CHP (~4 MW). Simulations are done with all generators in the district Harz and for different scenarios (2008, 2020, 100 %). Installed capacities in the district Harz: • Wind: 150,6 MW • Bio: 9,6 MW • CHP: 14.7 MW • PV: 10,4 MW • Water: 7,2 MW

Germany	DE3	DE4
Network	Distribution grid, Urban network	All voltage levels exist in the Harz district. The focus in the project is on medium level (DSO). The Harz district is a rural region.
Demand	• Passive demand (with local control) • Control of household appliances (white goods) • (Heat pumps, simulated)	There will be a field test where 46 households will get a variable price signal for one year. It is planned to include households with electric vehicles in this field test.
Customers	• 1 000 customers for field test • Smart meters • Customers can save money through variable tariffs • Selected customers were given a tablet pc with an application to monitor their energy consumption	s. Demand
Communications	• Communication to households • Broadband over Powerline (BPL) • Secured VPN within the project	The connection of the DER to the vpp is done with an ICT Gateway developed in the project. We defined a logical node according to EN 61850 for the energy management. This logical node consists of circa 10 parameters. This parameter set should describe all kinds of storage (biogas plants, batteries,...) and demand side management applications.
Storage	Only considered in theory	Beside the biogas plants and CHP, no storage will be connected to the vpp. Simulations are done with different kind of storage (pump storage plants, electric vehicles,...) varying in power and storage capacity.
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	EN 61968-11 / EN 61970-301 / EN 61970-501 (CIM) is used to exchange market data with households and it is intended to develop a standardized household bus system (EEBus). It is recognised that standards should be used, but due to the insufficiency for the project's needs, the plan to use standards was partially discarded and proprietary solutions were implemented where necessary. Considering the update of standards, especially EN 61850 should be extended to better support the control of distributed energy resources, and the CIM should be extended to better support market specific tariffs and price signals. Moreover, standards to control household appliances are considered a problematic factor.	With the logical node, we make a first suggestion for a standard parameter set for the communication between the vpp and DER. This should facilitate and easy and cost effective connection of DER to vpp.

Germany	DE3	DE4
Was there a need to solve interoperability problems? If so how was this done?	Interoperability problems were addressed using a holistic approach from use cases over requirements, an integrated information model down to interfaces. Finally, defined integration tests are to assure interoperability.	We developed the ICT Gateway. This ICT Gateway translates the different protocols of the DER in a standard protocol (EN 61850)
Information sources (public domain)	http://www.modellstadt-mannheim.de/moma/web/en/home/index.html	www.regmodharz.de
Any other comments / observations		No

Table A.10 — Norway 1 – 2

Norway	NO1	NO2
Title	Smart Energy Hvaler	Demo Steinkjer
Country	Norway	Norway
Value (Euros)	4 M€	5 M€ (first stage)
Funding mechanism / Regulatory Arrangements	Expenses covered by utilities and industry partners in the Norwegian Smart Grid Centres. No special regulatory incentives	Expenses covered by utilities and industry partners in the Norwegian Smart Grid Centres. No special regulatory incentives
Scope (Brief description)	Develop a Smart Grid infrastructure to test and verify technologies and business models for mainly: • Improved monitoring and management of distribution systems including quality of supply management – especially interruptions • Reduction of losses in electricity distribution through peak load management • Improved management of DG (micro generation)	Develop a Smart Grid infrastructure to test and verify technologies and business models for mainly: • Improved end user market participation (demand response) • Improved management of DG • Improved management of distribution systems including quality of supply management
Selection criteria and Objectives (learning outcomes)	The particular location was chosen as the site for the Smart Grid project for two main reasons: The distribution area is challenging from a reliability point of view with limited redundancy and many weather induced faults. The local DNO had to replace approx. 40 % of the energy meters on the Hvaler islands and thus used the opportunity to introduce smart meters. The main learning objectives are to evaluate use cases and technologies contributing to the overall objectives of the project in order to develop robust strategies for Smart Grid development. The pilot project is an open learning arena available for all Norwegian stakeholders.	The particular location was chosen as the site for the Smart Grid project for as the local utility offered the site to the Norwegian Smart Grid Centre as a national demo site. This implies that results from the different tasks in the project are open to all interested parties. The expected learning outcome is as in the Smart Energy Hvaler project: To evaluate use cases and technologies contributing to the overall objectives of the project in order to develop robust strategies for Smart Grid development.
Timetable (Start and Finish)	Start: 2011 Finish: 2016	Start: 2011 Finish: 2020

Norway	NO1	NO2
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Permanent installation of smart meters.	Permanent installation of smart meters.
Current status and results	Project plan for smart meter roll out established. Smart meters ordered. Main roll out summer 2011	Project plan for stage 1 developed
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	Main stakeholders are DNOs , network users (customers) ICT suppliers, equipment manufacturers. The regulator is also involved.	Main stakeholders are DNOs , network users (customers) ICT suppliers, equipment manufacturers. The regulator is also involved.
Generation	No DG in the supply area at present. However, there are plans for some distributed wind power and some PV.	1 small hydro power plant (2 x 4 MW) A few small thermal plants for heat generation (1MW and 400 kW) will run in parallel with the electricity system, but without any electricity generation.
Network	MV (18 kV) / LV (230 V) Rural Mostly MV/LV overhead lines with some LV underground feeders	MV (22 kV) / LV (230 V) Semirural Mixed overhead and underground
Demand	Mostly passive loads.	Mostly passive loads, but some smart house investments are planned. Heat pumps for space heating are present in the area and might increase. A few electric vehicles are present in the supply area, but more are expected.
Customers	6 700 customers of which a large part is holiday houses. All will be equipped with smart meters. Different customer engagement products will be investigated as well as different business models.	4 500 customers – 770 customers in stage 1 of which 700 are households. All will be equipped with smart meters. Different customer engagement products will be investigated as well as different business models.
Communications	Radio communication to distribution substations concentrators for monitoring, information exchange and controls.	Fibre optics communication with smart meters and distribution substations for monitoring, information exchange and controls. Data security / privacy Issues will be addressed.
Storage	None	None

Norway	NO1	NO2
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	No experience yet	No experience yet
Was there a need to solve interoperability problems? If so how was this done?	No experience yet	No experience yet
Information sources (public domain)	www.SmartEnergiHvaler.no (Active from September 2011)	A Norwegian web-page for information exchange with customers affected by the pilot is under construction
Any other comments / observations		

Table A.11 — Spain 1 – 3

Spain	ES1	ES2	ES3
Title	Bidelek Sareak Project	STAR PROJECT - CASTELLÓN	Smartcity Málaga
Country	Spain	Spain	Spain
Value (Euros)	Budget 60 M€	22 M€	31 M€
Funding mechanism / Regulatory Arrangements	Iberdrola and Vasc Government	Own resources	Technological Funding FEDER (2007-2013)
Scope (Brief description)	Focus on the following areas: • AMI system • Distribution Generation • Electrical Vehicle • MV Distribution Automation • Smart substations • Communications	Therefore, 175 000 clients will have this service, improving power supply quality by reducing incidences. To carry this out, IBERDROLA will renew over 100 000 counters currently at the service of its Clients. Furthermore, it will adapt the city’s transformer centres to render services remotely, perform readings of metering equipment, and manage registrations and cancellations or modifications to contracted power. The renovation of over 100 000 counters and the remodelling of the transformation centres in Castellón began in April 2010. The estimated completion date for these works is November of this same year.	Demonstration purposes. Technology implemented on field. "Living Lab" to test new technologies and services.
Selection criteria and Objectives (learning outcomes)	First Smart Grid large-scale project in Spain, area has been selected because different reasons (technical and politic issues). Main goals are: • Large-scale AMI system (mandatory). • Test new protection systems for PV plants. • Large-scale distribution automation sub-project (reduce OPEX, improve power quality, increase measuring accuracy and efficiency are expected). MV visibility.	Long term goals: Enhanced supply quality and energy efficiency	An improvement of 20 % in energy efficiency, an increase of 20 % in renewable sources, and a decrease of 20 % in CO_2 emissions.

Spain	**ES1**	**ES2**	**ES3**
	• Consumer engagement/customers behaviour. • Validate previous data for small-scale projects. • Check interoperability and validate new architecture.		
Timetable (Start and Finish)	Start: End of 2011 (3 years)	April 2010 – November 2010	2009-2012
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Project will be permanent installation.	permanent	Permanent installation.
Current status and results	Working on the legal process to set-up the AIE (legal entity to be responsible for the 3-year project)	New areas added to the project (phase 2)	13 MW minigeneration (MV), 33 kW microgeneration (LV), 72 secondary substations communicated by BPL Communications, 22 automated secondary substations, more than 6 000 smart meters installed, 5 buildings with energy efficiency solutions (7 in process), 2 charging posts, 34 replaced streetlights (69 in process), energy efficiency solutions developed for residential users in progress, 28 streetlights with generation facilities included (in process).
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	*DNO:* Iberdrola *Funding:* Vasc Government and BBK (Vasc Bank) *Suppliers:* Different manufacturers, local and international companies. • Local companies: Arteche, ZIV, Ingeteam, Ormazabal, Mesa, Incoesa, Zigor, Altel . • International companies: Siemens and GE.	DNO: Iberdrola Distribución Suppliers: Local suppliers (Ormazabal, ZIV, Arteche,….)	Endesa, Enel, Acciona, Isotrol, IBM, Ingeteam, GreenPowerTech, Neometrics, Ormazabal, Sadiel, Telvent.

Spain	ES1	ES2	ES3
	Technology institutes: Tecnalia R&D *Engineering companies:* Iberinco (Iberdrola's engineering company)		
Generation	Distribution Generation is going to be one of the sub-projects. Goal: Develop of a new protection scheme for anti-islanding detection. 6 PV plants will be used for the validation phase. Size is undefined yet.	None	Low voltage distributed photovoltaic and micro wind generators (33 kW), medium voltage tricogeneration and cogeneration (13 MW).
Network	*Smart substations:* 2 MV (30/13 kV) substations will be upgrade with the last technology available and one will be built with a new substation container concept. *Distribution automation:* 1 100 transformer stations are going to be update with latest remote monitoring and control systems. Rural and urban areas, underground and overhead lines will be included into the project.	LV Urban Mostly underground	Medium and Low voltage grids. Urban and underground, located in the front coast district of the city of Malaga, Spain. Automation of existing MT network (new secondary substations with capacity for automation, monitoring and communications). 5 MV lines (20 kV), with 38 km of circuits. 72 transformers MV/LV.
Demand	*Demand response system* is under discussion, final technology is not defined yet. Smart appliances could be into the scope of supply into a demo centre (not confirmed yet).	Some demand response features (e.g. Load shedding, TOU,…) have been tested during the project.	Smart Energy Management (Energy management systems via Internet, active demand management in homes and small business, efficient street lighting), Smart Buildings, Smart Mobility (electric vehicles).
Customers	230 000 domestic customers (410 000 citizens). Smart meters will be used.	175 000 clients Smart meters	6 000 smart meters installed, more in process. 300 industrial customers, 900 services customers and 12 000 household costumers, with 63 MW of contracted power and 70 GWh per year of energy demand. High acceptance of the project, with a lot of participants in the energy efficiency experience.

Spain	ES1	ES2	ES3
Communications	PLC over PRIME (1.3E) and DLMS COSEM will be used for the communications between the smart meters and the concentrators. EN 60870-5-104 communication protocol will be used for the communication between the RTU and level 1 (central systems). For the measuring acquisition, data will be encrypted according to AES 128.	PLC over PRIME (1.3E) and DLMS COSEM will be used for the communications between the smart meters and the concentrators. EN 60870-5-104 communication protocol will be used for the communication between the RTU and level 1 (central systems).	Real-time IP networks, providing: AMI (Advanced Meter Infrastructure) ADA (Advanced Distribution Automation) DER (Distributed Energy Resources) Based on BPL Communication and WiMax
Storage	No storage system into scope of supply.	None	Installation of 200 kW in MV and 20 kW in LV (in process), using Magnesium-Iron-Lithium batteries of 1,76 kWh.
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	International and utility standards (Iberdola requirements) will support the development of this project. No new standards are needed.	International and utility standards (Iberdola requirements) will support the development of this project. No new standards are needed.	There is an important need of new standards and a regulatory background to include most of these devices in a current grid
Was there a need to solve interoperability problems? If so how was this done?	Different equipment from different manufacturers will be installed, interoperability test will be perform during develop of this project.	Unknown.	No, there wasn't
Information sources (public domain)	http://www.eve.es/Noticias/El-Gobierno-Vasco-e-Iberdrola-invertiran-60-millon.aspx?lang=en-GB	https://www.iberdrola.es/webibd/corporativa/iberdrola?cambioIdioma=ESWEBREDDISREDINTCST	http://www.smartcitymalaga.com
Any other comments / observations			Control and Monitoring Centre located in Malaga, and available to visit.

Table A.12 — United Kingdom 1 – 3

United Kingdom	**UK1**	**UK2**	**UK3**
Title	Ashton Hayes Smart Village	Customer Led Network Revolution	Low Carbon London – A Learning Journey
Country	UK DNO = Scottish Power	UK DNO = Northern Powergrid	UK DNO = UK Power Networks
Value (Euros)	200 000 €	53,6 M£	36,06 M£
Funding mechanism / Regulatory Arrangements	LCNF Tier 1 (Part of the regulatory regime DPCR 5 for UK DNOs, See Ofgem website for details)	External Funding = 23,3 M£ DNO Compulsory contribution = 3,5 M£ Second Tier Funding – Ofgem Low Carbon Network Fund = 26,8 M£	External Funding = 6,17 M£ DNO Extra Contribution = 1,60 M£ DNO Compulsory Contribution = 3,00 M£ Second Tier Funding = 24,26 M£
Scope (Brief description)	The objectives of the Smart Village Project are on technical innovation and delivery of information to the community aimed at achieving a sustained reduction in carbon emissions. The scope of the Smart Village Project is: • To facilitate the connection of various micro generation technologies (wind, PV and CHP) and potentially electric vehicle (EV) charging point(s) on the LV network and its 11 kV feeders. • Engagement with the village and community to assist in the reduction and optimisation of total energy consumption to reduce carbon footprint. • To improve the accuracy and granularity of total electricity consumption measurement by installing additional metering on the network at secondary sub station feeder level and at renewable energy source(s) providing measurement of the gross generation embedded within the community.	This project explores how new tariffs can encourage customers to be more flexible in their use of electricity. For example, changing the times at which they charge up their electric vehicles, to fit periods of lower demand. It will demonstrate how networks can respond more flexibly to customers' needs by using more advanced voltage control devices, real time thermal rating and energy storage. The project uses the data collected to consider how new technology and changes in customer behaviour could help optimise value across the energy supply chain. **The problem**: The move to a low-carbon economy, in particular the growth in low carbon technologies (LCTs), will place additional strain on electricity distribution networks. If innovative solutions are not found, this will require significant extra network investment and could delay the take-up of LCTs. **The solution**: The network costs associated with mass uptake of LCTs could be significantly reduced, and delivery accelerated, by using a combination of:	The project Implements new tariffs, in conjunction with energy retailers, for electric vehicle charging points for people who want to charge their cars away from home. Works on the back of Transport for London is Plugged in Places scheme, which will roll out 25 000 electric vehicle charging points by 2015, supporting 100 000 electric vehicles. Low Carbon London will develop a new approach to distribution network management to meet growing demand from emerging low carbon technologies such as electric vehicles, heat pumps and distributed generation. It will focus on carbon reduction targets and the need to reduce dependency on conventional reinforcement. This project brings together a partnership of leading industry specialists to emulate the 2020 end-to-end electricity supply chain. It implements solutions to improve the overall efficiency of the distribution network. It maximises the capability of the network, and also the end-to-end electricity supply chain, to facilitate new low carbon initiatives such as wider use of decentralised generation and electricity for personal transport and home

United Kingdom	UK1	UK2	UK3
	• To introduce innovative and new techniques to introduce DSM capabilities aimed at assisting change in energy use related behaviours within residential homes and public properties.	• new network technologies; and • flexible customer response from both demand and generation. This will only happen if new commercial arrangements between suppliers, DNOs and customers are developed. **The method:** While network management and demand response technologies exist and are well documented, they have not been deployed at distribution level in a market with the degree of vertical separation of Great Britain (GB). This project will provide the knowledge and experience to bridge this gap. **The project:** The project leverages the strengths and expertise of the project partners. Through British Gas's industry-leading smart meter programme (currently extending to 110 000 meters and set to rise to 2 million by the end of 2012) the partners will engage with a range of domestic customers, both with and without LCTs, as well as industrial and commercial customers who have generation and controllable load.	heating, and a higher contribution from centralised wind generation.
Selection criteria and Objectives (learning outcomes)	• Working in collaboration with the community and stakeholders for the common benefits of the village, industry and the UK. • Near real time monitoring of the LV network to provide information to the community and DNO for analysis and design. • Installation and integration of a variety of low carbon technologies on the LV network in rural villages. • Analysis and optimisation of power flows on the LV network to minimise energy	**Outcomes.** The project is based on the generation of five specific learning outcomes. To achieve each learning outcome the DNO has designed a series of trials each of which examines a discrete combination of customer propositions and network technologies. • **Learning Outcome 1 (LO1):** What are current, emerging and possible future customer (load and generation) characteristics?	The project will generate new learning in the following areas: • How customers respond to energy efficiency measures, and to commercial and technological innovation; • How embracing commercial and technological innovation will impact the network operators and their processes; • How best to integrate demand response, distributed generation and emerging technologies into the development and operation of future distribution networks.

United Kingdom	UK1	UK2	UK3
	consumption.	• **Learning Outcome 2 (LO2):** To what extent are customers flexible in their load and generation, and what is the cost of this flexibility? • **Learning Outcome 3 (LO3):** To what extent is the network flexible and what is the cost of this flexibility? • **Learning Outcome 4 (LO4):** What is the optimum solution to resolve network constraints driven by the transition to a low carbon economy? • **Learning Outcome 5 (LO5):** What are the most effective means to deliver optimal solutions between customer, supplier and distributor?	A dedicated „Learning Laboratory at Imperial College London will capture the learning. It will create an interactive learning experience around how to plan, develop and operate an efficient low carbon distribution system. Other DNOs and parties will have access to this experience throughout the project. We will also seek to incorporate the experiences of the other DNO projects. The Learning Laboratory will produce a selection of reports.
Timetable (Start and Finish)	11th Sept 2010- 1 October 2013	January 2011 – December 2013	January 2011 – June 2014
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Monitoring equipment will be removed. The connections of DG and the electric vehicle will stay in place.	Trial The main network technology solutions being trialled are EAVC, Real Time Thermal Rating (RTTR) and network storage.	Trial Low Carbon London incorporates a co-ordinated suite of interdependent trials based on detailed Use Case Analyses involving National Grid; suppliers; aggregators; residential and I&C customers; electric vehicles (and charging infrastructure); distributed and micro-generation; and the impact on the distribution network of intermittent centralised wind generation. This project will involve real customers. It will not only test the impact of new carbon technologies, but also how customers use these technologies and how willing they are to engage with new commercial incentives.

United Kingdom	UK1	UK2	UK3
Current status and results	Monitoring equipment in the process of being installed. Electric vehicle, charging point and one PV unit installed.	Ongoing	04/01/2011 - Project start (based on Ofgem awarding the contract in December 2010). 04/04/2011 - First industrial & commercial contract in place. 08/07/11 - Learning Laboratory set up complete and ready to start trials analysis work.
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• DNOs • EA Technology • Embedded monitoring systems suppliers • Ashton Hayes Community • Ofgem • EV charger manufacturers • PV installers	• Northern Powergrid • British Gas • Durham University • EA Technology • Sustainability First • National Energy Action	Sainsbury's; Siemens; Imperial College; EDF Energy Customers Plc ; Logica; SmarterGrid Solutions; Greater London Authority; London Development Agency; EnerNOC; Flexitricity; Transport for London; National Grid; Lower Lea Valley Smart Buildings Project; Logica; RWE npower; Institute for Sustainability
Generation	10 kW PV. 15 kW PV. Wind and CHP planned	General, heat pumps (HP), photovoltaics (PV), CHP, electric vehicles (EVs	
Network	Rural LV mixture of cable, overhead (bare wire and ABC)	There are two locations in this trial. The first is likely to be located at Denwick, Northumberland which is a 20 kV network serving a sparse rural area, with a load curve dominated by storage heating and a consumption peak after midnight. The second is likely to be located at Rise Carr, Teesside which is a 6 kV dense urban network, with a classic mixed load curve and an early evening peak.	11 kV/400/230 V Urban Underground

United Kingdom	UK1	UK2	UK3
Demand	Studying existing load to disaggregate and understand how DSM could be applied to benefit the DNO. Plans to monitor and control an air source heat pump and electric vehicle charger.	Will monitor 600 intelligent white goods such as fridges Heat pumps (HP) ca. 1 500, photovoltaics (PV) ca. 800, CHP ca. 20, electric vehicles (EVs) ca. 150	Controlled None Heat Pumps, Electric Vehicles
Customers	370 households (1 000 inhabitants). Passive meters. Major engagement exercise.	Monitors 14 000 customers with smart meters, working on the back of British Gas' early roll out of smart meters in the area; as well as 2 250 small commercial customers; 14 000 industrial/commercial customers; 250 merchant generators.	The project will include at least 5 000 residential customers and 60 Industrial & Commercial customers (with their consent) through efficiency measures, Time Of Use tariffs, and responsive demand contracts. Distributed generation operators will be impacted (with their consent) where opportunities for active network management of dispatchable distributed generation and/or network capacity support services (e.g. ER P2/6 DG contribution) can be made available. Smart Metering Yes
Communications	Village meeting, focus groups, newsletters, website and through primary school. Published data amalgamated and anonymous.	Trial will include new communication channels between smart meters and network controllers and integration of enhanced voltage control and real time thermal rating devices with SCADA, with suppliers "demand response systems, and directly with end-users" plant controls.	The project includes an active network management system with half hourly inputs from at least 5 000 smart meters, marshalled through a head end solution; and an operational data store (with complex event processing integrated with an existing network management system)
Storage	None	1 off large electrical energy storage ca. 2,5 MW/ 2 MWh 2 off medium electric energy storage ca. 100 kW / 200 kWh 3 off small electrical energy storage ca. 50 kW / 100 kWh For voltage support, thermal rating support	None in this project

United Kingdom	UK1	UK2	UK3
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	15 kW of PV will be connected with an ‘enhanced G83’ application. G83 is a ‘fit and inform’ process for DG under 12 kW using factory tested protection. Based on the fact that the export is likely to be small, a G83 application has been accepted with slightly altered protection settings. These aim to prevent voltage rise but avoid nuisance tripping from faults elsewhere on the network.	Too early to determine	To early to determine
Was there a need to solve interoperability problems? If so how was this done?	No	Too early to determine	The project will identify these issues as the trials progress
Information sources (public domain)	http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/ftp/Pages/ftp.aspx http://www.goingcarbonneutral.co.uk/	Ofgem Web-site http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/stlcnp/Pages/stp.aspx	Ofgem web-site http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/stlcnp/Pages/stp.aspx
Any other comments / observations	Significant learning can be achieved by engaging in detail on a small scale however for the results to be rolled out they will need to be trialled in other contexts.	This project is in its very early stage of deployment	This project is in its very early stage of deployment

Table A.13 — United Kingdom 4 – 6

United Kingdom	UK4	UK5	UK6
Title	Low Carbon Hub - Optimising renewable energy resources in Lincolnshire	LV Network Templates for a Low-carbon Future’	Northern Isles New Energy Solutions (NINES)
Country	UK DNO = Western Power Distribution (WPD)	UK DNO = Western Power Distribution (WPD)	UK DNO = Scottish and Southern Energy (SSE)
Value (Euros)	3,5 M£	9,0 M£	51 M£
Funding mechanism / Regulatory Arrangements	External Collaboration = 30 000 £ DNO Compulsory Contribution = 349 829 £ Second Tier Funding (Ofgem) = 2 837 629 £	External Funding = 56 000 £ DNO Compulsory Contribution = 896 125 £ Second Tier Funding (Ofgem) = 7 847 579 £	Project partners will provide 45 % of the overall project cost of 51,6 M£. Our financing partners include a local authority, two charities, a housing association, two academic institutions and six private sector companies inclusive of SHEPD [Scottish Hydro Electric Power Distribution, part of SSE group] and, importantly, National Grid. The partnership has also applied for European Regional Development Funding and has secured finance from DECC’s Smart Grid Demonstration Grant Programme to complement LCNF.
Scope (Brief description)	The Low Carbon Hub solution will develop a distribution network optimised for demand and generation whilst demonstrating solutions to some of the network limitations. The project will connect up to 110 MW of additional distributed generation. The Low Carbon Hub has six project components and these will be trialled together as outlined below: 1. **Network enhancements** – Sections of existing overhead lines will be upgraded within the demonstration area with higher rated conductors to increase the network’s capacity to connect DG.	The project will give WPD a view of the power flows and voltages of the LV network in South Wales, together with visibility of impacts arising from Welsh Assembly Government (WAG) low-carbon initiatives covering some 3 000 homes, and including 1 000 PV installations. The project will compare non-stressed and stressed network locations, and thereby measure the impact of these low-carbon stresses. The project will also present National Grid with the ‘hidden’ generation available in the monitored areas, which will provide the ability to contribute to network efficiency and reduce the need for high-carbon spinning reserve generation. From the project data, Bath University will create a number of reusable network	The project will take place in the Northern Isles of Scotland, the largest groups of which are Shetland and Orkney. Phase 1 of the project will take place across the Shetland electrical network. The NINES project involves: Installing a 1 MW battery, part-funded by DECC, at the existing diesel power plant in Lerwick, to create Lerwick Hybrid Power Station, the largest of its type in the UK. Introducing domestic DSR with FR in 1 000 homes, by working with Shetland Islands Council and Hjaltland Housing Association to install advanced storage heating and water heating in 1 000 homes in

United Kingdom	UK4	UK5	UK6
	2. **New commercial agreements** – Innovative agreements will be negotiated with DG customers to optimise their output and mitigate network issues (e.g. to deliver reactive power service) using real time network measurements. 3. **Dynamic voltage control** – Building on the principles of an existing Innovation Funding Incentive (IFI) project, the 33 kV target voltage will be actively varied. This will be done dynamically based on real time measurements of demand and generation. 4. **33 kV active network ring** – The active ring allows increased control of the 33 kV system and network reconfiguration based on real time power flows. 5. **Flexible AC Transmission System (FACT) Device** – A Flexible AC Transmission system device will enable the DNO to control both network voltage and system harmonics of the active ring. This equipment is not normally deployed on Distribution networks for this purpose 6. **Dynamic system ratings** – The Skegness Registered Power Zone delivered innovative connections to offshore wind farms based on dynamic rating of overhead lines. This component will further develop the solution and test new techniques to calculate the network capacity and operating limits based on real time asset data.	templates, based on the ENA's templates, composed of varying characteristics about the nature of the network. Ultimately, with the aid of these templates, DNOs across the country will understand, without the need for early investment, further sensor deployment or reinforcement, the characteristics of the network and its varying capabilities to absorb low-carbon stresses and changes in demand, and thus, ultimately, streamline the connection of low-carbon generation. The data provided about the LV network, by this project, lies at the heart of all UK 'Smart Grid' endeavours. It should be the bedrock of every other Low Carbon Network Fund (LCNF) project, but only WPD offers such a statistically relevant trial, utilising existing and green-retrofitted properties and sites and building on £30m of existing investment by the Welsh Government, providing invaluable network template information to other DNOs to enable them to understand their networks better, easier and more cheaply.	Shetland by 2014, part funded by the European Regional Development Fund (ERDF). Introducing industrial scale demand side response, part funded by ERDF, by facilitating the connection of a 4 MW extension to Lerwick district heating system which will be supplied by the planned Gremista wind farm. Establishing new commercial arrangements for customers and generators, by working with several generators and potential providers of storage. Deploying an active network management (ANM) system which will provide fine control over the elements mentioned above and over the network as a whole to allow the DNO to manage it such that security of supply is maintained and the maximum possible amount of renewable energy can be accommodated on the Shetland system Developing network modelling and system forecasting tools. This work, which will resolve Shetlands frequency and network stability problems, will allow the DNO to facilitate connection of up to 10 MW of new generation, anticipated to be predominantly renewable, under new commercial arrangements linked to ANM.
Selection criteria and Objectives (learning outcomes)	The Low Carbon Hub will bring incremental learning in four key areas: • The hub network design is intended to offer more flexible operation that will allow more generator capacity to connect to a section of network at a lower cost of reinforcement. The project	The solution will enable 'visibility' of the LV network by installing over 8 000 voltage sensors and associated communications at over 1 000 distribution substations and over 7 000 selected 'feeder end' points (e.g. customer premises) in the South Wales area, in order to provide accurate information to assess the impacts of low-carbon stresses	the NINES project will generate high quality learning, clearly scalable to the GB System. A key aspect of NINES is the effective dissemination of the knowledge gained from the project to industry participants and other stakeholders, in particular DNOs.

United Kingdom	UK4	UK5	UK6
	will test the network design in terms of dynamic voltage control, network availability and level of losses. The results will influence network design into the future. • The use of a FACTS device in a distribution network will provide important learning in terms of both operational procedures and effectiveness. • The DNO and the generators that connect to the hub will develop commercial agreements that will be different to those traditionally held between DNOs and generators. The agreements will seek to optimise generator export in a way that will minimise network issues. • The project will deploy dynamic voltage control schemes and communications links to support network control and protection. The design of the voltage control schemes and the deployment of optic fibre and wireless communication links on wood pole overhead power lines will both require the development of technical specifications. It is likely that these specifications will form the basis of technical standards that can be adopted across the industry. The overall performance of the hub will be assessed by analysis of network data gathered by network transducers. An enhanced level of transducer coverage will give greater visibility of network performance, allowing comparison with modelled forecasts of network behaviour. This will allow robust conclusions on the effectiveness of control schemes and network devices. Learning about the	on the network. The project will directly involve in excess of 7 300 customers, and feature a number of partners and local housing initiatives in South Wales; the span of the network involved in the study encompasses 10 % of the South Wales population. These sites/customers have been selected because of their proximity to existing and future Welsh Assembly Government ‘Arbed’ sites, and npower’s Community Energy Saving Programme (CESP) and Carbon Emissions Reduction Target (CERT) customers, in parallel with sites that do not have a quantity of low-carbon stresses. Critically, this project is being undertaken on an existing network – vital when we consider that the majority of low-carbon impacts will not be on new network build. The monitoring equipment will also collect and provide data to NG on the quantity, availability and characteristics of the microgeneration operating on the LV network in the South Wales area, to demonstrate the feasibility of improving their load forecasting and generation scheduling. Bath University will analyse the data in order to evaluate network characteristics that will allow alignment of the network to the pre-agreed ‘network templates’. These templates form a significant part of the project, and are designed to drive benefits across GB network operators. Utilising this broad sensing array deployed by WPD on the LV network in South Wales will generate a number of templates that can be applied to the design of infrastructure across all networks, thereby avoiding or substantially reducing the need for further trials and evaluations in other regions and by other DNOs, and accelerate the facilitation of	

United Kingdom	UK4	UK5	UK6
	installation of equipment will be captured in method statements, specifications and technical standards. Commercial arrangements will be trialled and best practice will be proposed in agreement templates.	renewable generation and other low-carbon stresses network-wide. Finally, the results, and the templates, will be disseminated to Ofgem and other DNOs through the mandated channels.	
Timetable (Start and Finish)	02/2011 – 02/2015	01/2011 – 7/2013	2011-2014
Is this project intended to be a permanent installation or is it only a trial where the equipment will be removed upon completion?	Part permanent Installation Part Trial i.e., FACT device. This equipment is not normally deployed on Distribution networks	Permanent – It is proposed to leave the equipment in situ for future network improvements	Permanent
Current status and results	Hosted a workshop with distributed generators interested in connecting to the Low Carbon Hub. Dissemination to other GB DNOs and IDNOs of design recommendations for connecting optical fibres and wireless links to new and existing wood pole overhead power lines	7 January 2011 - Monitor fitters sourced and contract signed. 25 March 2011 - Monitor fitters trained and ready to deploy. 1 April 2011 - All internal teams ready to support project, and commence sending customer letters. 11 April 2011 - Receive first batch of monitoring equipment	09/2011 Initial Active Network Management (ANM) scheme commissioned for 1 MW battery installation: facilitates connection of additional 300 kW – 400 kW of small-scale community-based renewable generation.
Stakeholders (e.g. DNOs, Suppliers, Generators, Equipment manufacturers, Regulators, Customers …)	• Network Operators • FACTs – WPD has approached two market leaders with the capability of providing a solution • Generators • Regulators	• RWE npower • The University of Bath • Bristol University • Welsh Assembly Government's (WAG) and the Arbed scheme	A local authority, two charities, a housing association, two academic institutions and six private sector companies inclusive of SSE and, importantly, National Grid. Customers Manufacturers Regulators. Shetland Heat Energy and Power Limited, Glen Dimplex. Smarter Grid Solutions Ltd, Hjaltland Housing Association Ltd, Highlands and Islands Enterprise, Scottish Government
Generation	Various	Not applicable to this project	10 MW of new renewable generation, including the 6,9 MW Gremista wind farm installing a 1 MW battery, introducing domestic DSR with FR in

United Kingdom	UK4	UK5	UK6
			1 000 homes, connection of a 4 MW extension to Shetland Heat and Power's Lerwick district heating system
Network	33kV Rural Overhead	11 kV/400/230 V, mixed overhead & underground Major urban retail, commercial, campus / government, major urban high density, urban commuter belt, large town, smaller town, and rural/agricultural hamlets	• Voltage level(s): LV/MV • Urban / rural: Rural • Underground / overhead: Both
Demand	Passive	Not applicable to this project	• Introducing domestic DSR with FR in 1 000 homes • Introducing industrial scale demand side response • Facilitate connection of up to 10 MW of new generation
Customers	This project relates to the direct connection of distributed generation.	excess of 7 300 customers Yes	1 000 Smart Practicable engagement with customers
Communications	The project will deploy dynamic voltage control schemes and communications links to support network control and protection. The design of the voltage control schemes and the deployment of optic fibre and wireless communication links on wood pole overhead power lines will both require the development of technical specifications. It is likely that these specifications will form the basis of technical standards that can be adopted across the industry.	The solution will enable 'visibility' of the LV network by installing over 8 000 voltage sensors and associated communications at over 1 000 distribution substations and over 7 000 selected 'feeder end' points (e.g. customer premises) in the South Wales area, in order to provide accurate information to assess the impacts of low-carbon stresses on the network	Frequency Response

United Kingdom	UK4	UK5	UK6
Storage	None	Not applicable	Installing domestic Demand Side Response (DSR) with Frequency Response (FR) in up to 1 000 homes in the form of more efficient storage heaters and water tanks with enhanced storage capabilities to help network stability Installation of a 1 MW storage battery.
Sufficiency of existing Standards, i.e. are the existing standards sufficient to support the development or is there a need for new standards?	In this project the existing standards are sufficient although there may be a need to develop industry technical specifications	Existing standards should be sufficient for the needs of this project.	Has not stopped the project or been identified as an issue
Was there a need to solve interoperability problems? If so how was this done?	No	No	None
Information sources (public domain)	Ofgem Web Site http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/stlcnp/Pages/stp.aspx	Ofgem http://www.ofgem.gov.uk/Networks/ElecDist/lcnf/stlcnp/Pages/stp.aspx	Public Domain
Any other comments / observations	This project is in its very early stage of deployment	This project is in its very early stage of deployment and will take 3 years to complete.	

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[5] EN 61968-11, *Application integration at electric utilities — System interfaces for distribution management — Part 11: Common information model (CIM) extensions for distribution (IEC 61968-11)*

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